



BANK FOR INTERNATIONAL SETTLEMENTS



BIS Working Papers No 783

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Monetary and Economic Department

May 2019

JEL classification: E44, E52, F33, F34, F41, F42, F44, G01, G15, G32

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ISSN 1020-0959 (print)
ISSN 1682-7678 (online)

Dominant Currency Debt *

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This version: May 13, 2019

Abstract

We propose a “debt view” to explain the dominant international role of the dollar. We develop an international general equilibrium model in which firms optimally choose the currency composition of their nominal debt. Expansionary monetary policy in downturns prevents Fisherian debt deflation through its effects on inflation and exchange rates, and alleviates financial distress. Theoretically, the dominant currency is the one that depreciates in global downturns over horizons of corporate debt maturity. Empirically, the dollar fits this description, despite being a short-run safe-haven currency. We provide broad empirical support for the debt view. We also study the globally optimal monetary policy.

Keywords: Dollar debt, dominant currency, exchange rates, inflation, debt deflation

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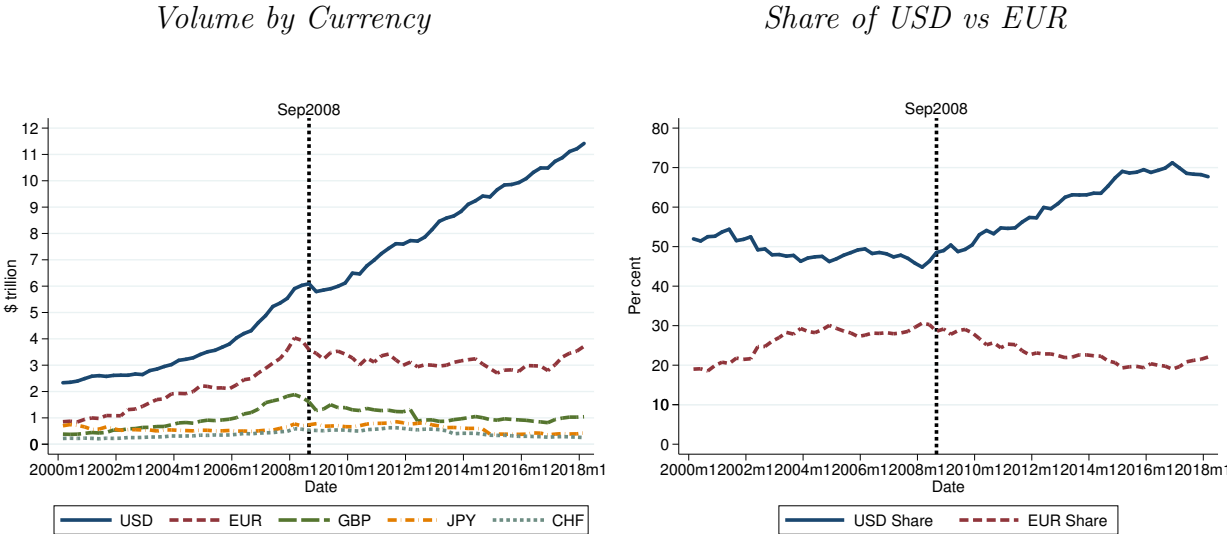
*First Version: August 16, 2018. We thank Stefan Avdjiev, Ryan Banerjee, Claudio Borio, Stijn Claessens, Giancarlo Corsetti, Husnu Dalgic (discussant), Kent Daniel, Darrell Duffie, Linda Goldberg, Gita Gopinath, Yuriy Gorodnichenko, Bryan Hardy, Harald Hau, Oleg Itkhoki, Sebnem Kalemli-Ozcan, Karen Lewis, Xu Lu, Matteo Maggiori, Emile Marin (discussant), Arnaud Mehl, Erwan Morellec, Dmitry Mukhin (discussant), Brent Neiman, Monika Piazzesi, Hélène Rey, Andreas Schrimpf, Amit Seru, Hyun Song Shin, Alp Simsek, Jeremy Stein, Michael Weber and seminar participants at the NBER IFM, CEPR ESSIM, Joint BIS-BoE-ECB-IMF Workshop, BIS, U. Zurich, EPFL, and ECB for helpful comments. Zuzana Filkova and Nicolas Lemerrier provided excellent research assistance. Semyon Malamud acknowledges the financial support of the Swiss National Science Foundation (Starting Grant “Liquidity”) and the Swiss Finance Institute. Parts of this paper were written when Malamud visited the BIS as a research fellow. The views in this article are those of the authors and do not necessarily represent those of the BIS. All errors are our own.

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The dollar is the most common currency of choice for debt contracts worldwide. According to the Bank for International Settlements, the dollar-denominated credit to non-banks outside the United States amounts to around \$11.5 trillion. While the dominance of the dollar had declined prior to 2008, the dollar has strengthened its international role since the Global Financial Crisis (Figure 1).¹

Figure 1: Currency Denomination of Foreign Currency Non-Bank Debt



Source: Bank for International Settlements (see BIS (2018) for details.)

In this paper, we study how a single currency can become the most common currency of choice for denominating debt contracts in general equilibrium, i.e. *the dominant currency*, why that choice is the dollar, and why the dominance of the dollar may have declined and recovered in the last two decades.

We develop an international general equilibrium model with multiple countries where firms optimally choose the currency composition of their debt. All firms are exporters, prices are flexible, and the firms have fully diversified cash flows. Firms issue equity and

¹Similar patterns were previously documented for debt issuance (see, for example, ECB (2017), Maggiori, Neiman and Schreger (2018), Aldasoro and Ehlers (2018)), and for global cross-border bond holdings (Maggiori, Neiman and Schreger (2018)), as well as for other parts of the global financial system (Maggiori, Neiman and Schreger (2019)).

nominal, defaultable debt to optimize the trade-off between tax benefits of debt and the risk of default. Debt can potentially be issued in any currency. Since debt is nominal, exchange rate movements affect their real debt burdens. When debt servicing costs are high relative to profits, firms face debt overhang. They cut production and reduce demand for their intermediate inputs imported from other countries. This global debt overhang channel spreads debt overhang costs along the global value chain and serves as a key mechanism for international spillovers.

Expansionary monetary policy in downturns prevents Fisherian debt deflation through its effect on inflation and exchange rates. We model a central bank policy as a countercyclical monetary policy rule that attempts to ease financing conditions for firms in times when output gap is high due to inefficient production with debt overhang. Central banks differ from each other in their willingness and ability to pursue inflation stabilization policies that protect borrowers and real debt burdens.² In the model, relative inflation between two countries determines the exchange rates via a relative purchasing power parity (PPP) condition where higher inflation leads to exchange rate depreciation.³

Our first main result is the existence of a *dominant currency debt equilibrium* defined as an equilibrium in which a single common currency is chosen as the currency for denominating all outstanding debt contracts, even though there may be other currencies with almost identical characteristics. Theoretically, the dominant currency is the one that depreciates in global downturns *over the horizons of corporate debt maturity*, which is typically around seven years.⁴ When an adverse shock hits, the risk of default is minimal if debt is issued in currencies that co-move positively with firms' discounted profits. When profits drop, such

²Our results can be interpreted either as central banks pursuing policies to generate higher inflation or avoiding downward inflation surprises in a downturn. Both operate similarly in the model, but due to central bank mandates and inflation targets, we favor the latter explanation and hence refer to these policies as inflation stabilization policies.

³See, for example, [Imbs, Mumtaz, Ravn and Rey \(2005\)](#), [Chowdhry, Roll and Xia \(2005\)](#) for evidence in favor of the relative PPP.

⁴See [section 5](#) and also [Cortina, Didier and Schmukler \(2018\)](#) for typical corporate debt maturities.

currencies tend to depreciate as well, thereby reducing these firms' debt service costs and alleviating financial distress.⁵

Empirically, the dollar fits the theoretical description of the dominant currency. We show that the dollar robustly depreciates during stock market downturns on horizons that accord with typical duration of corporate liabilities. Since typical corporate debt maturity is around seven years, the risk profile of the dollar over the medium run determines its use for the denomination of corporate debt. As a result, even though the dollar does co-move negatively with the stock markets for shorter horizons up to a year (i.e. it is a safe haven currency), this is less relevant for the choice of currency denomination of corporate debt.⁶

This pattern of the correlations between the dollar and the stock market has direct implications for the maturity choices of firms for dollar-denominated debt contracts. As the dollar co-movement with the stock market increases over longer horizons, our model predicts that the propensity to issue dollar-denominated debt increases with debt maturity. We use granular bond issuance data to formally test this prediction, and find strong support.

In our model, expectations of firms about the ability of a central bank to pursue inflation stabilization policies in global downturns impact the currency denomination choice of debt contracts to the extent that they affect exchange rates.⁷ While expectations about such counter-cyclical inflation policies are not directly observable, they can be backed out from the inflation risk premium (IRP). In fact, our model predicts that in the dominant currency debt equilibrium, the dominant currency is always the currency with the highest IRP.

We formally test our theoretical prediction about the link between the share of dollar-

⁵We proxy for the discounted profits with the stock market value in the empirical section.

⁶In this paper, we focus on the choices of corporates and hence the medium run risk properties of the dollar, and abstract from frictions that households face. However, one can argue that in a more realistic model with more frictions and differences in relevant horizons between households and firms, the short-run appreciation in bad times provides insurance to investors with shorter horizons and safety demand, and the medium-run depreciation of the dollar provides insurance to corporates with longer maturity nominal debt, thereby reinforcing the dominant international role of the dollar.

⁷The importance of accommodative monetary policy in helping reduce real debt burdens of firms and the differences across central banks in accomplishing this goal is also acknowledged by the European Central Bank (ECB). See, for example, [Praet \(2016\)](#) and [Cœuré \(2019\)](#).

and euro-denominated debt and inflation expectations, as captured by the IRP. We find that the dynamics of IRP in the United States and the Eurozone explains a large part of the variation in the share of dollar debt with the signs of the regression coefficients consistent with our theory, even at a quarterly frequency. We interpret this fact as strong evidence of a distinctive prediction of our theory: Changes to the currency composition of debt can occur in high frequency.

We provide additional broad empirical evidence in favor of the debt view. We show that the risk properties of currencies discussed in this paper shed light on patterns of debt issuance in other major currencies, such as the pound and the yen, as well as the dynamics of the shares of dollar- and pound-denominated debt during the interwar years as documented by [Chițu, Eichengreen and Mehl \(2014\)](#). We further show that an extension of our basic model can also be used to explain the distribution of local currency and dominant currency mix of corporate debt for a cross-section of emerging market economies.

Finally, our general equilibrium framework allows us to discuss the macroeconomic and monetary policy implications of a dominant currency debt equilibrium. We run the following thought experiment: In the dominant currency debt equilibrium, with firms around the entire world issuing dominant currency debt, how should the dominant currency central bank assign weights to the output gaps of each country to maximize the global welfare? We derive the optimal weights analytically and show that they are *lower* for countries with volatile TFP shocks, high debt restructuring costs and for those countries that are more important in world trade. Limiting the insurance given to those countries reduces the leverage of firms in these countries, thereby improving global (and domestic) welfare.

Related literature. The international role of the dollar has received a lot of attention in the recent literature. The dollar is omnipresent in all parts of the global financial system, including international trade invoicing (see [Goldberg and Tille \(2008\)](#), [Gopinath \(2015\)](#), [Casas, Díez, Gopinath and Gourinchas \(2017\)](#)); global banking ([Shin \(2012\)](#), [Ivashina, Scharfstein](#)

and Stein (2015), Aldasoro, Ehlers and Eren (2018)); corporate borrowing (Bruno, Kim and Shin (2018), Bruno and Shin (2017)); central bank reserve holdings (Bocola and Lorenzoni (2018)); and global portfolios (Maggiore, Neiman and Schreger (2018)). Our paper adds to the growing literature that studies the dominant role of the dollar in a general equilibrium framework.⁸

Our main contribution is the introduction of the “debt view” in explaining the international role of the dollar. Current explanations can be broadly classified into three categories. First is “the trade view,” wherein trade invoicing in dollars is the reason for the dollar’s role in the global economy (see, for example, Gopinath and Stein (2018)). Second is “the safe asset view,” in which the dollar is dominant because of its safe haven properties (see, for example, He, Krishnamurthy and Milbradt (2019), Farhi and Maggiore (2018)). Third is the “vehicle currency view,” wherein the dominance of the dollar arises from its international use as a vehicle currency (see for example Goldberg and Tille (2008)).

The debt view of the dollar’s dominance assigns an important role to the choice of debt currency denomination of firms, monetary policy and exchange rates.⁹ The debt view focuses on the medium run to account for typical corporate debt maturity, and in that complements other theories which focus on the short run frictions such as price stickiness, or the short-run appreciation of the dollar in bad times as an insurance to investors. In contrast to other theories, we show that a dominant currency equilibrium can arise without relying on network effects, price stickiness, pricing complementarities and safety demand.

The most closely related paper to ours is by Gopinath and Stein (2018), which demonstrates how the dollar can emerge as a key international currency starting from its role in trade invoicing and in turn affecting global banking, which in turn affects currency

⁸For example, Matsuyama, Kiyotaki and Matsui (1993), Rey (2001), Caballero, Farhi and Gourinchas (2008), Caballero and Krishnamurthy (2009), Devereux and Shi (2013), Chahrour and Valchev (2017), Mukhin (2017), Farhi and Maggiore (2018), He, Krishnamurthy and Milbradt (2019), Bocola and Lorenzoni (2017), Drenik, Kirpalani and Perez (2018) and Jiang, Krishnamurthy and Lustig (2018).

⁹The main mechanism in our model is similar to the one in Gomes, Jermann and Schmid (2016); however, in an international setting.

denomination of bank deposits and firm borrowing endogenously. In our setup, dollar’s dominance arises from debt currency choice of firms. In their paper, the dollar’s role for denominating debt depends on its role in trade invoicing. In our paper, it depends on the risk properties of the dollar compared to other currencies.

A growing literature studies reasons for persistent uncovered interest rate parity (UIP) violations and its implications for the foreign currency borrowing of emerging market firms (see, for example, [Hassan \(2013\)](#), [Baskaya, di Giovanni, Kalemli-Ozcan and Ulu \(2017\)](#) and [Salomao and Varela \(2018\)](#)). Our primary interest lies in understanding why it is the dollar that is the “dominant foreign currency” as opposed to similar currencies with similarly deep and liquid markets, such as the euro. Thus, we abstract from many features of currencies that lead to UIP deviations in reality to clearly highlight our main mechanism, even though it would be possible to capture these in reduced form, through differential issuance costs. That said, in [section 6](#), we provide theoretical and empirical results for the dominant and local currency mix in the debt of a cross-section of emerging market firms which depends on the properties of local inflation and its relation to the US inflation that could inform this literature.

Numerous papers in international macroeconomics study how the exchange rate pass-through into prices of real goods depends on price stickiness and the invoicing currency choice.¹⁰ We highlight a novel pass-through mechanism that operates through the financial channel. With dollar debt, a dollar appreciation shock puts leveraged firms in distress and increases their effective operational costs. Firms respond to this circumstance by raising prices, consistent with the mechanism highlighted in [Gilchrist, Schoenle, Sim and Zakrajšek \(2017\)](#) and [Malamud and Zucchi \(2018\)](#). Importantly, this pass-through channel operates even when prices are fully flexible.

¹⁰(see, for example, [Engel \(2006\)](#), [Gopinath, Itskhoki and Rigobon \(2010\)](#), [Goldberg and Tille \(2013\)](#), [Corsetti and Pesenti \(2015\)](#) and [Casas, Díez, Gopinath and Gourinchas \(2017\)](#)).

1 Model: Main mechanisms and general equilibrium

1.1 Households and exchange rates

Time is discrete, indexed by $t = 0, 1, \dots$. There are N countries, indexed by $i = 1, \dots, N$. Households work and consume. They maximize

$$E \left[\sum_{t=0}^{\infty} e^{-\beta t} U(C_{i,t}, N_{i,t}) \right]$$

with

$$U(C_{i,t}, N_{i,t}) = \frac{C_{i,t}^{1-\gamma}}{1-\gamma} - \nu N_{i,t}$$

for some $\gamma \geq 2$,¹¹ where $N_{i,t}$ is the number of hours worked,¹² and

$$C_{i,t} = \left(\sum_j \int_0^1 (\tilde{C}_{i,t}(j, \omega))^{\frac{\eta-1}{\eta}} d\omega \right)^{\frac{\eta}{\eta-1}}$$

is the constant elasticity of substitution (CES) consumption aggregator, with the elasticity of substitution η . Here, $\tilde{C}_{i,t}(j, \omega)$ denotes the consumption of type- ω goods imported from country j into country i , with $\omega \in [0, 1]$.

The price at which country j firms sell type- ω goods in country i is denoted by $P_t^i(j, \omega)$. This price is always in the domestic, country- i currency. The country- i price index is defined

¹¹Condition $\gamma \geq 2$ is imposed for technical reasons and can be relaxed.

¹²The simplifying assumption that the inverse Frisch elasticity of labour is zero allows us to pin down equilibrium wage without the need to keep track of equilibrium labour demand. It is done purely for technical reasons and can be removed at the cost of significant additional complexity of the calculations.

by the standard formula

$$\mathcal{P}_{i,t} \equiv \left(\sum_j \int_0^1 P_t^i(j, \omega)^{1-\eta} d\omega \right)^{1/(1-\eta)}. \quad (1)$$

For simplicity, we assume that prices are fully flexible and the aggregate nominal price level follows an exogenous, country-specific stochastic process $\mathcal{P}_{i,t}$.

Households have access to a complete, frictionless financial market with a domestic, nominal pricing kernel $M_{i,t,\tau}$ in the domestic currency, for any $t < \tau$. The following lemma characterizes their optimal consumption choices.

Lemma 1.1 *Optimal consumption demand is given by*

$$\tilde{C}_{i,t}(j, s) = (P_t^i(j, s))^{-\eta} (\mathcal{P}_{i,t})^\eta C_{i,t},$$

consumption expenditures satisfy the inter-temporal Euler equation,

$$e^{-\beta} C_{i,t+1}^{-\gamma} / C_{i,t}^{-\gamma} = M_{i,t,t+1} (\mathcal{P}_{i,t+1} / \mathcal{P}_{i,t})$$

and equilibrium wages are given by

$$w_{i,t} = \nu C_{i,t}^\gamma \mathcal{P}_{i,t}.$$

We denote by $\mathcal{E}_{i,j,t}$ the value of a unit of currency i in the units of currency j . That is, when $\mathcal{E}_{i,j,t}$ goes up, currency i appreciates relative to currency j . We select one reference currency (the dollar), denoted by \$, and use $\mathcal{E}_{i,t} = \mathcal{E}_{i,\$,t}$ to denote the nominal exchange rate against the dollar. Due to assumed market completeness, consumers in different countries attain perfect risk sharing and the pricing kernels $M_{i,t,t+1}$ and $M_{j,t,t+1}$ of any two countries i, j are linked through the no-arbitrage identity: $\frac{M_{i,0,t}}{M_{j,0,t}} = \frac{\mathcal{E}_{i,j,t}}{\mathcal{E}_{i,j,0}}$. For the sake of convenience,

everywhere in the sequel, we normalize the initial price levels $\mathcal{P}_{i,0}$ so that $\mathcal{E}_{i,0} = 1$ for all $i = 1, \dots, N$.

1.2 Firms' choices given an exogenous debt overhang

1.2.1 Production

Each country's production sector is populated by a continuum of ex-ante identical firms, as indexed by $\omega \in [0, 1]$, with firm ω producing type- ω goods. We use (i, ω) to denote firm ω in country i . All firms use labour as well as goods¹³ produced by other firms (domestic and foreign) as inputs in a standard Cobb-Douglas production technology: Absent debt overhang (as defined below), the production function of an (i, ω) firm is given by

$$Y_{i,t}^*(\omega, L_t(i, \omega), X_t(i, \omega)) = Z_{i,t}(\omega)^{(\eta-1)^{-1}} e^{a_{i,t}} L_t(i, \omega)^{1-\alpha} X_t(i, \omega)^\alpha, \quad (2)$$

where, for each $i = 1, \dots, N$,

- $Z_{i,t}(\omega) > 0$ is the firm (i, ω) idiosyncratic production shock that is drawn from the distribution with the density $\phi(z) = \ell z^{\ell-1}$ on $[0, 1]$ with a country specific parameter $\ell > 0$ and the cumulative distribution function

$$\Phi(z) = \int_0^z \phi(x) dx = z^\ell. \quad (3)$$

We assume that $Z_{i,t}$ are i.i.d. over time and across firms within a given country;

- $a_{i,t}$ is the country- i productivity shock;

¹³For simplicity we assume that all goods are used both for production (as intermediate inputs) and consumption.

- $L_t(i, \omega)$ is labour hired by the (i, ω) firm at time t ;
- $X_t(i, \omega)$ is the CES aggregator of goods used by the (i, ω) firm as inputs:¹⁴

$$X_t(i, \omega) = \left(\sum_{j=1}^N \int_0^1 (\tilde{X}_{t,(i,\omega)}(j, s))^{\frac{\eta-1}{\eta}} ds \right)^{\frac{\eta}{\eta-1}}.$$

Here, $\tilde{X}_{t,(i,\omega)}(j, s)$ is the demand of a (i, ω) firm for goods of a (j, s) -firm in country j .

We assume that firms are taxed on profits at the tax rate τ . As we show in the Appendix (see Lemma A.1), total nominal after tax profits of an (i, ω) -firm measured in country- i currency are given by

$$\Pi_{i,t}^*(\omega) = Z_{i,t}(\omega) \Omega_{i,t} \tag{4}$$

for some explicit, country-specific random variables $\Omega_{i,t}$, $i = 1, \dots, N$.

1.2.2 Debt

In order to highlight the mechanisms through which debt affects real outcomes in our model, we first introduce debt exogenously.¹⁵ We assume that all firms in each country i have nominal debt. When firms receive a low draw of either the idiosyncratic shock $Z_{i,t}$ or the country-specific TFP shock $a_{i,t}$, they become distressed and produce less efficiently. This form of *debt overhang* is the key mechanism by which debt is linked to real outcomes in our model.

¹⁴For simplicity, we assume that the consumption aggregator coincides with the production aggregator. Without this assumption, we would need to consider consumer and producer price indices separately, which would complicate the analysis. Furthermore, we assume that an (i, ω) firm does not use its own goods for production, so that in the integral $\int_0^1 (\tilde{X}_{t,(i,\omega)}(i, s))^{\frac{\eta-1}{\eta}} ds$ we need to integrate only over $s \neq \omega$.

¹⁵In section 2, and we endogenize the choice between debt and equity, as well as the choice of the compositions of the currency denomination of debt.

Assumption 1 (Debt Overhang) *Firms born at time $t - 1$ live for one period, $[t - 1, t]$ and are endowed with nominal debt. The random face value, $\mathcal{B}_{i,t}$, of this debt in domestic currency is realized at time t .*

- *Having observed an idiosyncratic shock realization, $Z_{i,t}$, and before starting production, the firm computes its optimal potential profits (4):*
 - *If the after-tax profits (4) are sufficient to cover the debt servicing cost, the firm then produces according to (2).*
 - *If the after-tax profits are insufficient to cover the debt servicing cost, then the firm enters a financial distress state, and it is only able to produce at a fraction $\zeta^{(\eta-1)^{-1}} \in (0, 1)$ of its capacity. That is, its production function is given by*

$$Y_{i,t}(\omega, L_t(i, \omega), X_t(i, \omega)) = Y_{i,t}^*(\omega, L_t(i, \omega), X_t(i, \omega))(1 + (\zeta^{(\eta-1)^{-1}} - 1)\mathbf{1}_{distress})$$

and, similarly, by direct calculation, total nominal profits are given by $\Pi_{i,t} = \Pi_{i,t}^(\omega)(1 + (\zeta - 1)\mathbf{1}_{distress})$.*

The simple nature of debt overhang in Assumption 1 implies that profits in distress are identical to those in (4), but with $Z_{i,t}$ being replaced by $\zeta Z_{i,t}$. Furthermore, Assumption 1 also implies that the firm enters financial distress when $Z_{i,t}$ falls below the distress threshold

$$\Psi_{i,t} \equiv \frac{\mathcal{B}_{i,t}}{\Omega_{i,t}}. \tag{5}$$

In the sequel, we also frequently refer to (5) as *leverage*: Indeed, $\Psi_{i,t}$ is the ratio of the face value of debt, $\mathcal{B}_{i,t}$, to the measure of country i nominal value of profits as given by $\Omega_{i,t}$ (see (4)).

Assumption 1 allows us to capture two key features of the behaviour of financially constrained firms. When the debt service costs are high relative to profits, financially

constrained firms often have problems paying their suppliers and employees, and they are thus often forced to fire employees and cut production. As a result, in such a distress state effective marginal costs surge, forcing these firms to raise prices and cut production.¹⁶ Both features are important for our results: In equilibrium, high prices hit global demand; firms respond by cutting their production and raising prices even further, thereby spreading the debt overhang costs worldwide.

1.3 General equilibrium

In our model, all the goods are used for both consumption and for production. Further, by assumption, households and firms in all countries are completely symmetric: They all have identical preferences and identical production functions, and hence, they only differ in productivity shocks $a_{i,t}$.¹⁷ Under this assumption, marginal rates of inter-temporal substitution are perfectly aligned across countries, so that

$$\bar{C}_t \equiv (C_{i,t}/C_{i,0})^{\gamma(\eta-1)}$$

is independent of i ,¹⁸. The nominal exchange rates are fully driven by inflation dynamics:

$$\mathcal{E}_{i,j,t} = \frac{\mathcal{P}_{i,t}^{-1}}{\mathcal{P}_{j,t}^{-1}}.$$

¹⁶See [Gilchrist, Schoenle, Sim and Zakrajšek \(2017\)](#) and [Malamud and Zucchi \(2018\)](#). In Section 2 we micro-find these costs by assuming that, in distress, debt-holders take over the firm, and they are less efficient in running production. See Section G.1 in the Appendix, where we show how to introduce investment decisions into the firm problem.

