The Hegemon's Dilemma.*

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Abstract

By keeping dollars scarce in international markets, the U.S. – the hegemon – earns monopoly rents when borrowing in dollar debt and investing in foreign currency assets. However, in equilibrium, these rents both result in a strong dollar, which depresses global demand for its exports and leads to losses on existing holdings of foreign assets, and give rise to private sector over-borrowing. Using an open economy model with nominal rigidities and segmented financial markets, I show that, because of over-borrowing, monetary policy alone cannot achieve the constrained efficient allocation. Absent a corrective macro-prudential tax on capital inflows, the hegemon is faced with a policy dilemma between achieving efficient stabilization or maximizing monopoly rents. By increasing liquidity in international markets, dollar swap lines extended by the central bank improve stabilization, but, unlike macro-prudential taxes, do so at the cost of eroding monopoly rents. The dilemma matters for distribution as well as efficiency. A scarce dollar leads to larger monopoly rents which benefit financially-active households, but they over-borrow at the expense of inactive households, who suffer the full blunt of aggregate demand externalities.

JEL Codes: E44, E63, F33, F40, G15

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1 Introduction

In periods of global financial distress, international capital systematically flows into dollar assets. Dollar shortages in foreign markets are an important and recurrent feature of recent financial crises, including as the 2007 Great Financial Crisis (GFC) and the early-stages of the Covid-19 pandemic. Foreign investors demand dollar debt in large quantities even though, as dollars becomes scarce, the dollar tends to appreciate and the return on a portfolio that is long in dollar bonds, funded by borrowing in foreign currencies becomes significantly negative.[1] Because of the specialness of the dollar, fluctuations in the supply and demand of dollar assets, and the conduct of U.S. policy matter disproportionately in the world economy.[2] Strong and volatile demand for dollars by foreign investors, however, also has stark implications for U.S. domestic outcomes.

The contribution of this paper is to re-consider the trade-offs faced by the hegemon, as issuer of dollar assets. On the one hand, A scarce dollar leads to a higher return on the net investment position of the U.S.– interpretable as monopoly rents from issuing dollar debt– which results in a transfer from abroad. On the other hand, this transfer leads to an equilibrium appreciation of the dollar which depresses the global demand for U.S. exports, resulting in unemployment and, on impact, results in losses on the portfolio of foreign-currency denominated assets coming due.[3] I show that, in the absence of an optimal macro-prudential tax to correct inefficient levels of private sector borrowing, monetary policy alone cannot support the constrained efficient allocation in the hegemon when there are dollar shortages abroad. In particular, the hegemon experiences inefficiently volatile output and prices and lower monopoly rents.I then highlight the scope for direct liquidity provision, through the Federal Reserve's Dollar Swap Line facilities, described in Section 2.4, to be welfare improving for both the hegemon and foreign investors.

I adopt a standard open-economy model, featuring nominal rigidities and financial frictions in international markets. Specifically, dollar and foreign currency markets for financial assets are separate, building on the segmented markets framework of Gabaix and Maggiori (2015). In this framework, dollar assets can be issued by U.S. agents and they can also be manufactured, at an increasing cost, by heterogeneous international financial intermediaries (e.g. non-U.S. banks). Following an increase in the demand for dollar debt by foreign investors, because intermediation is costly, the dollar appreciates and the cost of borrowing in dollars fall in

[1]McGuire and Peter (2009) document that European Banks' short term dollar funding gap (i.e dollar roll-over needs) were at least 7% of U.S. GDP at the onset of the GFC. Aldasoro et al. (2020) document that in June 2018, non-U.S. banks had $12.8 trillion of dollar-denominated borrowing, used to finance purchases of U.S. assets.

[2]For instance, an acute shortage of dollar assets can lead to deflationary safety traps (Caballero, Farhi, and Gourinchas (2017)) and a sharp tightening in international financial conditions (Jiang (2021)).Rey (2015) Kalemli-Ozcan (2019), Miranda-Agrippino and Rey (2020), and Jiang, Krishnamurthy, and Lustig (2020), amongst others, show that U.S. monetary policy has large spillovers in foreign and particularly emerging economies.

[3]As documented in Figure 7, a portfolio funded by dollar borrowing and long in foreign assets suffers losses at the onset of the crisis. However, this is followed by large returns during the crisis. Jiang, Krishnamurthy, and Lustig (2020) describe the higher expected future returns on the U.S. portfolio as a "capitalization" effect and document a wealth inflow to the U.S. during the GFC. This net wealth flow is debated in the literature: on empirical grounds, Maggiori (2017) and Gourinchas, Rey, and Govillot (2018) find evidence of losses for the U.S., albeit using a narrower definition for wealth, see Figure ??.

equilibrium.[4] Moreover, because aggregate intermediation costs are increasing in the size of dollar shortages, the hegemon faces a downward sloping demand for dollar debt.

The model is consistent with key recurrent patterns of the dollar around periods of international turmoil when the demand for dollars is high, see Figure 7 (Appendix A). In particular, the dollar appreciates at the onset of crises and depreciates thereafter. Interest rates on 3-month U.S. treasuries fall, but only moderately. Together, these patterns imply that foreign investors forego significant returns to hold a portfolio of dollar debt which they finance by borrowing in foreign currency during crises. For example, the return on this portfolio in August 2008 was −6% over the next 12 months.[5] Intuitively, foreign currencies which tend to contemporaneously depreciate vis-á-vis the dollar in periods of dollar shortages, systematically appreciate thereafter, therefore the dollar cost of repaying foreign debt rises, even if interest rate differentials are small.

The main results of my analysis are as follows. First, I establish that dollar shortages abroad lead to private sector over-borrowing by hegemon households because of two externalities: a financial (issuance) externality and an aggregate demand externality. The former arises because atomistic households borrowing in financial markets do not internalize that the country as a whole faces a downward sloping demand for dollar debt (the result of frictions faced by financial intermediaries). In other words, atomistic households fail to internalize that issuing an additional unit of dollar debt lowers the the price for all other units of debt. Aggregate demand externalities are the result of nominal rigidities in goods markets. Households do not take into account the stimulative effects of their spending on domestic goods. To show that these two externalities result in over-borrowing in the hegemon, I derive that the optimal macro-prudential response to an increase in dollar shortages, at the constrained efficient allocation, is a positive tax on borrowing. I define the constrained efficient allocation as the best feasible allocation that can be supported by the optimal mix of monetary and macro-prudential policy.

Second, I show that when the borrowing tax is not set optimally or is not available, private sector over-borrowing weighs on the trade-offs faced by monetary policy. On the one hand, monetary policy wants to cut interest rates to boost demand for exports and prevent a costly dollar appreciation. However, because of the presence of over-borrowing, monetary policy has an offsetting incentive to raise interest rates. Relative to the constrained efficient equilibrium, the equilibrium with monetary policy alone is characterized by excessively volatile output and prices and lower monopoly rents.

This result complements the idea put forth by Rey (2015) who argues that countries cannot set monetary policy independently because of a global financial cycle in asset prices driven by the dollar. Following Farhi and Werning (2014), I define monetary policy to be independent if it can achieve the constrained efficient allocation absent the use of any tax on borrowing from abroad. Based on this, my findings suggest that the U.S. *also* faces a Mundellian policy

[4] This mechanism is consistent with evidence in Krishnamurthy and Lustig (2019) and Georgiadis, Müller, and Schumann (2021) who find that in response to an increase in the demand for dollars,non-U.S. banks increase their issuance of dollar liabilities.

[5] Krishnamurthy and Lustig (2019) provide direct evidence of foreign investors taking loss-making positions, see Figure 9.

dilemma, since monetary policy does not achieve the constrained efficient allocation due to capital flows driven by foreigners' demand for dollars.[6]

Third, I find that the policy dilemma gives scope for direct dollar liquidity provision in international markets, as exemplified by the Federal Reserve (FED) dollar swap lines, to improve hegemon welfare. Swap lines are agreements according to which the FED lends dollars to a foreign central bank, against good collateral and over short maturities, in exchange for foreign currency. The foreign central bank, in turn, lends dollars to its domestic financial institutions alleviating their dollar constraints. Since the GFC, swap lines have been used extensively. The outstanding dollar swap liabilities amounted to 38% of U.S. GDP in 2008 Q4.[7] Like the (missing) macro-prudential borrowing tax, dollar swaps allow the hegemon to address inefficient over-borrowing and stabilize output, but, in stark contrast with the borrowing tax, they achieve these objectives at the cost of eroding monopoly rents as dollar assets become more easily available. As a result, dollar swaps improve outcomes for foreign investors, in contrast to the optimal macro-prudential tax. Since dollar swaps address over-borrowing, they help the hegemon regain monetary policy "independence". In the baseline model, dollar swaps never improve welfare when the optimal macro-prudential is used.

The workings of dollar swap lines in the model are as follows. Financial intermediaries can manufacture dollar debt but are subject to portfolio costs and position limits. Because of this, they are only willing to issue dollar debt if the cost of borrowing in dollars is lower than the cost of borrowing in foreign currency. The tighter the intermediaries' portfolio constraint, the larger the spread required for the dollar market to clear. By exchanging dollars for foreign currency, dollar swaps increase liquidity in international markets and alleviate the frictions constraining the supply of dollar debt by financial intermediaries. Since smaller dollar shortages moderate the pressure on the dollar to appreciate, swaps contribute to sustaining employment and weaken the incentive for hegemon residents to (over-)borrow. In the case where the only shock in the economy is a one-off dollar demand shock, dollar swaps can, by themselves, fully mute the effects of the shock —but, the resulting allocation does not coincide with the constrained optimal. This is because a macro-prudential tax that postpones consumption can simultaneously address over-borrowing *and* increase the size of monopoly rents transferred from abroad.

Fourth, I highlight that dollar shortages have strong domestic distributional consequences. Given the over-borrowing inefficiency, I consider an extension of the model which distinguishes between households who are financially-active, and can trade in dollar debt vis-à-vis financial intermediaries, and inactive households who consume their current income. Dollar shortages abroad have heterogenous effects one these two types of households. Financially-active households benefit from higher returns on their financial position (short in dollar bonds and long in

[6] Mundell's classical view is that countries can achieve two objectives out of capital market openness (no taxes on capital flows), monetary policy independence (addressing domestic objectives) and exchange rate stability. Recent literature has instead suggested that efficient monetary policy requires taxation in capital markets as well, therefore the policy choice is between exchange rate stability with free capital mobility and no monetary independence or monetary policy independence with capital flows management.

[7] Dollar swaps signal a recognition by the FED of the role of dollars in the international markets, and its own role as a *global* lender of last resort in the spirit of Bagehot, see Bahaj and Reis (2018).

foreign assets) and, unlike inactive households, are partly able to smooth the income loss from depressed exports and from losses on the government's portfolio of assets. Inactive households lose out even if, in equilibrium, financially-active households spend part of the rents they earn on domestic goods, raising domestic income for all residents. The use of dollar swap lines systematically redistributes from financially-active to inactive households because they mute the effect of shortages on the exchange rate and erode monopoly rents.[8]

I close the paper with a simple numerical illustration. I consider a one-off unanticipated shock to foreign investors' demand for dollars which leads to a 6-8% appreciation of the dollar (depending on the interest rate response), and results in a spread in the cost of borrowing in foreign currency vis-á-vis dollars of about 4%, consistent with the U.S. experience during the GFC (see Figure 7). While optimal monetary policy alone (a 3% interest rate cut) can improve aggregate outcomes in the face of dollar shortages, it achieves only *one-third* of the welfare gain which is possible at the constrained optimal allocation. The constrained efficient allocation instead requires interest rates to adjust by about 5%. At the constrained efficient allocation, a one-off unexpected increase in dollar shortages improves welfare, whereas welfare falls when neither monetary or macro-prudential policy respond optimally. Extending dollar swap lines, which partly offset the shock, will not achieve the constrained efficient allocation.Finally, I find that the distributional implications of dollar shortages persist even when monetary policy adjusts and, surprisingly, the allocation becomes can become more inequitable at the constrained efficient allocation.

Related Literature. Thematically, this paper belongs to the literature on the role of the U.S. and the dollar in the International Monetary System (IMS). Amongst recent contributions, Maggiori (2017), Gourinchas, Rey, and Govillot (2018), Kekre and Lenel (2020) consider general equilibrium models where the U.S. has a larger capacity to bear risk, earning excess returns outside of crises but facing losses during crises. Farhi and Maggiori (2016) emphasize, that the U.S. faces a downward sloping demand for its debt, derived from mean-variance investors, and earns monopoly rents. However, in their framework, monopoly rents arise only through lower interest rates. Similarly, Jiang, Krishnamurthy, and Lustig (2020) consider a model where the U.S. earns seignorage rents from issuing debt because foreign investors assign a convenience yield to dollar debt. Relative to these papers, I highlight the role for policy to manage the trade-offs faced by the U.S. and I highlight the macroeconomic externalities which arise.

I draw on a new, mostly theoretical, literature on optimal capital controls which aims to identify macroeconomic externalities in goods and financial markets. Specifically, Costinot, Lorenzoni, and Werning (2014) and Lloyd and Marin (2020), study the use of capital controls to internalise terms of trade externalities both inter-temporally and intra-temporally, Schmitt-Grohé and Uribe (2016) and Farhi and Werning (2016) look at aggregate demand externalities

[8] Chien and Morris (2017) show that financial market participation varies by U.S. state even when controlling for household income. Therefore, dollar shortages introduce a political trade-off in the hegemon and the extension of dollar swap lines can become a political decision.

and Basu et al. (2020) and Bianchi and Lorenzoni (2021) analyze financial externalities.[9] My analysis of second-best monetary policy relates to Bianchi and Coulibaly (2021), who show that monetary policy can be used to address inefficiently high borrowing in the economy, when capital controls are not available and Itskhoki and Mukhin (2022) who show that monetary policy must compromise between stabilizing the output gap and achieving efficient risk sharing because of intermediation frictions.[10]

Even though dollar swap lines have been one of the most prominent policy innovations over the past decade, there is comparatively little literature on their effect on macro outcomes.[11] A number of contributions have assessed the efficacy of dollar swaps empirically: Baba and Packer (2009) and Moessner and Allen (2013) analyse the effect of swap lines during the GFC using variation across currency pairs and Aizenman, Ito, and Pasricha (2021) conduct a similar analysis for the aftermath of COVID-19. Bahaj and Reis (2018) use both cross-sectional and time-series variation to show that dollar swaps introduce a ceiling on deviations from the covered interest rate parity, reduce portfolio flows into dollar assets and lower the price of dollar corporate bonds. The contribution of this paper is to characterize dollar swap lines as part of the (Ramsey) optimal policy and highlight a meaningful trade-off facing the U.S. when it extends these to foreign central banks.

Finally, this paper relates to an established literature that studies the implications of limited financial market participation on risk-sharing outcomes in closed and open economies.[12] Recently, Fanelli and Straub (2018) derive optimal foreign exchange interventions in a model with segmented international financial markets where hand-to-mouth households are hurt by a pecuniary externality. De Ferra, Mitman, and Romei (2019) study the effects of a sudden stop in capital inflows in a small-open HANK economy where household debt is partly denominated in foreign currency. Auclert et al. (2021), build on Corsetti and Pesenti (2001), to analyze the effects of household heterogeneity on the costs of an appreciation.

This paper is structured as follows. Section 2 lays out the model. Section 3 considers a stylized framework which outlines the key trade-offs. Section 4 solves for welfare maximizing policy and analyzes the hegemon's policy dilemma. Section 4.3 considers the distributional implications of dollar shortages in a two-agent version of the model. Section 5 conducts a calibration exercise. Section 6 concludes.

2 Model Setup

There is a continuum of countries $i \in [0, 1]$. I denote the *hegemon* by $i = 0$ and suppress the subscript for domestic variables. The baseline setup builds on a standard open-economy model

[9]Farhi and Werning (2014) emphasize that capital controls are generally useful, in addition to monetary policy, to smooth the terms of trade in a New-Keynesian model.

[10]Their model emphasizes that the exchange rate volatility needed to stabilize the output gap itself impinges on efficient risk sharing because of financiers' intermediation capacity is decreasing in exchange rate volatility.

[11]McCauley and Schenk (2020) detail the history of liquidity provision policies by the U.S. and other central banks.

[12]See e.g Alvarez, Atkeson, and Kehoe (2002), Alvarez, Atkeson, and Kehoe (2009), Kollmann (2012) and Cociuba and Ramanarayanan (2017)

as in Galí and Monacelli (2005), recently adopted in, e.g. Farhi and Werning (2016) and Egorov and Mukhin (2021). To distinguish between a market for dollar assets and a market for foreign currency assets, I allow for financial market segmentation in the spirit of Gabaix and Maggiori (2015). The hegemon differs from other countries in $i = [0,1]$ in one important way– it is the monopoly issuer of dollar assets in its market segment.

2.1 Households

A representative household in country $i = 0$ (Home) has preferences described by the following instantaneous utility function,

$$\mathcal{U}_t = \frac{C_t^{1-\sigma}}{1-\sigma} - \kappa \frac{L_t^{1+\psi}}{1+\psi} \tag{1}$$

where C_t is consumption of private goods and L_t is labour supplied. Private consumption is an index composed of Home and Foreign good varieties,

$$C_t = [\chi^{\frac{1}{\theta}} C_{H,t}^{\frac{\theta-1}{\theta}} + (1-\chi)^{\frac{1}{\theta}} C_{F,t}^{\frac{\theta-1}{\theta}}]^{\frac{\theta}{\theta-1}} \tag{2}$$

and $C_{H,t}, C_{F,t}$ consists of,

$$C_{H,t} = \left[\int_0^1 C_{H,t}(j)^{\frac{\epsilon-1}{\epsilon}} dj\right]^{\frac{\epsilon}{\epsilon-1}}, \tag{3}$$

$$C_{F,t} = \left[\int_0^1 C_{i,t}^{\frac{\theta-1}{\theta}} di\right]^{\frac{\theta}{\theta-1}}, \quad C_{i,t} = \left[\int_0^1 C_{i,t}(j)^{\frac{\epsilon-1}{\epsilon}} dj\right]^{\frac{\epsilon}{\epsilon-1}},$$

where j denotes different varieties of the the same good and ϵ is the constant elasticity of substitution between varieties, i denotes countries and θ is the constant (macro) elasticity of substitution between imports from different countries. The parameter χ reflects the weight of domestic goods in a country's final consumption index, where $\chi > 0.5$ captures home bias. Foreign households have analogous preferences and face a symmetrical problem.

Households purchase goods, earns wages W_t from providing labour L_t and receive profits $\Pi_t = \Pi_t^g + \Pi_t^f$ from their ownership of goods' and financial firms respectively. Households borrow in one-period, non-contingent bonds x_t at time t, denominated in domestic currency, and repay R_t at $t+1$. I also allow households to have an exogenous exposure to foreign-currency denominated assets. Households take a long position of a_t^F dollars in foreign currency debt (purchasing $\frac{1}{\mathcal{E}_t} a_t^F$ units) with a dollar return $R_t^* \mathcal{E}_t$ at $t+1$. The budget constraint is given by,

$$\begin{aligned} P_{F,t}C_{F,t} + P_{H,t}C_{H,t} \leq \Pi_t + W_t L_t + \\ x_t - R_{t-1}x_{t-1} - a_t^F + R_{t-1}^* \frac{\mathcal{E}_t}{\mathcal{E}_{t-1}} a_{t-1}^F \end{aligned} \tag{4}$$

The household's optimization problem consists of choosing a sequence $\{C_{H,t}, C_{F,t}, L_t, x_t\}$ to maximize lifetime utility (1) subject to the budget constraint (92), taking initial debt x_0, foreign exposures a_t^F, production $\{Y_{H,t}\}$ and prices $\{\mathcal{E}_t, W_t, R_t, P_{H,t}, P_{F,t}\}$ as given.

