Dollar Trinity and Global Co-movement*

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Abstract

Economic activity, trade, and asset prices co-move strongly across countries, giving rise to a global business cycle, a global financial cycle, and a global trade cycle that are themselves tightly synchronized. We document this co-movement and establish its link to the US dollar: the dollar systematically appreciates when the global cycles contract. We develop a structural two-country model of the world economy centered on "dollar trinity": the dollar's dominance in safe assets, cross-border financial contracts, and trade invoicing. The three dimensions of dollar dominance interact and are essential for generating global co-movement. We also use the model to study how an erosion of the dollar's safe-asset status affects global imbalances and economic activity.

Keywords: Dollar dominance, dominant currency paradigm, safe asset, convenience yield, international co-movement, liberation day, global imbalances
JEL-Classification: F31, F42, F44

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"The owl of Minerva spreads its wings only with the falling of dusk."
(G.W.F. Hegel, 1821)

1 Introduction

Three distinct forms of co-movement characterize the world economy. First, business cycles, financial conditions, and trade flows move closely together across countries, giving rise to global cycles. Second, the global business cycle, the global financial cycle, and the global trade cycle are themselves highly synchronized. Third, and perhaps most strikingly, these global cycles are closely intertwined with the US dollar: the dollar tends to appreciate when these cycles contract. In a perfectly symmetric world, exchange rates would not move when economic conditions across countries change in a synchronized manner. Alas, the world economy is not symmetric, and the dollar occupies a special position.

This raises the question of whether, and if so how, the dollar shapes international co-movement across countries and across economic cycles. We address this question in the present paper, at a time when the dollar's special status in the world economy is increasingly contested. The irony, as suggested by Hegel's observation cited above, is that the prevailing status quo—the workings of the world economy since the end of Bretton Woods—may be best understood precisely when it may already be unraveling (Bianchi & Sosa-Padilla 2025; Jiang, Richmond, & Zhang 2025; Jiang, Krishnamurthy, et al. 2025).

We proceed in three steps. First, we present unconditional evidence on global co-movement, focusing on the US and an aggregate of the rest of the world, or RoW for short. Second, we estimate a time-series model to study the dynamic adjustment of the US and RoW economies, the three global cycles and the dollar to US shocks: a main business-cycle shock, a monetary policy shock, and a risk shock. We uncover a propagation mechanism that is common across shocks: the adjustment features strong co-movement across countries, across cycles, and between the cycles and the dollar. Third, we develop a structural, fundamentally asymmetric model of the world economy centered on the dollar. The dollar is dominant in trade invoicing and international credit, and US Treasuries are the global safe asset: there is a "dollar trinity." The calibrated model replicates global co-movement, both unconditionally and conditionally on the identified shocks. We show that the interaction among the three dimensions of dollar dominance is key: dollar trinity is more than the sum of its parts. Finally, we simulate the dollar's demise as a safe-haven currency to provide an account of financial market developments following the April 2025-"Liberation Day" announcement.

In our empirical analysis, we rely on time-series data for the US and the RoW, spanning the 35-year heyday period of global dollar dominance from 1990 to 2024. The dataset includes measures of economic activity, interest rates, exchange rates, and the three global cycles. The global factor in risky asset prices, computed by Miranda-Agrippino & Rey (2020), serves as an indicator of the global financial cycle. Changes in global exports relative to GDP capture the global trade cycle, and changes in world GDP reflect the global business cycle. We first establish the three distinct forms of co-movement—across countries, across cycles, and with the US dollar—based on simple correlations. While these unconditional moments are suggestive of a specific role for the dollar, they do not identify the underlying propagation mechanism.

We therefore study the dynamic adjustment to identified US shocks, which allows us to assess whether co-movement across countries, across global cycles, and with the dollar can be traced back to the same underlying forces. Specifically, we estimate a Bayesian VAR model on time-series data for the US and the RoW and study the co-movement triggered by the main business-cycle shock originating in the US, using the approach of Angeletos et al. (2020).[1] The main business-cycle shock is identified as the linear combination of VAR residuals that accounts for the largest share of the volatility of US real activity over business-cycle frequencies. Working with this reduced-form object has the advantage that we can remain agnostic about the specific structural driver of US business-cycle fluctuations while still characterizing their global propagation. We find that the US main business-cycle shock induces a synchronized downturn in the US and the RoW, a synchronized contraction of the global cycles, and an appreciation of the US dollar. It also explains a sizable share of global fluctuations: roughly one fifth to one quarter of the variance of the three global cycles, and about one quarter to one third of their unconditional co-movement.

We move beyond the reduced-form evidence and turn to structural shocks that can be reasonably well identified in a proxy-VAR setting. Specifically, we identify US monetary policy and risk shocks using high-frequency surprises around Federal Reserve policy announcements and US risk events as external instruments. We find that these shocks generate essentially the same pattern of global co-movement as the US main business-cycle shock—across countries, across cycles, and with the dollar. This suggests that the reduced-form propagation pattern is not specific to a particular shock, but reflects a robust feature of the global transmission mechanism. At the same time, the identified shocks have a structural interpretation that maps directly into our model-based analysis.

[1] Chahrour et al. (2024) apply the approach to exchange rates, establishing that the "main exchange rate shock" is a dominant driver of exchange-rate fluctuations.

Our structural analysis is based on the "trinity model" of the world economy, which we develop to account for the dollar's central role in trade, finance, and safe-asset demand. The model features two countries, representing the US and the RoW, and is fundamentally asymmetric owing to the dollar's dominance along three dimensions, each of which has featured prominently in earlier work. First, cross-border credit is denominated in dollars (Bocola & Lorenzoni 2020; Eren & Malamud 2022). Financial intermediaries in the RoW fund themselves partly through cross-border dollar loans from the US, but do not lend to the US in their own currency (Aoki et al. 2020). Lending decisions of financial intermediaries in the US depend on the riskiness of their borrowers in the RoW. Second, US Treasuries are assumed to be safe assets (He et al. 2019; Coppola et al. 2023; Pflueger & Yared 2024). Holding US Treasuries loosens the leverage constraint of RoW financial intermediaries. Finally, the dollar is widely used as a vehicle currency in global trade (Rey 2001; Devereux & Shi 2013; Mukhin 2022).

We calibrate the model to match key moments of the data and find that it performs well along several dimensions. In particular, the model's predictions for the untargeted propagation of US risk and monetary policy shocks closely align with the VAR evidence. Moreover, the model also matches untargeted unconditional moments of US and RoW variables, including global co-movement across countries and cycles.

Dollar dominance in cross-border credit and safe assets drives a wedge in the uncovered interest parity (UIP) condition—a feature central to explaining major exchange-rate puzzles (Itskhoki & Mukhin 2021, 2025). In the trinity model, UIP deviations arise endogenously from intermediaries' leverage constraints. Extending the setup of Gabaix & Maggiori (2015), financial intermediaries relax constraints by holding Treasuries: UIP deviations reflect an endogenous convenience yield, consistent with Engel & Wu (2023). When global financial conditions tighten, Treasuries become more valuable in relaxing borrowing constraints, the convenience yield rises, and the dollar appreciates.

The fundamental asymmetry implied by dollar trinity is crucial for the model's empirical success. To see why, consider a US risk shock that tightens US banks' leverage constraints, reduces cross-border dollar credit, and raises credit spreads. Through the convenience-yield channel described above, the dollar appreciates. Because cross-border credit is denominated in dollars, this appreciation raises the local-currency value of RoW dollar liabilities, tightens RoW balance sheets, and further reduces credit supply of RoW as well as US Banks. The resulting increase in credit spreads triggers additional dollar appreciation and financial tightening, giving rise to a global financial accelerator that adds an international dimension to the mechanism in Akinci & Queralto (2024). Global trade contracts because trade prices are sticky in dollars and expenditure switches toward domestically produced goods. In short, safe-asset dominance is crucial for the dollar to appreciate; dollar credit dominance makes dollar appreciation recessionary; and dollar invoicing explains why global trade contracts when the dollar appreciates.

But dollar trinity is more than the sum of its parts. The effects of an increase in investor risk aversion hinge on the dollar being both the currency of safe assets and the currency of international credit. If cross-border credit were denominated in dollars but dollar assets were not particularly safe, there would be no convenience-yield channel and hence no dollar appreciation. Cross-border dollar credit would then not, on its own, amplify the shock through a global financial accelerator. Likewise, if dollar assets were particularly safe but financial intermediaries did not hold dollar liabilities, the dollar appreciation induced by the convenience-yield channel would not trigger the same balance-sheet amplification. Finally, without dollar-priced trade, global trade would not move in tandem with the dollar. The global financial, trade, and business cycles can therefore be understood as manifestations of a "global dollar cycle" (Obstfeld & Zhou 2022).

Given the empirical success of the model, we also use it to shed light on the effects of the Liberation Day announcement in April 2025. We capture a key aspect of the episode by simulating a decline in the dollar's safe-asset status, motivated by the fact that the dollar depreciated despite heightened global uncertainty. The experiment illustrates how a weakening of this dimension of dollar dominance can lead to a simultaneous depreciation of the dollar and an increase in the implied long-term interest rate, reflecting a persistent decline in the dollar's convenience yield. At the same time, economic activity contracts globally, reversing the usual co-movement with the dollar. We also find that the US external balance improves, even though we do not assume any change in tariffs; the increase in the external balance—whether intended or not—simply reflects capital outflows from the US.[2]

The paper is structured as follows. In the remainder of the introduction, we place the paper in the context of the literature and clarify its contribution. Section 2 introduces our data and establishes basic facts regarding global co-movement. Section 3 introduces the VAR model and presents results on the global transmission of US shocks. Section 4 outlines the trinity model. Section 5 discusses the

[2]For related analyses of the depreciation of the dollar around Liberation Day, see Itskhoki & Mukhin (2026), Acharya & Laarits (2026), Jiang et al. (2026), and Hassan et al. (2025).

calibration and assesses the model's quantitative performance. Section 6 runs a number of counterfactuals to understand the role of dollar trinity. Section 7 uses the model to shed light on the repercussions of the Liberation Day announcement and on how an erosion of the dollar's role as a safe-haven currency may play out. A final section concludes.

Related literature. In addition to the studies referenced above, our paper relates to several strands of the literature. First, it relates to work on the dollar as a global risk factor (Lustig et al. 2014; Verdelhan 2018), on global risk measures (Lilley et al. 2022; Hassan et al. 2024), and on the relationship between global risk, deviations from covered interest parity, the dollar, and cross-border credit (Avdjiev et al. 2019; Erik et al. 2020; Hofmann et al. 2020; Bianchi et al. 2021; Dao & Gourinchas 2025). Recent work by Ehlers et al. (2026) shows that dollar funding is key for synchronizing global house prices. Our analysis offers a structural interpretation of global co-movement—both through the lens of the VAR and the trinity model, respectively.[3]

Second, there is further model-based work on the special role of the dollar in the international monetary system (Gopinath et al. 2020; Akinci et al. 2024; Bacchetta et al. 2023; Cook & Patel 2023; Banerjee et al. 2016; Akinci et al. 2022; Hofmann et al. 2022; Kekre & Lenel 2024). While this line of work focuses on the implications of individual dimensions of dollar dominance, we highlight the implications of dollar trinity. Trinity also resolves the reserve-currency paradox of Maggiori (2017) and rationalizes the exorbitant privilege for the US in normal times as well as an exorbitant duty in crisis times (Gourinchas & Rey 2022). Other work explores how dollar dominance emerges in multiple dimensions due to complementarities in currency choice (Enders et al. 2018; Gopinath & Stein 2021; Chahrour & Valchev 2022; Bahaj & Reis 2026). We instead take dollar dominance as given and explore its implications for the global co-movement.

Third, a key feature of the trinity model is a balance-sheet constraint à la Gertler & Karadi (2011), recently employed in international business-cycle models (Hofmann et al. 2022; Bodenstein et al. 2023; Caldara et al. 2024). What sets our work apart is an endogenous balance-sheet-specific risk weight that gives rise to a global financial accelerator and, in turn, to global co-movement.

Fourth, the special status of US government debt on banks' balance sheets is central to closely related work by Devereux et al. (2023). In their model, as in ours, Treasuries carry a convenience yield because of their special role as

[3]In earlier work, we show that the dollar appreciates in response to global risk shocks and quantify the effects of this appreciation on the RoW (Georgiadis et al. 2024). The present paper differs by offering a model-based account of global co-movement.

collateral; this convenience yield emerges endogenously as a UIP wedge rather than being imposed as in Jiang et al. (2024). Our analysis differs, however, in that banks face not only a dollar-asset portfolio choice but also a dollar-liability choice. This additional margin gives rise to the global financial accelerator.[4]

2 Basic Facts

To set the stage for our analysis, this section provides details on our data set and establishes a number of basic facts regarding global co-movement.

2.1 Sample and Data

Our empirical analysis covers the period 1990–2024, the heyday of global dollar dominance. We use quarterly data for the unconditional facts in this section, so that the empirical moments map naturally into the calibrated model, in which one period corresponds to one quarter. For the time-series analysis in Section 3, by contrast, we estimate a monthly VAR. The higher frequency improves identification, in particular for US monetary policy and risk shocks, which rely on high-frequency external instruments.

Throughout the analysis, we treat the world economy as consisting of two blocks: the US and the rest of the world, or RoW. This split mirrors the structure of the model developed below and allows us to study co-movement across countries, across global cycles, and with the US dollar in a unified framework.

The construction of the RoW aggregate varies across empirical exercises. Our guiding principle is to use the broadest possible country coverage for each statistic, subject to data availability and comparability. The US and RoW blocks are not fully symmetric in the VAR, however. The VAR is designed from a US perspective because the shocks we identify originate in the US, where we can draw on established measures and identification strategies for monetary policy, risk, and business-cycle shocks. Accordingly, the US block includes variables that are standard in US monetary VARs, while the RoW block is chosen to capture the global transmission of these shocks as broadly as possible.

We complement the US and RoW variables with three measures of global cycles: the global factor in risky asset prices of Miranda-Agrippino & Rey (2020),

[4]This additional margin allows us to distinguish between *gross* and *net* financial flows, thereby breaking the tight link between the country's current account identity and banks' equilibrium foreign currency positions, usually present in models that purely focus on net flows. As a consequence, globally active banks are essentially free to choose their gross positions as there are infinitely many combinations of changes in gross assets and liabilities that comply with the national accounting identity (see Avdjiev et al. (2016) for a discussion).

Table 1: Global Co-movement

1) US & RoW		2) Global cycles		3) Global cycles & dollar	
Asset prices	0.80	Business & financial cycle	0.69	Dollar & financial cycle	-0.41
Trade	0.81	Business & trade cycle	0.76	Dollar & business cycle	-0.50
GDP	0.60	Financial & trade cycle	0.56	Dollar & trade cycle	-0.45

Notes: Unconditional correlations based on quarterly data for 1990–2024, measured in year-over-year log changes. We exclude the year 2020 because of the COVID-19 pandemic. Column 1 reports correlations between US and RoW variables. Column 2 reports correlations among the global business, trade, and financial cycles. Column 3 reports correlations between the dollar and the global cycles. Asset prices are measured by the S&P 500 for the US and by the Dow Jones excluding US assets for the RoW. Trade is measured by exports relative to GDP. The global financial cycle is measured by the global factor in risky asset prices from Miranda-Agrippino & Rey (2020); the global trade cycle by world exports relative to GDP; and the global business cycle by world real GDP. The dollar is the broad US dollar nominal effective exchange rate, with increases denoting dollar appreciation.

world exports relative to GDP, and world GDP or industrial production. These capture the global financial, trade, and business cycles, respectively. The dollar is measured by the broad US dollar nominal effective exchange rate, with increases denoting dollar appreciation. Details on data sources, transformations, and country coverage are provided in Table C.1.

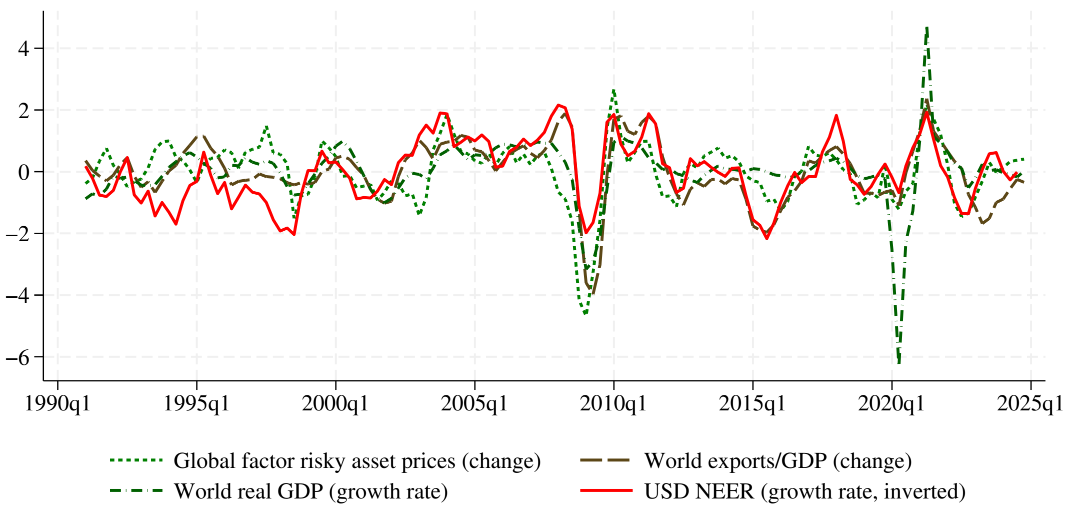
2.2 Global Co-Movement

We now establish global co-movement along three dimensions, using quarterly data for the period 1990–2024. First, asset prices, trade, and GDP co-move strongly across the US and the RoW. Cross-country output co-movement has been central to international business-cycle research at least since Backus et al. (1992), while the common component in risky asset prices across countries has been a major focus of research since Rey (2013). The left column of Table 1 documents these patterns for our sample and provides additional evidence of strong cross-country co-movement in trade. Since trade is measured as exports relative to GDP, this correlation is not mechanical.

Cross-country co-movement gives rise to a global financial cycle, a global business cycle, and a global trade cycle. With regard to these three global cycles, we establish a new fact: the cycles themselves are highly correlated, as shown in the middle column of Table 1. Finally, the right column of the table documents a third dimension of co-movement: all three cycles are negatively correlated with the US dollar. This means that global financial conditions, trade, and activity tend to weaken when the dollar appreciates.

We illustrate these patterns in Figure 1. The figure shows standardized year-

Figure 1: Global Co-movement and the Dollar



Notes: Standardized year-over-year changes for the period from 1990 to 2024. The global factor in risky asset prices is taken from Miranda-Agrippino & Rey (2020) and Miranda-Agrippino et al. (2020). World exports and real GDP are from the Dallas Fed Global Economic Indicators (Martínez-García et al. 2015). The US dollar nominal effective exchange rate is plotted on an inverted scale.

over-year changes in our measures of the three global cycles: the global factor in risky asset prices, world GDP, and world exports relative to GDP. The three series co-move strongly throughout the sample, with particularly pronounced joint declines during the global financial crisis and the COVID period. Finally, the figure also shows the US dollar nominal effective exchange rate, plotted on an inverted scale so that an increase corresponds to a dollar depreciation. The dollar tends to appreciate during crises and, more generally, when the global cycles slow.

3 Time-Series Evidence

In this section, we present new evidence on the global transmission of business-cycle shocks originating in the US, based on monthly data for the period 1990–2024. We first identify the main business-cycle shock in the US and then adopt a more structural framework focusing on risk and monetary policy shocks.

3.1 The VAR Model

Our estimation is based on a Bayesian structural VAR model along the lines of Rubio-Ramirez et al. (2010):

$$\boldsymbol{y}_t'\boldsymbol{A}_0 = \sum_{\ell=1}^{L} \boldsymbol{y}_{t-\ell}'\boldsymbol{A}_\ell + \boldsymbol{\mu}_0 + \boldsymbol{\mu}_1 D_t + \boldsymbol{\alpha}_0 t + \boldsymbol{\alpha}_1 t D_t + \boldsymbol{\epsilon}_t',$$

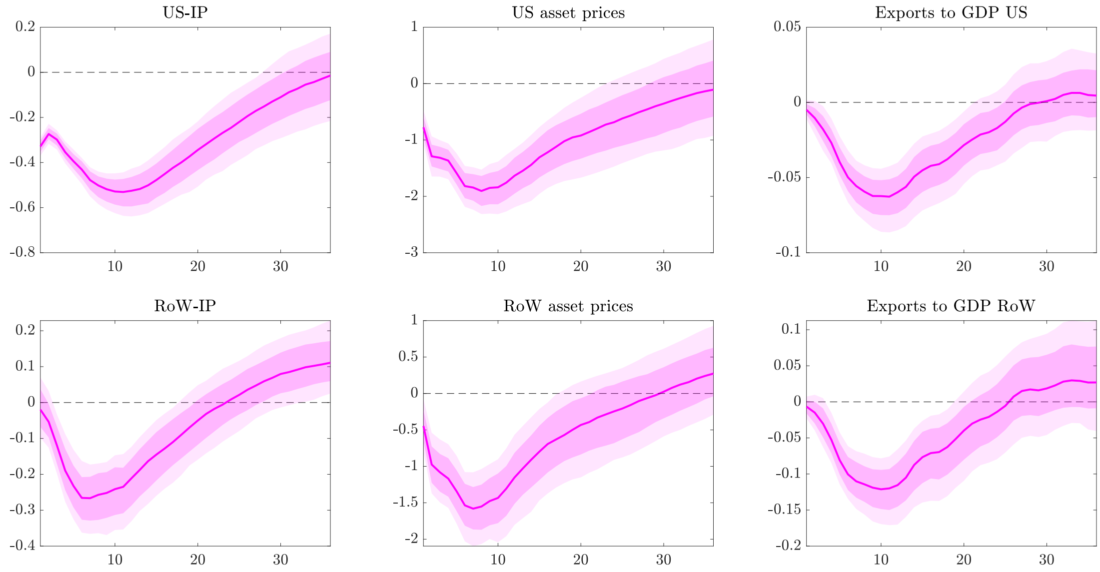
where $\boldsymbol{y}_t$ is an $n \times 1$ vector of endogenous variables, $\boldsymbol{\epsilon}_t$ is an $n \times 1$ vector of normally distributed structural shocks, and $\boldsymbol{A}_0$ captures contemporaneous relationships among the variables. As in Born et al. (2025), D_t is a dummy variable equal to one starting in March 2020, which accounts for possible shifts in level and trend after the onset of the COVID-19 pandemic; $\boldsymbol{\mu}_0$, $\boldsymbol{\mu}_1$, $\boldsymbol{\alpha}_0$, and $\boldsymbol{\alpha}_1$ capture constants and time trends.

In terms of variables, our point of departure is the VAR specification of Georgiadis et al. (2024). It features a US block along the lines of Gertler & Karadi (2015) and a RoW block. The two blocks are not entirely symmetric, owing to data availability and to the fact that we identify shocks originating in the US. The US block includes, as endogenous variables, the logarithms of US industrial production and consumer prices, the one-year Treasury bill rate as the monetary policy indicator, the excess bond premium (EBP) of Gilchrist & Zakrajsek (2012), and the VIX as measures of risk aversion and uncertainty. The RoW block includes the RoW policy rate, the logarithm of the dollar nominal effective exchange rate (NEER), and RoW industrial production. We add the global factor in risky asset prices of Miranda-Agrippino & Rey (2020), updated in Miranda-Agrippino et al. (2020), as an indicator of the global financial cycle; the world trade-to-GDP ratio as an indicator of the global trade cycle; and world industrial production as an indicator of the global business cycle. To keep the size of the VAR tractable, we add further variables of interest, for which we report results below, one at a time rather than all at once.[5]

We estimate the VAR model using the Bayesian approach of Arias et al. (2021), with Minnesota-type priors as in Miranda-Agrippino & Ricco (2021) and optimal hyperpriors controlling prior tightness and lag decay (Giannone et al. 2015). We furthermore incorporate the "pandemic priors" approach of Cascaldi-Garcia (2022) to account for the sequence of extreme observations during the COVID-

[5]Because of extreme values associated with hyperinflation episodes in some emerging market economies in the early to mid-1990s, we use changes in advanced-economy policy rates to extend the corresponding RoW policy-rate series backward from 2001. We interpolate the global trade-to-GDP ratio using the approach of Chow & Lin (1971). Specifically, we use data for global trade from Martínez-García et al. (2015) and interpolate monthly world GDP from monthly world industrial production. Descriptions of all variables used are provided in Table C.1.

Figure 2: Co-movement due to the US main business-cycle shock



Notes: The horizontal axis denotes time in months. The vertical axis denotes deviations from the pre-shock level in percent. The size of the shock is one standard deviation. Solid lines represent point-wise posterior means and shaded areas 68/90% equal-tailed, point-wise credible sets. The responses of the remaining variables in the VAR model are shown in Figure B.2.

19 pandemic. In our framework, this implies including dummies for March, April, and May 2020 alongside a non-informative prior for the corresponding coefficients.

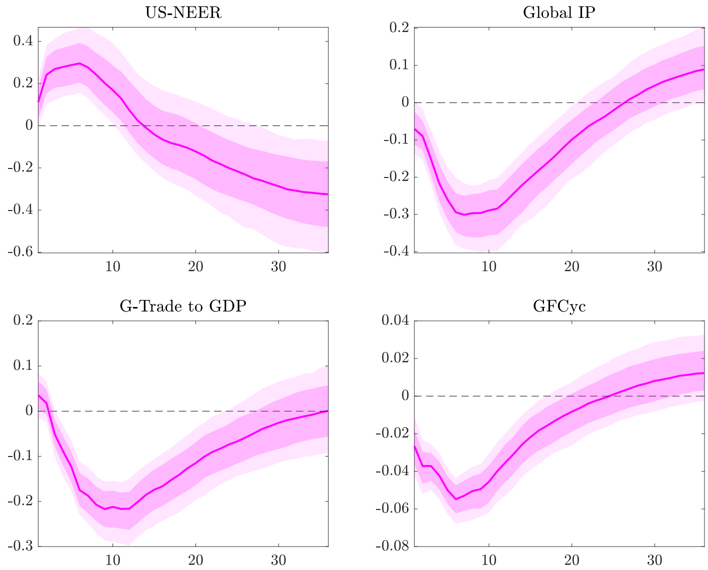
3.2 The US Main Business-Cycle Shock

We use the estimated VAR model to assess whether co-movement across countries, across global cycles, and with the dollar can be traced back to the same underlying forces. For this purpose, we first identify the US main business-cycle shock, following Angeletos et al. (2020). Specifically, we pin down the shock as the combination of reduced-form residuals that accounts for the largest share of the volatility of US real activity over the business cycle; see Appendix A.1.[6]

The columns of Figure 2 show the responses to the US main business-cycle shock of industrial production (left), asset prices (middle), and trade (right), with US responses in the top row and RoW responses in the bottom row. In each panel, the horizontal axis measures time after the shock in months, while the vertical axis shows deviations from the pre-shock level. The adjustment dynamics exhibit a striking pattern: the shock induces a synchronized contraction in US and RoW real activity, asset prices, and trade.

[6]At quarterly frequency, Stock & Watson (1999) define this frequency band as $[2\pi/6, 2\pi/32]$, which we adapt to monthly frequency accordingly.

Figure 3: Co-movement due to the US main business-cycle shock, cont'd



Notes: The horizontal axis denotes time in months. The vertical axis denotes deviations from the pre-shock level in percent for the US NEER and global IP, percentage points for global trade-to-GDP, and units of a standardized variable for the global financial cycle. The size of the shock is one standard deviation. Solid lines represent point-wise posterior means and shaded areas 68/90% equal-tailed, point-wise credible sets. The response of global IP is constructed by averaging the responses of US and RoW IP using average PPP weights over the sample. The responses of the remaining variables in the VAR model are shown in Figure B.2.

Figure 3 shows how the dollar and the global cycles respond to the US main business-cycle shock. The shock causes a persistent appreciation of the dollar, with some delayed overshooting (upper-left panel). At the same time, it triggers a highly synchronized contraction of the three global cycles: global activity, measured by industrial production, declines (upper-right panel) together with trade flows and asset prices (bottom panels).

In sum, the US main business-cycle shock generates the same patterns of co-movement that characterize the data unconditionally: co-movement across countries, across cycles, and with the US dollar. To quantify its contribution to the co-movement, we compute the share of the unconditional variances and covariances of the dollar and the global cycles accounted for by this shock. Following Kilian & Lütkepohl (2017), we approximate unconditional variances and covariances using forecast error variance decompositions at a very long horizon of 50 years.[7] Table 2 reports the results. The US main business-cycle

[7] To quantify its contribution, we rely on the structural vector moving-average representation of the VAR model; see Equation (A.1). We compute the forecast error variance-covariance matrix $\mathbf{V}(h) = \sum_{t=0}^{h-1} \boldsymbol{\Omega}_t \boldsymbol{Q}\boldsymbol{Q}'\boldsymbol{\Omega}_t'$, where $\boldsymbol{\Omega}_t$ is the matrix of reduced-form impulse responses at horizon t, and $\boldsymbol{Q}$ is an orthonormal rotation matrix whose first column is pinned down by the US main business-cycle shock. To gauge the importance of the shock for the variation and co-movement of the three global cycles, we compute $\mathbf{V}(h)$ for all horizons and then recompute

Table 2: Contribution of US main business-cycle shock to co-movement

	Dollar	Business cycle	Trade cycle	Financial cycle
Dollar	0.19 [0.13, 0.24]			
Business cycle	0.35 [0.26, 0.45]	0.25 [0.19, 0.33]		
Trade cycle	0.32 [0.21, 0.47]	0.23 [0.16, 0.31]	0.20 [0.14, 0.26]	
Financial cycle	0.35 [0.26, 0.46]	0.32 [0.24, 0.41]	0.29 [0.21, 0.38]	0.24 [0.18, 0.31]

Notes: The table reports the point-wise median share of the unconditional variances and covariances of the dollar and the global cycles accounted for by the US main business-cycle shock. Following Kilian & Lütkepohl (2017), we approximate unconditional variances and covariances using forecast error variance decompositions at a very long horizon of 50 years. In line with Figure 1, statistics are reported for year-over-year changes of the cycles, obtained by transforming the impulse responses accordingly. Brackets report 68% highest posterior density intervals.

shock explains 19% of the unconditional variance of the dollar exchange rate.[8] It also accounts for roughly 20–25% of the volatility of the three global cycles.[9] Moreover, the shock explains 24–35% of the contemporaneous co-movement among the three cycles.

3.3 Structural US Shocks

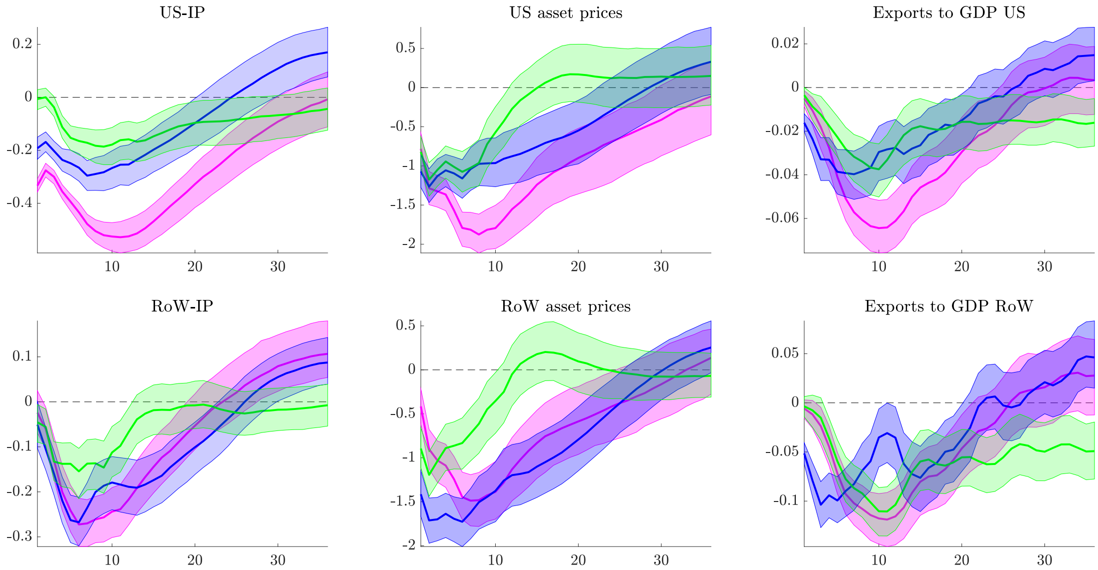
The US main business-cycle shock summarizes the component of VAR innovations that is most relevant for US real activity at business-cycle frequencies. This is useful because it lets us document the global propagation of US business-cycle fluctuations without taking a stand on their underlying structural source. We now ask whether the same propagation pattern also arises for shocks with a clearer economic interpretation: US monetary policy shocks and US risk shocks. These shocks are natural candidates because they can be disciplined by external instruments and map directly into the structural disturbances considered in the

the same statistic after setting to zero the impulse responses corresponding to the shock, which yields $\widetilde{\mathbf{V}}(h)$. For each element, we compute the difference between $\mathbf{V}(h)$ and $\widetilde{\mathbf{V}}(h)$ and divide it by the corresponding element of $\mathbf{V}(h)$. We report the median of this statistic at horizon 400, corresponding to 50 years, which provides a good approximation of the unconditional variance (Kilian & Lütkepohl 2017).

[8]The shock explains 30% of the unconditional variance of US industrial production. By construction, its contribution to the forecast error variance is larger at shorter horizons; at a horizon of three years, it amounts to about 60%.

[9]The most prominent of our cycle indicators—the global factor in risky asset prices—accounts for 25% of the variation in risky asset prices around the world (see Miranda-Agrippino & Rey 2020).

Figure 4: Global co-movement due to US shocks



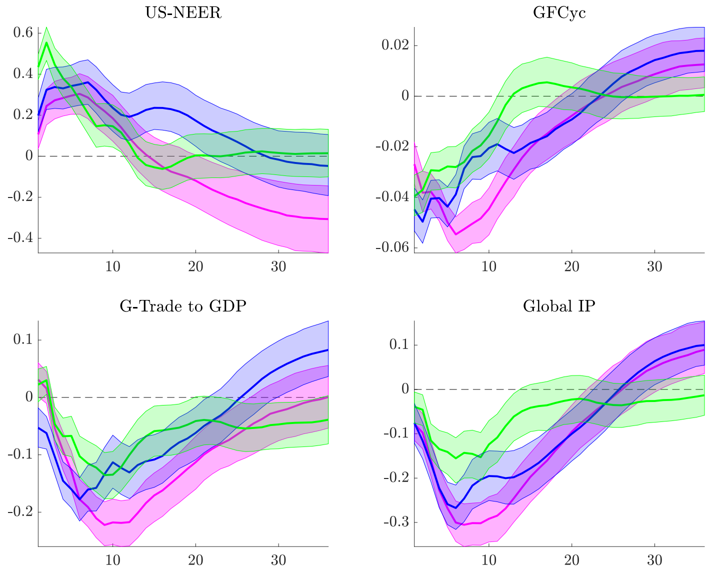
Notes: Responses to a US risk shock (blue), a US monetary policy shock (green), and the US main business-cycle shock (magenta). The horizontal axis denotes time in months. The vertical axis denotes deviations from the pre-shock level in percent or, for export-to-GDP ratios, percentage-point changes in the corresponding values. The size of each shock is one standard deviation. Solid lines represent point-wise posterior means and shaded areas 68% equal-tailed, point-wise credible sets.

model. If they generate the same pattern as the US main business-cycle shock, the evidence points to a robust global transmission mechanism and provides a direct bridge to the model-based analysis in Section 4 below.

