Balance Sheets, Exchange Rates, and International Monetary Spillovers*

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Abstract

We use a two-country New-Keynesian model with balance-sheet constraints on banks to investigate the extent of international spillovers of U.S. monetary policy. Home banks borrow from domestic households in domestic currency, as well as from residents of the foreign economy (the U.S.) in dollars. We assume agency frictions are more severe for foreign debt than for domestic deposits. As a consequence, a deterioration in domestic banks balance sheets induces an exchange rate depreciation and a deviation from uncovered interest parity. We use the model to investigate how domestic monetary transmission and international monetary spillovers are affected by the extent of banks' liability dollarization, and whether the latter makes it desirable for domestic policy to target the nominal exchange rate.

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1 Introduction

With U.S. monetary policy normalization well underway, an important question facing monetary policymakers across the globe is to what extent rising U.S. interest rates can have adverse spillovers to their own economies, and what are the tradeoffs they face in this environment. A common view, particularly among emerging market economies, recommends gearing policy toward preventing capital outflows and mitigating currency depreciation. A frequent argument underlying this view is the presence of currency mismatches in balance sheets, which render the latter undesirably vulnerable to movements in the nominal exchange rate.[1]

Our goal in this paper is to investigate how balance sheet dollarization of the domestic private sector may affect the degree of spillovers from U.S. monetary policy, and to lay out its consequences for the tradeoffs faced by domestic monetary policymakers. In particular, we investigate whether balance sheet dollarization provides grounds for an interest rate policy that attempts to stabilize the nominal exchange rate, as argued by the common view described above. To this end, we develop a two-country New Keynesian model, consisting of a "home" economy (e.g. an emerging market economy) and the U.S., and augment it with financial frictions in the banking sector of the home economy. We then allow for dollar-denominated liabilities in home banks' balance sheets, by assuming that domestic banks can borrow from U.S. households (in dollars) as well as from domestic households (in domestic currency). In each case, banks' borrowing is subject to agency frictions, modelled as in Gertler and Kiyotaki (2010).

An important assumption within our setting is that the agency frictions affect foreign borrowing more severely than domestic borrowing. Here we attempt to capture the realistic notion that it is harder for foreign creditors to monitor home-economy borrowers and enforce contracts with them than it is for domestic creditors. We begin by illustrating the role of this assumption by means of a very simple model designed to isolate the role of balance sheet constraints. We show how a domestic balance sheet deterioration induces a deviation from uncovered interest parity (a rise in the domestic "currency risk premium") and an exchange rate depreciation.

We then embed this mechanism within a larger-scale New Keynesian model with empirically realistic features. We use the model to investigate the quantitative role of balance

[1] Calvo and Reinhart (2002) and Hausmann, Panizza and Stein (2001), for example, appeal to currency mismatches in balance sheets, and the consequent sensitivity of the latter to exchange rate variations, as an explanation for the observed "fear of floating" among emerging economies.

sheet conditions in exchange rate determination, as well as how the transmission of domestic monetary policy is affected by the extent of liability dollarization. We then move on to quantify how the latter may influence the size of the spillovers from U.S. monetary tightening. Finally, we examine the desirability of following a standard inflation-targeting Taylor rule versus a policy rule aimed at nominal exchange rate stabilization.

The key findings that emerge from our analysis are as follows. First, the degree of liability dollarization significantly affects the transmission of domestic monetary policy. In particular, because a domestic interest rate hike hurts balance sheets, it induces a rise in the currency risk premium, which partially counteracts the standard effect through the uncovered interest parity (UIP henceforth) condition leading to an exchange rate appreciation. This effect turns more powerful as the degree of liability dollarization rises, because balance sheets turn more sensitive to a depreciation—thus exacerbating the adverse feedback between the state of balance sheets and the exchange rate. When dollarization is very high, a monetary tightening actually leads the currency to *depreciate* in the short run, due to a sharp rise in the currency risk premium.

Second, we find that dollarization significantly enhances the spillovers from a U.S. tightening to the home economy. The reason is the downward pressure on the currency exerted by a U.S. policy rate hike. The depreciation initiates losses in domestic balance sheets when dollarization is high, setting off the adverse feedback loop between exchange rates and balance sheets.

We next examine the spillovers from U.S. monetary policy under an alternative policy regime in which the domestic monetary authority systematically rises the policy rate as the nominal exchange rate depreciates. Our key finding is that the appeal of such a policy actually *diminishes* as the degree of liability dollarization rises, rather than increasing as suggested by the conventional view. The reason is the significant adverse effect on the currency risk premium exerted by a domestic tightening. In the case of a very high rate of dollarization, the alternative policy regime (the one that targets the nominal exchange rate) induces an enormous output drop following a U.S. tightening, and does not even succeed in stabilizing the nominal exchange rate.

Compared to standard New Keynesian models like Gali and Monacelli (2005), in which a UIP condition always holds, our model features significant deviations from uncovered interest parity, which are related to the state of domestic balance sheets (and therefore linked to domestic credit spreads). In the empirical section of the paper, we provide a test this feature of the model. We do so by augmenting Fama regressions (Fama (1984)) with measures of

domestic credit spreads, which proxying for the domestic external finance premium. Here we find significant support for the basic model prediction linking the currency risk premium with domestic credit spreads.