¹⁷This assumption is made purely and only for technical convenience and allows us to highlight the key mechanisms particularly clearly. In the Appendix, we show how our results can be extended to heterogeneous firms. Household heterogeneity (such as home bias in consumption) is another important direction for future research.

¹⁸That is, the real exchange rates equal 1. This is a convenient property that allows us not to have to worry about foreign exchange risk premia. Indeed, absent financial frictions, our model would be at odds with the exchange rate disconnect puzzle (see, e.g., [Gabaix and Maggiori \(2015\)](#) and [Itskhoki and Mukhin \(2017\)](#)) and would then generate counter-factual behaviour of currency risk premia.

The function

$$G(\Psi) = \ell(\ell + 1)^{-1} ((\zeta - 1)\Psi^{\ell+1} + 1), \quad \Psi \in [0, 1],$$

plays an important role in the subsequent analysis. It captures the total drop in productivity of country- i firms. Indeed, by (4), the total profits for country i firms are given by

$$\int_0^1 \Pi_{i,t}(\omega) d\omega = \Omega_{i,t} \int_0^1 (Z_{i,t}(\omega) \mathbf{1}_{Z_{i,t}(\omega) > \Psi_{i,t}} + \zeta Z_{i,t}(\omega) \mathbf{1}_{Z_{i,t}(\omega) < \Psi_{i,t}}) d\omega = G(\Psi_{i,t}) \Omega_{i,t}. \quad (6)$$

As explained above (see (5)), distressed firms are those firms with idiosyncratic shock realizations $Z_{i,t}$ below the threshold $\Psi_{i,t}$. Thus, by (3), the fraction of distressed firms is provided by the measure $[\omega : Z_{i,t}(\omega) < \Psi_{i,t}] = \min\{\Psi_{i,t}, 1\}^\ell$. We restrict our attention to *normal* equilibria in which a strictly positive fraction of firms in each country is not in distress, so that $\Psi_{i,t} < 1$ for all $i = 1, \dots, N$, and \bar{C}_t are monotonically increasing in $a_{j,t}$, $j = 1, \dots, N$.¹⁹ The following result shows explicitly how global debt overhang influences equilibrium consumption.

Theorem 1.2 *The constants ξ_i , $i = 1, \dots, N$ and α_* exist, such that:*

- *total after-tax profits of an (i, ω) firm are given by*

$$\Pi_{i,t}(\omega) = Z_{i,t}(\omega) \Omega_{i,t}, \text{ where } \Omega_{i,t} = \xi_i e^{a_{i,t}(\eta-1)} \bar{C}_t^{\hat{\eta}}, \text{ with } \hat{\eta} \equiv \frac{\gamma^{-1}}{\eta-1} + \alpha - 1. \quad (7)$$

- *if ζ is not too small and all random variables have bounded support, then there exists a unique normal equilibrium solution \bar{C}_t to the equation*

$$\bar{C}_t^{1-\alpha} = \alpha_* \sum_{j=1}^N \xi_j e^{a_{j,t}(\eta-1)} \left(1 - \Delta_t \bar{C}_t^{-\hat{\eta}(\ell+1)}\right), \quad (8)$$

¹⁹In the case of $\hat{\eta} > 0$, there might exist a “non-economic equilibrium” with an unreasonable feature that consumption is decreasing in productivity shocks $a_{j,t}$. For the rest of the paper, we neglect this equilibrium and focus on the normal equilibrium.

where

$$\Delta_t \equiv (1 - \zeta) \frac{\sum_{j=1}^N \xi_j e^{a_{j,t}(\eta-1)} \left(\frac{\mathcal{B}_{j,t} \mathcal{P}_{j,t}^{-1}}{\xi_j e^{a_{j,t}(\eta-1)}} \right)^{\ell+1}}{\sum_{j=1}^N \xi_j e^{a_{j,t}(\eta-1)}}.$$

is the Global Debt Overhang Factor.

We complete this section with two results that are crucial for understanding the real effects of debt overhang. First, since financial distress lowers production, debt overhang leads to an output gap and unemployment. Second, due to the input-output linkages, rising debt burdens in one country always transmit to other countries. Here we show that, under natural conditions, a rising debt burden in one country always leads to higher debt overhang costs in all other countries. The following two corollaries formalize this intuition.

Corollary 1.3 *Denote by $\bar{L}_t(i)$ and $\bar{O}_t(i)$ the country i equilibrium labour demand (employment) and output, respectively. Let $\bar{L}_t^*(i)$ and $\bar{O}_t^*(i)$ also denote the corresponding frictionless benchmarks absent the debt overhang. Then, both the output gap and the employment gap are given by*

$$\frac{\bar{L}_t(i)}{\bar{L}_t^*(i)} = \frac{\bar{O}_t(i)}{\bar{O}_t^*(i)} = \frac{G(\Psi_{i,t})}{\ell(\ell+1)^{-1}} < 1. \quad (9)$$

Corollary 1.4 (Default transmission) *Suppose that $\hat{\eta} > 0$.²⁰ Then, a shock to debt burden $\mathcal{B}_{j,t}$ of a country j always leads to an increase in the fraction of distressed firms in all other countries $i \neq j$.*

²⁰This assumption is important. While firm profits are always increasing in productivity, $a_{i,t}$, they may be decreasing in consumption when $\hat{\eta} < 0$. The sign of $\hat{\eta}$ depends on the importance of labour in the Cobb-Douglas production function (2). A higher \bar{C}_t leads to a higher equilibrium wage level, thereby making production too costly when α is very low.

2 Dominant Currency Debt: Theory

In this section, we study firms' choice of leverage and the composition of the currency denomination of their debt in general equilibrium. We assume that firms finance themselves by issuing both equity and defaultable short-term nominal bonds in *any* of the N currencies.²¹ Each bond has a nominal face value of one currency unit, and the firm is required to pay a coupon of c currency units per unit of outstanding debt.²² We denote by $B_{j,t}(i)$ the stock of outstanding nominal debt at time t of country i firms, denominated in the currency of country j . We also denote by $B_t = (B_{j,t}(i))_{j=1}^N$ the $N \times N$ matrix of debt stocks in different currencies. As in [Gomes, Jermann and Schmid \(2016\)](#), we assume that coupon payments are shielded from taxes, so that

$$\mathcal{B}_{i,t+1}(B_t) = ((1 - \tau)c + 1) \sum_{j=1}^N \mathcal{E}_{j,i,t+1} B_{j,t}(i)$$

is the total debt servicing cost in country- i currency, net of tax shields. The choice of firm leverage, therefore, depends on the trade-off between tax advantages and the distress costs.²³

Then, absent any default, nominal distribution to shareholders at time $t + 1$ is given by

$$\Pi_{t+1}(i, \omega) - \mathcal{B}_{i,t+1}(B_t). \tag{10}$$

²¹We interpret this one single period as the typical maturity of corporate debt of the order of several years. See, for example, [Cortina, Didier and Schmukler \(2018\)](#). In particular, we do not address the known fact that the US dollar tends to appreciate over the short term during crises (see, for example, [Maggiori \(2017\)](#) and [Farhi and Maggiori \(2018\)](#)), making that currency unattractive for short-term borrowing. Below, we provide empirical evidence suggesting that firms are well aware of this risk profile, and they tend to issue long-term dollar-denominated debt.

²²Apart from the multiple currencies assumption, when modelling the financing side, we closely follow [Gomes, Jermann and Schmid \(2016\)](#).

²³For simplicity, as in [Gomes, Jermann and Schmid \(2016\)](#), we assume that tax shields are the only motivation for issuing debt. However, one can also interpret τ as a reduced form of gains from debt issuance, such as the alleviation of adverse selection costs.

If the cash flows (10) are non-positive, shareholders will default on a firm's debt. Upon default, debt-holders take over the firm, and shareholders get zero.²⁴

2.1 Optimal leverage and the dominant currency debt

As we explain above, shareholders default whenever cash flows (10) are non-positive, that is, when $\Pi_{t+1}(i, \omega) \leq \mathcal{B}_{i,t+1}(B_t)$. Thus, default occurs whenever $Z_{i,t+1}$ falls below the default threshold

$$\Psi_{i,t+1}(B_t) \equiv \frac{\mathcal{B}_{i,t+1}(B_t)}{\Omega_{i,t+1}}.$$

We assume that, upon default, debt-holders only recover a fraction ρ_i of their promised value, $1 + c$.²⁵ Thus, by direct calculation, the nominal price in country i currency of one unit of debt denominated in currency j is given by

$$\delta_i^j(B_t) = E_t [M_{i,t,t+1} (1 - (1 - \rho_i)\Phi(\Psi_{i,t+1}(B_t))) (1 + c)\mathcal{E}_{j,i,t+1}].$$

We assume that country i firms face a proportional cost $q_i(j)$ of issuing in country j currency for $i, j = 1, \dots, N$ ²⁶ and it maximizes equity value plus the proceeds from the debt issuance

²⁴ In the Appendix (Proposition C.1), we show that under the assumption of shareholders receiving zero in default, firms will always choose not to hedge foreign exchange risk. The intuition behind this result is straightforward. Hedging effectively plays the role of investment, and the firm only gets the payoff X_{t+1} from this investment in good (survival) states, while paying the market price at time t to receive the payoff in all states. Thus, hedging is just a transfer of funds from shareholders to debt-holders, and firms will then optimally decide to minimize this transfer.

²⁵ We also assume that ρ_i is sufficiently small relative to ζ , so that debt holders can recover at most what they get from (inefficiently) running the firm net of the (unmodelled) default costs paid to lawyers, etc. We assume that these costs go directly to the representative consumer, and hence, they have no impact on the equilibrium outcomes. There are major differences in these default costs across different countries. See, Favara, Morellec, Schroth and Valta (2017).

²⁶ While we do not micro-found these costs, it is not difficult to do so. These costs may originate from underwriting costs, the limited risk bearing capacity of intermediaries (in the case of bank loans), or the actual debt placement costs incurred by the investment banks (such as locating bond investors). These costs can differ drastically depending on the currency in which the debt is issued. For example, according to Velandia and Cabral (2017), "... in the case of Mexico, the average bid-ask spread of the yield to maturity on outstanding USD-denominated international bonds is 7 basis points, compared to 10 basis points for

net of issuance costs:

$$\max_{B_t} \left\{ \sum_{j=1}^N \delta_i^j(B_t) B_{j,t} (1 - q_i(j)) + E_t[M_{i,t,t+1} \max\{\Pi_{t+1}(i, \omega) - \mathcal{B}_{i,t+1}(B_t), 0\}] \right\}.$$

Everywhere in the sequel, we use $E_t^\$$ and $\text{Cov}_t^\$$ to denote conditional expectation and covariance under the dollar risk neutral measure with the conditional density $E_t[M_{\$,t,t+1}]^{-1} M_{\$,t,t+1}$. Furthermore, for each stochastic process X_t , we consistently use the notation

$$X_{t,t+1} \equiv \frac{X_{t+1}}{X_t}.$$

We need the following assumption to ensure that the leverage choice problem has a non-trivial solution.

Assumption 2 *We have*

$$(1 - q_i(j))(1 + c) > (1 + c(1 - \tau)) \quad \text{and}$$

$$\bar{q}_i(j, \$) \equiv \frac{((1 - q_i(j))(1 + c) - (1 + c(1 - \tau)))}{(1 - \rho_i)(1 + c)[(1 - q_i(j)) + \ell(1 - q_i(\$))] - (1 + c(1 - \tau))} > 0$$

for all $i, j = 1, \dots, N$. Let also $\bar{q}_i(\$) \equiv \bar{q}_i(\$, \$)$.

The first condition ensures that the cost $q_i(j)$ of issuing debt is less than the gains, as measured by the value of tax shields, so there is positive debt issuance. The second condition ensures that the recovery rate ρ_i is sufficiently small: Otherwise, funding becomes so cheap for the firm that the firm may want to issue infinite amounts of debt. The following is true.

outstanding EUR-denominated bonds. Mexico is also an example with very liquid benchmarks on both currencies.”

Theorem 2.1 *Issuing debt only in dollars is optimal if and only if*

$$\frac{\bar{q}_i(j, \$)}{\bar{q}_i(\$)} - 1 \leq \frac{\text{Cov}_t^{\$} \left((\mathcal{E}_{i,t,t+1} \Omega_{i,t+1})^{-\ell}, \mathcal{E}_{j,t,t+1} \right)}{E_t^{\$} [(\Omega_{i,t+1} \mathcal{E}_{i,t,t+1})^{-\ell}] E_t^{\$} [\mathcal{E}_{j,t,t+1}]} \quad (11)$$

for all $j = 1, \dots, N$. In this case, optimal dollar debt satisfies

$$b_{\$,t}(i) = \mathcal{E}_{i,t}^{-1} B_{\$,t} = (1 + c(1 - \tau))^{-1} \left(\frac{\bar{q}_i(\$)}{E_t^{\$} [(\Omega_{i,t+1} \mathcal{E}_{i,t,t+1})^{-\ell}]} \right)^{\ell-1}. \quad (12)$$

The condition (11) shows that the incentives for issuing in dollars are determined by two forces: The effective cost of issuance, $\bar{q}_i(\$)$, and the risk profile of the dollar. Dollar capital and derivative markets are deep and liquid (see [Moore, Sushko and Schrimpf \(2016\)](#)); thus, the low effective cost of issuance, $\bar{q}_i(\$)$, is an obvious factor favoring the dollar as the dominant currency of choice for debt contracts. However, our main result does not rely on the dollar debt having low issuance costs: Theorem 2.1 implies that the dollar can rise as the dominant debt-denomination currency due purely to its risk profile. To understand the underlying mechanism, we note that, absent heterogeneity in effective issuance costs (that is, when $q_i(j)$ is independent of j), (11) takes the form of

$$\text{Cov}_t^{\$} \left((\mathcal{E}_{i,t+1} \Omega_{i,t+1})^{-\ell}, \mathcal{E}_{j,t,t+1} \right) \geq 0, \quad j = 1, \dots, N. \quad (13)$$

Here, $\mathcal{E}_{i,t+1} \Omega_{i,t+1}$ is the factor that determines the value of profits of country i firms in dollars (see (6)). Intuitively, at time t , firms when deciding on the currency composition of their debt choose to issue in dollars if they anticipate the dollar to depreciate at those times when their time $t + 1$ profits are low; the condition (13) provides a precise formalization of this intuition. Since $(\mathcal{E}_{i,t+1} \Omega_{i,t+1})^{-\ell}$ attains its largest value when dollar profits $\mathcal{E}_{i,t+1} \Omega_{i,t+1}$ are close to zero, covariance (13) overweighs the distress states: When ℓ is sufficiently high, (13)

essentially requires the dollar to depreciate against all its key competitors during times of major economic downturns.

It is also important to note that condition (13) corresponds to the problem a firm faces when choosing between dollar debt and debt denominated in other key currencies, such as e.g., the euro, the yen, the Swiss franc and the pound. For an emerging markets' firm that is choosing between local currency debt and dollar debt, heterogeneity in issuance costs may be as (if not more so) important as the currency risk profile. However, even for the choice between dollar- and euro-denominated debt, ignoring differences in issuance costs puts the dollar at a disadvantage: Existing evidence (see e.g., [Velandia and Cabral \(2017\)](#)) suggests that issuing debt in dollars is significantly cheaper than issuing in euros.

2.2 Dominant currency debt in general equilibrium

In this section, we combine the equilibrium characterization in Theorem 1.2 with the dominant currency debt condition of Theorem 2.1 to answer the following question: When does dominant currency debt arise in general equilibrium? We then make the following simplifying assumption:

Assumption 3 *We assume that*

- *issuing costs are independent of currency denomination: $q_i(\$) = q_i(j)$ for all $i, j = 1, \dots, N$.*
- *TFP shocks satisfy $a_{j,t} = a_t + \varepsilon_{j,t}^a$ for some common shock a_t and idiosyncratic TFP shocks $\varepsilon_{j,t}^a$ with a small variance that are independent across countries and also independent of a_t .*

As we explain above, in our model, consumption is perfectly aligned across countries, real exchange rates equal 1, and nominal exchange rate changes are determined purely by

the relative inflation rates: $\mathcal{E}_{i,t,t+1} = \mathcal{P}_{i,t,t+1}^{-1} \mathcal{P}_{\$,t,t+1}$. Thus, substituting profits $\Omega_{i,t}$ from (7) and using Assumption 3, we determine from (13) that issuing all debt denominated only in dollars is optimal if and only if

$$\text{Cov}_t^{\$} \left(\left(\bar{C}_{t+1}^{\hat{\eta}} e^{(\eta-1)a_{i,t+1}} \mathcal{P}_{\$,t,t+1} \right)^{-\ell}, \mathcal{P}_{j,t,t+1}^{-1} \mathcal{P}_{\$,t,t+1} \right) \geq 0 \quad (14)$$

for all $i, j = 1, \dots, N$.

In our model, a central bank policy that leads to a positive shock to $\mathcal{P}_{i,t}$ has two main functions: First, it eases the real debt burden of firms' borrowing in country's i currency; and secondly, it leads to a depreciation of country i 's currency. Therefore, an increase (respectively, decrease) in $\mathcal{P}_{i,t}$ can be interpreted as monetary easing (respectively, tightening).²⁷ We further assume a counter-cyclical monetary policy rule whereby the central bank eases (respectively, tightens) when employment or output falls (respectively, rises) relative to the frictionless benchmark (see (9)):

Assumption 4 *The inflation rate in country i is determined by*

$$\mathcal{P}_{i,t,t+1} = \left(1 - \bar{L}_{t+1}(i) / \bar{L}_{t+1}^*(i) \right)^{\phi_i} e^{\varepsilon_{i,t+1}}. \quad (15)$$

Here, $\phi_i > 0$, $i = 1, \dots, N$ is a country specific parameter that measures the responsiveness of domestic monetary policy to economic conditions, and $\varepsilon_{i,t+1}$ is a country-specific monetary policy shock with bounded support and variance $\sigma_{i,\varepsilon}^2$.

We can now characterize the conditions when a dominant currency debt equilibrium emerges.

Theorem 2.2 *Suppose that monetary policy uncertainties $\sigma_{i,\varepsilon}$, $i = 1, \dots, N$ are sufficiently small and the indices ϕ_i are all pairwise different, and $1 - \zeta$ is not too large. Then, there*

²⁷There is ample evidence that monetary easing typically leads to a simultaneous currency depreciation. See, for example, [Ferrari, Kearns and Schrimpf \(2017\)](#).

exists a Dominant Currency Debt equilibrium. The dominant debt currency is always the currency of the country with the highest index ϕ_i .

In addition to inflation stabilization indices ϕ_i , countries may also differ in the volatility of inflation shocks, $\sigma_{i,\varepsilon}$. Naturally, firms view this uncertainty as an additional and undesirable form of risk. The following is true:

Proposition 2.3 *Absent heterogeneity in the indices ϕ_i , $i = 1, \dots, N$, firms always issue debt in the currency of the country that has the lowest volatility of inflation shocks, $\sigma_{i,\varepsilon}$.*

While $\sigma_{i,\varepsilon}$ does represent idiosyncratic inflation volatility in our model, Proposition 2.3 holds true for any shocks to exchange rates that are unrelated to economic fundamentals, for example, monetary policy shocks or temporary demand pressures and liquidity shocks in currency markets. Proposition 2.3 suggests that, in addition to insufficient market liquidity (modelled by high issuance costs), the significant idiosyncratic volatility of emerging market currencies may serve as an additional important mechanism that explains why firms do not want to issue in these currencies, despite the fact that such currencies do tend to significantly depreciate during crises (see also [Du, Pflueger and Schreger \(2016\)](#)). As an illustration, consider a typical emerging market currency, the Argentinian Peso (ARS). During the period of November 1995-September 2018, the standard deviation of the monthly returns on the dollar index was 1.9%, while the standard deviation of monthly returns on the ARS/USD exchange rate was 7.1%. Further, this volatility was almost entirely due to idiosyncratic shocks, as indeed, the R^2 of a regression of the monthly ARS/USD returns on the returns on the dollar index was only 0.0033.

3 Dominant Currency Debt: Empirical Evidence

As we show above (see condition (13)), firms prefer to issue in dollars if the dollar exchange rate co-moves positively²⁸ with the present value of their profits, which we proxy by their stock market value. For the stock market, we use S&P 500 and MSCI AC World indices measured in dollars as we also measure profits in dollars in our theoretical results. As a proxy for the global dollar exchange rate, we use the trade-weighted dollar index against major currencies, including those in the Eurozone, Canada, Japan, United Kingdom, Switzerland, Australia, and Sweden, as obtained from the FRED database. We also provide results using the bilateral exchange rates between the dollar and the euro,²⁹ the yen, the pound and the Swiss franc.

3.1 Why is the dollar the dominant currency? Results with the dollar index

Given that the dollar is the most common currency of denomination in international debt markets, the first prediction of our model is that the returns on the dollar index positively correlate with the returns on the stock market indices at horizons that correspond to the weighted average corporate debt maturity, that is around 6-7 years (see section 5, Choi, Hackbarth and Zechner (2018), Cortina, Didier and Schmukler (2018)). To test this prediction, we first run the following regressions for the horizons of $h \in \{3, 12, 24, 36, 48, 60, 72, 84, 96, 108, 120\}$ months:³⁰

$$Return_USD_t^h = \alpha^h + \beta_h Return_SP500_t^h + \epsilon_t^h . \quad (16)$$

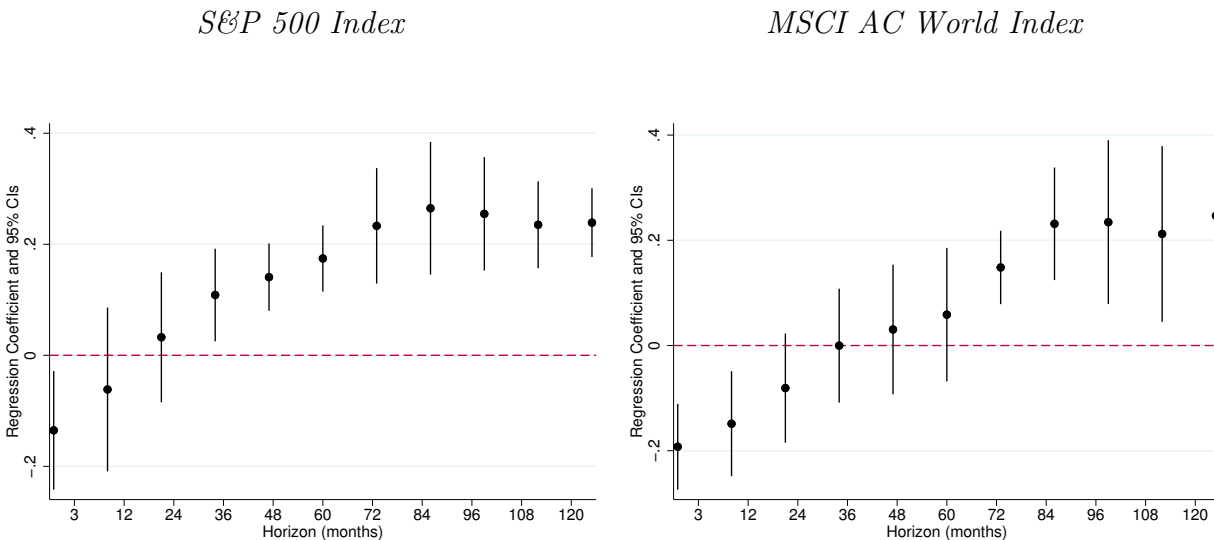
²⁸In fact, given that issuing in dollars is cheaper than issuing in any other currency, condition (11) implies that firms would issue all their debt in dollars even if this correlation were negative, but not too negative relative to the cost gain of issuing in dollars.

²⁹We use the Deutsche mark prior to the introduction of the euro using the euro/Deutsche mark exchange rate at the time of the inception of the euro.

³⁰We then control for autocorrelation at the respective horizons by using the Newey-West correction with the respective number of lags.

Here, $Return_USD_t^h$ and $Return_SP500_t^h$ denote the rolling returns on the dollar index and the SP500 index over h months, respectively. The left-hand panel of Figure 2 reports the results for the regression coefficient β_h for different horizons, together with the 95% confidence intervals for the period between January 1994 and September 2018.³¹

Figure 2: Correlation of the USD index with stock market indices



Notes: The graph on the left-hand side herein reports the regression coefficients β_h from the regressions (16). The graph on the right-hand side reports the regression coefficients from the regressions (17). The dots show the corresponding values of the β_h coefficients, while the lines show the 95% confidence intervals for these coefficients. Standard errors are corrected using the Newey-West procedure with the number of lags being equal to the horizon h of returns for each respective regression.

The results show a pattern of negative correlations at short horizons and positive and mostly increasing correlations at longer horizons. These findings, together with condition (13), suggest that US firms are better off if they borrow in dollars rather than in other major international currencies if their debt maturity exceeds roughly two years, which is the case here.