The first-order conditions characterizing the households' optimal allocation are given by,

$$\frac{C_t^{-\sigma}}{P_t} - \beta \mathbb{E}_t \left[\frac{C_{t+1}^{-\sigma}}{P_{t+1}} \right] R_t = 0, \tag{5}$$

$$\kappa L_t^{\psi} C^{\sigma} = \frac{W_t}{P_t}, \tag{6}$$

$$C_{H,t} = \frac{\chi}{1-\chi} \left(\frac{P_{H,t}}{P_{F,t}} \right)^{-\theta} C_{F,t}, \tag{7}$$

where (5) is the household Euler equation governing the intertemporal allocation of consumption, (6) characterises the optimal labour allocation and (7) determines the allocation of spending between home and foreign good varieties.

For simplicity, I assume the foreign asset position of hegemon households is exogenous and not derived from maximizing behaviour.[13]

2.2 Firms

In each country there is a continuum of firms indexed by j, which produce a unique variety of tradable goods and are endowed with linear production technology which uses only labour,

$$Y_{H,t}(j) = A_t L_t(j) \tag{8}$$

where A_t is a Home (aggregate) productivity. Goods are consumed both domestically and exported abroad:

$$Y_{H,t} = C_{H,t} + C_{H,t}^*, \tag{9}$$

where $C_{H,t}^*$ denotes foreign demand.

I focus on the case where prices are perfectly rigid.[14] I consider a model which allows for price rigidities in traded goods therefore I can assess the implications of limited exchange rate pass-through to U.S. imports. Under producer currency pricing (PCP), domestic producers set identical domestic prices for all the goods they produce, regardless of whether they are consumed domestically or exported, as assumed in Galí and Monacelli (2005) and Farhi and Werning (2012). However, in the data, exported goods are predominantly denominated in dollars. This is referred to as DCP and is documented in Gopinath et al. (2020). I assume the

[13]In Fanelli and Straub (2018), the authors assume there is a maximum position in foreign currency that households can take, i.e $\overline{a}^F$. If there is no uncertainty, households will take a position $\overline{a}^F$ at time t as long as $R^* \frac{\mathcal{E}_{t+1}}{\mathcal{E}_t} > R_t$. Partial segmentation is considered in the online appendix of Gabaix and Maggiori (2015) where the demand a_t^F is limited to linear rules.

[14]This assumptions, also used in Egorov and Mukhin (2021) and Basu et al. (2020), allow me to abstract from price dynamics and dispersion. Price dynamics in open economies have been the focus of a large literature on open economy New-Keynesian models, see Galí and Monacelli (2005), Farhi and Werning (2012) and Corsetti, Dedola, and Leduc (2018) amongst others.

hegemon also issues the dominant currency, consistent with the case of the dollar.[15] I allow for a constant employment tax τ^L and define the effective wage for firms by $\tilde{W}_t = W_t(1+\tau^L)$.

Consider the maximization faced by a firm j in the Home country when prices are perfectly rigid,

$$\max_{P_H(j)} \mathbb{E}_0 \sum_{t=0}^{\infty} \left[P_{H,t}(j) Y_{H,t}(j) - \frac{\tilde{W}_t}{A_t} L_t(j) \right] \tag{10}$$

In a symmetric equilibrium $P_{H,t}(j) = P_{H,t}$, $Y_{H,t}(j) = Y_{H,t}$. The price is given by,

$$P_{H,t} = \frac{\epsilon}{\epsilon - 1}(1+\tau^L) \frac{\mathbb{E}_t \left[\sum_{s=0}^{\infty} \Lambda_{t+s} \frac{W_{t+s}}{A_{t+s}} Y_{H,t+s} \right]}{\mathbb{E}_t \left[\sum_{s=0}^{\infty} \Lambda_{t+s} Y_{H,t+s} \right]}, \tag{11}$$

where the labour subidy is chosen to eliminate steady state monopolistic distortions $1 + \tau^L = (\epsilon - 1)/\epsilon$ and Λ_t is households stochastic discount factor. Consistent with the literature, I assume firms set the same price for all export destinations. In contrast, if prices are perfectly flexible, firm j chooses prices such that for each period,

$$\max_{P_{H,t}(j)} P_{H,t}(j) Y_{H,t}(j) - \frac{\tilde{W}_t}{A_t} L_t(j) \tag{12}$$

and in equilibrium,

$$P_{H,t}^{flex} = \frac{\epsilon}{\epsilon - 1}(1+\tau^L) \frac{W_t}{A_t} \tag{13}$$

such that firms charge a constant mark-up over $\tilde{W}_t / A_t$.

Price indices, exchange rates and foreign variables. The home consumer price index (CPI) is defined as $P_t = [\chi P_{H,t}^{1-\theta} + (1-\chi) P_{F,t}^{1-\theta}]^{\frac{1}{1-\theta}}$. I define $\mathcal{E}_t$ as the effective dollar nominal exchange rate, where an increase in $\mathcal{E}_t$ reflects a depreciation of the dollar. Import and export prices for the home country satisfy:

$$P_{H,t}^* = \frac{P_{H,t}}{\mathcal{E}_t^{\lambda}}, \quad P_{F,t} = P_{F,t}^* \mathcal{E}_t^{\lambda^*} \tag{14}$$

where λ is exchange rate pass-through to imports in $i = 0$ and λ^* is exchange rate pass-through on hegemon exports. Under (full) DCP, $\lambda = 0, \lambda^* = 1$.[16] Assuming prices at the border are perfectly rigid, consumer prices are time-varying only if pass-through is non-zero. Without loss of generality, I assume $\overline{P}_F^* = 1$.

To emphasize the distinction between the Home (hegemon) and other countries, I assume all foreign countries are symmetric and I model a single foreign sector consisting of $i \in (0,1]$ countries. Foreign sector variables are denoted by an asterisk.

[15]Recent literature argues that the dominance of the dollar in financial and goods market is closely connected, see Gopinath and Stein (2018) and Chahrour and Valchev (2021).

[16]For comparison, $\lambda = \lambda^* = 1$ under PCP where the law of one price holds.

2.3 International Financial Markets

Asset markets are incomplete and segmented. Markets are incomplete because households in each country trade in non-contingent bonds denominated in domestic currency. Markets are segmented because households are confined to trade within their own financial market segment only, i.e. they cannot directly trade with households in other countries. For simplicity, I focus on a '*dollar*' and a '*foreign*' market segment only. Figure 1 below illustrates the market structure.

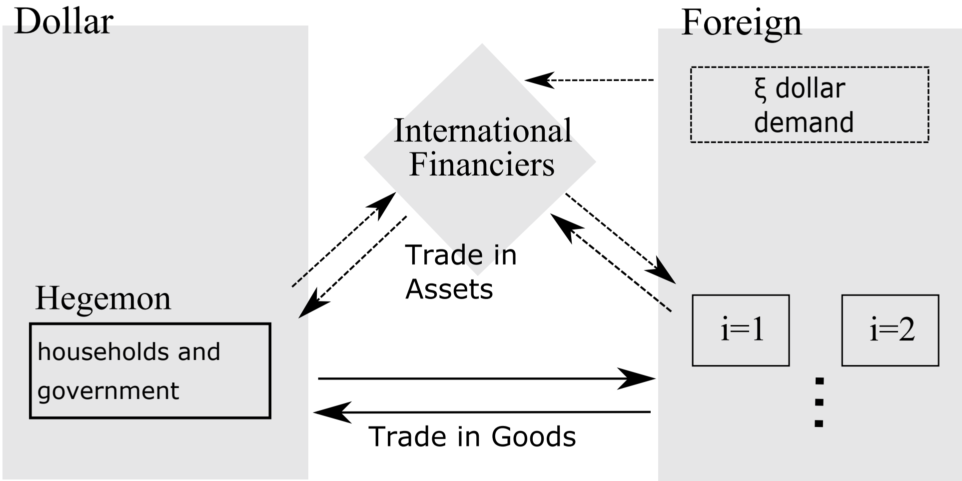

Figure 1: International financial market structure

A continuum of financial intermediaries indexed by $k \in [0, \hat{k})$ trade one-period, non-contingent bonds at each time t, across market segments, with agents in the home and foreign segments. Each financier starts with no initial capital, faces a participation cost k and position limits $\{-\overline{Q}, \overline{Q}\}$.[17] The variable k corresponds to both the financiers' cost of participating and their index. Without loss of generality, I assume financial intermediaries trade in a single foreign bond with the foreign sector with dollar return $R_t^* \mathcal{E}_t$. Since foreign countries are symmetric, $R_{i,t} = R_t^*$ for $i > 0$. Financiers choose a position in dollar bonds $q_t(k)$, financed by a position -$\frac{q_t(k)}{\mathcal{E}_t}$ in foreign-currency bonds, to maximize profits earned at $t+1$. Specifically, $q_t(k) < 0$ denotes a short position in dollar bonds, i.e. financiers sell a promise to a dollar tomorrow in exchange for $q_t(k)$ dollars today. The problem of an individual financier, indexed by k, at time t can be summarised as,

$$\max_{q_t(k) \in \{-\overline{Q}_t,\ \overline{Q}_t\}} \left(R_t - R_t^* \mathbb{E}_t \left[\frac{\mathcal{E}_{t+1}}{\mathcal{E}_t} \right] \right) q_t(k) - k$$

Financial intermediaries participate as long as $|R_t - R_t^* \frac{\mathbb{E}_t[\mathcal{E}_{t+1}]}{\mathcal{E}_t}| \overline{Q}_{t+1} > k$. In equilibrium, a measure $\mathbf{k}_t = |R_t - R_t^* \frac{\mathbb{E}_t[\mathcal{E}_{t+1}]}{\mathcal{E}_t}| \overline{Q}_t$ participate. The total demand for dollars by financiers is

[17] The formulation of this problem is closest to Fanelli and Straub (2018). Position limits can be motivated by collateral constraints, see e.g Gromb and Vayanos (2002), Gromb and Vayanos (2010) or value at risk constraints, see Adrian and Shin (2014). The timing of the intermediation problem follows Alvarez, Atkeson, and Kehoe (2002) and Cociuba and Ramanarayanan (2017). Position limits restrict the level of dollar liquidity in markets.

given by $Q_t = sign(R_t - R_t^* \frac{\mathbb{E}_t[\mathcal{E}_{t+1}]}{\mathcal{E}_t})\overline{Q}_t\mathbf{k}_t$. I define $\Gamma_t = 1/\overline{Q}_t^2$.

In equilibrium, because of non-zero entry costs and position limits, financial intermediaries require excess returns when there are dollar imbalances in international markets ($Q_t \neq 0$), leading to deviations from UIP:

$$\left(R_t - R_t^*\mathbb{E}_t\left[\frac{\mathcal{E}_{t+1}}{\mathcal{E}_t}\right]\right) = \Gamma_t Q_t \tag{15}$$

The LHS of (15) reflects the return required by financiers to engage in abritrage across markets. Suppose there is a shortage of dollars $Q_t < 0$. Then, (15) is the compensation financiers require to intermediate dollar shortages for a given level of (inverse) dollar liquidity Γ.[18] In periods of low liquidity, when financiers are more constrained (i.e $\overline{Q}_t$ is low and Γ_t is high) a larger spread is required for a given Q_t. As a result, the dollar price of dollar debt exceeds that of foreign-currency denominated debt.[19] In the limit where dollar liquidity is abundant ($\Gamma_t = 0$) the spread does not depend on Q_t.

Furthermore, I assume there is a separate group of non-optimizing, unconstrained agents belonging to the foreign sector who have inelastic demand $\xi_t \geq 0$ for dollar debt, which they finance by taking a position $-\frac{\xi_t}{\mathcal{E}_t}$ in foreign currency debt. Market clearing in the dollar segment requires:

$$Q_t = x_t - \xi_t, \tag{16}$$

For markets to clear, the financiers' position in dollar debt (Q_t) is equal to the supply of dollar assets x_t minus the demand for dollar debt ξ_t. Equations (15) and (16) summarise the dollar market equilibrium.

The model implies an upward sloping supply curve for dollar debt by financial intermediaries. Figure 2 below illustrates the equilibrium in the dollar market. The demand faced by financial intermediaries when foreign investors inelastically demand ξ_t and U.S. households supply an exogenous quantity x is $\xi_t - x$. The Figure considers the case where $x_t = a_t^F$. Excess demand for dollar debt generates monopolistic rents for both financiers (green triangle) and the hegemon (purple rectangle), which I discuss in detail later on.

Multipolar World. To highlight the special position of the hegemon in the model, consider the case when there are N competing issuers within a segment, and for clarity, consider the

[18]The distinction between deviations in the covered (CIP) and uncovered (UIP) interest rate parities depends on risk. In particular, deviations in the covered interest rate parity arise in the absence of risk (i.e when financiers fully hedge exchange rate risk using swaps) and translate 1:1 to deviations in uncovered interest rate parity. The model is silent on this distinction, but UIP deviations tend to be an order of magnitude greater than their CIP counterparts.

[19]Liao (2020) and Jiang, Krishnamurthy, and Lustig (2020) show that a similar but smaller spread exists for corporate bonds (AAA to AA-) as well, suggesting the private sector in the U.S. also benefits from this.

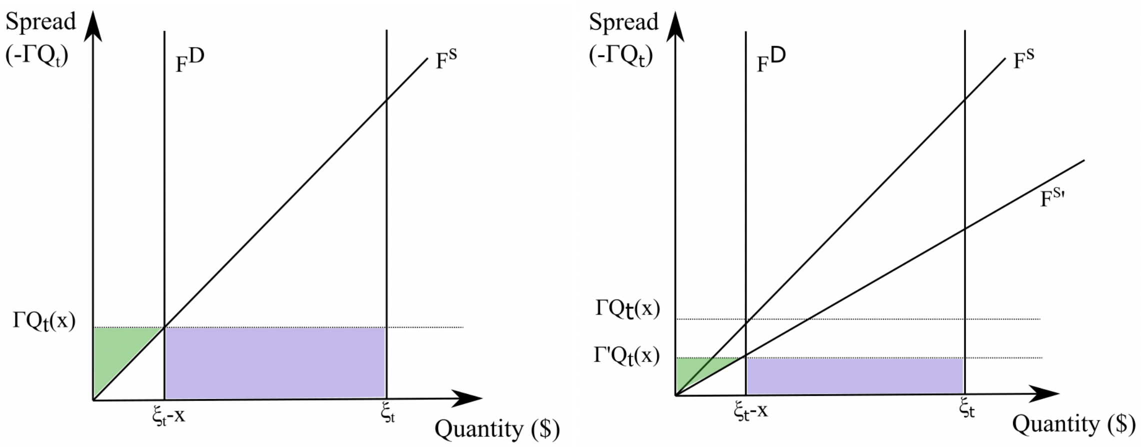

Figure 2: LHS: Equilibrium in the dollar market. F^S denotes the supply of dollars ($Q_t < 0$) by financial intermediaries and F^D denotes the demand for dollar debt financial intermediaries face. RHS: Extending dollar swaps lines lowers the gradient of F^S.

dollar segment. Market clearing is then given by,

$$Q_t = x_t + \sum_{i>0}^{N-1} x_t^i - \xi_t, \tag{17}$$

where x_t^i is the issuance of dollar assets by issuer $i > 0$ households. If foreign issuers of close-substitute debt respond to changes in ξ_t (which leads to a fall in R_t) by a factor $\epsilon > 0$, as the number of issuers becomes large, shortages cannot arise in the market segment.[20]

2.4 Dollar Swap Lines

A key institutional innovation in recent years has been the (re-)establishment of dollar swap lines. As part of a swap line agreement, the U.S. FED lends dollars to a foreign central bank over a short maturity. The foreign central bank, in turn, lends dollars to their domestic financial institutions– in this instance, the financial intermediation sector. The FED receives a foreign currency deposit as collateral and at the end of the loan, the FED gets its currency back at the original exchange rate. In the model, I assume the FED swaps dollars directly with financial intermediaries expanding the portfolio limits they face.

Absent dollar swaps, each financier can promise a to deliver a maximum $\overline{Q}$ dollars tomorrow. Instead, when dollar swaps are available, I assume the financier can promise an additional Q^s dollars tomorrow, which it draws from the swap facility.[21] Financiers will choose to do so as

[20] In Appendix B, I show within a stylized model that if N symmetric governments compete á la Cournot when issuing substitutable varieties of debt, dollar shortages in international markets go to zero, as do rents from issuance.

[21] Note that a period in the model corresponds to a quarter, whereas dollar swaps are usually completed within a week. Therefore, I assume financial intermediaries are exposed to the entirety of the currency fluctuation even when they engage in swap line operations.

long as the currency-adjusted interest rate differential is greater than the participation cost and the cost of taking up dollar-swaps. Specifically, when dollar swap lines are available, a financier indexed by k faces the following maximization:

$$\max_{\substack{q_t(k) \in \{-\overline{Q}, \overline{Q}\} \\ q_t^s(k) \in \{-Q^s, 0\}}} \left\{ \left(R_t - R_t^* \mathbb{E}_t \left[\frac{\mathcal{E}_{t+1}}{\mathcal{E}_t} \right] \right) (q_t(k) + q_t^s(k)) - \tau^s q_t^s(k) - k \right\}$$

where $q_t^s(k)$ reflects the financier's position in dollars, backed by dollar swaps. The cost of drawing $q_t^s(k)$ from the dollar swap line is $q_t^s(k)\tau^s$. Financiers' enter with a position $\overline{Q} + Q^s$ as long as,

$$\left(R_t - R_t^* \mathbb{E}_t \left[\frac{\mathcal{E}_{t+1}}{\mathcal{E}_t} \right] \right) (\overline{Q} + Q^s) - \tau^s (\overline{Q} + Q^s) \frac{Q^s}{(\overline{Q} + Q^s)} \geq k \tag{18}$$

In equilibrium, redefining $\Gamma = \frac{1}{\overline{Q}+Q^s}^2$.

$$\left(R_t - R_t^* \mathbb{E}_t \left[\frac{\mathcal{E}_{t+1}}{\mathcal{E}_t} \right] \right) - \tau^s \frac{Q^s}{(\overline{Q} + Q^s)} = \Gamma Q_t \tag{19}$$

The next lemma summarises the effect of dollar swaps on the equilibrium UIP deviations.

Lemma 1 (Dollar Swaps)
If $\tau^s = 0$ (no spread on dollar swaps), then, the model is isomorphic to the baseline with UIP deviations given by (15), except the semi-elasticity of demand is now given by:

$$\Gamma_t = \left(\frac{1}{\overline{Q} + Q^s} \right)^2 < \left(\frac{1}{\overline{Q}} \right)^2$$

Total up-take of dollar swaps in the model is given by:

$$\mathbf{k}_t Q^s = -Q_t \frac{Q^s}{\overline{Q} + Q^s} \geq 0 \tag{20}$$

where $\mathbf{k}_t = Q(\overline{Q} + Q^s)^{-1}$.

When dollar swaps are extended, fewer, more specialized financiers are able to take larger positions and satisfy the demand for dollar debt. This has a number of implications. First, the aggregate cost of intermediating dollar shortages is lower, resulting in a narrower equilibrium spread.[22] Lemma 1 details that dollar swap lines lower Γ_t, as illustrated in Figure 2 (right panel). A key contribution of this paper is to show that the hegemon planner faces a meaningful trade-

[22]The literature has emphasized that subsidizing entry of financial intermediaries can effectively remove the financial constraint, see e.g. Kiyotaki and Moore (1997), Gabaix and Maggiori (2015) and He and Krishnamurthy (2013). Here, dollar swaps reduce the measure of participating intermediaries. However, more efficient intermediaries are able to intermediate larger positions, thus relaxing the financial constraint.

off when deciding whether or not to extend dollar swap lines, which does not rely on the spread τ^s. Therefore I consider the limit as $\tau^s \to 0$.[23] Second, equation (20) maps directly to the data on dollar swap up-take in Figure 11 (Appendix A). Through the lens of the model, the up-take of dollar swaps is proportional to the size of dollar shortages with coefficient $\frac{Q^s}{\overline{Q}+Q^s}$. Finally, since dollars are easier to come by, financiers' profits captured by the green triangle are lower when swaps are available.