The paper is organized as follows. We begin by describing, in Section 2, a very simple model aimed at isolating the role of domestic balance sheet on deviations from uncovered interest parity—the novel element in our setting relative to Gali and Monacelli (2005) or Erceg et al. (2007). Section 3 describes the full model. Section 5 shows our quantitative experiments. Section 6 contains the empirical analysis. Section 7 concludes.

Literature. We build on Gali and Monacelli (2005) and Erceg et al. (2007) by allowing for financial frictions modelled following Gertler and Kiyotaki (2010) and Gertler and Karadi (2011). Evidence on currency mismatches: Goldstein and Turner (2004), Chui, Kuruc and Turner (2016). Recent related work: Aoki et al. (2016), Bocola and Lorenzoni (2017), Gabaix and Maggiori (2015). Prior work on balance sheets and exchange rates: Gertler et al. (2007), Céspedes et al. (2004), Aghion et al. (2001), Aghion et al. (2004), Krugman (1999).

[to be completed]

2 Simple Model

We begin with a very simple, stripped-down version of the model which allows us to isolate the role of the state of domestic balance sheets on the exchange rate. The model consists of a foreign economy (the U.S.) and a domestic economy populated by households, firms, and bankers. Bankers borrow from domestic households and from U.S. households to fund the acquisition of physical capital. An agency friction potentially limits the bankers' ability to borrow (from both domestic and foreign creditors) to finance productive capital.

2.1 Banks

We assume each banker i lives for one period, and operates on behalf of the representative household.[2] At the beginning of the period, the banker receives an equity transfer from the household. The banker then uses this equity endowment ξ_{it} (an exogenous variable) as well as borrowed funds from domestic households (D_{it}) and foreign households (D^*_{it}, in real dollars)

[2]In the larger-scale model presented later, we allow for long-lived bankers.

to finance capital purchases S_{it}:

$$q_t S_{it} = D_{it} + \mathcal{Q}_t D^*_{it} + \xi_{it}$$

where q_t is price of capital and $\mathcal{Q}_t$ is the real exchange rate (the real price of foreign currency). S_{it} is claims on domestic firms, which are perfectly state-contingent on the underlying return. Thus, the banker can be thought of as a holder of equity of domestic firms.

In $t+1$, the bank receives net payment

$$\underbrace{(r_{Kt+1} + q_{t+1})}_{\equiv R_{Kt+1}} S_{it} - R_{t+1} D_{it} - R^*_{t+1} \mathcal{Q}_{t+1} D^*_{it}$$

which he or she transfers to the household and then exits. Here r_{Kt+1} is the dividend payout and R_{t+1}, R^*_{t+1} are the (noncontingent) interest rates on domestic and foreign funds, respectively.

The agency friction takes the form of a simple limited enforcement problem. In particular, after borrowing funds, the banker may default on creditors and divert the amount

$$\theta\Big(D_{it} + (1+\gamma)\mathcal{Q}_t D^*_{it} + \xi_{it}\Big)$$

for personal gain, where $0 < \theta < 1$ and $\gamma > 0$. The latter assumption, $\gamma > 0$, implies that foreign loans are more easily divertable than domestic loans. We believe this is a natural assumption: It captures the notion that it is harder for foreign creditors to monitor borrowers and enforce contracts than it is for domestic creditors. Upon default, creditors liquidate the bank and recover the remaining amount. For creditors to be willing to supply funds in the first place, the banker's choices need to satisfy an incentive constraint requiring his or her continuation value to be higher than the value of defaulting and diverting funds.

Let

$$\begin{aligned}
\mu_t &\equiv \beta \mathbb{E}_t \left(R_{Kt+1} - R_{t+1}\right) \\
\varrho_t &\equiv \beta \mathbb{E}_t \left(R_{Kt+1} - \frac{R^*_{t+1}\mathcal{Q}_{t+1}}{\mathcal{Q}_t}\right) \\
x_{it} &\equiv \frac{\mathcal{Q}_t D^*_{it}}{q_t S_{it}}
\end{aligned}$$

The variable μ_t denotes expected excess returns with respect to the domestic rate R_{t+1}, while

ϱ_t is expected excess returns relative to the foreign borrowing rate. The variable x_{it} is the foreign funding ratio—the ratio of the banks' foreign liabilities (expressed in real domestic currency) to total assets. Each banker solves the following problem:

$$\max_{S_{it},x_{it}} \quad \Big[x_{it}\varrho_t + (1-x_{it})\mu_t\Big] q_t S_{it} + \xi_{it}$$

subject to

$$\Big[x_{it}\varrho_t + (1-x_{it})\mu_t\Big] q_t S_{it} + \xi_{it} \geq \theta\left(1+\gamma x_{it}\right) q_t S_{it} \quad \text{(IC)}$$

The incentive constraint (IC) above requires that the banker's continuation value be higher than the value of defaulting.

Given a binding IC, the banker's first order conditions imply the optimal liability portfolio condition

$$(1+\gamma)\mu_t = \varrho_t$$

The intuition is straightforward. Consider a marginal increase in the bank's foreign borrowing, financed by a decrease of the amount of borrowing from the domestic market. The benefit of this operation is ϱ_t, the excess return on foreign borrowing. The cost is $(1+\gamma)\mu_t$—the excess return on domestic borrowing, μ_t, plus the loss due to a tighter IC, $\gamma\mu_t$ (recall that an extra unit of foreign borrowing tightens the constraint by γ marginally). If the bank's portfolio is optimal in the first place, the benefit of the operation must equal its cost.