In what follows, we identify these shocks using external instruments. We discuss the instruments and identifying assumptions in detail in Appendix A.2. For the US monetary policy shock, we use changes in one-month federal funds futures in narrow intraday windows around monetary policy events from Georgiadis & Jarocinski (2025) as an instrument. Following recent work that highlights the informational content of surprises around different monetary policy events (Swanson 2023, 2024), we extend the analysis in Georgiadis et al. (2024) and consider not only FOMC meetings, but also FOMC press conferences, minutes releases, and Fed Chair speeches and testimonies. We purge these surprises of central-bank information effects using the poor-man's approach of Jarociński & Karadi (2020), setting interest-rate surprises to zero when the associated stock-price surprises are positive. For the US risk shock, we use changes in the price of gold in intraday windows around a series of narratively selected US events as an instrument (Bloom 2009; Piffer & Podstawski 2018; Bobasu et al. 2021).

We find that both shocks transmit in much the same way as the US main

Figure 5: Global co-movement due to US shocks, cont'd



Notes: Responses to a US risk-aversion shock (blue), a US monetary policy shock (green), and the US main business-cycle shock (magenta). The horizontal axis denotes time in months. The vertical axis denotes deviations from the pre-shock level in percent for the US NEER and global IP, percentage points for global trade-to-GDP, and standard deviation units for the global financial cycle. The size of each shock is one standard deviation. Solid lines represent point-wise posterior means and shaded areas 68% equal-tailed, point-wise credible sets. The response of global IP is constructed from the responses of US IP and RoW IP using PPP weights. Responses of the remaining variables are shown in Figure 4 and Figure B.3.

business-cycle shock. Figure 4 presents the responses to one-standard-deviation US risk and monetary policy shocks, shown in blue and green, respectively, alongside the response to the US main business-cycle shock, shown in magenta.[10] Results for the remaining variables are shown in Figure B.3. As with the US main business-cycle shock, both US risk and monetary policy shocks cause downturns in industrial production (left column), asset prices (middle column), and trade (right column), which are highly synchronized across the US (top row) and the RoW (bottom row).

Figure 5 is organized in the same way as Figure 4 and shows the responses of the global cycles and the dollar to the three shocks. It juxtaposes the responses to the US main business-cycle shock, shown in Figure 3 above, with those to the two structural shocks. As before, the adjustment patterns are very similar across shocks and thus suggest a common propagation mechanism: dollar appreciation coincides with tighter global financial conditions, a slowdown in global trade, and a contraction in global production.

[10]In a simple regression, the US monetary policy and US risk shocks explain about 48% of the variance of the US main business-cycle shock. Individually, the US risk shock accounts for 34% and the US monetary policy shock for 14%. Thus, US risk and US monetary policy shocks also account for an important part of the business cycle.

4 The trinity model

Our model of the world economy features two country blocks, the US (U) and the RoW (R), and dollar trinity: trade prices are sticky in dollars, cross-border credit is denominated in dollars, and U Treasuries serve as a safe asset for R banks. Hence the dollar "trinity model." Beyond trinity, we assume standard and symmetric real and nominal frictions, including sticky prices and wages, habit formation in consumption, investment-adjustment costs, and variable capital utilization, which are important for matching key properties of aggregate time-series data (Smets & Wouters 2007). Monetary policy in U and R follows standard Taylor rules responding to final consumer-good inflation and output deviations. Fiscal policy issues one-quarter nominal bonds that pay the corresponding central-bank interest rates and balances the budgets by raising lump-sum taxes. We keep the model description short and focus the exposition on dollar dominance in global financial markets and trade. The full model description is provided in Appendix D.

4.1 Households

Economies are populated by households and firms, a fraction $s \in [0, 1]$ of which resides in R. Households are symmetric except for wages and labor supply, which we model as in Erceg et al. (2000). In modeling banks, we follow Gertler & Karadi (2011). A fraction $1 - f$ of household members are workers, while a fraction f are bankers. Workers supply labor, choose consumption, and save by making deposits with domestic banks; bankers accumulate equity and intermediate funds to domestic firms. To ensure that bankers remain dependent on external funds, we assume that in every period a bank closes with probability $1 - \theta_B$ and that its accumulated equity is transferred to the household. An equal number of workers randomly become bankers.

4.2 Firms

In each country, there are four types of firms. A continuum of perfectly competitive intermediate-goods firms combines labor and capital using a standard CES production function and sells its output to domestic retailers. To acquire capital for use in next period's production, an intermediate-goods firm raises funds by issuing claims that pay the return on capital; these claims are purchased by financial intermediaries (see Appendix D.4 for details). Capital is provided by capital-producing firms, which use domestic and imported goods in production and face quadratic adjustment costs (Appendix D.5). Retail firms operate under monopolistic competition and use intermediate goods to produce retail goods subject to sticky prices in either domestic or foreign currency (Appendix D.7). Finally, perfectly competitive firms assemble final goods (Appendix D.6).

4.3 Trade

The first dimension of dollar trinity relates to bilateral trade between U and R, as well as to trade within R. Specifically, we assume that prices of bilateral exports between U and R, as well as a fraction of intra-R sales, are at least partly sticky in dollars. To capture this, we adopt the multi-layered production structure of Georgiadis & Schumann (2021), in which differentiated goods are aggregated sequentially. For example, to allow a share of R exports to U to be priced in dollars, a perfectly competitive importing firm in U combines differentiated dollar-priced and R-currency-priced goods produced by R firms into an import good. Analogously, to reflect the large share of trade between countries in the RoW that is priced in dollars in the data, we assume that R final-goods producers combine an import good from U with dollar-priced and R-currency-priced differentiated goods produced by R firms into a domestic final good; see Appendix D for details and Figure D.2 for a schematic overview.

4.4 Financial intermediation

Cross-border financial intermediation is asymmetric because credit is denominated in dollars and U Treasuries serve as safe assets for R banks. This gives rise to differences in the incentives and constraints faced by banks in U and R, which we discuss next. Dollar dominance in cross-border credit and safe assets implies an endogenous wedge in the UIP condition that emerges as a key driver of the dollar exchange rate. This UIP wedge has a natural interpretation as a convenience yield on U Treasury holdings for R banks.

4.4.1 *R* Banks

In a given period t, a generic R bank j funds its claims on domestic capital, $K_{R,j,t}$, and its holdings of U Treasuries, $GB_{R,j,t}$, with domestic deposits, $D_{R,j,t}$, and cross-border dollar loans from U banks, $CBDL_{R,j,t}$. Denoting by $Q_{R,t}$ the price of domestic capital in terms of the final consumption good, $P^C_{R,t}$, the balance sheet reads

$$Q_{R,t}K_{R,j,t} + RER_tGB_{R,j,t} = D_{R,j,t} + RER_tCBDL_{R,j,t} + N_{R,j,t}, \qquad (1)$$

where $RER_t = \mathcal{E}_t P^C_{U,t} / P^C_{R,t}$ denotes the real exchange rate and $\mathcal{E}_t$ is the nominal exchange rate, defined as the price of one dollar in units of R currency. An increase in $\mathcal{E}_t$ therefore represents an appreciation of the dollar. $N_{R,j,t}$ denotes net worth. The balance sheet identity in Equation (1) reflects the assumption that cross-border credit is denominated in dollars—the second dimension of dollar trinity.[11] Claims on domestic capital and holdings of U Treasuries earn the rate $R^K_{R,t}$ and $D\mathcal{E}_t R^{GB}_{U,t-1}$, respectively, with $D\mathcal{E}_t \equiv \mathcal{E}_t / \mathcal{E}_{t-1}$. For simplicity, we assume that the return on U Treasuries (net of exchange rate changes) is the U risk-free, central-bank rate $R^{GB}_{U,t} = R_{U,t}$, while deposits cost the pre-determined interest rate $R_{R,t-1}$, which we assume equals the R risk-free, central-bank rate. The interest rate R banks pay on cross-border dollar loans from U banks is $D\mathcal{E}_t R^{CBDL}_{U,t-1}$.

Banks apply the household's real stochastic discount factor $\Theta_{R,t,t+s}$ as they maximize the discounted value of current and expected future equity $N_{R,j,t}$, while taking into account an exogenous closing probability θ_B:

$$V_{R,j,t} = \max \mathbb{E}_t \sum_{s=0}^{\infty} (1-\theta_B)\theta_B^s \Theta_{R,t,t+s} N_{R,j,t+1+s}. \tag{2}$$

We assume that banks face a balance-sheet constraint that captures, in a stylized way, regulatory requirements.[12] For example, the Basel III framework imposes limits on banks' leverage ratios, defined in terms of risk-weighted assets relative to equity (Basel Committee on Banking Supervision 2019). Accordingly, we assume that the value of the bank must not fall below a fraction of its risk-weighted assets:

$$V_{R,j,t} \geq \delta_{R,j,t} \left(Q_{R,t} K_{R,j,t} + \Gamma^{GB}_R RER_t GB_{R,j,t} \right), \tag{3}$$

with

$$\delta_{R,j,t} = \bar{\delta}_R \left[1 - \epsilon_{R,\alpha} \alpha^{GB}_{R,j,t} + \frac{\kappa_{R,\alpha,\ell}}{2} \left(\alpha^{GB}_{R,j,t} - \ell^{CBDL}_{R,j,t} \right)^2 \right], \qquad \bar{\delta}_R > 0. \tag{4}$$

Here, $\alpha^{GB}_{R,j,t} \equiv RER_t GB_{R,j,t} / (Q_{R,t} K_{R,j,t} + RER_t GB_{R,j,t})$ is the share of U Treasuries in total assets, and $\ell^{CBDL}_{R,j,t} \equiv RER_t CBDL_{R,j,t} / (Q_{R,t} K_{R,j,t} + RER_t GB_{R,j,t})$ is the share of total assets funded by cross-border dollar loans.

The assumptions in Equations (3) and (4) imply that U Treasuries are spe-

[11]We abstract from cross-border credit in R currency because about 70% of global cross-border debt is denominated in dollars (Bertaut et al. 2021).

[12]Because we solve the model in the neighborhood of the steady state, we assume that the balance-sheet constraint binds throughout.

cial because of their unique safety and liquidity independently of their relative safety—the third dimension of dollar trinity. First, the asset-specific risk weight $\Gamma_R^{GB} < 1$ in Equation (3) means that less equity is required when holding Treasuries than when holding claims on domestic capital, which reflects relative safety assessments in regulatory requirements.[13] Second, $\epsilon_{R,\alpha} > 0$ in Equation (4) incentivizes banks to hold *U* Treasuries independently from their relative safety, which reflects regulatory requirements to hold liquid assets to cover funding shortages in stress scenarios.[14] Third, $\kappa_{R,\alpha,\ell} > 0$ in Equation (4) further incentivizes banks to hold *U* Treasuries independently from their relative safety, which reflects regulatory requirements to hedge foreign-currency liabilities by holding foreign-currency assets.[15] As we discuss below, the assumptions in Equations (3) and (4) give rise to an endogenous convenience yield, which is the distinct feature of a safe asset (Gorton 2017).[16]

4.4.2 *U* banks

U banks differ from *R* banks in four ways. First, *U* banks are cross-border lenders rather than borrowers. Therefore, dollar loans appear on the asset side of the balance sheet of bank *j*:

$$Q_{U,t}K_{U,j,t} + CBDL_{U,j,t} = D_{U,j,t} + N_{U,j,t}, \tag{5}$$

where $K_{U,j,t}$, $CBDL_{U,j,t}$, $D_{U,j,t}$ and $N_{U,j,t}$ are claims on domestic capital, cross-border dollar loans, domestic deposits and net worth, respectively, measured in terms of the *U* consumption good. Claims on domestic capital and cross-border dollar loans earn the rate $R_{U,t}^K$ and $R_{U,t-1}^{CBDL}$, respectively, and deposits cost the pre-determined interest rate $R_{U,t-1}$, which we assume equals the risk-free, central-bank rate in *U*. Second, for simplicity and in order to focus on *R*, we assume *U* banks do not hold *U* Treasuries. Third, for *U* banks we assume the

[13]Under Basel III, AAA to AA- rated central government debt—such as *U* Treasuries—carry a risk weight of zero (Basel Committee on Banking Supervision 2019, CRE20).

[14]Under Basel III the "liquidity coverage ratio" ensures an adequate stock of high-quality liquid assets (HQLA) that can be converted into cash easily and immediately in private markets to meet liquidity needs in a 30 calendar day liquidity stress scenario (Basel Committee on Banking Supervision 2019, LCR30). To qualify as an HQLA, an asset's liquidity-generating capacity should remain intact even in periods of severe idiosyncratic and market stress and, ideally, it should be eligible as collateral for central bank liquidity facilities.

[15]Basel III risk weights are meant to account for the possibility of losses due to asset price—including exchange rate—movements. Of particular relevance for our purposes is that these risk weights are reduced if a bank's foreign-currency asset position hedges a corresponding liability position (Basel Committee on Banking Supervision 2019, MAR11.3).

[16]"The specialness of safe assets implies the existence of non-pecuniary returns (called the 'convenience yield'), in the form of liquidity or moneyness and safety, and so the pecuniary return is lower than it otherwise would be." (Gorton 2017, p.2)

balance-sheet constraint

$$V_{U,j,t} \geq \delta_{U,j,t}(Q_{U,t}K_{U,j,t} + \Gamma_{U,t}^{CBDL} CBDL_{U,j,t}), \tag{6}$$

with the risk weight of cross-border dollar loans given by

$$\Gamma_{U,t}^{CBDL} = \bar{\Gamma}_{U}^{CBDL} + \Phi_{U,\phi}\phi_{R,j,t}. \tag{7}$$

Here, $\phi_{R,j,t} \equiv (Q_{R,t}K_{R,j,t} + RER_t GB_{R,j,t})/N_{R,j,t}$ denotes the leverage ratio of R banks. It captures regulatory requirements under which cross-border dollar lending carries a risk weight that reflects the riskiness of the borrower's balance sheet.[17] Note that this ties together the balance-sheet constraints of U and R banks. Finally, in contrast to R banks, a U bank does not have any foreign-currency exposure. Therefore, for a U bank we assume that the balance-sheet risk weight $\delta_{U,j,t}$ is given by

$$\delta_{U,j,t} = \overline{\delta}_U + \epsilon_t^{\delta}. \tag{8}$$

Following Gabaix & Maggiori (2015), we interpret ϵ_t^{δ} as a risk-aversion shock, or simply a risk shock. It reduces the willingness of depositors of U banks to provide funding for a given balance-sheet size and composition. We assume that ϵ_t^{δ} evolves according to an AR(1) process

$$\epsilon_t^{\delta} = \rho_{\delta}\epsilon_{t-1}^{\delta} + \eta_t^{\delta}. \tag{9}$$

We characterize the behavior of banks in R and U in Appendix D.3. In particular, we show that there is an endogenous optimal maximum leverage ratio, which depends on the riskiness and profitability of the asset and liability composition of a bank's balance sheet. Before calibrating and solving the model, we highlight key model implications that arise from dollar trinity.

4.5 Uncovered interest rate parity and convenience yield

The first implication of dollar dominance in cross-border credit and safe assets is an endogenous convenience yield on U Treasuries, reflected in a wedge in the uncovered interest parity (UIP) condition that is central to exchange-rate dynamics. To see this, note that the optimal portfolio choice of bank j in R

[17] Credit risk weights specified in Basel III need to take into account, among other things, counterparty risk and default probabilities; see Basel Committee on Banking Supervision (2019, CRE20).

satisfies

$$\mathbf{E}_t \left[\Omega_{R,j,t,t+1} \left(D\mathcal{E}_{t+1} R^{GB}_{U,t} - R_{R,t} \right) \right] + CY_{R,j,t} = RP^{GB}_{R,j,t}, \tag{10}$$

where $\Omega_{R,j,t,t+1}$ is the banks stochastic discount factor. The first term on the left of Equation (10) represents the expected excess return on U Treasuries, which would be zero if UIP held. The two remaining terms capture wedges in the UIP equation, implying that the expected excess return on U Treasuries may be negative, in line with the empirical evidence (e.g., Kalemli-Özcan & Varela 2021).

The first wedge in Equation (10) is given by

$$CY_{R,j,t} = -\frac{\partial \delta_{R,j,t} / \partial \alpha^{GB}_{R,j,t}}{\delta_{R,j,t}} \left[(1 - \alpha^{GB}_{R,j,t}) + \Gamma^{GB}_R \alpha^{GB}_{R,j,t} \right] \\ \times \mathbf{E}_t \left[\Omega_{R,j,t,t+1} \left(R^K_{R,t+1} - R_{R,t} \right) \right], \tag{11}$$

which we refer to as the convenience yield on U Treasuries. In the steady state of the calibrated model, the convenience yield is positive, in line with the evidence (Du et al. 2018; Jiang et al. 2021; Engel & Wu 2023). Compared with other work on exchange rates and dollar dominance, such as Jiang et al. (2024), the term in Equation (11) offers a structural interpretation of the Treasury convenience yield: holding U Treasuries loosens the balance-sheet constraint of R banks, $\partial \delta_{R,j,t} / \partial \alpha^{GB}_{R,j,t} < 0$, in Equations (3) and (4). As a result, all else equal and depending on the existing asset portfolio structure, $\left[(1 - \alpha^{GB}_{R,j,t}) + \Gamma^{GB}_R \alpha^{GB}_{R,j,t} \right]$, banks can acquire additional claims on domestic capital and earn the credit spread $R^K_{R,t+1} - R_{R,t}$.

This matters for the dollar: an increase in the convenience yield, for example, because of an exogenous tightening of banks' balance-sheet constraints or an increase in credit spreads, requires, all else equal, a decline in the expected excess return on Treasuries according to Equation (10). This implies an expected depreciation of the dollar and hence an instantaneous appreciation.

The second UIP wedge in Equation (10) is given by

$$RP^{GB}_{R,j,t} = \Gamma^{GB}_R \mathbf{E}_t \left[\Omega_{R,j,t,t+1} \left(R^K_{R,t+1} - R_{R,t} \right) \right], \tag{12}$$

which is non-zero as long as U Treasuries carry a non-zero risk weight, $\Gamma^{GB}_R > 0$. The higher the risk weight of U Treasuries, the higher their equilibrium excess return has to be for R banks to hold them, all else equal. If treasuries carry zero risk weight, $\Gamma = 0$, this term vanishes.

4.6 A global financial accelerator

A second important implication of dollar dominance in cross-border credit and safe assets is a global financial accelerator. Recall that the asset-specific risk weight $\Gamma^{CBDL}_{U,t}$ on a U bank's cross-border dollar lending in Equation (7) depends positively on the leverage ratio of its borrower, the R bank, which is given by

$$\phi_{R,j,t} \equiv \frac{Q_{R,t}K_{R,j,t} + RER_t GB_{R,j,t}}{Q_{R,t}K_{R,j,t} + RER_t GB_{R,j,t} - D_{R,j,t} - RER_t CBDL_{R,j,t}}. \tag{13}$$

The numerator is the R-currency value of the bank's assets, and the denominator is the R-currency value of its equity.

As part of the R bank's assets and liabilities are in dollars, its leverage ratio fluctuates with the exchange rate. In particular, the derivative of the leverage ratio with respect to the exchange rate is

$$\frac{\partial \phi_{R,j,t}}{\partial RER_{E,t}} = \frac{CBDL_{R,j,t} \times Q_{R,t}K_{R,j,t} - GB_{R,j,t} \times D_{R,j,t}}{\left(Q_{R,t}K_{R,j,t} + RER_t GB_{R,j,t} - D_{R,j,t} - RER_t CBDL_{R,j,t}\right)^2}. \tag{14}$$

The leverage ratio rises as the dollar appreciates if the R bank (i) has a dollar net short position $CBDL_{R,j,t} > GB_{R,j,t}$ or (ii) is fully hedged $CBDL_{R,j,t} = GB_{R,j,t}$. This is because in both cases we have that $Q_{R,t}K_{R,j,t} > D_{R,j,t}$ via the balance-sheet identity in Equation (1), given some positive net worth $N_{R,j,t} > 0$.[18] As a consequence, the U bank's asset-specific risk weight on cross-border dollar loans increases when the dollar appreciates, which forces it to deleverage and charge higher cross-border loan credit spreads. This further appreciates the dollar and triggers another round of amplification.

The result is a global financial accelerator, illustrated graphically in Figure B.4. To develop intuition, suppose there is an exogenous decline in depositors' willingness to fund U banks, that is, an increase in the risk aversion of US creditors. As these global lenders cut back on lending, credit spreads rise and the dollar appreciates through the convenience-yield channel, reflecting its special role as a global safe asset. With dollar dominance in cross-border debt, the shock to U banks also tightens the balance-sheet constraints of R banks, because it raises the value of their dollar liabilities, and further tightens the constraints of U banks, which now lend to riskier R banks. As banks in both U and R reduce cross-border lending and domestic investment, credit spreads rise simultaneously in both economies. This further appreciates the dollar and triggers another round

[18]In the fully hedged case, hedging shields the denominator of the leverage ratio (i.e. the net worth) from exchange rate depreciation, but the numerator still moves if the bank holds some dollar assets.

of financial amplification. Hence, as the dollar appreciates, financial conditions tighten across U and R: a global financial cycle emerges.

4.7 The co-movement of global cycles

The third key implication of the trinity model is that the global business and trade cycles are intertwined with the global financial cycle; see again Figure B.4 for an illustration. When global financial conditions tighten, dollar dominance in safe assets raises the convenience yield and appreciates the dollar. Because exports are partly priced in dollars, this appreciation reduces U and intra-R exports. At the same time, dollar dominance in cross-border debt amplifies the initial tightening of financial conditions globally, reducing investment financing and output in both U and R. Thus, global business, trade, and financial cycles emerge jointly through the dollar. Although we have described the mechanism for an initial disruption in financial markets, the model simulations below show that the same propagation mechanism operates more generally whenever shocks move the dollar.

5 Quantitative Model Assessment

We next solve the model numerically and assess its quantitative performance before turning to the transmission of shocks. We approximate the model around its deterministic steady state.

5.1 Calibration and Shock Processes

We distinguish three sets of parameters. The first set governs household preferences, intermediate-, final-, and capital-goods production, monetary policy, and the financial sector. We discipline these parameters using earlier work and direct empirical evidence. To save space, we do not discuss them in detail here; Table D.4 provides an overview.

The second set of parameters relates to dollar dominance. Given the first set of parameters, we determine their values by targeting the degree of dollar dominance observed in the data and documented in the existing literature. We summarize the calibration targets in Table 3. Consider first dollar dominance in trade. The share of R firms that invoice exports to U in dollars is given by $\widehat{\gamma}_U^R = 1 - \gamma_U^R$ and is set to 93%, in line with the invoicing shares documented in Gopinath (2015). Based on the calculations in Georgiadis & Schumann (2021), we set the share of U firms that price in dollars when exporting to R, $\widehat{\gamma}_R^U = 1 - \gamma_R^U$,

Table 3: Calibration targets for dollar dominance parameters

Moment	Target	Parameter	Value	Reference
U-R export DCP shares	93%, 97%	$\widehat{\gamma}_R^U, \widehat{\gamma}_U^R$	0.93, 0.97	Boz et al. (2022)
Intra-R export DCP share	37.5%	$\widehat{\gamma}_R^R$	0.09	Boz et al. (2022)
R bank \$-assets/total assets	15%	$\epsilon_{R,\alpha}$	0.55	Adrian & Xie (2020)
R bank \$-liabilities/total assets	25%	$\kappa_{R,\alpha,\ell}$	2.74	Aldasoro et al. (2021)
U external debt/GDP	86%	$\overline{\delta}_R$	0.68	Data mean
Exorbitant privilege	1%	$\bar{\Gamma}_U^{CBDL}$	0.30	Bertaut et al. (2024)
Treasury convenience yield	1.5%	Γ_R^{GB}	0.00	Jiang et al. (2024)

Notes: Parameters and calibration targets for dollar dominance. Targets are in many cases mutually dependent and generally depend on all parameter values; the table associates parameters with targets on which they have a strong influence.

to 97%. Consistent with the invoicing shares in Boz et al. (2022), we target a fraction of intra-R exports priced in dollars of 37.5%, which implies that the share of total intra-R sales priced in dollars, $\widehat{\gamma}_R^R = 1 - \gamma_R^R$, is 9%.[19] Next we turn to the parameters that relate to the degree of dollar dominance in cross-border credit and safe assets. In particular, for R banks, we jointly determine the parameters $\epsilon_{R,\alpha}$ and $\kappa_{R,\alpha,\ell}$ to target a portfolio that invests 15% of total assets in U Treasuries, while cross-border dollar loans account for 25% of liabilities. On the one hand, the dollar asset share of 15% is close to the average for non-US banks (Adrian & Xie 2020) and, when combined with our assumption on the steady-state size of R banks' balance sheet governed by $\overline{\delta}_R$, implies a U gross external-debt-to-GDP ratio of 86%, which is approximately the average in the data in our sample period. On the other hand, the dollar liability share of 25% is close to the number for non-US banks in BIS data (Aldasoro et al. 2021), and is also close to (estimated) values in the literature (Cesa-Bianchi et al. 2024; Akinci & Queralto 2024).[20]

We set the asset-specific risk weight on U Treasuries, Γ_R^{GB}, to zero, implying that R banks do not need to hold additional equity when investing in U Treasuries, in line with Basel III regulations. Combined with our assumptions on country-specific discount factors—and hence steady-state interest rates, shown in

[19]We first target the average intra-R exports-to-GDP ratio for R, approximately 24%. Next, we use the average share of global exports invoiced in dollars from Boz et al. (2022) and subtract the fraction of U in global trade to arrive at 37.5%. Multiplying the two numbers gives about 9%. Analogously, we calibrate the share of intra-R PCP exports in total intra-R PCP sales by targeting the fraction of total intra-R exports to GDP for R, which amounts to setting $\widetilde{\omega}_R^R$ to 0.165.

[20]Combined with the assumption that banks are the only entities that engage in cross-border lending, our calibration implies that R has a *negative* net dollar exposure and is a net debtor to U ($\alpha_R^{TREAS} - \ell_R^{CBDL} < 0$). While this is in line with the net dollar exposures of the RoW *banking sector* in the data as documented by Shin (2012), the RoW *as a whole* has a *positive* net dollar exposure and is a net creditor to the US. In Section F.1 we consider an extension in which R is a net creditor of U with a positive net dollar exposure.

Table D.4—and with the parameters governing dollar portfolio shares, $\epsilon_{R,\alpha}$ and $\kappa_{R,\alpha,\ell}$, this implies an annualized steady-state convenience yield of 1.5%, which falls within the range of estimates in Jiang et al. (2021) and Jiang et al. (2024).

For the parameters related to the portfolio choice of U banks, we target a cross-border credit spread that, given the convenience yield, implies an annualized steady-state "exorbitant privilege" (Gourinchas & Rey 2007) of 1%, close to the time average in Bertaut et al. (2024). This pins down $\bar{\Gamma}_U^{CBDL}$, which, conditional on the remaining parameters for U banks, determines the excess return from cross-border dollar lending to R banks.[21]

Our calibration implies a steady-state U trade-deficit-to-GDP ratio of 2.1% and a steady-state global trade-to-GDP ratio of 47%. Both are close to their empirical counterparts. In the steady state, U finances its trade deficit with positive net financial income, reflecting higher returns on cross-border dollar lending to R than the interest payments on R holdings of U Treasuries. As a result, U attains higher steady-state per capita consumption than R as a direct consequence of the exorbitant privilege. In Section F.1, we extend the model to also feature an "exorbitant duty" (Gourinchas & Rey 2007).

Finally, we calibrate a third set of parameters governing the standard deviations of the five shock processes in the model. Specifically, the model features technology and monetary policy shocks in U and R, as well as a risk shock originating in U.[22] We calibrate the standard deviations of these shocks by targeting key exchange-rate moments. These moments have long challenged the literature and are often referred to as puzzles, given the difficulty international macro models have in accounting for them. Recent work by Itskhoki & Mukhin (2021) shows that a model with segmented international financial markets—like ours—can account for these moments through financial shocks that generate UIP deviations. The trinity model, however, matches these moments through the endogenous response of the UIP wedge to a broad range of shocks, including monetary policy and productivity shocks, without resorting to financial or UIP shocks. The precise response of the UIP deviation differs across shocks, so the exchange-rate moments help identify the relative importance of the different shocks.

[21]This spread is closely linked to the risk weight attached to cross-border dollar loans, which is given by the sum of a constant risk weight and a term that depends on the R bank's leverage ratio (see Equation (7)). To distribute between these two terms we target a credit spread of 0.6% for an R bank with a leverage ratio of zero. This roughly corresponds to the average of the quarterly spread between the dollar-based Libor and the 3-month Treasury bill rate over 1990-2024. These two targets pin down $\bar{\Gamma}_U^{CBDL}$ and $\Phi_{U,\phi}$.

[22]We assume that technology shocks follow AR(1) processes with persistence 0.9, that monetary policy shocks are *i.i.d.* because of interest-rate smoothing, and that the persistence of the risk-aversion shock is calibrated to match the VAR dynamics in Figure 6.

Table 4: Calibration targets for shock variances

FX puzzle	Moment	Data	Trinity model
Exchange-rate disconnect	$\sigma(\Delta\mathcal{E})/\sigma(\Delta Z_R)$	5.32	5.32
PPP puzzle	$\text{corr}(\Delta\mathcal{E}, \Delta RER)$	0.95	0.99
Backus–Smith puzzle	$\text{corr}(\Delta RER, \Delta C_R - \Delta C_U)$	-0.40	-0.40
Fama puzzle	β in Fama regression	-0.37	-0.37
Std. global output	$\sigma(\Delta Z_G)$	0.44	0.44

Notes: We compute the model-implied moments by simulating 10,000 periods of data from the model. To estimate the relative variances, we numerically minimize the root mean squared error, rescaling deviations from each target in percentage terms to account for differences in scale. $\mathcal{E}$ denotes the nominal exchange rate, and Z_R denotes R GDP. Δ refers to quarter-on-quarter log changes. We use quarterly data from 1990 to 2024 and exclude the first two quarters of 2020 because of the large output volatility during the pandemic. For the Backus–Smith puzzle, we follow Itskhoki & Mukhin (2021) and use the average estimate from Corsetti et al. (2008), which is representative of the conventional value in the literature. "Fama β" refers to the regression coefficient in a Fama-style UIP regression of the realized change in the nominal effective dollar exchange rate on the US–RoW interest-rate differential. Because of large outliers in the RoW policy rate, we proxy for it with the advanced-economy policy rate. Consequently, we use the narrow nominal exchange rate in the Fama regression, and PPP-weighted OECD real GDP excluding the US for consistency. Results are robust to using the broad dollar exchange rate and RoW GDP.

Table 4 lists the five moments we target to pin down the relative standard deviations of the shocks. Four of these summarize major exchange-rate puzzles: the volatility of the dollar exchange rate relative to R output, the correlation between changes in the nominal and real exchange rates, the correlation between real exchange-rate changes and the cross-country consumption differential and the coefficient estimate from a Fama regression. The fifth moment, the volatility of global output, sets the overall scale.

5.2 Model Performance

To assess the model's performance, we first confront its predictions for co-movement with the data. Table 5 reports results based on model simulations, contrasting the data moments in the left column, reproduced from Table 1, with model predictions based on each shock in isolation and with all shocks active in the right column. The top panel reports cross-country co-movement between the US and the RoW. The model performs well along this dimension: it predicts strong co-movement in asset prices, trade, and output, irrespective of the source of shocks. The same holds for the co-movement among the global cycles and for the co-movement of these cycles with the dollar, shown in the middle and bottom

Table 5: Global Co-movement—Model vs. Data

Moment	Data	U MP	R MP	U risk	R TFP	U TFP	All shocks
A. International co-movement							
$\text{corr}(\boldsymbol{\Delta} Q_R, \boldsymbol{\Delta} Q_U)$	0.80	0.99	0.99	0.99	0.96	0.96	0.96
$\text{corr}(\boldsymbol{\Delta} T_R/Z_R, \boldsymbol{\Delta} T_U/Z_U)$	0.81	0.99	0.65	0.99	0.15	0.98	0.95
$\text{corr}(\boldsymbol{\Delta} Z_R, \boldsymbol{\Delta} Z_U)$	0.60	0.94	0.98	0.97	0.90	0.92	0.74
B. Global cycles							
$\text{corr}(\boldsymbol{\Delta} Z_G, \boldsymbol{\Delta} GFCyc)$	0.69	0.60	0.55	0.51	0.69	0.71	0.51
$\text{corr}(\boldsymbol{\Delta} Z_G, \boldsymbol{\Delta} T_G^G/Z_G)$	0.76	0.62	0.71	0.57	0.43	0.38	0.50
$\text{corr}(\boldsymbol{\Delta} GFCyc, \boldsymbol{\Delta} T_G^G/Z_G)$	0.56	1.00	0.97	0.99	0.87	0.92	0.93
C. Global cycles and dollar exchange rate							
$\text{corr}(\boldsymbol{\Delta} \mathcal{E}, \boldsymbol{\Delta} GFCyc)$	-0.41	-0.95	-0.93	-0.94	-0.44	-0.95	-0.87
$\text{corr}(\boldsymbol{\Delta} \mathcal{E}, \boldsymbol{\Delta} Z_G)$	-0.51	-0.78	-0.77	-0.74	0.20	-0.61	-0.61
$\text{corr}(\boldsymbol{\Delta} \mathcal{E}, \boldsymbol{\Delta} T_G^G/Z_G)$	-0.45	-0.96	-0.98	-0.97	-0.64	-0.92	-0.96

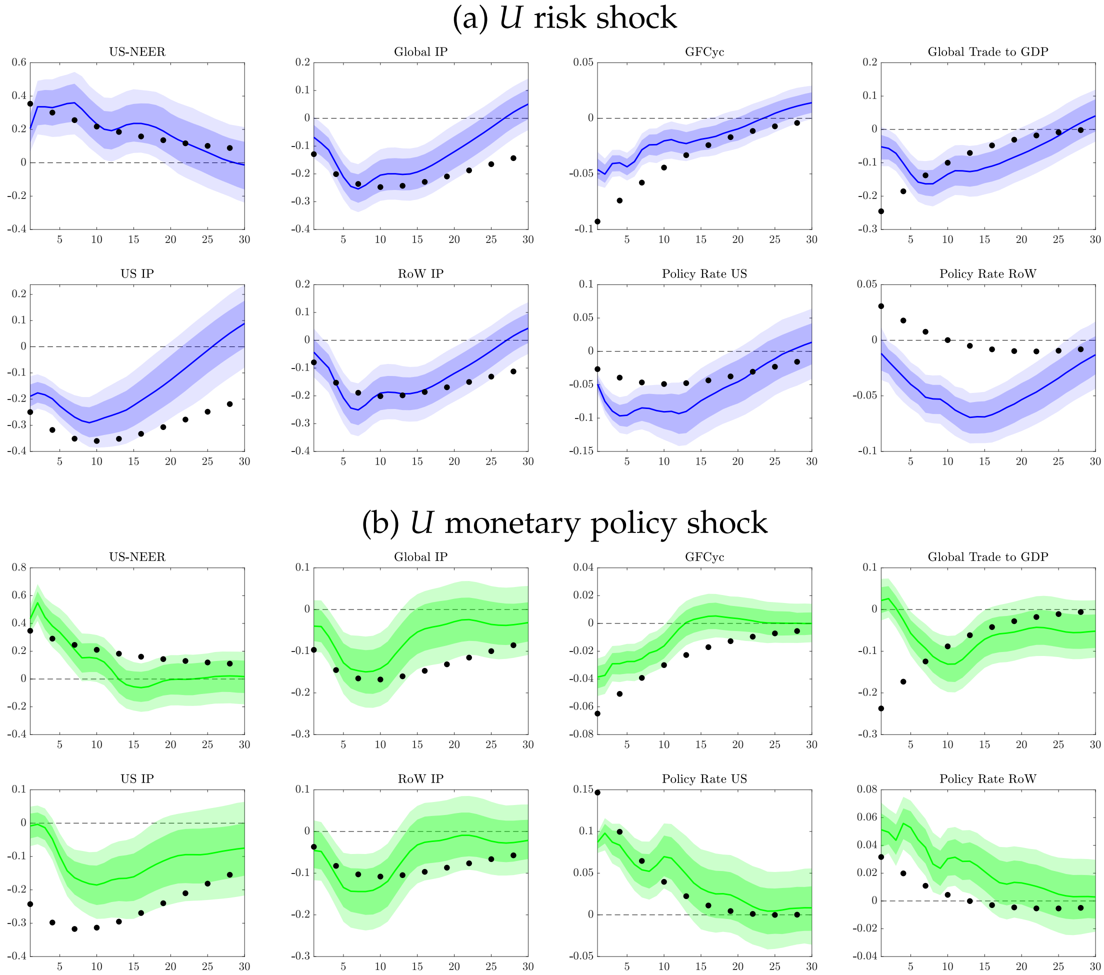
Notes: Each column reports moments based on 10,000 simulated periods for model versions with different shocks or combinations of shocks. $\boldsymbol{\Delta}$ refers to year-over-year log changes. See the notes to Table 1. In the trinity model, $GFCyc$ denotes the global financial cycle, measured as in the data by the first principal component of changes in U and R asset prices. Z_G and T_G^G/Z_G denote global GDP and the global exports-to-GDP ratio, constructed as country-size-weighted averages; see Equation (D.68) and Equation (D.69). $\mathcal{E}$ denotes the nominal dollar exchange rate. Q_R and Q_U denote the price of capital in R and U, respectively. Country-specific trade-to-GDP ratios are constructed analogously.

panels, respectively. Importantly, these moments did not serve as calibration targets.