Next, we turn to the rest of the world and compute the correlation of the returns on the

³¹The results are qualitatively similar though with larger confidence intervals if we start the sample period in December 1987, the start of the MSCI series.

dollar index with the returns on the MSCI AC World Index. We follow the same procedure as before and run the following regressions, for the same horizons h as shown above:

$$Return_USD_t^h = \alpha^h + \beta_h Return_MSCIACWorld_t^h + \epsilon_t^h. \quad (17)$$

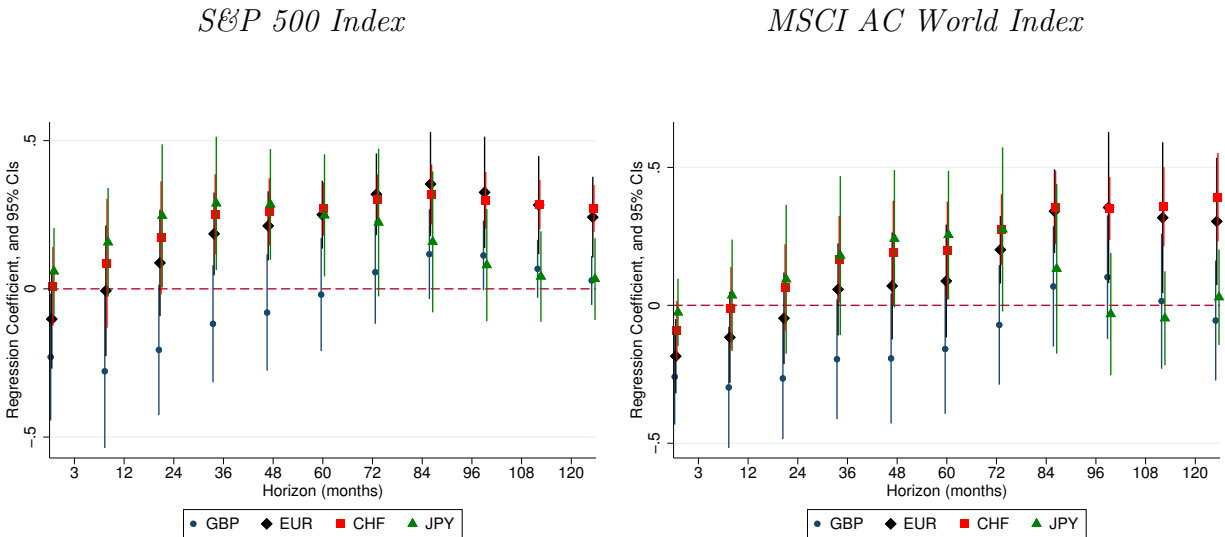
The right-hand panel of [Figure 2](#) reports the results for the regression coefficient β_h for different horizons, together with the 95% confidence intervals for the period between January 1994 and September 2018. The results from these regressions are aligned with the results for the S&P 500 stock index. While the dollar is negatively correlated with the MSCI AC World Index at short horizons, this correlation turns positive at horizons that are longer than three years. Thus, condition (13) suggests that international firms with average debt maturities longer than three years (which is indeed the case for most firms; see [section 5](#), and also [Choi, Hackbarth and Zechner \(2018\)](#), [Cortina, Didier and Schmukler \(2018\)](#)) are better off issuing debt that is denominated in dollars.

3.2 Why is the dollar the dominant currency? Results with bilateral exchange rates

In this section, we provide the results for the same regressions as in [Section 3.1](#), but using bilateral exchange rates for the dollar against four other major currencies. As [Figure 3](#) shows, the dominant currency condition (13) holds empirically with i =dollar and currency j being the euro (EUR), the yen (JPY), or the Swiss franc (CHF). The only exception is British pound (GBP), for which our empirical proxy estimates in [Figure 3](#) for the covariance in (13) have a negative sign. However, these covariance estimates are statistically insignificantly different from zero at the horizons of average corporate debt maturity. Thus, even absent differences in issuance costs, firms would strictly prefer issuing debt denominated in dollars,

even if they could issue in EUR, JPY, or CHF. And even a slight difference in issuance costs favouring dollar to GBP would also make dollar immediately dominate over GBP.

Figure 3: Correlation of the bilateral exchange rate of the dollar against major currencies with stock market indices



Notes: The graph on the left-hand side herein reports the regression coefficients β_h from the regressions (16). The graph on the right-hand side reports the regression coefficients from the regressions (17). The dots show the corresponding values of the β_h coefficients, while the lines show the 95% confidence intervals for these coefficients. Standard errors are corrected using the Newey-West procedure with the number of lags being equal to the horizon h of returns for each respective regression.

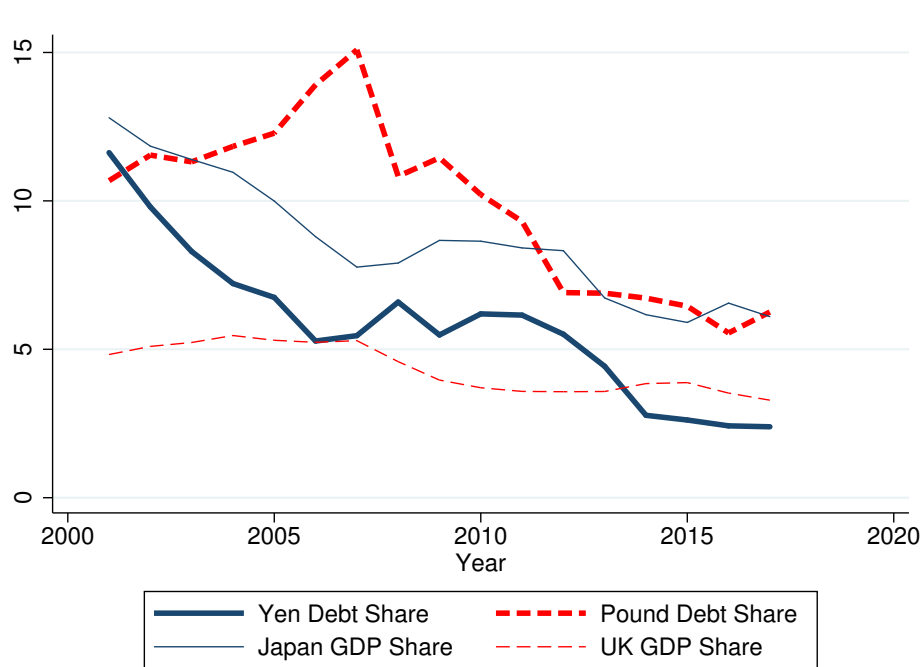
3.3 Yen vs. pound

As we show in Section 3.2, the risk properties of the dollar alone can explain why the dollar dominates the euro, the yen and the Swiss franc in the sense of Theorem 2.1. One notable case is the pound: By Figure 3, the pound has favorable risk properties for debt issuers compared to most of the other major currencies. In reality, it is not reasonable to expect the pound to compete with the dollar on a large scale because of the mere size of the US economy. However, it is reasonable to compare the dynamics of corporate debt issuance in GBP to that in JPY, since Japan and the Great Britain have similar size in the world

economy. In this case, [Figure 3](#) shows that (13) holds empirically with $i=GBP$ and $j=JPY$, and hence corporates should strictly prefer issuing in GBP to issuing in JPY.

[Figure 4](#) confirms this prediction of our model. Indeed, surprisingly, despite the slightly larger share of Japan in the world economy and lower nominal interest rates in Japan, the share of pound-denominated debt is higher than the share of yen-denominated debt.

Figure 4: The yen versus the pound



Source: BIS, IMF WEO, authors' calculations

4 The fall and the rise of the dollar

In our model, relative inflation dynamics in the two countries determine exchange rates. This is a simplifying assumption that we use to compute general equilibrium. An explicit relationship between inflation and exchange rates is not crucial for our previous empirical

results. However, in this section we do take the model seriously and explore whether there is actually an empirical link between inflation and the choice of the dominant currency.

The explicit link between relative inflation dynamics and exchange rates in our model is the key element behind Theorem 2.2. The latter states that firms should be issuing dollar debt only if they expect the United States to have the most counter-cyclical inflation over the horizon of their debt maturity.³² These expectations about inflation cyclicity can be backed out from the inflation risk premium, given by the difference between inflation expectations under the risk-neutral and the physical measures:

$$IRP_{i,t} = \log \left(\frac{E_t^i[\mathcal{P}_{i,t,t+1}]}{E_t[\mathcal{P}_{i,t,t+1}]} \right) = \log \left(\frac{e^{r_{i,t}} \text{Cov}_t(M_{i,t,t+1}, \mathcal{P}_{i,t,t+1})}{E_t[\mathcal{P}_{i,t,t+1}]} \right). \quad (18)$$

The covariance term, $\text{Cov}_t(M_{i,t,t+1}, \mathcal{P}_{i,t,t+1})$, reflects the basic intuition, namely, that the inflation risk premium is determined by market expectations regarding inflation cyclicity. The following is true.

Proposition 4.1 *Under the hypotheses of Theorem 2.2, the inflation risk premium, $IRP_{i,t}$, has the largest value for the dominant currency country.*

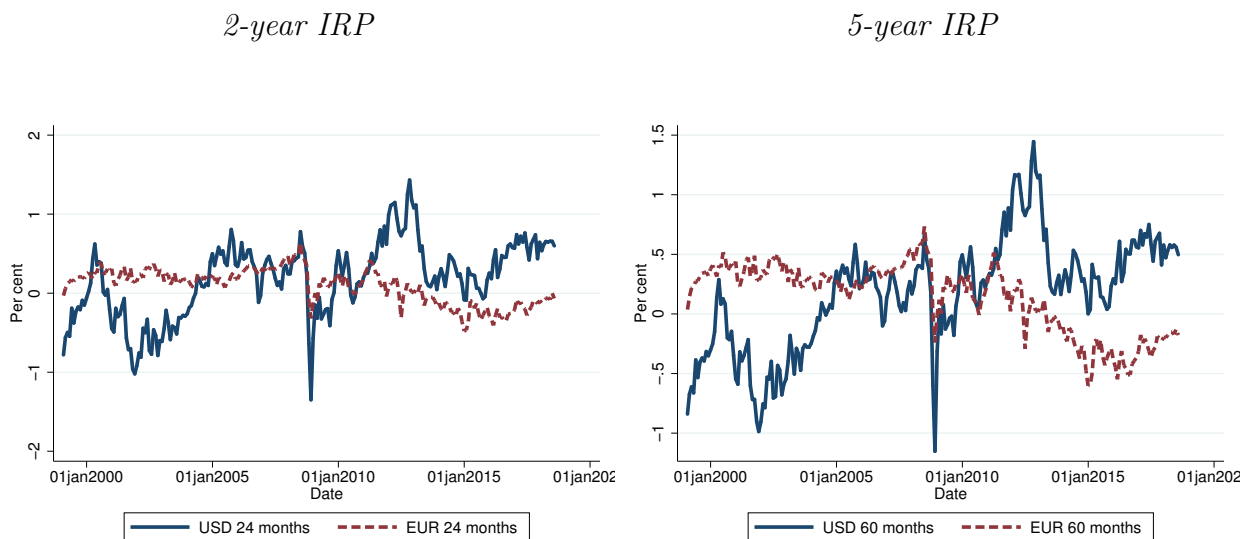
The key prediction of Proposition 4.1 is a direct link between the IRP and the dominance of a currency. To test this prediction empirically, one can consider an extension of our benchmark model featuring time variation in the coefficients $\phi_{\text{€},t}$ and $\phi_{\text{§},t}$, the respective abilities of the ECB, and the Federal Reserve to pursue counter-cyclical stabilization policies (see Assumption 4). In such an extended model, Theorem 2.2 implies that a change in the sign of $\phi_{\text{§},t} - \phi_{\text{€},t}$ from positive to negative will immediately trigger a regime change, thereby making the dollar lose its dominant currency status to the euro. Proposition 4.1 further predicts that this status change should be accompanied with a simultaneous change in the

³²While the perfect link between exchange rates and inflation relies on a strong form of PPP, Theorem 2.2 would still hold true even with large PPP deviations, as long as the relative inflation component of the exchange rates contributed significantly to the covariance (13) over the horizons of debt maturity of a typical firm.

sign of $IRP_{\$,t} - IRP_{\€,t}$ from positive to negative. Importantly, what matters is not the actual value of these coefficients, but rather the firms' and market participants' expectations about them: The former determine debt issuance policies; the latter determine the IRP.

We compare the pre- and post-crisis trends in the shares of euro- and dollar-denominated debt (Figure 1) with the pre- and post-crisis dynamics of inflation risk premia (18) in the United States and the Eurozone.³³ Figure 1 and Figure 5 show a behaviour that is consistent with our key prediction: In the pre-crisis period, the inequality $IRP_{\€,t} \geq IRP_{\$,t}$ held true most of the time, and the fraction of euro-denominated debt rose; post crisis, the relationship reverted to $IRP_{EUR,t} \leq IRP_{\$,t}$, and the fraction of euro-denominated debt started to fall.

Figure 5: Inflation Risk Premia in the United States and the Eurozone



Source: [Hördahl and Tristani \(2014\)](#), authors' calculations.

In our model, IRP can be viewed as a barometer of market expectations of inflation

³³We use the estimates from [Hördahl and Tristani \(2014\)](#) for the inflation risk premia in the United States and the Eurozone. [Hördahl and Tristani \(2014\)](#) uses a joint macroeconomic and term structure model, combined with survey data on inflation and interest rate expectations, as well as price data on nominal and inflation index-linked bonds. To the best of our knowledge, [Hördahl and Tristani \(2014\)](#) is the only paper in the existing literature that applies the same rigorous methodology to recover IRP for both the United States and the Eurozone. We report their estimates for the 2-year and 5-year horizons in Figure 5; the results for other horizons are qualitatively similar .

counter-cyclicality, as captured by $\phi_{\epsilon,t}$. Hence, our results suggest that the significant rise in the post-crisis share of dollar-denominated debt may be due to declining expectations of inflation stabilization and an increasing expected risk of deflation in the Eurozone following the Global Financial Crisis in 2008 and the European Debt Crisis in 2011.

Consistent with [Figure 1](#), [Maggiore, Neiman and Schreger \(2018\)](#) show that the share of dollar-denominated debt in cross-border corporate holdings has drastically increased during the post-crisis period compared to that for the euro. We argue that this pattern is to a large extent driven by the bond-supply channel of [Figure 1](#); bond investors hold what the firms issue to clear the markets in general equilibrium. That said, while bond investors might generally dislike holding nominal bonds with a high inflation risk premium, there is an opposite force in our model that increases the attractiveness of dollar-denominated bonds for lenders: The default probability of these bonds is lower because it is easier for firms to repay dollar debt due to lower real debt burdens in bad times.³⁴ However, when in equilibrium, the former dominates, and hence the dominant debt currency has a higher inflation risk premium.

We further investigate the dynamic link between IRP and debt issuance in different currencies. Clearly, the presence of any type of inertia in debt currency denomination (e.g., due to some implicit or explicit adjustment costs or smooth variations in beliefs) will make the transition between the euro- and dollar-dominance regimes smooth, with the share of dollar debt increasing in $IRP_{\$,t}$ and decreasing in $IRP_{\epsilon,t}$. Stated formally, we test the following hypothesis.

Hypothesis IRP-1: The share of dollar-denominated debt, USD_t^{shr} , positively relates to $IRP_{\$,t} - IRP_{\epsilon,t}$. More specifically, it positively relates to $IRP_{\$,t}$, while it negatively relates to $IRP_{\epsilon,t}$.

[Table 1](#) presents the results of a linear regression. First, in column (1), we find a positive, statistically significant relationship between the share of dollar-denominated debt

³⁴See also [Kang and Pflueger \(2015\)](#).

Table 1: The debt currency choice and inflation risk premium

	(1)	(2)	(3)	(4)	(5)
	USD_t^{shr}	USD_t^{shr}	USD_t^{shr}	USD_t^{shr}	ΔUSD_t^{shr}
$IRP_{\$,t}^{5Y} - IRP_{\€,t}^{5Y}$	9.636***		1.553**		
	(1.129)		(0.718)		
$IRP_{\$,t}^{5Y}$		2.079*		0.841	
		(1.053)		(0.688)	
$IRP_{\€,t}^{5Y}$		-22.71***		-4.863***	
		(1.495)		(0.967)	
$\Delta IRP_{\$,t}^{5Y}$					0.330
					(0.816)
$\Delta IRP_{\€,t}^{5Y}$					-2.069*
					(1.059)
Year dummy			✓	✓	
Freq.	Q	Q	Q	Q	Q
Observations	72	72	72	72	71
R-squared	0.528	0.786	0.986	0.989	0.075

Notes: Robust standard errors are shown in parentheses. *, **, *** denote significance at the 10, 5, and 1% levels respectively. USD_t^{shr} refers to the share of dollar debt, including both bank loans and debt securities. $IRP_{\$,t}^{5Y}$ and $IRP_{\€,t}^{5Y}$ refer to the 5-year inflation risk premia for the dollar and the euro respectively, as measured by [Hördahl and Tristani \(2014\)](#). Q refers to the quarterly frequency since 2000. Δ refers to quarterly first difference.

on the IRP differential with an R^2 of 52.8%. In column (3), even after including year dummies, the positive sign remains positive and statistically significant. The estimates are

also economically large: A 1 percentage point increase in the IRP differential between the dollar and the euro is associated with an increase in the share of dollar-denominated debt of about 10 percentage points.

An alternative specification includes both inflation risk premia for the dollar and the euro separately as independent variables in the regression. In columns (2) and (4), we report the results without and with year dummies, respectively. These results are again consistent with our hypothesis: The share of dollar-denominated debt is positively related to $IRP_{\$,t}^{5Y}$, while it is negatively related to $IRP_{\€,t}^{5Y}$. Furthermore, the R^2 of the specification in column (2) is much higher than that in column (1), and the coefficient for the $IRP_{\€,t}^{5Y}$ is economically very large. A 1 percentage point increase in the euro IRP is associated with a drop in the share of dollar-denominated debt of about 22 percentage points. The negative coefficient remains economically significant even after the inclusion of year dummies in the quarterly regressions in column (4). In column (5), we run the regression with quarterly first differences which yields qualitatively similar results as in column (4).

5 Debt currency and maturity choice

Our results in [section 3](#) have direct implications on the link between debt maturity and the incentives to issue dollar-denominated debt. Namely, as the dollar’s co-movement with the stock market increases over longer horizons, we expect that firms with a longer maturity of debt have a preference for issuing this debt in dollars.

We use data at the bond issuance level in order to formally test the hypothesis that the propensity to issue dollar-denominated debt increases with debt maturity. We restrict our attention to non-financial corporations that issued bonds between 2000 and 2019.^{35,36}

³⁵The dataset includes perpetual bonds as well. In order to include them in the analysis, we winsorize the maturity of the bonds at 5%, both at the lower and upper tail of their maturity distribution.

³⁶We drop all observations for which the issuer is not a non-financial firm or the industry is coded as “Finance.”

5.1 Data

We use data from Dealogic where observations are at the ISIN level of bond issuance. In order to keep the timing of our analysis similar to the previous sections, we restrict the sample to bonds issued between January 2000 and February 2019. Our dataset includes a total of 102,159 bonds, issued by 23,992 firms that are headquartered in 110 different countries.

The dataset includes information on the identity of the firm, the country where it is headquartered, the industry as well as information on the bonds, such as the currency denomination, date of issuance, maturity date, issued amount denominated in the local currency of the firm’s headquarters, and whether the bond is investment-grade or is not.

In the full sample, the mean of the winsorized maturity is 2,950 days, with a standard deviation of 2,646 days; the minimum value is 375 days and the maximum value is 10,958 days. We present the summary statistics regarding debt maturity by different currencies in [Figure 9](#) in a box plot in the Appendix. As [Figure 9](#) shows, the maturities of bonds issued in pounds have the largest median, followed by bonds issued in dollars.

5.2 Results

Following our results in [section 3](#) and the patterns in [Figure 1](#), we test the following hypotheses using micro-level data on bond issuance.

Hypothesis BI-1: A longer debt maturity is associated with a higher propensity to issue dollar-denominated debt.

In our model, we take debt maturity as a given. As we have shown previously, given debt maturity, firm propensity to issue in dollars increases with the correlation of the dollar with the stock market; hence, *Hypothesis BI-1* follows directly from the fact that the correlation of the dollar with the stock market is higher over longer horizons.

To measure the propensity to issue dollar-denominated debt, we use $\mathbb{1}(USD)$, which is a dummy variable that takes the value 1 if the currency denomination of the bond is the dollar.

Then, the independent variables of interest in our regressions become: $Maturity_w$, which is the winsorized and standardized value of maturity at the 5% level; $\mathbb{1}(Maturity > 1y)$, which is a dummy variable that takes the value 1 if the non-winsorized maturity is greater than one year. According to our hypotheses, we expect a positive coefficient for these variables.

Other control variables are the size of the issuance and a dummy variable that is equal to 1 if the bond is investment-grade. Moreover, depending on the specification, we include $Industry$, $Country * Month$ and $Firm * Month$ fixed effects. We cluster the standard errors at the $Country * Year$ level.³⁷

We run different linear regressions, varying the fixed effects used and making different cuts of the sample in order to test the predictions of our theory. [Table 2](#) presents the results.

The first three columns control for bond characteristics as well as industry and $Country * Month$ fixed effects. In column (1), we run the regression using the full sample. The coefficient on $Maturity_w$ suggests that a one standard deviation increase in maturity increases the likelihood of the currency denomination of the bond to be dollars by 2 percentage points. In column (2), in order to address worries that this result might be driven by the ease of issuing longer maturity bonds in dollars, we still use the full set of firms, but we restrict the sample to bonds with maturity of 10 years or less. For this specification, we use the non-winsorized sample and test whether $\mathbb{1}(Maturity > 1y)$ predicts a higher likelihood of dollar debt issuance. Indeed, dollar bond issuance is more likely for maturities of 1y-10y, in line with our findings in [section 3](#). In column (3), we restrict the sample to bonds that are issued by non-US, non-Eurozone, non-JP, non-GB, non-CHF firms and ones that are only issued in USD, EUR, JPY, GBP and CHF. We obtain the same result that longer maturities correspond to a higher likelihood of issuance in dollars.

For identification, we rely on firms that issue multiple bonds in at least two different currencies in a given month. This choice allows us to tightly identify that the same firm

³⁷ In the benchmark specification, we use the country where the headquarters of the parent company of the issuer is located. As a robustness check, we use the residence of the issuer instead. Our results then are virtually unchanged.

Table 2: Debt maturity and currency choice

	(1)	(2)	(3)	(4)	(5)
Sample:	Full	Full & < 10y	Partial & FC	Full [†]	Partial & FC [†]
	$\mathbb{1}(USD)$	$\mathbb{1}(USD)$	$\mathbb{1}(USD)$	$\mathbb{1}(USD)$	$\mathbb{1}(USD)$
<i>Maturity_w</i>	0.0195***		0.0203***	0.0405***	0.0786***
	(0.00294)		(0.00543)	(0.0148)	(0.0253)
$\mathbb{1}(Maturity > 1y)$		0.0343***			
		(0.00742)			
Controls	X	X	X	X	X
Industry FE	X	X	X		
Country*Month FE	X	X	X		
Firm*Month FE				X	X
Observations	99,283	72,382	6,826	4,127	727
R-squared	0.744	0.714	0.646	0.409	0.531
Mean of Dep. Var	0.330	0.247	0.842	0.344	0.635

Notes: Standard errors clustered by *Country * Year* in parantheses. *, **, *** denote significance at the 10, 5 ,and 1% levels, respectively. $\mathbb{1}(USD)$ is a dummy variable that takes the value 1 if the currency of the issued bond is the dollar. *Maturity_w* is the standardized value of maturity winsorized at 5% and 95% levels. $\mathbb{1}(Maturity > 1y)$ is a dummy variable that is 1 if maturity is greater than 1 year. Controls include the local currency amount of the size of the issuance and a dummy variable for the status of investment-grade status of the bond. The full sample includes all observations. Partial & FC refers to observations where the nationality of the company is not the United States, a country in the Eurozone, Japan, Great Britain or Switzerland, but the currency is either USD, EUR, JPY, GBP or CHF. [†] means that the sample is further restricted only to those firms that issued debt in multiple currencies in a given month.

that has access to multiple markets chooses to issue the longer maturity bond in dollars as opposed to issuing in other currencies. In column (4), we repeat the results for a modification

of the regression in column (1), but use $Firm * Month$ fixed effects instead in a sample that is restricted to those firms that issued debt in multiple currencies in a given month. In column (5), we repeat column (3) in the new sample with $Firm * Month$ fixed effects. In both cases, the results corroborate Hypothesis BI-1.³⁸

6 Local currency and dominant currency debt mix

In this section, we test the predictions of our model using a cross-section of the emerging market economies for which data on corporate debt in different currencies are available.³⁹ To this end, we prove the following extension of Theorem 2.1 for the case wherein firms issue a mixture of local currency (LC) and dollar-denominated debt (see Theorem G.1 in the Appendix for the proof. Note that, while Proposition 6.1 is a partial equilibrium result, it still holds true in general equilibrium when debt overhang costs are sufficiently small).

Proposition 6.1 *Suppose that (1) $q_i(i) = q_i(\$)$ (that is, issuing in LC costs the same as issuing in dollars); (2) the variance of all shocks is sufficiently small; (3) inflation in all countries is determined by (15); and (4) issuing debt in both LC and dollars is optimal. Then,*

(a) *the fraction $\frac{B_{i,t}(i)}{B_{i,t}(\$)\mathcal{E}_{\$,i,t}}$ is monotone increasing in the covariance $\text{Cov}_t(\varepsilon_{i,t+1}, \varepsilon_{\$,t+1})$ if and only if $B_{i,t}(i) \geq B_{i,t}(\$)\mathcal{E}_{\$,i,t}$;*

(b) *the fraction $\frac{B_{i,t}(i)}{B_{i,t}(\$)\mathcal{E}_{\$,i,t}}$ is always monotone decreasing in $\sigma_{i,\varepsilon}$.*

Items (a)-(b) of Proposition 6.1 directly translate into the following two empirical hypotheses:

³⁸ When we repeat column (2) using $Firm * Month$ fixed effects, we get a coefficient similar in magnitude, but yet statistically insignificant. Note, however, that the power of these regressions is low due to the large number of fixed effects.

³⁹ Data were obtained from the Institute for International Finance (IIF) for the period from 2005 Q1 to 2018 Q2. The countries in our sample are Argentina, Brazil, Chile, China, Colombia, Czechia, Hong Kong, Hungary, India, Indonesia, Israel, Republic of Korea, Malaysia, Mexico, Poland, Russian Federation, Saudi Arabia, Singapore, South Africa, Thailand and Turkey.