The wedge in the UIP condition (or the "foreign exchange risk premium") is then given by:

$$\begin{aligned}
\mu_t^* &\equiv \beta\mathbb{E}_t\left(R_t - \frac{R_{t+1}^*\mathcal{Q}_{t+1}}{\mathcal{Q}_t}\right) \\
&= \varrho_t - \mu_t \\
&= \gamma\mu_t
\end{aligned}$$

Thus the foreign exchange risk premium is proportional to the domestic excess return μ_t, with constant of proportionality given by the parameter γ.

Throughout we assume that the parameters are such that the IC always binds:

$$(1+\gamma x_{it})\, q_t S_{it} = \frac{\xi_{it}}{\theta - \mu_t}$$

2.2 Households and export demand

The representative consumer maximizes

$$\mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t U(C_{Dt}, M_{Ct})$$

subject to

$$C_{Dt} + \mathcal{Q}_t M_{Ct} + D_t \leq W_t \overline{L} + R_t D_{t-1} + \pi_t$$

C_{Dt} is domestic-good consumption, M_{Ct} is imports, D_t is bank deposits, and π_t is net transfers from bankers. Assuming preferences take the form $U(C_D, M_C) = C_D + \chi_m \log(M_C)$, we get the following first-order conditions:

$$R = \beta^{-1}$$
$$M_{Ct} = \chi_m \mathcal{Q}_t^{-1}$$

Given symmetric preferences in the foreign country, export demand from the foreign country is analogous to import demand: $M^*_{Ct} = \chi_x \mathcal{Q}_t$.

We assume inelastic labor supply and linear utility in C_D for simplicity, as these features are not essential (qualitatively) to the transmission from balance sheets to exchange rates. On the other hand, it is important to allow for a qualitatively realistic response of net exports to the real exchange rate, justifying the assumption of curvature in the preferences for imports and exports.

2.3 Equilibrium conditions

We assume that physical capital is in fixed aggregate supply $\overline{K}$. Capital market clearing is then given by $\int S_{it} di = \overline{K}$. We assume banks' transfer is $\xi_{it} = \xi_t q_t \overline{K}$, where ξ_t follows an exogenous process with mean $\overline{\xi} \in (0, \theta + \overline{\mu})$, where $\overline{\mu}$ denotes the steady-state value of μ_t. This assumption ensures that IC binds in the deterministic steady state. Aggregating

banks' incentive constraint and assuming symmetry, we get

$$1 + \gamma x_t = \frac{1}{\theta - \mu_t}\xi_t$$

Aggregating domestic budget constraints (where $R^* = \beta^{*-1} < R$),

$$\begin{aligned} \mathcal{Q}_t \left(R^* D^*_{t-1} - D^*_t \right) &= NX_t \\ NX_t &= \chi_x \mathcal{Q}_t - \chi_m \end{aligned}$$

The full set of equilibrium conditions consists of 5 equations:

$$1 + \gamma x_t = \frac{1}{\theta - \mu_t}\xi_t \qquad \text{(1. IC)}$$

$$\mathcal{Q}_t D^*_t = x_t q_t \overline{K} \qquad \text{(2. Foreign funding ratio)}$$

$$q_t = \beta \frac{\mathbb{E}_t(\overline{r}_K + q_{t+1})}{1 + \mu_t} \qquad \text{(3. Price of capital)}$$

$$\mathcal{Q}_t = \frac{\frac{\beta}{\beta^*}\mathbb{E}_t(\mathcal{Q}_{t+1})}{1 - \gamma\mu_t} \qquad \text{(4. RER)}$$