Next, we consider dynamics conditional on U risk and monetary policy shocks. Figure 6 compares the impulse responses from the trinity model (dots) with the VAR estimates from Section 3 (solid lines). Because the structural model is quarterly whereas the VAR is monthly, we plot model responses only every three months. We also account for the fact that the model features real GDP, whereas the VAR includes industrial production, and for the fact that the model-implied global financial cycle is measured by global asset prices rather than by the factor of Miranda-Agrippino & Rey (2020).[23] The impulse responses

[23]To make percentage deviations of flow variables—such as output—from the quarterly trinity model comparable to those from the monthly VAR model, we report the corresponding three-month trailing moving average of the latter's impulse responses, as suggested by Born & Pfeifer (2014). Since industrial production is about 2.5 times more volatile than real GDP in quarterly data, we scale the model-implied real GDP response accordingly; see Georgiadis et al. (2024) for a discussion. To compare the model-implied response of global asset prices, Q_G, to the global financial cycle measure, we use the mapping in Miranda-Agrippino & Rey (2020), according to which a 40% impact fall in the global financial cycle measure roughly translates into an 8% impact

Figure 6: Adjustment to structural shocks: model vs. VAR



Notes: Solid blue and green lines show VAR responses to the U risk and U monetary policy shocks, respectively; shaded areas denote 68/90% credible sets. Black dots show impulse responses from the trinity model. We scale the model responses so that the dollar appreciates, on average, by the same amount over the first year as in the VAR responses. Footnote 23 provides further details on the scaling of the impulse responses. To save space, responses of US consumer prices, the US credit spread, and global asset prices as measured by the Dow Jones World Index are shown in Figure B.5 in the Appendix.

in the trinity model align well with their empirical counterparts.

6 Understanding Trinity

To understand the role of dollar trinity for global co-movement, we first benchmark the transmission mechanism in the baseline model against a counterfactual

decline in local stock markets. We account for the fact that Miranda-Agrippino & Rey (2020) use a non-standardized global financial cycle series for this calculation, whereas the VAR model uses their standardized series. As shown in Figure B.5, this transformation is not crucial, since the model-implied changes in global asset prices are also close to the shock-induced changes in the Dow Jones World index.

model without dollar dominance. We then trace the difference between the trinity and no-dominance models to the individual contributions of the three dimensions of dollar dominance and, importantly, to their interaction.

6.1 A Counterfactual without Dollar Dominance

The counterfactual model without dollar dominance is nested in the trinity model of Section 4. First, to remove dollar dominance in trade, we assume producer-currency pricing for U–R trade and intra-R sales, setting $\widehat{\gamma}_R^U = \widehat{\gamma}_R^R = 0$ and $\widehat{\gamma}_U^R = 1$. Second, to remove dollar dominance in cross-border credit, we eliminate R banks' steady-state incentive to borrow in dollars from U banks by setting the cost of cross-border dollar borrowing equal to the cost of domestic funding.[24] In U, cross-border credit is frictionless: U banks act only as intermediaries, with $\Gamma^{CBDL} = 0$ and $\Phi_{U,\phi} = 0$, and earn no profits from doing so. Finally, to remove dollar dominance in safe assets, we eliminate R banks' steady-state incentive to hold U Treasuries. Treasuries no longer have a liquidity advantage, $\epsilon_{R,\alpha} = 0$, nor do they hedge dollar liabilities, $\kappa_{R,\alpha,\ell} = 0$. The convenience yield is therefore zero, and UIP holds.[25]

To benchmark the trinity model against the counterfactual, we focus on the transmission of a risk shock originating in U. Figure 7 reports the responses of selected variables.[26] Red lines with circles depict the adjustment in the trinity model, while blue lines with diamonds depict the adjustment in the no-dominance model. The difference is stark. In the trinity model, the U risk shock raises the convenience yield for the reasons discussed in Section 4.5 (upper-left panel), which induces the dollar to appreciate. In contrast, without dollar dominance, UIP holds, and there is no convenience yield; as a result, the dollar response is largely flat.

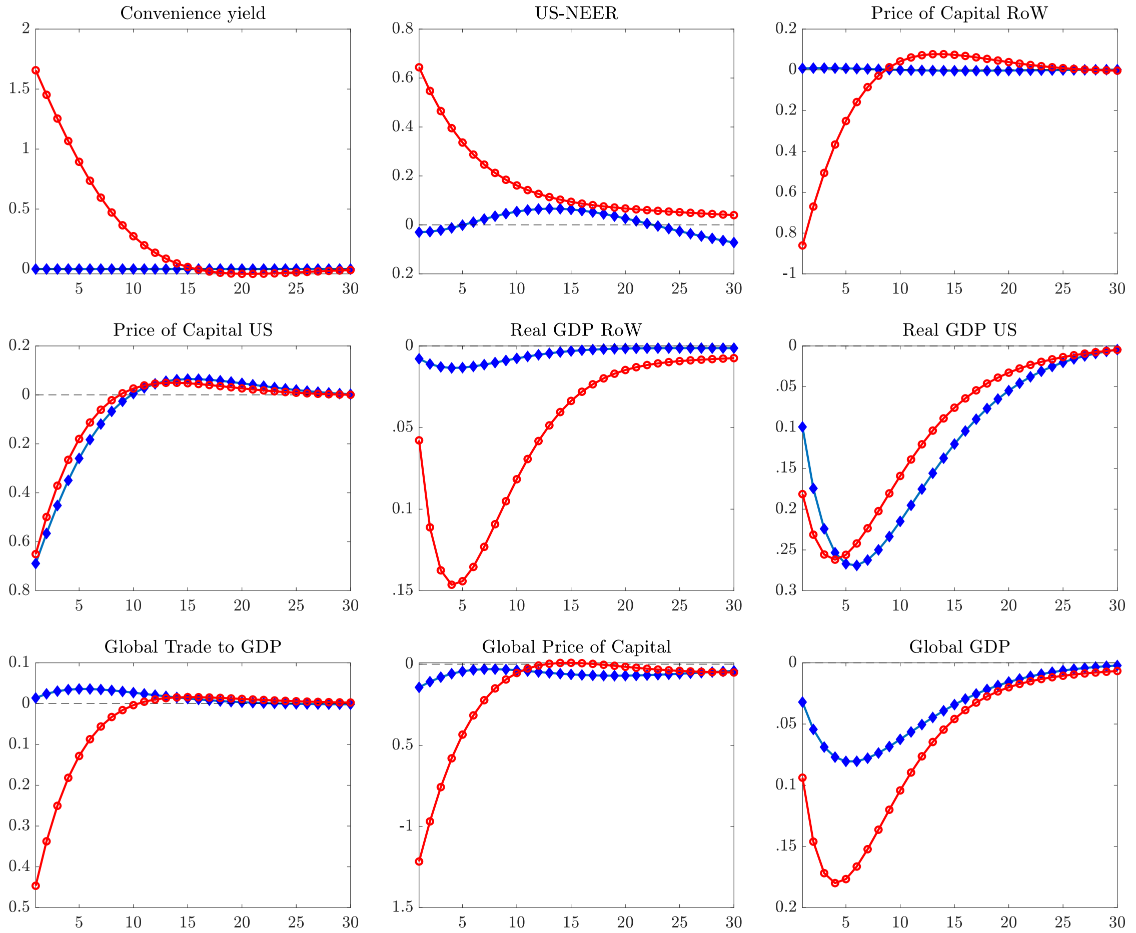
Financial conditions in R also remain largely unaffected by the shock in the no-dominance world (upper-right panel). The drop in asset prices is confined to U (middle-left panel), and the same holds for output in R (middle panel): while R output contracts in sync with U output in the trinity model (center panel), the recession remains largely confined to U in the counterfactual. This difference is also reflected in the global cycles, whose key indicators are shown in the bottom

[24]Specifically, the R government taxes cross-border loans on R banks' balance sheets so that the cost of cross-border dollar borrowing equals the cost of local borrowing.

[25]We assume that the R government subsidizes the returns R banks earn on U Treasuries so that, in steady state, they equal the R risk-free rate. To ensure determinacy, we assume that the balance-sheet constraint tightens with the share of unhedged dollar loans, along the lines of Schmitt-Grohé & Uribe (2003), so that $\kappa_{R,\alpha,\ell}$ is only approximately zero.

[26]Results are similar for other shocks: see Figure B.6 for the responses to the U monetary policy shock.

Figure 7: Responses to a risk shock: trinity vs. no-dominance counterfactual



Notes: Red lines with circles show impulse responses of the trinity model; blue lines with diamonds show impulse responses of the no-dominance counterfactual. The U risk shock is normalized to increase the U bank balance-sheet risk weight by 1%. The global price of capital is the country-size-weighted average of the prices of capital in U and R, expressed in dollars and U per capita terms; see Equation (D.69). The global trade-to-GDP ratio is calculated as the ratio of global trade—the sum of U–R, R–U, and intra-R exports—to global GDP, given by the country-size-weighted average of U and R GDP; see Equation (D.68).

row. Absent dollar trinity, there is little global co-movement. Only the global business cycle contracts noticeably, because U accounts for 25% of the global economy in the model calibration.[27]

[27]Note that the US GDP is similarly affected in both model versions. On the one hand, in the trinity model, the global financial accelerator implies that the effects of the shock on R spill back to U. Dollar appreciation raises the local-currency value of R banks' dollar liabilities and increases their leverage. This raises the risk weight on cross-border lending for U banks, which in turn charge higher rates to foreign banks and reduce cross-border dollar credit. On the other hand, in the trinity, dollar appreciation generates imported deflation in U, inducing monetary easing that partly stabilizes domestic consumption, investment, and bank net worth. On impact, however, the spillback through R bank leverage almost doubles the contraction in U output.

6.2 Trinity is more than the sum of its parts

So far, we have established that trinity is key for global co-movement in response to U shocks. We now show that trinity is more than the sum of its parts by decomposing the response to a U risk shock into the contributions of the three dimensions of dollar dominance and, importantly, their interaction. To this end, we distinguish the trinity model ($\ell = \text{T}$), a model with no dollar dominance ($\ell = \text{NOD}$), a model with dollar dominance only in trade ($\ell = \text{DCP}$), only in cross-border debt ($\ell = \text{DCD}$), and only in safe assets ($\ell = \text{DCA}$). Let $\boldsymbol{\theta}^{\ell}$ denote the response of a variable to a U risk shock in model ℓ. We then have the identity

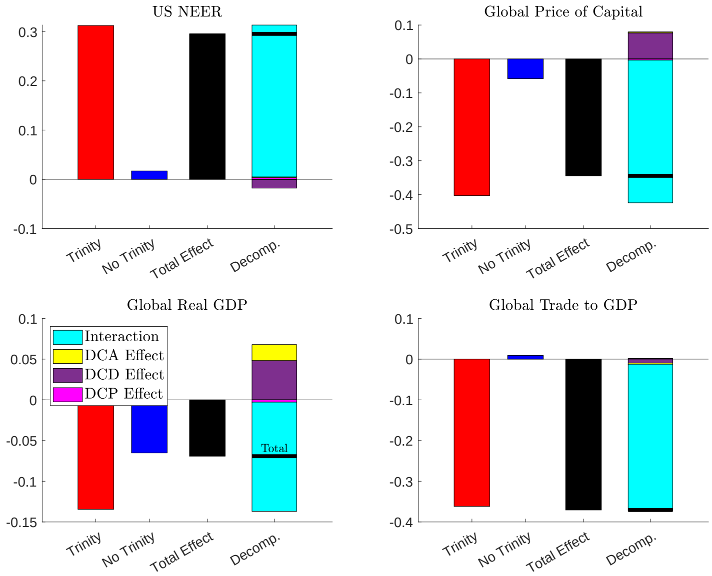
$$\underbrace{\boldsymbol{\theta}^{\text{T}} - \boldsymbol{\theta}^{\text{NOD}}}_{\substack{\text{total}\\ \text{trinity effect}}} = \underbrace{\left(\boldsymbol{\theta}^{\text{DCP}} - \boldsymbol{\theta}^{\text{NOD}}\right)}_{\text{DCP effect}} + \underbrace{\left(\boldsymbol{\theta}^{\text{DCD}} - \boldsymbol{\theta}^{\text{NOD}}\right)}_{\text{DCD effect}} + \underbrace{\left(\boldsymbol{\theta}^{\text{DCA}} - \boldsymbol{\theta}^{\text{NOD}}\right)}_{\text{DCA effect}} + \underbrace{\mathcal{I}}_{\substack{\text{trinity inter-}\\ \text{action effect}}}, \tag{15}$$

where $\mathcal{I}$ is the residual that makes the decomposition hold. The first three terms on the right-hand side capture the effects of adding one dimension of dollar dominance at a time relative to the no-dominance model. The interaction term is non-zero whenever the three dimensions of dollar dominance jointly generate effects that go beyond the sum of their individual contributions.

Figure 8 shows the decomposition for selected variables. In each panel, the left bar (red) shows the average impulse response to the risk shock over the first three years. The second bar (blue) shows the response in the no-dominance counterfactual, $\ell = \text{NOD}$, while the third bar (black) shows the difference between the two. The rightmost bar decomposes this difference into the contributions of the individual dimensions of dollar dominance and their interaction; the horizontal black line indicates the total trinity effect, $\boldsymbol{\theta}^{\text{T}} - \boldsymbol{\theta}^{\text{NOD}}$. Within this bar, the yellow, purple, and magenta areas show the effects of dollar dominance in safe assets (DCA), cross-border debt (DCD), and trade (DCP), respectively, relative to the no-dominance response, that is, $\boldsymbol{\theta}^{\text{DCA}} - \boldsymbol{\theta}^{\text{NOD}}$, $\boldsymbol{\theta}^{\text{DCD}} - \boldsymbol{\theta}^{\text{NOD}}$, and $\boldsymbol{\theta}^{\text{DCP}} - \boldsymbol{\theta}^{\text{NOD}}$. The cyan area captures the residual trinity interaction effect, $\mathcal{I}$. The decomposition is similar for the U monetary policy shock; see Figure B.8.

Consider first the exchange-rate response, shown in the upper-left panel. The dollar appreciation under trinity is almost entirely due to interaction effects. The reason is that safe-asset dominance and dollar credit dominance reinforce each other. Safe-asset dominance creates a convenience-yield channel, but this channel becomes quantitatively powerful only because dollar appreciation tightens R banks' balance sheets through dollar-denominated liabilities, raising the value of safe collateral. Conversely, dollar debt dominance generates amplification

Figure 8: Decomposing dollar trinity after a U risk shock



Notes: Black bars show the average difference between the effect of a U risk shock in the trinity model and the no-dominance model, $\boldsymbol{\theta}^{\mathrm{T}} - \boldsymbol{\theta}^{\mathrm{NOD}}$, over the first three years. Yellow, purple, and magenta bars show the effects of adding dominance in safe assets, $\boldsymbol{\theta}^{\mathrm{DCA}} - \boldsymbol{\theta}^{\mathrm{NOD}}$, cross-border debt, $\boldsymbol{\theta}^{\mathrm{DCD}} - \boldsymbol{\theta}^{\mathrm{NOD}}$, and trade, $\boldsymbol{\theta}^{\mathrm{DCP}} - \boldsymbol{\theta}^{\mathrm{NOD}}$, respectively. Turquoise bars indicate the trinity interaction effect, $\mathcal{I}$. The U risk shock is normalized to increase the U balance-sheet-specific risk weight by 1%. The global price of capital is a country-size-weighted average of the prices of capital in U and R; see Equation (D.69). The global trade-to-GDP ratio is the ratio of global trade—the sum of U–R, R–U, and intra-R exports—to global GDP, given by the country-size-weighted average of U and R GDP; see Equation (D.68). The corresponding dynamic impulse responses are shown in Figure B.7 in the Appendix.

only when dollar assets command a convenience yield. A very similar picture emerges for global asset prices, shown in the upper-right panel, but with the sign reversed.

Turning to global GDP, shown in the lower-left panel, the interaction effect is particularly striking because it reverses the sign of the individual effects. In isolation, both dollar dominance in safe assets (DCA) and dollar dominance in cross-border debt (DCD) make the output response more benign than in the no-dominance benchmark. Under DCA alone, R banks can shift toward U Treasuries when the shock hits. Since Treasuries relax their balance-sheet constraint, this cushions the decline in lending and output. Under DCD alone, R banks are initially better hedged because cross-border dollar borrowing provides an additional funding source, while U banks diversify away from domestic claims by lending to R banks. Since the dollar does not appreciate notably in the absence of DCA, these stabilizing forces are not offset by balance-sheet losses on dollar liabilities.

Under trinity, however, the same mechanisms interact with very different

Table 6: Decomposing dollar trinity

Moment	Data	Trinity	No trinity	DCP	DCD	DCA
A. International co-movement						
corr$(\boldsymbol{\Delta} Q_R, \boldsymbol{\Delta} Q_U)$	0.80	0.96	0.05	0.05	-0.22	-0.05
corr$(\boldsymbol{\Delta} T_R/Z_R, \boldsymbol{\Delta} T_U/Z_U)$	0.80	0.95	-1.00	0.11	-1.00	-1.00
corr$(\boldsymbol{\Delta} Z_R, \boldsymbol{\Delta} Z_U)$	0.60	0.74	0.09	0.14	-0.09	0.10
B. Global cycles						
corr$(\boldsymbol{\Delta} Z_G, \boldsymbol{\Delta} GFCyc)$	0.69	0.51	0.26	0.26	0.30	0.21
corr$(\boldsymbol{\Delta} Z_G, \boldsymbol{\Delta} T_G^G/Z_G)$	0.76	0.50	-0.11	-0.12	0.44	0.00
corr$(\boldsymbol{\Delta} GFCyc, \boldsymbol{\Delta} T_G^G/Z_G)$	0.56	0.93	-0.45	0.20	0.72	-0.45
C. Global cycles and dollar						
corr$(\boldsymbol{\Delta}\mathcal{E}, \boldsymbol{\Delta} GFCyc)$	-0.41	-0.87	-0.17	-0.25	0.72	-0.36
corr$(\boldsymbol{\Delta}\mathcal{E}, \boldsymbol{\Delta} Z_G)$	-0.51	-0.61	0.17	0.09	0.22	-0.02
corr$(\boldsymbol{\Delta}\mathcal{E}, \boldsymbol{\Delta} T_G^G/Z_G)$	-0.45	-0.96	0.43	-0.85	0.71	0.31
D. Model fit						
RMSE relative to trinity		1.00	3.05	1.92	3.23	2.95

Notes: See notes to Table 5. RMSE is the Root Mean Square Error, computed for each model by comparing the model-implied moments to the data. We normalize the RMSE for the Trinity model to one, so that, for all other model versions, the difference in the RMSE relative to 1 can be interpreted as a percentage deviation relative to the Trinity model. For comparability, we do not optimize or re-optimize over the variances of the shocks when switching off different dimensions of trinity. The results are robust to doing so; see Table C.2.

implications. Safe-asset dominance makes the dollar appreciate through the convenience-yield channel, and this appreciation turns dollar debt from a hedge into an amplification device: it raises the local-currency value of R banks' dollar liabilities, tightens their balance sheets, and feeds back into U banks through higher risk weights on cross-border lending. The interaction between DCA and DCD therefore overturns their benign individual effects and amplifies the contraction in global output. A similar picture emerges for the U monetary shock (see Figure B.8).

Note that dollar dominance in trade (DCP) alone plays essentially no role in generating the total trinity effect. The reason is that, with dominance in trade only, the dollar exchange rate does not appreciate, so the relative price of dollar-invoiced imports does not rise compared with the no-dominance case. As a result, DCP alone generates neither stronger expenditure switching nor any other differential adjustment relative to the no-dominance benchmark. Yet DCP is crucial in an interaction sense: once the dollar appreciates because of the financial dimensions of trinity, dollar pricing is what translates this appreciation into the contraction in global trade (bottom-right panel).

Finally, moving beyond the adjustment to a U risk shock, Table 6 shows that the model matches the forms of co-movement only under trinity. No individual dimension of dollar dominance comes close to matching the data moments on co-movement across countries, across cycles, and with the dollar, as measured by the root mean squared error. This remains true even when, for each model version, we re-optimize over the shock variances to best explain the exchange-rate puzzles in Table 4; see Table C.2 in the Appendix. Again, the individual dimensions of dollar dominance interact to produce the total trinity effect.

7 Liberation Day, the Dollar, and Global Imbalances

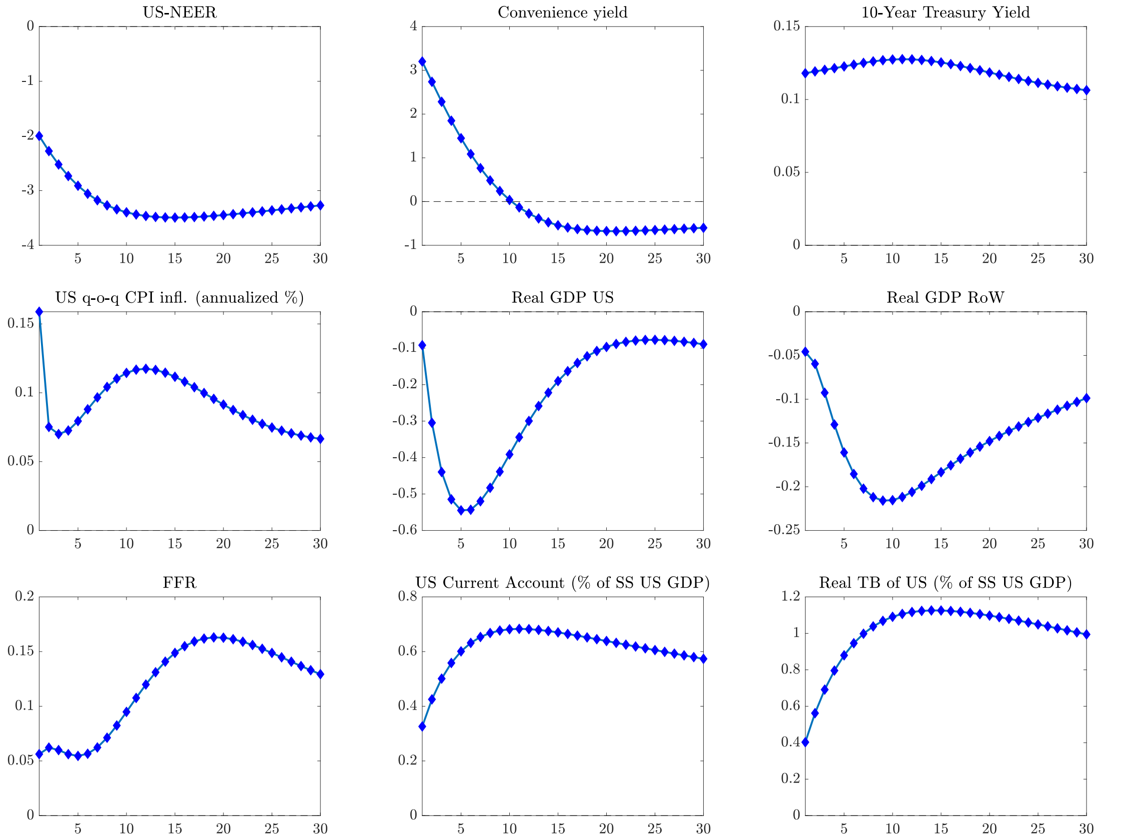
After the Liberation Day announcement by US President Trump in April 2025, global economic uncertainty (and risk aversion) increased. Yet the US dollar weakened overall rather than receiving a safe-haven boost. At the same time, US long-term interest rates rose—a change in the pattern of co-movement compared with previous years that many observers found noteworthy (see, for instance, Financial Times 2025; Jiang, Krishnamurthy, et al. 2025). The announcement was primarily about tariffs, but it took place against the backdrop of discussions within the second Trump administration about weakening the dollar or "taxing" foreign dollar holdings, sometimes referred to as a possible "Mar-a-Lago Accord." As a consequence, the episode raised doubts about the dollar's safe-asset status.

Given its empirical success, we use the trinity model to develop a structural interpretation of the developments in the wake of the Liberation Day announcement (see also Itskhoki & Mukhin 2026; Hassan et al. 2025; Acharya & Laarits 2026; Jiang et al. 2026). Specifically, we capture the effect of the announcement on the dollar's role as a safe asset through a decline in $\epsilon_{R,\alpha}$ in Equation (4).[28] This captures, in reduced form, the idea that the announcement made Treasuries less safe, reducing the convenience yield of Treasury holdings in the RoW:

$$CY_{R,t} = \underbrace{-\frac{\partial\delta_{R,t}/\partial\alpha^{GB}_{R,t}}{\delta_{R,t}}}_{\text{weaker as } \epsilon_{R,\alpha} \text{ declines}} \cdot \underbrace{(1-\alpha^{GB}_{R,t})\mathbf{E}_t\left[\Omega_{R,t,t+1}\left(R^K_{R,t+1}-R^D_{R,t}\right)\right]}_{\text{returns from freed-up leverage}}.$$

[28] Since this is a parameter change and not an ordinary stochastic process, the experiment can be interpreted as an "MIT shock."

Figure 9: Adjustment to the Liberation Day announcement



Notes: Responses to a reduction in $\epsilon_{R,\alpha}$ calibrated to depreciate the dollar by 2%. We assume a persistence of 0.99, so that the decline in the safety of Treasuries is almost permanent.

To illustrate the implications for the dollar exchange rate, we assume $\Gamma^{GB} = 0$, as before, and linearize and iterate Equation (10) forward to obtain

$$\widehat{\mathcal{E}}_t = \lim_{k\to\infty} \mathbf{E}_t[\widehat{\mathcal{E}}_{t+k}] + \sum_{j=0}^{\infty} \mathbf{E}_t \left[r_{U,t+j} - r_{R,t+j} + cy_{R,t+j} \right].$$

The equation shows that the current value of the dollar is determined by the expected future path of interest-rate differentials and convenience yields. In particular, a lower expected future convenience yield reduces the attractiveness of holding dollars and therefore puts downward pressure on the exchange rate today.

Figure 9 shows the impulse responses to the reduction in $\epsilon_{R,\alpha}$ based on the calibrated model. The dollar depreciates on impact (upper-left panel), with the size of the shock chosen to generate a 2% dollar depreciation in line with developments following the Liberation Day announcement. In the model, this reflects the decline in convenience yields over the medium to long run (upper-middle panel): as Treasuries become less safe, investors require a smaller non-pecuniary return from holding them, and the dollar loses part of its safe-asset premium. For the same reason, the pecuniary yield on long-term bonds, computed using the expectations hypothesis, rises (upper-right panel). Note, however, that the convenience yield rises in the short run because financial conditions tighten: its decline in the longer-run dominates the impact response of the dollar.

The second row shows the responses of US inflation (left), U GDP (middle), and R GDP (right). GDP contracts in both countries because credit conditions tighten globally; US inflation rises because the dollar depreciates and induces US monetary policy to tighten (lower-left panel). At the same time, the US current account and trade balance improve substantially, as shown in the lower-middle and lower-right panels. This improvement reflects weaker R demand for Treasuries and the associated capital outflows from the US.

In sum, within the confines of our model, the Liberation Day announcement contributes to a rebalancing of global trade flows by altering financial conditions—notably by weakening the dollar's role as a safe-haven currency—and does so independently of how tariffs ultimately play out.

8 Conclusion

The world economy is marked by three layers of co-movement. Economic activity, financial conditions, and trade flows co-move across countries, giving rise to global business, financial, and trade cycles. These cycles are themselves tightly synchronized and systematically linked to the US dollar: when the cycles contract, the dollar tends to appreciate. We argue that this pattern reflects the dollar's special role in an asymmetric world economy. Because the dollar is dominant in trade invoicing, cross-border credit, and safe assets, shocks that move the dollar also propagate across countries and across cycles. Dollar trinity is therefore central to understanding why global financial conditions, trade, and activity move together.

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Online Appendices to
Dollar Trinity and Global Co-movement

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A Identification of shocks in the BPSVAR

A.1 Identifying the U.S. Main Business Cycle shock

It is well known that without further assumptions, the matrix A_0 in Equation (3.1) as well as its inverse A_0^{-1}, which captures the contemporaneous effect of structural shocks on the endogenous variables are not uniquely identified. As shown for instance in Arias et al. (2021) this identification problem can be restated by decomposing the impact matrix as $A_0^{-1'} = SQ$ where S is well identified lower-triangular matrix, which orthogonalizes the reduced form residuals and Q represents an unidentified, orthonormal matrix, where each column is linked to a specific structural shock. Given stationarity of the SVAR system, it allows for an SVMA representation of the form

$$y_t = \Theta(L)\epsilon = C(L)Q\epsilon_t, \tag{A.1}$$

with $\Theta(L)$ as an infinite polynomials capturing the structural impulse responses to the (unidentified) structural shocks, while $C(L)$ captures the (identified) impulse responses under the triangularized system defined by the matrix S. Given this decomposition, each column q of the matrix Q can be related to a specific structural shock and, as shown by Angeletos et al. (2020), the contribution of this shock to the spectral density of the variable d over the frequency band $[\underline{\omega}, \bar{\omega}]$ can be written as

$$\Gamma(q; d, \underline{\omega}, \bar{\omega}) = q'\Phi(d, \underline{\omega}, \bar{\omega})q = q' \int_{\underline{\omega}}^{\bar{\omega}} \overline{C^d(e^{-i\omega})} C^d(e^{-i\omega}) d\omega \, q, \tag{A.2}$$

with C^d as the impulse responses of the triangularized system that correspond to the variable of interest d. $\bar{x}$ indicates the complex conjugate transpose of x.[29] Lastly the matrix $\Phi(d, \underline{\omega}, \bar{\omega})$ expresses the entire volatility of the variable d in terms of the the shocks in the triangularized system as described by the matrix S and can be recovered from the data without any identifying assumptions. The U.S. Main Business Cycle shock is then identified by solving for the unit length vector q that maximizes the contribution of the corresponding shock to the volatility of US industrial production over the business cycle as defined in Equation (A.2). This boils down to computing the matrix $\Phi(d, \underline{\omega}, \bar{\omega})$ for the dollar and defining the column vector q that represents the MDS as the eigenvector associated with the largest eigenvalue of $\Phi(d, \underline{\omega}, \bar{\omega})$.

[29] We choose $\underline{\omega}$ and $\bar{\omega}$ such that, at quarterly frequency, the frequency band is given by $[\underline{\omega}, \bar{\omega}] = [\frac{2\pi}{6}, \frac{2\pi}{32}]$ which is the frequency band typically associated with the business cycle (Stock & Watson (1999), Angeletos et al. (2020))

A.2 Identifying the risk and monetary policy shocks

To achieve identification the BPSVAR framework exploits a $k \times 1$ vector of observed proxy variables—or, in alternative jargon, external instruments—$\boldsymbol{p}_t$. The proxy variables are assumed to be correlated with the k unobserved structural shocks of interest $\boldsymbol{\epsilon}_t^*$ (relevance condition) and orthogonal to the remaining unobserved structural shocks $\boldsymbol{\epsilon}_t^o$ (exogeneity condition):

$$E[\boldsymbol{p}_t \boldsymbol{\epsilon}_t^{*\prime}] = \boldsymbol{V}, \qquad E[\boldsymbol{p}_t \boldsymbol{\epsilon}_t^{o\prime}] = \boldsymbol{0}. \tag{A.3}$$

Our analysis closely builds on Georgiadis et al. (2024).

For the US risk, we use intra-daily changes in the price of gold around the time stamps of narratively selected events. The latter were originally selected by Bloom (2009), later updated by Piffer & Podstawski (2018) and Bobasu et al. (2021). To identify the U.S. risk shocks, we use all events that were labeled as U.S.-related events.

For the U.S. monetary policy shock we follow the industry standard and use intra-daily changes in three-month Federal (Fed) funds futures around FOMC announcements (Gertler & Karadi 2015; Miranda-Agrippino & Rey 2020). We account for the possible presence of central bank information effects by keeping only the interest-rate surprises for FOMC meetings for which the associated equity-price surprises have the opposite sign (Jarociński & Karadi 2020).