Hypothesis CS-1: The local currency share of corporate debt is *higher* for countries in which domestic inflation correlates more with US inflation when controlling for relevant factors.

Indeed, local currency debt partly replicates insurance properties of the dominant currency in downturns, while it is a better hedge against domestic productivity shocks. In order to test this hypothesis, we proceed as follows. For each country i in our sample, we estimated the following time series regression:

$$\pi_t^i = \gamma_0 + \gamma_1 \cdot \text{Return_MSCIACWorld}_t + \Gamma \cdot \text{Return_DomesticStockIndex}_t^i + \pi_t^{\text{res},i}, \quad (19)$$

where π_t^i is the domestic monthly inflation rate in country i and $\text{Return_MSCIACWorld}_t$ is the monthly return on the MSCI AC World Index. $\text{Return_DomesticStockIndex}_t^i$ is the monthly return on the domestic stock market index. $\pi_t^{\text{res},i}$ are the residuals from this regression. We also run the following regression for the US:

$$\pi_t^{\text{US}} = \mu_0 + \mu_1 \text{Return_MSCIACWorld}_t + \pi_t^{\text{res},\text{US}}, \quad (20)$$

We then run the following regression to compute a proxy for the covariance $\text{Cov}_t(\varepsilon_{i,t+1}, \varepsilon_{\$,t+1})$ between the residual domestic inflation and residual US inflation (see item (a) of Proposition 6.1),

$$\pi_t^{\text{res},i} = \alpha + \beta \pi_t^{\text{res},\text{US}} + \epsilon_t,$$

where $\pi_t^{\text{res},i}$ is the residual domestic monthly inflation rate in country i from (19) and $\pi_t^{\text{res},\text{US}}$ is the residual monthly inflation rate in the US from (20). We denote the estimated slope coefficient by $\hat{\beta}_i^{\pi_t^{\text{res},i}, \pi_t^{\text{res},\text{US}}}$.

We then run the following cross-sectional regression:

$$\frac{\text{LCU}}{\text{USD}}_i = \alpha_1 + \beta_1 \hat{\beta}_i^{\pi_t^{\text{res},i}, \pi_t^{\text{res},\text{US}}} + X_i + \eta_i. \quad (21)$$

Here, $\frac{\bar{LCU}}{\bar{USD}_i}$ is the average ratio of debt denominated in local currency to debt denominated in dollars for corporates in the countries of the dataset; X_i denotes other control variables.⁴⁰

Item (a) of Proposition 6.1 predicts that the coefficient β_1 in the regression (21) should be positive. The first three columns of Table 3 show that this is indeed the case. In column (1), we show the results of a univariate regression. In column (2), we add an additional control variable $ka\bar{o}pen_i$: a financial openness index obtained from Chinn and Ito (2006). In column (3), we take the predictions of the model literally as they appear in item (a) of the Proposition 6.1: $\beta_1 > 0$ for countries where $\frac{\bar{LCU}}{\bar{USD}_i} > 1$ and we exclude the two countries where $\frac{\bar{LCU}}{\bar{USD}_i} < 1$, namely, Hong Kong and Mexico. In all three columns, regressions corroborate *Hypothesis CS-1*.⁴¹

A second hypothesis is the following:

Hypothesis CS-2: Firms in countries with more volatile domestic inflation tend to have less debt denominated in local currency.⁴²

To test this hypothesis, we calculate the standard deviation of $\pi_t^{res,i}$ as a proxy for $\sigma_{\varepsilon,i}$ in Proposition 6.1, and then run the following cross-sectional regression:

$$\frac{\bar{LCU}}{\bar{USD}_i} = \alpha_2 + \beta_2 \sigma_i^{\pi_t^{res,i}} + X_i + \eta_i. \quad (22)$$

Proposition 6.1, item (b) predicts that $\beta_2 < 0$. Column (4) of Table 3 shows the results of regression (22). Although the result is lacking statistical significance, the sign of the coefficient is indeed consistent with our theoretical prediction.

⁴⁰See subsection G.2 for averages across countries.

⁴¹All our results are qualitatively and quantitatively similar when we use raw domestic and US inflation rates, instead of residuals. Moreover, all results remain valid if we use the share of local currency debt in total debt instead of the ratio of local currency debt to USD debt.

⁴²Farhi and Maggiori (2018) make a related prediction that firms in countries with a volatile nominal rate tend to issue dollars.

Table 3: The cross-section of the local currency to dollar debt ratio

	(1)	(2)	(3)	(4)
	$\frac{\bar{LCU}}{USD}_i$	$\frac{\bar{LCU}}{USD}_i$	$\frac{\bar{LCU}}{USD}_i$	$\frac{\bar{LCU}}{USD}_i$
$\hat{\beta}_i^{\pi_t^{res,i}, \pi_t^{res,US}}$	3.951***	3.930***	3.713***	
	(0.680)	(0.640)	(0.775)	
\bar{kaopen}_i		-0.0108	0.102	-0.334
		(0.327)	(0.413)	(0.349)
$\sigma_i^{\pi_t^{res,i}}$				-2.218
				(1.306)
Observations	17	17	15	17
R-squared	0.537	0.537	0.409	0.217

Notes: Robust standard errors in parentheses. *, **, *** denote significance at the 10, 5, and 1% levels respectively. $\frac{\bar{LCU}}{USD}_i$ is the mean share of local currency debt obtained from the IIF for each of the 17 emerging market economies between 2005 Q1 and 2018 Q2. $\hat{\beta}_i^{\pi_t^{res,i}, \pi_t^{res,US}}$ is the estimated regression coefficient for a linear regression of residuals of monthly domestic inflation rate from (19) on the residuals of the US inflation rate from (20). \bar{kaopen}_i is the mean of the Chinn-Ito financial openness index for each country. $\sigma_i^{\pi_t^{res,i}}$ is the standard deviation of the residuals of the monthly domestic inflation rate obtained from (19). In column (3), Hong Kong and Mexico are excluded.

7 Optimal monetary policy

Our general equilibrium framework allows us to discuss the macroeconomic implications of a dominant currency debt equilibrium and the role of the central bank of that dominant currency country as the world's central bank.

An active stabilization policy of the dominant currency country lowers *ex-post* the real debt burdens of firms through higher inflation and exchange rate depreciation. Therefore, this policy reduces the effective cost of issuing dominant currency debt, thereby prompting firms to take on a higher leverage *ex-ante*. However, higher leverage also means higher distress costs in the face of more severe shocks. Even though active monetary policy in economic downturns is optimal *ex-post* when a crisis state is realized, that policy is never optimal *ex-ante*. Namely, expected welfare gains from reducing the distress costs of firms are more than offset by the welfare costs of higher leverage. Central banks would prefer not to provide this insurance to firms *ex-ante*, but they cannot credibly do so.

We thus undertake the following thought experiment. Assume that the global central bank optimally assigns weights on the output gaps of different countries in order to maximize global welfare, taking into account all spillovers that arise from the interconnectedness of different countries due to global value chains. We then make the following assumption:

Assumption 5 *There exist $\chi_i \geq 0$, $i = 1, \dots, N$, such that*

$$\mathcal{P}_{\$,t,t+1} = \prod_i (1 - \bar{L}_{t+1}(i)/\bar{L}_{t+1}^*(i))^{\chi_i} .$$

The following is thus true.

Proposition 7.1 *The welfare maximizing policy is to react only to the output gap in countries with:*

- *low TFP variance of $a_{i,t}$*

- *low restructuring cost*, $1 - \zeta_i$
- *low importance in global trade*, ξ_i

The global central bank chooses weights to precisely limit the leverage of firms in countries where the adverse effects of leverage are the highest as shown in Proposition 7.1. That in turn reduces leverage ex-ante and improves global welfare. Our results also have implications for the recent literature on the Global Financial Cycle.⁴³ First, it might be optimal for the dominant currency country to respond to global economic conditions; and second, the dynamics of global expectations for the monetary policy of the dominant currency central bank might be as important as the monetary policy itself because it is these expectations that determine the ex-ante leverage of firms.

8 Additional results and further evidence

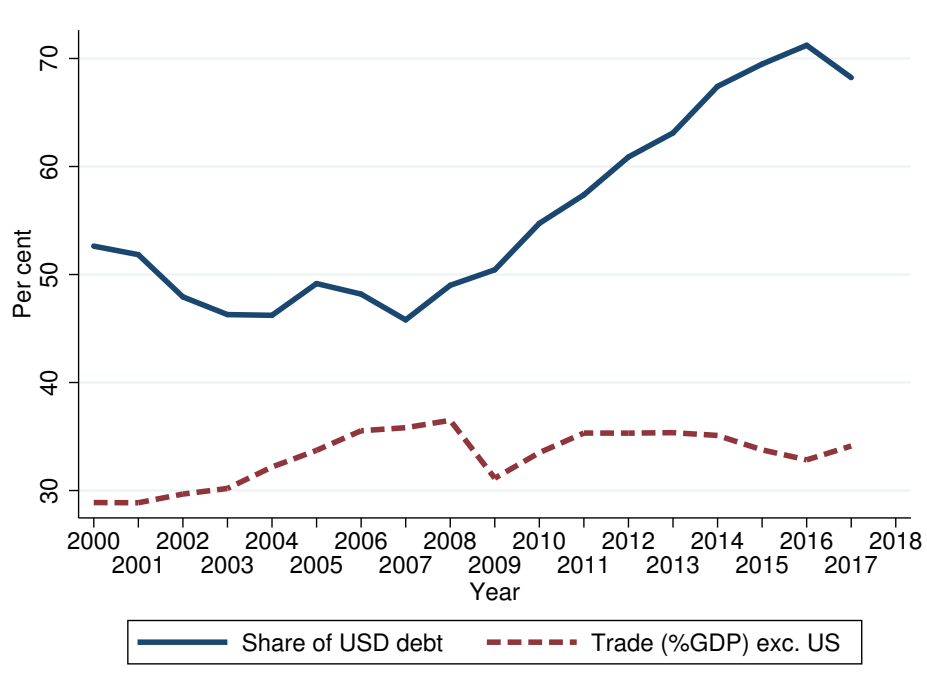
8.1 Dollar debt and international trade

Our model also makes predictions about the relationship between international trade and dollar-denominated debt. As we show in the Appendix (see the proof for Proposition 7.1), in the dominant currency debt equilibrium of Theorem 2.2, an increase in the coefficient ϕ of monetary policy effectiveness of the dominant currency country's central bank is always associated with (i) more issuance of debt denominated in the dominant currency; and (ii) a drop in the conditional expectations for the amount of international trade. This result is intuitive: An aggressive monetary policy provides incentives for firms to choose higher leverage, which ex post leads to more debt overhang and a drop in international demand. Thus, in the extended version of the model that is discussed in the previous section, shocks to $\phi_{\$,t}$ should move trade and the amount of debt denominated in the dominant currency

⁴³(see, for example, [Gourinchas and Rey \(2007\)](#), [Gourinchas, Govillot and Rey \(2010\)](#), [Rey \(2013\)](#), [Cerutti, Claessens and Rose \(2017\)](#), [Miranda-Agrippino and Rey \(2018\)](#)).

in opposite directions. Figure 6 shows the joint dynamics of dollar-denominated debt and international trade over the last two decades. Consistent with our theory, the pre- and post-crisis trends in Figure 1 move-to-one with opposite trends in international trade.⁴⁴

Figure 6: Trade and Debt



Source: BIS, World Bank, FRED, authors' calculations

Notes: $TotalTrade(\%GDP)_t^{exUS}$ is the total trade to world GDP, excluding the US.

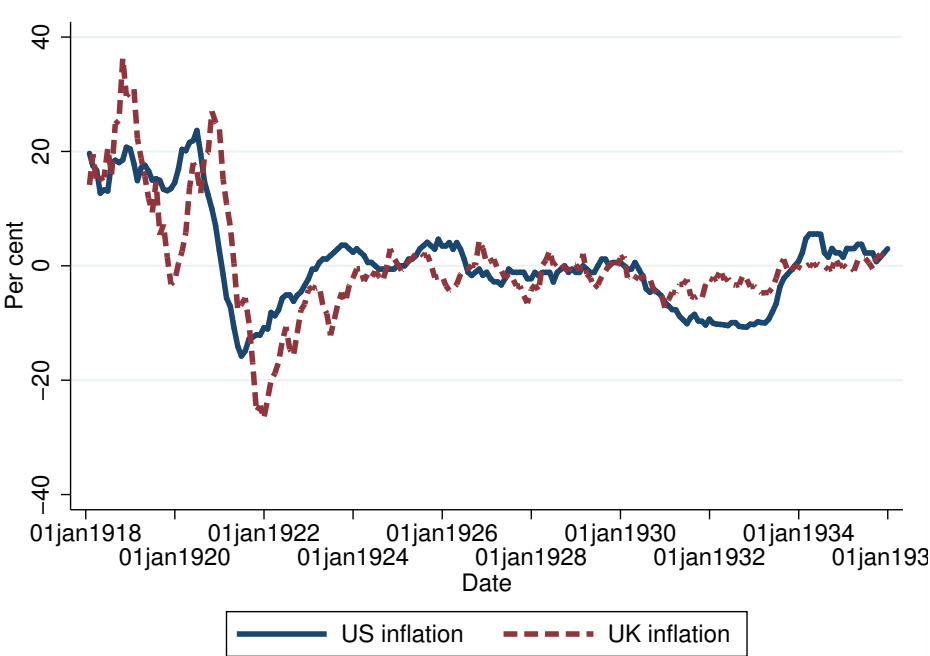
8.2 Pound vs. dollar in the interwar years

One can use the expectations channel to shed light on the history of multiple, repeated switches between the pound and the dollar and their roles in the main reserve currencies

⁴⁴Indeed, regressions of yearly data for the share of dollar debt on differences in dollar and Euro IRP and total trade to world GDP, excluding the US, yields a positive and significant coefficient for IRP differences and a negative coefficient for trade in line with our predictions. We omit this for brevity, but the results are available upon request.

during the inter-war period (see [Chițu, Eichengreen and Mehl \(2014\)](#)). Consider the two currencies (the pound and the dollar) with sufficiently similar indices $\phi_{\$,t} \approx \phi_{GBP,t}$. Our model predicts that shocks to expectations about the difference $\phi_{\$,t} - \phi_{GBP,t}$ can lead to quick switches back and forth between different dominant currency debt equilibria, wherein one currency repeatedly gains and then loses the dominant currency role to its competitor. Consistent with our theory, the pound started losing its role as the dominant currency after the negative inflation surprise at the beginning of the 1920s during the 1920-21 recession ([Figure 7](#)). At the same time, the dollar faced greater deflation during the Great Depression, (1929-1939) with a subsequent partial regaining of dominance by the pound, based on the evidence provided by [Chițu, Eichengreen and Mehl \(2014\)](#).

Figure 7: Historical Inflation Rates



Source: *Global Financial Data, Office of National Statistics, BIS*

9 Conclusion

We propose a “debt view” to explain the dominant international role of the dollar using an international general equilibrium model in which firms optimally choose the currency composition of their nominal debt. Theoretically, the dominant currency is the one that depreciates in global downturns at the horizons of corporate debt maturity (around six years). Empirically, the dollar fits this description, despite being a safe haven currency over horizons up to a year. Monetary policy is a key determinant in the choice of the dominant currency. Expansionary monetary policy in global downturns lowers real debt burdens of firms through its impact on inflation and exchange rates. Indeed, differences in inflation risk premia between the United States and the Eurozone can explain the fall and the rise of the dominance of the dollar.

What do our results imply for the future of the dollar? Many explanations of the dominant role of the dollar in the international monetary system feature arguments like inertia, size, network externalities, and market liquidity. All these arguments suggest that changes in the dominance status of a currency occur very slowly. By contrast, our results suggest that the dollar can lose its dominance if the expectations that the Federal Reserve is able to stimulate the economy and reduce real debt burdens of firms during global crises actually decline. As this view relies on the beliefs of market participants, this change might occur abruptly.

Our model can be extended in multiple directions. First, addressing the interactions between the role of the dollar in trade and finance may shed important light on endogenous inflation dynamics and the role of the dollar in trade invoicing. Second, modelling the demand for safe assets would help in understanding the role of the dollar for financial intermediation and household balance sheets. We leave these important questions for future research.

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A Consumption and production decisions

In the appendix, we consider a more general preference specification with potentially different weights θ_j defining the consumption bundle:

$$C_{i,t} = \left(\sum_j \theta_j \int_0^1 (\tilde{C}_{i,t}(j, \omega))^{\frac{\eta-1}{\eta}} d\omega \right)^{\frac{\eta}{\eta-1}}.$$

We will also define the respective price index

$$P_{i,t} = \left(\sum_j \theta_j^\eta \int_0^1 (P_t^i(j, \omega))^{1-\eta} d\omega \right)^{(1-\eta)^{-1}}. \quad (23)$$

We also allow the idiosyncratic shock distributions to be heterogeneous across countries, with country-specific indices ℓ_j , $j = 1, \dots, N$.

Proof of Lemma 1.1. Given a chosen level of nominal consumption expenditures $\hat{C}_{i,t}$, the intra-temporal optimization problem of a household is given by

$$\max \left\{ \sum_j \theta_j \int_0^1 (\tilde{C}_{i,t}(j, \omega))^{\frac{\eta-1}{\eta}} d\omega : \sum_j \int \tilde{C}_{i,t}(j, \omega) P_t^i(j, \omega) d\omega = \hat{C}_{i,t} \right\}.$$

The first order condition gives

$$\theta_j \tilde{C}_{i,t}(j, \omega)^{-1/\eta} = \lambda^{-1/\eta} P_t^i(j, \omega),$$

where λ is the Lagrange multiplier of the intra-temporal budget constraint. Thus,

$$\tilde{C}_{i,t}(j, \omega) = \lambda \theta_j^\eta P_t^i(j, \omega)^{-\eta}$$

and the budget constraint implies

$$\hat{C}_{i,t} = \lambda \sum_j \theta_j^\eta \int (\tilde{P}_t^i(j, \omega))^{1-\eta} d\omega$$

implying that

$$\lambda = \hat{C}_{i,t} \mathcal{P}_{i,t}^{\eta-1}.$$

so that

$$\tilde{C}_{i,t}(j, \omega) = \theta_j^\eta (\hat{C}_{i,t} / \mathcal{P}_{i,t}) P_t^i(j, \omega)^{-\eta} \mathcal{P}_{i,t}^\eta.$$

and hence the consumption aggregator is given by

$$\begin{aligned} C_{i,t} &= \left(\sum_j \theta_j \int_0^1 (\tilde{C}_{i,t}(j, \omega))^{\frac{\eta-1}{\eta}} d\omega \right)^{\eta/(\eta-1)} \\ &= \left(\sum_j \theta_j \int_0^1 (\theta_j^\eta (\hat{C}_{i,t} / \mathcal{P}_{i,t}) P_t^i(j, \omega)^{-\eta} \mathcal{P}_{i,t}^\eta)^{\frac{\eta-1}{\eta}} d\omega \right)^{\eta/(\eta-1)} \\ &= \mathcal{P}_{i,t}^{-1} \hat{C}_{i,t}. \end{aligned}$$

This is the known result about Dixit-Stiglitz aggregators: Consumption expenditures equal consumption aggregator times the price index.

Thus, the utility function of the households in terms of the nominal expenditures can be expressed as

$$E \left[\sum_{t=0}^{\infty} e^{-\beta t} \left(\frac{C_{i,t}^{1-\gamma}}{1-\gamma} - \nu N_{i,t} \right) \right]$$

under the inter-temporal budget constraint

$$E \left[\sum_{t=0}^{\infty} C_{i,t} \mathcal{P}_{i,t} M_{i,t} \right] \leq W_{i,0} + E \left[\sum_{t=0}^{\infty} w_{i,t} N_{i,t} M_{i,t} \right],$$

where $W_{i,0}$ is household's initial wealth. That is, total present value (discounted with the market stochastic discount factor) of nominal expenditures should not exceed initial wealth plus the value of nominal wages. Intra-temporal optimization over $C_{i,t}$, $N_{i,t}$ delivers

$$e^{-\beta t} C_{i,t}^{-\gamma} = \lambda \mathcal{P}_{i,t} M_{i,t}, \quad e^{-\beta t} \nu = \lambda w_{i,t} M_{i,t},$$

which gives $w_{i,t} = \nu C_{i,t}^{\gamma} \mathcal{P}_{i,t}$, as well as the inter-temporal Euler equation $e^{-\beta} C_{i,t+1}^{-\gamma} / C_{i,t}^{-\gamma} = M_{i,t,t+1} (\mathcal{P}_{i,t+1} / \mathcal{P}_{i,t})$. Q.E.D.

Due to the assumed identical CES structure of consumption and production aggregators, for each time $t + 1$, each firm (i, ω) faces the downward sloping demand for its goods sold in country j , and given by

$$D_{t+1}^j(i) = \mathcal{D}_{t+1}^j(i) (P_{t+1}^j)^{-\eta}, \tag{24}$$

where the demand coefficients $\mathcal{D}_{t+1}^j(i)$ are determined in equilibrium. We will use

$$\bar{D}_{t+1}(i) = \sum_{j=1}^N \mathcal{D}_{t+1}^j(i)$$

to denote the global demand for the goods produced by any given (i, ω) firm. Since all firms within each country are symmetric, this demand does not depend on ω .

With flexible prices and CES demand, it is always optimal for each firm to set prices in different countries using the law of one price: $P_{t+1}^j(i) = P_{t+1}^i(i) / \mathcal{E}_{j,i,t+1}$. Therefore, global

demand can be rewritten as $\bar{D}_{t+1}(i) = (P_{t+1}^i(i))^{-\eta} \tilde{\mathcal{D}}_t(i)$, with

$$\tilde{\mathcal{D}}_t(i) \equiv \sum_j \mathcal{D}_t^j(i) \mathcal{E}_{j,i,t}^\eta. \quad (25)$$

The following is true.

Lemma A.1 *Let*

$$\bar{\alpha} = \left(\frac{\alpha}{1-\alpha} \right)^{1-\alpha} + \left(\frac{1-\alpha}{\alpha} \right)^\alpha.$$

A country i firm optimally sets the price

$$P_t^i(i) = \mathcal{P}_{i,t} \frac{\eta}{\eta-1} \bar{\alpha} (\nu C_{i,t}^\gamma)^{1-\alpha} Z_{i,t}^{-(\eta-1)^{-1}} e^{-a_{i,t}} \quad (26)$$

in the domestic market (in domestic currency) and sets prices in other countries using the law of one price; it hires labour

$$L_t(i) = \bar{\mathcal{L}}_i (\nu C_{i,t}^\gamma)^{-(\alpha+\eta(1-\alpha))} \mathcal{P}_{i,t}^{-\eta} \tilde{\mathcal{D}}_t(i) Z_{i,t} e^{a_{i,t}(\eta-1)},$$

where we have defined

$$\bar{\mathcal{L}}_i = \left(\frac{\eta}{\eta-1} \bar{\alpha} \right)^{-\eta} \left(\frac{1-\alpha}{\alpha} \right)^\alpha,$$

and spends

$$X_t(i, \omega) = \bar{\chi} (\nu C_{i,t}^\gamma)^{(1-\alpha)(1-\eta)} \mathcal{P}_{i,t}^{-\eta} \tilde{\mathcal{D}}_t(i) Z_{i,t}(\omega) e^{a_{i,t}(\eta-1)}$$

on intermediate goods, where we have defined

$$\bar{\chi} = \left(\frac{\eta}{\eta - 1} \bar{\alpha} \right)^{-\eta} \left(\frac{\alpha}{1 - \alpha} \right)^{1 - \alpha}.$$

The demand of country i firms for (j, s) goods is given by

$$\tilde{X}_{t,(i,\omega)}(j, s) = \theta_j^\eta (P_t^i(j, s))^{-\eta} \bar{\chi} (\nu C_{i,t}^\gamma)^{(1-\alpha)(1-\eta)} \tilde{\mathcal{D}}_t(i) e^{a_{i,t}(\eta-1)} Z_{i,t} \quad (27)$$

Total after tax profits of country i firms are given by

$$\Pi_{i,t} = \Omega_{i,t} Z_{i,t}$$

with

$$\Omega_{i,t} = \tilde{\mathcal{D}}_t(i) \mathcal{P}_{i,t}^{1-\eta} (1 - \tau_i) \bar{\eta} \left((\nu C_{i,t}^\gamma)^{1-\alpha} e^{-a_{i,t}} \right)^{1-\eta}. \quad (28)$$

Proof of Lemma A.1. For an (i, ω) firm, the global demand for its goods is linear in the vector $((P_t^j(i, \omega))^{-\eta})_{j=1}^N$, and the firm will be choosing that price vector. Given that vector, the firm will face a vector of demands,

$$D_t^j((i, \omega), P) = \mathcal{D}_t^j(i) P_t^j(i, \omega)^{-\eta},$$

and hence the nominal income in the domestic currency will be given by

$$\mathcal{I}((P_t^j)_{j=1}^N) = \sum_j \mathcal{D}_t^j(i) P_t^j(i, \omega)^{1-\eta} \mathcal{E}_{j,i,t}.$$

Thus, first, the objective of the firm is to maximize its income given the fixed demand:

$$\max\{\mathcal{I}((P_t^j)_{j=1}^N) : \sum_j \mathcal{D}_t^j(i) P_t^j(i, \omega)^{-\eta} = \bar{D}\}.$$