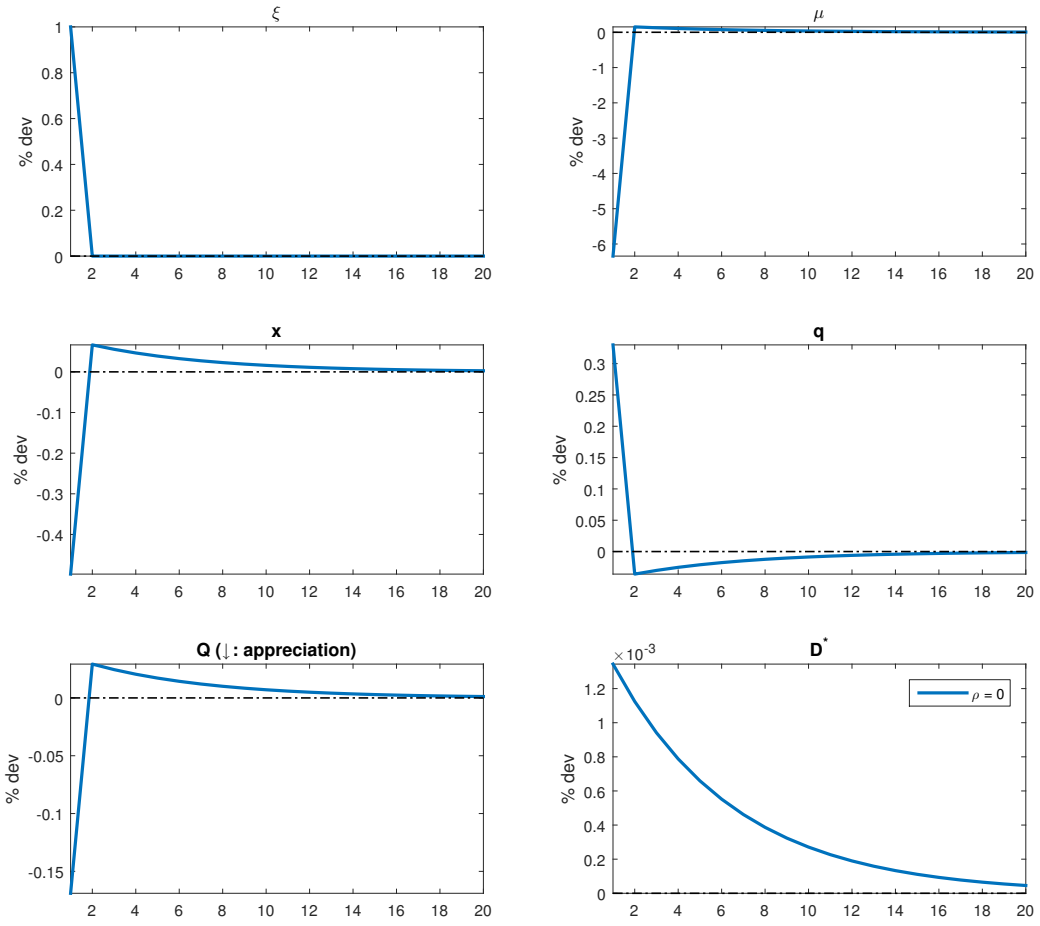
$$\mathcal{Q}_t \left(R^* D^*_{t-1} - D^*_t \right) = \chi_x \mathcal{Q}_t - \chi_m \qquad \text{(5. BOP)}$$

We assume firms are perfectly competitive and operate a Cobb-Douglas technology $Y_t = K_t^\alpha L_t^{1-\alpha}$. Given the aggregate supplies of labor and capital $\overline{K}$ and $\overline{L}$, the dividend payout is $\overline{r}_K = \alpha(\overline{K}/\overline{L})^{\alpha-1}$.

2.4 Effect of net worth shock

What are the consequences of in increase in aggregate bank net worth? Figure 1 shows the impulse responses to an innovation to ξ_t, assuming that the latter follows an *iid* process. We set the parameters to the values indicated below Figure 1, but emphasize that the basic qualitative patterns hold more generally. On impact ($t = 1$), higher net worth allows the excess return μ_t to fall, via equation 1 (the incentive constraint). Through the optimal portfolio condition, the exchange risk premium falls, and the real exchange rate appreciates (see equation 4 determining the real exchange rate). The appreciation reduces net exports, leading D^*_t to rise through the balance of payments (BOP) equation. On impact, the foreign funding ratio x_t falls despite the rise in D^*_t, as $\mathcal{Q}$ falls and q rises—both pushing down x_t