A.2.1 Identifying assumptions

Denote by ϵ_t^r the US risk aversion shock and by ϵ_t^{mp} the US monetary policy shock, and define $\boldsymbol{\epsilon}_t^* \equiv (\epsilon_t^r \epsilon_t^{mp})'$. Further denote by p_t^g the monthly time series of the intra-daily gold-price surprises on the narratively selected events, by p_t^i monthly time series of the intra-daily Fed-funds-futures surprises around FOMC meetings, and define $\boldsymbol{p}_t \equiv (p_t^g, p_t^i)'$. The relevance and exogeneity conditions are

$$E[\boldsymbol{\epsilon}_t^* \boldsymbol{p}_t'] = \begin{pmatrix} E[p_t^g \epsilon_t^r] & E[p_t^i \epsilon_t^r] \\ E[p_t^g \epsilon_t^{mp}] & E[p_t^i \epsilon_t^{mp}] \end{pmatrix} = \boldsymbol{V}, \tag{A.4a}$$

$$E[\boldsymbol{\epsilon}_t^o \boldsymbol{p}_t'] = \begin{pmatrix} E[p_t^g \boldsymbol{\epsilon}_t^o] & E[p_t^i \boldsymbol{\epsilon}_t^o] \end{pmatrix} = \boldsymbol{0}. \tag{A.4b}$$

First, in the relevance condition in Equation (A.4a) we assume that US risk shocks drive gold-price surprises in intra-daily windows around the narratively selected events, that is $E[p_t^g \epsilon_t^r] \neq 0$ and $E[p_t^g \epsilon_t^u] \neq 0$. Intuitively, an increase in US risk aversion up the price of gold as the archetypal safe asset (Baur & McDermott 2010). Piffer & Podstawski (2018) provides evidence that gold-price surprises are relevant instruments for risk/uncertainty shocks based on F-tests and Granger-causality tests. Ludvigson et al. (2021) use gold-price changes as a proxy variable in a similar context; and Engel & Wu (2018) use the gold price as a proxy for risk. Regarding the exogeneity condition $E[p_t^g \epsilon_t^o] = 0$ in Equation (A.4b), Piffer & Podstawski (2018) document that the intra-daily gold-price surprises on the narratively selected events are not systematically correlated with a range of measures of non-risk aversion/uncertainty shocks.[30]

Second, we assume that US monetary policy shocks drive the Fed-funds-futures surprises in intra-daily windows around FOMC announcements in the relevance condition in Equation (A.4a), $E[p_t^i \epsilon_t^{mp}] \neq 0$ (Gertler & Karadi 2015; Jarociński & Karadi 2020; Miranda-Agrippino & Rey 2020). Regarding the exogeneity condition $E[p_t^i \epsilon_t^o] = 0$ in Equation (A.4b), it is plausible that around FOMC meetings—especially after cleansing from central bank information effects—Fed-funds-futures surprises are driven only by monetary policy shocks.

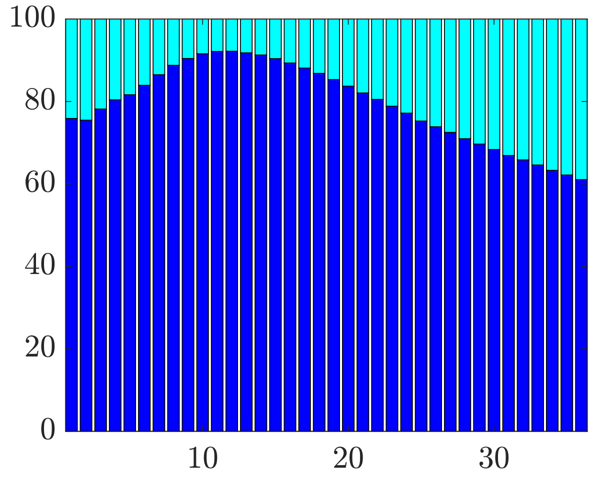
Third, we follow (Georgiadis et al. 2024) and impose an additional restriction to disentangle US risk from US monetary shocks. In particular, we impose the additional restriction that Fed-funds-futures surprises on FOMC meeting days are not driven by US risk shocks, that is $E[p_t^i \epsilon_t^r] == 0$ in Equation (A.4a). This additional restriction is implicitly maintained in the literature on the effects of monetary policy (Gertler & Karadi 2015; Jarociński & Karadi 2020; Miranda-Agrippino & Rey 2020; Miranda-Agrippino & Ricco 2021).[31]

[30]Note that the exogeneity condition $E[p_t^g \epsilon_t^o] = 0$ does not state that on every narratively selected event only risk aversion and uncertainty shocks occurred. Instead, the exogeneity condition states that only risk aversion shocks *systematically* across *all* narratively selected events.

[31]It would be natural to impose the analogous additional restriction that gold-price surprises on the narratively selected events are not driven by US monetary policy shocks, that is $E[p_t^g \epsilon_t^{mp}] = 0$ in Equation (A.4a). However, in the estimation algorithm of Arias et al. (2021) such over-identifying restrictions cannot be implemented. Therefore, we do not impose this additional restriction.

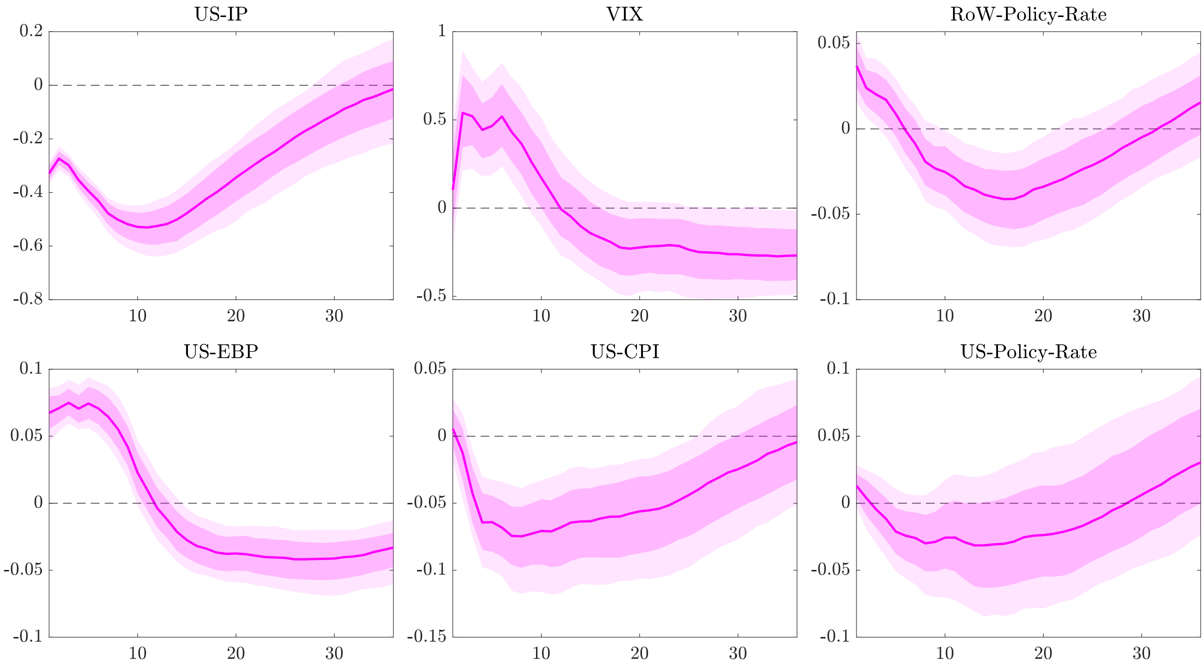
B Online appendix - Additional figures

Figure B.1: Role of the MBCS in the Forecast Error Variance of the US-Industrial Production



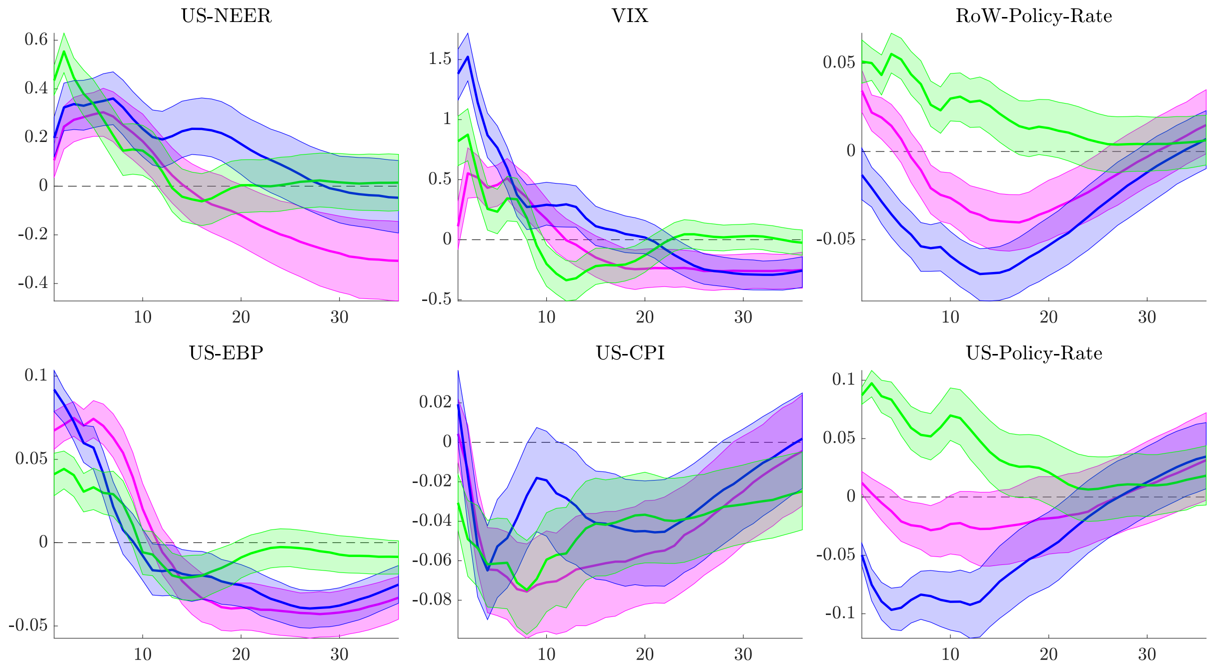
Note: The figure shows the point-wise median of the estimated contribution of the MBCS for the Forecast Error Variance of the US-NEER at different horizons. The blue (turquoise) bars measure the corresponding contribution of the MBCS (other shocks).

Figure B.2: Remaining IRFs to the US Main Business Cycle Shock



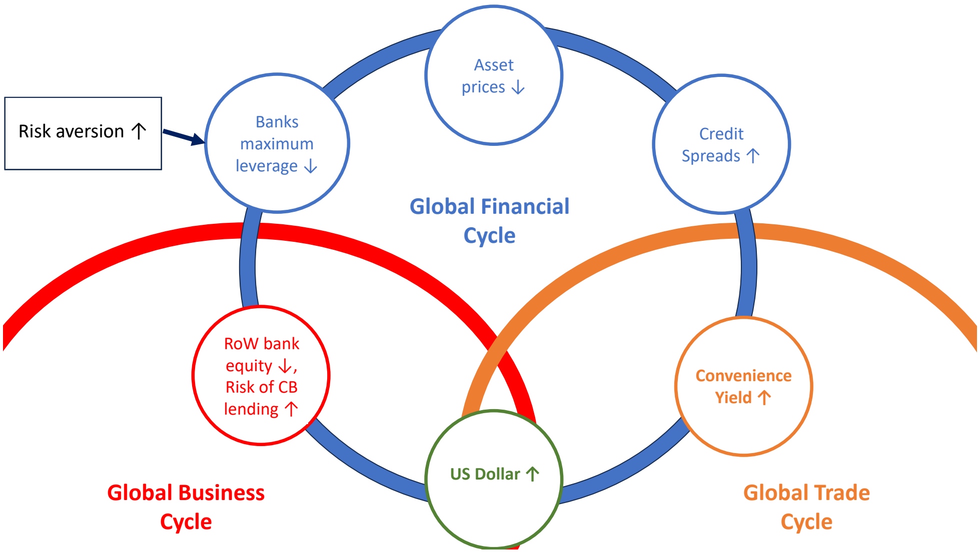
Note: The horizontal axis denotes time in months. Blue solid lines represent point-wise posterior means and shaded areas 68/90% equal-tailed, point-wise credible sets.

Figure B.3: Remaining IRFs for US risk (blue), US monetary policy (green), and US main business cycle shock (magenta)



Note: Responses to a US risk aversion (blue), US monetary policy (green) shock, and the US main business cycle Shock (magenta). The horizontal axis denotes time in months. The vertical axis deviation from pre-shock level in percent or annualized percentage rates (for interest rates and credit spreads). The size of shock is one standard deviation.

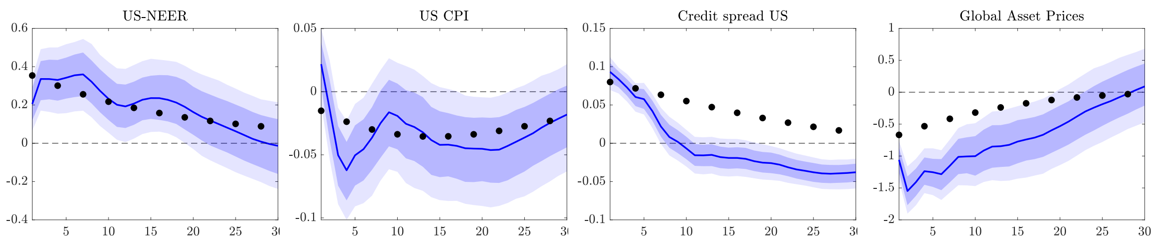
Figure B.4: The dollar exchange rate and global cycles



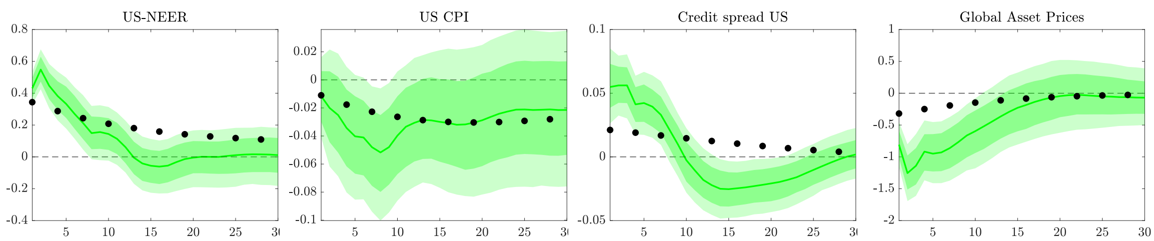
Note: This figure illustrates the interaction of the three global cycles embedded in the trinity model

Figure B.5: The global transmission mechanism—Trinity v VAR (add. variables)

a) US risk shock

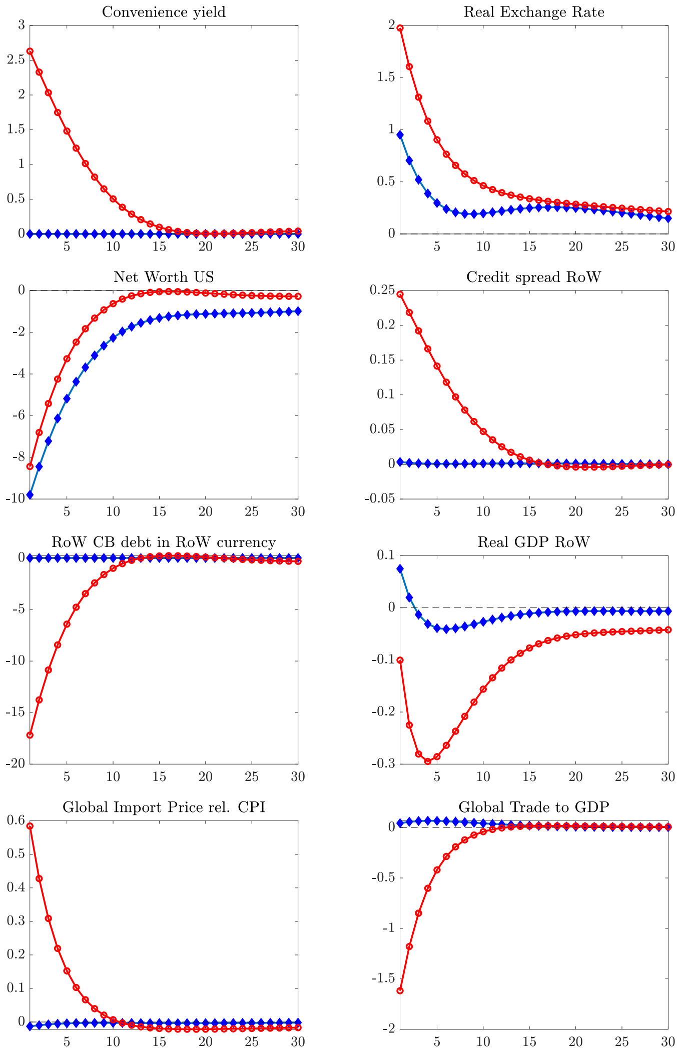


b) U.S. Monetary policy shock



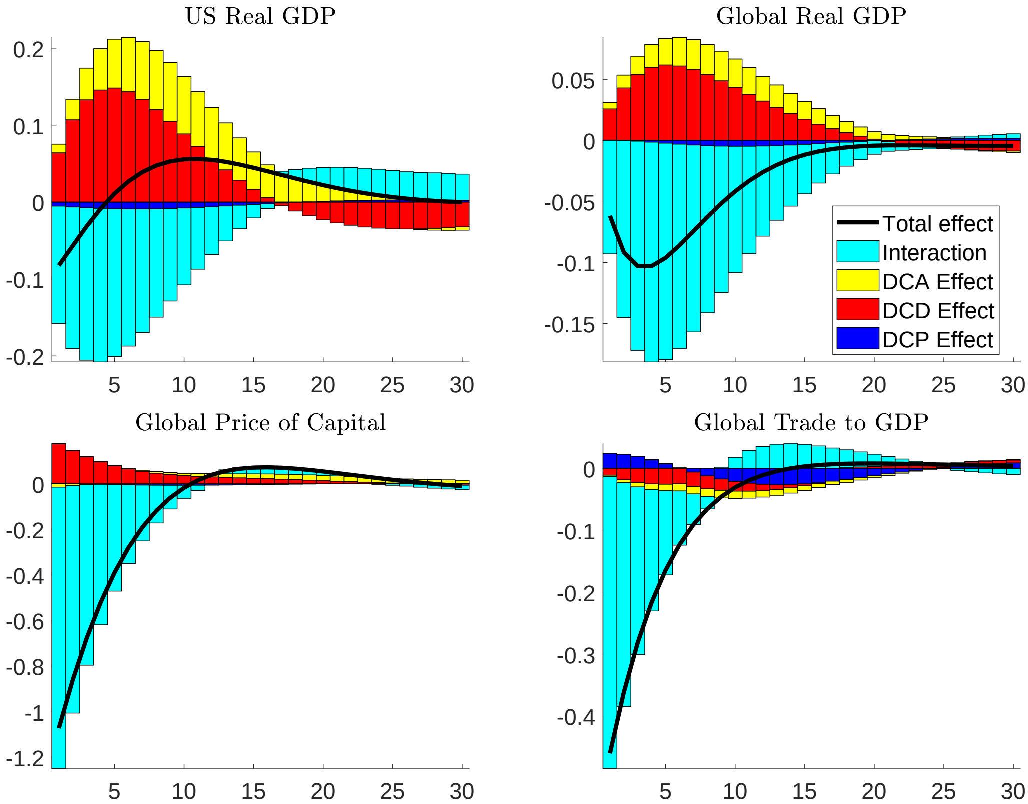
Note: Solid blue lines show BPSVAR model responses. Red dots show impulse responses of trinity model. Footnote 23 provides further details on the scaling of impulse responses. The Dow Jones World Index was added to the baseline BPSVAR to construct another measure for the global financial cycle that does not suffer from the scaling issues that plague the GFCyc of Miranda-Agrippino & Rey (2020).

Figure B.6: Responses to a US monetary policy shock with (red circles) and without (blue diamonds) dollar trinity



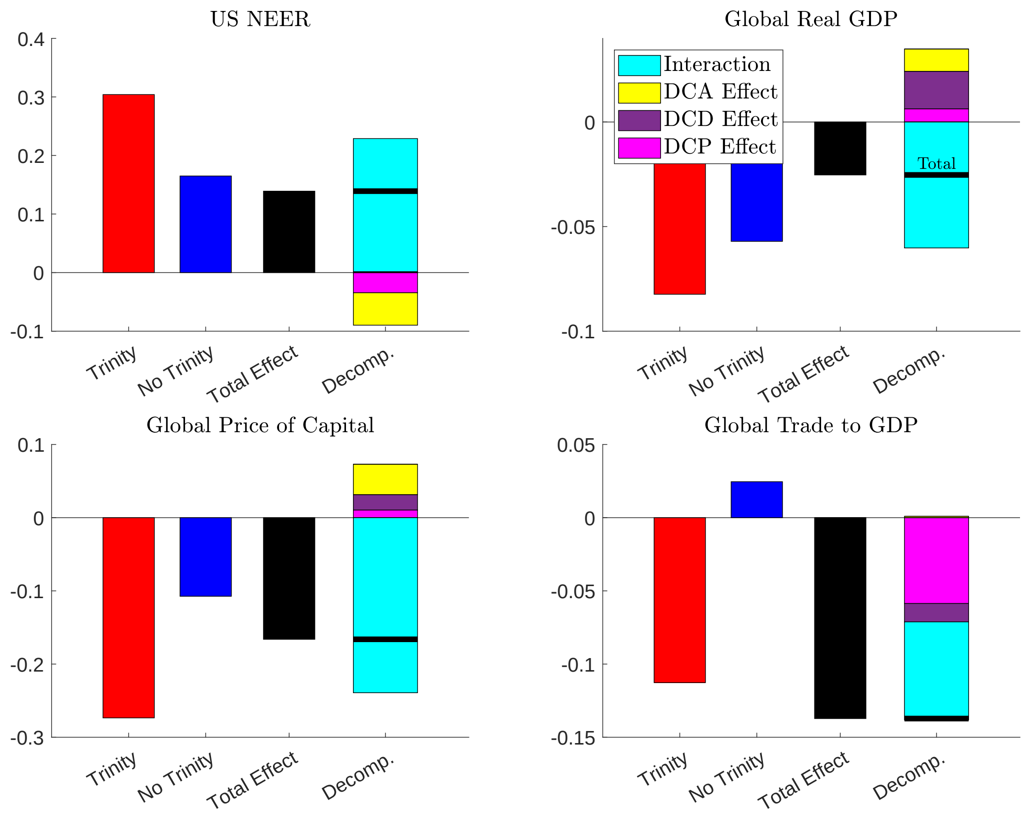
Note: The red lines with circles show the impulse responses of baseline model and the blue lines with diamonds from an alternative model in which we switch off dollar trinity. The US monetary policy shock aversion shock is normalized to increase the US policy rate by 25 basis points.

Figure B.7: Dynamics the role of individual dollar dominance dimensions for the US risk shock



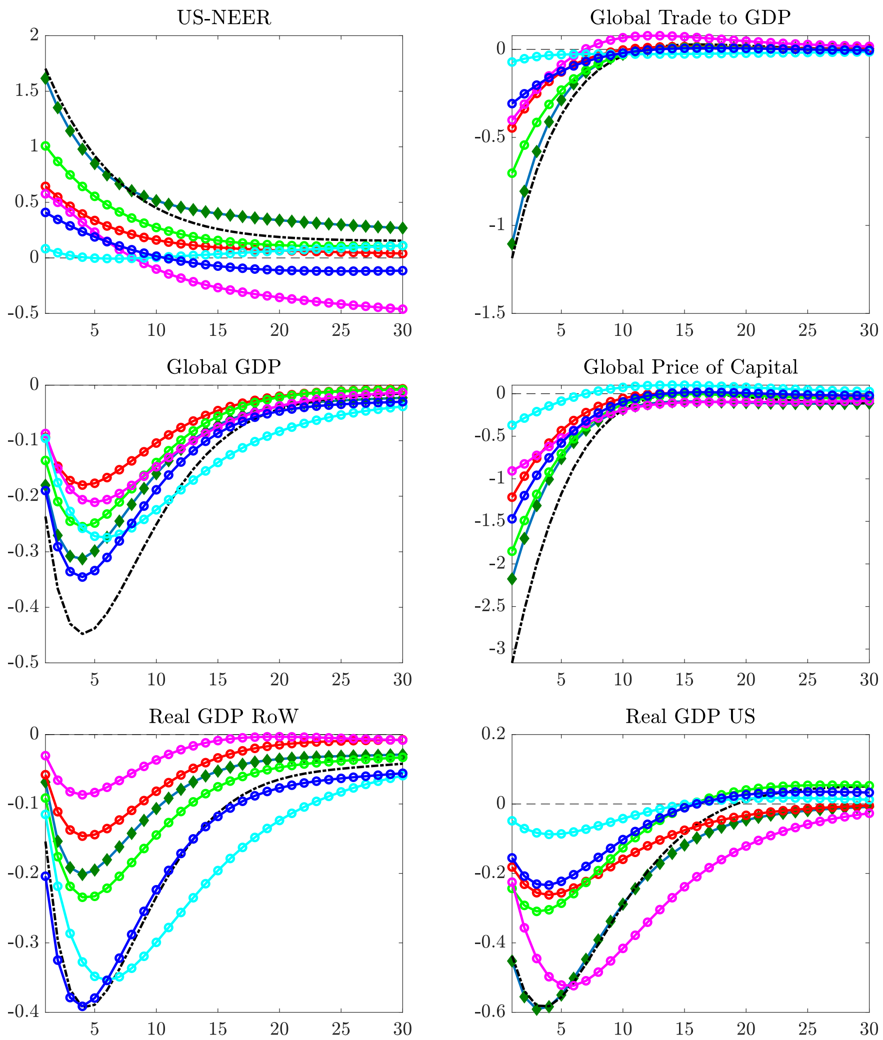
Note: Black lines show the difference between the effect of a US risk shock in the trinity model and the no-dominance model, $\boldsymbol{\theta}^{T} - \boldsymbol{\theta}^{NOD}$. Yellow, red, and blue bars show the effects of moving from the trinity to the models with dominance in safe assets ($\boldsymbol{\theta}^{\text{DCA}} - \boldsymbol{\theta}^{\text{cf}}$), cross-border debt ($\boldsymbol{\theta}^{\text{DCD}} - \boldsymbol{\theta}^{\text{cf}}$), and dominant in trade ($\boldsymbol{\theta}^{\text{DCP}} - \boldsymbol{\theta}^{\text{cf}}$), respectively. Turquoise bars indicate the trinity interaction effect ($\mathcal{I}$). The shock is normalized to increase the US balance-sheet-specific risk weight by 1%. The global price of capital is a country-size weighted average of the prices of capital in U and R (see Equation (D.69)). The global trade-to-GDP ratio is calculated as the ratio of global trade, as given by the sum of $U-R$ and $R-U$ and intra R export, relative to global GDP as given by the country size weighted average of U and R GDP (see Equation (D.69))

Figure B.8: Unpacking the role of individual dollar dominance dimensions for the US monetary policy shock shock



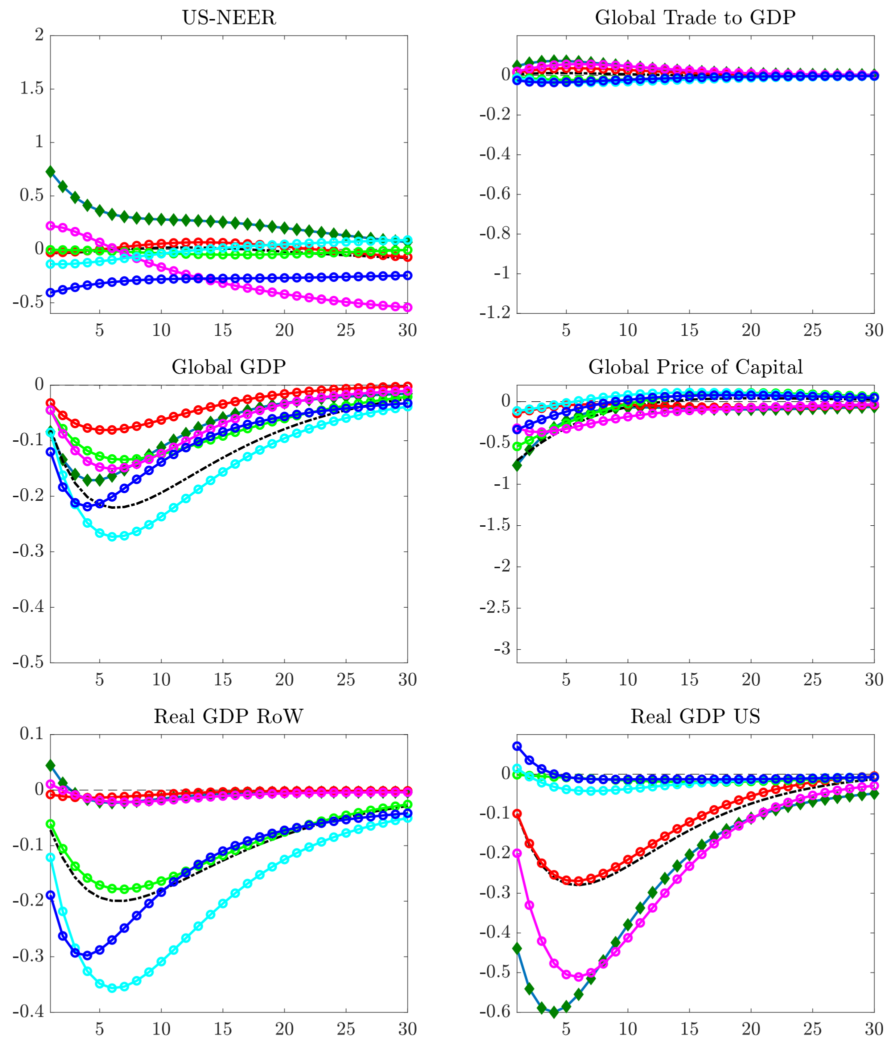
Note: Black bars show the average difference between the effect of a U Monetary Policy Shock in the trinity model and the no-dominance model, $\boldsymbol{\theta}^{T} - \boldsymbol{\theta}^{NOD}$ over the first 3 years. Yellow, purple, and magenta bars show the effects of moving from the trinity to the models with dominance in safe assets ($\boldsymbol{\theta}^{\text{DCA}} - \boldsymbol{\theta}^{\text{cf}}$), cross-border debt ($\boldsymbol{\theta}^{\text{DCD}} - \boldsymbol{\theta}^{\text{cf}}$), and dominant in trade ($\boldsymbol{\theta}^{\text{DCP}} - \boldsymbol{\theta}^{\text{cf}}$), respectively. Turquoise bars indicate the trinity interaction effect ($\mathcal{I}$). The UMonetary Policy Shock is normalized to increase the U policy rate by 25 basis points on impact. The global price of capital is a country-size weighted average of the prices of capital in U and R (see Equation (D.69)). The global trade-to-GDP ratio is calculated as the ratio of global trade, as given by the sum of $U - R$ and $R - U$ and intra R export, relative to global GDP as given by the country size weighted average of U and R GDP (see Equation (D.69)). The corresponding dynamics impulse responses are shown in Figure B.7 of the Appendix.

Figure B.9: Responses to a global risk aversion shock (black dashed, correlated US and RoW risk shocks), a US local risk aversion shock (red circled), RoW local risk aversion shock (light green circles), US monetary policy shock (green diamonds), RoW monetary policy shock (blue circles), US TFP shock (magenta circles), RoW TFP (cyan circles)



Note: The global risk (a correlated shock to US and RoW balance sheet constraints) and US local risk shocks are normalized to increase the US bank-specific risk weight by 1% on impact. The RoW local risk shock increases the RoW balance-sheet-specific risk weight by 1% on impact. The US (RoW) TFP and monetary policy shock is normalized to, on average, decrease US (RoW) GDP over the first 3 years by as much as the global risk aversion shock .

Figure B.10: No $-Trinity: Responses to a global risk aversion shock (black dashed, correlated US and RoW risk shocks), a US local risk aversion shock (red circled), RoW local risk aversion shock (light green circles), US monetary policy shock (green diamonds), RoW monetary policy shock (blue circles), US TFP shock (magenta circles), RoW TFP (cyan circles)



Note: Shock sizes are the same as in Figure B.9.

C Online appendix - Additional tables

Table C.1: Data description

Variable	Description	Source	Coverage
US IP	Industrial production excl. construction	FRB/Haver	1990m1-2024m12
US CPI	US consumer price index	BLS/Haver	1990m1-2024m12
US NEER	Nominal broad trade-weighted dollar index	FRB/Haver	1990m1-2024m12
US EBP		Favara et al. (2016)	
US 1-year TB rate	1-year Treasury Bill yield at constant maturity	FRB/Haver	1990m1-2024m12
US equity prices	S&P 500	S&P/Haver	1990m1-2024m12
VIX	S&P 500 Market Volatility Index	CBOE/Haver	1990m1-2024m12
RoW policy rate	Short-term official/policy rate (US trade weighted); AE (excl. US) policy rate before 2000m12	GEI/Haver	1990m1-2024m12
RoW IP	Industrial production (PPP GDP weighted)	GEI/Haver	1990m1-2024m12
RoW CPI	Consumer price index (PPP GDP weighted)	GEI/Haver	1990m1-2024m12
Global risky asset prices	Latent common factor of world asset prices extracted from dynamic factor model	Miranda-Agrippino et al. (2020)	1990m1-2024m12
RoW IP	Industrial production (PPP GDP weighted)	GEI/Haver	1990m1-2024m12
RoW equity prices	Dow Jones Global Index: World excl. US	Haver	1990m1-2024m11
RoW equity prices	**MXWOU Index: MSCI world excl. US**	**Bloomberg**	**1990m1-2024m11**
AE policy rate	Short-term official/policy rate (US trade weighted)	GEI/Haver	1990m1-2024m12
World real GDP	World real GDP (PPP GDP weights)	GEI/Haver	1990q1-2024q4
Non-US OECD real GDP	**Non-US OECD real GDP (PPP GDP weights)**	**OECD**	**1990q1-2024q4**
US exports-to-GDP	Constructed as merchandise exports divided by nominal GDP, linearly interpolated from quarterly to monthly	Exports: IMF DoTS/Haver, GDP: BEA/Haver	1990q1-2024q4
RoW exports-to-GDP	Constructed as merchandise exports divided by nominal GDP, linearly interpolated from quarterly to monthly	Exports: IMF DoTS/Haver, GDP: national sources/Haver	1990q1-2024q4
World trade-to-GDP	Constructed as merchandise exports and imports divided by nominal GDP, linearly interpolated from quarterly to monthly	Exports: IMF DoTS/Haver, GDP: national sources/Haver	1990q1-2024q4

Notes: RoW stands for rest of the world, AE for advanced economies, BLS for Bureau of Labour Statistics, FRB for Federal Reserve Board, BEA for Bureau of Economic Analysis, GEI for Dallas Fed Global Economic Indicators (Martínez-García et al. 2015), and IMF DoTS for International Monetary Fund Direction of Trade Statistics.