The first order conditions for this problem give

$$(1 - \eta)\mathcal{D}_t^j(i) P_t^j(i, \omega)^{-\eta} \mathcal{E}_{j,i,t} + \lambda \eta \mathcal{D}_t^j(i) P_t^j(i, \omega)^{-\eta-1} = 0,$$

which gives

$$P_t^j(i, \omega) \mathcal{E}_{j,i,t} = \lambda \frac{\eta}{\eta - 1}$$

implying that a flexible price monopolist facing CES demand always sets the prices satisfying the law of one price. Thus, total demand satisfies

$$\begin{aligned} \bar{D} &= \sum_j \mathcal{D}_t^j(i) P_t^j(i, \omega)^{-\eta} = \sum_j \mathcal{D}_t^j(i) (P_t^j(i, \omega) / \mathcal{E}_{j,i,t})^{-\eta} = P_t^i(i, \omega)^{-\eta} \sum_j \mathcal{D}_t^j(i) \mathcal{E}_{j,i,t}^\eta \\ &= P_t^i(i, \omega)^{-\eta} \tilde{\mathcal{D}}_t(i). \end{aligned}$$

At the same time, the income is given by

$$\sum_j \mathcal{D}_t^j(i) P_t^j(i, \omega)^{1-\eta} \mathcal{E}_{j,i,t} = \sum_j \mathcal{D}_t^j(i) (P_t^j(i, \omega) / \mathcal{E}_{j,i,t})^{1-\eta} \mathcal{E}_{j,i,t} = P_t^i(i, \omega)^{1-\eta} \tilde{\mathcal{D}}_t(i).$$

Given the production function (2), the firm matching the demand needs to produce

$$\bar{D} = Z_{i,t}(\omega)^{(\eta-1)^{-1}} e^{a_{i,t}} L_t(i, \omega)^{1-\alpha} X_t(i, \omega)^\alpha \quad (29)$$

with

$$X_t(i, \omega) = \left(\sum_{j=1}^N \theta_j \int_0^1 (\tilde{X}_{t,(i,\omega)}(j, s))^{\frac{\eta-1}{\eta}} ds \right)^{\frac{\eta}{\eta-1}}.$$

Hence, the first objective of the firm is to minimize the production cost:

$$\min \left(w_{i,t} L_{i,t}(\omega) + \sum_j \int_0^1 P_t^i(j, s) \tilde{X}_{t,(i,\omega)}(j, s) ds \right)$$

under the demand-matching constraint (29). Writing down the first order conditions gives

$$w_{i,t} = \lambda(1 - \alpha) Z_{i,t}(\omega)^{(\eta-1)^{-1}} e^{a_{i,t}} L_t(i, \omega)^{-\alpha} X_t(i, \omega)^\alpha$$

so that

$$L_t(i, \omega) = \left(\lambda(1 - \alpha) w_{i,t}^{-1} Z_{i,t}(\omega)^{(\eta-1)^{-1}} e^{a_{i,t}} X_t(i, \omega)^\alpha \right)^{\alpha^{-1}}$$

Similarly,

$$P_t^i(j, s) = \lambda \alpha Z_{i,t}(\omega)^{(\eta-1)^{-1}} e^{a_{i,t}} L_t(i, \omega)^{1-\alpha} X_t(i, \omega)^{\alpha-1} \frac{\eta}{\eta-1} X_t(i, \omega)^{\eta-1} \theta_j \frac{\eta-1}{\eta} \tilde{X}_{t,(i,\omega)}(j, s)^{-1/\eta}$$

implying that

$$\tilde{X}_{t,(i,\omega)}(j, s) = \theta_j^\eta (P_t^i(j, s))^{-\eta} \Gamma$$

where

$$\Gamma = \left(\lambda \alpha Z_{i,t}(\omega)^{(\eta-1)^{-1}} e^{a_{i,t}} L_t(i, \omega)^{1-\alpha} X_t(i, \omega)^{\eta-1+\alpha-1} \right)^\eta$$

Hence,

$$\begin{aligned}
X_t(i, \omega) &= \left(\sum_{j=1}^N \theta_j \int_0^1 (\theta_j^\eta (P_t^i(j, s))^{-\eta} \Gamma)^{\frac{\eta-1}{\eta}} ds \right)^{\frac{\eta}{\eta-1}} \\
&= \mathcal{P}_{i,t}^{-\eta} \Gamma = \mathcal{P}_{i,t}^{-\eta} \left(\lambda \alpha Z_{i,t}(\omega)^{(\eta-1)^{-1}} e^{a_{i,t}} L_t(i, \omega)^{1-\alpha} X_t(i, \omega)^{\eta^{-1}+\alpha-1} \right)^\eta \\
&= \mathcal{P}_{i,t}^{-\eta} \left(\lambda \alpha Z_{i,t}(\omega)^{(\eta-1)^{-1}} e^{a_{i,t}} \left(w_{i,t}^{-1} \lambda (1-\alpha) Z_{i,t}(\omega)^{(\eta-1)^{-1}} e^{a_{i,t}} X_t(i, \omega)^\alpha \right)^{\alpha^{-1}} \right)^{1-\alpha} X_t(i, \omega)^{\eta^{-1}+\alpha-1} \Big)^\eta \\
&= \mathcal{P}_{i,t}^{-\eta} X_t(i, \omega) (Z_{i,t}(\omega)^{(\eta-1)^{-1}} e^{a_{i,t}})^{\alpha^{-1}\eta} \lambda^{\alpha^{-1}\eta} \alpha^{\alpha^{-1}\eta} \alpha^\eta (w_{i,t}^{-1} (1-\alpha))^{\alpha^{-1}\eta}.
\end{aligned}$$

Hence,

$$\begin{aligned}
\lambda &= \left(\mathcal{P}_{i,t}^{-\eta} (Z_{i,t}(\omega)^{(\eta-1)^{-1}} e^{a_{i,t}})^{\alpha^{-1}\eta} \alpha^\eta (w_{i,t}^{-1} (1-\alpha))^{\alpha^{-1}\eta} \right)^{-\alpha\eta^{-1}} \\
&= \mathcal{P}_{i,t}^\alpha (Z_{i,t}(\omega)^{(\eta-1)^{-1}} e^{a_{i,t}})^{-1} \alpha^{-\alpha} w_{i,t}^{1-\alpha} (1-\alpha)^{-(1-\alpha)}
\end{aligned}$$

At the same time, (29) takes the form

$$\begin{aligned}
\bar{D} &= Z_{i,t}(\omega)^{(\eta-1)^{-1}} e^{a_{i,t}} L_t(i, \omega)^{1-\alpha} X_t(i, \omega)^\alpha \\
&= Z_{i,t}(\omega)^{(\eta-1)^{-1}} e^{a_{i,t}} \left(w_{i,t}^{-1} \lambda (1-\alpha) Z_{i,t}(\omega)^{(\eta-1)^{-1}} e^{a_{i,t}} X_t(i, \omega)^\alpha \right)^{\alpha^{-1}(1-\alpha)} X_t(i, \omega)^\alpha \\
&= (w_{i,t}^{-1} \lambda (1-\alpha))^{\alpha^{-1}-1} (Z_{i,t}(\omega)^{(\eta-1)^{-1}} e^{a_{i,t}})^{\alpha^{-1}} X_t(i, \omega) \\
&= \left((\mathcal{P}_{i,t}/w_{i,t})^\alpha (Z_{i,t}(\omega)^{(\eta-1)^{-1}} e^{a_{i,t}})^{-1} \alpha^{-\alpha} (1-\alpha)^\alpha \right)^{\alpha^{-1}-1} \\
&\quad \times (Z_{i,t}(\omega)^{(\eta-1)^{-1}} e^{a_{i,t}})^{\alpha^{-1}} X_t(i, \omega)
\end{aligned}$$

so that

$$X_t(i, \omega) = \left(\frac{w_{i,t}}{\mathcal{P}_{i,t}} \right)^{1-\alpha} \bar{D} Z_{i,t}^{-(\eta-1)^{-1}} e^{-a_{i,t}} \left(\frac{\alpha}{1-\alpha} \right)^{1-\alpha}$$

and

$$L_t(i, \omega) = \left(\frac{\mathcal{P}_{i,t}}{w_{i,t}} \right)^\alpha \bar{D} Z_{i,t}^{-(\eta-1)^{-1}} e^{-a_{i,t}} \left(\frac{1-\alpha}{\alpha} \right)^\alpha$$

Thus, given the link between demand and prices, $\bar{D} = \tilde{\mathcal{D}}_t(i) P_t^i(i, \omega)^{-\eta}$, the maximization problem over prices is reduced to maximizing

$$\begin{aligned} & - (w_{i,t} L_{i,t}(\omega) + X_t(i, \omega) \mathcal{P}_{i,t}) + \tilde{\mathcal{D}}_t(i) P_t^i(i, \omega)^{1-\eta} \\ & = - \left(w_{i,t} \left(\frac{\mathcal{P}_{i,t}}{w_{i,t}} \right)^\alpha \bar{D} Z_{i,t}^{-(\eta-1)^{-1}} e^{-a_{i,t}} \left(\frac{1-\alpha}{\alpha} \right)^\alpha + \left(\frac{w_{i,t}}{\mathcal{P}_{i,t}} \right)^{1-\alpha} \bar{D} Z_{i,t}^{-(\eta-1)^{-1}} e^{-a_{i,t}} \left(\frac{\alpha}{1-\alpha} \right)^{1-\alpha} \mathcal{P}_{i,t} \right) \\ & + \tilde{\mathcal{D}}_t(i) P_t^i(i, \omega)^{1-\eta} \\ & = -\bar{\alpha} w_{i,t}^{1-\alpha} (\mathcal{P}_{i,t})^\alpha \bar{D} Z_{i,t}^{-(\eta-1)^{-1}} e^{-a_{i,t}} + \tilde{\mathcal{D}}_t(i) P_t^i(i, \omega)^{1-\eta} \\ & = -\bar{\alpha} w_{i,t}^{1-\alpha} (\mathcal{P}_{i,t})^\alpha \tilde{\mathcal{D}}_t(i) P_t^i(i, \omega)^{-\eta} Z_{i,t}^{-(\eta-1)^{-1}} e^{-a_{i,t}} + \tilde{\mathcal{D}}_t(i) P_t^i(i, \omega)^{1-\eta}, \end{aligned}$$

where we have defined

$$\bar{\alpha} = \left(\frac{\alpha}{1-\alpha} \right)^{1-\alpha} + \left(\frac{1-\alpha}{\alpha} \right)^\alpha.$$

Hence, the optimal price set by the firm is given by

$$P_t^i = \frac{\eta}{\eta-1} \bar{\alpha} w_{i,t}^{1-\alpha} (\mathcal{P}_{i,t})^\alpha Z_{i,t}^{-(\eta-1)^{-1}} e^{-a_{i,t}},$$

and the total profit is given by

$$\begin{aligned} & -\bar{\alpha} w_{i,t}^{1-\alpha} (\mathcal{P}_{i,t})^\alpha \tilde{\mathcal{D}}_t(i) \left(\frac{\eta}{\eta-1} \bar{\alpha} w_{i,t}^{1-\alpha} (\mathcal{P}_{i,t})^\alpha Z_{i,t}^{-(\eta-1)^{-1}} e^{-a_{i,t}} \right)^{-\eta} Z_{i,t}^{-(\eta-1)^{-1}} e^{-a_{i,t}} \\ & + \tilde{\mathcal{D}}_t(i) \left(\frac{\eta}{\eta-1} \bar{\alpha} w_{i,t}^{1-\alpha} (\mathcal{P}_{i,t})^\alpha Z_{i,t}^{-(\eta-1)^{-1}} e^{-a_{i,t}} \right)^{1-\eta} \\ & = \bar{\eta} \left(w_{i,t}^{1-\alpha} (\mathcal{P}_{i,t})^\alpha Z_{i,t}^{-(\eta-1)^{-1}} e^{-a_{i,t}} \right)^{1-\eta} \tilde{\mathcal{D}}_t(i) \end{aligned}$$

where we have defined

$$\bar{\eta} \equiv \frac{(\eta - 1)^{\eta-1} \bar{\alpha}^{1-\eta}}{\eta^\eta}.$$

Q.E.D.

B General equilibrium

In our model, all goods are used both for consumption and for production. Total demand $D_t^i(j, s) = D_t^i(j)$ of country i (that is, the joint demand by households and firms) for any given good s produced in country j by the (j, s) firms is thus given by the sum of consumers' and firms' demand:

$$D_t^i(j) = \tilde{C}_{i,t}(j) + \int_0^1 \tilde{X}_{t,(i,\omega)}(j) d\omega. \quad (30)$$

Since all (j, s) firms set prices that are independent of s , we omit the s index and denote these prices by $P_t^i(j) = P_t^i(j, s)$. By Lemma 1.1, consumers' demand is given by

$$\tilde{C}_{i,t}(j) = \theta_j^\eta (P_t^i(j))^{-\eta} \mathcal{P}_{i,t}^\eta C_{i,t}.$$

At the same time, country i firms' demand can be decomposed into the demand of distressed and non-distressed firms. By the law of large numbers, formula (27) and Assumption 1 imply that total country i firms' demand for (j, s) goods can be rewritten as

$$\begin{aligned} & \int_0^1 \tilde{X}_{t,(i,\omega)}(j, s) d\omega \\ &= \theta_j^\eta (P_t^i(j))^{-\eta} \mathcal{P}_{i,t}^{\eta-1} \frac{\bar{\chi}}{\bar{\eta}(1-\tau_i)} \Omega_{i,t} \int_0^1 (Z_{i,t}(\omega) \mathbf{1}_{Z_{i,t}(\omega) > \Psi_{i,t}} + \zeta_i Z_{i,t}(\omega) \mathbf{1}_{Z_{i,t}(\omega) < \Psi_{i,t}}) d\omega, \end{aligned}$$

where $\Psi_{i,t}$ is the distress threshold (5). Define

$$G_i(\Psi_{i,t}) = \ell_i(\ell_i + 1)^{-1} \left((\zeta_i - 1)\Psi_{i,t}^{\ell_i+1} + 1 \right).$$

Then, by direct calculation

$$\int_0^1 (Z_{i,t}(\omega)\mathbf{1}_{Z_{i,t}(\omega) > \Psi_{i,t}} + \zeta_i Z_{i,t}(\omega)\mathbf{1}_{Z_{i,t}(\omega) < \Psi_{i,t}}) d\omega = G_i(\Psi_{i,t})$$

and therefore, using (30), we can rewrite the coefficient $\mathcal{D}_t^i(j)$ in the demand schedule

$D_t^i(j) = \mathcal{D}_t^i(j)(P_t^i(j))^{-\eta}$ (see (24)) as

$$\mathcal{D}_t^i(j) = (\mathcal{P}_{i,t})^\eta \hat{\mathcal{D}}_{i,t}, \quad (31)$$

with

$$\hat{\mathcal{D}}_{i,t} = \theta_j^\eta \left(C_{i,t} + G_i(\Psi_{i,t}) \frac{\bar{\chi}}{\bar{\eta}(1 - \tau_i)} \mathcal{P}_{i,t}^{-1} \Omega_{i,t} \right), \quad i = 1, \dots, N. \quad (32)$$

Equation (32) defines the equilibrium system for global demand coefficients: demand of country i firms for any given good depends on the global demand $\tilde{\mathcal{D}}_t(i)$ (see (25)) for country i goods, as reflected in formula (28) for $\Omega_{i,t}$. Substituting (31) into (25), we get, after some algebra, that $\mathcal{P}_{j,t}^{-\eta} \tilde{\mathcal{D}}_t(j) = \sum_i \hat{\mathcal{D}}_{i,t} \tilde{\mathcal{E}}_{i,j,t}^\eta$. Substituting real exchange rates, we get defining $c_{j,0} = C_{j,0}^\gamma$ that

$$\mathcal{P}_{j,t}^{-\eta} \tilde{\mathcal{D}}_t(j) = \theta_j^\eta (c_{j,0}^{-1} C_{j,t}^\gamma)^\eta \bar{\mathcal{D}}_t, \quad (33)$$

where we have defined the *global demand factor*

$$\bar{\mathcal{D}}_t \equiv \sum_i \hat{\mathcal{D}}_{i,t} c_{i,0}^\eta C_{i,t}^{-\gamma\eta}. \quad (34)$$

Now, in order to derive the equilibrium system for global consumption, we need to compute price indices (1) and their response to debt overhang. By (26) and the Law of One Price, we get that the total contribution of country j firms to country i price index is given by

$$\begin{aligned} \int_0^1 (P_t^i(j, \omega))^{1-\eta} d\omega &= \int_0^1 (\mathcal{E}_{j,i,t} P_t^j(j, \omega))^{1-\eta} d\omega \\ &= (\mathcal{P}_{i,t}^{-1} \tilde{\mathcal{E}}_{j,i,t})^{1-\eta} C_{j,t}^{\gamma(1-\alpha)(1-\eta)} \left(\frac{\eta}{\eta-1} \nu_j^{1-\alpha} \bar{\alpha} e^{-a_{j,t}} \right)^{1-\eta} G_j(\Psi_{j,t}). \end{aligned} \quad (35)$$

Therefore, debt overhang directly affects price level: Consistent with the evidence in [Gilchrist, Schoenle, Sim and Zakrajšek \(2017\)](#), financially constrained firms raise prices because their effective marginal cost of production is higher in distress.⁴⁵ Substituting (35) into formula (23) for the price index, we get

$$1 = \sum_j \theta_j^\eta \left(C_{j,t}^{-\gamma} / C_{i,t}^{-\gamma} \frac{c_{j,0}}{c_{i,0}} \right)^{1-\eta} C_{j,t}^{\gamma(1-\alpha)(1-\eta)} \left(\frac{\eta}{\eta-1} \nu_j^{1-\alpha} \bar{\alpha} e^{-a_{j,t}} \right)^{1-\eta} G_j(\Psi_{j,t}). \quad (36)$$

By assumption, all agents in all countries have identical preferences, markets are complete, and hence consumption is perfectly aligned across countries. As a result, *real exchange rates equal one for all country pairs i, j* and hence nominal exchange rates move one-to-one with relative inflation. This is important: Absent financial frictions, our model would be at odds with the exchange rate disconnect puzzle (see, e.g., [Gabaix and Maggiori \(2015\)](#) and [Itskhoki and Mukhin \(2017\)](#)) and generate counter-factual behaviour of currency risk premia. Define $\bar{C}_t = (C_{i,t}^\gamma c_{i,0}^{-1})^{\eta-1}$. Then, (36) takes the form

$$\bar{C}_t^{1-\alpha} \equiv \sum_{j=1}^N \theta_j^\eta (c_{j,0}^{1-\eta})^{(1-\alpha)} \left(\frac{\eta}{\eta-1} \nu_j^{1-\alpha} \bar{\alpha} e^{-a_{j,t}} \right)^{1-\eta} G_j(\Psi_{j,t}). \quad (37)$$

Equation (37) characterizes equilibrium consumption in the presence of debt overhang. In the frictionless case, we have $G_j(\Psi_{j,t}) = \ell_j(\ell_j + 1)^{-1}$ and hence the frictionless aggregate

⁴⁵See also [Malamud and Zucchi \(2018\)](#).

consumption index, which we denote by $\bar{C}_{t,*}$, is a (non-linear) aggregate of total factor productivities. To solve for the equilibrium with debt overhang, we first need to derive the relationship between global consumption and production demands. To this end, we note that global production demand is proportional to the total exchange-rate weighted sum of domestic production demands, (34). Each domestic demand (32) is a sum of consumption demand $C_{i,t} = (c_{i,0}\bar{C}_t^{(\eta-1)^{-1}})^{\gamma^{-1}}$, and production demand. The latter is proportional to profits, $\Omega_{i,t}$, which are in turn proportional to the global demand factor (34). This leads to an equilibrium fixed point system, whose solution is reported in the following proposition.

Proposition B.1 *We have $\bar{D}_t = d_*\bar{C}_t^{\frac{\gamma^{-1}-\eta}{\eta-1}}$ for some $d_* > 0$.*

We will restrict our attention to equilibria in which a strictly positive fraction of firms in each country is not in distress. That is, $\Psi_{i,t} < 1$ for all $i = 1, \dots, N$. Define

$$\xi_j \equiv d_*(1 - \tau_j)\bar{\eta}(c_{j,0}^{1-\eta})^{(1-\alpha)} (\nu_j^{1-\alpha})^{1-\eta}.$$

By direct calculation, we have

$$\Omega_{i,t} = \xi_i e^{a_{i,t}(\eta-1)} \bar{C}_t^{\hat{\eta}}, \quad \hat{\eta} \equiv \frac{\gamma^{-1}}{\eta-1} + \alpha - 1.$$

The following is true.

Theorem B.2 *There exists at most one equilibrium solution \bar{C}_t to the equation*

$$\bar{C}_t^{1-\alpha} = A \sum_{j=1}^N \frac{\xi_j}{1 - \tau_j} e^{a_{j,t}(\eta-1)} G_j \left(\frac{\mathcal{B}_{j,t} \mathcal{P}_{j,t}^{-1}}{\xi_j e^{a_{j,t}(\eta-1)} \bar{C}_t^{\hat{\eta}}} \right)$$

*satisfying $\max_i \Psi_{i,t} < 1$ and such that \bar{C}_t that is monotonically increasing in $a_{j,t}$, $j = 1, \dots, N$.*⁴⁶

⁴⁶In the case of $\hat{\eta} > 0$, there might exist a “non-economic equilibrium” with an unreasonable feature that

Proof of Proposition B.1. By (33) and (28), we have

$$\Omega_{i,t} = \theta_i^\eta (C_{i,0}^{-\gamma} C_{i,t}^\gamma)^\eta \bar{\mathcal{D}}_t \mathcal{P}_{i,t} (1 - \tau) \bar{\eta} ((\nu C_{i,t}^\gamma)^{1-\alpha} e^{-a_{i,t}})^{1-\eta},$$

so that

$$\begin{aligned} \bar{\mathcal{D}}_t &= \sum_i \hat{\mathcal{D}}_{i,t} C_{i,0}^{\gamma\eta} C_{i,t}^{-\gamma\eta} = \sum_i \left(C_{i,t} + G_i(\Psi_{i,t}) \frac{\bar{\chi}}{\bar{\eta}(1-\tau)} \mathcal{P}_{i,t}^{-1} \Omega_{i,t} \right) C_{i,0}^{\gamma\eta} C_{i,t}^{-\gamma\eta} \\ &= \sum_i \left((C_{i,0}^\gamma (\bar{C}_t)^{(\eta-1)^{-1}})^{\gamma^{-1}} \bar{C}_t^{-\eta/(\eta-1)} \right. \\ &\quad \left. + \theta_i^\eta G_i(\Psi_{i,t}) \bar{\mathcal{D}}_t \bar{C}_t^{\alpha-1} (C_{i,0}^{\gamma(1-\eta)})^{(1-\alpha)} ((\nu)^{1-\alpha} e^{-a_{i,t}})^{1-\eta} \right) \\ &= \bar{c}_0 \bar{C}_t^{\frac{\gamma-1-\eta}{\eta-1}} + \bar{\mathcal{D}}_t \bar{C}_t^{\alpha-1} \bar{\chi} \sum_i \theta_i^\eta G_i(\Psi_{i,t}) (C_{i,0}^{\gamma(1-\eta)})^{(1-\alpha)} ((\nu)^{1-\alpha} e^{-a_{i,t}})^{1-\eta}. \end{aligned}$$

Substituting from (37), we get with $\bar{c}_0 = \sum_i C_{i,0}$ that

$$\bar{\mathcal{D}}_t = \bar{c}_0 \bar{C}_t^{\frac{\gamma-1-\eta}{\eta-1}} + \bar{\mathcal{D}}_t \bar{C}_t^{\alpha-1} \bar{\chi} \bar{C}_t^{1-\alpha} (\bar{\alpha}^{1-\eta} \left(\frac{\eta}{\eta-1} \right)^{1-\eta})^{-1}$$

implying that

$$\bar{\mathcal{D}}_t = d_* \bar{C}_t^{\frac{\gamma-1-\eta}{\eta-1}}$$

with

$$d_* \equiv \frac{\bar{c}_0}{1 - \bar{\chi} (\bar{\alpha}^{1-\eta} \left(\frac{\eta}{\eta-1} \right)^{1-\eta})^{-1}},$$

consumption is decreasing in productivity. For the rest of the paper, we neglect this equilibrium and only focus on the one that we call the “normal equilibrium;” that is, the equilibrium in which \bar{C}_t is monotonically increasing in $a_{j,t}$ for all j .

and hence

$$\begin{aligned}\Omega_{i,t} &= \theta_i^\eta (C_{i,0}^{-\gamma} C_{i,t}^\gamma)^\eta d_* \bar{C}_t^{\frac{\gamma-1-\eta}{\eta-1}} \mathcal{P}_{i,t} (1-\tau) \bar{\eta} ((\nu C_{i,t}^\gamma)^{1-\alpha} e^{-a_{i,t}})^{1-\eta} \\ &= \theta_i^\eta (C_{i,0}^{-\gamma})^\eta d_* \mathcal{P}_{i,t} (1-\tau) \bar{\eta} ((\nu)^{1-\alpha})^{1-\eta} e^{a_{i,t}(\eta-1)} \bar{C}_t^{\bar{\eta}}.\end{aligned}$$

Q.E.D.

Proof of Theorem B.2. We have

$$\Psi_{i,t} = \frac{\mathcal{B}_{i,t}}{\Omega_{i,t}} = \frac{\mathcal{B}_{i,t} \mathcal{P}_{i,t}^{-1}}{\theta_i^\eta (C_{i,0}^{-\gamma})^\eta d_* (1-\tau) \bar{\eta} ((\nu)^{1-\alpha})^{1-\eta} e^{a_{i,t}(\eta-1)} \bar{C}_t^{\bar{\eta}}}$$

and substituting this into equation (37) we get the required. Uniqueness follows by direct calculation. Q.E.D.