Figure 1: *iid* ξ shock in the simple model

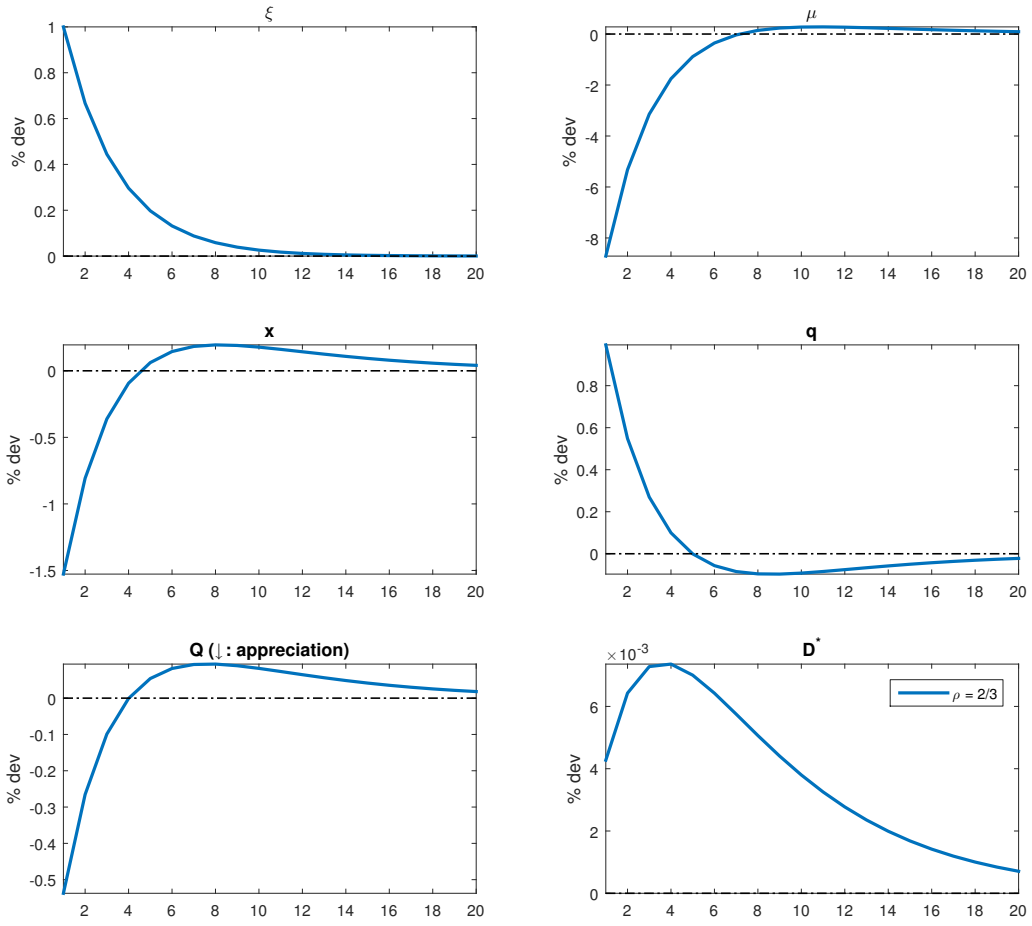


$(\beta = 0.96, \beta^* = 0.99, \gamma = 0.5, \theta = 0.2, \xi = 0.25, \chi_m = \chi_x = .25)$

as seen in equation 2. For $t > 1$, the economy now starts with an elevated D^*_{t-1} (the only state variable other than ξ_t) which, from the BOP, implies an elevated D^*_t, or a high $\mathcal{Q}_t$, or both. In either case, the foreign funding ratio x_t must rise, pushing up μ_t through the IC—as higher holdings of foreign debt worsen the agency friction. With higher μ_t, the price of capital q_t falls and the real exchange rate depreciates ($\mathcal{Q}_t$ rises). The depreciation then slowly helps build then net foreign asset position by boosting net exports, thus bringing down D^*_t.

A similar logic applies to the more realistic case in which the movement in net worth has some persistence, shown in Figure 2. The key difference is that now the initial appreciation lasts longer than just one period, with $\mathcal{Q}_t$ remaining below zero for about four quarters. The increase above zero of $\mathcal{Q}_t$ and its convergence back to steady state from above now occur in

Figure 2: Persistent ξ shock in the simple model



a delayed and more gradual manner.

3 Full Model

The core model is a two-country extension of an open-economy New Keynesian model (for example, Gali and Monacelli (2005) and Erceg et al. (2007)) augmented with with banks as in Gertler and Kiyotaki (2010) (abstracting from liquidity risks). Compared to the simple model in the previous section we now allow banks to be long-lived. This introduces endogenous persistence in their net worth and, more importantly, allows it to be affected by movements in the exchange value of domestic currency (to the extent that part of banks' liabilities are in foreign currency). In addition, we include a standard set of nominal and real rigidities, aimed to enhance the model's empirical realism.

3.1 Banks

We begin by describing the banker's problem in the full model. We first describe the evolution of banks' net worth, and then review their optimization problem.

3.1.1 Balance sheet and net worth evolution

Banks' survival probability $\sigma_b > 0$ implies endogenous evolution of net worth. Exiting bankers are replaced by new entrants, which receive a small endowment ξ_b (as a fraction of the value of the aggregate capital stock). The balance sheet identity is

$$\underbrace{q_t S_{it}}_{\substack{\text{claims on} \\ \text{domestic firms}}} \equiv \underbrace{D_{it}}_{\substack{\text{domestic} \\ \text{deposits}}} + \underbrace{\mathcal{Q}_t D^*_{it}}_{\substack{\text{(real) dollar} \\ \text{deposits}}} + \underbrace{N_{it}}_{\substack{\text{net} \\ \text{worth}}}$$

The banker's budget constraint, expressed in (real) domestic currency, is

$$q_t S_{it} + R_t D_{it-1} + R^*_t \mathcal{Q}_t D^*_{it-1} \leq R_{kt} q_{t-1} S_{it-1} + D_{it} + \mathcal{Q}_t D^*_{it}$$

The left-hand side is banks' uses of funds, including banks' lending plus deposit repayments (both domestic and foreign), and the right-hand side is the source of funds, including returns from past loans plus deposits issued.

Combining the two equations above yields the evolution of net worth:

$$N_{it} = (R_{kt} - R_t) q_{t-1} S_{it-1} + \left(R_t - R^*_t \frac{\mathcal{Q}_t}{\mathcal{Q}_{t-1}} \right) \mathcal{Q}_{t-1} D^*_{it-1} + R_t N_{it-1} \tag{1}$$

3.1.2 Optimization problem

The banker's objective is

$$V_{it} = \max_{S_{it}, D_{it}, D^*_{it}} (1 - \sigma_b) \mathbb{E}_t \Big[\Lambda_{t,t+1} \big(R_{kt+1} q_t S_{it} - R_{t+1} D_{it} - R^*_{t+1} \mathcal{Q}_{t+1} D^*_{it} \big) \Big] + \sigma_b \mathbb{E}_t \Big(\Lambda_{t,t+1} V_{it+1} \Big)$$

subject to

$$\begin{aligned} q_t S_{it} &= D_{it} + \mathcal{Q}_t D^*_{it} + N_{it} \\ N_{it+1} &= (R_{kt+1} - R_{t+1}) q_t S_{it} + \left(R_{t+1} - R^*_{t+1} \frac{\mathcal{Q}_{t+1}}{\mathcal{Q}_t} \right) \mathcal{Q}_t D^*_{it} + R_{t+1} N_{it} \\ V_t &\geq \theta \left(1 + \frac{\gamma}{2} x_t^2 \right) q_t S_{it} \quad \text{(IC)} \end{aligned}$$

where $x_{it} = \mathcal{Q}_t D^*_{it} / q_t S_{it}$ and $\Lambda_{t,t+1}$ is household's stochastic discount factor between t and $t+1$. Compared to the simple model, here we assume that the default payoff is quadratic in the foreign funding ratio (rather than linear). This turns out to have some desirable properties, without affecting the qualitative insights obtained from the simpler linear case. In particular, the quadratic formulation implies an interior solution for each bank's foreign funding ratio.