Table C.2: Unpacking the role of individual dollar dominance dimensions for the unconditional moments of the global cycles (**re-optimizing over variances**)

Moment	Data	Trinity	No Trinity	DCP	DCD	DCA
A. International co-movement						
corr($\mathbf{\Delta} Q_R, \mathbf{\Delta} Q_U$)	0.80	0.96	-0.01	0.25	0.02	-0.09
corr($\mathbf{\Delta} T_R / Z_R, \mathbf{\Delta} T_U / Z_U$)	0.81	0.95	-0.99	0.37	-1.00	-1.00
corr($\mathbf{\Delta} Z_R, \mathbf{\Delta} Z_U$)	0.60	0.74	0.23	0.20	-0.16	0.31
B. Global cycles						
corr($\mathbf{\Delta} Z_G, \mathbf{\Delta} GFCyc$)	0.69	0.51	0.45	0.41	0.20	0.58
corr($\mathbf{\Delta} Z_G, \mathbf{\Delta} T_G^G / Z_G$)	0.76	0.50	-0.91	0.21	-0.30	0.93
corr($\mathbf{\Delta} GFCyc, \mathbf{\Delta} T_G^G / Z_G$)	0.56	0.93	-0.49	0.95	-0.83	0.47
C. Global cycles and dollar						
corr($\mathbf{\Delta} \mathcal{E}, \mathbf{\Delta} GFCyc$)	-0.42	-0.87	-0.19	-0.91	-0.96	-0.35
corr($\mathbf{\Delta} \mathcal{E}, \mathbf{\Delta} Z_G$)	-0.51	-0.61	-0.23	-0.35	-0.25	-0.30
corr($\mathbf{\Delta} \mathcal{E}, \mathbf{\Delta} T_G^G / Z_G$)	-0.45	-0.96	0.34	-0.90	0.90	-0.20
D. Model fit						
RMSE relative to trinity		1.00	3.36	1.46	3.58	2.36

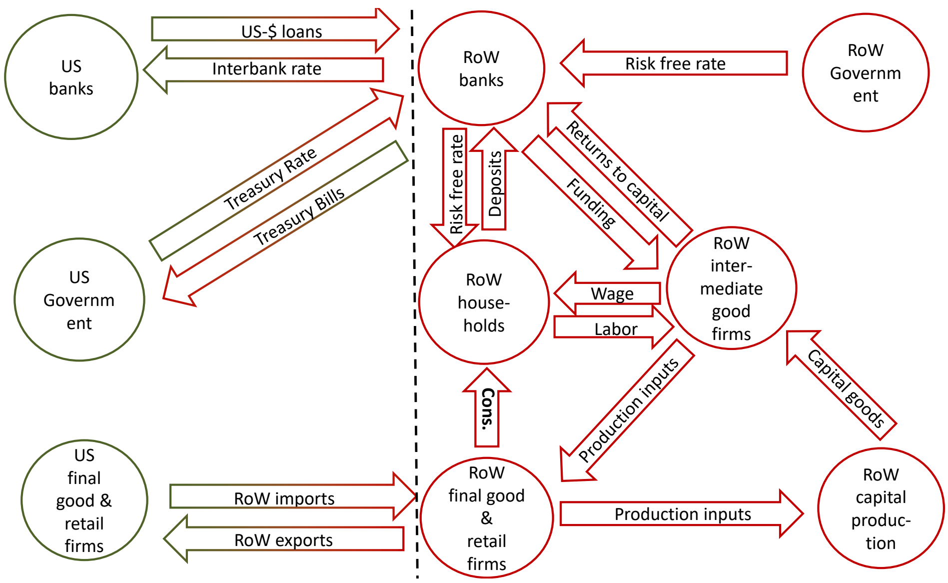
Notes: See notes to Table 6. For each model version, we re-optimize over the variances of the shocks such that the model version best explains the exchange rate puzzles in Table 4.

D Online Appendix - Additional model details

D.1 Model structure

The model consists of two economies, the US denoted by U, and a RoW block denoted by R, which are linked through trade, cross-border bank lending and investment in US Treasuries. The model features standard real and nominal frictions such as sticky prices and wages, habit formation in consumption, investment adjustment costs and variable capital utilization. At the heart of the model are US and RoW banks that engage in leveraged domestic and cross-border lending and borrowing. We assume the structure of frictions is (up to parametrization) symmetric for the US and the RoW; the key exceptions are financial frictions and global trade. In particular on the financial side, we assume US banks intermediate domestic dollar funds to the RoW and that US Treasuries are the global safe asset. Regarding international trade we assume that (i) for trade between the US and the RoW is largely prices are largely sticky in US$ and (ii) a fraction of intra RoW trade is also sticky in US$. The latter comes about because the RoW block is supposed to be an aggregate of countries and as document by Gopinath et al. (2020), even if the US is not directly involved in the trade, countries tend to invoice a lot of their trade in US$. Figure D.1 gives a schematic overview of the model structure. As frictions are largely symmetric for the two blocks, we lay out the equations for the RoW block unless indicated otherwise.

Figure D.1: Schematic overview of the model



D.2 Households and unions

In each period a household consumes a non-traded final good subject to habit formation in consumption. Furthermore each households is a monopolistic supplier of a differentiated labor service $L_{R,t}(h)$ and sells this to a perfectly competitive union that transforms it into an aggregate labor supply using a constant elasticity of substitution (CES) technology. Households satisfy demand for labor given the wage rate $W_{R,t}$, with wage setting being subject to frictions à la Calvo. The period-by-period utility function is given by

$$U(C_{R,t}, L_{R,t}) = \frac{1}{1-\sigma^c}(C_{R,t} - h_R C_{R,t-1})^{1-\sigma^c} - \frac{\kappa_{R,w}}{1+\varphi} L_{R,t}^{1+\varphi}. \tag{D.1}$$

with $\sigma^c, \varphi, h_R, \kappa_{R,w}$ as the intertemporal elasticity of substitution, the inverse Frisch elasticity of labor supply, the habit formation parameter and an exogenous labor scale parameter respectively. Households maximize utility subject to the following budget constraint

$$\frac{B^n_{R,t}}{P^C_{R,t}} + C_{R,t} = \frac{B^n_{R,t-1} R_{R,t-1}}{P^C_{R,t}} + \frac{W_{R,t}(h) L_{R,t}(h) + IS_{R,t}(h)}{P^C_{R,t}} + \frac{\Pi^C_{R,t}}{P^C_{R,t}} + \frac{\Pi^R_{R,t}}{P^C_{R,t}},$$

where we chose the final consumption and investment good price $P^C_{R,t}$ as the numeraire. $R_{R,t-1}$ is the predetermined domestic risk-free rate paid on nominal deposits with domestic banks $B^n_{R,t}$. $IS_{R,t}$ furthermore denotes an income stream from domestic state-contingent securities ensuring that all households will choose the same consumption and savings plans, despite temporarily receiving different wages due to the assumption of Calvo-type wage setting. Lastly $\Pi^C_{R,t}$ and $\Pi^R_{R,t}$ represent nominal profits from domestic (RoW) capital producing and retail firms respectively. The first-order condition of the household with respect to the choice of consumption is given by

$$\Lambda_{R,t} = (C_{R,t} - h_R C_{R,t-1})^{-\sigma_c} - \beta_R h_R \mathbb{E}_t[(C_{R,t+1} - h_R C_{R,t})^{-\sigma_c}] \tag{D.2}$$

with $\Lambda_{R,t}$ as the marginal utility of consumption. The intertemporal optimality conditions for the individual holdings of deposits with the local bank reads as

$$\Lambda_{R,t} = \mathbb{R}_t\Big[\beta_R \Lambda_{R,t+1} \frac{R_{R,t}}{1+\pi^C_{R,t+1}}\Big]. \tag{D.3}$$

where $\pi^C_{R,t+1}$ corresponds to the net inflation rate of the final consumption good. The working part of the household also sells its differentiated labor services

$L_{R,t}(h)$ to a competitive union, which combines the differentiated labor services into a composite labor good using CES technology. Lastly the union leases the combined labor service to the intermediate good firms at the aggregate nominal wage rate $W_{R,t}$. The worker optimally chooses its wage given labor demand by the union taking into account that wage setting is subject to frictions à la Calvo, meaning that in each period they face a constant probability $(1-\theta_{w,R})$ of being able to adjust their nominal wage. As such the aggregate real wage index evolves as

$$w_{R,t}^{1-\psi_w} = (1-\theta_{w,R})\tilde{w}_{R,t}^{1-\psi_w} + \theta_{w.R}(1+\pi_{R,t}^{C})^{\psi_w-1} w_{R,t-1}^{1-\psi_w} \tag{D.4}$$

with $\tilde{w}_{R,t}$ as the optimal reset wage and $w_{R,t}$ as the economy wide real wage.

D.3 Financial Intermediation

D.3.1 RoW financial intermediaries

We assume RoW banks raise funds through domestic deposits and cross-border dollar loans from US banks and use them to finance claims on domestic capital and holdings of US Treasuries. Specifically, consider RoW bank j and let $K_{R,j,t}$ be its claims on domestic capital in period t, $Q_{R,t}$ the price of such a claim relative to the price of the RoW final consumption good $P_{R,t}^{C}$, $GB_{R,j,t}$ holdings of US Treasuries, $B_{R,j,t}$ deposits from households, $CBDL_{R,j,t}$ funding through cross-border dollar loans, and $N_{R,j,t}$ net worth. The bank's balance sheet identity in real terms is

$$Q_{R,t}K_{R,j,t} + RER_t GB_{R,j,t} = B_{R,j,t} + RER_t CBDL_{R,j,t} + N_{R,j,t}, \tag{D.5}$$

where $RER_t = \mathcal{E}_t P_{U,t}^{C}/P_{R,t}^{C}$ represents the real exchange rate in terms of relative consumer-price levels and $\mathcal{E}_t$ the nominal exchange rate defined as the price of a dollar in units of RoW currency; an increase in $\mathcal{E}_t$ thus represents an appreciation of the dollar.

On the asset side of the RoW bank's balance sheet in Equation (D.5), claims on domestic capital $K_{R,j,t}$ earn the rate $R_{R,t}^{K}$, and—when converted to RoW currency—holdings of US Treasuries $GB_{R,j,t}$ earn the rate $D\mathcal{E}_t R_{U,t-1}^{GB}$, $D\mathcal{E}_t \equiv \mathcal{E}_t/\mathcal{E}_{t-1}$. On the liability side, deposits of domestic households $B_{R,j,t}$ cost the rate $R_{R,t-1}$—which we assume equals the RoW risk-free, central bank rate—and cross-border dollar loans from US banks $CBDL_{R,j,t}$ the rate $D\mathcal{E}_t R_{U,t-1}^{CBDL}$. The law of motion for the

RoW bank's net worth is

$$N_{R,j,t} = \frac{1}{1+\pi^C_{R,t}} \Big\{ R_{R,t-1} N_{R,j,t-1} + \Big[(1-\alpha^{GB}_{R,j,t-1}) R^K_{R,t} + \alpha^{GB}_{R,j,t-1} D\mathcal{E}_t R^{GB}_{U,t-1} \qquad \text{(D.6)}$$

$$- (1-\ell^{CBDL}_{R,j,t-1}) R_{R,t-1} - \ell^{CBDL}_{R,j,t-1} D\mathcal{E}_t R^{CBDL}_{U,t-1} \Big] AS_{R,j,t-1} \Big\},$$

where $AS_{R,j,t} \equiv Q_{R,t} K_{R,j,t} + RER_t GB_{R,j,t}$ denotes the bank's total assets, $\alpha^{GB}_{R,j,t} \equiv RER_t GB_{R,j,t} / AS_{R,j,t}$ the share of total assets accounted for by US Treasuries, and $\ell^{CBDL}_{R,j,t} \equiv RER_t CBDL_{R,j,t} / AS_{R,j,t}$ the share of total assets funded by cross-border dollar loans.

Equation (D.6) shows that a RoW bank's net worth generally fluctuates with the dollar exchange rate. In particular, even when returns on US Treasuries equal the costs of cross-border dollar loans ($R^{GB}_{U,t-1} = R^{CBDL}_{U,t-1}$), if the share of assets funded by cross-border dollar loans exceeds the asset share of Treasuries ($\ell^{CBDL}_{R,j,t} - \alpha^{GB}_{R,j,t} > 0$) the bank's net worth drops when the dollar appreciates ($D\mathcal{E}_t > 0$).

The objective of a RoW bank is to maximize the discounted value of current and expected future equity streams. The bank's value function is

$$V_{R,j,t} = \max \mathbb{E}_t \sum_{s=0}^{\infty} (1-\theta_B) \theta_B^s \Theta_{R,t,t+s} N_{E,j,t+1+s}, \qquad \text{(D.7)}$$

where $\Theta_{R,t,t+s}$ is the household's real stochastic discount factor, given by $\Theta_{R_{t,t+s}} = \beta_R^s \frac{\Lambda_{R,t+s}}{\Lambda_{R,t}}$ and θ_B an exogenous closing probability as in Gertler & Karadi (2011).

In order to put a ceiling on the amount of leverage a RoW bank can take on we assume it faces a balance-sheet constraint in the spirit of Gertler & Karadi (2011). We motivate this balance-sheet constraint as an eligibility requirement the bank needs to satisfy in order for creditors to provide funding. In particular, for the bank to attract creditors and be able to leverage, the sum of its discounted current and expected future equity streams has to be larger than a risk-weighted sum of its current assets

$$V_{R,j,t} \geq \delta_{R,j,t} (Q_{R,j,t} K_{R,j,t} + \Gamma^{GB}_R RER_t GB_{R,j,t}). \qquad \text{(D.8)}$$

We assume creditors apply two types of risk weights in the balance-sheet constraint in Equation (D.8). First, the *asset-specific* risk weight Γ^{GB}_R represents the perceived riskiness of Treasuries relative to claims on domestic capital (for a similar interpretation see Karadi & Nakov 2021; Coenen et al. 2018). In particular, we assume that US Treasuries are perceived to be less risky than claims on domestic capital ($\Gamma_R^{GB} < 1$).

Second, the *balance-sheet-specific* risk weight $\delta_{R,j,t}$ represents the perceived riskiness of the bank's relative *asset and liability* composition. The balance-sheet constraint in Equation (D.8) thus shows how creditors weigh the perceived riskiness of the size and structure of the bank's asset and liability portfolio on the right-hand side against its discounted current and expected future level of equity on the left-hand side.[32] In particular, we assume the balance-sheet-specific risk weight varies with the asset and liability shares according to

$$\delta_{R,j,t}\left(\ell_{R,j,t}^{CBDL}, \alpha_{R,j,t}^{GB}\right) = \overline{\delta}_R\left[1 + \frac{\kappa_{R,\alpha,\ell}}{2}\left(\alpha_{R,j,t}^{GB} - \ell_{R,j,t}^{CBDL}\right)^2 - \epsilon_{R,\alpha}\alpha_{R,j,t}^{GB}\right] + \epsilon_t^{\delta_R}, \quad \text{(D.9)}$$

where $\epsilon_t^{\delta_R}$ is an exogenous shock which we interpret as a shock to the willingness of creditors to provide funding for a given level of net worth. In other words we assume that this shock raises the risk aversion of creditors. Because we are interested in a *global* risk aversion shock, we assume that for each country i, the shock $\epsilon^{\delta_{i,B}}$ has a factor structure with a domestic component $\eta_t^{\delta_i}$ and a global component $\eta_t^{\delta_G}$ and evolves as

$$\epsilon_t^{\delta_{i,B}} = \rho_\delta \epsilon_{t-1}^{\delta_{i,B}} + \eta_t^{\delta_i} + \eta_t^{\delta_G}. \quad \text{(D.10)}$$

The specification of the balance-sheet-specific risk weight in Equation (D.9) is key for the transmission mechanisms in the model. First, cross-border dollar loan funding increases the balance-sheet-specific risk weight as long as it is not met by corresponding dollar assets in terms of holdings of US Treasuries ($\kappa_{R,\alpha,\ell} > 0$). We make this assumption because unhedged cross-border dollar borrowing exposes the RoW bank's net worth to fluctuations in the exchange rate and dollar funding shortages.[33] Second, apart from hedging funding through cross-border dollar loans, holding US Treasuries reduces the balance-sheet-specific risk weight ($\epsilon_{R,\alpha} > 0$). We make this assumption because Treasuries are viewed as the safe asset whose market price is relatively stable so that it can be sold with limited losses or even gains on its face value in times of stress in order to provide liquidity buffer in any type of funding shortage (Bianchi et al. 2021). In other words, Equation (D.9) incorporates a general and a dollar-specific incentive for

[32] The balance-sheet constraint in Equation (D.8) is algebraically very similar to that postulated in Gertler & Karadi (2011), who motivate it referring to the idea that the banker can 'abscond' with a fraction of assets.

[33] Under the 'absconding' interpretation of the balance-sheet constraint of Gertler & Karadi (2011) this assumption entails that the amount of assets the bank can run away with increases with the unhedged share of funding through cross-border dollar loans. This assumption may be motivated by the observation that bankruptcy laws are biased towards domestic lenders (Akinci & Queralto 2024).

holding Treasuries as liquidity-buffer.[34]

It can be shown that the value function of a bank, just like the law of motion its equity, is linear in its components. In particular after guessing the value function can be written as

$$V_{R,j,t} = \Big[(1-\alpha^{GB}_{R,j,t})v_{R,t} + \alpha^{GB}_{R,j,t}v^{GB}_{R,t} - \ell_{R,j,t}u_{R,t})\Big]AS_{R,j,t} + n_{R,t}N_{R,j,t} \tag{D.11}$$

its possible to verify procedure the solution to the bankers problem can be characterized by the following set of equations.

$$v_{R,t} = \mathbf{E}_t\Big(\Omega_{R,t,t+1}(R_{R,k,t+1} - R_{R,t})\Big) \tag{D.12}$$

$$v^{GB}_{R,t} = \mathbf{E}_t\Big(\Omega_{R,t,t+1}(\mathcal{E}_{t+1}/\mathcal{E}_t R^{GB}_{R,t} - R_{R,t})\Big) \tag{D.13}$$

$$n_{R,t} = \mathbf{E}_t\Big(\Omega_{E,t,t+1}(R_{R,t})\Big) \tag{D.14}$$

$$u_{R,t} = \mathbf{E}_t\Big(\Omega_{R,t,t+1}\mathcal{E}_{t+1}/\mathcal{E}_t R^{CBDL}_{U,t} - R_{E,t}\Big) \tag{D.15}$$

$$\Omega_{R,t,t+1} = \mathbf{E}_t\Big(\frac{\beta_R \Lambda_{R,t+1}}{\Lambda_{R,t}(1+\pi^c_{R,t+1})}\Big[(1-\theta_B) \tag{D.16}$$

$$+ \theta_B([v_{R,t+1}(1-\alpha^{GB}_{R,j,t+1}) + v^{GB}_{R,t+1}\alpha^{GB}_{R,j,t+1} - u_{R,t+1}\ell^{CBDL}_{R,j,t+1}]\phi_{R,j,t+1} + n_{R,t+1})\Big]$$

Equations D.12, D.13, D.14, D.15, represent the discounted excess returns from borrowing domestically and lending domestically, the discounted excess returns from borrowing domestically and investing into US government bonds, the discounted excess costs of borrowing in US-$ instead of acquiring domestic deposits and the discounted marginal value of an additional unit of equity. Equation D.16 is the bankers "augmented" real stochastic discount factor, which accounts for marginal value of funds internal to the financial intermediary and the fact that the bank may have to close with a probability of $1-\theta_B$. Lastly $\phi_{R,j,t} = AS_{R,j,t}/N_{R,j,t}$ corresponds to the optimal leverage ratio of the RoW bank described below.

With a closed form solution for $V_{R,j,t}$ at hand its straightforward to derive the first order conditions taking into account the balance sheet constraint in Equation (D.8).Regarding the choice of the optimal composition of asset side its possible

[34] Note that strictly speaking Equation (D.9) states that also a positive net dollar exposure ($\alpha^{GB}_{R,j,t} - \ell^{CBDL}_{R,j,t} > 0$) increases the balance-sheet-specific risk weight. Thus, Equation (D.9) can also be read as stating that the bank has an incentive to take on cross-border dollar loans to hedge holdings of Treasuries. However, as we discuss in the calibration below, in the steady state the bank has a *negative* net dollar exposure.

to show that this the following first order condition.

$$\mathbf{E}_t \left[\Omega_{R,j,t,t+1} \left(D\mathcal{E}_{t+1} R^{GB}_{U,t} - R_{R,t} \right) \right] + CY_{R,j,t} = RP^{GB}_{R,j,t}. \tag{D.17}$$

The first term on the left-hand side coincides with the UIP condition in a standard model without financial frictions and safe asset demand. In particular, in a standard setup, in order to rule out arbitrage profits for RoW banks the exchange-rate-adjusted return of Treasuries—whose dollar-return equals the US risk-free rate $R^{GB}_{U,t} = R_{U,t}$ by assumption—has to equal the cost of funding through domestic deposits in terms of the risk-free rate $R_{R,t}$. Equation (D.17) shows that our model gives rise to two UIP deviations $CY_{R,j,t}$ and $RP^{GB}_{R,j,t}$.

The first UIP deviation is given by

$$RP^{GB}_{R,j,t} = \Gamma^{GB}_R \mathbf{E}_t \left[\Omega_{R,j,t,t+1} \left(R^K_{R,t+1} - R_{R,t} \right) \right], \tag{D.18}$$

and arises because optimal portfolio choice requires that in equilibrium the overall, exchange-rate-adjusted excess return of US Treasuries on the left-hand side in Equation (D.17) has to equal the risk-weight-adjusted excess return of the alternative investment in domestic capital on the right-hand side in Equation (D.17).

The second UIP deviation is given by

$$CY_{R,j,t} = -\frac{\partial \delta_{R,j,t} / \partial \alpha^{GB}_{R,j,t}}{\delta_{R,j,t}} \left[(1 - \alpha^{GB}_{R,j,t}) + \Gamma^{GB}_R \alpha^{GB}_{R,j,t} \right] \mathbf{E}_t \left[\Omega_{R,j,t,t+1} \left(R^K_{R,t+1} - R_{R,t} \right) \right], \tag{D.19}$$

and arises because in our setup the *overall* return of US Treasuries for a RoW bank on the left-hand side is made up of the direct component $R^{GB}_{U,t}$ and an additional, *indirect* component: Holding Treasuries loosens a RoW bank's balance-sheet constraint in Equations (D.8) and (D.9), thereby allows it to leverage more, exploit more investment opportunities and generate additional profits. In other words, because of their dominant safe asset property, holding Treasuries may be optimal for a RoW bank even if their direct, expected, exchange-rate-adjusted return is lower than the risk-weight-adjusted return of domestic capital $RP^{GB}_{R,j,t}$. We interpret this indirect return $CY_{R,j,t}$ as a convenience yield.

Equation (D.19) shows that the magnitude of the convenience yield is pinned down by the degree to which holding Treasuries reduces a RoW bank's balance-sheet-specific risk weight, how the freed leverage translates into additional claims on domestic capital, and the corresponding excess return. For example, when domestic credit spreads are high, holding additional Treasuries and thereby relaxing a RoW bank's balance-sheet constraint is particularly profitable, and hence the convenience yield is high. Note that Equation (D.17) instills a structural interpretation to the convenience yield in the UIP condition in the no-arbitrage finance framework in Krishnamurthy & Lustig (2019). Apart from the risk premium $RP^{GB}_{R,j,t}$, Equation (D.17) also coincides with the UIP condition in the structural model of Jiang et al. (2024). However, in their setup the convenience yield is introduced *ad hoc* as a UIP deviation that is assumed to decline in the global stock of safe assets. In contrast, in our model the convenience yield and its relation to global financing conditions emerge endogenously from the optimal portfolio choice of RoW banks.

As a UIP condition Equation (D.17) pins down the evolution of the dollar exchange rate. First, for a given RoW domestic deposit rate ($R_{R,t}$), in standard UIP logic an increase in the US risk-free rate and hence by assumption the return on Treasuries ($R^{GB}_{U,t}$) requires an expected depreciation of the dollar ($D\mathcal{E}_{t+1}$ declines), which is in part achieved by a contemporaneous appreciation. Second, for a given RoW domestic deposit rate ($R_{R,t}$) and US risk-free rate ($R^{GB}_{U,t}$), an increase in the convenience yield ($CY_{R,j,t}$) has to be accompanied by an expected depreciation of the dollar ($D\mathcal{E}_{t+1}$ declines), which is again in part achieved by a contemporaneous appreciation.

Regarding the optimal choice of the liability composition, it can be shown that the total returns on cross border dollar loans $R^{CBDL}_{U,t}$ have to equal the costs of domestic funding up to an endogenous wedge.

$$\mathbf{E}_t \left(\Omega_{R,j,t,t+1} R_{R,t}\right) = \mathbf{E}_t \left(\Omega_{R,j,t,t+1} D\mathcal{E}_{t+1} R^{CBDL}_{U,t}\right) + RP^{CBDL}_{R,j,t}, \tag{D.20}$$

with

$$RP^{CBDL}_{R,j,t} = \frac{\partial \delta_{R,j,t} / \partial \ell^{CBDL}_{R,j,t}}{\delta_{R,j,t}} \mathbf{E}_t \Omega_{R,j,t,t+1} \big[(1 - \alpha^{GB}_{R,j,t})(R^K_{R,t+1} - R_{R,t}) \tag{D.21}$$

$$+ \alpha^{GB}_{R,j,t} \left(D\mathcal{E}_{t+1} R^{GB}_{U,t} + CY_{R,j,t} - R_{R,t} \right) \big]. \tag{D.22}$$

Cross-border dollar borrowing has an additional, *indirect* cost, as it tightens the RoW bank's balance-sheet constraint in Equations (D.8) and (D.9), thereby limits its leverage and thus reduces profits. This risk premium implies that in order for the RoW bank to borrow cross-border dollar funds the *direct* cost has to be lower than for domestic deposits. Thus, consistent with the data, in our model cross-border dollar borrowing is—or at least appears to be—cheap compared to domestic funding (Caramichael et al. 2021; Gutierrez et al. 2023). Analogous to the UIP condition in Equation (D.17), also Equation (D.20) provides intuition for the evolution of the dollar exchange rate. For example, when global financing conditions tighten so that domestic credit spreads rise, the risk premium on cross-border dollar loans increases. Equation (D.20) shows that for a given deposit rate and cross-border dollar credit rate this rise in the risk premium has to be accompanied by an expected depreciation of the dollar. This is partly accomplished by a contemporaneous appreciation. This mechanism is similar to the "two-way feedback between balance sheets and exchange rates" in Akinci & Queralto (2024, p.3).

The remaining equations of the RoW banking block are fairly standard. In particular, we impose market clearing for domestic capital, US treasuries and specify the start-up funds for a newly entering bank n as a fraction of last period's portfolio, $N_{R,n,t} = \omega_R AS_{R,t-1}$. In equilibrium all banks choose the same portfolio structure as they face the same returns and costs. The law of motion for aggregate net worth of the RoW banking sector is given by

$$N_{R,t} = \frac{\theta_B}{1+\pi^C_{R,t}} \Big\{ R_{R,t-1}N_{R,t-1} + \Big[(1-\alpha^{GB}_{R,t-1})R^K_{R,t} + \alpha^{GB}_{R,t-1}D\mathcal{E}_t R^{GB}_{U,t-1} - (1-\ell^{CBDL}_{R,t-1})R_{R,t-1} - \ell^{CBDL}_{R,t-1}D\mathcal{E}_t R^{CBDL}_{U,t-1}\Big] AS_{R,t-1} \Big\} + \omega_R AS_{R,t-1} \tag{D.23}$$

When the model is parameterized so that the balance-sheet constraint in Equation (D.8) binds in a neighbourhood of the steady-state, the maximum equilibrium leverage ratio is given by

$$\phi_{R,j,t} \equiv \frac{AS_{R,j,t}}{N_{R,j,t}} = \frac{n_{R,j,t}}{\mathcal{R}_{R,j,t} - \mathcal{P}_{R,j,t}}, \tag{D.24}$$

where

$$\mathcal{R}_{R,j,t} \equiv \delta_{R,j,t}\left[(1-\alpha^{GB}_{R,j,t}) + \Gamma^{GB}_R \alpha^{GB}_{R,j,t}\right], \tag{D.25}$$

$$\mathcal{P}_{R,j,t} \equiv \mathbf{E}_t\Omega_{R,j,t,t+1}\Big[(1-\alpha^{GB}_{R,j,t})R^K_{R,t+1} + \alpha^{GB}_{R,j,t}D\mathcal{E}_{t+1}R^{GB}_{U,t} - (1-\ell^{CBDL}_{R,j,t})R_{R,t} - \ell^{CBDL}_{R,j,t}D\mathcal{E}_{t+1}R^{CBDL}_{U,t}\Big], \tag{D.26}$$

are the RoW bank's asset-share-weighted bank and asset-specific risk weight and its expected profitability, respectively; the terms $\Omega_{R,j,t,t+1}$ and $n_{R,j,t}$ denote the bank's stochastic discount factor and the expected discounted returns to equity respectively. Equation (D.24) shows that the RoW bank's maximum leverage is pinned down by its portfolio's expected profitability and perceived riskiness in terms of risk weights. In particular, the RoW bank can attain a higher leverage ratio, thereby exploit more investment opportunities and generate more profits if (i) the perceived riskiness in terms of $\mathcal{R}_{R,j,t}$ is low, (ii) its expected profitability in terms of $\mathcal{P}_{R,j,t}$ is high, and/or (iii) expected discounted returns to equity in terms of $n_{R,j,t}$ are large.

D.3.2 US financial intermediaries

US banks differ from RoW banks in four ways. First, a US bank acts as cross-border lender rather than borrower, and so dollar loans appear on the asset side of its balance sheet

$$Q_{U,t}K_{U,j,t} + CBDL_{U,j,t} = B_{U,j,t} + N_{U,j,t}, \tag{D.27}$$

where $K_{U,j,t}$, $CBDL_{U,j,t}$, $B_{U,j,t}$ and $N_{U,j,t}$ are the total amount of claims on domestic capital, cross-border dollar loans, domestic deposits and net worth, respectively, deflated by the price of the US consumption good.

Second, for simplicity and in order to focus on the RoW, we assume US banks do not hold Treasuries. In contrast to RoW banks a US bank's net worth

$$\begin{aligned} N_{U,j,t} =& \frac{1}{1+\pi^C_{U,t}}\Big[(R^K_{U,t} - R_{U,t-1})Q_{U,t-1}K_{U,j,t-1} \\ & + (R^{CBDL}_{U,t-1} - R_{U,t-1})CBDL_{U,j,t-1} + R_{U,t-1}N_{U,j,t-1}\Big], \end{aligned} \tag{D.28}$$

is not affected by exchange rate valuation effects as its liabilities and assets are all denominated in dollar.

Third, for a US bank we assume the balance-sheet constraint

$$V_{U,j,t} \geq \delta_{U,j,t}(Q_{U,t}K_{U,j,t} + \Gamma^{CBDL}_{U,t}CBDL_{U,j,t}), \tag{D.29}$$

with the asset-specific risk weight creditors attach to cross-border dollar loans

$$\Gamma^{CBDL}_{U,t} = \bar{\Gamma}^{CBDL}_{U} + \Phi_{U,\phi}\phi_{R,j,t}, \tag{D.30}$$

and where $\phi_{R,j,t}$ is the leverage ratio of RoW banks from Equation (D.24). Specifically, in Equation (D.30) we assume cross-border dollar lending is perceived to be more risky by a US bank's creditors when RoW banks are more leveraged. The motivation for this specification is that while RoW banks lend to the US government (the least risky borrower by assumption) and US firms (which pledge the entire return to capital), US banks also lend to leveraged and thus risky RoW banks, whose leverage (and thereby riskiness) endogenously fluctuates with the state of the economy.

Fourth, in contrast to RoW banks, a US bank does not engage in foreign-currency borrowing so that there is no asset-liability currency mismatch creditors may be concerned about. Therefore, we assume the balance-sheet-specific risk weight $\delta_{U,j,t}$ for a US bank does not vary endogenously and is given by

$$\delta_{U,j,t} = \overline{\delta}_U + \epsilon_t^{\delta_U}, \tag{D.31}$$

where $\epsilon_t^{\delta_U}$ is an exogenous risk aversion shock discussed previously.

We assume for simplicity that the return on US Treasuries equals the risk-free, monetary policy rate: $R^{GB}_{U,t} = R_{U,t}$. [35].

As in the RoW case, the objective of the US banker is to maximize the discounted value of current and future equity streams subject to the balance sheet constraint. The bank's value function is

$$V_{U,j,t} = \max\ \mathbb{E}_t \sum_{s=0}^{\infty} (1-\theta_B)\Theta_{U,t,t+s} N_{U,j,t+1+s}, \tag{D.32}$$

where $\Theta_{U,t,t+s}$ is the household's real stochastic discount factor.

Defining $\alpha^{CBDL}_{U,j,t} = \frac{CBDL_{U,j,t}}{AS_{U,j,t}}$ as the asset ratio of cross border dollar loans to total assets of the banks assuming that the value function $V_{U,j,t}$ is linear in the components of the LOM for net worth its possible to show that

$$V_{U,j,t} = \Big[(1-\alpha^{CBDL}_{U,j,t})v_{U,t} + \alpha^{CBDL}_{U,j,t} v^{CBDL}_{U,t})\Big] AS_{U,j,t} + n_{U,t} N_{U,j,t} \tag{D.33}$$

$$v_{U,t} = \mathbb{E}_t\Big(\Omega_{U,t,t+1}(R^K_{U,t+1} - R_{U,t})\Big) \tag{D.34}$$

$$v^{CBDL}_{U,t} = \mathbb{E}_t\Big(\Omega_{U,t,t+1}(R^{CBDL}_{U,t} - R_{U,t})\Big) \tag{D.35}$$

$$n_{U,t} = \mathbb{E}_t\Big(\Omega_{U,t,t+1}(R_{U,t})\Big) \tag{D.36}$$

$$\Omega_{U,t,t+1} = \mathbb{E}_t\Big(\frac{\Theta_{U,t,t+1}}{(1+\pi^c_{U,t+1})}\times \Big[(1-\theta_B) + \theta_B\Big([(1-\alpha^{CBDL}_{U,j,t+1})v_{U,t+1} + \alpha^{CBDL}_{U,j,t+1} v^{CBDL}_{E,t+1}]\phi_{U,j,t+1} + n_{U,t+1}\Big)\Big]\Big). \tag{D.37}$$

With $V_{U,j,t}, v_{U,t}, v^{CBDL}_{U,t}, n_{U,t}$ and $\Omega_{F,t,t+1}$ as the slightly different versions of their RoW counterparts touched up on the previous section.

[35]This would result endogenously if we assumed US banks can hold Treasuries, if the corresponding asset-specific risk weight in the balance-sheet constraint in Equation (D.29) was zero, and if the balance-sheet-specific risk weight in Equation (D.31) was independent of these holdings

As in the RoW case the optimal portfolio choice of US banks choice requires

$$\Gamma^{CBDL}_{U,t}\mathbb{E}_t\Big[\Omega_{U,j,t,t+1}\big(R^K_{U,t+1}-R_{U,t}\big)\Big]=\mathbb{E}_t\left[\Omega_{U,j,t,t+1}\Big(R^{CBDL}_{U,t}-R_{U,t}\Big)\right]-RP^{CBDL}_{U,j,t}, \tag{D.38}$$

stating that the expected risk-weight-adjusted excess returns on domestic capital on the left-hand side and cross-border dollar loans on the right-hand side have to equalize.

Apart from the term $RP^{CBDL}_{U,j,t}$, Equation (D.38) coincides with the equilibrium condition in a standard model without financial frictions on cross-border dollar lending and borrowing. In particular, in a standard setup expected, risk-weight-adjusted returns of different assets have to equalize. In Equation (D.38) this means that the expected, risk-weight-adjusted excess returns on claims on domestic capital have to equal the expected excess returns on cross-border lending. Equation (D.38) shows that in our model the *direct* expected excess return of cross-border dollar lending has to be higher than the risk-weight-adjusted excess return of claims on domestic capital due to a risk premium $RP^{CBDL}_{U,j,t}$.