C Leverage

Proposition C.1 *Suppose that firms have a possibility of hedging foreign exchange risk by acquiring $h_t \geq 0$ units of a financial derivative contract with a payoff of $X_{t+1} \geq 0$ and a price of $E_t[M_{i,t,t+1} X_{t+1}]$ to be paid at time t . The firm always chooses $h_t = 0$.*

The intuition behind this result is straightforward. Hedging effectively plays a role of investment, and the firm only gets the payoff X_{t+1} from this investment in good (survival) states, while paying the market price at time t to get the payoff in all states. Thus, hedging is just a transfer of funds from shareholders to debt-holders, and firms optimally decide to minimize this transfer.⁴⁷

⁴⁷There is ample evidence that firms often choose not to hedge their foreign currency risk. See, for example, Bodnár (2006) who shows that only 4% of Hungarian firms with foreign currency debt hedge their currency risk exposure. Furthermore, according to Salomao and Varela (2018): “data from the Central Bank of Peru reveals that only 6% of firms borrowing in foreign currency employ financial instruments to hedge the exchange rate risk, and a similar number is found in Brazil.” See also Niepmann and Schmidt-Eisenlohr (2017), Bruno and Shin (2017). While it is known that costly external financing makes hedging optimal (see, for example, Froot, Scharfstein and Stein (1993) and Hugonnier, Malamud and Morellec (2015)),

Proof of Proposition C.1. The maximization problem is

$$\max_{h_t} \left\{ -E_t[M_{t,t+1}X_{t+1}]h_t + E_t \left[M_{t,t+1} \int_{\Omega_{i,t+1} Z_{i,t+1} > \mathcal{B}_{t+1}(B_t) - h_t(1-\tau)X_{t+1}} (\Omega_{i,t+1} Z_{i,t+1} - \mathcal{B}_{t+1}(B_t) + h_t(1-\tau)X_{t+1}) \phi(Z_{i,t+1}) dZ_{i,t+1} \right] \right\}.$$

The derivative of this objective function with respect to h_t is given by

$$-E_t[M_{t,t+1}X_{t+1}] + (1-\tau)E_t \left[M_{t,t+1}X_{t+1} \left(1 - \Phi \left(\frac{\mathcal{B}_{t+1}(B_t) - h_t(1-\tau)X_{t+1}}{\Omega_{i,t+1}} \right) \right) \right] < 0,$$

and hence $h_t = 0$ is optimal.

Q.E.D.

Proof of Theorem 2.1. Firm's problem is to maximize

$$\sum_j E_t \left[M_{i,t,t+1} \left[\left(1 - (1-\rho_i) \left(\frac{\mathcal{B}_{t+1}(B_t)}{\Omega_{i,t+1}} \right)^\ell \right) (1+c) \mathcal{E}_{j,i,t+1} \right] B_{j,t}(1-q_i(j)) + E_t \left[M_{i,t,t+1} \left[-\mathcal{B}_{t+1}(B_t) \left(1 - \left(\frac{\mathcal{B}_{t+1}(B_t)}{\Omega_{i,t+1}} \right)^\ell \right) + \Omega_{i,t+1} \ell(\ell+1)^{-1} \left(1 - \left(\frac{\mathcal{B}_{t+1}(B_t)}{\Omega_{i,t+1}} \right)^{\ell+1} \right) \right] \right] \right]$$

Differentiating, we get from the standard Kuhn-Tucker conditions that borrowing only in

[Rampini, Sufi and Viswanathan \(2014\)](#) show both theoretically and empirically that, in fact, more financially constrained firms hedge less.

dollars is optimal if and only if

$$\begin{aligned}
& E_t \left[M_{i,t,t+1} \left[\left(1 - (1 - \rho_i) \left(\frac{\mathcal{B}_{t+1}(B_t)}{\Omega_{i,t+1}} \right)^\ell \right) (1 + c) \mathcal{E}_{j,i,t+1} \right] \right] (1 - q_i(j)) \\
& + E_t \left[M_{i,t,t+1} \left[\left(-\ell(1 - \rho_i) \left(\frac{\mathcal{B}_{t+1}(B_t)}{\Omega_{i,t+1}} \right)^{\ell-1} \Omega_{i,t+1}^{-1} \right) (1 + c) \mathcal{E}_{\$,i,t+1} (1 + c(1 - \tau)) \mathcal{E}_{j,i,t+1} \right] \right] B_{\$,t} (1 - q_i(\$)) \\
& - (1 + c(1 - \tau)) E_t [M_{i,t,t+1} \mathcal{E}_{j,i,t+1}] \\
& + E_t \left[M_{i,t,t+1} (\ell + 1) \left(\frac{\mathcal{B}_{t+1}(B_t)}{\Omega_{i,t+1}} \right)^\ell (1 + c(1 - \tau)) \mathcal{E}_{j,i,t+1} \right. \\
& \left. - \ell \left(\frac{\mathcal{B}_{t+1}(B_t)}{\Omega_{i,t+1}} \right)^\ell (1 + c(1 - \tau)) \mathcal{E}_{j,i,t+1} \right] \leq 0
\end{aligned}$$

for all j with the identity for $j = \$$. This inequality can be rewritten as

$$\begin{aligned}
& E_t [M_{i,t,t+1} \mathcal{E}_{j,i,t+1}] ((1 - q_i(j))(1 + c) - (1 + c(1 - \tau))) \\
& \leq E_t \left[M_{i,t,t+1} \left(\frac{\mathcal{B}_{t+1}(B_t)}{\Omega_{i,t+1}} \right)^\ell \mathcal{E}_{j,i,t+1} \right] ((1 - \rho_i)(1 + c)[(1 - q_i(j)) + \ell(1 - q_i(\$))] - (1 + c(1 - \tau)))
\end{aligned}$$

At the same time, for the dollar debt we get

$$\begin{aligned}
& E_t [M_{i,t,t+1} \mathcal{E}_{\$,i,t+1}] ((1 - q_i(\$))(1 + c) - (1 + c(1 - \tau))) \\
& = E_t \left[M_{i,t,t+1} \left(\frac{\mathcal{B}_{t+1}(B_t)}{\Omega_{i,t+1}} \right)^\ell \mathcal{E}_{\$,i,t+1} \right] ((1 + \ell)(1 - \rho_i)(1 + c)(1 - q_i(\$)) - (1 + c(1 - \tau)))
\end{aligned}$$

implying that

$$B_{\$,t} (1 + c(1 - \tau)) = \left(\frac{E_t [M_{i,t,t+1} \mathcal{E}_{\$,i,t+1}]}{E_t [M_{i,t,t+1} \Omega_{i,t+1}^{-\ell} \mathcal{E}_{\$,i,t+1}^{1+\ell}]} \right)^{\ell-1}$$

and we get the Kuhn-Tucker conditions

$$\frac{\bar{q}_i(j, \$)}{\bar{q}_i(\$)} \frac{E_t[M_{i,t,t+1}\mathcal{E}_{j,i,t+1}]}{E_t\left[M_{i,t,t+1}\Omega_{i,t+1}^{-\ell}\mathcal{E}_{j,i,t+1}\mathcal{E}_{\$,i,t+1}^\ell\right]} \leq \frac{E_t[M_{i,t,t+1}\mathcal{E}_{\$,i,t+1}]}{E_t\left[M_{i,t,t+1}\Omega_{i,t+1}^{-\ell}\mathcal{E}_{\$,i,t+1}^{1+\ell}\right]}$$

Q.E.D.

D Proof of Theorem 2.2

Substituting the debt servicing costs $\mathcal{B}_{\$,t}(B_{\$,t-1}) = ((1 - \tau_{\$})c + 1)b_{\$,t-1}(j)\mathcal{P}_{\$,t-1,t}^{-1}\mathcal{P}_{j,t-1,t}$ into equation (9) for unemployment, and then using the assumed policy equation (15), we get that the US monetary policy satisfies the fixed point equation

$$\mathcal{P}_{\$,t-1,t} = \left((1 - \zeta_{\$})e^{-(\ell_{\$}+1)(\eta-1)a_{\$,t}} \left(\xi_{\$}^{-1}((1 - \tau_{\$})c + 1)b_{\$,t-1}(\$)\mathcal{P}_{\$,t-1,t}^{-1}\bar{C}_t^{-\hat{\eta}} \right)^{\ell_{\$}+1} \right)^{\phi_{\$}} e^{\varepsilon_{\$,t+1}} \quad (38)$$

Indeed, the inflation policy is assumed to respond to unemployment, while the unemployment in turn responds to the inflation policy. The counter-cyclical policy assumption (that is, $\phi_{\$} > 0$) implies that there is a unique solution to (38), given by

$$\mathcal{P}_{\$,t-1,t} = \left(\left((1 - \zeta_{\$})e^{-(\ell_{\$}+1)(\eta-1)a_{\$,t}} \left(\xi_{\$}^{-1}((1 - \tau_{\$})c + 1)b_{\$,t-1}(\$)\bar{C}_t^{-\hat{\eta}} \right)^{\ell_{\$}+1} \right)^{\phi_{\$}} e^{\varepsilon_{\$,t+1}} \right)^{(1+(\ell_{\$}+1)\phi_{\$})^{-1}}. \quad (39)$$

We have

Lemma D.1 *Country j firms' default threshold is given by*

$$\Psi_{j,t}(b_{t-1}) = \tilde{\phi}_j(b_{t-1})e^{-(\eta-1)a_{j,t} + \frac{-(\eta-1)[-(\ell_{\$}+1)\phi_{\$}a_{\$,t} + \varepsilon_{\$,t}]}{1+(\ell_{\$}+1)\phi_{\$}}} \bar{C}_t^{-\frac{\hat{\eta}}{1+(\ell_{\$}+1)\phi_{\$}}},$$

where we have defined

$$\tilde{\phi}_j(b_{t-1}) = \frac{((1 - \tau)c + 1)b_{\$,t-1}(j)}{\xi_j((1 - \zeta_{\$})(\xi_{\$}^{-1}((1 - \tau_{\$})c + 1)b_{\$,t-1}(\$))^{\ell_{\$}+1})^{\frac{\phi_{\$}}{1+(\ell_{\$}+1)\phi_{\$}}}}. \quad (40)$$

As above, we are only interested in equilibria in which $\Psi_{j,t} < 1$ for all j , which is equivalent to $\bar{C}_t^{\hat{\eta}} > (\bar{C}_t^M)^{\hat{\eta}}$, where

$$\bar{C}_t^M \equiv \max_j \left(\tilde{\phi}_j(b_{t-1}) e^{\frac{-1}{1+(\ell_{\$}+1)\phi_{\$}}[(\eta-1)a_t + \varepsilon_{\$,t}]} \right)^{\frac{1+(\ell_{\$}+1)\phi_{\$}}{\hat{\eta}}}.$$

The equilibrium condition of Theorem 1.2 implies the following result.

Proposition D.2 *Let $\bar{C}_{t,*}(a_t)$ be the frictionless consumption, solving (8) for the case with no debt overhang and exogenous monetary policy. All equilibria with active monetary policy (15) are then characterized by solutions $\bar{C}_t(b_{t-1}, a_t)$ to the equation*

$$\bar{C}_t^{1-\alpha} + A \sum_{j=1}^N \frac{\xi_j}{1-\tau} e^{a_{j,t}(\eta-1)} \frac{\ell(1-\zeta_j)}{\ell+1} (\Psi_{j,t}(b_{t-1}))^{\ell+1} = \bar{C}_{t,*}^{1-\alpha},$$

There is at most one economic equilibrium that is monotonically increasing in the common TFP shock a_t .

We can now prove the characterization of the dominant currency debt equilibrium.

Proof of Theorem 2.2. By (39)

$$\begin{aligned}
& \mathcal{P}_{j,t-1,t}^{-1} \mathcal{P}_{\$,t-1,t} \\
&= \left(\left((1 - \zeta_{\$}) e^{-(\ell_{\$}+1)(\eta-1)a_t} \left(b_{\$,t-1}(\$) \bar{C}_t^{-\hat{\eta}} \right)^{\ell_{\$}+1} \right)^{\phi_{\$}} \right)^{(1+(\ell_{\$}+1)\phi_{\$})^{-1}} \\
&\times \left((1 - \zeta_j) e^{-(\ell+1)(\eta-1)a_t} \right. \\
&\times \left(b_{j,t-1}(\$) \left(\left((1 - \zeta_{\$}) e^{-(\ell_{\$}+1)(\eta-1)a_t} \left(b_{\$,t-1}(\$) \bar{C}_t^{-\hat{\eta}} \right)^{\ell_{\$}+1} \right)^{\phi_{\$}} \right)^{-(1+(\ell_{\$}+1)\phi_{\$})^{-1}} \right. \\
&\times \left. \left. \bar{C}_t^{-\hat{\eta}} \right)^{\ell+1} \right)^{-\phi_j} \\
&= \tilde{b}_{t-1} \left(e^{-(\eta-1)a_t} \bar{C}_t^{-\hat{\eta}} \right)^{\frac{(\ell_{\$}+1)\phi_{\$}(1+\phi_j(\ell+1))}{1+(\ell_{\$}+1)\phi_{\$}}} \left(e^{(\eta-1)a_t} \bar{C}_t^{\hat{\eta}} \right)^{(\ell+1)\phi_j}.
\end{aligned}$$

Thus, if $(\ell + 1)\phi_j < (\ell_{\$} + 1)\phi_{\$}$, then (14) always holds.

Q.E.D.

Proof of Proposition 7.1. Since we assume that idiosyncratic TFP shocks are small, we will simply set $a_{j,t} = a_t$ in the future calculations. Defining

$$\Delta_{i,t-1} \equiv \left(\frac{\bar{q}_i(\$) E_{t-1} \left[C_{t-1,t}^{-\gamma} \mathcal{P}_{\$,t-1,t}^{-1} \right]}{E_{t-1} \left[C_{t-1,t}^{-\gamma} \mathcal{P}_{\$,t-1,t}^{-\ell-1} (\bar{C}_t^{\hat{\eta}} e^{(\eta-1)a_t})^{-\ell} \right]} \right)^{\ell-1}, \quad (41)$$

equation (12) implies that

$$b_{\$,t-1}(j) = \xi_j \Delta_{j,t-1} \mathcal{P}_{j,t-1},$$

and hence we get from (40) that

$$\tilde{\phi}_j(b_{t-1}) = \frac{\Delta_{j,t-1}}{((1 - \zeta_{\$})(\Delta_{\$,t-1})^{\ell_{\$}+1})^{\frac{\phi_{\$}}{1+(\ell_{\$}+1)\phi_{\$}}}}$$

whereas, (39) takes the form

$$\mathcal{P}_{\$,t-1,t} = \left(\left((1 - \zeta_{\$}) e^{-(\ell_{\$}+1)(\eta-1)a_t} \left(\Delta_{\$,t-1} \bar{C}_t^{-\hat{\eta}} \right)^{\ell_{\$}+1} \right)^{\phi_{\$}} \right)^{(1+(\ell_{\$}+1)\phi_{\$})^{-1}}. \quad (42)$$

Thus, substituting (42) into (41), we get

$$\begin{aligned} \Delta_{\$,t-1}^{\frac{1}{1+(\ell_{\$}+1)\phi_{\$}}} &= \left(\bar{q}_i(\$) E_{t-1} \left[\bar{C}_t^{-(\eta-1)^{-1}} \left(\left((1 - \zeta_{\$}) e^{-(\ell_{\$}+1)(\eta-1)a_t} \left(\bar{C}_t^{-\hat{\eta}} \right)^{\ell_{\$}+1} \right)^{\phi_{\$}} \right)^{-(1+(\ell_{\$}+1)\phi_{\$})^{-1}} \right] \right) / \\ E_{t-1} &\left[\bar{C}_t^{-(\eta-1)^{-1}} \left(\left((1 - \zeta_{\$}) e^{-(\ell_{\$}+1)(\eta-1)a_t} \left(\bar{C}_t^{-\hat{\eta}} \right)^{\ell_{\$}+1} \right)^{\phi_{\$}} \right)^{-(\ell_{\$}+1)(1+(\ell_{\$}+1)\phi_{\$})^{-1}} \right. \\ &\left. \times \left(\bar{C}_t^{\hat{\eta}} e^{(\eta-1)a_t} \right)^{-\ell_{\$}} \right]^{\ell_{\$}^{-1}}, \end{aligned}$$

which gives

$$\Delta_{\$,t-1}^{\frac{1}{1+(\ell_{\$}+1)\phi_{\$}}} = \left(\frac{\bar{q}_i(\$) (1 - \zeta_{\$})^{\frac{\phi_{\$}}{1+(\ell_{\$}+1)\phi_{\$}}} E_{t-1} \left[\bar{C}_t^{-\frac{1}{\eta-1} + \frac{(\ell_{\$}+1)\phi_{\$}}{1+(\ell_{\$}+1)\phi_{\$}} \hat{\eta}} e^{\frac{(\ell_{\$}+1)\phi_{\$}}{1+(\ell_{\$}+1)\phi_{\$}} (\eta-1)a_t} \right]}{E_{t-1} \left[\bar{C}_t^{-\frac{1}{\eta-1} + \frac{(\ell_{\$}+1)\phi_{\$} - \ell_{\$}}{1+(\ell_{\$}+1)\phi_{\$}} \hat{\eta}} e^{\frac{(\ell_{\$}+1)\phi_{\$} - \ell_{\$}}{1+(\ell_{\$}+1)\phi_{\$}} (\eta-1)a_t} \right]}} \right)^{\ell_{\$}^{-1}}.$$

Thus,

$$\begin{aligned} \Delta_{i,t-1} &= \Delta_{\$,t-1}^{\frac{(\ell_{\$}+1)\phi_{\$}}{1+(\ell_{\$}+1)\phi_{\$}}} \left(\bar{q}_i(\$) E_{t-1} \left[C_{t-1,t}^{-\gamma} \left(\left(\left((1 - \zeta_{\$}) e^{-(\ell_{\$}+1)(\eta-1)a_t} \left(\bar{C}_t^{-\hat{\eta}} \right)^{\ell_{\$}+1} \right)^{\phi_{\$}} \right)^{(1+(\ell_{\$}+1)\phi_{\$})^{-1}} \right)^{-1} \right] \right) \\ &\times E_{t-1} \left[C_{t-1,t}^{-\gamma} \left(\left(\left((1 - \zeta_{\$}) e^{-(\ell_{\$}+1)(\eta-1)a_t} \left(\bar{C}_t^{-\hat{\eta}} \right)^{\ell_{\$}+1} \right)^{\phi_{\$}} \right)^{(1+(\ell_{\$}+1)\phi_{\$})^{-1}} \right)^{-\ell-1} \left(\bar{C}_t^{\hat{\eta}} e^{(\eta-1)a_t} \right)^{-\ell} \right]^{-1} \right)^{\ell-1}, \end{aligned}$$

Define

$$\tilde{C}_t \equiv \bar{C}_t^{\hat{\eta}} e^{(\eta-1)at}.$$

Then,

$$\begin{aligned} E_{t-1} & \left[C_t^{-\gamma} \left(\left(\left(e^{-(\ell_{\mathfrak{s}}+1)(\eta-1)at} \left(\bar{C}_t^{-\hat{\eta}} \right)^{\ell_{\mathfrak{s}}+1} \right)^{\phi_{\mathfrak{s}}} \right)^{(1+(\ell_{\mathfrak{s}}+1)\phi_{\mathfrak{s}})^{-1}} \right)^{-1} \right] \\ & = E_{t-1} [C_t^{-\gamma} \tilde{C}_t \tilde{C}_t^{\hat{\ell}_{\mathfrak{s}}}] \end{aligned}$$

where we have defined

$$\hat{\ell}_{\mathfrak{s}} \equiv -\frac{1}{1 + (\ell_{\mathfrak{s}} + 1)\phi_{\mathfrak{s}}}.$$

Similarly,

$$\begin{aligned} E_{t-1} & \left[C_t^{-\gamma} \left(\left(\left(e^{-(\ell_{\mathfrak{s}}+1)(\eta-1)at} \left(\bar{C}_t^{-\hat{\eta}} \right)^{\ell_{\mathfrak{s}}+1} \right)^{\phi_{\mathfrak{s}}} \right)^{(1+(\ell_{\mathfrak{s}}+1)\phi_{\mathfrak{s}})^{-1}} \right)^{-\ell-1} \left(\bar{C}_t^{\hat{\eta}} e^{(\eta-1)at} \right)^{-\ell} \right] \\ & = E_{t-1} \left[C_t^{-\gamma} \tilde{C}_t^{\frac{(\ell_{\mathfrak{s}}+1)\phi_{\mathfrak{s}}(\ell+1) - \ell(1+(\ell_{\mathfrak{s}}+1)\phi_{\mathfrak{s}})}{1+(\ell_{\mathfrak{s}}+1)\phi_{\mathfrak{s}}}} \right] \\ & = E_{t-1} [C_t^{-\gamma} \tilde{C}_t \tilde{C}_t^{\hat{\ell}_{\mathfrak{s}}(\ell+1)}]. \end{aligned}$$

Thus,

$$\begin{aligned} & \tilde{\phi}_i(b_{t-1}) \\ & = \bar{q}_i(\$)^{\ell-1} \left(\frac{E_{t-1} [C_t^{-\gamma} \tilde{C}_t \tilde{C}_t^{\hat{\ell}_{\mathfrak{s}}}] }{E_{t-1} [C_t^{-\gamma} \tilde{C}_t \tilde{C}_t^{\hat{\ell}_{\mathfrak{s}}(\ell+1)}]} \right)^{\ell-1}. \end{aligned}$$

When leverage is small, we have

$$\bar{C}_t \approx \bar{C}_t^* = K e^{(\eta-1)(1-\alpha)^{-1}at}$$

for some $K > 0$, so that

$$\tilde{C}_t = K \hat{\eta} e^{(\eta-1)[\hat{\eta}(1-\alpha)^{-1}+1]at}$$

and

$$C_t^\gamma = k \bar{C}_t^{(\eta-1)^{-1}} = k K^{(\eta-1)^{-1}} e^{(1-\alpha)^{-1}at},$$

and hence, under the log-normal assumption, we get

$$\begin{aligned} \frac{E_{t-1}[C_t^{-\gamma} \tilde{C}_t \tilde{C}_t^{\hat{\ell}_s}]}{E_{t-1}[C_t^{-\gamma} \tilde{C}_t \tilde{C}_t^{\hat{\ell}_s(\ell+1)}]} &= \frac{E_{t-1}[e^{[-(1-\alpha)^{-1}+(1+\hat{\ell}_s)(\eta-1)[\hat{\eta}(1-\alpha)^{-1}+1]at}]}{E_{t-1}[e^{[-(1-\alpha)^{-1}+(1+\hat{\ell}_s(\ell+1))(\eta-1)[\hat{\eta}(1-\alpha)^{-1}+1]at}]} \\ &= e^{-\hat{\ell}_s \ell (\eta-1)[\hat{\eta}(1-\alpha)^{-1}+1] \mu_{t-1}^a} \\ &\times e^{0.5[-(1-\alpha)^{-1}+(1+\hat{\ell}_s)(\eta-1)[\hat{\eta}(1-\alpha)^{-1}+1]]^2 - [-(1-\alpha)^{-1}+(1+\hat{\ell}_s(\ell+1))(\eta-1)[\hat{\eta}(1-\alpha)^{-1}+1]]^2} (\sigma_{t-1}^a)^2 \\ &= e^{-\hat{\ell}_s \ell (\eta-1)[\hat{\eta}(1-\alpha)^{-1}+1] \mu_{t-1}^a} e^{-0.5 \hat{\ell}_s^2 \tilde{\eta}^2 \ell (\ell+2) (\sigma_{t-1}^a)^2} \end{aligned}$$

where we have defined

$$\tilde{\eta} \equiv (\eta-1)[\hat{\eta}(1-\alpha)^{-1}+1].$$

Thus, default probability is given by

$$\bar{q}_i(\$) \left(e^{-\hat{\ell}_s (\eta-1)[\hat{\eta}(1-\alpha)^{-1}+1] \mu_{t-1}^a} e^{-0.5 \hat{\ell}_s^2 \tilde{\eta}^2 (\ell+2) (\sigma_{t-1}^a)^2} \tilde{C}_t^{\hat{\ell}_s} \right)^\ell$$

while losses due to debt overhang are given by

$$\bar{q}_i(\$)^{\ell^{-1}(\ell+1)}(1 - \zeta_j) \left(e^{-\hat{\ell}_s(\eta-1)[\hat{\eta}(1-\alpha)^{-1}+1]\mu_{t-1}^a} e^{-0.5\hat{\ell}_s^2\tilde{\eta}^2(\ell+2)(\sigma_{t-1}^a)^2} \tilde{C}_t^{\hat{\ell}_s} \right)^{\ell+1}$$

Expected welfare is then

$$\begin{aligned} (1 - \gamma)^{-1} E_{t-1}[C_t^{1-\gamma}] &\approx (1 - \gamma)^{-1} E_{t-1}[(C_t^*)^{1-\gamma}] \\ &- \sum_i \kappa_i E_{t-1}[(C_t^*)^{-\gamma} \bar{q}_i(\$)^{\ell^{-1}(\ell+1)}(1 - \zeta_j) \left(e^{-\hat{\ell}_s(\eta-1)[\hat{\eta}(1-\alpha)^{-1}+1]\mu_{t-1}^a} e^{-0.5\hat{\ell}_s^2\tilde{\eta}^2(\ell+2)(\sigma_{t-1}^a)^2} \tilde{C}_t^{\hat{\ell}_s} \right)^{\ell+1}] \\ &= (1 - \gamma)^{-1} E_{t-1}[(C_t^*)^{1-\gamma}] \\ &- \sum_i \kappa_i E_{t-1}[e^{-(1-\alpha)^{-1}a_t} \bar{q}_i(\$)^{\ell^{-1}(\ell+1)}(1 - \zeta_j) \\ &\times \left(e^{-\hat{\ell}_s(\eta-1)[\hat{\eta}(1-\alpha)^{-1}+1]\mu_{t-1}^a} e^{-0.5\hat{\ell}_s^2\tilde{\eta}^2(\ell+2)(\sigma_{t-1}^a)^2} e^{\hat{\ell}_s\tilde{\eta}a_t} \right)^{\ell+1}] \end{aligned}$$

for some constants κ_i . Thus, utility losses are given by

$$\begin{aligned} &E_{t-1}[e^{-(1-\alpha)^{-1}a_t} \bar{q}_i(\$)^{\ell^{-1}(\ell+1)}(1 - \zeta_j) \\ &\times \left(e^{-\hat{\ell}_s(\eta-1)[\hat{\eta}(1-\alpha)^{-1}+1]\mu_{t-1}^a} e^{-0.5\hat{\ell}_s^2\tilde{\eta}^2(\ell+2)(\sigma_{t-1}^a)^2} e^{\hat{\ell}_s\tilde{\eta}a_t} \right)^{\ell+1}] \\ &\approx e^{-(1-\alpha)^{-1}\mu_{t-1}} (1 - 0.5\sigma_{t-1}^2((\ell+1)(\hat{\ell}_s^2\tilde{\eta}^2 + 2\hat{\ell}_s\tilde{\eta}(1-\alpha)^{-1}) + (1-\alpha)^{-2})), \end{aligned}$$

Q.E.D.