3.2 Employment agencies

As in **?**, there is a continuum of households indexed by $i \in [0,1]$, each of which is a monopolistic supplier of specialized labor $L_{i,t}$. A large number of competitive "employment agencies" combine specialized labor into a homogeneous labor input used by intermediate goods producers, according to

$$L_t = \left[\int_0^1 L_{i,t}^{\frac{1}{1+\theta_w}} di \right]^{1+\theta_w}$$

From employment agencies' cost minimization, demand for labor variety i is

$$L_{i,t} = \left(\frac{W_{i,t}}{W_t} \right)^{-\frac{1+\theta_w}{\theta_w}} L_t$$

where $W_{i,t}$ is the nominal wage received by supplier of labor of type i and the wage paid by goods producers is

$$W_t = \left[\int_0^1 W_{i,t}^{-\frac{1}{\theta_w}} dj \right]^{-\theta_w} \tag{2}$$

3.3 Domestic households and wage setting

Household i seeks to maximize

$$\mathbb{E}_0 \sum_{j=0}^{\infty} \beta^j \left(\frac{\sigma}{\sigma - 1} \left(C_{t+j} - hC_{t+j-1} \right)^{\frac{\sigma-1}{\sigma}} - \frac{\chi_0}{1+\chi} L_{i,t+j}^{1+\chi} \right)$$

subject to

$$\begin{aligned} P_{Ct}C_t + P_{Ct}D_t &\leq W_{i,t}L_{i,t} + P_{Ct}R_tD_{t-1} + \Pi_t + \mathcal{W}_{it} \\ C_t &= \left[(1-\omega)^{\frac{\rho}{1+\rho}} C_{Dt}^{\frac{1}{1+\rho}} + \omega^{\frac{\rho}{1+\rho}} \left(\varphi_{Ct} M_{Ct} \right)^{\frac{1}{1+\rho}} \right]^{1+\rho} \\ P_{Ct} &= \left[(1-\omega) P_{Dt}^{\frac{1}{1+\rho}} + \omega P_{Mt}^{\frac{1}{1+\rho}} \right]^{1+\rho} \end{aligned}$$

Following Erceg, Guerrieri and Gust (2006) we assume costs of adjusting consumption imports, which take the following form:

$$\varphi_{Ct} = 1 - \frac{\varphi_M}{2} \left(\frac{\frac{M_{Ct}}{C_{Dt}}}{\frac{M_{Ct-1}}{C_{Dt-1}}} - 1 \right)^2$$

This specification implies that it is costly to change the proportion of domestic and foreign goods in the aggregate consumption bundle.

We assume producer currency pricing (PCP): $P_{Mt} = e_t P_{Dt}^*$, where e_t is the nominal exchange rate (in domestic currency per dollar).

Fraction ξ_w of households cannot set the wage but instead follows

$$W_{i,t} = W_{i,t-1} \pi_{wt-1}^{\iota_w}, \quad \pi_{wt} \equiv \frac{W_t}{W_{t-1}}$$

The remaining fraction of households solves

$$\max_{W_t^o} \ \mathbb{E}_t \left\{ \sum_{j=0}^{\infty} (\xi_w \beta)^j \Big[- \frac{\chi_0}{1+\chi} L_{i,t+j}^{1+\chi} + \frac{U_{C,t+j}}{P_{Ct+j}} L_{i,t+j} W_t^o \prod_{k=1}^{j} \pi_{wt+k-1}^{\iota_w} \Big] \right\}$$

subject to the labor demand function (2).

3.4 Foreign (U.S.) households

U.S. household's problem is analogous to that of domestic households:

$$\max \ \ \mathbb{E}_0 \sum_{j=0}^{\infty} \beta^{*j} \left(\frac{\sigma}{\sigma - 1} \left(C^*_{t+j} - hC^*_{t+j-1} \right)^{\frac{\sigma-1}{\sigma}} - \frac{\chi_0{}^*}{1+\chi} L^*_{i,t+j}{}^{1+\chi} \right)$$

subject to

$$P^*_{Ct} C^*_t + B^*_t + P^*_{Ct} D^*_t \leq W^*_{i,t} L^*_{i,t} + R^{n*}_t B^*_t + P^*_{Ct} R^*_t D^*_{t-1} + \Pi^*_t + \mathcal{W}^*_{it}$$

where D^*_t is short-term deposits in home banks by U.S. households, B^*_t is short-term nominal bonds (in zero net supply), R^*_t is real return on deposits in home banks (in real dollars), and R^{n*}_t is the Fed funds rate. U.S. households also face nominal wage rigidities and costs of adjusting imports, in a symmetric manner as domestic households.