In particular, this risk premium on cross-border lending is given by

$$RP^{CBDL}_{U,j,t}=\frac{\partial\Gamma^{CBDL}_{U,t}}{\partial\alpha^{CBDL}_{U,j,t}}\alpha^{CBDL}_{U,j,t}\mathbf{E}_t\Omega_{U,j,t,t+1}\Big[(1-\alpha^{CBDL}_{U,j,t})(R^K_{U,t+1}-R_{U,t}) \tag{D.39}$$
$$+\alpha^{CBDL}_{U,j,t}(R^{CBDL}_{U,t}-R_{U,t})\Big],$$

and arises because the US bank's cross-border dollar lending raises the RoW bank's leverage, which feeds back and raises the US bank's asset-specific risk weight (see Equation (D.30)) and thereby has an additional, *negative indirect* return: It tightens the US bank's balance-sheet constraint in Equations (D.29) and (D.30), which limits its leverage and thus reduces profits.[36]

Equation (D.39) shows that the magnitude of this risk premium is pinned down by the degree to which cross-border dollar lending raises the US bank's asset-specific risk weight on cross-border dollar lending, how the ensuing reduction in the bank's leverage cuts into claims on domestic capital and cross-border dollar lending, and their corresponding excess returns. For example, when domestic credit spreads are high, the foregone profits implied by the tightening in the bank's balance-sheet constraint due to cross-border dollar lending are particularly high, and hence the risk premium on cross-border dollar lending is

[36]Using the market clearing conditions alongside the balance sheets of the two banks it can be shown that $\frac{\partial\Gamma^{CBDL}_{U,t}}{\partial\alpha^{CBDL}_{U,j,t}}=\Phi^F_{U,\phi}\frac{\frac{1-s}{s}RER_tAS_{U,t}}{N_{R,t}}$

high.

The remaining equations of the US banking block are fairly standard. In particular, we impose market clearing for domestic capital, cross border dollar loans and specify the start-up funds for a newly entering bank n as a fraction of last period's portfolio, $N_{U,n,t} = \omega_U AS_{U,t-1}$. The law of motion for aggregate net worth of the US banking sector is given by

$$N_{U,t} = \frac{\theta_B}{1+\pi^C_{U,t}} \Bigg\{ R_{U,t-1} N_{U,t-1} + \Big[(1-\alpha^{CBDL}_{U,t-1})(R^K_{U,t} - R_{U,t-1}) + \alpha^{CBDL}_{U,t-1}(R^{GB}_{U,t-1} - R_{U,t-1}) \Big] AS_{U,t-1} \Bigg\} + \omega_U AS_{U,t-1} \tag{D.40}$$

When the model is parameterized so that the balance-sheet constraint in Equation (D.8) binds in a neighbourhood of the steady-state, the maximum equilibrium leverage ratio again reflects a risk-profitability trade-off

$$\phi_{U,j,t} \equiv \frac{AS_{U,j,t}}{N_{U,j,t}} = \frac{Q_{U,t}K_{U,j,t} + CBDL_{U,j,t}}{N_{U,j,t}} = \frac{n_{U,j,t}}{\mathcal{R}_{U,j,t} - \mathcal{P}_{U,j,t}}, \tag{D.41}$$

where

$$\mathcal{R}_{U,j,t} = \delta_{U,j,t} \left[(1-\alpha^{CBDL}_{U,j,t}) + \Gamma^{CBDL}_{U,t} \alpha^{CBDL}_{U,j,t} \right], \tag{D.42}$$

$$\mathcal{P}_{U,j,t} = \mathbf{E}_t \Omega_{U,j,t,t+1} \left[(1-\alpha^{CBDL}_{U,j,t}) R^K_{U,t+1} + \alpha^{CBDL}_{U,j,t} R^{CBDL}_{U,t} - R_{U,t} \right], \tag{D.43}$$

D.4 Intermediate good firms

In each economy there exists a continuum of perfectly competitive intermediate goods firms that sell their output to domestic retailers. We assume that at the end of period t but before the realization of shocks the intermediate good firm acquires capital for use in next period's production. To do so, the intermediate good firm i claims equal to the number of units of capital acquired, and prices each claim at the real price of a unit of capital $Q_{R,t}$. The production function is

$$Z_{R,i,t} = e^{A_R} \left(U_{R,i,t} K_{R,i,t-1} \right)^{\alpha} L^{(1-\alpha)}_{R,i,t}, \tag{D.44}$$

with $Z_{R,i,t}$ the amount of output produced by the individual RoW intermediate good firm in period t, $L_{R,i,t}$ the labor used in production, and $U_{R,i,t}$ the employed utilization rate of capital. Finally A_R represents the exogenous (log) level of TFP, which evolves according to an AR(1) process.

Cost minimization yields the standard equations for the optimal amount of production inputs

$$MC^r_{R,t} = \frac{w^{1-\alpha}_{R,t}\tau_{R,t}(U_{R,t})'^{\alpha}}{e^{A_R}(1-\alpha)^{(1-\alpha)}\alpha^{\alpha}}. \tag{D.45}$$

$$\frac{w_{R,t}}{\tau_{R,t}(U_{R,t})'} = \frac{1-\alpha}{\alpha}\frac{(U_{R,t}K_{R,t-1})}{L_{R,t}}, \tag{D.46}$$

where $MC^r_{R,t}$ denote the real marginal costs of the intermediate good firms deflated by the RoW final good price $P^C_{R,t}$ and $\tau_{R,t}(U_{R,t})'$ as the derivative of the adjustment cost function, which maps a change in utilization rate into a change in the depreciation rate[37]. The optimal choice of capital gives the resulting gross nominal returns on capital, which are transferred to the bank in exchange for funding

$$R_{K,E,t} = (1+\pi^c_{R,t})\frac{\left(MC^r_{R,t}\alpha\frac{Z_{R,t}}{K_{t-1}}\right) + (Q_{R,t} - \tau_{R,t}U_{R,t})}{Q_{R,t-1}}. \tag{D.47}$$

D.5 Capital producers

Capital-producing firms buy and refurbish depreciated capital from the intermediate goods firm at price $P^C_{R,t}$ and also produce new capital using the RoW final good, which consists of domestically produced and imported retail goods, as an input. Furthermore we assume that they face quadratic adjustment costs on net investment and that profits, which arise outside of the steady state, are distributed lump sum to the households.[38] The optimal choice of investment yields the familiar *Tobins Q* relation for the evolution of the relative price of capital

$$\begin{aligned} Q_{R,t} = 1 + \frac{\Psi}{2}\Big(\frac{In_{R,t}+Iss_R}{In_{R,t-1}+Iss_R} - 1\Big)^2 + \Psi\Big(\frac{In_{R,t}+Iss_R}{In_{R,t-1}+Iss_R} - 1\Big)\frac{In_{R,t}+Iss_R}{In_{R,t-1}+Iss_R} \\ - \beta\frac{\Lambda_{E_{t+1}}}{\Lambda_{E_t}}\Psi\Big(\frac{In_{R,t+1}+Iss_R}{In_{R,t}+Iss_R} - 1\Big)\Big(\frac{In_{R,t+1}+Iss_R}{In_{R,t}+Iss_R}\Big)^2 \end{aligned} \tag{D.48}$$

[37]The adjustment cost function is given by $\tau_{R,t}(U_{R,t}) = \tau_{R,ss,scale} + \zeta_{R,1}\frac{U_t^{1+\zeta_2}}{1+\zeta_2}$ with $\tau_{R,ss,scale}$ as an exogenous scale parameter in order to normalize utilization in the steady state.

[38]Following Gertler & Karadi (2011) we assume that adjustment costs are only present when changing net investment in order for the optimal choice of the utilization rate to be independent from fluctuations in the relative price of capital $Q_{R,t}$

alongside the law of motion for capital

$$K_{R,t} = K_{R,t-1} + In_{R,t} \tag{D.49}$$

D.6 Goods bundling and pricing

The third key element in our model is dollar dominance in terms of DCP in bilateral trade between the US and the RoW, following the seminal work of Gopinath et al. (2020). This means that the prices of both US and RoW exports are sticky in dollar.

In our model we go beyond DCP in bilateral trade between the US and the RoW and assume that prices of a share of domestic sales in the RoW are also sticky in dollar. In particular, Boz et al. (2022) document that a large share of trade among countries in the RoW is also priced in dollar; this is the actual meaning of a dominant—in the context of trade also often termed 'vehicle'—currency. It implies that when the dollar appreciates expenditure switching does not only affect imports from the US, but imports in general. Therefore, dollar pricing in third-country trade—in our model captured by domestic sales in the RoW—may be consequential for the effects of dollar appreciation in the context of a global risk aversion shock. To incorporate dollar pricing of a share of domestic sales in the RoW, we consider a multi-layered production structure in the spirit of Georgiadis & Schumann (2021) and depicted in Figure D.2

D.6.1 Final consumption and investment good

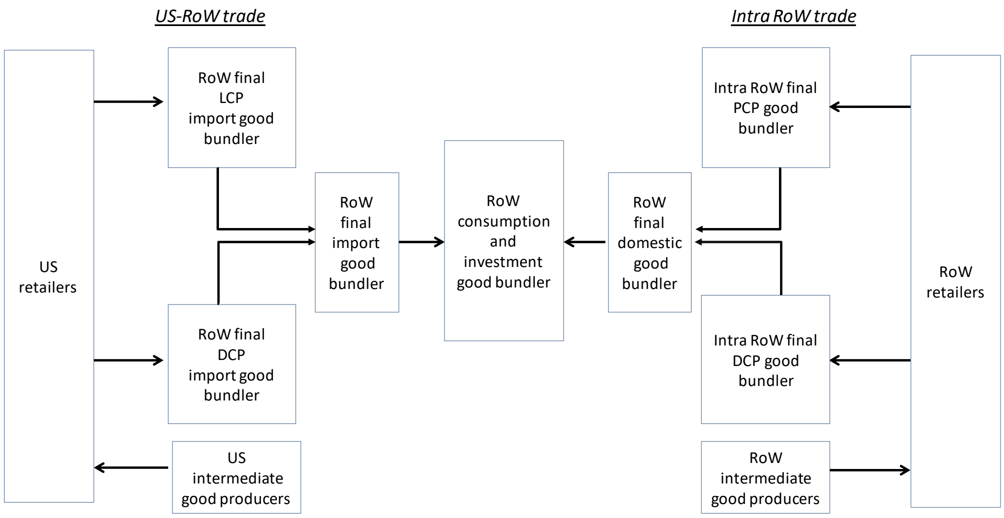
This sector operates at the top layer of this producttion structure and is populated by a continuum of firms that operate under perfect competition and combine a final domestically produced good $Y^R_{R,t}$ and a final import good $Y^R_{U,t}$ into a combined final good, employing the following CES technology

$$Y^C_{E,t} = \left[n_R^{\frac{1}{\psi_f}} {Y^R_{R,t}}^{\frac{\psi_f - 1}{\psi_f}} + (1 - n_R)^{\frac{1}{\psi_f}} {Y^R_{U,t}}^{\frac{\psi_f - 1}{\psi_f}} \right]^{\frac{\psi_f}{\psi_f - 1}}. \tag{D.50}$$

The parameter n_R governs the share of domestically produced goods and thereby the degree of home bias in the assembling process[39]. The parameter ψ_f on the other hand corresponds to the elasticity of substitution between the final domestic and import good.

[39]The home bias parameter is adjusted in order to take into account the differences in country size as in Sutherland (2005). In particular, given a degree of general trade openness op_R and the relative country size of the RoW s, the parameter n_R takes the value $n_R = 1 - op_R(1 - s)$ with a similar adjustment for the US counterpart

Figure D.2: Multi-layered production structure for the RoW consumption and investment good



Note: The figure lays out the multi-layered production structure in the structural model, focusing on the RoW consumption and investment good.

Taking the prices of the domestic final good $P^R_{R,t}$ and the price of the final import good expressed in domestic currency $(\mathcal{E}_t P^R_{U,t})$[40] as well as total demand from consumers and capital producers as given, the optimal demand for goods produced domestically and abroad is governed by

$$Y^R_{R,t} = n_R \Big(\frac{P^R_{R,t}}{P^C_{R,t}} \Big)^{-\psi_f} Y^C_{R,t} \tag{D.51}$$

$$Y^R_{U,t} = (1 - n_R) \Big(\frac{\mathcal{E}_t P^R_{U,t}}{P^C_{R,t}} \Big)^{-\psi_f} Y^C_{R,t}. \tag{D.52}$$

Lastly note that the three equations above imply that the price of the final consumption and investment good in the RoW $P^C_{E,t}$ is (up to first order) a weighted average of the prices of the final domestic and import good

$$P^c_{E,t} = \Big[n_E P^{E}_{E,t}{}^{1-\psi_f} + (1 - n_E)(\mathcal{E}^F_E P^E_{F,t})^{1-\psi_f} \Big]^{\frac{1}{1-\psi_f}}. \tag{D.53}$$

[40]Note that because of the pricing-to-market assumption the price for US exports expressed in US-\$ $P^R_{U,t}$ will in general be different from the price charged for US goods sold in the US $P^U_{U,t}$.

D.6.2 RoW domestically produced and sold final good

We assume markets are partly segmented and firms set different prices in different markets depending on demand conditions. We assume a fraction of RoW firms $1-\gamma_R^R$ sets their prices for domestic sales in dollar, while the remaining prices are sticky in RoW currency. As in Gopinath et al. (2020), we assume firms cannot choose their pricing currency, but are assigned to it exogenously and do not change it over time.

The firms that put together the RoW final domestic good $Y_{R,t}^R$ shown on the right side in Figure D.2 operate under perfect competition and combine inputs $\widetilde{Y}_{R,t}^R$ and $\widehat{Y}_{R,t}^R$ using a CES technology. The inputs are produced by two branches of firms that also operate under perfect competition and combine RoW retail goods. The firms in the first branch combine RoW retail goods $\widehat{Y}_{R,t}^R(i)$ priced in dollar (DCP goods) into the RoW final DCP good $\widehat{Y}_{R,t}^R$; analogously, the firms in the second branch combine RoW retail goods $\widetilde{Y}_{R,t}^R(i)$ priced in the producer's currency (PCP goods) into the RoW final PCP good $\widetilde{Y}_{R,t}^R$.

The next layer consists of RoW retail-goods-producing firms which buy and repackage RoW intermediate goods. These firms operate under monopolistic competition and serve the RoW as well as the US market; for simplicity Figure D.2 only shows their domestic sales. The share of RoW retail-goods-producing firms whose domestic sales prices are sticky in dollar is given by $(1-\gamma_R^R)$. Therefore, $(1-\gamma_R^R)$ also reflects the degree to which movements in the dollar exchange rate cause fluctuations in the RoW aggregate producer-price index $P_{R,t}^R$.

Table D.1 provides an overview of the core equations and first order conditions for the multistage bundling process.

D.6.3 Import good bundling

As shown on the left side in Figure D.2, the RoW import good $Y_{U,t}^R$ is produced analogously to the RoW final domestic good $Y_{R,t}^R$. [41] In particular, RoW final import good producers use inputs from two branches of firms that operate under perfect competition and aggregate goods from US retail goods producers. The latter operate under monopolistic competition and set prices that are either sticky in the producer's currency (PCP goods) or in the importer's currency (LCP goods). Likewise, we assume that when exporting a fraction $(1-\gamma_U^R)$ of RoW and $(1-\gamma_R^U)$ of US retailers faces prices that are sticky in the currency of the importer, while the prices of the remaining firms are sticky in the producer's currency.

[41] Notice that the subscript indicates the country where the good is produced and the superscript the country where it is consumed.

Table D.1: RoW domestic sales bundling

Production function/Price index	Demand functions
RoW domestically produced final good	
$Y^R_{R,t} = \left[{\gamma^R_R}^{\frac{1}{\psi_i}} {\tilde{Y}^R_{R,t}}^{\frac{\psi_i-1}{\psi_i}} + (1-\gamma_R)^{R^{\frac{1}{\psi_i}}} {\hat{Y}^R_{R,t}}^{\frac{\psi_i-1}{\psi_i}} \right]^{\frac{\psi_i}{\psi_i-1}}$	$\tilde{Y}^R_{R,t} = \gamma^R_R \left(\frac{\tilde{P}^R_{R,t}}{P^R_{R,t}} \right)^{-\psi_i} Y^R_{R,t}$
$P^R_{R,t} = \left[\gamma^R_R {\tilde{P}^R_{R,t}}^{1-\psi_i} + (1-\gamma^R_R) \left(\mathcal{E}_t \hat{P}^R_{R,t} \right)^{1-\psi_i} \right]^{\frac{1}{1-\psi_i}}$	$\hat{Y}^R_{R,t} = (1-\gamma^R_R) \left(\frac{\mathcal{E}_t \hat{P}^R_{R,t}}{P^R_{R,t}} \right)^{-\psi_i} Y^R_{R,t}$
RoW domestically sold PCP good	
$\tilde{Y}^R_{R,t} = \left[\left(\frac{1}{\gamma^R_R} \right)^{\frac{1}{\psi_i}} \int_0^{\gamma^R_E} \tilde{Y}^R_{R,t}(i)^{\frac{\psi_i-1}{\psi_i}} di \right]^{\frac{\psi_i}{\psi_i-1}}$	$\tilde{Y}^R_{R,t}(i) = \frac{1}{\gamma^R_R} \left(\frac{\tilde{P}^R_{R,t}(i)}{\tilde{P}^R_{R,t}} \right)^{-\psi_i} \tilde{Y}^R_{R,t}$
$\tilde{P}^R_{R,t} = \left[\frac{1}{\gamma^R_R} \int_0^{\gamma^R_R} \tilde{P}^R_{R,t}(i)^{1-\psi_i} di \right]^{\frac{1}{1-\psi_i}}$	$= \left(\frac{\tilde{P}^R_{R,t}(i)}{P^R_{R,t}} \right)^{-\psi_i} Y^R_{R,t}$
RoW domestically sold DCP good	
$\hat{Y}^R_{R,t} = \left[\left(\frac{1}{1-\gamma^R_R} \right)^{\frac{1}{\psi_i}} \left(\int_{\gamma^R_R}^1 \hat{Y}^R_{R,t}(i)^{\frac{\psi_i-1}{\psi_i}} di \right) \right]^{\frac{\psi_i}{\psi_i-1}}$	$\hat{Y}^R_{R,t}(i) = \frac{1}{1-\gamma^R_R} \left(\frac{\mathcal{E}_t \hat{P}^R_{R,t}(i)}{\mathcal{E}_t \hat{P}^R_{R,t}} \right)^{-\psi_i} \hat{Y}^R_{R,t}$
$\mathcal{E}_t \hat{P}^R_{R,t} = \left[\frac{1}{(1-\gamma^R_R)} \int_{\gamma^R_R}^1 (\mathcal{E}_t \hat{P}^R_{R,t}(i))^{1-\psi_i} di \right]^{\frac{1}{1-\psi_i}}$	$= \left(\frac{\mathcal{E}_t \hat{P}^R_{R,t}(i)}{P^R_{R,t}} \right)^{-\psi_i} Y^R_{R,t}$

Table D.2 provides an overview of the core equations and first order conditions for the multistage bundling process of the final import good in the US. Equations are analogues for the RoW import good bundling process.

D.7 Retail good pricing

There exists a continuum of firms that operate under monopolistic competition and use intermediate goods to produce a retail good that is eventually sold to the specialized branches of the firm. Each retail firm sells its product in the domestic and foreign markets; as mentioned above, for simplicity we only show sales to RoW in Figure D.2. When selling in the RoW (i.e. domestic) market, a fraction γ^R_R of RoW retail-goods-producing firms sets prices in RoW currency, while the remaining $(1-\gamma^R_R)$ share of firms sets their prices in dollar. A similar setting exists in the market for US imports, with γ^R_U indicating the fraction of RoW firms that price their exports in the producer's currency. Regardless of the pricing currency, all firms use the same production technology and face the same factor costs. Because firms are subject to Calvo-style price-setting frictions and can only change their price with a probability $(1-\theta^R_p)$ each period, the mark-up of a firm whose price is sticky in dollar fluctuates with the exchange rate. As RoW firms serving domestic and US markets, respectively, set their prices optimally and as in each market they use different pricing currencies, their profit functions differ as shown in table D.3. As standard in Calvo-style price setting, firms choose their optimal reset price given demand and their pricing currency while taking

Table D.2: US import good bundling

Production function/Price index	Demand functions
US final import goods	
$Y^U_{R,t} = \left[\gamma_U^{R\frac{1}{\psi_i}} \tilde{Y}^{U\frac{\psi_i-1}{\psi_i}}_{R,t} + (1-\gamma_U)^{R\frac{1}{\psi_i}} \hat{Y}^{U\frac{\psi_i-1}{\psi_i}}_{R,t}\right]^{\frac{\psi_i}{\psi_i-1}}$ $P^{R^I}_{U,t} = \left[\gamma^E_F\left(\frac{\tilde{P}^F_{E,t}}{\mathcal{E}^F_{E,t}}\right)^{1-\psi_i} + (1-\gamma^E_F)\hat{P}^{F^{1-\psi_i}}_{E,t}\right]^{\frac{1}{1-\psi_i}}$	$\tilde{Y}^U_{R,t} = \gamma^R_U\left(\frac{\tilde{P}^R_{U,t}}{\mathcal{E}_t P^{R^I}_{U,t}}\right)^{-\psi_i} Y^U_{R,t}$ $\hat{Y}^U_{R,t} = (1-\gamma^R_U)\left(\frac{\hat{P}^U_{R,t}}{P^{R^I}_{U,t}}\right)^{-\psi_i} Y^U_{R,t}.$
US imported PCP good	
$\tilde{Y}^U_{R,t} = \left[\left(\frac{1}{\gamma^E_F}\right)^{\frac{1}{\psi_i}}\left(\int_0^{\gamma^R_U} \tilde{Y}^U_{R,t}(i)^{\frac{\psi_i-1}{\psi_i}} di\right)\right]^{\frac{\psi_i}{\psi_i-1}}$ $\frac{\tilde{P}^U_{R,t}}{\mathcal{E}_t} = \left[\frac{1}{\gamma^R_U}\int_0^{\gamma^R_U}\left(\frac{\tilde{P}^U_{R,t}(i)}{\mathcal{E}_t}\right)^{1-\psi_i} di\right]^{\frac{1}{1-\psi_i}}$	$\tilde{Y}^U_{R,t}(i) = \frac{1}{\gamma^R_U}\left(\frac{\tilde{P}^U_{R,t}(i)}{\tilde{P}^U_{U,t}}\right)^{-\psi_i}\tilde{Y}^U_{R,t}$ $= \left(\frac{\tilde{P}^U_{R,t}(i)}{\mathcal{E}_t P^{R^I}_{U,t}}\right)^{-\psi_i} Y^U_{R,t}$
US imported DCP good	
$\hat{Y}^U_{R,t} = \left[\left(\frac{1}{1-\gamma^R_U}\right)^{\frac{1}{\psi_i}}\left(\int_{\gamma^R_U}^1 \hat{Y}^U_{R,t}(i)^{\frac{\psi_i-1}{\psi_i}} di\right)\right]^{\frac{\psi_i}{\psi_i-1}}$ $\hat{P}^U_{R,t} = \left[\frac{1}{(1-\gamma^R_U)}\int_{\gamma^E_F}^1 \hat{P}^U_{R,t}(i))^{1-\psi_i} di\right]^{\frac{1}{1-\psi_i}}$	$\hat{Y}^U_{R,t}(i) = \frac{1}{1-\gamma^R_U}\left(\frac{\hat{P}^U_{R,t}(i)}{\hat{P}^U_{R,t}}\right)^{-\psi_i}\hat{Y}^U_{R,t}$ $= \left(\frac{\hat{P}^U_{R,t}(i)}{P^{R^I}_{U,t}}\right)^{-\psi_i} Y^U_{R,t}$

into account that they might not be able to reset their price in the future. For instance the optimal price choice of a DCP firm i for its sales in the RoW market, taking into account the fact that it may not be able to reset its US-$ denominated price $\hat{P}^E_{E,t}(i)$, can be written as

$$\underset{\hat{P}^E_{E,t}(i)}{max}\,\mathbb{E}_t \sum_{s=0}^{\infty} \theta_p^{E^s}\Theta_{E_{t,t+s}}\left[\mathcal{E}^E_{E,t}\hat{P}^E_{E,t}(i)Y^E_{E,t}(i) - MC_{E,t}Y^E_{E,t}(i)\right]. \tag{D.54}$$

It is possible to show that the optimal reset price of a firm that sets its price for the RoW market in US-$, relative to the aggregate RoW DCP sales price index $\hat{P}^E_{E,t}$, is given by

$$\frac{\hat{P}^E_{E,t}(i)}{\hat{P}^E_{E,t}} = \hat{p}^E_{E,t} = \frac{\psi_i}{(\psi_i - 1)}\frac{\hat{x}^E_{E,1,t}}{\hat{x}^E_{E,2,t}}. \tag{D.55}$$

The auxiliary recursive variables $\hat{x}^E_{E,1,t}$ and $\hat{x}^E_{E,2,t}$ read as

$$\hat{x}^E_{E,1,t} = \Lambda_{E,t}\left(\frac{\mathcal{E}^F_{E,t}\hat{P}^E_{E,t}}{P^E_{E,t}}\right)^{-\psi_i} Y^E_{E,t}\frac{P^E_{E,t}}{P^C_{E,t}}MC^{rp}_{E,t} + \beta\theta_p\mathbb{E}_t\hat{x}^E_{E,1,t+1}(1+\hat{\pi}^E_{E,t+1})^{\psi_i} \tag{D.56}$$

$$\hat{x}^E_{E,2,t} = \Lambda_{E,t}\left(\frac{\mathcal{E}^F_{E,t}\hat{P}^E_{E,t}}{P^E_{E,t}}\right)^{-\psi_i} Y^E_{E,t}\left(\frac{\mathcal{E}^F_{E,t}\hat{P}^E_{E,t}}{P^C_{E,t}}\right) + \beta\theta^E_p\mathbb{E}_t\hat{x}^E_{E,1,t+1}(1+\hat{\pi}^E_{E,t+1})^{\psi_i-1}, \tag{D.57}$$

with $MC^{rp}_{E,t}$ as marginal costs deflated in by the aggregate producer price $P^E_{E,t}$. It becomes apparent that not only does the exchange rate $\mathcal{E}^F_{E,t}$ impact the optimal DCP price setting decision as it determines the demand for DCP goods via

Table D.3: Market and pricing paradigm specific profit functions of RoW firms

Type of firm and market	Profit function
RoW market PCP firm	$\tilde{\Pi}^E_{E,t}(i) = \tilde{P}^E_{E,t}(i)\tilde{Y}^E_{E,t}(i) - MC_{E,t}\tilde{Y}^E_{E,t}(i)$
RoW market DCP firm	$\hat{\Pi}^E_{E,t}(i) = \mathcal{E}^F_{E,t}\hat{P}^E_{E,t}(i)\hat{Y}^E_{E,t}(i) - MC_{E,t}\hat{Y}^E_{E,t}(i)$
US import market PCP firm	$\tilde{\Pi}^F_{E,t}(i) = \tilde{P}^F_{E,t}(i)\tilde{Y}^F_{E,t}(i) - MC_{E,t}\tilde{Y}^F_{E,t}(i)$
US import market DCP firm	$\hat{\Pi}^F_{E,t}(i) = \mathcal{E}^F_{E,t}\hat{P}^F_{E,t}(i)\hat{Y}^F_{E,t}(i) - MC_{E,t}\hat{Y}^F_{E,t}(i)$

the relative price $\frac{\mathcal{E}^F_{E,t}\hat{P}^E_{E,t}}{P^E_{E,t}}$, it also impacts the optimal reset price via the term $\frac{\mathcal{E}^F_{E,t}\hat{P}^E_{E,t}}{P^C_{E,t}}$, which translates the local currency revenues that a DCP firm makes from selling one unit of its good $\mathcal{E}^F_{E,t}\hat{P}^E_{E,t}$ into the unit of account that the firm's owners (households) care about $P^C_{E,t}$. Everything else equal, an appreciation of the US-$ exchange rate, will cause the local currency revenues per unit of DCP good sold to rise, while the input costs, which are denominated in the RoW currency, remain roughly stable. Thus the mark-up rises above the optimal mark-up and a DCP good firm would like to lower its US-$ price in response to an appreciation of the US-$ over and above what the induced fall in RoW demand for the DCP good would dictate. It is easy to verify that when aggregating across intra RoW sales of RoW DCP firms the inflation rate of the aggregate RoW sales DCP price (expressed in US-$) is given by

$$1 = (1-\theta_p)\hat{p}^{E^{1-\psi_i}}_{E,t} + \theta_p(1+\hat{\pi}^E_{E,t})^{(\psi_i - 1)}, \tag{D.58}$$

where $\hat{p}^E_{E,t}$ denotes the ratio of the optimal reset price relative to the aggregate price index. Using the profit functions in table D.3 its easy its easy to show similar equations hold for the optimal price of RoW retail firms that set their prices in the US import market in US-$ as well as, with slight adaptions, for PCP firms.

D.7.1 Fiscal and monetary policy

We assume the US government issues new bonds, raises taxes and transfers the accrued funds to households in a lump-sum fashion. The US government's balance sheet reads as

$$GB_{U,t} + \tau_{U,t} = TRA_{U,t} + R^{GB}_{U,t-1}GB_{U,t-1}. \tag{D.59}$$

Central banks set the nominal risk-free rate according to a standard Taylor-rule

$$\hat{r}_{i,t} = \rho_{i,r}\hat{r}_{i,t-1} + (1-\rho_{i,r})(\phi_{i,\pi}\hat{\pi}^c_{i,t} + \phi_{i,z}\hat{z}_{i,t}) + \sigma^r_{i,\varepsilon}\varepsilon^r_{i,t}, \quad i \in U, R, \tag{D.60}$$

where $\pi^C_{i,t}$ is final (consumption) good inflation, $Z_{i,t}$ real GDP, $\varepsilon^r_{i,t}$ is a monetary policy shock, and hats denote deviations from steady state.

D.8 Market clearing and the aggregate budget constraint

Turning to the market clearing conditions, aggregate demand for the domestic consumption good $Y^C_{E,t}$ is given by the sum of individual demand from all sources that either consume the good or use it as an input in production

$$Y^C_{R,t} = C_{R,t} + I_{R,t} + \frac{\Psi}{2}\Big(\frac{In_{R,t} + Iss_R}{In_{R,t-1} + Iss_R} - 1\Big)^2 (In_{R,t} + Iss_R). \tag{D.61}$$

Aggregating across all intermediate and retail goods firms and imposing market clearing yields the aggregate production function of the economy

$$Z_{R,t} = (U_{R,t}K_{R,t-1})^{\alpha} L^{(1-\alpha)}_{R,t} = \delta^R_{R,t} Y^R_{R,t} + \delta^F_{R,t} Y^F_{R,t}, \tag{D.62}$$

with $\delta^R_{R,t}$ and $\delta^F_{R,t}$ as price dispersion terms which are zero up to a first-order approximation. $Y^R_{R,t}$ corresponds to the aggregate domestic demand for the final *domestically produced* RoW good given by

$$Y^R_{R,t} = n_R \Big(\frac{P^R_{R,t}}{P^C_{R,t}}\Big)^{-\psi_f} Y^C_{R,t}, \tag{D.63}$$

with $Y^C_{R,t}$ as the households and firms demand for the final good.

This demand is distributed across intra-RoW DCP and PCP goods according to

$$\widehat{Y}^R_{R,t} = (1-\gamma^E_E)\Big(\frac{\widehat{P^R_{R,t}}}{P^R_{R,t}}\Big)^{-\psi_i} Y^R_{R,t}, \tag{D.64}$$

and

$$\widetilde{Y}^R_{R,t} = (1-\gamma^E_E)\Big(\frac{\widetilde{P^R_{R,t}}}{P^R_{R,t}}\Big)^{-\psi_i} Y^R_{R,t}. \tag{D.65}$$

Total intra-RoW Exports are then given by

$$X^R_{R,t} = \widehat{Y}^R_{R,t} + \widetilde{\omega}^R_R \widetilde{Y}^R_{R,t} \tag{D.66}$$

, with $\widetilde{\omega}^R_R$ as the fraction of intra-RoW exports in total intra-RoW PCP sales.

Furthermore, the aggregate demand for RoW goods produced for exports reads as

$$Y^U_{R,t} = \frac{1-s}{s}(1-n_F)\Big(\frac{\mathcal{E}_t P^F_{R,t}}{P^C_{F,t}}\Big)^{-\psi_f} Y^C_{F,t}, \tag{D.67}$$

where it is important to note that variables are expressed in per capita terms and therefore, following Sutherland (2005), the relative population size has to be taken into account when aggregating across countries as indicated by the ratio $\frac{1-s}{s}$.

Given that we not only explicitly model US and RoW trade but also intra-RoW trade, we can define global exports ($\mathcal{T}^G_{G,t}$) as the sum of the of all (country-size adjusted) global exports

$$\mathcal{T}^G_{G,t} = \Big[Y^R_{US,t} + \frac{s}{1-s}\Big(Y^{US}_{R,t} + \widehat{Y}^R_{R,t} + (1-\widetilde{\omega}^R_R)\widetilde{Y}^R_{R,t}\Big)\Big],$$

where $\widehat{Y}^R_{R,t}$ and $\widetilde{Y}^R_{R,t}$ corresponds to total intra-RoW DCP and PCP sales respectively, and $\widetilde{\omega}^R_R$ measures to the fraction of intra-RoW PCP *exports* in total intra-RoW PCP *sales*.[42] Our model analog of the global trade to global GDP ratio is then given by

$$\frac{\mathcal{T}^G_{G,t}}{Z_{G,t}} = \frac{\mathcal{T}^G_{G,t}}{Z_{U,t} + \frac{s}{1-s}Z_{R,t}}. \tag{D.68}$$

with $Z_{U,t}$ and $Z_{R,t}$ describing US and RoW GDP respectively.

Analogously, we can define the global capital price measured in dollars as

$$Q_{G,t} = Q_{U,t} + \frac{s}{1-s}\Big(\frac{Q_{R,t}}{RER_t}\Big) \tag{D.69}$$

We assume financial markets clear, which implies $GB_{U,t} = \frac{s}{1-s}GB_{R,t}$ and $CBDL_{U,t} = \frac{s}{1-s}CBDL_{R,t}$, where s is the relative country size parameter. When aggregating across budget constraints in the RoW, we recover the national accounting identity

$$\begin{aligned} RER_t\Big[\Big(GB_{R,t} - \frac{R^{GB}_{U,t-1}}{1+\pi^C_{U,t}}GB_{R,t-1}\Big) - \Big(CBDL_{R,t} - \frac{R^{CBDL}_{U,t-1}}{1+\pi^C_{U,t}}CBDL_{R,t-1}\Big)\Big] = \\ \frac{P^R_{R,t}}{P^C_{R,t}}Y^R_{R,t} + \frac{\mathcal{E}_t P^F_{R,t}}{P^C_{R,t}}Y^U_{R,t} - Y^C_{R,t}. \end{aligned} \tag{D.70}$$

The left-hand side represents the sum of the changes in the RoW net foreign

[42]We compute a corresponding global import price index using the steady-state shares of the different import categories.

asset position and the net financial account, while the right-hand side is the trade balance (taking into account that prices charged differ across domestically produced and exported goods). Importantly, and in contrast to Akinci & Queralto (2024), Devereux et al. (2020) and many others, we explicitly model *gross* rather than only net financial flows. As a consequence, the national accounting identity does not dictate the evolution of all financial flows as in a net-flows model. In a net-flow model, where, for instance, RoW banks can only borrow in dollars but not hold dollar assets (i.e. gross liabilities equal net liabilities), the trade balance and costs of funds borrowed in the previous period determine uniquely the foreign banking sector's liability position in the next period. In contrast, in our model the national accounting identity only uniquely determines the *sum of the changes* in gross assets and liabilities has to equal the sum of the trade balance and the financial account.