2.5 Equilibrium

In this paper, I make two assumptions for simplicity and to derive sharp results. First, the hegemon is modelled as a small open economy (SOE) which takes P_F^*, the price of foreign goods, and R^* as given, but is large in dollar markets. Therefore, the hegemon affects its interest rate only by manipulating excess exchange rate returns.[24] Second, I specialize preferences to the case of unitary elasticity of substitution, unitary macro elasticity $\sigma = \theta = 1$. [25]Following the tradition in public finance, building on Lucas and Stokey (1983), I summarise the equilibrium using a small number of equations.

Lemma 2 (Implementability)
Given $\{\xi_t\}$, a household allocation $\{C_{H,t}, C_{F,t}, x_t, L_t, a_t^F\}$ and a swap policy $\{Q_t^s\}$ with prices $\{\mathcal{E}_t, R_t, W_t, P_{H,t}, P_{F,t}\}$, taking $\{C_t^*, R_t^*, P_{F,t}^*\}$ as given, constitute part of equilibrium if and only if conditions (5),(7), (8), (9), and (19) hold.

Substituting the expressions for $C_{H,t}^*$, and Π_t into (92), using (9) and (19) yields the con-

[23]The model can be generalised to the case where the FED earns a positive spread $\tau^s > 0$. In this case, an individual financier can choose to take position $\overline{Q}$ or $\overline{Q} + Q^s$. In the limit where all financiers take a position $\overline{Q} + Q^s$ and dollar swap lines are large $\frac{Q^s}{\overline{Q}+Q^s} \to 1$, the semi-elasticity of demand is $\Gamma_t = \frac{1}{\overline{Q}+Q^s}^2$, the relevant spread is $\left(R_t - R_t^* \mathbb{E}_t \left[\frac{\mathcal{E}_{t+1}}{\mathcal{E}_t}\right]\right) - \tau^s$ and the hegemon earns $\tau^s \overline{Q}^s \boldsymbol{k}$ rents from extending the dollar swap.

[24]Generally, there are three channels through which the home country can manipulate its interest rate R_t: its size in financial markets, its size in goods markets and as a result of dominant currency pricing. This paper focuses on the first, rules out the second by assuming the hegemon is a small in goods markets and rules out the third channel. For a recent analysis of (goods market) terms of trade manipulation see Costinot, Lorenzoni, and Werning (2014), and Lloyd and Marin (2019) for an extension with trade taxes. Egorov and Mukhin (2021) show the U.S. can manipulate foreign prices and the foreign SDF, even if it is a SOE, under DCP and Corsetti, Dedola, and Leduc (2020) investigate optimal policy in large open economy with DCP.

[25]Appendix E studies the case of $\theta, \sigma \neq 1$.

solidated household budget constraint:[26]

$$C_{F,t} \leq \mathcal{E}_t^{-\lambda}\Bigg\{ \underbrace{\zeta \mathcal{E}_t^{\eta} \overline{P}_H^{1-\eta}}_{\mathcal{E}_t P_{H,t} C^*_{H,t}} + \underbrace{(x_t - a_t^F)}_{\text{net foreign liabilities}} - R^* \frac{\mathbb{E}_{t-1}[\mathcal{E}_t]}{\mathcal{E}_{t-1}}(x_{t-1} - a_{t-1}^F)$$
$$\underbrace{-\Gamma_{t-1} Q_{t-1} x_{t-1}}_{\text{(a) Monopoly rents}} \underbrace{-R^* \frac{\mathbb{E}_{t-1}[\mathcal{E}_t] - \mathcal{E}_t}{\mathcal{E}_{t-1}} a_{t-1}^F}_{\text{(b) Valuation effects}} \underbrace{+\omega \Gamma_t Q_t^2}_{\text{(c) Financiers' profits } (+ve)} \Bigg\} \tag{23}$$

The first term on the right-hand side reflects total revenues earned from the export of goods. The next two terms reflect the return on the net external position for the U.S. which is financed at cost R_{t-1}. If there are no dollar shortages (or dollar liquidity is abundant $\Gamma \to \infty$), and no unexpected movements in the supply or demand for dollars, then $Q_t = 0$ and $\mathbb{E}_{t-1}[\mathcal{E}_t] = \mathcal{E}_t$ so the terms (a), (b) and (c) are zero. The model then coincides with a canonical SOE where dollar and foreign currency debt are interchangeable. Instead, consider the case of an unexpected increase in the demand for dollars by foreigners $\xi_t - \mathbb{E}[\xi_t] > 0$. Then $Q_t < 0$ and term (a) captures the positive rents from issuing dollar assets and investing them in foreign currency assets. Notice that at time t, monopoly rents are 0 but are positive from $t+1$ onwards since $Q_{t+h} < 0$ for some h. Term (b) captures the valuation effects discussed in Gourinchas, Rey, and Govillot (2018). The contemporaneous appreciation of the dollar at time t lowers the return in dollar terms on foreign assets purchased at $t-1$ and, since this was unexpected, it is not reflected in $\mathcal{E}_{t-1}$ or R_{t-1}. [27]

Consider also the outcomes of foreign investors taking the position ξ_t. Their portfolio return is given by:

$$\Pi^*_{\xi,t} = \xi_t \left(R_t - R^* \frac{\mathcal{E}_{t+1}}{\mathcal{E}_t} \right) \tag{24}$$

This is the opposite portfolio to financial intermediaries and the return is negative whenever $Q_t < 0$. Foreign investors can also be rebated a share financiers' profits Π_t^F, but this would not significantly alter my results.

Rents, the Transfer Problem and Monetary Policy. However, the transfer of wealth leads to a contemporaneous dollar appreciation which can lead to trade-offs. At the crux of

[26] From (15), we can derive total profits accruing to the financial intermediation sector,

$$\Pi_t^f = \left(\mathbb{E}_{t-1}\left[\frac{\mathcal{E}_t}{\mathcal{E}_{t-1}}\right] R_t^* - R_t \right) Q_{t-1} = \Gamma_{t-1} Q_{t-1}^2 \geq 0 \tag{21}$$

Additionally, (22) can also be rewritten as:

$$C_{F,t} \leq \mathcal{E}_t^{-\lambda}\left\{ \zeta \mathcal{E}_t^{\eta} \overline{P}_H^{1-\eta} + (x_t - a_t^F) - R_{t-1}(x_{t-1} - a_{t-1}^F)\Gamma_{t-1} Q_{t-1} a_{t-1}^F + R^* \frac{\mathbb{E}_{t-1}[\mathcal{E}_t] - \mathcal{E}_t}{\mathcal{E}_{t-1}} a_{t-1}^F \right\} \tag{22}$$

showing that monopoly rents are non-zero even if R is held constant.

[27] The losses due to the initial appreciation last only one period because all debt is short-term. The introduction of long maturity debt has important implications for the quantification of monopoly rents and valuation effects, and I leave this to future work.

this trade-off is a version of the transfer problem, first debated in Keynes (1929) and Ohlin (1929).[28,29] Monetary policy in the hegemon has to balance the costs from the dollar appreciation at the onset of the crisis, with the wealth transfer which follows. Note that the hegemon earns rents even if monetary policy keeps interest rates relatively constant, consistent with the relatively narrow interest rate differentials documented in Fig. 7, but also if interest rates adjust to offset the initial appreciation.[30]

3 Analytical Hegemon's Dilemma

In this section, I illustrate the trade-off between maximizing monopoly rents and moderating the demand effects of a dollar appreciation, statically, and for a given monetary policy stance. I describe how debt issuance and dollar swaps affect equilibrium outcomes.

Setup. Consider a two-period version $t = \{1, 2\}$ of the model described in Section 2. At $t = 0$, I normalize dollar supply, demand and imbalances to zero ($x_0 = \xi_0 = Q_0 = 0$) and I assume inverse dollar liquidity is given by $\Gamma_0 = \overline{Q}^{-2}$ (dollar swaps are not used). In the final period $t = 2$, I assume there is no issuance of new households debt in period 2 ($x_2 = 0$) and monetary policy credibly commits to a long-run exchange rate $\mathcal{E}_2 = \overline{\mathcal{E}}$ such that $\tau_2 = \tau_0 = 0$. To capture the idea of an increase in the demand for dollars from abroad I assume foreigners' demand for dollar debt rises to $\xi_1 = 1$ at $t = 1$.

Monetary policy plays a key role in the mode of transmission of dollar shortages to hegemon allocations. To capture this in a tractable manner, I define the monetary instrument $\mu_t = \mathcal{E}_t^{\lambda} C_{F,t} + \overline{P}_H C_{H,t}$, such that $R_1 = \beta \frac{\overline{\mu}}{\mu_1}$. An increase in μ_1 implies a fall in interest rates.[31] For simplicity, I further assume $\beta = \beta^* = 1$. Rearranging (15) and substituting in R_1, the expression for the exchange rate at time $t = 1$ is given by:

$$\mathcal{E}_1 = \overline{\mathcal{E}} \left(\frac{\overline{\mu}}{\mu_1} - \Gamma_1 Q_1 \right)^{-1} \tag{25}$$

I specify a monetary policy rule parametrized by a single responsiveness parameter s: (i) if $s = 0$, monetary policy maintains a constant R_1 and the adjustment happens through a dollar appreciation (ii) if $s > 0$, the monetary policy response to shortages is expansionary ($R_1 \downarrow$) and,

[28] Keynes argued that war reparations paid by Germany to France would impose further costs to the German economy in the form of adverse terms of trade movements, which Ohlin suggested would not materialise if the French spent the reparations on German goods. Relative to the initial debate, as well as the price movements, associated with a transfer, I emphasize the pecuniary externalities which result from them.

[29] In contrast to classical analyses of the transfer problem, I emphasize that transfer leads to macroeconomic externalities not internalized by private agents who trade in financial markets, building on recent theoretical contributions most recently summarized in Bianchi and Lorenzoni (2021).

[30] Monetary policy can determine the magnitude of the rents to the extent that an interest rate movement affects the total supply of dollar debt, away from the $\sigma = \theta = 1$ limit, akin to a Bernanke and Blinder (1992) credit channel, or the insurance channel in Caballero and Krishnamurthy (2004), Wang (2019). See Appendix E.

[31] As in, e.g, Corsetti and Pesenti (2001), the quantity μ_t is the return on a perpetual bond. This follows from iterating the Euler equation forward and using the identify for μ_t.

in the limit ($s = 1$), targets an exchange rate $\overline{\mathcal{E}}$. The monetary policy rule is given by:

$$\frac{\mu_1}{\overline{\mu}} = (1 - s) + s(1 + \Gamma_1 Q_1)^{-1} \tag{26}$$

Stabilization and Monopolist Incentives. Define the period-1 labour wedge τ_1 as,

$$\tau_1 = 1 - \frac{1}{A_1}\frac{\kappa}{\chi} C_{H,1} L_1^{\psi}, \tag{27}$$

where $L_1 = C_{H,1} + C^*_{H,1}$. The labour wedge is frequently considered in the literature as a measure of the output gap, see e.g. Chari, Kehoe, and McGrattan (2007) and Farhi and Werning (2016). The labour wedge is equal to zero if prices are flexible such that (6) holds, but is generally non-zero if prices are rigid. I define periods where $\tau_t > 0$ to be periods of *recession*, since there is involuntary unemployment in the economy and conversely periods where $\tau_t < 0$ as *boom* periods– more specifically, periods when households are over-working relative to the flex-price allocations. Dollar shortages transmit to the labour wedge through two channels. First, the dollar appreciation reduces demand for exports leading to a fall in employment ($L_1 \downarrow$). Second, the monetary policy responds by cutting interest rates ($\mu_1 \uparrow$) according to the parameter $s > 0$ which stimulates domestic consumption ($C_{H,1} \uparrow$).

Next, I define Ω_2 as the return on a portfolio x_1 of dollar borrowing, invested in foreign assets and adjusted for the hegemon's share of intermediaries' profits. For simplicity, I assume the hegemon forms an arbitrage portfolio in period 1 ($x_1 = a_1^F$), earning $R_1 - R^* \frac{\overline{\mathcal{E}}}{\mathcal{E}_1}$ in period 2.[32] The portfolio return for the hegemon is given by:

$$\Omega_2 = -\Gamma_1 Q_1 x_1 + \omega \Gamma_1 Q_1^2 \tag{28}$$

I posit that the hegemon planner optimally chooses private debt issuance in period x_1 at $t = 1$, via an implicit macro-prudential tax, and the level of dollar liquidity $\Gamma_1 = \frac{1}{\overline{Q} + Q_1^s}^2$, via issuance of dollar swaps Q_1^s, to maximize a convex combination over two incentives: employment stabilization and maximization of monopoly rents[33]

$$\max_{\{x_1, \Gamma_1 \leq \overline{Q}^{-2}\}} \left\{ w^S \; |\tau_0 - \tau_1(x_1, \Gamma_1; \xi_1)| + (1 - w^S) \; \Omega_2^M(x_1, \Gamma_1; \xi_1) \right\} \tag{HD1}$$

I make explicit the dependence of the period 1 labour wedge and monopoly rents (earned in period 2) on the supply of dollar assets x_1, (inverse) dollar liquidity Γ_1 and dollar demand ξ_1. The parameter w^S captures the preference for stabilization. The optimal allocation is summarised by the first-order conditions for (HD1) with respect to x_1 and Γ_1 (if the positivity constraint does not bind) and are presented in Appendix B.

[32]This assumption imposes that hegemon net foreign assets are zero in every period, further emphasizing the importance of gross flows.

[33]This modelling choice is made for clarity and I make no claim that it maps to welfare optimization. Specifically, there is a welfare maximizing level for w^s and s, but I take these values as given. Nonetheless, when I solve for the welfare maximizing allocation in Section 4, I show that stabilization of the labour wedge is approximately attained in the constrained optimal allocation.

Proposition 1 (Analytical Hegemon's Dilemma)
(i) An increase in dollar shortages ($Q_1 < 0$) *increases monopoly rents* ($\Omega_2 > 0$) *and widens the labour wedge* ($|\tau_1 - \overline{\tau}| > 0$) *as long as* $s \neq \overline{s}$*.*
(ii) Consider the limit $w^S = 1$ *(*stabilization strategy*). The hegemon supplies dollar assets to satisfy demand* ($x_1 = \xi_1$) *or extends dollar swaps such that* $\Gamma_1 \to 0$ *to perfectly stabilize employment. Instead, if* $w^s = 0$ *(*monopolist strategy*), the hegemon chooses* x_1 *at the top of a 'returns Laffer' curve and dollar swaps are not used* $\Gamma_1 = \overline{Q}^{-2}$*.*
Proof. See Appendix B. □

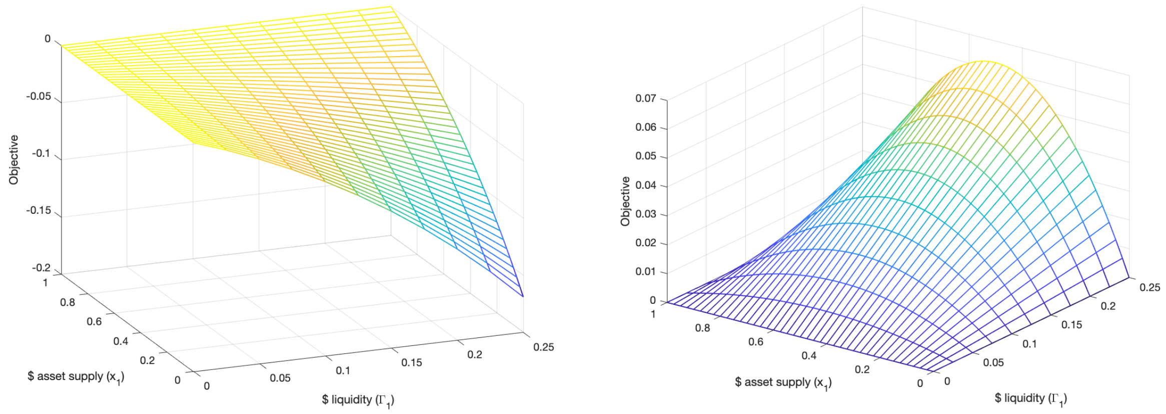

Figure 3: Left panel: $w^S = 1$. Right panel: $w^S = 0$. Parametrization: $s = 0.5, \kappa = \overline{\mu} = \overline{\mathcal{E}} = \zeta = \eta = \psi = 1,\ \chi = 0.6, \beta = \beta^* = 1$.

A surge in capital inflows results in a widening of the labour wedge unless $s = \overline{s}$, in which case R_1 moves to exactly offset the effect of dQ_1 on τ_1.Proposition 1 isolates two key channels which drive the hegemon policy response –macroeconomic stabilization and monopoly (financial) rent extraction. Suppose the hegemon is only concerned with closing the labour wedge gap ($w^S = 1$), i.e a '*stabilization*' strategy. Then, following a rise in dollar demand $\xi_1 > 0$, the planner can either choose debt issuance x_1 such that for any level of dollar demand ξ_1, dollar shortages are zero $Q_1 = 0$ or extend dollar swaps such that $\Gamma_1 \to 0$ and shortages do not imply any movement in the exchange rate. However, this strategy comes at the cost of a lower price for dollar debt.

Suppose instead that $w^S = 0$, corresponding to a '*monopolist*' strategy. In this case, the hegemon chooses debt x_1 at the top of a Laffer curve for portfolio returns, detailed in Appendix B and targets a level of dollar shortages $Q_1 < 0$. Since monopoly rents are strictly decreasing in dollar liquidity Γ_1 therefore dollar swaps are not used. Figure 14 illustrates the locus of x_1, Γ_1 which maximize the hegemon's objective function in each of the two corner cases. For intermediate values of ω^S, the hegemon compromises between the two strategies and the Laffer curve shifts to higher levels of x_1. In Appendix B, I pursue two extensions within this stylized framework. I analyse the implications of an appreciation on a portfolio set at $t = 0$ and I look at how the results change when there are competing issuers of dollar assets (or other reserve currencies).

4 Optimal Policy

In this section, I identify the macroeconomic externalities which arise in the dynamic model, especially due to dollar shortages abroad, and analyse how they impinge on the efficiency of monetary policy. To do so, I first derive the constrained optimal allocation, attained when the hegemon is able to set monetary and macroprudential policy optimally. Macroprudential policy takes the form of a time-varying tax on private borrowing.[34] The hegemon planner chooses allocations and prices to maximize *domestic household welfare only*, subject to the equilibrium conditions detailed in Lemma 2. I assume the planner is endowed with perfect commitment and I restrict the analysis to one-off unanticipated shocks as in Farhi and Werning, 2014 and others. The planning problem for the hegemon can be summarised as follows:[35]

$$\max_{\{C_{F,t},x_t,\mathcal{E}_t\}_{t\geq 0}} \sum_{t=0}^{\infty} \beta^t V(C_{F,t},\mathcal{E}_t) \tag{HD2}$$

$$\text{s.t (22)},$$

where I attach multiplier η_t^C to the implementability condition (22). The indirect utility function $V(C_{F,t},\mathcal{E}_t)$ is given by,

$$V(C_{F,t},\mathcal{E}_t) = \chi \log\left(\tfrac{\chi}{1-\chi}\tfrac{\mathcal{E}_t^\lambda}{\overline{P}_H}C_{F,t}\right) + (1-\chi)\log(C_{F,t}) - \tfrac{1}{1+\psi}\left(\tfrac{1}{A_t}\left[\tfrac{\chi}{1-\chi}\tfrac{\mathcal{E}_t^\lambda}{\overline{P}_H}C_{F,t} + \zeta\tfrac{\mathcal{E}_t}{\overline{P}_H}^\eta\right]\right)^{1+\psi} \tag{29}$$

I assume that the planning problem is convex in the region of interest such that the first-order conditions characterise the equilibrium allocation. I characterize the planner's allocation as a function of partial derivatives of the indirect utility with respect to $C_{F,t}$ and $\mathcal{E}_t$, denoted by $V_{C_{F,t}}, V_{E_t}$ respectively, and wedges. Key to my analysis is the case where the planner does not have access to the optimal borrowing tax and therefore cannot optimally choose $\{x_t\}$. Then, the planner also faces households' Euler (5) as a constraint, to which I attach multiplier η_t^E.