3.5 Firms and price setting

A continuum of mass unity of retail firms produce final output using intermediate goods. Final output Y_t is

$$Y_t = \left(\int_0^1 Y_{i,t}^{\frac{1}{1+\theta_p}} di \right)^{1+\theta_p}$$

Cost minimization by users of final output the following demand function for firm i's output:

$$Y_{i,t} = \left(\frac{P_{Di,t}}{P_{Dt}} \right)^{-\frac{1+\theta_p}{\theta_p}} Y_t$$

Each firm can reset its price with probability $1-\xi_p$. Firms not resetting their price follow the indexation rule

$$P_{Di,t} = P_{Di,t-1} \pi^{\iota_p}_{t-1}, \quad \pi_t \equiv P_{Dt}/P_{Dt-1}$$

The problem facing a firm resetting its price in period t is thus

$$\max_{P_{Dt}^o} \ \mathbb{E}_t \sum_{j=0}^{\infty} \Lambda_{t,t+j} \xi_p^j \left(P_{Dt}^o \prod_{k=1}^{j} \pi_{t+k-1}^{\iota_p} - MC_{t+j} \right) Y_{i,t+j}$$

The production function of each intermediate goods firm i is given by $Y_{i,t} = K_{i,t}^{\alpha} L_{i,t}^{1-\alpha}$.

3.6 Capital producers

Capital producers produce new capital goods subject to costs of adjusting the level of investment I_t, given by

$$\phi_{It} = \frac{\psi_I}{2} \left(\frac{I_t}{I_{t-1}} - 1 \right)^2 I_t$$

As in the case of consumption goods, investment goods are a composite of domestic (I_{Dt}) and imported (M_{It}) goods, also subject to costs of adjusting the imported-domestic good mix:

$$I_t = \left[(1-\omega)^{\frac{\rho}{1+\rho}} I_{Dt}^{\frac{1}{1+\rho}} + \omega^{\frac{\rho}{1+\rho}} \left(\varphi_{It} M_{It} \right)^{\frac{1}{1+\rho}} \right]^{1+\rho}$$

with

$$\varphi_{It} = 1 - \frac{\varphi_M}{2} \left(\frac{\frac{M_{It}}{I_{Dt}}}{\frac{M_{It-1}}{I_{Dt-1}}} - 1 \right)^2$$

Optimality with respect to the investment aggregate I_t gives rise to an investment-q relation:

$$\begin{aligned} q_t = 1 + & p_{Dt} \phi \left(\frac{I_t}{I_{t-1}} - 1 \right) \frac{I_t}{I_{t-1}} + p_{Dt} \frac{\phi_I}{2} \left(\frac{I_t}{I_{t-1}} - 1 \right)^2 \\ & - \mathbb{E}_t \left\{ \Lambda_{t,t+1} p_{Dt+1} \phi \left(\frac{I_{t+1}}{I_t} - 1 \right) \left(\frac{I_{t+1}}{I_t} \right)^2 \right\} \end{aligned}$$

where $p_{Dt} \equiv P_{Dt}/P_{Ct}$.

3.7 Domestic market clearing, BOP, and monetary policy rule

The market clearing condition for the home good is as follows:

$$Y_t = C_{Dt} + I_{Dt} + \frac{\xi_f}{\xi_h}\left(M^*_{Ct} + M^*_{It}\right) + \phi_{It}$$

where $\frac{\xi_f}{\xi_h}$ is the relative population size of the foreign economy (note that all variables are expressed in per capita terms). The balance of payments is

$$\mathcal{Q}_t\left(D^*_t - R^*_t D^*_{t-1}\right) = C_t + I_t + p_{Dt}\phi_{It} - p_{Dt}Y_t$$

In our baseline case, monetary policy in each country follows an inertial Taylor rule:

$$R^n_t = \left(R^n_{t-1}\right)^{\gamma_r}\left(\overline{R}\pi_t^{\gamma_\pi} x_t^{\gamma_x}\right)^{1-\gamma_r}\varepsilon^r_t \tag{3}$$

where $\pi_t \equiv P_{Dt}/P_{Dt-1}$ and x_t is the output gap.

4 Calibration

Tables 1 and 2 report the parameter values. We calibrate the U.S. discount factor, β^*, to 0.9975, implying a steady-state real interest rate of 1% per year in the U.S. The calibration of the home discount factor, β, is described below. The intertemporal elasticity of substitution (σ), capital share (α) and capital depreciation rate (δ) are calibrated to the conventional values of 1, 0.33, and 0.025, respectively. We also calibrate the steady-state wage and price markup to 20 percent, a conventional value. For the remaining parameters governing features of the domestic economy, we rely on estimates from Justiniano et al. (2010). These parameters include the degree of consumption habits (h), the inverse Frisch elasticity of labor supply (χ), the parameters governing price and wage rigidities ($\theta_p, \xi_p, \theta_w$, and ξ_w), the investment adjustment cost parameter (Ψ_I), and the coefficients of our baseline Taylor rule (γ_r, γ_π, and γ_x). The values for these parameters are listed in the top part of Table 1.

Turning to parameters governing international trade, we set the trade price elasticity $\frac{1+\rho}{\rho}$ to unity, following estimates by Hooper et al. (2000). We set a relatively high home bias in preferences for consumption and investment goods ($1-\omega = 0.95$). Here we want to capture an economy with a relatively low degree of trade openness with respect to the U.S.