D.9 Calibration

As discussed in the main text of the paper, we distinguish between three parameter groups. While the second (third) one summarizes the parameters that govern the degree of dollar dominance in the model (volatility of the shock processes) and has been discussed in detail, we deferred the first one, which groups the "conventional" parameters where we can draw on ample evidence from earlier work, to the appendix. Below we discuss our calibration for the parameters that are most important for our results and provide a comprehensive overview all of parameters in table D.4.

We generally allow parameter values to differ across the US and the RoW (see Table D.4). For parameters that govern standard model elements, to the extent possible we draw on estimates from existing literature. In particular, for US parameters we rely on Justiniano et al. (2010) whenever possible. For the RoW it is more difficult to find suitable estimates, as it reflects an aggregate of countries. Since the euro area accounts for more than one-quarter of the RoW in the data in terms of output, we use the estimates in Coenen et al. (2018) for many of the RoW parameters.

Regarding international trade, we calibrate the relative country size s such that the steady-state share of US real GDP in global output is 25%. Given the country sizes, we set the general RoW openness vis-à-vis the US (op_R) such that the steady-state share of imports from the US in the aggregate RoW bundle ($1 - \eta_R$) is roughly 5.1%, in line with the data over 1990-2019. In the same vein, we set US trade openness (op_U) such that the share of imports in the US bundle ($1 - \eta_U$) is roughly 14%. We set the fraction of intra-RoW PCP *sales* that are counted as intra-RoW PCP *exports* ($\widetilde{\omega}_R^R$) to 0.165 to achieve an Intra-RoW exports to GDP ratio of 24% in line with Worldbank data. We set the trade-price elasticity for trade between the US and the RoW to 1.12, which is the value estimated in Coenen et al. (2018) and lies in the ballpark of the values used in the literature.

Regarding domestic and international financial intermediation we follow Akinci & Queralto (2024) and assume a (risk-weight adjusted) steady-state leverage ratio of five, a conventional value in the literature. Furthermore, we impose that the steady-state domestic credit spread ($R_i^K - R_i$) equals 200 basis points, which roughly corresponds to the average of the GZ-spread of Gilchrist & Zakrajsek (2012) and also closely corresponds to the values used by Akinci & Queralto (2024) and Coenen et al. (2018). These two assumptions imply the country-specific values for the bank's start-up fund parameter (ω_B) and the constants in balance-sheet-specific risk weights ($\bar{\delta}$) shown in Table D.4. We set $\theta_{U,B} = \theta_{R,B}$ of 0.9667 so that the average bank planning horizon is 7.5 years, which is between the 10 years in Gertler & Karadi (2011) and the 5 years in Akinci & Queralto (2024), respectively. In the cross-border loan credit spread is closely credit spread is given by the sum of a constant risk weight and a variable term that depends on the leverage ratio of the borrower (see Equation (7)). To distribute between these two terms we aim for a credit spread of 0.6% in the case of a borrower with very low counter-party risk (a leverage ratio of zero). This roughly corresponds to the sample average of the quarterly spread between the dollar-based Libor and the 3-month treasury bill rate and pins down $\Phi_{U,\phi}$.

Finally, we impose that the US and RoW steady-state risk-free rates are 2% and 3.5%, respectively. These values roughly correspond to the averages in the data and pin down the discount factors β_U and β_R. Our calibration endogenously implies the US steady-state trade-deficit-to-GDP ratio is 2.1%, and the steady state global trade-to-GDP ratio amounts to 46.2%. Both of these are close to the average in the data. Furthermore, the US finances this trade deficit by a positive net financial income, which results from the US earning higher returns from cross-border dollar lending to the RoW than it pays for Treasuries held by the RoW. Therefore, the US maintains a higher steady-state per capita consumption than the RoW as a direct consequence of the exorbitant privilege.

Table D.4: Parameter values for baseline calibration

Param.	Val.	Description	Source
International trade			
op_R	0.200	General trade openness RoW	$\eta_R \approx 0.95$
op_U	0.185	General trade openness US	$\eta_U \approx 0.86$
n	0.750	Share of RoW in global economy	$1 - \frac{GDP_{US}}{GDP_{RoW}}$
ψ_f	1.120	Trade price elasticity	CKSW(2018)
RoW financial intermediaries			
ω_B^U	0.0004	Start-up funds RoW	Endogenous in SS
θ_B^U	0.9667	Survival probability of banks RoW	Avg. AQ(2024), GK(2011)
US financial intermediaries			
ω_B^U	0.0003	Start-up funds parameter US	Endogenous in SS
θ_B^U	0.966	Survival probability of banks US	Avg. AQ(2024), GK(2011)
$\overline{\delta}_{B,U}$	1.0468	Constant in incentive constraint	Endogenous in SS
$\Phi_{\Gamma,U}$	0.1012	Semi-elasticity of Γ_U^{CBDL} w.r.t. $\phi_{R,t}$	Endogenous in SS
Households			
h_R	0.620	Consumption habits RoW	CKSW(2018)
h_U	0.790	Consumption habits US	JPT(2010)
σ_c	1.002	Intertemporal elasticity of substitution	$\approx$ log utility
φ	2.000	Inverse Frisch elasticity of labor	CKSW(2018)
β_U	0.995	Discount factor US	2% annual US rate
β_R	0.9913	Discount factor RoW	3.5% annual RoW rate
Wage decision			
ψ_w	6.000	Elasticity of substitution across labor services	20% wage markup
θ_w^R	0.780	Calvo parameter wages RoW	CKSW(2018)
θ_w^U	0.840	Calvo parameter wages US	JPT(2010)
Intermediate goods production			
α	0.333	Share of capital in production	AQ(2024)
ζ_2	5.800	Elasticity of depreciation w.r.t. utilization	JPT(2010)
$\tau_{R,ss}$	0.020	Normalization depreciation RoW	Endogenous in SS
ζ_1^R	0.035	Normalization of utilization RoW	Endogenous in SS
ζ_1^U	0.035	Normalization of utilization US	Endogenous in SS
$\tau_{U,ss}$	0.020	Normalization of depreciation US	Endogenous in SS
Retail good pricing			
θ_P^R	0.820	Calvo parameter retail firms RoW	CKSW(2018)
θ_P^U	0.840	Calvo parameter retail firms US	JPT(2010)
$\widetilde{\omega}_R^R$	0.165	Intra-RoW PCP exports in all PCP sales	24% intra-RoW exports/GDP
ψ_i	3.500	Elasticity of substitution across retail goods	40% markup
Capital goods production			
Ψ_R	5.770	Investment adjustment costs RoW	CKSW(2018)
Ψ_U	2.950	Investment adjustment costs US	JPT(2010)
Monetary policy			
$\rho_{U,r}$	0.930	RoW interest-rate smoothing	CKSW(2018)
$\phi_{U,\pi}$	2.740	RoW Taylor-rule coefficient inflation	CKSW(2018)
$\phi_{U,z}$	0.030	RoW Taylor-rule coefficient output	CKSW(2018)
$\rho_{R,r}$	0.810	US interest-rate smoothing	JPT(2010)
$\phi_{R,\pi}$	1.970	US Taylor-rule coefficient inflation	JPT(2010)
$\phi_{R,z}$	0.050	US Taylor-rule coefficient output	JPT(2010)
Shock persistence			
$\rho_{R,A}$	0.9	Persistence RoW TFP shock	IM(2021)
$\rho_{U,A}$	0.9	Persistence US TFP shock	IM(2021)
ρ_δ	0.95	Persistence global risk shock	SVAR dynamics
Steady-state targets			
$L_{R,ss}$	0.333	Labor scaling RoW	GK(2011)
U_{ss}	1.000	Utilization rate RoW and US	JPT(2010)
τ_{ss}	0.025	Depreciation-rate target RoW and US	JPT(2010)
$S_{R,ss}$	2%	Credit spread RoW, annualized	$\approx$ CKSW(2018)
$S_{U,ss}$	2%	Credit spread US, annualized	$\approx$ avg. GZ spread
$\phi_{R,ss}$	5.00	RoW leverage ratio, risk-weighted	$\approx$ AQ(2024)
$\phi_{U,ss}^F$	5.00	US leverage ratio, risk-weighted	AQ(2024)
X_R^R/Y_R^R	0.24	Intra-RoW exports over intra-RoW sales	$\approx$ WB data average

Notes: GK(2011), JPT(2010), CKSW(2018), GZ(2012), JKL(2021), JKL(2024), AQ(2019), G(2015), AX(2020), AEH(2021), BSFO(2024), and IM(2021) denote Gertler & Karadi (2011), Justiniano et al. (2010), Coenen et al. (2018), Gilchrist & Zakrajsek (2012), Jiang et al. (2021), Jiang et al. (2024), Akinci & Queralto (2024), Gopinath (2015), Adrian & Xie (2020), Aldasoro et al. (2021), Bertaut et al. (2024), and Itskhoki & Mukhin (2021), respectively.

E Online Appendix - List of all model equations

This section contains all the relevant model equations of the Trinity model of Georgiadis et al. (2023) as they appear in the corresponding code.[43]

E.1 Households

Marginal Utility RoW

$$\Lambda_{Rt} = exp\left(\varepsilon^{\beta}_{Rt}\right)\,\left(C_{Rt} - h_R\,C_{Rt-1}\right)^{(-\sigma_c)} - \beta_R\,h_R\,\left(exp\left(\varepsilon^{\beta}_{Rt+1}\right)\,C_{Rt+1} - C_{Rt}\,h_R\right)^{(-\sigma_c)} \tag{E.1}$$

Euler equation RoW

$$\Lambda_{Rt} = \beta_R\,\left(1 + R_{Rt}\right)\,\frac{\Lambda_{Rt+1}}{1 + \pi^{C}_{Rt+1}} \tag{E.2}$$

Demand shock RoW

$$\varepsilon^{\beta}_{Rt} = \rho^{\beta}\,\varepsilon^{\beta}_{Rt-1} + \frac{\eta^{\beta}_{Rt}}{100} \tag{E.3}$$

Marginal Utility US

$$\Lambda_{Ut} = exp\left(\varepsilon^{\beta}_{Ut}\right)\,\left(C_{Ut} - h_U\,C_{Ut-1}\right)^{(-\sigma_c)} - \beta_U\,h_U\,\left(exp\left(\varepsilon^{\beta}_{Ut+1}\right)\,\left(C_{Ut+1} - C_{Ut}\,h_U\right)\right)^{(-\sigma_c)} \tag{E.4}$$

Euler equation US

$$\Lambda_{Ut} = \beta_U\,\left(1 + R_{Ut}\right)\,\frac{\Lambda_{Ut+1}}{1 + \pi^{C}_{Ut+1}} \tag{E.5}$$

Demand Shock US

$$\varepsilon^{\beta}_{Ut} = \rho^{\beta}\,\varepsilon^{\beta}_{Ut-1} + \frac{\eta^{\beta}_{Ut}}{100} \tag{E.6}$$

UIP deviation

$$\widehat{UIP}_t = \left(1 + R_{Ut}\right)\,\left(1 + D\mathcal{E}_{t+1}\right) - \left(1 + R_{Rt}\right) \tag{E.7}$$

E.2 RoW financial intermediaries

Discounted excess return to investing in domestic capital RoW

$$v_{Rt} = \Omega_{Rt+1}\,\left(R_{K,R_{t+1}} - \left(1 + R_{Rt}\right)\right) \tag{E.8}$$

Discounted return to equity RoW

$$n_{Rt} = \left(1 + R_{Rt}\right)\,\Omega_{Rt+1} \tag{E.9}$$

[43] The corresponding *DYNARE* file is available upon request

Aggregate Net worth RoW financial sector

$$N_{Rt} = N_{R,e_t} + N_{R,n_t} \tag{E.10}$$

RoW credit spread

$$S_{Rt} = R_{K,R_{t+1}} - (1 + R_{Rt}) \tag{E.11}$$

RoW capital price expressed in dollars

$$Q_{R,US\$_t} = \frac{Q_{Rt}}{RER_t} \tag{E.12}$$

Aggregate Assets RoW (taking into account that $\phi_{R,t}$ is the *risk adjusted* leverage ratio in the code)

$$AS_{Rt} = \frac{N_{Rt}\,\phi_{Rt}}{(1-\alpha_R^{GB})_t + \Gamma_R^{GB}\,\alpha_R^{GB}{}_t} \tag{E.13}$$

Net Worth of new banks RoW

$$N_{R,n_t} = \omega^R\,(AS_{R,t-1}) \tag{E.14}$$

Discounted excess costs of borrowing in Dollars

$$u_{Rt} = \Omega_{Rt+1}\left((1 + D\mathcal{E}_{t+1})\,R_{U,t}^{CBDL} - (1 + R_{Rt})\right) \tag{E.15}$$

RoW banks stochastic discount factor

$$\Omega_{Rt} = \beta_R\,\frac{\Lambda_{Rt}}{\Lambda_{Rt-1}}\,\frac{1}{1+\pi_{Rt}^C}\left(1 - \theta_B^R + \theta_B^R\left(n_{Rt} + \left(v_{Rt}\,(1-\alpha_R^{GB})_t + \alpha_R^{GB}{}_t\,v_R^{GB}{}_t - u_{Rt}\,\ell_{R,t}^{CBDL}\right)\frac{\phi_{Rt}}{(1-\alpha_R^{GB})_t + \Gamma_R^{GB}\,\alpha_R^{GB}{}_t}\right)\right) \tag{E.16}$$

FOC optimal liability choice RoW

$$-u_{Rt} = \frac{\delta'_{R,\ell_t}}{\delta_{R,B_t}}\left(v_{Rt}\,(1-\alpha_R^{GB})_t + \alpha_R^{GB}{}_t\left(v_R^{GB}{}_t + CV_{Rt}\right)\right) \tag{E.17}$$

Risk weight adjusted optimal leverage ratio RoW

$$\phi_{Rt} = \frac{n_{Rt}\,\left((1-\alpha_R^{GB})_t + \Gamma_R^{GB}\,\alpha_R^{GB}{}_t\right)}{u_{Rt}\,\ell_{R,t}^{CBDL} + (1-\alpha_R^{GB})_t\,\delta_{R,B_t} + \alpha_R^{GB}{}_t\,\Gamma_R^{GB}\,\delta_{R,B_t} - v_{Rt}\,(1-\alpha_R^{GB})_t - \alpha_R^{GB}{}_t\,v_R^{GB}{}_t} \tag{E.18}$$

Time varying balance sheet specific risk weight RoW

$$\delta_{R,B_t} = \bar{\delta}_R\left(1 - \alpha_R^{GB}{}_t\,\epsilon_{R,\alpha} + \frac{\kappa_{R,\alpha,\ell_t}}{2}\left(\alpha_R^{GB}{}_t - \ell_{R,t}^{CBDL}\right)^2\right)e\left(\epsilon^{\delta^R}{}_t\right) \tag{E.19}$$

Risk aversion shock RoW

$$\epsilon^{\delta^R}{}_t = \rho^\delta\,\epsilon^{\delta^R}{}_{t-1} + \sigma_\eta^{\delta_R}\,\eta_{Rt}^\delta + \sigma_\eta^{\delta_G}\,\eta_{Gt}^\delta \tag{E.20}$$

LOM aggregate equity of existing banks RoW banking sector

$$N_{R,e\,t} = \frac{1}{1+\pi^{C}_{R\,t}} \theta^{R}_{B} \Big[\Big\{ \left(R_{K,R\,t} - (1+R_{R,t-1})\right)(1-\alpha^{GB}_{R,t-1}) + \Big((1+D\mathcal{E}_t)\; R^{GB}_{R,t-1} - (1+R_{R,t-1})\Big)\,\alpha^{GB}_{R,t-1} - \Big((1+D\mathcal{E}_t)\; R^{CBDL}_{U,t-1} - (1+R_{R,t-1})\Big)\,\ell^{CBDL}_{R,t-1} \Big\} AS_{R,t-1} + (1+R_{R,t-1})\, N_{R,t-1} \Big] \tag{E.21}$$

Definition of CBDL portfolio share

$$\ell^{CBDL}_{R,t} = \frac{RER_t\, CBDL_{R,t}}{AS_{R\,t}} \tag{E.22}$$

Aggregate assets RoW banking sector

$$AS_{R\,t} = Q_{R\,t}\, K_{R\,t} + RER_t\, GB_{R\,t} \tag{E.23}$$

Definition of US treasury portfolio share RoW

$$\alpha^{GB}_{R\;t} = \frac{GB_{R,val\,t}}{AS_{R\,t}} \tag{E.24}$$

Definition of domestic investment portfolio share RoW (redundant)

$$(1-\alpha^{GB}_{R})_t = \frac{Q_{R\,t}\, K_{R\,t}}{AS_{R\,t}} \tag{E.25}$$

Total value of US treasuries held by RoW banks

$$GB_{R,val\,t} = RER_t\, GB_{R\,t} \tag{E.26}$$

Return on treasuries (in US-$)

$$R^{GB}_{R\;t} = 1 + R_{U\,t} \tag{E.27}$$

Discounted excess returns (in RoW currency) from investing in US treasuries

$$v^{GB}_{R\;t} = \Omega_{R\,t+1} \left((1+D\mathcal{E}_{t+1})\; R^{GB}_{R\;t} - (1+R_{R\,t}) \right) \tag{E.28}$$

Derivative of time varying balance sheet specific risk weight wrt. CBDL share

$$\delta'_{R,\ell\,t} = \bar{\delta}_R \left(\underbrace{\epsilon_{R,\ell}}_{\text{0 in baseline}} \left(\ell^{CBDL}_{R,t} - \bar{\ell}_R\right) + \kappa_{R,\alpha,\ell\,t} \left(\ell^{CBDL}_{R,t} - \alpha^{GB}_{R\;t}\right) \right) \tag{E.29}$$

Derivative of time varying balance sheet specific risk weight wrt. treasury share

$$\delta'_{R,\alpha\,t} = \bar{\delta}_R \left(\kappa_{R,\alpha,\ell\,t} \left(\alpha^{GB}_{R\;t} - \ell^{CBDL}_{R,t}\right) - \epsilon_{R,\alpha} \right) \tag{E.30}$$

Convenience yield from investing in treasuries RoW banks

$$CV_{R\,t} = v_{R\,t}\,\left(-\left((1-\alpha_R^{GB})_t + \Gamma_R^{GB}\,\alpha_R^{GB}{}_t\right)\right)\,\frac{\delta'_{R,\alpha\,t}}{\delta_{R,B\,t}} \tag{E.31}$$

FOC asset choice

$$v_R^{GB}{}_t = v_{R\,t}\,\Gamma_R^{GB} - CV_{R\,t} \tag{E.32}$$

E.3 US financial intermediaries

Discounted returns to investing domestically US

$$v_{U\,t} = \Omega_{U\,t+1}\,\left(R_{K,U\,t+1} - (1 + R_{U\,t})\right) \tag{E.33}$$

Discounted returns to equity US

$$n_{U\,t} = (1 + R_{U\,t})\,\Omega_{U\,t+1} \tag{E.34}$$

US balance sheet specific risk weight (constant up to shock)

$$\delta^U{}_t = \overline{\delta_U}\,exp\left(\epsilon_{U\,t}^{\delta}\right) \tag{E.35}$$

US risk aversion shock

$$\epsilon_{U\,t}^{\delta} = \sigma_\eta^{\delta_G}\,\eta_{G\,t}^{\delta} + \rho^\delta\,\epsilon_{U\,t-1}^{\delta} + \sigma_\eta^{\delta_U}\,\eta_{R\,t}^{\delta} \tag{E.36}$$

Aggregate equity US financial sector

$$N_{U\,t} = N_{U,e\,t} + N_{U,n\,t} \tag{E.37}$$

Credit spread US

$$S_{U\,t} = R_{K,U\,t+1} - (1 + R_{U\,t}) \tag{E.38}$$

Aggregate equity US financial sector

$$N_{U,n\,t} = \omega^U\,AS_{U,t-1} \tag{E.39}$$

Time varying asset specific risk weight of cross border lending

$$\Gamma_{U_t}^{CBDL} = \Gamma_{R,ss}^{CBDL}\,exp\left(\epsilon_{\Gamma\,t}\right) + \Phi_U^\Gamma\left(\phi_{R\,t} - (\bar{\phi}_R)\right) \tag{E.40}$$

Shock to asset specific risk weight of cross border dollar lending

$$\epsilon_{\Gamma\,t} = \rho_\Gamma\,\epsilon_{\Gamma\,t-1} + \sigma_\eta^\Gamma\,\eta_{U\,t}^\Gamma \tag{E.41}$$

Ratio of total CBDL to dometic lending (This is equivalent to $\ell_{U,t}^{CBDL}/(1-\ell_{U,t}^{CBDL})$)

$$\xi_{U_t}^{CBDL} = \frac{AS_{Rt}\,\ell_{R,t}^{CBDL}\,\frac{s}{1-s}}{RER_t\,Q_{Ut}\,K_{Ut}} \tag{E.42}$$

Ratio of total CBDL to dometic lending excluding valuation effects

$$\xi_{U,real,t}^{CBDL} = \frac{AS_{Rt}\,\ell_{R,t}^{CBDL}\,\frac{s}{1-s}}{RER_t\,K_{Ut}} \tag{E.43}$$

Stochastic discount factor US Banks

$$\Omega_{Ut} = \beta_U\,\frac{\Lambda_{Ut}}{\Lambda_{Ut-1}}\,\frac{1}{1+\pi_{Ut}^C}\,\left(1-\theta_B^U+\theta_B^U\,\left(n_{Ut}+\frac{v_{Ut}+\xi_{U,t}^{CBDL}\,v_{U,t}^{CBDL}}{1+\Gamma_{U,t}^{CBDL}\,\xi_{U,t}^{CBDL}}\,\phi_{Ut}\right)\right) \tag{E.44}$$

Discounted excess returns from cross border lending

$$v_{U,t}^{CBDL} = \Omega_{Ut+1}\,\left(R_{U,t}^{CBDL}-(1+R_{Ut})\right) \tag{E.45}$$

CBDL risk premium in Dollar

$$RP_{U,t}^{CBDL} = \Phi_U^{\Gamma}\,\left(v_{Ut}+\xi_{U,t}^{CBDL}\,v_{U,t}^{CBDL}\right)\,\frac{K_{Ut}\,Q_{Ut}\,RER_t\,\frac{(1-s)}{s}\,\xi_{U,t}^{CBDL}}{N_{Rt}} \tag{E.46}$$

FOC optimal asset choice US

$$v_{U,t}^{CBDL} = RP_{E,b_t}^{F} + v_{Ut}\,\Gamma_{U,t}^{CBDL} \tag{E.47}$$

Existing banks equity US

$$\begin{aligned} N_{U,e_t} =& \frac{1}{1+\pi_{Ut}^C}\,\theta_B^U\,\Big(K_{Ut-1}\,\Big(R_{K,U_t}-(1+R_{Ut-1})+\left(R_{U,t-1}^{CBDL}-(1+R_{Ut-1})\right)\,\xi_{U,t-1}^{CBDL}\Big)\,Q_{Ut-1} \\ &+(1+R_{Ut-1})\,N_{Ut-1}\Big) \end{aligned} \tag{E.48}$$

Definition of aggregate assets US banks

$$AS_{Ut} = K_{Ut}\,Q_{Ut}\,\left(1+\xi_{U,t}^{CBDL}\right) \tag{E.49}$$

Definition of of portfolio share of domestic investment (redundant)

$$(1-\alpha_{U,t}^{CBDL}) = \frac{Q_{Ut}\,K_{Ut}}{AS_{Ut}} \tag{E.50}$$

Definition of of portfolio share of CBDL investment US

$$\alpha_{U,t}^{CBDL} = \frac{CBDL_{Rt}\,\frac{s}{1-s}}{AS_{Ut}} \tag{E.51}$$

Risk weight adjusted optimal leverage ratio US

$$\phi_{U_t} = \frac{n_{U\,t}\,\left((1-\alpha^{CBDL}_{U,t}) + \Gamma^{CBDL}_{U,t}\alpha^{CBDL}_{U,t}\right)}{\delta^{U}{}_{t}\,\left((1-\alpha^{CBDL}_{U,t}) + \Gamma^{CBDL}_{U,t}\,\alpha^{CBDL}_{U,t}\right) - v_{U,t}\,(1-\alpha^{CBDL}_{U,t}) - v^{CBDL}_{U,t}\,\alpha^{CBDL}_{U,t}} \tag{E.52}$$

Aggregate Assets US (taking into account that $\phi_{U,t}$ is the *risk adjusted* leverage ratio in the code)

$$AS_{U_t} = \frac{N_{U\,t}\,\phi_{U_t}}{(1-\alpha^{CBDL}_{U,t}) + \Gamma^{CBDL}_{U,t}\,\alpha^{CBDL}_{U,t}} \tag{E.53}$$

Cross border lending spread (in US-$)

$$S^{CBDL}_{U,t} = R^{CBDL}_{U,t} - (1 + R_{U\,t}) \tag{E.54}$$

E.4 Wage setting

Numerator Calvo style wages RoW

$$X^{w}_{1,R_t} = \kappa^{R}_{w}\,exp\left(\epsilon^{W}_{R\ t}\right)\,w_{R_t}^{\psi_w\,(1+\varphi)}\,L_{R_t}^{1+\varphi} + \beta_R\,\theta^{R}_{w}\,\left(1+\pi^{C}_{R\,t+1}\right)^{\psi_w\,(1+\varphi)}\,X^{w}_{1,R_{t+1}} \tag{E.55}$$

Denominator Calvo style wages RoW

$$X^{w}_{2,R_t} = L_{R\,t}\,\Lambda_{R\,t}\,w_{R_t}^{\psi_w} + \beta_R\,\theta^{R}_{w}\,\left(1+\pi^{C}_{R\,t+1}\right)^{\psi_w-1}\,X^{w}_{2,R_{t+1}} \tag{E.56}$$

Optimal real reset wage RoW

$$\tilde{w}_{R_t}^{1+\psi_w\,\varphi} = \frac{X^{w}_{1,R_t}\,\frac{\psi_w}{\psi_w-1}}{X^{w}_{2,R_t}} \tag{E.57}$$

Evolution real wage RoW

$$w_{R_t}^{1-\psi_w} = \left(1-\theta^{R}_{w}\right)\,\tilde{w}_{R_t}^{1-\psi_w} + \theta^{R}_{w}\,\left(1+\pi^{C}_{R\,t}\right)^{\psi_w-1}\,w_{R_{t-1}}^{1-\psi_w} \tag{E.58}$$

Labor supply shock RoW (redundant)

$$\epsilon^{W}_{R\ t} = \rho_w\,\epsilon^{W}_{R\ t-1} + \frac{\eta^{W}_{R\ t}}{100} \tag{E.59}$$

Numerator Calvo style wages US

$$X^{w}_{1,U_t} = \kappa^{U}_{w}\,exp\left(\epsilon^{W}_{U\ t}\right)\,w_{U_t}^{\psi_w\,(1+\varphi)}\,L_{U_t}^{1+\varphi} + \beta_U\,\theta^{U}_{w}\,\left(1+\pi^{C}_{U\,t+1}\right)^{\psi_w\,(1+\varphi)}\,X^{w}_{1,U_{t+1}} \tag{E.60}$$

Denominator Calvo style wages US

$$X^{w}_{2,U_t} = L_{U\,t}\,\Lambda_{U\,t}\,w_{U_t}^{\psi_w} + \beta_U\,\theta^{U}_{w}\,\left(1+\pi^{C}_{U\,t+1}\right)^{\psi_w-1}\,X^{w}_{2,U_{t+1}} \tag{E.61}$$

Optimal real reset wage US

$$\tilde{w}_{U_t}^{1+\psi_w\,\varphi} = \frac{\frac{\psi_w}{\psi_w-1}\,X^w_{1,U_t}}{X^w_{2,U_t}} \tag{E.62}$$

Evolution of real wage US

$$w_{U_t}^{1-\psi_w} = \left(1-\theta^U_w\right)\,\tilde{w}_{U_t}^{1-\psi_w} + \theta^U_w\,\left(1+\pi^C_{U\,t}\right)^{\psi_w-1}\,w_{U_{t-1}}^{1-\psi_w} \tag{E.63}$$

Labour Supply Shock US (redundant)

$$\epsilon^W_{U\,t} = \rho_w\,\epsilon^W_{U\,t-1} + \frac{\eta^W_{U\,t}}{100} \tag{E.64}$$

E.5 Final Good Bundler

RoW demand for domestically produced goods

$$Y^R_{R\,t} = \eta_{R,t}\,exp\left(\epsilon^\eta_{R\,t}\right)\,IP_{R_t}^{(-\psi_f)}\,Y^C_{R\,t} \tag{E.65}$$

RoW demand for import good from the US

$$Y^R_{U\,t} = Y^C_{R\,t}\,\frac{n}{1-n}\,\left(1-\eta_{R,t}\,exp\left(\epsilon^\eta_{R\,t}\right)\right)\,\left(IP_{R\,t}\,IT^U_{R\,t}\right)^{(-\psi_f)} \tag{E.66}$$

RoW home bias shock (redundant)

$$\epsilon^\eta_{R\,t} = \rho_\eta\,\epsilon^\eta_{R\,t-1} + \frac{\eta^\eta_{R\,t}}{100} \tag{E.67}$$

US demand for domestically produced goods

$$Y^U_{U\,t} = \eta_{F,t}\,exp\left(\epsilon^\eta_{U\,t}\right)\,IP_{U_t}^{(-\psi_f)}\,Y^C_{U\,t} \tag{E.68}$$

US demand for for import good from RoW

$$Y^U_{R\,t} = Y^C_{U\,t}\,\frac{1-n}{n}\,\left(1-\eta_{F,t}\,exp\left(\epsilon^\eta_{U\,t}\right)\right)\,\left(IP_{U\,t}\,IT^R_{U\,t}\right)^{(-\psi_f)} \tag{E.69}$$

Definition of US imports (in US per capita units)

$$Imp_{U\,t} = Y^C_{U\,t}\,\left(1-eta_{F,t}\,exp\left(\epsilon^\eta_{U\,t}\right)\right)\,\left(IP_{U\,t}\,IT^R_{U\,t}\right)^{(-\psi_f)} \tag{E.70}$$

US home bias shock (redundant)

$$\epsilon^\eta_{U\,t} = \rho_\eta\,\epsilon^\eta_{U\,t-1} + \frac{\eta^\eta_{U\,t}}{100} \tag{E.71}$$

Definition of US export import ratio

$$\frac{Exp}{imp}_{Ut} = \frac{Y_{U,t}{}^{R}}{Imp_{Ut}} \tag{E.72}$$

E.6 Intermediate Goods producers

Depreciation Function RoW

$$\tau_{Rt} = \tau_{R,ss,scale} + \frac{\zeta_1^R U_{R_t}^{1+\zeta_2}}{1+\zeta_2} \tag{E.73}$$

Derivative Depreciation Function RoW

$$\tau'_{Rt} = \zeta_1^R U_{R_t}^{\zeta_2} \tag{E.74}$$

Optimal RoW capital services to labor ratio (implicitly defining optimal utilization)

$$\frac{w_{Rt}}{\tau'_{Rt}} = \frac{\frac{1-\alpha}{\alpha} K_{Rt-1} U_{Rt}}{L_{Rt}} \tag{E.75}$$

Real marginal costs in CPI terms RoW

$$MC^r_{Rt} = \frac{w_{R_t}^{1-\alpha} \tau'^{\alpha}_{Rt}}{(1-\alpha)^{1-\alpha} \alpha^{\alpha}} \tag{E.76}$$

Real marginal costs in PPI terms RoW

$$MC^{rp}_{R\,t} = \frac{MC^r_{Rt}}{IP_{Rt}} \tag{E.77}$$

RoW gross returns to capital

$$R_{K,R_t} = \left(1 + \pi^C_{Rt}\right) \frac{Q_{Rt} + \frac{\alpha MC^r_{Rt} Z_{Rt}}{K_{Rt-1}} - \tau_{Rt}}{Q_{Rt-1}} \tag{E.78}$$

Depreciation Function US

$$\tau_{Ut} = \tau_{U,ss,scale} + \frac{\zeta_1^U U_{U_t}^{1+\zeta_2}}{1+\zeta_2} \tag{E.79}$$

Derivative Depreciation Function US

$$\tau'_{Ut} = \zeta_1^U U_{U_t}^{\zeta_2} \tag{E.80}$$

Optimal US capital services to labor ratio (implicitly defining optimal utilization)

$$\frac{w_{Ut}}{\tau'_{Ut}} = \frac{\frac{1-\alpha}{\alpha} K_{Ut-1} U_{Ut}}{L_{Ut}} \tag{E.81}$$

Real marginal costs in US CPI

$$MC^{r}_{U\,t} = \frac{{w_{U}}_t^{1-\alpha}\,{\tau'_{U\,t}}^{\alpha}}{(1-\alpha)^{1-\alpha}\;\alpha^{\alpha}} \tag{E.82}$$

Real marginal costs in US PPI terms

$$MC^{rp}_{U\,t} = \frac{MC^{r}_{U\,t}}{IP_{U\,t}} \tag{E.83}$$

US gross returns to capital

$$R_{K,U_t} = \left(1+\pi^{C}_{U\,t}\right)\,\frac{Q_{U\,t} + \frac{\alpha\,MC^{r}_{U\,t}\,Z_{U\,t}}{K_{U\,t-1}} - \tau_{U\,t}}{Q_{U\,t-1}} \tag{E.84}$$

E.7 RoW Capital Goods Producers

RoW Tobins Q/RoW Price of Capital

$$\begin{aligned} Q_{R\,t} =& 1+\frac{\Psi_R}{2}\,\left(\frac{In_{R\,t}+(\bar{I_R})}{(\bar{I_R})+In_{R\,t-1}}-1\right)^2+\frac{In_{R\,t}+(\bar{I_R})}{(\bar{I_R})+In_{R\,t-1}}\,\Psi_R\,\left(\frac{In_{R\,t}+(\bar{I_R})}{(\bar{I_R})+In_{R\,t-1}}-1\right) \\ &-\Psi_R\,\frac{\beta_R\,\Lambda_{R\,t+1}}{\Lambda_{R\,t}}\,\left(\frac{(\bar{I_R})+In_{R\,t+1}}{In_{R\,t}+(\bar{I_R})}-1\right)\,\left(\frac{(\bar{I_R})+In_{R\,t+1}}{In_{R\,t}+(\bar{I_R})}\right)^2 \end{aligned} \tag{E.85}$$

RoW LOM for capital

$$K_{R\,t} = K_{R\,t-1} + In_{R\,t} \tag{E.86}$$

Definition of net investment

$$In_{R\,t} = I_{R\,t} - K_{R\,t-1}\,\tau_{R\,t} \tag{E.87}$$

US Tobins Q/US Price of Capital

$$\begin{aligned} Q_{U\,t} =& 1+\frac{\Psi_U}{2}\,\left(\frac{In_{U\,t}+(\bar{I_U})}{(\bar{I_U})+In_{U\,t-1}}-1\right)^2+\frac{In_{U\,t}+(\bar{I_U})}{(\bar{I_U})+In_{U\,t-1}}\,\Psi_U\,\left(\frac{In_{U\,t}+(\bar{I_U})}{(\bar{I_U})+In_{U\,t-1}}-1\right) \\ &-\Psi_U\,\frac{\beta_U\,\Lambda_{U\,t+1}}{\Lambda_{U\,t}}\,\left(\frac{(\bar{I_U})+In_{U\,t+1}}{In_{U\,t}+(\bar{I_U})}-1\right)\,\left(\frac{(\bar{I_U})+In_{U\,t+1}}{In_{U\,t}+(\bar{I_U})}\right)^2 \end{aligned} \tag{E.88}$$