I begin by defining a measure of over-borrowing by private households in the economy. By analogy to the labour wedge τ_t defined in (27), I define the financing (issuance) wedge τ_t^Ω:

$$\tau_t^\Omega = \frac{R_t + \Gamma_t x_t - 2\omega\Gamma_t Q_t}{R_t} - 1, \tag{30}$$

where the numerator reflects the social cost of issuing an additional unit of dollar debt (i.e the

[34] I distinguish between capital controls and a macroprudential borrowing tax, by assuming that the former would enter as a wedge in the UIP equation. Therefore, capital controls in the model would correspond to a tax on financiers.

[35] The full derivation of both the indirect utility function and the implementation constraints is presented in Appendix C. In the main body, I maintain $\sigma = \theta = 1$ and relegate the generalization to Section E.

cost faced by the country as a whole) and the denominator reflects the private (individual) cost faced by households. A positive wedge reflects the failure of atomistic private households to internalize the effect of their savings decision on the price of dollar debt. The wedge is positive as long as the hegemon borrowing (in gross) in dollars is positive ($x_t > 0$), which is the case when the foreign sector demands dollar debt ($\xi_t > 0$).The wedge is also increasing in the share of financiers' profits accruing to the hegemon (ω), since dollar shortages lead to intermediation profits.

Proposition 2 (Over-borrowing by private agents)
Households over-borrow in dollar debt as long as:

$$\frac{1 + \frac{\chi}{1-\chi}\tau_{t+1}}{1 + \frac{\chi}{1-\chi}\tau_t}(1 + \tau_t^{\Omega}) > 1, \tag{31}$$

and under-issue otherwise.

Proof. Combine the first order condition (FOC) for the planner with respect to x_t, which characterizes the socially optimal level of private borrowing, with the FOC with respect to $C_{F,t}$ and the expression for $V_{C_{F,t}}$ detailed in Appendix C. Then, derive the optimal tax τ_t^x on private borrowing by comparing the planners' optimality condition with the Euler equation (5), which dictates the privately optimal level of borrowing. Households over-borrow if the optimal borrowing tax is positive ($\tau_t^x > 0$). □

The efficient level of borrowing by hegemon households is determined by the interaction of two key frictions in the model– segmented international financial markets leading to dollar scarcity and nominal rigidities. Financial market segmentation is particularly important because it exposes the hegemon economy (and optimal policy) to fluctuations in the supply and demand of dollar assets abroad. Consider first the case where prices are flexible or monetary policy finds it optimal to target the flexible allocation, such that the labour wedge is zero ($\tau_t = \tau_{t+1} = 0$). In this case, over-borrowing still arises because households do not act as monopolists in the market for dollars. Next, suppose that prices are rigid and the monetary authority responds to dollar shortages by lowering the interest rate sufficiently, such that $\tau_t \leq \tau_{t+1} < 0$. Then, in addition to the issuance externality, private households fail to internalize that the social value of a unit of $C_{F,t}$ tomorrow is higher due to its effects on employment. So monetary policy can affect the efficient level of borrowing even if $\sigma = \theta = 1$ and x_t does not responding.Notice that the two externalities which underlie the over-borrowing are dynamic versions of the incentives detailed in (HD1). The following corollary details the borrowing tax required at the constrained efficient allocation.

Corollary (Optimal tax on borrowing)
The optimal ex-post borrowing tax is given by:

$$1-\tau_t^x = \frac{1+\frac{\chi}{1-\chi}\tau_{t+1}}{1+\frac{\chi}{1-\chi}\tau_t}(1+\tau_t^\Omega), \tag{32}$$

where $\tau_t^x < 0$ *denotes a tax on borrowing.*

Over-borrowing matters because it compromises the ability of other policy instruments to achieve their objectives. To quantify the effects of over-borrowing, I consider the multiplier on the Euler equation denoted by η_t^E, which is positive whenever households are over-borrowing, i.e (31) is satisfied. Taking the first-order condition of (HD2), with respect to x_t, with the Euler (5) attached as constraint and rearranging,

$$\eta_t^E = \left\{\Gamma_t \frac{1}{\mathcal{E}_{t+1}^\lambda C_{F,t+1}}\right\}^{-1} \left\{\beta\eta_{t+1}^C \mathcal{E}_{t+1}^{-\lambda}\left[R_t + \Gamma_t x_t - 2\omega\Gamma_t Q_t\right] - \eta_t^C \mathcal{E}_t^{-\lambda}\right\} \tag{33}$$

First, households over-borrow when the cost of borrowing faced by the country as a whole (the term in square brackets) is higher than that faced by an atomistic household R_t, captured by $\tau_t^\Omega > 0$. Second, households over-borrow when when the social value of a unit of consumption tomorrow (η_{t+1}^C) is high relative to its private value, as is the case when the labour wedge tomorrow is relatively high.[36]

4.1 Monetary policy

In open economies, monetary policy faces a well-understood trade-off between macroeconomic stabilisation and risk-sharing incentives. With flexible exchange rates monetary policy can target the flexible price allocation ($\tau_t = 0$). Generally, however, when markets are incomplete, monetary policy does not target $\tau_t = 0$ because of the incentive to depreciate the dollar lowering the burden of debt and a counteracting incentive to appreciate the exchange rate such that the price of imports per unit of labour falls. I assume monetary policy chooses the exchange rate $\mathcal{E}_t$. Combining the FOCs with respect to $\mathcal{E}_t$ and $C_{F,t}$ yields a targeting rule for monetary policy,

$$\underbrace{V_{\mathcal{E}_t} + X_{\mathcal{E}_t}(\eta_t^C)}_{\text{terms of trade}} + \underbrace{\mathcal{F}_{\mathcal{E}_t}(\eta_t^C, \eta_{t+1}^C)}_{\text{risk-sharing}} + \underbrace{\mathcal{R}_{\mathcal{E}_t}(\eta_t^E, \eta_{t-1}^E)}_{\text{over-borrowing inefficiency}} = 0 \tag{35}$$

where $X_{\mathcal{E}_t}$ denotes the effect of a depreciation on the foreign demand for exports, $\mathcal{F}_{\mathcal{E}_t}$ denotes the effect of a depreciation on households' returns on their financial position and $\mathcal{R}_{\mathcal{E}_t}$ is the

[36] As derived in Appendix C, when monetary policy is optimally set,

$$\eta_t^C = V_{C_{F,t}} = u_{C_{F,t}}(1+\tfrac{\chi}{1-\chi})\tau_t, \tag{34}$$

where $V_{C_{F,t}}$ is the social value of a unit of consumption and $u_{C_{F,t}}$ is the marginal value. If monetary policy is constrained or unresponsive, then $\eta_t^C = V_{C_{F,t}} - \eta_t^\mu$ which may exacerbate over-borrowing, as detailed in Section C.

derivative of the implicit formulation of the Euler equation (5). Each terms depends on the constraint multipliers and is detailed in Appendix C.

When macro-prudential policy is available ($\mathcal{R}_{\mathcal{E}_t} = 0$ because $\eta_t^E = \eta_{t-1}^E = 0$), the monetary policy targeting rule faces familiar trade-offs. The partial derivative $V_{\mathcal{E}_t}$ captures the direct effects of a depreciation on households' utility. This balances the positive effect of an increase in consumption of home goods as they become relatively cheaper and the negative effect that households must work relatively more to afford the same amount of imports. Monetary policy also takes into account that a depreciation increases export revenues expressed in terms of imports. Together these channels capture the terms of trade motive of monetary policy. The risk-sharing motive of monetary policy, summarised in $\mathcal{F}_{\mathcal{E}_t}$, depends on the level of issuance $\{x_t\}$, the level of asset holdings $\{a_t^F\}$ and the level of dollar demand $\{\xi_t\}$. If pass-through to import prices is non-zero ($\lambda > 0$), monetary policy has an incentive to depreciate debt coming due, captured by $\mathcal{F}_{\mathcal{E}_t}$. Moreover, monetary policy wants to fight the initial appreciation following an increase in ξ_t to offset the losses accruing on the U.S. portfolio at the onset of the crisis. On the other hand, since issuance rents are denominated in dollars, an appreciation is desirable as it increases the amount of imports monopoly rents can buy (if $\lambda > 0$).

Absent macro-prudential policy, monetary policy cannot attain the constrained efficient allocation in the economy when there are dollar shortages. When $\eta_t^E > 0$, $\mathcal{R}_{\mathcal{E}_t} \neq 0$ and therefore monetary policy no longer efficiently balances the terms-of-trade and risk-sharing incentives.[37] Consider the case where $\lambda = 1$ (PCP) and the hegemon holds no foreign assets.[38] Even if $\sigma = \theta = \zeta = 1$, monetary policy faces an additional incentive to raise interest rates, appreciating the currency so as to manipulate the terms of trade (reflected in the labour wedge) to offset over-borrowing due to the financial externality, as per Proposition 1. Relative to the constrained efficient allocation, the dollar is excessively appreciated, which further depresses export demand and lowers the dollar return on foreign currency assets at time t, and there is over-borrowing in equilibrium.

This finding can also be interpreted in terms of the classical Mundellian Trilemma. Using (35), I tightly define hegemon monetary policy to be independent when it can achieve the constrained efficient allocation, *independent of the level of dollar shortages abroad.* While Rey (2015) shows that a dollar-led global financial cycle compromises monetary policy independence in the rest of the world, I show that the relationship goes both ways. U.S. monetary policy too is compromised by capital inflows. [39]

[37]Bianchi and Coulibaly (2021) study the scope for monetary policy to address borrowing inefficiencies for different paraterizations of σ and θ. If $\sigma < \theta$, contractionary monetary policy leads to a fall in households borrowing.

[38]Allowing for $\lambda < 1$ (DCP) and foreign asset holdings $a^F > 0$, monetary policy has additional wealth effects through the hegemon's portfolio as in Wang (2019), and relatedly in Itskhoki and Mukhin (2022).

[39]If $\sigma < \theta$, since shortages of dollars themselves provide an incentive for higher interest rates in the U.S, this in itself reduces the supply of dollar debt, perpetuating dollar shortages and potentially worsening outcomes for the rest of the world.

4.2 Dollar Swaps

I now endow the hegemon with the ability to extend dollar swap lines $Q^s > 0$ to financial intermediaries, easing portfolio constraints and increasing dollar liquidity in international markets ($\Gamma = (\overline{Q} + Q^s)^{-2} \leq \overline{Q}^{-2}$). I show that dollar swap lines support stabilize the economy at the cost of eroding monopoly rents.[40] To illustrate the mechanisms driving the choice to extend dollar swaps, I assume the hegemon can indirectly choose the level of liquidity period by period and I consider the first order condition of (HD2) with respect to Γ_t :

$$\underbrace{-\eta_{t+1}^{C}\mathcal{E}_t^{-\lambda}\{Q_t x_t + \omega Q_t^2\}}_{\text{cost of foregone issuance rents}} \quad = - \underbrace{\eta_t^E \frac{1}{\mathcal{E}_{t+1}^{\lambda} C_{F,t+1}} Q_t}_{\text{cost of over-borrowing}} \tag{36}$$

The left hand side of (36) represents the marginal cost of increasing liquidity by one unit. Suppose there are dollar shortages ($Q_t < 0$). Increasing dollar liquidity erodes monopoly rents from issuance of dollar debt by households, since intermediaries can now issue dollars at a lower cost. The right hand side of (36) captures the marginal (social) benefit of increasing liquidity by one unit which relies on the over-borrowing externality. Dollar swaps affect the interest rate and therefore the allocation of private sector borrowing over time. Increasing liquidity by one unit raises the cost of borrowing through a lower exchange rate premium, lowering over-borrowing ($\eta_t^E \downarrow$). Instead, if the optimal borrowing tax were available, private borrowing would be at an optimal and $\eta_t^E = 0$. In that case, the net marginal benefit of issuing dollar swaps in the model is negative and the constraint $Q^s \geq 0$ binds.

Proposition 3 (Dollar Swaps)
Faced with dollar shortages, dollar swaps address over-borrowing at the cost of lower monopoly rents from issuance. Dollar swaps are not used if an optimal borrowing tax is available.

While dollar swaps are an imperfect substitute to macro-prudential taxation for addressing internal objectives in the hegemon, the two policies lead to very different outcomes internationally. On the one hand, the optimal borrowing tax restricts private sector issuance resulting in larger dollar shortages and worse portfolio returns for foreign investors. On the other hand, the provision of dollar swaps narrows the spread in borrowing costs for any level of shortages, improving outcomes for foreign investors. Since dollar swaps can be Pareto improving globally, this may explain why dollar swaps were preferred to macroprudential policiy, which would instead restrict the international supply of dollar assets, during recent crises.

[40] In practice, the hegemon establishes dollar swap lines (with a high or no ceiling) *in anticipation* of dollar shortages, and their up-take is determined by financial intermediaries according to (20). If I assume dollar swaps are established after the unanticipated increase in demand for dollars occurs, the analysis is unchanged with $\xi_t = \rho_\xi(\overline{\xi} + \epsilon_\xi)$ where ρ_ξ is the persistence of the dollar demand shock and ϵ_ξ is the innovations. The country incurs the full effects in the prior period where $\Gamma_{t-1} = 1/\overline{Q}^2$.

Lemma 3 (Dollar Swaps vs. Macroprudential Tax)
Both dollar swaps and macroprudential policy can improve outcomes for the hegemon if $\eta_t^E > 0$. *Macroprudential policy leads to worse outcomes for foreign investors, given by* Π_t^F, *if* (31) *is satisfied, whereas dollar swaps improve* Π_t^F.

Unresponsive monetary policy In addition to assuming that a macro-prudential tax is not available, I now analyze the case where monetary policy is unresponsive:[41]

$$R_t = R$$

Specifically, I define

$$\mathcal{E}_t^\lambda C_{F,t} = \mu_t(1-\chi), \tag{37}$$

where μ_t is a synthetic monetary instrument and $R_t = \beta \frac{\mu_{t+1}}{\mu_t}$. When μ_t grows at a constant rate, this ensures nominal interest rates R_t are constant in the absence of macro-prudential policy. For simplicity, I consider the case $\mu_t = \mu$ and attach the multiplier η_t^μ to the monetary policy constraint (37). Intuitively, when interest rates don't adjust, each additional unit of $C_{F,t}$ is also associated with a dollar appreciation which further depresses domestic demand for $H-$ type goods. This pushes down the value of a unit of consumption today and the cost of over-borrowing will tend to rise.[42]

In Section 5.3, I detail three extensions of the model which highlight the scope for dollar swaps to improve U.S. welfare. First, I consider an extension of the model with firesale of assets by foreign investors such that hegemon households earn lower returns on foreign assets when there are dollar shortages abroad. In this case, I show that dollar swaps can be desirable, even if the macroprudential tax is chosen optimally. Secondly, I show that faced with productivity shock (A_t), dollar swaps help recover monetary policy independence but cannot themselves offset the effects of the shock. Instead, in the case of a shock to dollar demand ξ_t, dollar swaps are able to directly address the shock and achieve stabilisation regardless of monetary policy. Third, I discuss whether public debt issuance can be used to support the monopolistic allocation.

4.3 Limited Financial Market Participation

I extend the model to allow for limited financial market participation and I show that dollar shortages in international markets have distributional consequences for households in the hege-

[41]Over the past decade, interest rates have hovered around the zero lower bound (ZLB) and interest rates are largely unresponsive to shocks. The analysis in this section coincides with imposing a zero lower bound in the limit $\beta \to 1$. I present the first order conditions associated with this problem in Appendix C

[42]Note that this is true even if the level of over-borrowing, as measured by the required tax (see Corollary 1), falls because $\tau_t > \tau_{t+1}$.

mon. I consider two types of households. Financially-active households trade in a domestic currency, non-contingent bond with financial intermediaries. I denote active household quantities by an A superscript and the measure of financially active households is exogenously given by $\mathbf{a}_t$. Financially inactive households, have allocations denoted by an NA superscript, and consume their wages and profits in every period.[43] I make the following assumptions.

A.3 (Limited Financial Market Participation)

($i.$) Labour is rationed equally when the economy is demand constrained: $L_t^A = L_t^{NA}$.

($ii.$) Profits from goods' firms Π_t^g accrue equally amongst all households.

($iii.$) Profits from ownership of financial firms Π_t^f accrue exclusively to active households.

A full exposition of the model is delegated to Appendix D. Here, I detail two key features of the model. First, financially active households trade in complete markets domestically and price traded assets:

$$\frac{1}{\mathcal{E}_t^{\lambda} C_{F,t}^A} = \beta R_t \frac{1}{\mathcal{E}_{t+1}^{\lambda} C_{F,t+1}^A}, \tag{38}$$

Therefore, only active household allocations appear in the Euler condition. Inactive households consume their wages in each period, and a representative inactive household can be considered because of the absence of idiosyncratic risks. Goods market clearing is given by $Y_{H,t} = \mathbf{a}_t C_{H,t}^A + (1-\mathbf{a}_t) C_{H,t}^{NA} + C_{H,t}^*$. Second, dollar market clearing now requires:

$$Q_t = \alpha_t x_t - \xi_t \tag{39}$$

The next proposition highlights the distributional implications of dollar shortages abroad for hegemon households.

Proposition 4 (Dollar Shortages and Redistribution)
Consumptions of individual active and inactive households are given by,

$$C_{F,t}^A \leq \mathcal{E}_t^{-\lambda} \left[\zeta P_H^{1-\eta} \mathcal{E}_t^{\eta} + (1-(1-\mathbf{a}_t)\chi) F_t \right], \tag{40}$$

$$C_{F,t}^{NA} \leq \mathcal{E}_t^{-\lambda} \left[\zeta P_H^{1-\eta} \mathcal{E}_t^{\eta} + \mathbf{a}_t \chi F_t \right], \tag{41}$$

[43] In the literature, these households are often referred to as *hand-to-mouth*, see Aguiar et al. (2015) for an empirical investigation. Alvarez, Atkeson, and Kehoe (2002) and Alvarez, Atkeson, and Kehoe (2009) study models of endogenous financial market segmentation based on fixed costs, analogous to the problems faced by financial intermediaries in Section 3.

respectively, where,

$$F_t = x_t - a_t^F - R^* \frac{\mathbb{E}_{t-1}[\mathcal{E}_t]}{\mathcal{E}_{t-1}}(x_{t-1} - a_{t-1}^F) \underbrace{-\Gamma_{t-1} Q_{t-1} x_{t-1}}_{\textit{Monopoly rents}} - R^* \frac{\mathbb{E}_{t-1}[\mathcal{E}_t] - \mathcal{E}_t}{\mathcal{E}_{t-1}} a_{t-1}^F + \omega \Gamma_t Q_t^2$$

In equilibrium, monopoly issuance rents accrue disproportionately to active households if $\chi < 1$.
Proof: See Appendix D □

Under $A.3(i)$, export revenues contribute equally to both active and inactive households' consumption, but monopoly rents disproportionally accrue to financially-active households as long as $\chi < 1$, i.e. active households spend a share of their rents abroad.Active households partly spend monopoly rents on domestic goods, contributing to domestic demand and boosting inactive household consumption but less than one to one. The set-up above resembles a two agent model as in Bilbiie (2020) and Auclert et al. (2021). In these models a spending multiplier arises, equal to $\frac{1}{1-(1-\alpha)}$, where $1-\alpha$ is the measure of hand-to-mouth households. In open economies, financially active households spend a share $1-\chi$ income on foreign goods, so the multiplier becomes $\frac{1}{1-(1-\alpha)\chi} < \frac{1}{1-(1-\alpha)}$. Allowing for redistributive taxes (ruled out by A.3 (iii)) or domestically complete markets ($\mathbf{a} = 1$), then $C_{F,t}^A = C_{F,t}^{NA}$.