Proof of Proposition 4.1. We need to compute

$$IRP_{i,t} = \frac{e^{r_{i,t}} \text{Cov}_t(M_{i,t,t+1}, \mathcal{P}_{i,t,t+1})}{E_t[\mathcal{P}_{i,t,t+1}]}.$$

We have

$$\mathcal{P}_{i,t,t+1} = \kappa_t \left(\left(e^{-(\eta-1)a_{s,t}} \bar{C}_t^{-\hat{\eta}} \right)^{(\ell+1)\phi} e^{\varepsilon_{s,t+1}} \right)^{(1+(\ell_s+1)\phi_s)^{-1}}$$

Now, when leverage is small, we have that consumption is close to the frictionless one,

$$\bar{C}_t \sim e^{a_t(\eta-1)(1-\alpha)^{-1}}$$

Since $\bar{C}_t \sim (C_t^\gamma)^{\eta-1}$, we get that

$$C_t^{-\gamma} = \bar{C}_t^{-(\eta-1)^{-1}} \sim e^{-(1-\alpha)^{-1}a_t}.$$

whereas

$$e^{-(\eta-1)a_t}\bar{C}_t^{-\hat{\eta}} \sim e^{-(\eta-1)a_t}\bar{C}_t^{-\left(\frac{\gamma}{\eta-1}+\alpha-1\right)} = e^{-(\eta-1)a_t}e^{-a_t(\eta-1)(1-\alpha)^{-1}\left(\frac{\gamma}{\eta-1}+\alpha-1\right)} = e^{-a_t(1-\alpha)^{-1}\gamma^{-1}}.$$

Thus, ignoring the monetary shock, we get that

$$\mathcal{P}_{i,t,t+1} \sim \left(e^{-a_{t+1}(1-\alpha)^{-1}\gamma^{-1}} \right)^{(\ell+1)\phi(1+(\ell_s+1)\phi_s)^{-1}}.$$

At the same time,

$$M_{i,t,t+1} = e^{-\beta}C_{t,t+1}^{-\gamma}\mathcal{P}_{i,t,t+1}^{-1} \sim e^{-(1-\alpha)^{-1}a_{t+1}} \left(e^{a_{t+1}(1-\alpha)^{-1}\gamma^{-1}} \right)^{(\ell+1)\phi(1+(\ell_s+1)\phi_s)^{-1}}$$

Our goal is to prove that

$$\begin{aligned} IRP_{i,t} + 1 &= \frac{E_t[M_{i,t,t+1}\mathcal{P}_{i,t,t+1}]}{E_t[M_{i,t,t+1}]E_t[\mathcal{P}_{i,t,t+1}]} \\ &= \frac{E_t[e^{-(1-\alpha)^{-1}a_{t+1}}]}{E_t[e^{-(1-\alpha)^{-1}a_{t+1}}(e^{a_{t+1}(1-\alpha)^{-1}\gamma^{-1}})^{(\ell+1)\phi(1+(\ell_s+1)\phi_s)^{-1}}]E_t[(e^{-a_{t+1}(1-\alpha)^{-1}\gamma^{-1}})^{(\ell+1)\phi(1+(\ell_s+1)\phi_s)^{-1}}]} \end{aligned}$$

is monotone increasing in ϕ . Define

$$x \equiv \gamma^{-1}(\ell + 1)\phi(1 + (\ell_{\$} + 1)\phi_{\$})^{-1}, \quad \tilde{a}_{t+1} = (1 - \alpha)^{-1}a_{t+1}.$$

Then, we can rewrite it as

$$IRP_t(x) + 1 = \frac{E_t[e^{-\tilde{a}_{t+1}}]}{E_t[e^{-\tilde{a}_{t+1}(1-x)}]E_t[e^{-\tilde{a}_{t+1}x}]}.$$

Thus,

$$\frac{\partial}{\partial x} \log(IRP_t(x) + 1) = \frac{E_t[e^{-\tilde{a}_{t+1}x}\tilde{a}_{t+1}]}{E_t[e^{-\tilde{a}_{t+1}x}]} - \frac{E_t[e^{-\tilde{a}_{t+1}(1-x)}\tilde{a}_{t+1}]}{E_t[e^{-\tilde{a}_{t+1}(1-x)}]}$$

Making a change of measure $d\tilde{P} = e^{-\tilde{a}_{t+1}x}/E_t[e^{-\tilde{a}_{t+1}x}]$, we can rewrite the required inequality as

$$\tilde{E}_t[\tilde{a}_{t+1}] > \frac{\tilde{E}_t[e^{-\tilde{a}_{t+1}(1-2x)}\tilde{a}_{t+1}]}{\tilde{E}_t[e^{-\tilde{a}_{t+1}(1-2x)}]},$$

which is equivalent to $\tilde{Cov}_t(e^{-\tilde{a}_{t+1}(1-2x)}, \tilde{a}_{t+1}) < 0$.

Q.E.D.

E Optimal monetary policy

Suppose that the DC CB follows the monetary policy

$$\mathcal{P}_{\$,t,t+1} = \prod_i (1 - \bar{L}_{t+1}(i)/\bar{L}_{t+1}^*(i))^{\chi_i}$$

This gives the fixed point equation

$$\mathcal{P}_{\$,t-1,t} = \prod_i \left((1 - \zeta_{\$})e^{-(\ell+1)(\eta-1)a_{i,t}} \left(((1 - \tau_{\$})c + 1)\Delta_{i,t-1} \mathcal{P}_{\$,t-1,t}^{-1} \bar{C}_t^{-\hat{\eta}} \right)^{\ell+1} \right)^{\chi_i}$$

Thus,

$$\mathcal{P}_{\$,t-1,t} = q_* \prod_i (\Delta_{i,t-1} \tilde{C}_{i,t}^{-1})^{(\ell+1)\chi_i/(1+\bar{\chi})}$$

where

$$\tilde{C}_{i,t} = \bar{C}^{\hat{\eta}} e^{a_{i,t}(\eta-1)}$$

and where we still have

$$\begin{aligned} \Delta_{i,t-1} &= \left(\frac{\bar{q}_i(\$) E_{t-1} [C_{t-1,t}^{-\gamma} \mathcal{P}_{\$,t-1,t}^{-1}]}{E_{t-1} [C_{t-1,t}^{-\gamma} \mathcal{P}_{\$,t-1,t}^{-\ell-1} (\bar{C}_t^{\hat{\eta}} e^{(\eta-1)a_{i,t}})^{-\ell}]} \right)^{\ell-1} \\ &= \left(\frac{\bar{q}_i(\$) E_{t-1} [C_{t-1,t}^{-\gamma} (\bar{C}^{\hat{\eta}} e^{\bar{a}_t(\eta-1)})^{\bar{\chi}/(1+\bar{\chi})}]}{E_{t-1} [C_{t-1,t}^{-\gamma} (\bar{C}^{\hat{\eta}} e^{\bar{a}_t(\eta-1)})^{\bar{\chi}(\ell+1)/(1+\bar{\chi})} (\bar{C}_t^{\hat{\eta}} e^{(\eta-1)a_{i,t}})^{-\ell}]} \right)^{\ell-1} q_* \prod_j (\Delta_{j,t-1})^{(\ell+1)\chi_j/(1+\bar{\chi})} \end{aligned}$$

where we have defined

$$\bar{\chi} = \sum_i (1+\ell)\chi_i, \quad \bar{a}_t = \sum_i (1+\ell)\chi_i a_{i,t} / \bar{\chi}.$$

This gives the fixed point system for leverage. Defining

$$e^{Q_i} \equiv \left(\frac{E_{t-1} [C_{t-1,t}^{-\gamma} (\bar{C}^{\hat{\eta}} e^{\bar{a}_t(\eta-1)})^{\bar{\chi}/(1+\bar{\chi})}]}{E_{t-1} [C_{t-1,t}^{-\gamma} (\bar{C}^{\hat{\eta}} e^{\bar{a}_t(\eta-1)})^{\bar{\chi}(\ell+1)/(1+\bar{\chi})} (\bar{C}_t^{\hat{\eta}} e^{(\eta-1)a_{i,t}})^{-\ell}]} \right)^{\ell-1} q_*(i),$$

we get

$$\log \Delta_{i,t-1} = Q_i + \sum_j (\ell+1)\chi_j (1+\bar{\chi})^{-1} \log \Delta_{j,t-1}.$$

Multiplying by

$$(\ell + 1)\chi_j$$

and summing up, we get

$$\sum_j (\ell + 1)\chi_j \log \Delta_{j,t-1} = \sum_j (\ell + 1)\chi_j Q_j + \bar{\chi} \sum_j (\ell + 1)\chi_j (1 + \bar{\chi})^{-1} \log \Delta_{j,t-1}$$

so that

$$\sum_j (\ell + 1)\chi_j (1 + \bar{\chi})^{-1} \log \Delta_{j,t-1} = \sum_j (\ell + 1)\chi_j Q_j.$$

Thus,

$$\log \Delta_{i,t-1} = Q_i + \sum_j (\ell + 1)\chi_j Q_j.$$

Now, in the small shock approximation, we have

$$\begin{aligned} \log \bar{C}_t^{1-\alpha} &\approx \log \bar{\kappa} + \log \sum_j \kappa_j e^{a_{j,t}(\eta-1)} \\ &\approx \bar{\mu}_{t-1}(\eta-1) + \log(1 + \sum_j \kappa_j ((a_{j,t} - \mu_{t-1}) + 0.5(a_{j,t} - \mu_{t-1})^2)) \\ &\approx (\eta-1)\tilde{a}_t + 0.5(\eta-1)^2 v_t, \end{aligned}$$

so that

$$C_t^{-\gamma} = \bar{C}_t^{-(\eta-1)^{-1}} \approx e^{-(1-\alpha)^{-1}(\tilde{a}_t + 0.5(\eta-1)v_t)}$$

Define also

$$\tilde{a}_t = \sum_j \kappa_j a_{j,t}, \quad \tilde{v}_{t-1} = E_{t-1} \left[\sum_j \kappa_j (a_{j,t} - \mu_{t-1})^2 - \left(\sum_j \kappa_j (a_{j,t} - \mu_{t-1}) \right)^2 \right],$$

and note that since v_t is of the order ε^2 , only its expectation will matter for the approximate calculations below. Here, the weights κ_j are normalized to add up to one. Thus,

$$\begin{aligned} e^{Q_i \ell} &= q_*(i)^\ell \frac{E_{t-1} \left[C_{t-1,t}^{-\gamma} (\bar{C}^{\hat{\eta}} e^{\bar{a}_t(\eta-1)})^{\bar{\chi}/(1+\bar{\chi})} \right]}{E_{t-1} \left[C_{t-1,t}^{-\gamma} (\bar{C}^{\hat{\eta}} e^{\bar{a}_t(\eta-1)})^{\bar{\chi}(\ell+1)/(1+\bar{\chi})} (\bar{C}_t^{\hat{\eta}} e^{(\eta-1)a_{i,t}})^{-\ell} \right]} \\ &= q_*(i)^\ell E_{t-1} \left[e^{-(1-\alpha)^{-1}(\bar{a}_t + 0.5(\eta-1)\tilde{v}_{t-1})} (e^{(1-\alpha)^{-1}\hat{\eta}((\eta-1)\bar{a}_t + 0.5(\eta-1)^2\tilde{v}_{t-1})} e^{\bar{a}_t(\eta-1)})^{\bar{\chi}/(1+\bar{\chi})} \right] \\ &\times E_{t-1} \left[e^{-(1-\alpha)^{-1}(\bar{a}_t + 0.5(\eta-1)\tilde{v}_{t-1})} (e^{(1-\alpha)^{-1}\hat{\eta}((\eta-1)\bar{a}_t + 0.5(\eta-1)^2\tilde{v}_{t-1})} (\bar{\chi}-\ell)/(1+\bar{\chi})} \right. \\ &\times \left. (e^{\bar{a}_t(\eta-1)})^{\bar{\chi}(\ell+1)/(1+\bar{\chi})} (e^{(\eta-1)a_{i,t}})^{-\ell} \right]^{-1} \\ &= q_*(i)^\ell e^{(1-\alpha)^{-1}\hat{\eta}(\eta-1)^2 0.5\ell(1+\bar{\chi})^{-1}\tilde{v}_{t-1}} \frac{E_{t-1} [e^{\Gamma_1 \bar{a}_t + \Gamma \bar{a}_t}]}{E_{t-1} [e^{\Gamma_3(i)\bar{a}_t + \Gamma_4(i)\bar{a}_t - (\eta-1)\ell a_{i,t}}]} \\ &= q_*(i)^\ell e^{\hat{\mu}_{i,t-1}} e^{(1-\alpha)^{-1}\hat{\eta}(\eta-1)^2 0.5\ell(1+\bar{\chi})^{-1}\tilde{v}_{t-1}} \\ &\times \exp \left(0.5(\Gamma_1^2 - \Gamma_3^2) \tilde{\sigma}_{t-1}^2 + 0.5(\Gamma^2 - \Gamma_4^2(i)) \bar{\sigma}_{t-1}^2 - 0.5(\eta-1)^2 \ell^2 \sigma_{i,t-1}^2 \right. \\ &\left. + \sigma_{t-1}(\bar{a}, \tilde{a})(\Gamma_1 \Gamma - \Gamma_3(i) \Gamma_4(i)) + \sigma_{t-1}(\bar{a}, a_i)(\eta-1)\ell \Gamma_4(i) + \sigma_{t-1}(\tilde{a}, a_i)(\eta-1)\ell \Gamma_3(i) \right) \end{aligned}$$

where

$$\begin{aligned} \Gamma_1 &= -(1-\alpha)^{-1} + (1-\alpha)^{-1}\hat{\eta}(\eta-1)\bar{\chi}/(1+\bar{\chi}) \\ \Gamma &= (\eta-1)\bar{\chi}/(1+\bar{\chi}) \\ \Gamma_3(i) &= -(1-\alpha)^{-1} + (1-\alpha)^{-1}\hat{\eta}(\eta-1)(\bar{\chi}-\ell)/(1+\bar{\chi}) \\ \Gamma_4(i) &= (\eta-1)(\ell+1)\bar{\chi}/(1+\bar{\chi}). \end{aligned}$$

Furthermore,

$$\bar{Q} = \sum_i (\ell + 1) \chi_i Q_i$$

and

$$\mathcal{P}_{\mathbb{S}, t-1, t} = q_* \tilde{C}_t^{-\bar{\chi}/(1+\bar{\chi})} e^{\bar{Q}}$$

We have

$$\mathcal{B}_{j,t}(B_{t-1}) = ((1 - \tau)c + 1) b_{\mathbb{S}, t-1}(j) \mathcal{P}_{\mathbb{S}, t-1, t}^{-1} \mathcal{P}_{j, t-1, t}$$

with

$$b_{\mathbb{S}, t-1}(j) = \xi_j \Delta_{j, t-1} \mathcal{P}_{j, t-1}$$

Thus,

$$\Psi_{j,t} = \frac{\mathcal{B}_{j,t} \mathcal{P}_{j,t}^{-1}}{\xi_j e^{a_{j,t}(\eta-1)} \tilde{C}_t^{\hat{\eta}}} = \frac{\Delta_{j,t-1} \mathcal{P}_{\mathbb{S}, t-1, t}^{-1}}{e^{a_{j,t}(\eta-1)} \tilde{C}_t^{\hat{\eta}}} = \frac{e^{Q_i} \tilde{C}_t^{\bar{\chi}/(1+\bar{\chi})}}{\tilde{C}_t} = e^{Q_i} \tilde{C}_t^{-(1+\bar{\chi})^{-1}}.$$

Expected welfare is then

$$(1 - \gamma)^{-1} E_{t-1}[C_t^{1-\gamma}] \approx (1 - \gamma)^{-1} E_{t-1}[(C_t^*)^{1-\gamma}] - \sum_i \kappa_i E_{t-1}[(C_t^*)^{-\gamma} (1 - \zeta_j) (\Psi_{j,t})^{\ell+1}].$$

Thus, utility losses from country i debt overhang are given by

$$E_{t-1}[(C_t^*)^{-\gamma} (1 - \zeta_j) (\Psi_{i,t})^{\ell+1}] = (1 - \zeta_j) e^{Q_i(\ell+1)} E_{t-1}[(C_t)^{-\gamma} \tilde{C}_t^{-(1+\bar{\chi})^{-1}(\ell+1)}]$$

We have

$$\begin{aligned}
C_t^{-\gamma} \tilde{C}_t^{-(1+\bar{\chi})^{-1}(\ell+1)} &\approx (e^{-(1-\alpha)^{-1}(\tilde{a}_t + 0.5(\eta-1)\tilde{v}_{t-1})})(\bar{C}^{\hat{\eta}} e^{a_{i,t}(\eta-1)})^{-(1+\bar{\chi})^{-1}(\ell+1)} \\
&= (e^{-(1-\alpha)^{-1}(\tilde{a}_t + 0.5(\eta-1)\tilde{v}_{t-1})}) (e^{(1-\alpha)^{-1}\hat{\eta}((\eta-1)\tilde{a}_t + 0.5(\eta-1)^2\tilde{v}_{t-1})} e^{a_{i,t}(\eta-1)})^{-(1+\bar{\chi})^{-1}(\ell+1)} \\
&= e^{-\tilde{a}_t(1-\alpha)^{-1}(1+\hat{\eta}(\eta-1)(1+\bar{\chi})^{-1}(\ell+1)) - 0.5\tilde{v}_t(1-\alpha)^{-1}(\eta-1)(1+\hat{\eta}(\eta-1)(1+\bar{\chi})^{-1}(\ell+1))} e^{-a_{i,t}(\eta-1)(1+\bar{\chi})^{-1}(\ell+1)} \\
&= e^{-K_1(i)\tilde{a}_t - K_2(i)v_t - K_3(i)a_{i,t}}.
\end{aligned}$$

Thus,

$$\begin{aligned}
&E_{t-1}[(C_t)^{-\gamma} \tilde{C}_t^{-(1+\bar{\chi})^{-1}(\ell+1)}] \\
&\approx E_{t-1}[e^{-K_1(i)\tilde{a}_t - K_2(i)v_t - K_3(i)a_{i,t}}] \\
&\approx e^{-K_1(i)\tilde{\mu}_{t-1} - K_2(i)\tilde{v}_{t-1} - K_3(i)\mu_{t-1} + 0.5(K_1(i)^2\tilde{\sigma}_{t-1}^2 + K_3(i)^2\sigma_{i,t-1}^2 + 2K_1(i)K_3(i)\sigma_{t-1}(\tilde{a}, a_i))}
\end{aligned}$$

and hence the welfare loss is proportional to

$$\begin{aligned}
&\sum_i (1 - \zeta) e^{Q_i(\ell+1)} e^{-K_1(i)\tilde{\mu}_{t-1} - K_2(i)\tilde{v}_{t-1} - K_3(i)\mu_{t-1} + 0.5(K_1(i)^2\tilde{\sigma}_{t-1}^2 + K_3(i)^2\sigma_{i,t-1}^2 + 2K_1(i)K_3(i)\sigma_{t-1}(\tilde{a}, a_i))} \\
&= \sum_i (1 - \zeta) q_*(i)^{\ell+1} e^{\hat{\mu}_{i,t-1}(1+\ell^{-1})} e^{(1-\alpha)^{-1}\hat{\eta}(\eta-1)^2 0.5\ell(1+\bar{\chi})^{-1}\tilde{v}_{t-1}(1+\ell^{-1})} \\
&\times \exp \left(\left(0.5(\Gamma_1^2 - \Gamma_3^2)\tilde{\sigma}_{t-1}^2 + 0.5(\Gamma^2 - \Gamma_4^2(i))\tilde{\sigma}_{t-1}^2 - 0.5(\eta-1)^2\ell^2\sigma_{i,t-1}^2 \right. \right. \\
&\left. \left. + \sigma_{t-1}(\tilde{a}, \tilde{a})(\Gamma_1\Gamma - \Gamma_3(i)\Gamma_4(i)) + \sigma_{t-1}(\tilde{a}, a_i)(\eta-1)\ell\Gamma_4(i) + \sigma_{t-1}(\tilde{a}, a_i)(\eta-1)\ell\Gamma_3(i) \right) (1 + \ell^{-1}) \right) \\
&\times e^{-K_1(i)\tilde{\mu}_{t-1} - K_2(i)\tilde{v}_{t-1} - K_3(i)\mu_{t-1} + 0.5(K_1(i)^2\tilde{\sigma}_{t-1}^2 + K_3(i)^2\sigma_{i,t-1}^2 + 2K_1(i)K_3(i)\sigma_{t-1}(\tilde{a}, a_i))}
\end{aligned}$$

Note that

$$\tilde{v}_{t-1} = \sum_j \kappa_j \sigma_{j,t-1}^2 - \tilde{\sigma}_{t-1}^2.$$

Denoting

$$\tilde{q}_i \equiv \kappa_i(1 - \zeta)q_*(i)^{\ell+1},$$

we get that the volatility part of the welfare loss is (up to an additive constant) approximately given by

$$\begin{aligned} & \sum_i \tilde{q}_i \left((1 - \alpha)^{-1} \hat{\eta}(\eta - 1)^2 0.5\ell(1 + \bar{\chi})^{-1} \left(\sum_j \kappa_j \sigma_{j,t-1}^2 - \tilde{\sigma}_{t-1}^2 \right) (1 + \ell^{-1}) \right. \\ & + \left(0.5(\Gamma_1^2 - \Gamma_3^2) \tilde{\sigma}_{t-1}^2 + 0.5(\Gamma^2 - \Gamma_4^2(i)) \bar{\sigma}_{t-1}^2 - 0.5(\eta - 1)^2 \ell^2 \sigma_{i,t-1}^2 \right. \\ & \left. \left. + \sigma_{t-1}(\bar{a}, \tilde{a})(\Gamma_1 \Gamma - \Gamma_3(i) \Gamma_4(i)) + \sigma_{t-1}(\bar{a}, a_i)(\eta - 1) \ell \Gamma_4(i) + \sigma_{t-1}(\tilde{a}, a_i)(\eta - 1) \ell \Gamma_3(i) \right) (1 + \ell^{-1}) \right. \\ & \left. - 0.5 \left(\sum_j \kappa_j \sigma_{j,t-1}^2 - \tilde{\sigma}_{t-1}^2 \right) (1 - \alpha)^{-1} (\eta - 1) (1 + \hat{\eta}(\eta - 1)(1 + \bar{\chi})^{-1} (\ell + 1)) \right. \\ & \left. + 0.5(K_1(i)^2 \tilde{\sigma}_{t-1}^2 + K_3(i)^2 \sigma_{i,t-1}^2 + 2K_1(i)K_3(i)\sigma_{t-1}(\tilde{a}, a_i)) \right) \\ & = \sum_j \Xi_j \sigma_{j,t-1}^2 + \bar{\Xi} \bar{\sigma}_{t-1}^2 + \tilde{\Xi} \tilde{\sigma}_{t-1}^2 + \hat{\Xi} \tilde{\sigma}_{t-1}(\tilde{a}_t, \bar{a}_t) + \sigma_{t-1}(\bar{a}_t, \hat{a}_t) + \sigma_{t-1}(\tilde{a}_t, \check{a}_t) \end{aligned}$$

Here,

$$\begin{aligned}
\Xi_j &= -\tilde{q}_j 0.5(\eta - 1)^2 \ell^2 (1 + \ell^{-1}) + 0.5 \tilde{q}_j K_3(j)^2 \\
&+ \kappa_j \sum_i \tilde{q}_i \left((1 - \alpha)^{-1} \hat{\eta}(\eta - 1)^2 0.5 \ell (1 + \bar{\chi})^{-1} (1 + \ell^{-1}) - (1 - \alpha)^{-1} (\eta - 1) (1 + \hat{\eta}(\eta - 1) (1 + \bar{\chi})^{-1} (\ell + 1)) \right) \\
\bar{\Xi} &= \sum_i \tilde{q}_i 0.5 (\Gamma^2 - \Gamma_4^2(i)) (1 + \ell^{-1}) \\
\tilde{\Xi} &= \left(- \sum_i \tilde{q}_i (1 - \alpha)^{-1} \hat{\eta}(\eta - 1)^2 0.5 \ell (1 + \bar{\chi})^{-1} (1 + \ell^{-1}) \right. \\
&+ \sum_i \tilde{q}_i 0.5 (\Gamma_1^2 - \Gamma_3^2 + K_1(i)^2) (1 + \ell^{-1}) \\
&+ \left. \sum_i \tilde{q}_i 0.5 (1 - \alpha)^{-1} (\eta - 1) (1 + \hat{\eta}(\eta - 1) (1 + \bar{\chi})^{-1} (\ell + 1)) \right) \\
\hat{\Xi} &= \sum_i \tilde{q}_i (\Gamma_1 \Gamma - \Gamma_3(i) \Gamma_4(i)) (1 + \ell^{-1}) \\
\hat{a}_t &= \sum_i \tilde{q}_i (\eta - 1) \ell \Gamma_4(i) (1 + \ell^{-1}) a_{i,t} \\
\check{a}_t &= \sum_i \tilde{q}_i [(\eta - 1) \ell \Gamma_3(i) (1 + \ell^{-1}) + K_1(i) K_3(i)] a_{i,t}.
\end{aligned}$$

Our interest is in the dependence on the coefficients defining \bar{a}_t . This is the only place the exorbitant duty coefficients enter the welfare. This part of welfare can be rewritten as

$$\bar{\Xi} \bar{\sigma}_{t-1}^2 + \sigma_{t-1} (\bar{a}_t, \hat{\Xi} \check{a}_t + \hat{a}_t).$$

Here,

$$\begin{aligned}
\hat{\Xi} \check{a}_t + \hat{a}_t &= \sum_i \left(\hat{\Xi} \kappa_i + \tilde{q}_i (\eta - 1) \ell \Gamma_4(i) (1 + \ell^{-1}) \right) a_{j,t} \\
&= \sum_i \left(\hat{\Xi} \kappa_i + \tilde{q}_i (\eta - 1) \ell (\eta - 1) (\ell + 1) \bar{\chi} / (1 + \bar{\chi}) (1 + \ell^{-1}) \right) a_{j,t}
\end{aligned}$$

with

$$\begin{aligned}
\hat{\Xi} &= \sum_i \tilde{q}_i (\Gamma_1 \Gamma - \Gamma_3(i) \Gamma_4(i)) (1 + \ell^{-1}) \\
&= (\eta - 1) \bar{\chi} / (1 + \bar{\chi}) (1 - \alpha)^{-1} \sum_i \tilde{q}_i \left((-1 + \hat{\eta}(\eta - 1)) \right. \\
&\quad \left. - (-1 + \hat{\eta}(\eta - 1) (\bar{\chi} - \ell) / (1 + \bar{\chi})) (\ell + 1) \right) (1 + \ell^{-1}) \\
&= (\eta - 1) \bar{\chi} / (1 + \bar{\chi}) (1 - \alpha)^{-1} \sum_i \tilde{q}_i \left(\ell + \hat{\eta}(\eta - 1) \frac{1 - \ell(\bar{\chi} - (\ell + 1))}{1 + \bar{\chi}} \right) (1 + \ell^{-1})
\end{aligned}$$

and

$$\begin{aligned}
\bar{\Xi} &= \sum_i \tilde{q}_i 0.5 (\Gamma^2 - \Gamma_4^2(i)) (1 + \ell^{-1}) \\
&= -((\eta - 1) \bar{\chi} / (1 + \bar{\chi}))^2 \sum_i \tilde{q}_i 0.5 \ell (\ell + 2)
\end{aligned}$$

Our result follows then from the following general lemma.