US LOM for capital

$$K_{U\,t} = K_{U\,t-1} + In_{U\,t} \tag{E.89}$$

US definition of net investment

$$In_{U\,t} = I_{U\,t} - K_{U\,t-1}\,\tau_{U\,t} \tag{E.90}$$

E.8 Intra RoW retail good pricing

Numerator Calvo pricing PCP intra RoW sales

$$\tilde{X}^R_{R,1_t} = Y^R_{R\,t}\, MC^{rp}_{R\,t}\, IP_{Rt}\, \Lambda_{Rt}\, \widetilde{CP}^{R(-\psi_i)}_{Rt} + \beta_R\, \theta^R_P\, \left(1 + \tilde{\pi}^R_{Rt+1}\right)^{\psi_i} \tilde{X}^R_{R,1_{t+1}} \tag{E.91}$$

Denominator Calvo pricing PCP intra RoW sales

$$\tilde{X}^R_{R,2_t} = Y^R_{R\,t}\, IP_{Rt}\, \Lambda_{Rt}\, \widetilde{CP}^{R\,1-\psi_i}_{Rt} + \beta_R\, \theta^R_P\, \left(1 + \tilde{\pi}^R_{Rt+1}\right)^{\psi_i - 1} \tilde{X}^R_{R,2_{t+1}} \tag{E.92}$$

Optimal reset price Calvo pricing PCP intra RoW sales

$$\tilde{p}^R_{Rt} = \frac{\tilde{X}^R_{R,1_t}\, \frac{\psi_i}{\psi_i - 1}}{\tilde{X}^R_{R,2_t}} \tag{E.93}$$

RoW domestic sales PCP retailers inflation

$$1 = \left(1 - \theta^R_P\right)\, \tilde{p}^{R\,1-\psi_i}_{Rt} + \theta^R_P\, \left(1 + \tilde{\pi}^R_{Rt}\right)^{\psi_i - 1} \tag{E.94}$$

Numerator Calvo pricing DCP intra RoW sales

$$\hat{X}^R_{R,1_t} = Y^R_{R\,t}\, MC^{rp}_{R\,t}\, IP_{Rt}\, \Lambda_{Rt}\, \widehat{CP}^{R(-\psi_i)}_{Rt} + \beta_R\, \theta^R_P\, \left(1 + \hat{\pi}^R_{Rt+1}\right)^{\psi_i} \hat{X}^R_{R,1_{t+1}} \tag{E.95}$$

Denominator Calvo pricing DCP intra RoW sales

$$\hat{X}^R_{R,2_t} = Y^R_{R\,t}\, IP_{Rt}\, \Lambda_{Rt}\, \widehat{CP}^{R\,1-\psi_i}_{Rt} + \beta_R\, \theta^R_P\, \left(1 + \hat{\pi}^R_{Rt+1}\right)^{\psi_i - 1} \hat{X}^R_{R,2_{t+1}} \tag{E.96}$$

Optimal reset price Calvo pricing DCP intra RoW sales

$$\hat{p}^R_{Rt} = \frac{\frac{\psi_i}{\psi_i - 1}\, \hat{X}^R_{R,1_t}}{\hat{X}^R_{R,2_t}} \tag{E.97}$$

RoW domestic sales DCP retailers inflation

$$1 = \left(1 - \theta^R_P\right)\, \hat{p}^{R\,1-\psi_i}_{Rt} + \theta^R_P\, \left(1 + \hat{\pi}^R_{Rt}\right)^{\psi_i - 1} \tag{E.98}$$

E.9 Intra US retail good pricing

Numerator Calvo pricing intra US sales

$$X^U_{U,1_t} = Y^U_{U\,t}\, MC^{rp}_{U\,t}\, \Lambda_{Ut}\, IP_{Ut} + \beta_U\, \theta^U_P\, \left(1 + \pi^U_{Ut+1}\right)^{\psi_i} X^U_{U,1_{t+1}} \tag{E.99}$$

Denominator Calvo pricing intra US sales

$$X^U_{U,2_t} = Y^U_{U\,t}\, \Lambda_{Ut}\, IP_{Ut} + \beta_U\, \theta^U_P\, \left(1 + \pi^U_{Ut+1}\right)^{\psi_i - 1} X^U_{U,2_{t+1}} \tag{E.100}$$

Optimal reset price Calvo pricing intra US sales

$$\overline{p}^{U}_{U\,t} = \frac{\frac{\psi_i}{\psi_i - 1}\, X^{U}_{U,1_t}}{X^{U}_{U,2_t}} \tag{E.101}$$

US domestic retail good price inflation

$$1 = \left(1 - \theta^{U}_{P}\right)\, \overline{p}^{U\,1-\psi_i}_{U\,t} + \theta^{U}_{P}\, \left(1 + \pi^{U}_{U\,t}\right)^{\psi_i - 1} \tag{E.102}$$

E.10 Export Pricing

Numerator Calvo Pricing RoW PCP exports to US

$$\tilde{X}^{U}_{R,1_t} = Y^{U}_{R\,t}\, IP_{R\,t}\, MC^{rp}_{R\,t}\, \Lambda_{R\,t}\, \widetilde{CP}^{U(-\psi_i)}_{R\,t} + \beta_R\, \theta^{R}_{P}\, \left(1 + \tilde{\pi}^{U}_{R\,t+1}\right)^{\psi_i}\, \tilde{X}^{U}_{R,1_{t+1}} \tag{E.103}$$

Denominator Calvo Pricing RoW PCP exports to US

$$\tilde{X}^{U}_{R,2_t} = Y^{U}_{R\,t}\, IP_{R\,t}\, \Lambda_{R\,t}\, \widetilde{CP}^{U(-\psi_i)}_{R\,t}\, \widetilde{EM}^{U}_{R\,t} + \beta_R\, \theta^{R}_{P}\, \left(1 + \tilde{\pi}^{U}_{R\,t+1}\right)^{\psi_i - 1}\, \tilde{X}^{U}_{R,2_{t+1}} \tag{E.104}$$

Optimal reset price Calvo Pricing RoW PCP exports to US

$$\tilde{p}^{U}_{R\,t} = \frac{\frac{\psi_i}{\psi_i - 1}\, \tilde{X}^{U}_{R,1_t}}{\tilde{X}^{U}_{R,2_t}} \tag{E.105}$$

PCP price inflation RoW exports to US

$$1 = \left(1 - \theta^{R}_{P}\right)\, \tilde{p}^{U\,1-\psi_i}_{R\,t} + \theta^{R}_{P}\, \left(1 + \tilde{\pi}^{U}_{R\,t}\right)^{\psi_i - 1} \tag{E.106}$$

Numerator Calvo Pricing RoW DCP exports to US

$$\hat{X}^{U}_{R,1_t} = Y^{U}_{R\,t}\, IP_{R\,t}\, MC^{rp}_{R\,t}\, \Lambda_{R\,t}\, \widehat{CP}^{U(-\psi_i)}_{R\,t} + \beta_R\, \theta^{R}_{P}\, \left(1 + \hat{\pi}^{U}_{R\,t+1}\right)^{\psi_i}\, \hat{X}^{U}_{R,1_{t+1}} \tag{E.107}$$

Denominator Calvo Pricing RoW DCP exports to US

$$\hat{X}^{U}_{R,2_t} = Y^{U}_{R\,t}\, IP_{R\,t}\, \Lambda_{R\,t}\, \widehat{CP}^{U(-\psi_i)}_{R\,t}\, \widehat{EM}^{U}_{R\,t} + \beta_R\, \theta^{R}_{P}\, \left(1 + \hat{\pi}^{U}_{R\,t+1}\right)^{\psi_i - 1}\, \hat{X}^{U}_{R,2_{t+1}} \tag{E.108}$$

Optimal reset price Calvo Pricing RoW DCP exports to US

$$\hat{p}^{U}_{R\,t} = \frac{\frac{\psi_i}{\psi_i - 1}\, \hat{X}^{U}_{R,1_t}}{\hat{X}^{U}_{R,2_t}} \tag{E.109}$$

DCP price inflation RoW exports to US

$$1 = \left(1 - \theta^{R}_{P}\right)\, \hat{p}^{U\,1-\psi_i}_{R\,t} + \theta^{R}_{P}\, \left(1 + \hat{\pi}^{U}_{R\,t}\right)^{\psi_i - 1} \tag{E.110}$$

Numerator Calvo Pricing US DCP exports to RoW

$$\tilde{X}^R_{U,1_t} = Y^R_{U\,t}\, IP_{U\,t}\, MC^{rp}_{U\,t}\, \Lambda_{U\,t}\, \widetilde{CP}^{R\,(-\psi_i)}_{U\,t} + \beta_U\, \theta^U_P\, \left(1 + \tilde{\pi}^R_{U\,t+1}\right)^{\psi_i}\, \tilde{X}^R_{U,1_{t+1}} \tag{E.111}$$

Denominator Calvo Pricing US DCP exports to RoW

$$\tilde{X}^R_{U,2_t} = Y^R_{U\,t}\, IP_{U\,t}\, \Lambda_{U\,t}\, \widetilde{CP}^{R\,(-\psi_i)}_{U\,t}\, \widetilde{EM}^R_{U\,t} + \beta_U\, \theta^U_P\, \left(1 + \tilde{\pi}^R_{U\,t+1}\right)^{\psi_i - 1}\, \tilde{X}^R_{U,2_{t+1}} \tag{E.112}$$

Optimal reset price Calvo Pricing US DCP exports to RoW

$$\tilde{p}^R_{U\,t} = \frac{\frac{\psi_i}{\psi_i - 1}\, \tilde{X}^R_{U,1_t}}{\tilde{X}^R_{U,2_t}} \tag{E.113}$$

DCP price inflation US exports to RoW

$$1 = \left(1 - \theta^U_P\right)\, \tilde{p}^{R\,1-\psi_i}_{U\,t} + \theta^U_P\, \left(1 + \tilde{\pi}^R_{U\,t}\right)^{\psi_i - 1} \tag{E.114}$$

Numerator Calvo Pricing US LCP exports to RoW

$$\underline{X}^R_{U,1_t} = Y^R_{U\,t}\, IP_{U\,t}\, MC^{rp}_{U\,t}\, \Lambda_{U\,t}\, \underline{CP}^{R\,(-\psi_i)}_{U\,t} + \beta_U\, \theta^U_P\, \left(1 + \underline{\pi}^R_{U\,t+1}\right)^{\psi_i}\, \underline{X}^R_{U,1_{t+1}} \tag{E.115}$$

Denominator Calvo Pricing US LCP exports to RoW

$$\underline{X}^R_{U,2_t} = Y^R_{U\,t}\, IP_{U\,t}\, \Lambda_{U\,t}\, \underline{CP}^{R\,(-\psi_i)}_{U\,t}\, \underline{EM}^R_{U\,t} + \beta_U\, \theta^U_P\, \left(1 + \underline{\pi}^R_{U\,t+1}\right)^{\psi_i - 1}\, \underline{X}^R_{U,2_{t+1}} \tag{E.116}$$

Optimal reset price Calvo Pricing US LCP exports to RoW

$$\underline{p}^R_{U\,t} = \frac{\frac{\psi_i}{\psi_i - 1}\, \underline{X}^R_{U,1_t}}{\underline{X}^R_{U,2_t}} \tag{E.117}$$

LCP price inflation US exports to RoW

$$1 = \left(1 - \theta^U_P\right)\, \underline{p}^{R\,1-\psi_i}_{U\,t} + \theta^U_P\, \left(1 + \underline{\pi}^R_{U\,t}\right)^{\psi_i - 1} \tag{E.118}$$

E.11 Monetary Policy

RoW Taylor rule

$$\frac{1 + R_{R\,t}}{1 + R_{E,SS}} = \left(\frac{1 + R_{R\,t-1}}{1 + R_{E,SS}}\right)^{\rho_{R,r}} \left(\left(\frac{1 + \pi^C_{R\,t}}{1 + (\bar{\pi}^C_R)}\right)^{\phi_{R,\pi}} \left(\frac{Z_{R\,t}}{(\bar{Z}_R)}\right)^{\phi_{R,z}}\right)^{1-\rho_{R,r}} exp\left(\varepsilon^R_{R\,t}\right) \tag{E.119}$$

US Taylor rule

$$\frac{1 + R_{U\,t}}{1 + RSS_{F,ss}} = \left(\frac{1 + R_{U\,t-1}}{1 + R_{F,ss}}\right)^{\rho_{U,r}} \left(\left(\frac{1 + \pi^C_{U\,t}}{1 + (\bar{\pi}^C_U)}\right)^{\phi_{U,\pi}} \left(\frac{Z_{U\,t}}{(\bar{Z}_U)}\right)^{\phi_{U,z}}\right)^{1-\rho_{U,r}} exp\left(\varepsilon^R_{U\,t}\right) \tag{E.120}$$

RoW MP shock

$$\varepsilon^R_{Rt} = \rho^r_\epsilon \, \varepsilon^R_{Rt-1} + \sigma^r_{R,\epsilon} \, \eta^r_{Rt} \tag{E.121}$$

US MP shock

$$\varepsilon^R_{Ut} = \rho^r_\epsilon \, \varepsilon^R_{Ut-1} + \frac{\sigma^r_{U,\epsilon}}{100} \, \eta^r_{Ut} \tag{E.122}$$

E.12 Relative Prices

Relative price of RoW domestic DCP sales and RoW domestic PCP sales

$$\hat{IT}^R_{Rt} = \hat{IT}^R_{Rt-1} \frac{(1 + D\mathcal{E}_t)\,\left(1 + \hat{\pi}^R_{Rt}\right)}{1 + \tilde{\pi}^R_{Rt}} \tag{E.123}$$

Relative price of RoW domestic PCP sales to Aggregate RoW PPI

$$\widetilde{CP}^R_{Rt} = \left(\gamma^{R,PCP}_R + \left(1 - \gamma^{R,PCP}_R\right) \hat{IT}^{R\,1-\psi_i}_{Rt}\right)^{\frac{1}{\psi_i - 1}} \tag{E.124}$$

Relative price of RoW domestic DCP sales to Aggregate RoW PPI

$$\widehat{CP}^R_{Rt} = \widetilde{CP}^R_{Rt} \, \hat{IT}^R_{Rt} \tag{E.125}$$

Aggregate RoW PPI inflation as a function of domestic PCP and DCP prices

$$1 + \pi^R_{Rt} = \left(1 + \tilde{\pi}^R_{Rt}\right) \frac{\widetilde{CP}^R_{Rt-1}}{\widetilde{CP}^R_{Rt}} \tag{E.126}$$

Export margins for DCP exports from RoW to US in RoW currency (price of DCP exports over domestic sales price

$$\widehat{EM}^U_{R\,t} = \widehat{EM}^U_{R\,t-1} \frac{(1 + D\mathcal{E}_t)\,\left(1 + \hat{\pi}^U_{R\,t}\right)}{1 + \pi^R_{Rt}} \tag{E.127}$$

Export margins for PCP exports from RoW to US in RoW currency (price of DCP exports over domestic sales price

$$\widetilde{EM}^U_{R\,t} = \widetilde{EM}^U_{R\,t-1} \frac{1 + \tilde{\pi}^U_{R\,t}}{1 + \pi^R_{Rt}} \tag{E.128}$$

Aggregate margins for exports from RoW to US in RoW currency (agg. export price over domestic sales PPI)

$$EM^U_{R\,t} = \left(\gamma^{R,PCP}_{U,t} \, \widetilde{EM}^{U\,1-\psi_i}_{R\,t} + \left(1 - \gamma^{R,PCP}_{U,t}\right) \widehat{EM}^{U\,1-\psi_i}_{R\,t}\right)^{\frac{1}{1-\psi_i}} \tag{E.129}$$

Import price inflation of US imports from the RoW in US-D

$$1 + \pi^{R^I}_{U\;t} = \frac{\left(1 + \pi^R_{Rt}\right) \frac{EM^U_{R\,t}}{EM^U_{R\,t-1}}}{1 + D\mathcal{E}_t} \tag{E.130}$$

Export margins for PCP exports from the US to RoW in US-D (price of PCP exports over domestic sales price)

$$\widetilde{EM}^{R}_{U\,t} = \widetilde{EM}^{R}_{U\,t-1} \frac{1+\tilde{\pi}^{R}_{U\,t}}{1+\pi^{U}_{U\,t}} \tag{E.131}$$

Export margins for LCP exports from the US to RoW in US-D (price of LCP exports over domestic sales price)

$$\underline{EM}^{R}_{U\,t} = \frac{\left(1+\underline{\pi}^{R}_{U\,t}\right) \frac{\underline{EM}^{R}_{U\,t-1}}{1+D\mathcal{E}_t}}{1+\pi^{U}_{U\,t}} \tag{E.132}$$

Aggregate margins for exports from US to RoW in US-D currency (agg. export price over domestic sales PPI)

$$EM^{R}_{U\,t} = \left(\gamma^{F,PCP}_{E,t} \, \widetilde{EM}^{R\,1-\psi_i}_{U\,t} + \left(1-\gamma^{F,PCP}_{E,t}\right) \underline{EM}^{R\,1-\psi_i}_{U\,t}\right)^{\frac{1}{1-\psi_i}} \tag{E.133}$$

Import price inflation of RoW imports from the US in RoW currency

$$1+\pi^{U^I}_{R\;t} = (1+D\mathcal{E}_t)\left(1+\pi^{U}_{U\,t}\right) \frac{EM^{R}_{U\,t}}{EM^{R}_{U\,t-1}} \tag{E.134}$$

Interior terms of trade RoW (US exports prices (in RoW currency) relative to RoW PPI)

$$IT^{U}_{R\,t} = IT^{U}_{R\,t-1} \frac{1+\pi^{U^I}_{R\;t}}{1+\pi^{R}_{R\,t}} \tag{E.135}$$

Interior Producer Price RoW (PPI over CPI)

$$IP_{R\,t} = \left(\eta_{R,t} + (1-\eta_{R,t}) \; IT^{U\,1-\psi_f}_{R\,t}\right)^{\frac{1}{\psi_f - 1}} \tag{E.136}$$

RoW CPI inflation

$$1+\pi^{C}_{R\,t} = \left(1+\pi^{R}_{R\,t}\right) \frac{IP_{R\,t-1}}{IP_{R\,t}} \tag{E.137}$$

Interior terms of trade US (RoW exports prices (in US-D currency) relative to US PPI)

$$IT^{R}_{U\,t} = \frac{EM^{U}_{R\,t}\, EM^{R}_{U\,t}}{IT^{U}_{R\,t}} \tag{E.138}$$

Interior Producer Price US (PPI over CPI)

$$IP_{U\,t} = \left(\eta_{U,t} + (1-\eta_{U,t}) \; IT^{R\,1-\psi_f}_{U\,t}\right)^{\frac{1}{\psi_f - 1}} \tag{E.139}$$

US consumer price inflation

$$1+\pi^{C}_{U\,t} = \left(1+\pi^{U}_{U\,t}\right) \frac{IP_{U\,t-1}}{IP_{U\,t}} \tag{E.140}$$

Definition of the Real exchange rate (in terms of CPI baskets)

$$RER_t = \frac{IP_{Rt}\, EM^{U}_{R\,t}}{IP_{Ut}\, IT^{R}_{U\,t}} \tag{E.141}$$

PCP export price over agg. US import price

$$\widetilde{CP}^{U}_{R\,t} = \frac{IP_{Rt}\, \frac{\widetilde{EM}^{U}_{R\,t}}{IT^{R}_{U\,t}}}{IP_{Ut}} \frac{1}{RER_t} \tag{E.142}$$

DCP export price over agg. US import price

$$\widehat{CP}^{U}_{R\,t} = \frac{1}{RER_t} \frac{IP_{Rt}\, \frac{\widehat{EM}^{U}_{R\,t}}{IT^{R}_{U\,t}}}{IP_{Ut}} \tag{E.143}$$

DCP export price over agg. RoW import price

$$\widetilde{CP}^{R}_{U\,t} = RER_t \frac{IP_{Ut}\, \frac{\widetilde{EM}^{R}_{U\,t}}{IT^{U}_{R\,t}}}{IP_{Rt}} \tag{E.144}$$

LCP export price over agg. RoW import price

$$\underline{CP}^{R}_{U\,t} = RER_t \frac{IP_{Ut}\, \frac{\underline{EM}^{R}_{U\,t}}{IT^{U}_{R\,t}}}{IP_{Rt}} \tag{E.145}$$

E.13 Market Clearing

Agg. demand for RoW final composite good

$$Y^{C}_{R\,t} = C_{Rt} + I_{Rt} + (In_{Rt} + (\bar{I_R}))\, \frac{\Psi_R}{2} \left(\frac{In_{Rt} + (\bar{I_R})}{(\bar{I_R}) + In_{Rt-1}} - 1\right)^2 \tag{E.146}$$

Agg. demand for US final composite good

$$Y^{C}_{U\,t} = C_{Ut} + I_{Ut} + (In_{Ut} + (\bar{I_U}))\, \frac{\Psi_U}{2} \left(\frac{In_{Ut} + (\bar{I_U})}{(\bar{I_U}) + In_{Ut-1}} - 1\right)^2 \tag{E.147}$$

RoW aggregate production function

$$Z_{Rt} = (K_{Rt-1}\, U_{Rt})^{\alpha}\; L_{Rt}^{1-\alpha} \tag{E.148}$$

US aggregate production

$$Z_{Ut} = (K_{Ut-1}\, U_{Ut})^{\alpha}\; L_{Ut}^{1-\alpha} \tag{E.149}$$

RoW market clearing

$$Z_{Rt} = Y^{R}_{R\,t}\, \delta^{R}_{R\,t} + Y^{U}_{R\,t}\, \delta^{U}_{R\,t} \tag{E.150}$$

US market clearing

$$Z_{U\,t} = Y^{U}_{U\,t}\,\delta^{U}_{U\,t} + Y^{R}_{U\,t}\,\delta^{U}_{R\,t} \tag{E.151}$$

E.14 Price dispersion terms (constant up to first order)

$$\tilde{\delta}^{R}_{R\,t} = \left(1-\theta^{R}_{P}\right)\,\tilde{p}^{R\,(-\psi_i)}_{R\,t} + \theta^{R}_{P}\,\left(1+\tilde{\pi}^{R}_{R\,t}\right)^{\psi_i}\,\tilde{\delta}^{R}_{R\,t-1} \tag{E.152}$$

$$\hat{\delta}^{R}_{R\,t} = \left(1-\theta^{R}_{P}\right)\,\hat{p}^{R\,(-\psi_i)}_{R\,t} + \theta^{R}_{P}\,\left(1+\hat{\pi}^{R}_{R\,t}\right)^{\psi_i}\,\hat{\delta}^{R}_{R\,t-1} \tag{E.153}$$

$$\delta^{R}_{R\,t} = \tilde{\delta}^{R}_{R\,t}\,\widetilde{CP}^{R\,(-\psi_i)}_{R\,t}\,\gamma^{R,PCP}_{R,t} + \hat{\delta}^{R}_{R\,t}\,\widehat{CP}^{R\,(-\psi_i)}_{R\,t}\,\left(1-\gamma^{R,PCP}_{R,t}\right) \tag{E.154}$$

$$\tilde{\delta}^{U}_{R\,t} = \left(1-\theta^{R}_{P}\right)\,\tilde{p}^{U\,(-\psi_i)}_{R\,t} + \theta^{R}_{P}\,\left(1+\tilde{\pi}^{U}_{R\,t}\right)^{\psi_i}\,\tilde{\delta}^{U}_{R\,t-1} \tag{E.155}$$

$$\hat{\delta}^{U}_{R\,t} = \left(1-\theta^{R}_{P}\right)\,\hat{p}^{U\,(-\psi_i)}_{R\,t} + \theta^{R}_{P}\,\left(1+\hat{\pi}^{U}_{R\,t}\right)^{\psi_i}\,\hat{\delta}^{U}_{R\,t-1} \tag{E.156}$$

$$\delta^{U}_{R\,t} = \tilde{\delta}^{U}_{R\,t}\,\widetilde{CP}^{U\,(-\psi_i)}_{R\,t}\,\gamma^{R,PCP}_{U,t} + \hat{\delta}^{U}_{R\,t}\,\widehat{CP}^{U\,(-\psi_i)}_{R\,t}\,\left(1-\gamma^{R,PCP}_{U,t}\right) \tag{E.157}$$

$$\delta^{U}_{U\,t} = \left(1-\theta^{U}_{P}\right)\,\overline{p}^{U\,(-\psi_i)}_{U\,t} + \theta^{U}_{P}\,\left(1+\pi^{U}_{U\,t}\right)^{\psi_i}\,\delta^{U}_{U\,t-1} \tag{E.158}$$

$$\tilde{\delta}^{R}_{U\,t} = \left(1-\theta^{U}_{P}\right)\,\tilde{p}^{R\,(-\psi_i)}_{U\,t} + \theta^{U}_{P}\,\left(1+\tilde{\pi}^{R}_{U\,t}\right)^{\psi_i}\,\tilde{\delta}^{R}_{U\,t-1} \tag{E.159}$$

$$\underline{\delta}^{R}_{U\,t} = \left(1-\theta^{U}_{P}\right)\,\underline{p}^{R\,(-\psi_i)}_{U\,t} + \theta^{U}_{P}\,\left(1+\underline{\pi}^{R}_{U\,t}\right)^{\psi_i}\,\underline{\delta}^{R}_{U\,t-1} \tag{E.160}$$

$$\delta^{R}_{U\,t} = \tilde{\delta}^{R}_{U\,t}\,\widetilde{CP}^{R\,(-\psi_i)}_{U\,t}\,\gamma^{U,PCP}_{R,t} + \underline{\delta}^{R}_{U\,t}\,\underline{CP}^{R\,(-\psi_i)}_{U\,t}\,\left(1-\gamma^{U,PCP}_{R,t}\right) \tag{E.161}$$

E.15 Balance of Payments

RoW Current account in RoW currency

$$CA^{F}_{R,nom\,t} = Y^{R}_{R\,t}\,IP_{R\,t} + Y^{U}_{R\,t}\,IT^{R}_{U\,t}\,RER_{t}\,IP_{U\,t} - Y^{C}_{R\,t} \tag{E.162}$$

Balance of Payments

$$RER_t \left(GB_{Rt} - \frac{R^{GB}_{R\ t-1}}{1+\pi^C_{Ut}} \left(GB_{Rt-1}\right) \right) - RER_t \left(CBDL_{Rt} - CBDL_{Rt-1} \frac{R^{CBDL}_{U,t-1}}{1+\pi^C_{Ut}} \right) = CA^F_{R,nom\,t} \tag{E.163}$$

Trade Balance RoW

$$TB_{Rt} = Y^U_{R\ t} - \frac{(1-n)\ Y^R_{Ut}}{n} \tag{E.164}$$

Change in the NFA (including valuation effects) relative to RoW GDP

$$\Delta NFA_{Rt} = \frac{RER_t\ (GB_{Rt-1}) - (GB_{Rt-1})\ RER_{t-1} - RER_t\, CBDL_{Rt-1} + CBDL_{Rt-1}\, RER_{t-1}}{(\bar{Z_R})} \tag{E.165}$$

E.16 Model local variables

Share of PCP goods in US Import Basket

$$\gamma^{R,PCP}_U = 1 - \hat{\gamma}^R_U$$

Share of PCP goods in RoW Import basket

$$\gamma^{U,PCP}_R = 1 - \tilde{\gamma}^U_R$$

Share of PCP goods in RoW Local Basket

$$\gamma^{R,PCP}_R = 1 - \hat{\gamma}^R_R$$

RoW steady state net interest rate

$$R_{R,SS} = \frac{1}{\beta_R} - 1$$

US steady state net interest rate

$$R_{R,SS} = \frac{1}{\beta_U} - 1$$

Size adjusted import share RoW

$$\eta_R = (1 - op_R)\,(1 - s)$$

Size adjusted import share US

$$\eta_{US} = (1 - op_U)s$$

F Online Appendix - Model Extensions

F.1 Exorbitant Duty

In the data the aggregate RoW has a positive net dollar position vis-à-vis the US. This partly underlies the US's 'exorbitant duty' (Gourinchas et al. 2012; Gourinchas & Rey 2022): When risk aversion increases and the dollar appreciates, the US (RoW) experiences a negative (positive) exchange-rate valuation effect on its external balance sheet.[44] In contrast, in the calibration of our baseline trinity model the RoW has a *negative* net dollar position vis-à-vis the US. As a result, there is no wealth transfer from the US to the RoW due to an exchange-rate valuation effect when risk increases and the dollar appreciates.

However, we argue the absence of this exorbitant duty in the baseline trinity model is inconsequential for the transmission of the GFCyc. In particular, the RoW's positive net foreign asset position vis-à-vis the US in the data is to a large extent accounted for by entities that are arguably not sensitive to short-term exchange rate valuation effects (i.e. not short-term leverage-constrained) as for example foreign exchange reserve managers, pension and sovereign wealth funds—so that they simply absorb exchange-rate valuation effects over time without contributing to a global financial accelerator.[45]

In order to illustrate the implications of this, we consider an extension in which we introduce an unconstrained RoW government entity that holds dollar assets such that the *aggregate* RoW has a positive net foreign asset position vis-à-vis the US, while the RoW banking sector continues to be net short in dollar. In particular, we assume that in the RoW there exists a continuum of entities—which we refer to as sovereign wealth funds (SWFs) for simplicity—that in each period take on deposits $D^{SWF}_{R,j,t}$ from RoW households at the rate $R_{R,t-1}$ which they use to purchase US Treasuries $GB^{SWF}_{R,j,t}$. As bank deposits return the same rate as deposits with the SWFs, RoW households are indifferent between the two. After each period, SWFs transfer profits or losses from these operations to households. The balance sheet of SWF j in real terms reads as

$$RER_t GB^{SWF}_{R,j,t} = D^{SWF}_{R,j,t}, \tag{F.1}$$

[44]According to Gourinchas & Rey (2022) the largest part of the overall valuation effect arises because the US is the 'global venture capitalist': Its foreign liabilities are tilted towards instruments—e.g. Treasury securities—whose prices rise when risk aversion increases while the prices of its foreign assets—e.g. foreign equity—fall.

[45]Sufficiently detailed data on the composition of US-RoW cross-border positions by counterparty country and sector, currency and instrument necessary to document this does not exist. However, at least some circumstantial evidence can be inferred from existing but less detailed data. For example, according to data from US Treasury International Capital RoW (quasi-)government—including sovereign wealth fund—holdings of US debt and equity securities amounted to 28% of US annual GDP over 2005 to 2019, while according to the data from Benetrix et al. (2020) over the same period the US net foreign asset position amounted to -30%. Similarly, the IMF's Currency Composition of Official Foreign Exchange Reserves (COFER) data suggest that global official dollar-denominated foreign exchange reserves amounted to 37% of US annual GDP over 1991 to 2019 (assuming the same dollar share for un-allocated as for allocated reserves), compared to a US net foreign asset position of -20%. While not conclusive, this data suggests a non-trivial share of the RoW's holdings of US assets making up its net foreign asset position is held by arguably unconstrained entities.

and the period-by-period flow-of-funds constraint can be written as

$$\frac{R_{R,t-1}}{(1+\pi^C_{R,t})} D^{SWF}_{R,t-1} + RER_t GB^{SWF}_{R,j,t} = \frac{R^{GB}_{U,t-1}}{(1+\pi_{U,t})} RER_t GB^{SWF}_{R,j,t-1} + D^{SWF}_{R,t}. \tag{F.2}$$

In contrast to the baseline, we assume that the supply of Treasuries is fixed at $\overline{GB}_U$, which is calibrated to yield a negative US net-foreign-asset-to-GDP-ratio in line with the data.[46] Market clearing then determines the optimal amount of US Treasuries $GB_{R,t}$ held by the RoW SWFs as

$$GB^{SWF}_{R,t} = \frac{(1-s)}{s} \overline{GB}_U - GB_{R,t}, \tag{F.3}$$

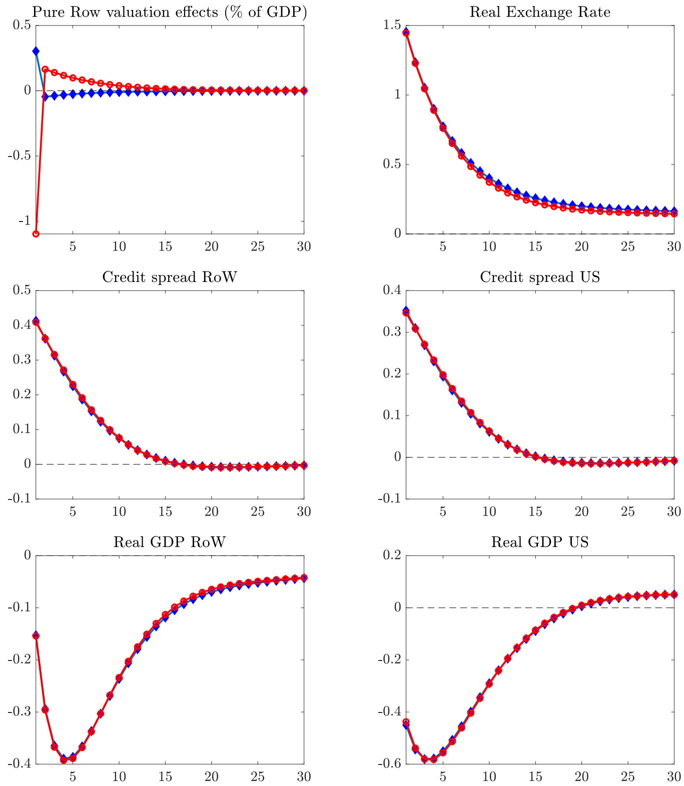
where s denotes relative country size. One way to think of this set-up is that given a fixed supply of Treasuries, RoW banks purchase Treasuries to optimally manage the riskiness of their balance sheets, and RoW SWFs just absorb the residual. After imposing market clearing and aggregating across budget constraints of RoW firms and households, the aggregate RoW budget constraint (i.e. the national accounting identity) in Equation (**??**) includes an additional term which tracks the evolution of US Treasuries holdings of RoW SWFs.

The first panel in Figure F.1 shows that in this setup the RoW experiences a exchange-rate valuation gain of roughly 0.4% of GDP following a dollar appreciation due to a risk aversion shock. Most importantly, however, the responses of the remaining variables are virtually unchanged relative to the baseline trinity model.

This is because as long as the RoW entity that accounts for the positive net foreign asset position vis-à-vis the US is unconstrained and profits are distributed lump-sum to unconstrained households, exchange-rate valuation effects hardly affect consumption and savings choices (Kaplan et al. 2018). Thus, the overall RoW net foreign asset position vis-à-vis the US is not key for the transmission of the GFCyc. What matters is the net foreign asset position of constrained RoW banks.

[46] While our baseline calibration implies the US has a positive net foreign asset position of 46% of GDP, here we calibrate $\overline{GB}_U$ to roughly match the average in the sample used in the empirical analysis in Section 3 at -14%.

Figure F.1: Responses to a risk aversion shock with (red circles) and without (blue diamonds) exorbitant duty



Note: The red lines with circles show the impulse responses of baseline model and the blue lines with diamonds from an alternative model in which we add unconstrained RoW sovereign wealth funds which hold enough US dollar denominated assets, such that the RoW is a net creditor to the US.