Optimal policy with limited financial market participation. I denote the indirect utility function with limited financial market participation by $V(C_{F,t}^A, C_{F,t}^{NA}, \mathcal{E}_t; \boldsymbol{\lambda}, \mathbf{a}_t)$, where $\boldsymbol{\lambda} = [\lambda^A \ \lambda^{NA}]$ are Pareto weights with $\mathbf{a}_t \lambda^A + (1 - \mathbf{a}_t)\lambda^{NA} = 1$. The planning problem is given by,

$$\max_{\{C_{F,t}^A, C_{F,t}^{NA}, \mathcal{E}_t, x_t\}} \sum_{t=0}^{\infty} V(C_{F,t}^A, C_{F,t}^{NA}, \mathcal{E}_t; \boldsymbol{\lambda}, \mathbf{a}_t)$$

$$\text{s.t.} \qquad (40), \ (41)$$

where (40) and (41) are the constraints for active and inactive households respectively. I detail the indirect utility function, the conditions governing the planner's allocation in Appendix D.

I also consider the comparative statics with respect to **a**. I show that on the one hand, welfare rises with participation since the total size of monopoly rents grows (Proposition 4). On the other hand, a higher **a** implies a larger financial externality. Therefore, welfare is rising with **a** at the constrained efficient allocation but may be decreasing when macro-prudential policy is not available.

5 Numerical Exercise

Calibration. The calibration is quarterly. I choose $\beta = \beta^* = 0.99$ based on an annual natural interest rate of about 4%. I maintain that the CRRA coefficient is $\sigma = 1$ and the elasticity of substitution across domestic and imported goods ($\theta = 1$), which are not far from the literatature estimates. Similarly, I set the Frisch elasticity ψ of substitution to 2.5 and choose κ to target a steady-state labour supply of two-thirds.[44] I choose $\chi = 0.85$ such that $C_H^*/Y_H = 0.15$, consistent with data from the Bureau of Economic Analysis (BEA) for the U.S and I choose an export demand elasticity $\zeta = 2.5$. I choose $\frac{1}{Q}^2 = 0.14$, based on an internal calibration such that a 1% of U.S. GDP change in dollar shortages leads to about a 2% appreciation for the dollar, on impact, holding R_t constant, consistent with evidence of FX dollar swaps vis-a-vis Brazil as identified in Kohlscheen and Andrade (2014). To generate realistic values for monopoly rents in the U.S. economy, I consider a steady state where net foreign assets are zero, but the gross asset and liability position of the U.S. are 100% GDP.[45]

Dollar demand shock. I consider a one-off unanticipated shock to dollar demand by foreign agents ξ_t. Dollar demand follows an AR(1) process with quarterly persistence 0.85, see Figure 4 (left panel). I choose the size of the dollar demand shock ξ to result in an exchange rate appreciation (on impact) of about 7% if interest rates are held constant, see Figure 4 (right panel). The implied size of the dollar demand shock is about 7% of U.S. GDP.[46]

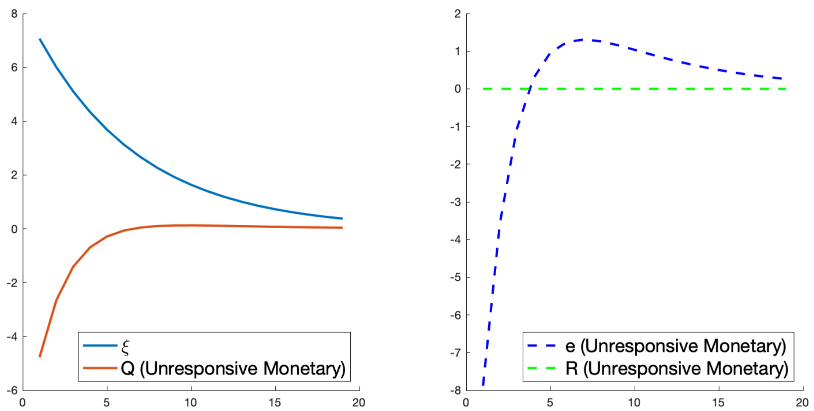

Figure 4: Impulse response to dollar demand shock ξ_t. Left panel: Dollar demand shock and dollar shortages (% of U.S. GDP). Right panel: Exchange rate appreciation (% deviations from steady state).

Monetary policy only. Figure 5 contrasts the effects of a dollar demand shock on allocations and prices in the hegemon, and shortages abroad, if interest rates are held constant and if monetary policy is set optimally according to (35). In both cases, the demand shock $\xi_t > 0$ leads to an excess demand for dollars ($Q_t < 0$). [47] The middle panel illustrates exchange rate and interest rate movements under the two monetary regimes, expanding on Figure 4. The hegemon optimally lowers interest rates such that a smaller dollar appreciation is required to

[44]See e.g Valchev (2020), Eichenbaum, Johannsen, and Rebelo (2020).

[45]In the steady state this implies $Q_t = 0, x_t = a^F = \bar{\xi}$.

[46]McGuire and Peter (2009) find that European bank's dollar shortfall (the biggest counterparty for the U.S. in terms of dollar swap lines) at the onset of the GFC was about $1 - 1.2$ trillion, or roughly 7-8% of U.S. GDP in 2007, so the size of the dollar shock implied by the model is reasonable.

[47]Dollar shortages are more prevalent and more persistent when monetary policy is optimally set. This is because households face a smaller recession (or boom) and therefore borrow less in foreign markets since $\eta > 1$.

satisfy financiers' optimality condition (15). The right panel illustrates the response of the average labour wedge. When interest rates are held constant, the demand shock leads to a domestic recession ($\tau_t > 0$), driven by a fall in the demand for exported goods and a fall in public spending due to portfolio losses. Instead, if interest rates respond optimally, the hegemon experiences a temporary boom ($\tau_t < 0$), although a recession follows after about 6 quarters.[48]

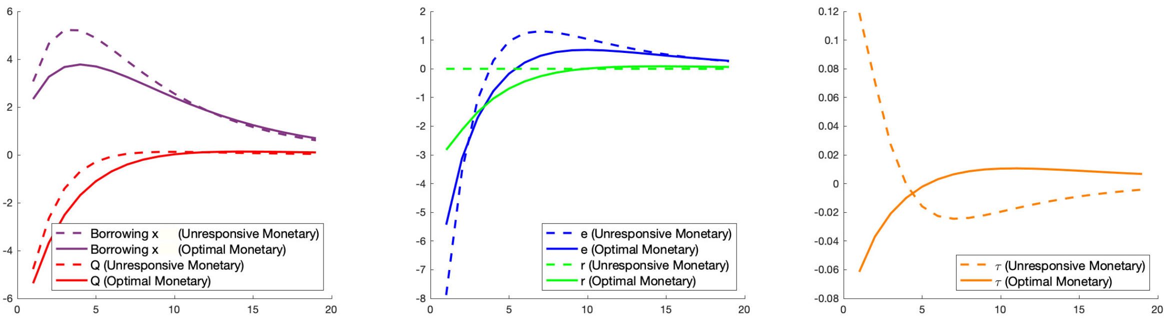

Figure 5: Impulse response to dollar demand shock ξ_t Comparison of optimal monetary (solid line) policy vs. passive monetary policy (dashed line). Left Panel: Private borrowing (deviations from steady state in % GDP). Middle panel: Exchange rate and interest rate movements (% deviations from steady state.) Right panel: Labour wedge deviations.

Constrained efficient allocation. Interest rates are cut significantly to stem the appreciation and the borrowing tax is used to postpone consumption to the future, monopolistically restricting the supply of dollars abroad. The left panel in Figure 6 shows that total borrowing falls and, as a result, dollar shortages are larger and more persistent. At the constrained optimum allocation, the interest rate cut is larger (5% vs. 3%), lowering the pressure on the exchange rate to appreciate (middle panel). This difference reflects how much dollar shortages abroad weigh on monetary policy in the absence of a borrowing tax. With the additional use of the borrowing tax, the aggregate labour wedge is almost fully stabilized. At the constrained efficient allocation, the planner no longer accepts externally induced employment instability and is at the same time able to efficiently maximize the transfer of monopoly rents from abroad.

5.1 Welfare

To assess the welfare implications of a rise in dollar shortages for the hegemon, I denote the present discounted value of welfare for a household $i \in \{A, NA\}$, following a dollar demand shock $\{\xi_t\} > 0$ when dollar liquidity is Γ, by:

$$\mathcal{W}^i(\{\mathcal{E}_t, \tau_t^x\}; \{\Gamma, \xi_t\}) \tag{42}$$

[48]Since only a measure $\mathbf{a} < 1$ of households in the hegemon participate in financial markets in any given period, dollar shortages have heterogeneous effects on the two groups of households within the hegemon. Inactive households experience involuntary unemployment, but the effect is significantly stronger when interest rates are constant. On the other hand, active households experience involuntary unemployment only if interest rates are held constant, and are overworked otherwise. See Figure 16 in Appendix F.

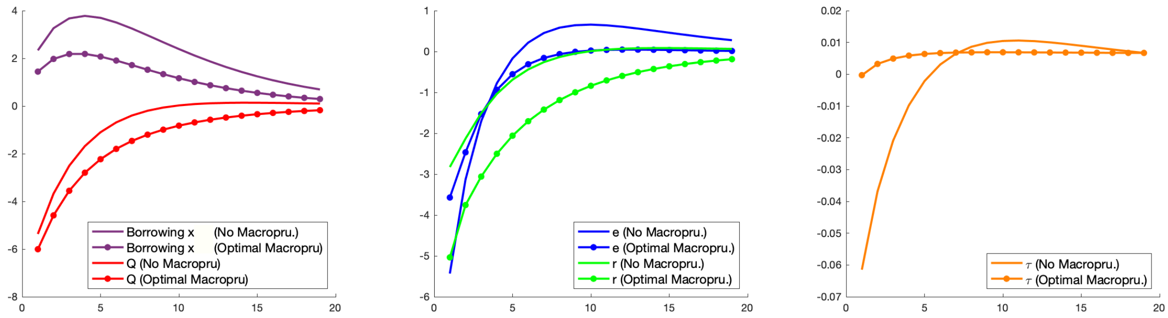

Figure 6: Impulse response to $\xi^* > 0$. Comparison of optimal macropru (rivetted line) vs. no macropru.(solid line). Left Panel: Private and public borrowing (deviations from steady state as% GDP) Middle panel: Exchange rate and interest rate movements (% deviations from steady state). Right panel: Labour wedge deviations.

where I make explicit the dependence of welfare on policy. I next define the Hicksian equivalent variation for consumption,

$$\sum_{t=0}^{\infty} \beta^t \left[\frac{C_t^i (1+\nu_t^i)^{1-\sigma}}{1-\sigma} - \kappa \frac{L_t^{1+\psi}}{1+\psi} \right] = \mathcal{W}^i(\{\mathcal{E}_t, \tau_t^x\}; \Gamma, 0), \tag{43}$$

where ν_t^i is a proportional consumption transfer, calculated over the period of elevated dollar demand, such that household $i \in \{A, NA\}$ is equally well-off whether or not the dollar demand shock occurs.[49] A positive transfer $\nu > 0$ suggests that a one-off unexpected increase in dollar shortages is costly to the household, i.e $\mathcal{W}(\{\mathcal{E}_t, \tau_t^x\}; \Gamma, 0) > \mathcal{W}(\{\mathcal{E}_t, \tau_t^x\}; \{\Gamma, \xi_t\})$. Table 1 details the welfare outcomes from a one-off dollar demand shock for the calibration discussed above.

	Active	Inactive	Aggregate
Unresponsive monetary (no macropru.)	0.25%	0.43%	0.31%
Optimal monetary (no macropru.)	-0.81%	0.17%	-0.51%
Constrained Optimal	-2.2%	0.23%	-1.5%

Table 1: Hicksian welfare transfers under different policy regimes, in response to a one-off, unanticipated dollar-asset demand shock.

When interest rates do not respond (first row of Table 1), dollar shortages cost about 0.31% of consumption equivalent per quarter, in the aggregate, over the 2 year duration of the crisis due to a combination of decreased export demand and valuation effects. These are driven by both losses to financially-active and inactive households, although the latter suffer disproportionately as per Proposition 4. Instead if monetary policy responds optimally, which requires an interest rate cut of just over 2%, the aggregate economy gains the equivalent of 0.5% consumption per quarter over the 2 years, but this is only one-third of the gain that could be achieved at the constrained optimal, in conjunction with an optimal tax on borrowing. However, this figure

[49] Such consumption transfers are used Lucas (2003) to evaluate the welfare costs of business cycles. I assume $\nu_t^i = \nu$ for the first 8 quarters after the shock hits (after which its size becomes negligible) and $\nu_t^i = 0$ thereafter.

masks welfare losses facing inactive households (0.17%), which are more than offset by gains to active (0.81%).

5.2 Revisiting Dollar Swaps.

In practice, dollar swap lines are extended by the FED at a time t, and their take-up in future periods is determined by the demand of foreign central banks. Therefore, the U.S. makes a one-off decision to extend dollar swaps if:

$$\int \lambda^i \mathcal{W}^i(\{\mathcal{E}_t, \tau_t^x\}; \{\frac{1}{Q+Q^s}^2, \xi_t\})di > \int \lambda^i \mathcal{W}^i(\{\mathcal{E}_t, \tau_t^x\}; \{\frac{1}{Q}^2, \xi_t\})di \tag{44}$$

where $\lambda^i = \mathbf{a}\lambda^A$ for $i = A$ and $\lambda^i = (1 - \mathbf{a})\lambda^{NA}$ for $i = NA$.

Dollar demand shocks, on their own, have muted macroeconomic consequences for the hegemon if dollar liquidity is sufficiently high, therefore swaps are optimal when dollar demand leads to welfare losses. In contrast, since dollar swaps cannot achieve the constrained efficient allocation, dollar swaps are not desirable when dollar shortages improve aggregate welfare for the hegemon. So, dollar swaps are optimal for the hegemon when $R_t = R$ or when λ^{NA}, the Pareto weight attached to inactive households, is high. Unresponsive monetary policy, possibly due to low rates we have experienced since the GFC, and a preference for redistribution to financially-inactive households are two reasons the model suggests dollar swap lines have become so prominent in recent years.

5.3 Extensions

Firesales. Suppose the return on foreign asset holdings (a_t^F) is $R^*(1 - \phi(\Gamma_t, \xi_t))$, where ϕ denotes a *haircut* which can accrue on foreign assets.[50] This captures a situation where the foreign sector is selling-off these assets (fire-sales) because of liquidity shortages. To capture that fire-sales are more likely when dollar liquidity is scarce and foreign investors make large losses on their dollar portfolios, I assume $\frac{d\phi(\Gamma)}{d\Gamma} > 0$. Then, dollar swap lines can be desirable even when optimal macro-prudential policy is in place, see (93) in Appendix G.

Productivity shocks. Consider a productivity shock (A_t falls), detailed in Appendix F. Households experience an income loss and borrow to smooth their consumption when $\sigma > \theta$. From Proposition 1, we know that households will over-borrow because they fail to internalise their size in financial markets. Once again, absent a borrowing tax, monetary policy cannot efficiently trade-off internal objectives. Dollar swaps help hegemon monetary policy regain its independence, narrow the issuance wedge τ^Ω and the economy moves closer to the efficient allocation.[51]

[50] Firesales by foreign investors were cited as a key concern by the FED when it announced the Dollar Swap Lines. See `https://www.federalreserve.gov/newsevents/pressreleases/swap-lines-faqs.htm`.

[51] As pointed out in Farhi and Werning (2014), controls on capital flows are also required to deal with terms of trade motives so dollar swaps cannot replace the borrowing tax. However, the inefficiency is no longer dependent on the level of dollar shortages abroad.

Public debt. Consider an extension of the model with government spending and public debt issuance. Although debt issuance can be chosen to implement the desired level of dollar shortages abroad, this will generally not be the optimal allocation because of domestic fiscal incentives such as smoothing of public spending. Dollar swaps, instead, have little effect on the public sector balance sheet and directly target the spread in the cost of borrowing in dollars vis-a-vis foreign currency.

Additionally, the extension of the model to consider public debt issuance yields insight on the effects of quantitative easing (QE). QE, by which the FED purchases U.S. treasuries, also results in a reduction in the supply of dollar assets domestically and abroad, manifesting in dollar shortages.[52]

6 Conclusion

The prominent role of the dollar in financial markets is not only costly for non-U.S. investors who search for dollar debt despite its poor return, but can also interfere with the efficient working of U.S. monetary policy. Because dollars are scarce, U.S. households and the government earn monopoly rents from issuing domestic-currency denominated debt, but face costs associated with a dollar appreciation. Monetary policy in the hegemon can stabilize the domestic economy, but it cannot achieve the constrained efficient allocation absent a macro-prudential tax because of (inefficient) over-borrowing by households. This arises because atomistic households fail to internalize their size in dollar markets and because of nominal rigidities. Relative to the constrained efficient allocation,I show that with monetary policy alone, U.S. output and prices are more volatile, and monopoly rents are low.

Dollar swaps can improve welfare for the hegemon, in place of a missing macro-prudential tax, but they cannot achieve the constrained efficient allocation. Dollar swaps expand the portfolio limits faced by financial intermediaries who can manufacture dollar debt and alleviate dollar shortages in foreign markets. This addresses the over-borrowing but only at the cost of eroding monopoly rents. Dollar swaps are more desirable if monetary policy is unresponsive and if pass-through to import prices is low (DCP). When a measure of households in the hegemon country do not participate in financial markets, dollar shortages abroad lead to distributional consequences which can drive the policy response. Specifically, dollar swaps systematically favour inactive households by stabilizing wages, at the expense of active households who forego excess returns on their portfolio.

In conclusion, this paper analyses the ability of monetary policy to manage large and volatile capital flows driven by the demand for dollars. Macro-prudential policy, in the form of a tax on borrowing, which exacerbates dollar shortages abroad can be used to achieve the constrained efficient allocation for the U.S. By restricting the supply of dollars abroad, the U.S. can earn monopoly rents at the expense of foreign investors. Such a policy could however undermine the position of the dollar moving forward or prompt retaliatory action, which may be why it

[52] Krishnamurthy and Lustig (2019) show that quantitative easing where the FED purchased treasuries indeed widened the treasury basis, consistent with larger shortages in my model.

not used in practice. The International Monetary System seems instead to have settled in an uncomfortable equilibrium, where the U.S. provides dollar liquidity via swap lines when needed (acting as a lender of last resort), even though by doing so it foregoes some monopoly rents. A rethinking of the system may be on the horizon, which could entail the use of a new global reserve currency, digital currencies or centralized clearing of financial markets.

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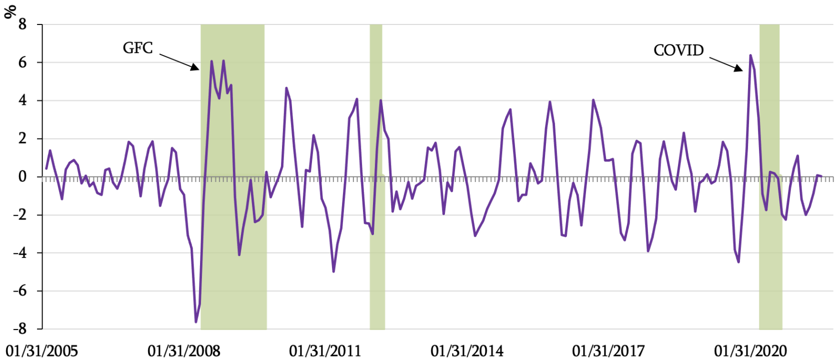
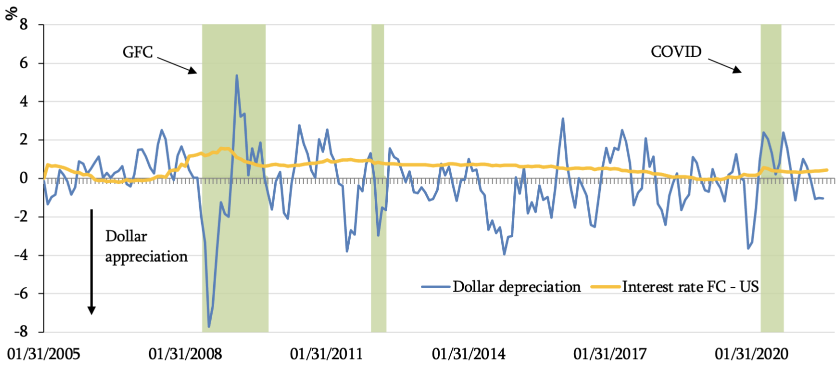
A Empirical Evidence.