Lemma E.1 *Consider the minimization problem*

$$\min_A \left\{ \text{Cov}_{t-1} \left(\sum_i A_i a_{i,t}, \sum_i \Psi_i a_{i,t} \right) - 0.5 \text{Var}_{t-1} \left(\sum_i A_i a_{i,t} \right) \right\}$$

over the unit simplex

$$A_i \geq 0, \quad \sum_i A_i = 1.$$

Let $\bar{A} \equiv \sum_j \sigma_j A_j$. Then, there is a threshold χ_* such that $A_i > 0$ if and only if $\Psi_i \sigma_i (1 - \rho) + A_i \sigma_i^2 - \sigma_i \bar{A} < \chi_*$.

Proof. We have

$$\text{Cov}_{t-1}\left(\sum_i A_i a_{i,t}, \sum_i \Psi_i a_{i,t}\right) = \sum_i A_i (\Psi_i \sigma_i^2 + \rho \sigma_i \sum_{j \neq i} \sigma_j \Psi_j) = \sum_i A_i \sigma_i (\Psi_i \sigma_i (1 - \rho) + \rho \bar{\Psi})$$

with

$$\bar{\Psi} = \sum_j \sigma_j \Psi_j.$$

Thus, the first order Kuhn-Tucker condition takes the form

$$\Psi_i \sigma_i (1 - \rho) + \rho \bar{\Psi} - \sum_{j \neq i} \sigma_i \sigma_j \rho A_j - \lambda \geq 0$$

when the constraint $A_i \geq 0$ binds, and and

$$\Psi_i \sigma_i (1 - \rho) + \rho \bar{\Psi} - \sigma_i^2 A_i - \sum_{j \neq i} \sigma_i \sigma_j \rho A_j - \lambda = 0$$

when $A_i > 0$. Here, λ is the Lagrange multiplier for the constraint $\sum_i A_i = 1$. That is, $A_i = 0$ for all countries for which

$$\Psi_i \sigma_i (1 - \rho) + \rho \bar{\Psi} - \sigma_i \sum_j \sigma_j \rho A_j - \lambda \geq 0,$$

while the interior solution is for

$$\Psi_i \sigma_i (1 - \rho) + \rho \bar{\Psi} - \sigma_i^2 (1 - \rho) A_i - \sigma_i \sum_j \sigma_j \rho A_j - \lambda = 0$$

This gives

$$A_i = \frac{\Psi_i \sigma_i (1 - \rho) + \rho \bar{\Psi} - \sigma_i \bar{A} - \lambda}{\sigma_i^2 (1 - \rho)}$$

F Additional results

G Mixture of local currency and dominant currency

We first state the following extension of the Theorem 2.1 for the case of firms borrowing both in local currency and in dollars.

Theorem G.1 *Suppose that $q_i(i) = q_i(\$)$. Then, issuing in a mixture of local currency and dollars is optimal if and only if*

$$\frac{\bar{q}_i(j, \$)}{\bar{q}_i(\$)} - 1 \leq \frac{\text{Cov}_t^\$ \left(\left(\frac{\Omega_{i,t+1}}{\mathcal{B}_{t+1}(B_t)} \right)^{-\ell}, \mathcal{E}_{j,t,t+1} \right)}{E_t^\$ \left[\left(\frac{\Omega_{i,t+1}}{\mathcal{B}_{t+1}(B_t)} \right)^{-\ell} \right] E_t^\$ [\mathcal{E}_{j,t,t+1}]}$$

for all $j = 1, \dots, N$.

Proof of Theorem G.1. The standard Kuhn-Tucker conditions that borrowing only in LC and dollars is optimal if and only if

$$\begin{aligned} & E_t \left[M_{i,t,t+1} \left[\left(1 - (1 - \rho_i) \left(\frac{\mathcal{B}_{t+1}(B_t)}{\Omega_{i,t+1}} \right)^\ell \right) (1 + c) \mathcal{E}_{j,i,t+1} \right] \right] (1 - q_i(j)) \\ & + E_t \left[M_{i,t,t+1} \left[\left(-\ell(1 - \rho_i) \left(\frac{\mathcal{B}_{t+1}(B_t)}{\Omega_{i,t+1}} \right)^{\ell-1} \Omega_{i,t+1}^{-1} \right) (1 + c) \mathcal{E}_{j,i,t+1} \right] \mathcal{B}_{t+1}(B_t) \right] (1 - q_i(\$)) \\ & - (1 + c(1 - \tau)) E_t [M_{i,t,t+1} \mathcal{E}_{j,i,t+1}] \\ & + E_t \left[M_{i,t,t+1} (\ell + 1) \left(\frac{\mathcal{B}_{t+1}(B_t)}{\Omega_{i,t+1}} \right)^\ell (1 + c(1 - \tau)) \mathcal{E}_{j,i,t+1} \right. \\ & \left. - \ell \left(\frac{\mathcal{B}_{t+1}(B_t)}{\Omega_{i,t+1}} \right)^\ell (1 + c(1 - \tau)) \mathcal{E}_{j,i,t+1} \right] \leq 0 \end{aligned}$$

for all j with the identity for $j = i, \$$. This inequality can be rewritten as

$$\bar{q}_i(j, \$) \frac{E_t[M_{i,t,t+1} \mathcal{E}_{j,i,t+1}]}{E_t \left[M_{i,t,t+1} \left(\frac{\mathcal{B}_{t+1}(B_t)}{\Omega_{i,t+1}} \right)^\ell \mathcal{E}_{j,i,t+1} \right]} \leq 1 = \bar{q}_i(\$) \frac{E_t[M_{i,t,t+1} \mathcal{E}_{\$,i,t+1}]}{E_t \left[M_{i,t,t+1} \left(\frac{\mathcal{B}_{t+1}(B_t)}{\Omega_{i,t+1}} \right)^\ell \mathcal{E}_{\$,i,t+1} \right]}$$

and the first claim follows.

For the second claim, we get the system

$$\begin{aligned} 1 &= \bar{q}_i(\$) \frac{E_t[M_{i,t,t+1} \mathcal{E}_{\$,i,t+1}]}{E_t \left[M_{i,t,t+1} \left(\frac{\mathcal{B}_{t+1}(B_t)}{\Omega_{i,t+1}} \right) \mathcal{E}_{\$,i,t+1} \right]} \\ 1 &= \bar{q}_i(\$) \frac{E_t[M_{i,t,t+1}]}{E_t \left[M_{i,t,t+1} \left(\frac{\mathcal{B}_{t+1}(B_t)}{\Omega_{i,t+1}} \right) \right]} \end{aligned}$$

whereby

$$\mathcal{B}_{t+1}(B_t) = (1 + c(1 - \tau))(B_t(i) + B_t(\$)\mathcal{E}_{\$,i,t+1})$$

Thus, we get the system

$$\begin{aligned} E_t[M_{i,t,t+1} \Omega_{i,t+1}^{-1}] B_t(i) + E_t[M_{i,t,t+1} \Omega_{i,t+1}^{-1} \mathcal{E}_{\$,i,t+1}] B_t(\$) &= \tilde{q}_i(\$) E_t[M_{i,t,t+1}] \\ E_t[M_{i,t,t+1} \Omega_{i,t+1}^{-1} \mathcal{E}_{\$,i,t+1}] B_t(i) + E_t[M_{i,t,t+1} \Omega_{i,t+1}^{-1} \mathcal{E}_{\$,i,t+1}^2] B_t(\$) &= \tilde{q}_i(\$) E_t[M_{i,t,t+1} \mathcal{E}_{\$,i,t+1}] \end{aligned}$$

where we have defined

$$\tilde{q}_i(\$) = \bar{q}_i(\$) / (1 + c(1 - \tau)).$$

Thus,

$$\begin{pmatrix} B_t(i) \\ B_t(\$) \end{pmatrix} = \tilde{q}_i(\$) \Delta_t^{-1} \begin{pmatrix} E_t[M_{i,t,t+1} \Omega_{i,t+1}^{-1} \mathcal{E}_{\$,i,t+1}^2] & -E_t[M_{i,t,t+1} \Omega_{i,t+1}^{-1} \mathcal{E}_{\$,i,t+1}] \\ -E_t[M_{i,t,t+1} \Omega_{i,t+1}^{-1} \mathcal{E}_{\$,i,t+1}] & E_t[M_{i,t,t+1} \Omega_{i,t+1}^{-1}] \end{pmatrix} \begin{pmatrix} E_t[M_{i,t,t+1}] \\ E_t[M_{i,t,t+1} \mathcal{E}_{\$,i,t+1}] \end{pmatrix}.$$

where

$$\Delta_t = E_t[M_{i,t,t+1}\Omega_{i,t+1}^{-1}\mathcal{E}_{\$,i,t+1}^2]E_t[M_{i,t,t+1}\Omega_{i,t+1}^{-1}] - (E_t[M_{i,t,t+1}\Omega_{i,t+1}^{-1}\mathcal{E}_{\$,i,t+1}])^2$$

Thus,

$$\frac{B_t(i)}{B_t(\$)\mathcal{E}_{t,\$,i}} = \frac{-\text{Cov}_t^{\$}(\Omega_{i,t+1}^{-1}\mathcal{E}_{t,t+1,\$,i}, \mathcal{E}_{t,t+1,\$,i}^{-1})}{\text{Cov}_t^{\$}(\Omega_{i,t+1}^{-1}, \mathcal{E}_{t,t+1,\$,i}^{-1})}.$$

Thus,

$$\frac{B_t(i)}{B_t(\$)\mathcal{E}_{t,\$,i}} = \frac{-\text{Cov}_t^{\$}\left(\left(\bar{C}_{t+1}^{\hat{\eta}}e^{(\eta-1)a_{i,t+1}}\mathcal{P}_{\$,t,t+1}\right)^{-1}, \mathcal{P}_{i,t,t+1}^{-1}\mathcal{P}_{\$,t,t+1}\right)}{\text{Cov}_t^{\$}\left(\left(\bar{C}_{t+1}^{\hat{\eta}}e^{(\eta-1)a_{i,t+1}}\mathcal{P}_{i,t,t+1}\right)^{-1}, \mathcal{P}_{i,t,t+1}^{-1}\mathcal{P}_{\$,t,t+1}\right)}.$$

Let now $\tilde{a}_{i,t+1} \equiv \log(\bar{C}_{t+1}^{\hat{\eta}}e^{(\eta-1)a_{i,t+1}}) - \beta\tilde{a}_{\$,t+1}$ where $\tilde{a}_{\$,t+1} = \log(\bar{C}_{t+1}^{\hat{\eta}}e^{(\eta-1)a_{\$,t+1}})$ and where β is such that $\tilde{a}_{i,t+1}$ and $\tilde{a}_{\$,t+1}$ are uncorrelated.

Recall also that we assume that

$$\log \mathcal{P}_{i,t,t+1} = -\hat{\alpha}_i\tilde{a}_{\$,t+1} - \alpha_i\tilde{a}_{i,t+1} + \varepsilon_{i,t+1}, \quad \log \mathcal{P}_{\$,t,t+1} = -\tilde{\alpha}_{\$}\hat{a}_{\$,t+1} + \varepsilon_{\$,t+1}$$

where $\varepsilon_{i,t+1} \sim N(0, \sigma_{\varepsilon,i}^2)$. We also allow $\sigma_{\varepsilon,i,\$} \equiv \text{Cov}_t(\varepsilon_{i,t+1}, \varepsilon_{\$,t+1}) \neq 0$. Then, to the first order in variance, the measure change is irrelevant and

$$\begin{aligned} & -\text{Cov}_t^{\$}\left(\left(\bar{C}_{t+1}^{\hat{\eta}}e^{(\eta-1)a_{i,t+1}}\mathcal{P}_{\$,t,t+1}\right)^{-1}, \mathcal{P}_{i,t,t+1}^{-1}\mathcal{P}_{\$,t,t+1}\right) \\ & \approx -\text{Cov}_t(-\tilde{a}_{i,t+1} - \beta\tilde{a}_{\$,t+1} + \alpha_{\$}\tilde{a}_{\$,t+1} - \varepsilon_{\$,t+1}, -\alpha_{\$}\tilde{a}_{\$,t+1} + \varepsilon_{\$,t+1} + \alpha_i\tilde{a}_{i,t+1} + \hat{\alpha}_i\tilde{a}_{\$,t+1} - \varepsilon_{i,t+1}) \end{aligned}$$

whereas

$$\begin{aligned} & \text{Cov}_t^{\$} \left((\bar{C}_{t+1}^{\hat{\eta}} e^{(\eta-1)a_{i,t+1}} \mathcal{P}_{i,t,t+1})^{-1}, \mathcal{P}_{i,t,t+1}^{-1} \mathcal{P}_{\$,t,t+1} \right) \\ & \approx \text{Cov}_t(-\tilde{a}_{i,t+1} - \beta \tilde{a}_{\$,t+1} + \alpha_i \tilde{a}_{i,t+1} + \hat{\alpha}_i \tilde{a}_{\$,t+1} - \varepsilon_{i,t+1}, -\alpha_{\$} \tilde{a}_{\$,t+1} + \varepsilon_{\$,t+1} + \alpha_i \tilde{a}_{i,t+1} + \hat{\alpha}_i \tilde{a}_{\$,t+1} - \varepsilon_{i,t+1}) \end{aligned}$$

In the small variance approximation, we that's get

$$\frac{B_t(i)}{B_t(\$)\mathcal{E}_{t,\$,i}} \approx \frac{\sigma_{\varepsilon,\$}^2 - \sigma_{\varepsilon,i,\$} + \alpha_i \sigma_c^2(i) + \alpha_{\$}^2 \sigma_c^2(\$) - (\alpha_{\$} + \alpha_i \alpha_{\$}) \sigma_c(i, \$)}{\sigma_{\varepsilon,i}^2 - \sigma_{\varepsilon,i,\$} + (1 - \alpha_i)(\alpha_{\$} \sigma_c(i, \$) - \alpha_i \sigma_c^2(i))}$$

where $\sigma_c(i)^2 = \text{Var}_t[\log(\bar{C}_{t+1}^{\hat{\eta}} e^{(\eta-1)a_{i,t+1}})]$ and $\sigma_c(i, \$) = \text{Cov}_t[\log(\bar{C}_{t+1}^{\hat{\eta}} e^{(\eta-1)a_{i,t+1}}), \log(\bar{C}_{t+1}^{\hat{\eta}} e^{(\eta-1)a_{\$,t+1}})]$.

Q.E.D.

G.1 Investment and debt overhang

In this section, we assume that the firm can pay a cost of

$$h_i(1 + \beta^{-1})^{-1} k_{i,t}^{\beta^{-1}+1},$$

to increase the lower bound of the support of the idiosyncratic shock distribution. Namely, upon having selected $k_{i,t}$, the firm gets $Z_{i,t}$ drawn from the distribution with the density $\phi(z) = (1 + k_{i,t})\ell z^{\ell-1}$ on $[q_{i,t}, 1]$ with $q_{i,t} = (1 - (1 + k_{i,t})^{-1})^{\ell-1}$.

The firm is then solving

$$\begin{aligned} & -h_i \Omega_{i,t} (\beta + 1)^{-1} k_i^{\beta+1} + k_i \Omega_{i,t} \int_{\Psi_{i,t}}^1 z \phi(z) dz \\ & = -h_i \Omega_{i,t} (\beta^{-1} + 1)^{-1} k_i^{\beta^{-1}+1} + (k_i + 1) \Omega_{i,t} \ell (\ell + 1)^{-1} (1 - \Psi_{i,t}^{\ell+1}). \end{aligned}$$

Solving the optimization problem gives

$$k_{i,t} = (h_i^{-1}\ell(\ell+1)^{-1}(1 - \Psi_{i,t}^{\ell+1}))^\beta .$$

In particular, absent debt overhang,

$$k_{i,t} = k_i^* = (h_i^{-1}\ell(\ell+1)^{-1})^\beta .$$

Note that here $1 + k_i = (1 - q_i^\ell)^{-1}$.

Then, redefining

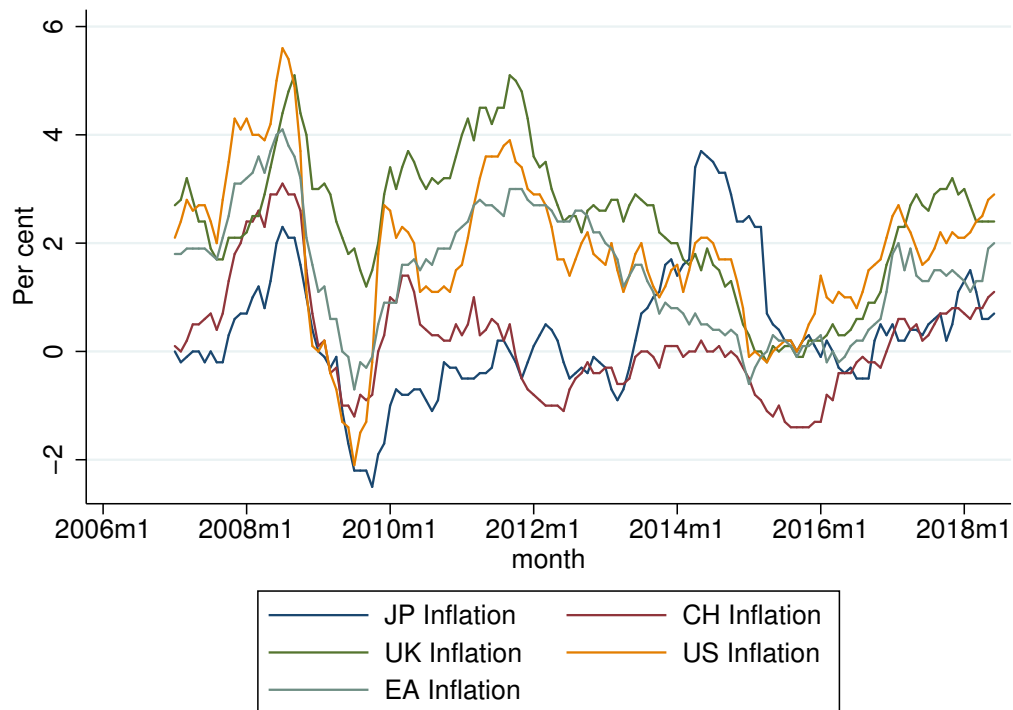
$$\begin{aligned} G_i(\Psi_{i,t}) &= \ell(\ell+1)^{-1} \left(1 + (h_i^{-1}\ell(\ell+1)^{-1}(1 - \Psi_{i,t}^{\ell+1}))^\beta \right) \\ &\times \left((\zeta - 1)\Psi_{i,t}^{\ell+1} + 1 - \zeta \left(\left(1 - \left(1 + (h_i^{-1}\ell(\ell+1)^{-1}(1 - \Psi_{i,t}^{\ell+1}))^\beta \right)^{-1} \right) \right)^{\ell^{-1}+1} \right) , \end{aligned}$$

we get the same equilibrium equation.

G.2 Data appendix

G.2.1 Inflation rates by currency

Figure 8: Inflation rates by Currency



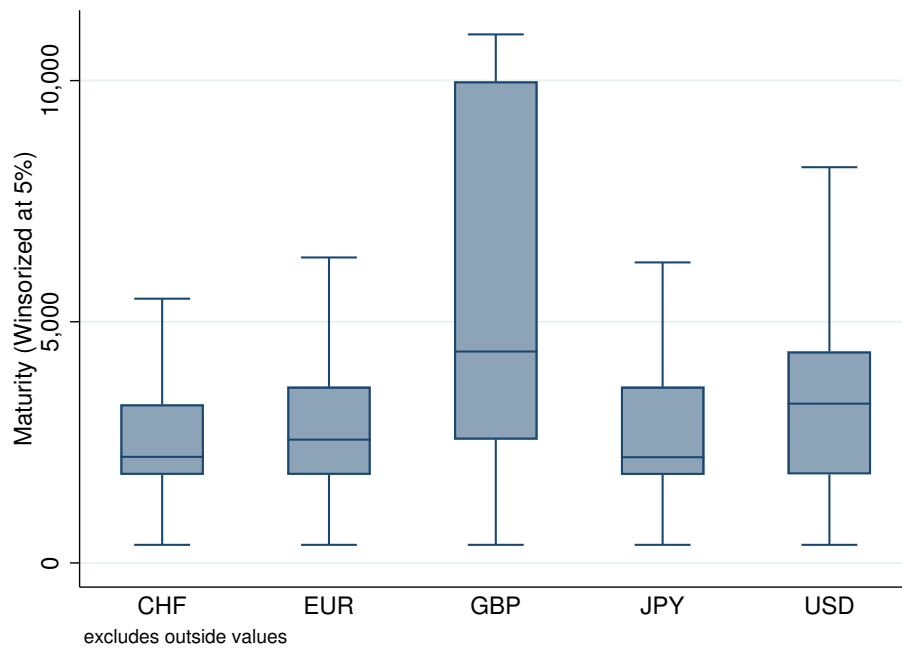
Source: National data

G.2.2 Debt maturity across currencies

G.2.3 Local currency to dollar debt ratios across countries

Figure 10 shows the mean of the debt ratio, $\frac{LCU}{USD}_i$, for each country in our sample. The left-hand panel shows several outliers: China and the EU countries in the sample (Czechia, Hungary, and Poland), while the right-hand panel shows the rest of the countries. We

Figure 9: Summary statistics of maturity by currency

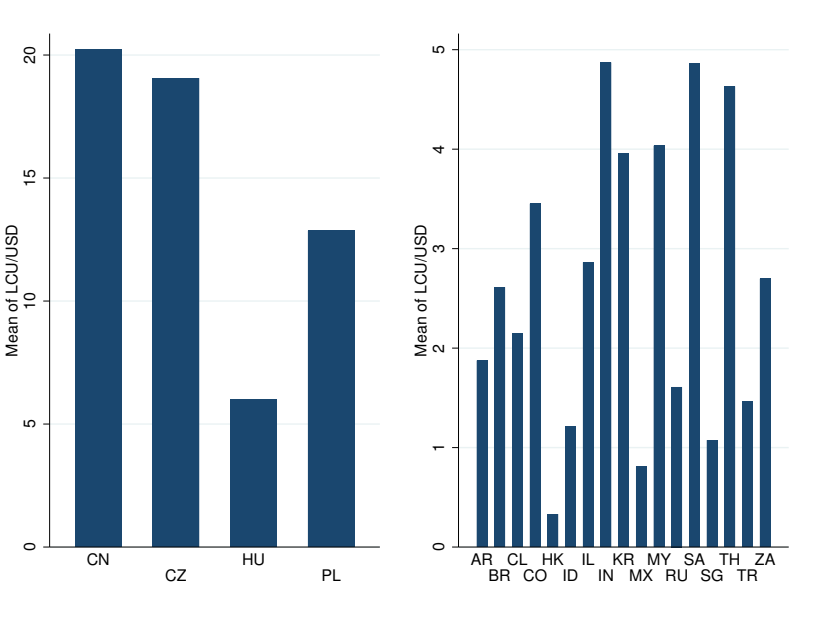


Source: Dealogic, authors' calculations

Notes: The box plots the 25th and the 75th percentile on the outside; the line inside the box is the median. The whiskers show the lower and upper adjacent values.

exclude outliers from our regressions and focus only on the sample of countries listed in the right-hand panel.

Figure 10: Mean of the local currency to USD debt ratio by country



Source: IIF, authors' calculations

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