This appendix provides evidence in support of the motivation and mechanisms of the chapter.

Evidence on deviations from the Uncovered Interest Parity Figure 7 documents the recurrent patterns of returns on a portfolio long in foreign currency bonds, funded by borrowing in U.S. treasuries. The sample considers all G10 and EM7 currencies. Figure 8 splits the sample intro the two country groups. Both G10 and EM7 currency-denominated debt trades at a higher (realized) return during crises. The portfolio returns for EM7 currencies are larger, and significantly so in the most recent COVID-19 episode. However, the spread exists for G10 countries too.



(a)



(b)

Figure 7: (a) 3-month forward sum of ex-post deviations from the uncovered interest rate parity (UIP) based on a trade-weighted average of G10 and EM7 currencies in *p.p.* (b) 3-month Interest rate differentials, 3-month dollar index movements Shaded regions reflect periods when dollar swap facilities exceeded \$60000 million. Source: Global Financial Data, Federal Reserve and author's calculations.

Evidence on dollar demand. Next, I discuss evidence on the correlation of capital flows and portfolio returns. As is clear from Figure 7, the difference in the returns on foreign currency and dollar debt is small outside of crises. At the onset of crises, the dollar appreciates resulting in a higher realised cost of borrowing in dollar debt. Borrowing in dollar debt is however much cheaper during crises, generating the monopoly rents at the core of this paper. Figure 9 plots gross trade volumes and the peak occurs during the GFC. Specifically, Krishnamurthy and

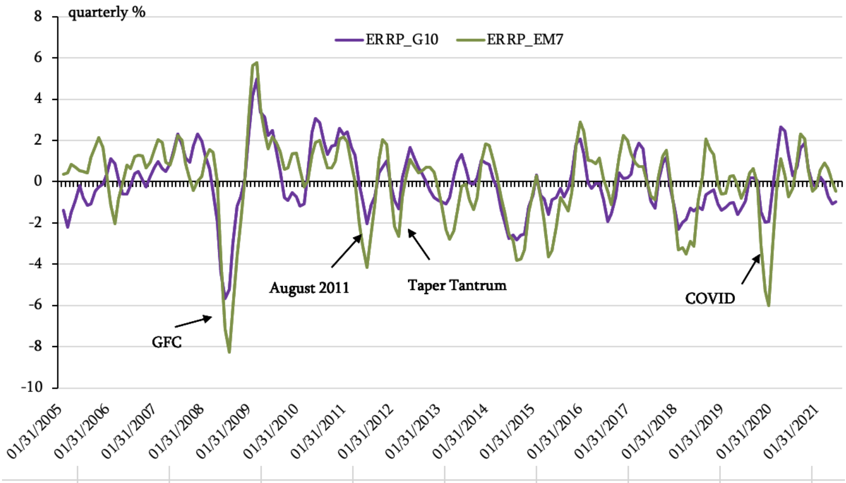


Figure 8: Source: Federal Reserve

Lustig (2019) show that gross flows are strongly negatively correlated with the changes in the spread. The correlation between gross purchases of Treasuries by foreigners and the change in the 3-month spread is -0.58 at monthly frequencies, so foreign investors go long in treasuries $-\xi_t > 0$ in the model– when it is least profitable to do.

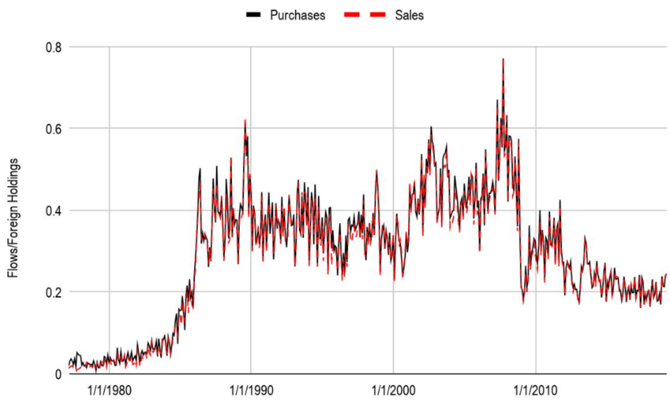
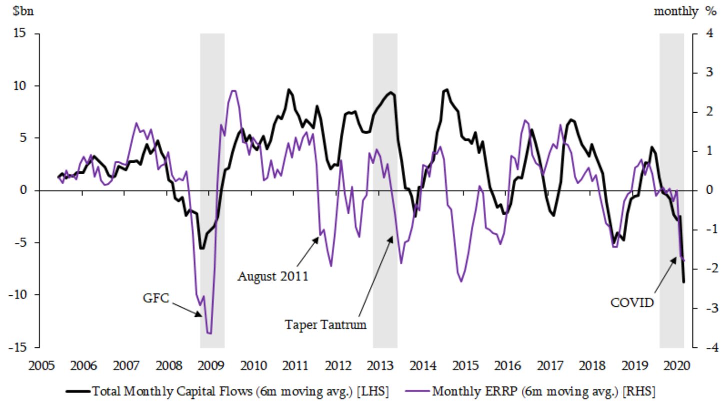


Figure 9: Evidence on timing of purchases of U.S. bonds by foreigners. Purchases by foreign investors and sales to foreign investors normalised by the foreign holdings of Treasuries. Source: Krishnamurthy and Lustig (2019).

Related to this, Figure 10, from Corsetti, Lloyd, and Marin (2020), plots emerging market capital flows and exchange rate risk premia as 6-month moving averages. While the correlation of these two variables is close to zero when calculated over the whole period, it becomes strongly positive around periods of significant financial distress and low liquidity. Over a 2005:01-2020:03 sample, the correlation between non-resident portfolio flows to EMs and the EM PPP-weighted exchange rate risk premium, at monthly frequency, is just 0.08, consistent with a Γ_t close to zero.

This result is often highlighted by the literature on the 'exchange rate disconnect', stressing the apparent weak relationship between currency valuation and economic fundamentals, including capital flows, see e.g. Meese and Rogoff (1983). However, a rolling correlation between these series over a 6-month window highlights that this correlation rises to above 0.75 during periods of financial distress: the Great Financial Crisis, the 2013 Taper Tantrum and the recent COVID crisis—all of which are characterised by large capital movements and low international liquidity. In these periods, through the lens of the model, the data suggests that the level of liquidity – Γ_t in the model– that is substantially high.

Figure 10: Capital flows and *ex post* exchange rate risk premia for EMs



Note: 6-month moving average of: non-resident portfolio flows to EMs, and 1-month *ex post* EM exchange rate risk premia vis-à-vis US dollar (PPP-weighted). Capital flows cumulated over each calendar month, with negative value implying an outflow from EMs. Moving averages plotted at end-date of period. Shaded areas denote periods in which 6-month rolling correlation of raw capital flows and exchange rate risk premia exceed 0.75. Unconditional correlation of raw series equal to 0.08 over the sample. *Dates*: January 2005 to March 2020. *Data Sources*: Datastream, IIF, IMF International Financial Statistics.

Lemma 1 suggests that within the model, dollar demand is proportional to the up-take of dollar swap lines. 11 below plots dollar swap up-take and suggests that dollar demand peaked during the GFC, the European sovereign debt crisis and after COVID-19, consistent with the evidence above.

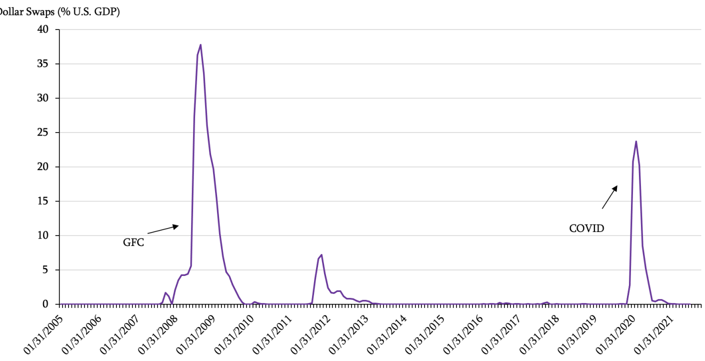


Figure 11: Weekly outstanding dollar swaps (Wednesday level). Source: Federal Reserve

Evidence on U.S. Carry Trade Portfolio. In the model, monopoly rents for the U.S. accrue even in the absence of interest rate adjustments through its holdings of foreign currency assets.Figure 12 (left panel) plots the net investment position of the U.S., as a % of GDP, from 2006Q1 to 2021Q4, calculated as the difference in gross external assets and liabilities (right panel), and has rapidly worsened over time. Data from Bénétrix, Lane, and Shambaugh (2015) suggests that over 80% of external liabilities are dollar denominated, and over 60% of external assets are foreign currency denominated, so the U.S. holds a large carry trade portfolio consistent with the mechanisms in the paper.

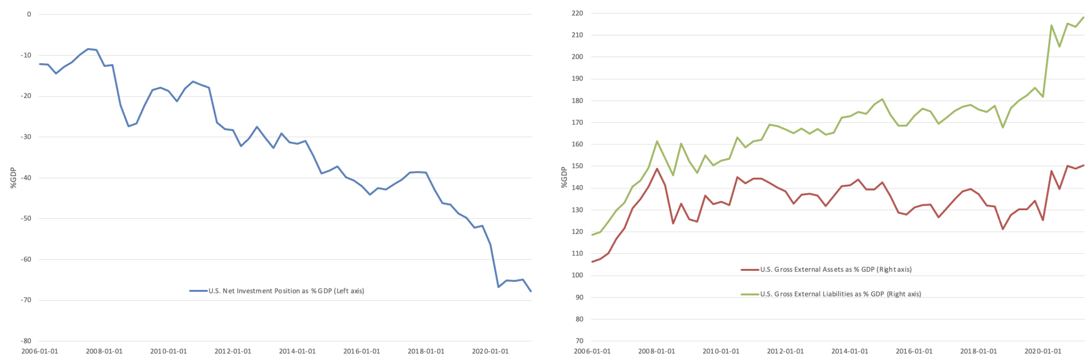


Figure 12: Left Panel: Net Investment Position for the United States in as % GDP. Right panel: Gross assets and liabilities as % GDP. Source: BEA and author's calculations.

Evidence of Wealth Inflows to the U.S. during the GFC The final figure contrasts the calculation of the U.S. net foreign asset position around the GFC by Maggiori (2017) and Jiang, Krishnamurthy, and Lustig (2020). The latter consider a wider set of assets and find evidence of a net transfer to the U.S. from abroad, even though the position deteriorated in absolute value. – consistent with the mechanism in this paper. Specifically, they consider equities, bonds, and deposits issued in the U.S. , held by both U.S. and non-U.S. agents, plotted by the black-dashed line. The red line measures the same quantity for Canada, Germany, France, Great Britain and

Japan.

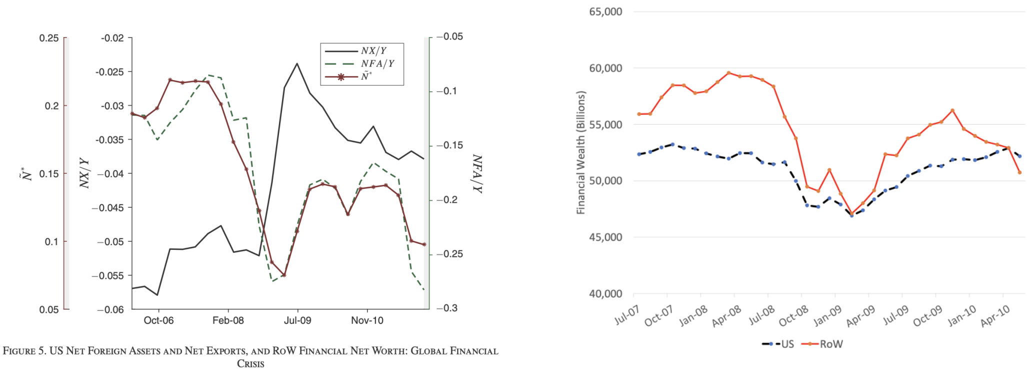


Figure 13: Left panel: Figure 5 from Maggiori (2017). Right panel: Figure 5 from Jiang, Krishnamurthy, and Lustig (2020).

B Further derivations for Section 3: Analytical Hegemon's Dilemma

For convenience, I repeat below the expression for the exchange rate,

$$\mathcal{E}_1 = \overline{\mathcal{E}} \left(\frac{\overline{\mu}}{\mu_1} - \Gamma_1 Q_1 \right)^{-1} \tag{45}$$

for a given monetary policy μ_1. The monetary policy rule determining μ_1 is given by:

$$\mu = (1-s)\overline{\mu} + s\overline{\mu}\left(1 + \Gamma_1 Q_1\right)^{-1} \tag{46}$$

For $s < 1$, dollar shortages ($Q_1 < 0$) leads to an appreciation.

The derivatives $\frac{d\mu_1}{dQ_1}$ and $\frac{d\mu_1}{d\Gamma_1}$ characterize monetary decisions in response to dollar imbalances and liquidity and, in turn, these determine $\frac{d\mathcal{E}_1}{dQ_1}$, $\frac{d\mathcal{E}_1}{d\Gamma_1}$. Specifically,

$$\frac{d\mathcal{E}_1}{dQ_1} = -\overline{\mathcal{E}} \left(\frac{\overline{\mu}}{\mu_1} - \Gamma_1 Q_1 \right)^{-2} \left[-\frac{\overline{\mu}}{\mu_1^2} \frac{d\mu_1}{dQ_1} - \Gamma_1 \right], \tag{47}$$

$$\frac{d\mathcal{E}_1}{d\Gamma_1 1} = -\overline{\mathcal{E}} \left(\frac{\overline{\mu}}{\mu_1} - \Gamma_1 Q_1 \right)^{-2} \left[-\frac{\overline{\mu}}{\mu_1^2} \frac{d\mu_1}{d\Gamma_1} - Q_1 \right], \tag{48}$$

where the first term in the square brackets is the standard "UIP channel" by which interest rates affect exchange rates and the second term is the risk premium channel, akin to a Bernanke and Blinder (1992) "credit channel".

Consider the labour wedge τ_1, given by (27). The derivatives with respect to Q_1 and Γ_1 are given by:

$$\frac{d\tau_1}{dQ_1} = -\frac{1}{A_1}\frac{\kappa}{\overline{P}_H} \left\{ \frac{d\mu_1}{dQ_1} L_1^{\psi} + \mu\psi L^{\psi-1} \left[\frac{\chi}{\overline{P}_H}\frac{d\mu_1}{Q_1} + \frac{\zeta}{\overline{P}_H^{\eta}} \mathcal{E}_1^{\eta-1}\eta \frac{d\mathcal{E}_1}{dB_1} \right] \right\}, \tag{49}$$

$$\frac{d\tau_1}{d\Gamma_1} = -\frac{1}{A_1}\frac{\kappa}{\overline{P}_H^{\eta}} \left\{ \frac{d\mu_1}{d\Gamma_1} L_1^{\psi} + \mu\psi L^{\psi-1} \left[\frac{\chi}{\overline{P}_H}\frac{d\mu_1}{d\Gamma_1} + \frac{\zeta}{\overline{P}_H} \mathcal{E}_1^{\eta-1}\eta \frac{d\mathcal{E}_1}{d\Gamma_1} \right] \right\}, \tag{50}$$

where $\dfrac{d\mu_1}{dQ_1} = -s\overline{\mu}\frac{\Gamma_1}{(1+\Gamma_1 Q_1)^2}$, and $\dfrac{d\mu_1}{d\Gamma_1} = -s\overline{\mu}\frac{Q_1}{(1+\Gamma_1 Q_1)^2}$,

Consider next the portfolio returns Ω_2, which can be rewritten as:

$$-\Gamma_1 x_1^2 + \Gamma_1 \xi_1 x_1 + \omega\Gamma_1 (x_1 - \xi_1)^2 \tag{51}$$

An additional unit of x_1 lowers the return on the portfolio by eroding the scarcity of dollar abroad but, for a given size of dollar shortages, an additional unit of x_1 expands the size of the portfolio– so (51) captures the 'returns Laffer curve'.

The derivatives of monopoly rents Ω_2 with respect to x_1 and Γ_1 are as follows:

$$\frac{d\Omega_2}{dx_1} = -2\Gamma_1 x_1 + \Gamma_1 \xi_1 + 2\omega\Gamma_1 Q_1, \tag{52}$$

$$\frac{d\Omega_2}{d\Gamma_1} = -x_1^2 + \xi_1 x_1 + \omega Q_1^2 \tag{53}$$

where (51) describes the returns Laffer curve faced by the hegemon. For low values of x, each additional unit issued increases Ω_2 but for high values of x_1, $\frac{d\Omega_2}{dx_1}$ turns negative.

Proof to Proposition 1.

Trade-off- part (i): The relationship between the labour wedge and dollar shortages is given by (49) and depends on the responsiveness parameter s through $\frac{d\mu_1}{dQ_1}$. The level of s which stabilises the labour wedge $\bar{s}$ is implicitly defined by setting $\frac{d\tau_1}{dQ_1} = 0$. Notice that for $s = 0$, $\frac{d\mu_1}{dQ_1} > 0$ since the appreciation lowers exports and μ_1 is constant. Instead, if $s = 1$, $\frac{d\mu_1}{dQ_1} < 0$, since exchange rates are stabilised but monetary policy is expansionary. Given that $\frac{d\mu_1}{dQ_1}$ is a continuous function, $\bar{s}$ exists by the intermediate value theorem.

The relationship between the hegemon's portfolio returns and dollar shortages is given by (52) and is strictly increasing ($\frac{d\Omega_2}{dQ1} < 0$) as long as there are dollar shortages $Q_1 < 0$.

Optimality- part (ii): The first-order conditions for (HD1) with respect to x_1 and Γ_1 respectively are given by ,

$$\omega^S \text{sign}(\overline{\tau} - \tau_1)\frac{d\tau_1}{dx_1} + (1 - \omega^S)\frac{d\Omega_2}{dx_1} = 0, \tag{54}$$

$$\omega^S \text{sign}(\overline{\tau} - \tau_1)\frac{d\tau_1}{d\Gamma_1} + (1 - \omega^S)\frac{d\Omega_2}{d\Gamma_1} = 0, \tag{55}$$

where $\frac{d\tau_1}{dx_1}, \frac{d\Omega_2}{dx_1}, \frac{d\tau_1}{d\Gamma_1}, \frac{d\Omega_2}{d\Gamma_1}$ are given by (49), (50), (52) and (53). If the planner chooses $\Gamma_1 \geq \Gamma_1 = \frac{1}{\underline{Q}}^2$ then (55) is replaced by $\Gamma_1 = \frac{1}{\underline{Q}}^2$. Combining (54) and (55) with (49), (50), (52) and (53) yields the optimal allocation $\{x_1, \Gamma_1\}$.

Consider the case where the planner only cares to stabilize the labour wedge, captured by $\omega^S = 1$. If Γ_1 is bounded from below above zero, perfect stabilization can only be achieved if $dx_1 = -d\xi_1$, i.e the hegemon satisfies dollar excess demand by issuing dollar bonds. If $\Gamma_1 = 0$ can be reached with dollar swaps, stabilization can be achieved using either dollar swaps or issuance.

Instead, consider the case where the planner only cares about maximizing its portfolio returns $\omega^S \to 0$. Then, rearranging (54) :

$$x_1 = \xi_1 \frac{1 - 2\omega}{2 - 2\omega} \tag{56}$$

which is the level of x_1 at the top of the Laffer curve (51). From this, it follows that $0 < \frac{dx_1}{d\xi_1} < 1$ leading to $\frac{dQ_1}{d\xi_1} < 0$. In other words, the optimal allocation does not entail perfectly stabilising shortages. Additionally, $\frac{d\Omega_1^M}{d\Gamma_1} > 0$ as long as $x_1 > 0$ and $Q_1 < 0$ therefore dollar swaps are not used.

For intermediate values of ω^S, the hegemon trades off monopoly rent maximization for macroeconomic stabilization requiring inefficiently high x_1, relative to (56). Given $\frac{d\tau_1}{d\Gamma_1} > 0$, $\frac{d\Omega_1^M}{d\Gamma_1} > 0$ if $Q_1 < 0$ then, from (55) we see that dollar swaps become useful as $|\tau - \overline{\tau}|$ grows. □

The following figure plots the objective function when $w^S = 0.2$. Notice that the Laffer curve is now shifted to higher levels of x_1.

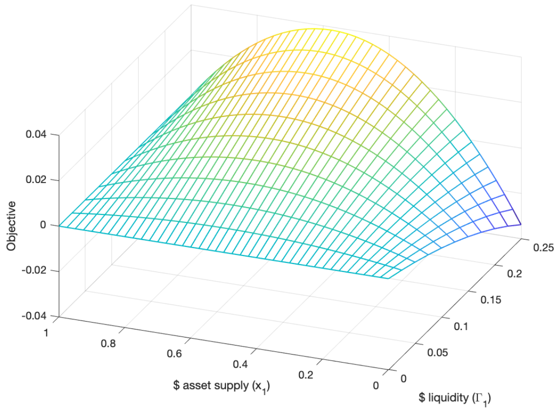


Figure 14: $w^S = 0.2$. Parametrization: $s = 0.5, \kappa = \overline{\mu} = \overline{\mathcal{E}} = \zeta = \eta = \psi = 1$, $\chi = 0.6, \beta = \beta^* = 1$.

Exorbitant privilege vs. valuation effects. Monopoly rents represent a wealth inflow to the U.S. during crises, when demand for dollars is high. However, the return on the U.S. portfolio of assets initially falls due to the sharp appreciation, documented in Figure 7. This initial fall in portfolio returns is referred to as 'valuation effects', see e.g. Gourinchas and Rey (2007) and Gourinchas, Rey, and Govillot (2018) and contributes to a wealth outflow at the onset of crises. To analyze the two-way relationship between fiscal policy and dollar swaps on valuation effects, I consider the return on a portfolio ($x_1 = a^F$) formed at time 0. From this, the hegemon earns $R^* \frac{\mathcal{E}_1}{\mathcal{E}_0} - R_0$ in period 1. An unanticipated appreciation of the dollar lowers the dollar-return of the time 0 portfolio at $t = 1$.[53] For all values of w^S, the hegemon has a stronger incentive to prevent an appreciation at $t = 1$, either by issuing more debt or by extending dollar swaps.

Cournot competition in issuance. I leverage the stylized framework to analyze the effects of international competition in issuance of dollar (or close-substitute) assets, embedding the results in Farhi and Maggiori (2016). Dollar market clearing is given by (17) when there are N other countries issuing assets that are close substitutes to dollar assets. I focus on the case $w^S = 0$ and, now, (54) implies the following analogue to (56):

$$x_1 = \frac{\xi_1 - x_1 - \sum_{i>0}^{N-1}(x_1^i)}{2},$$

[53]Notice that this return can be re-written using (15) as $-\Gamma_0 Q_0 - (\mathbb{E}_0[\mathcal{E}_1] - \mathcal{E}_1)/\mathcal{E}_0$, where $\Gamma_0 Q_0 = 0$ and $\mathbb{E}_0[\mathcal{E}_1 - \mathcal{E}_1] > 0$. Then, $\Omega_2 = -\Gamma_1 Q_1 x_1 + \omega \Gamma_1 Q_1^2 - \left(1 - \frac{\mathcal{E}_1}{\overline{\mathcal{E}}}\right) x_0$. Since $\frac{\mathcal{E}_1}{\overline{\mathcal{E}}} < 1$ for all $s < 1$, Ω_2 falls relative to before for $Q_1 < 0$.

Imposing symmetry ($x_1^i = x_1 \; \forall i$) yields the optimal issuance chosen by the planner when there are N competing issuers:

$$x_1 = \frac{\xi_1 - \sum_{i>0}^{N-1} x_1^i}{N+1}, \quad Q_1 = \frac{\xi_1 - x_1 - \sum_{i>0}^{N-1} x_1^i}{N}$$

As the number of competing issuers becomes large, dollar shortages go to zero. In the case $w^S = 1$, as detailed above, each individual issuer finds $Q_1 = 0$ optimal.

C Further derivations for Section 4: Constrained Optimal Allocation

C.1 Deriving indirect utility function

To derive the indirect utility function, start from (1) and substitute in (7) and (9):

$$V(C_{F,t}, \mathcal{E}_t) = \chi \log\left(\frac{\chi}{1-\chi}\frac{P_{F,t}}{P_{H,t}}C_{F,t},\right) + (1-\chi)\log(C_{F,t}) \\ -\kappa \frac{\left(\frac{1}{A_t}\left[\frac{\chi}{1-\chi}\frac{P_{F,t}}{P_{H,t}}C_{F,t}, +(1-\chi)\frac{P_t^*}{P_{H,t}}C_t^*\right]\right)^{1+\psi}}{1+\psi} \tag{57}$$

Assuming prices are perfectly rigid, $P_{H,t} = \overline{P}_H$, and normalizing foreign prices to 1, $P_{F,t} = \overline{P}_F^* \mathcal{E}_t^\lambda = \mathcal{E}_t^\lambda$. With perfectly rigid prices, the firms' pricing condition (11), is not a constraint in equilibrium on the planning problem, but is instead only used to back out prices. Note also that,

$$C_H^* = (1-\chi)\left(\frac{P^*}{P_H^*}\right)^\eta C^* = \underbrace{(1-\chi)\mu^*}_{\zeta}\left(\frac{\mathcal{E}_t}{\overline{P}_H}\right)^\eta. \tag{58}$$

The partial derivatives with respect to $C_{F,t}$ and $\mathcal{E}_t$, are given by,

$$V_{C_{F,t}} = \frac{1-\chi}{C_{F,t}}\left(1 + \frac{\chi}{1-\chi}\tau_t\right), \tag{59}$$

$$V_{\mathcal{E}_t} = \frac{1-\chi}{C_{F,t}}\left(\tau_t\left(\frac{\chi}{1-\chi}\lambda\mathcal{E}_t^{-1}C_{F,t} + \zeta\eta\overline{P}_H^{1-\eta}\mathcal{E}_t^{\eta-\lambda-1} + \frac{\chi^G}{1-\chi^G}\lambda\mathcal{E}_t^{-1}G_{F,t}\right) - \zeta\eta\overline{P}_H^{1-\eta}\mathcal{E}_t^{\eta-\lambda-1} \\ - \frac{\chi^G}{1-\chi^G}\lambda\mathcal{E}_t^{-1}G_{F,t}\right) + \omega^G\frac{1-\chi^G}{G_{F,t}}\frac{\chi^G}{1-\chi^G}\lambda\mathcal{E}_t^{-1}G_{F,t}, \tag{60}$$

where I have used that $-\kappa L_t^\psi = (\tau_t - 1)A_t\frac{1-\chi}{C_{F,t}}\frac{\overline{P}_H}{\mathcal{E}_t^\lambda}$.

The planner's first order conditions for (HD2), with respect to $C_{F,t}, \mathcal{E}_t, x_t, G_{F,t}$ and B_t respectively, are given by:

$$C_{F,t}: \qquad V_{C_{F,t}} - \eta_t^C - \eta_t^\mu + \frac{1}{\mathcal{E}_t^\lambda C_{F,t}^2}\left[\eta_t^E - R_{t-1}\eta_{t-1}^E\right] = 0, \tag{61}$$

$$\begin{aligned}\mathcal{E}_t: \qquad & V_{\mathcal{E}_t} + \eta_t^C \zeta(\eta-\lambda)\mathcal{E}_t^{\eta-\lambda-1}\overline{P}_H^{1-\eta} + \\ \eta_t^C & \left\{ -\lambda \mathcal{E}_t^{-\lambda-1}(x_t - a_t^F) - (1-\lambda)\frac{R^* \mathcal{E}_t^{-\lambda}}{\mathcal{E}_{t-1}}(x_{t-1} - a_{t-1}^F) + \lambda \mathcal{E}_t^{-\lambda-1}\Gamma_{t-1}Q_{t-1}(x_{t-1}) \right\} \\ & + \beta \eta_{t+1}^C \left\{ \frac{R^* \mathcal{E}_{t+1}^{1-\lambda}}{\mathcal{E}_t^2}(x_t - a_t^F) \right\} \\ & + \eta_t^E \left\{ \frac{1}{C_{F,t}}\lambda \mathcal{E}_t^{-\lambda-1} - \frac{1}{C_{F,t+1}}\beta R^* \frac{\mathcal{E}_{t+1}^{1-\lambda}}{\mathcal{E}_t^2} \right\} + \eta_{t-1}^E \frac{1}{C_{F,t}} \left\{ (1-\lambda)R^* \frac{\mathcal{E}_t^{-\lambda}}{\mathcal{E}_{t-1}} - \lambda \mathcal{E}_t^{-\lambda-1}\Gamma_{t-1}Q_{t-1} \right\} \\ & - \eta_t^\mu \lambda \mathcal{E}_t^{-\lambda-1}\mu(1-\chi) = 0, \end{aligned} \tag{62}$$

$$x_t: \qquad \eta_t^C \mathcal{E}_t^{-\lambda} - \beta \eta_{t+1}^C \mathcal{E}_{t+1}^{-\lambda}\left[R_t + \Gamma_t(x_t + B_t) - 2\omega\Gamma_t Q_t\right] + \eta_t^E \beta \Gamma_t \frac{1}{\mathcal{E}_{t+1}^\lambda C_{F,t+1}} = 0, \tag{63}$$

$$\tag{64}$$

Next, I focus on deriving the monetary policy rule (35). Using (90) the monetary policy targetting rule can be written as:

$$V_{\mathcal{E}_t} + \eta_t^C \frac{dC_{H,t}^*}{d\mathcal{E}_t} + \left\{ \eta_t^C \frac{dF_t}{d\mathcal{E}_t} + \eta_{t+1}^C \frac{dF_{t+1}}{d\mathcal{E}_t} \right\} + \left\{ \eta_t^E \frac{d\mathcal{R}_t}{d\mathcal{E}_t} \right\} + \left\{ \eta_{t-1}^E \frac{d\mathcal{R}_{t-1}}{d\mathcal{E}_t} \right\} = 0,$$

where,

$$\frac{dC_{H,t}^*}{d\mathcal{E}_t} = \zeta(\eta-\lambda)\mathcal{E}_t^{\eta-\lambda-1}\overline{P}_H^{1-\eta}, \tag{65}$$

$$\begin{aligned}\frac{dF_t}{d\mathcal{E}_t} &= -\lambda \mathcal{E}_t^{-\lambda-1}(x_t + B_t - a_t^F) - (1-\lambda)\frac{R^* \mathcal{E}_t^{-\lambda}}{\mathcal{E}_{t-1}}(x_{t-1} - a_{t-1}^F) \\ & \quad + \lambda \mathcal{E}_t^{-\lambda-1}\Gamma_{t-1}Q_{t-1}(x_{t-1}),\end{aligned} \tag{66}$$

$$\frac{dF_{t+1}}{d\mathcal{E}_t} = \beta \frac{R^* \mathcal{E}_{t+1}^{1-\lambda}}{\mathcal{E}_t^2}(x_t - a_t^F), \tag{67}$$

$$\frac{dR_t}{d\mathcal{E}_t} = \frac{1}{C_{F,t}}\lambda \mathcal{E}_t^{-\lambda-1} - \frac{1}{C_{F,t+1}}\beta R^* \frac{\mathcal{E}_{t+1}^{1-\lambda}}{\mathcal{E}_t^2}, \tag{68}$$

$$\frac{dR_{t-1}}{d\mathcal{E}_t} = \frac{1}{C_{F,t}}\left\{ (1-\lambda)\frac{\mathcal{E}_t^{-\lambda}}{\mathcal{E}_{t-1}} - \lambda \mathcal{E}_t^{-\lambda-1}\Gamma_{t-1}Q_{t-1} \right\} \tag{69}$$

In the main body, (35) follows from grouping the terms in (71) as follows:

$$\underbrace{V_{\mathcal{E}_t} + \eta_t^C \frac{dC_{H,t}^*}{d\mathcal{E}_t}}_{X_{\mathcal{E}_t}} + \underbrace{\left\{\eta_t^C \frac{dF_t}{d\mathcal{E}_t} + \eta_{t+1}^C \frac{dF_{t+1}}{d\mathcal{E}_t}\right\}}_{\mathcal{F}_{\mathcal{E}_t}} \tag{70}$$

$$+ \underbrace{\left\{\eta_t^E \frac{d\mathcal{R}_t}{d\mathcal{E}_t}\right\} + \left\{\eta_{t-1}^E \frac{d\mathcal{R}_{t-1}}{d\mathcal{E}_t}\right\}}_{\mathcal{R}_{\mathcal{E}_t}} = 0$$

If $\eta_t^E > 0$, the hegemon has an incentive to appreciate the exchange rate (higher interest rates) so that households delay consumption to the future. Since policy is set with commitment this is anticipated. Households at t expecting an appreciation at time $t+1$, would instead increase their consumption and borrowing.

D Further Derivations for Section 5 : Limited Financial Market Participation

Proof to Proposition 4.

Consider the market clearing equation (9) with $C_{H,t} = \mathbf{a}_t C_{H,t}^A + (1-\mathbf{a}_t) C_{H,t}^{NA}$. Assume equal rationing of goods' firm profits, employment and lump-sum taxes such that $\Pi^g, i = \Pi$, $L^i = L$ but assume that financiers profits accrue fully to active households. We can express inactive households' consumption by,

$$C_{F,t}^{NA} \leq \frac{\mathbf{a}_t \chi}{1-(1-\mathbf{a}_t)\chi} \mathcal{E}_t^\lambda C_{F,t}^A + \frac{1-\chi}{1-(1-\mathbf{a}_t)\chi} \left(\zeta \mathcal{E}_t^\eta \overline{P}_H^{1-\eta}\right) \tag{71}$$

Similarly, evaluating the budget constraint (92) for active households' and substituting (9) yields,

$$\mathcal{E}_t^\lambda C_{F,t}^A \left(1 + \frac{\chi}{1-\chi}(1-\mathbf{a}_t\right) \leq (1-\mathbf{a}_t)\frac{\chi}{1-\chi} \mathcal{E}_t^\lambda C_{F,t}^{NA} + \zeta \mathcal{E}_t^\eta \overline{P}_H^{1-\eta} + F_t, \tag{72}$$

where,

$$F_t = x_t - a_t^F - R_{t-1}(x_{t-1} - a_{t-1}^F) - \Gamma_{t-1} Q_{t-1} a_{t-1}^F - R^* \tfrac{\mathbb{E}_{t-1}[\mathcal{E}_t] - \mathcal{E}_t}{\mathcal{E}_{t-1}} a_{t-1}^F + \omega \Gamma_t Q_t^2$$

Solving (71) and (72) jointly yields :

$$C_{F,t}^A \leq \mathcal{E}_t^{-\lambda} \left[\zeta \mathcal{E}_t^\eta \overline{P}_H^{1-\eta} + (1-(1-\alpha)\chi) F_t\right], \tag{73}$$

as detailed in (40). Substituting back into (71) yields:

$$C_{F,t}^{NA} \leq \mathcal{E}_t^{-\lambda} \left[\zeta \mathcal{E}_t^\eta \overline{P}_H^{1-\eta} + \alpha \chi F_t\right], \tag{74}$$

The total private portfolio return is given by $[\mathbf{a}_t(1-(1-\mathbf{a}_t)\chi)+(1-\mathbf{a}_t)\mathbf{a}_t\chi]F_t = \mathbf{a}_tF_t$ and total export revenues are given by $(\mathbf{a}_t + (1-\mathbf{a}_t))\zeta\mathcal{E}_t^{-\eta}\overline{P}_H^{1-\eta} = \zeta\mathcal{E}_t^{-\eta}\overline{P}_H^{1-\eta}$. □

With limited financial market participation, the indirect utility function for the hegemon planner is given by,

$$V\left(C_{F,t}^A, C_{F,t}^{NA}, \mathcal{E}_t; \boldsymbol{\lambda}, \mathbf{a}_t\right) = \mathbf{a}_t\lambda^A\,\mathcal{U}\left(\frac{\chi}{1-\chi}\frac{P_{F,t}^*\mathcal{E}_t^\lambda}{P_{H,t}}C_{F,t}^A, C_{F,t}^A, L_t\right) + (1-\mathbf{a}_t)\lambda^{NA}\mathcal{U}\left(\frac{\chi}{1-\chi}\frac{P_{F,t}^*\mathcal{E}_t^\lambda}{P_{H,t}}C_{F,t}^{NA}, C_{F,t}^{NA}, L_t\right) \tag{75}$$

where $\boldsymbol{\lambda} = [\lambda^A, \lambda^{NA}]$ are the Pareto weights the planner attaches to A and NA households respectively and satisfy $\mathbf{a}_t\lambda^A + (1-\mathbf{a}_t)\lambda^{NA} = 1$. Moreover, $C_{F,t}^A$ is given by (72), $C_{F,t}^{NA}$ is given by (74) and $L_t^A = L_t^{NA}$ is given by market clearing and $L_t = Y_t/A_t$. The partial derivatives of the indirect utility function with respect to $C_{F,t}^A$, $C_{F,t}^{NA}$ and $\mathcal{E}_t$ are given,respectively, by:

$$V_{C_{F,t}^A} = \alpha\lambda^A\frac{1-\chi}{C_{F,t}^A}\left(1+\frac{\chi}{1-\chi}\tau_t^A\right), \tag{76}$$

$$V_{C_{F,t}^{NA}} = (1-\alpha)\lambda^A\frac{1-\chi}{C_{F,t}^{NA}}\left(1+\frac{\chi}{1-\chi}\tau_t^{NA}\right), \tag{77}$$

$$\begin{aligned}V_{\mathcal{E}_t}(C_{F,t}, \mathcal{E}_t; \mathbf{a}_t) = \ & \mathbf{a}_t\lambda^A\ \frac{1-\chi}{C_{F,t}^A}\Bigg\{\frac{\chi}{1-\chi}C_{F,t}^A\lambda\mathcal{E}_t^{-1} + \\ & (\tau_t^A - 1)\left(\frac{\chi}{1-\chi}\lambda\mathcal{E}_t^{-1}[\mathbf{a}_tC_{F,t}^A + (1-\mathbf{a}_t)C_{F,t}^{NA}] + \zeta\eta\mathcal{E}_t^{\eta-\lambda-1}\right)\Bigg\} \\ & (1-\mathbf{a}_t)\lambda^{NA}\ \frac{1-\chi}{C_{F,t}^{NA}}\Bigg\{\frac{\chi}{1-\chi}C_{F,t}^A\lambda\mathcal{E}_t^{-1} + \\ & (\tau_t^{NA} - 1)\left(\frac{\chi}{1-\chi}\lambda\mathcal{E}_t^{-1}[\mathbf{a}_tC_{F,t}^A + (1-\mathbf{a}_t)C_{F,t}^{NA}] + \zeta\eta\mathcal{E}_t^{\eta-\lambda-1}\right)\Bigg\}\end{aligned} \tag{78}$$

With limited financial market participation, the interest rate reflects the marginal rate of substitution for A households only, see (38)) Therefore, the condition characterising unresponsive monetary policy is given by,

$$P_{F,t}^*\mathcal{E}_t^\lambda C_{F,t}^A = \mu_t(1-\chi), \tag{79}$$

where μ is a synthetic monetary instrument. If μ_t/μ_{t+1} is constant, $R_t = \frac{1}{\beta}$.

The hegemon planner now maximizes (75) subject to (72) and (74). I assume $\mathbf{a}_t = \mathbf{a}$ and I attach multipliers η_t^A and η_t^{NA} to (72) and (74) respectively. The optimal allocation is characterized by the following first order conditions:

$$C_{F,t}^{A}: \qquad V_{C_{F,t}} - \mathbf{a}\eta_t^A - \eta_t^\mu + \mathbf{a}\frac{1}{\mathcal{E}_t^\lambda C_{F,t}^2}\left[\eta_t^E - R_{t-1}\eta_{t-1}^E\right] = 0, \tag{80}$$

$$C_{F,t}^{NA}: \qquad V_{C_{F,t}^{NA}} - (1-\mathbf{a})\eta_t^{NA} = 0, \tag{81}$$

$$\begin{aligned}
\mathcal{E}_t: \qquad & V_{\mathcal{E}_t} + [\mathbf{a}\eta_t^A + (1-\mathbf{a})\eta_t^{NA}]\zeta(\eta-\lambda)\mathcal{E}_t^{\eta-\lambda-1}\overline{P}_H^{1-\eta} + \\
& [\mathbf{a}\eta_t^A(1-(1-\mathbf{a})\chi) + (1-\mathbf{a})\eta_t^{NA}\mathbf{a}\chi]\Big\{ -\lambda\mathcal{E}_t^{-\lambda-1}(x_t - a_t^F) - (1-\lambda)\frac{R^*\mathcal{E}_t^{-\lambda}}{\mathcal{E}_{t-1}}(x_{t-1} - a_{t-1}^F) + \\
& \lambda\mathcal{E}_t^{-\lambda-1}\Gamma_{t-1}Q_{t-1}(x_{t-1})\Big\} + \beta[\mathbf{a}\eta_{t+1}^A(1-(1-\mathbf{a})\chi) + (1-\mathbf{a})\eta_{t+1}^{NA}\mathbf{a}\chi]\left\{\frac{R^*\mathcal{E}_{t+1}^{1-\lambda}}{\mathcal{E}_t^2}(x_t - a_t^F)\right\} + \\
& \mathbf{a}\eta_t^E\left\{\frac{1}{C_{F,t}^A}\lambda\mathcal{E}_t^{-\lambda-1} - \frac{1}{C_{F,t+1}^A}\beta R^*\frac{\mathcal{E}_{t+1}^{1-\lambda}}{\mathcal{E}_t^2}\right\} + \mathbf{a}\eta_{t-1}^E\frac{1}{C_{F,t}^A}\left\{(1-\lambda)\frac{\mathcal{E}_t^{-\lambda}}{\mathcal{E}_{t-1}} - \lambda\mathcal{E}_t^{-\lambda-1}\Gamma_{t-1}Q_{t-1}\right\} \\
& - \eta_t^\mu\lambda\mathcal{E}_t^{-\lambda-1}\mu(1-\chi) = 0,
\end{aligned} \tag{82}$$

$$\begin{aligned}
x_t: \qquad & [\mathbf{a}\eta_t^A(1-(1-\mathbf{a})\chi) + (1-\mathbf{a})\eta_t^{NA}\mathbf{a}\chi)]\mathcal{E}_t^{-\lambda} - \\
& \beta[\mathbf{a}\eta_{t+1}^A(1-(1-\mathbf{a})\chi) + (1-\mathbf{a})\eta_{t+1}^{NA}\mathbf{a}\chi)]\mathcal{E}_{t+1}^{-\lambda}\left[R_t + \mathbf{a}\Gamma_t(x_t - a_t^F) - 2\omega\mathbf{a}\Gamma_t Q_t\right] + \\
& + \mathbf{a}\eta_t^E\left\{\mathbf{a}\Gamma_t\frac{1}{\mathcal{E}_{t+1}^\lambda C_{F,t+1}^A}\right\} = 0
\end{aligned} \tag{83}$$

E Generalizing preferences

In this subsection, I consider the generalisation of the model beyond the Cole-Obstfeld (C-O) specification, specifically allowing for $\sigma \neq 1$, such that a movement in R_t has an effect on households' borrowing decisions x_t. For completeness, I present the indirect utility function and its derivatives for general σ and θ, and then specify $\theta = 1$. I focus on this case because it retains the tractability of the C-O parameterization.[54]

The indirect utility function is given by:

$$\begin{aligned}
V(C_{F,t},\mathcal{E}_t) = \frac{1}{1-\sigma}&\left(\left[\chi^{\frac{1}{\theta}}\left(\frac{\chi}{1-\chi}\left(\frac{P_{F,t}^*\mathcal{E}_t^\lambda}{P_{H,t}}\right)^\theta C_{F,t}\right)^{\frac{\theta-1}{\theta}} + (1-\chi)^{\frac{1}{\theta}}C_{F,t}^{\frac{\theta-1}{\theta}}\right]^{\frac{\theta}{\theta-1}}\right)^{1-\sigma} \\
&-\kappa\frac{1}{1+\psi}\left[\left(\frac{\chi}{1-\chi}\left(\frac{P_{F,t}^*\mathcal{E}_t^\lambda}{P_{H,t}}\right)^\theta C_{F,t}\right) + \zeta\left(\frac{\mathcal{E}_t}{P_{H,t}}\right)^\eta\right]^{1+\psi}
\end{aligned} \tag{84}$$

[54] In the job market version of this paper, I explore the case of $\theta \neq 1$ as well, but qualitatively, the results are unchanged.

The partial derivatives with respect to $C_{F,t}$ and $\mathcal{E}_t$ are given as follows:

$$V_{C_{F,t}} = C_t^{\frac{1-\theta\sigma}{\theta}} \left\{ \chi^{\frac{1}{\theta}} \left[\frac{\chi}{1-\chi} \left(\frac{P^*_{F,t}\mathcal{E}_t^\lambda}{P_{H,t}} \right)^\theta \right] C_{H,t}^{\frac{-1}{\theta}} + (1-\chi)^{\frac{1}{\theta}} C_{F,t}^{\frac{-1}{\theta}} \right\} - \kappa L_t^\psi \frac{\chi}{1-\chi} \left(\frac{P^*_{F,t}\mathcal{E}_t^\lambda}{P_{H,t}} \right)^{\frac{1}{\theta}}, \tag{85}$$

$$V_{\mathcal{E}_t} = C_t^{\frac{1-\theta\sigma}{\theta}} \left\{ \chi^{\frac{1}{\theta}} C_{H,t}^{\frac{-1}{\theta}} \left(\frac{P^*_{F,t}\mathcal{E}_t^\lambda}{P_{H,t}} \right)^{\frac{1-\theta}{\theta}} \lambda \mathcal{E}_t^{\lambda-1} \frac{1}{P_{H,t}} C_{F,t} \right\} - \tag{86}$$

$$\kappa L_t^\psi \left\{ \frac{\chi}{1-\chi} \left(\frac{P^*_{F,t}\mathcal{E}_t^\lambda}{P_{H,t}} \right)^{\frac{1-\theta}{\theta}} \lambda \mathcal{E}_t^{\lambda-1} \frac{1}{P_{H,t}} C_{F,t} + \zeta\eta \left(\frac{\mathcal{E}_t}{P_{H,t}} \right)^{\eta-1} \right\}$$

Focusing on $\theta = 1$, the implementability condition is still given by (22), but the Euler equation becomes:

$$\frac{1}{P_t C_t^\sigma} = \beta R_t \frac{1}{\mathbb{E}_t[P_{t+1} C_{t+1}^\sigma]}, \tag{87}$$

where $P_t = \chi^{-\chi}(1-\chi)^{\chi-1} \overline{P}_H^\chi \mathcal{E}_t^{\lambda(1-\chi)}$. The Euler condition can be re-expressed as:

$$\frac{1}{\mathcal{E}_t^{\lambda(1-\chi+\chi\sigma)} C_{F,t}^\sigma} = \beta R_t \frac{1}{\mathbb{E}_t \left[\mathcal{E}_{t+1}^{\lambda(1-\chi+\chi\sigma)} C_{F,t+1}^\sigma \right]}, \tag{88}$$

If $R = R_t$, I additionally attach the constraint $\mathcal{E}_t^\lambda C_{F,t}^\sigma = \mu(1-\chi)$.

The first order conditions associated with the planning problem are given by:

$$C_{F,t}: \qquad V_{C_{F,t}} - \eta_t^C - \eta_t^\mu + [\mathcal{E}_t^{\lambda(1-\chi+\chi\sigma)} C_{F,t}^\sigma)]^{-2} \sigma C_{F,t}^{\sigma-1} \left[\eta_t^E - R_{t-1}\eta_{t-1}^E\right] = 0, \tag{89}$$

$$\begin{aligned}
\mathcal{E}_t: \qquad & V_{\mathcal{E}_t} + \eta_t^C \zeta(\eta-\lambda)\mathcal{E}_t^{\eta-\lambda-1}\overline{P}_H^{1-\eta} + \\
&\eta_t^C \left\{ -\lambda\mathcal{E}_t^{-\lambda-1}(x_t - a_t^F) - (1-\lambda)\frac{R^*\mathcal{E}_t^{-\lambda}}{\mathcal{E}_{t-1}}(x_{t-1} - a_{t-1}^F) + \lambda\mathcal{E}_t^{-\lambda-1}\Gamma_{t-1}Q_{t-1}(x_{t-1}) \right\} \\
&+ \beta\eta_{t+1}^C \left\{ \frac{R^*\mathcal{E}_{t+1}^{1-\lambda}}{\mathcal{E}_t^2}(x_t - a_t^F) \right\} \\
&+ \eta_t^E \left\{ \frac{1}{C_{F,t}^\sigma}\lambda(1-\chi+\chi\sigma)\mathcal{E}_t^{-\lambda(1-\chi+\chi\sigma)-1} - \frac{1}{C_{F,t+1}^\sigma}\beta R^* \frac{\mathcal{E}_{t+1}^{1-\lambda(1-\chi+\chi\sigma)}}{\mathcal{E}_t^2} \right\} + \\
&\eta_{t-1}^E \frac{1}{C_{F,t}^\sigma} \left\{ (1-\lambda(1-\chi+\chi\sigma))R^* \frac{\mathcal{E}_t^{-\lambda(1-\chi+\chi\sigma)}}{\mathcal{E}_{t-1}} - \lambda(1-\chi+\chi\sigma)\mathcal{E}_t^{-\lambda(1-\chi+\chi\sigma)-1}\Gamma_{t-1}Q_{t-1} \right\} \\
&- \eta_t^\mu \lambda \mathcal{E}_t^{-\lambda-1}\mu(1-\chi) = 0,
\end{aligned} \tag{90}$$

$$x_t: \qquad \eta_t^C \mathcal{E}_t^{-\lambda} - \beta\eta_{t+1}^C \mathcal{E}_{t+1}^{-\lambda}\left[R_t + \Gamma_t(x_t + B_t) - 2\omega\Gamma_t Q_t\right] + \eta_t^E \beta\Gamma_t \frac{1}{\mathcal{E}_{t+1}^{\lambda(1-\chi+\chi\sigma)} C_{F,t+1}^\sigma} = 0 \tag{91}$$

All the expression in this section coincide with the main body counterparts in the limit $\sigma, \theta \to 1$. The expressions for the $\mathbf{a} < 1$ case follow from expanding on the relevant conditions in Appendix D.

Monetary policy stabilization when $\sigma \neq 1$. Figure 15 below plots the effect of a one period increase in interest rates for stabilization when $\sigma = \{0.5, 1, 2\}$. Specifically, this section mirrors the findings in Bianchi and Coulibaly (2021) that for $\sigma < \theta$, contractionary monetary policy can contribute to a reduction in borrowing and address the over-borrowing externality which arises when ξ_t rises. Instead, borrowing rises in response to $R \uparrow$ if $\sigma > \theta$ and is unresponsive at $\sigma = \theta = \eta = 1$.

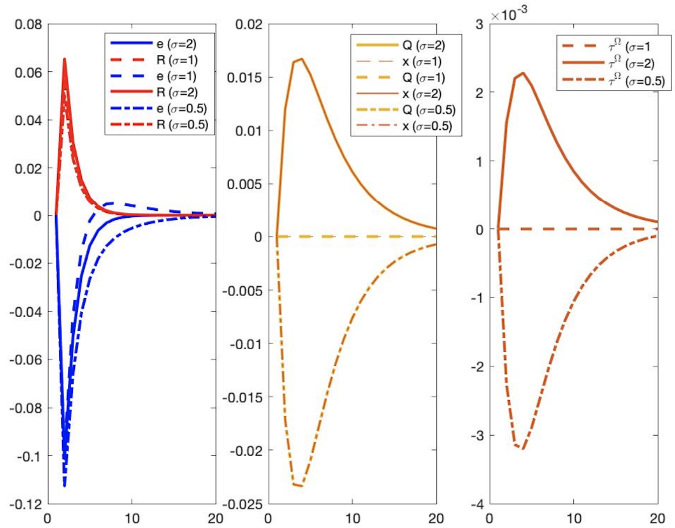


Figure 15: Impulse response to a monetary policy shock (decrease in μ) . Variables plotted as deviations from steady state. Parametrization as in 2 except $\eta = 1, \bar{\xi} = a^F = 0$, and variable σ.

F Further Results for Calibration Exercise

The table below details the parametrization used in Section 5.

Parameter	**Value**	**Description**	Target
$\beta = \beta^*$	0.99	Discount factor, quarterly calibration	4% annual interest
σ	1	Coefficient of relative of risk aversion	
θ	1	Macro elasticity of substitution	
ψ	2.5	Frisch elasticity of labour supply	standard
ζ	0.37	Size of foreign economy	Normalisation
η	2.5	Elasticity of export demand	standard
κ	6	Disutility from labour	standard
$P_F^* = 1$	1	Price of foreign goods	Normalisation
ω	0	Home ownership of financiers	
χ	0.85	Share of Home goods	$\frac{C_H^*}{Y} = 15\%$ BEA data
λ	0.2	Pass-through for U.S. imports	Matarazzi et al. (2019)
λ^*	1	DCP	
$\bar{\Gamma}$	0.14	Elasticity of financiers' demand	$\frac{d\mathcal{E}}{dQ} \approx 2$
$\bar{\xi}$	10	Steady state dollar demand	Gross ext. debt (100% GDP)
a^F	10	Steady state FC assets	Gross ext. assets (100% GDP)
α	0.3	Share of inactive households	Survey Cons. Finances

Table 2: Benchmark Model Calibration.

Figure 16 below shows that NA households experience worse outcomes than A households following an increase in xi. Specifically, since by assumption, $L_t^A = L_t^{NA}$, a higher τ_t^{NA} reflects lower NA consumption. The aggregate labour wedge in Figure 5 is calculated as $\tau_t = \mathbf{a}\tau_t^A +$

$(1-\mathbf{a})\tau_t^{NA}$.

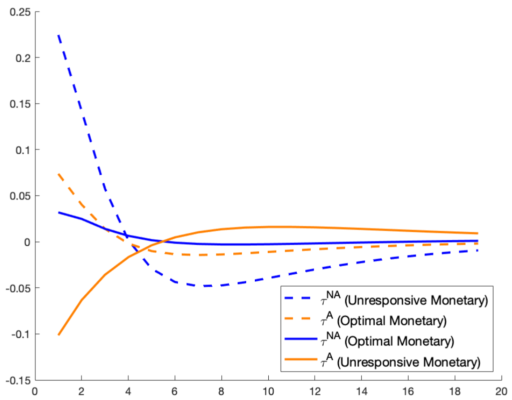


Figure 16: Impulse response to dollar demand shock ξ_t. Labour wedge deviations.

G Extensions

Firesales. Consider an extension of the model where there is a haircut $\phi(\Gamma)$ on foreign asset returns. Assuming $\mathbf{a} = 1$, the budget constraint for hegemon households is given by,

$$\begin{aligned} & P_{F,t}C_{F,t} + P_{H,t}C_{H,t} \leq \Pi_t + W_t L_t + \\ & x_t - R_{t-1}x_{t-1} - a^F_t + R^*_{t-1}(1 - \phi(\Gamma_{t-1}))\frac{\mathcal{E}_t}{\mathcal{E}_{t-1}} a^F_{t-1} \end{aligned} \tag{92}$$

The optimality condition for dollar swap lines, replacing (55) in the main body, is given by:

$$\underbrace{-\eta^C_{t+1}\mathcal{E}_t^{-\lambda}\{Q_t x_t + \omega Q_t^2\}}_{\text{cost of foregone issuance rents}} \; \underbrace{-R^* \frac{\mathcal{E}_{t+1}}{\mathcal{E}_t}\frac{d\phi(\Gamma_t)}{d\Gamma_t} a^F_{t-1}}_{\text{gains from improved } a^F \text{ returns}} = - \underbrace{\eta^E_t \frac{1}{\mathcal{E}^\lambda_{t+1} C_{F,t+1}} Q_t}_{\text{cost of over-borrowing}} \tag{93}$$

When the hegemon levies the optimal macroprudential tax, $\eta^E_t = 0$. However, when $\frac{d\phi(\Gamma_t)}{d\Gamma_t} > 0$, dollar swaps can be desirable as the hegemon trades off foregone monopoly rents against improved returns on foreign assets.

Productivity Shocks Figure 17 below plots the impulse response to a negative productivity shock, contrasting the $\sigma = 1$ and $\sigma = 2$ allocations. As is standard, following a negative productivity shock, monetary policy raises interest rates leading to an appreciation. When $\sigma > \theta$, this leads to increased borrowing due to an income effect. This in turn increases the supply of dollars in foreign markets, eroding the hegemon's monopoly rents.

The right panel illustrates the effect of dollar swaps on the issuance wedge τ^Ω. Extending dollar swaps is analogous to considering a lower Γ and this narrows the issuance wedge. Since the issuance wedge weighs negatively on welfare, dollar swaps promote efficient stabilization, alongside monetary policy.

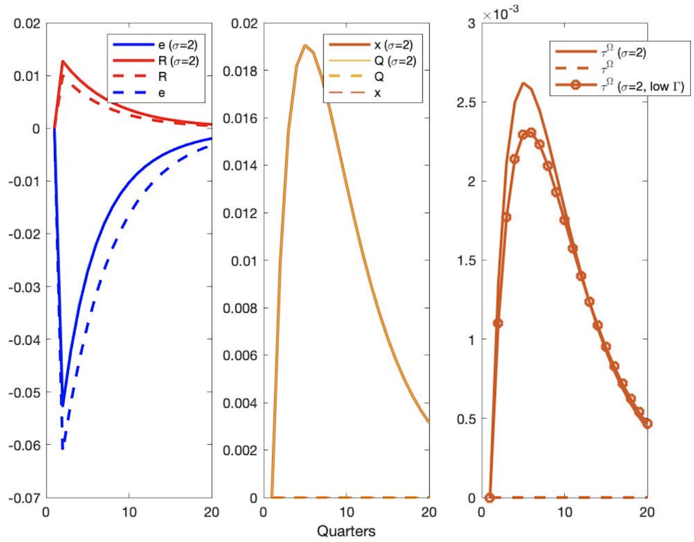


Figure 17: Impulse response to a 10% fall in A_t. Variables plotted as deviations from steady state. The dashed line assumes the standard parameters above, zero steady state gross positions, and $\sigma = \theta = \zeta = 1$. The solid line considers $\sigma = 2$ and the solid line with rivets in the right panel considers $\Gamma = 0.1$ (as opposed to $\Gamma = 0.14$).