Table 1: Common Parameters

Parameter	Symbol	Value	Source/Target
Conventional			
U.S. discount factor	β^*	0.9975	U.S. real interest rate of 1% p.a.
IES	σ	1	Conventional
Habit parameter	h	0.78	Justiniano et al. (2010)
Inverse Frisch elasticity of labor supply	χ	3.79	Justiniano et al. (2010)
Trade price elasticity	$\frac{1+\rho}{\rho}$	1	Hooper et al. (2000)
Home bias in goods preferences	$1-\omega$	0.95	
Relative home size	ξ_h/ξ_f	0.2	
Import adjustment cost parameter	φ_M	10	Erceg et al. (2006)
Capital share	α	0.33	Conventional
Capital depreciation	δ	0.025	Conventional
Prob. of keeping price fixed	ξ_p	0.84	Justiniano et al. (2010)
Price indexation	ξ_p	0.24	Justiniano et al. (2010)
Price markup	θ_p	0.2	Conventional
Prob. of keeping wage fixed	ξ_p	0.70	Justiniano et al. (2010)
Wage indexation	ξ_p	0.15	Justiniano et al. (2010)
Wage markup	θ_p	0.2	Conventional
Investment adjustment cost parameter	Ψ_I	2.85	Justiniano et al. (2010)
Taylor rule smoothing	γ_r	0.82	Justiniano et al. (2010)
Taylor rule inflation	γ_π	2.09	Justiniano et al. (2010)
Taylor rule output gap	γ_x	0.07	Justiniano et al. (2010)
Financial frictions			
Bank survival rate	σ_b	0.969	Survival horizon of 8 years
Bank fraction divertable	θ	0.59	{ Leverage of 6, credit spread
Bank transfer rate	ξ_b	0.03	of 150 bps p.a., 1% foreign liab.
Home bias in bank funding	γ	12	in low-dollarization economy }

as our benchmark case, as this is the case in which the benefits for the domestic economy of fighting a currency depreciation would be expected to be highest (since the benign effect of a depreciation via net exports is small). We later consider the implications of greater trade openness. We set the population size of the home economy to one fifth that of the U.S. The trade adjustment cost parameter φ_M is set to 10, following Erceg et al. (2006).

We assume that the home discount factor β is lower than its counterpart in the U.S., β^*. This implies that in the deterministic steady state of the model banks have an incentive to borrow U.S. funds, as they offer a lower interest rate than domestic funds. Countering this

Table 2: Low v. high dollarization

Parameter	**Low dollarization**	**High dollarization**
Discount factor, β	0.9968	0.9900
Steady-state values		
Real interest rate (% p.a.)	1.25	4
Foreign liability ratio $\frac{\mathcal{Q}D^*}{\mathcal{Q}D^*+D}$ (%)	1	19

effect is the fact that $\gamma > 0$, implying that foreign funds tighten banks' constraints and thus limiting the extent to which banks want to borrow from abroad. Since our goal in the model simulations below is to illustrate the consequences of the extent to which banks' liabilities are in dollars, we consider two calibrations of the home discount factor, one in which its value is close to that of the U.S. (though still lower), and another in which β is substantially below β^*. We label the first calibration "low dollarization," and the second "high dollarization." As seen in Table 2, in the low dollarization economy we set $\beta = 0.9968$, which yields a steady-state interest rate in the home economy that is only 25 basis points above the U.S. rate. In the high dollarization economy we set $\beta = 0.99$, so that the domestic interest rate is 4 percent—i.e. 4 times the value in the U.S. We then set parameter governing home bias in banks' funding, γ, to target a ratio of foreign to total liabilities of only 1 percent in the low dollarization economy. As seen in Table 2, when the domestic interest rate is 4 percent the degree of liability dollarization becomes almost 20 percent, a value in the high end of the range of available estimates.[3] To calibrate the remaining parameters governing financial frictions (the survival rate σ_b, the asset diversion parameter θ, and the transfer rate ξ_b) we target the following three features of the low-dollarization economy: a survival horizon of 8 years, a steady-state spread of 150 basis points, and a leverage ratio (assets to net worth) of 6.

[3]See Goldstein and Turner (2004) and Chui, Kuruc and Turner (2016).

5 Model Analysis

5.1 Net worth shock

We begin by illustrating the role of net worth in the full model model. We do so by documenting the effects of a one-time transfer of wealth from bankers to households (think of a tax levied on banks' equity, the proceeds of which are distributed lump-sum back to households). We size the transfer to 5 percent of steady-state net worth. The results are shown in Figure 3.

Starting with the low dollarization case (red dash-dotted line), the dynamic responses of the credit spread $\mathbb{E}(R_K - R)$, the currency risk premium $\mathbb{E}(R - R^*\mathcal{Q}'/\mathcal{Q})$, the price of capital q and the real exchange rate $\mathcal{Q}$ resemble the responses highlighted by the simple model described earlier (with the sign inverted, given that we are now considering a negative movement in net worth). For example, zooming in the real exchange rate response reveals that this variable rises (i.e., the home real exchange rate depreciates) by about 25 basis points on impact, and remains high for about 10 quarters before turning negative and gradually converging back to zero from below. This dynamic pattern resembles the one obtained from the much simpler model from Section 2. There are, however, some notable differences with respect to the simple model described earlier. Note, first, that now the drop in net worth is persistent, even though the transfer shock is transient. This reflects the fact that bankers are long-lived. Second, note that the net worth drops by 10 percent on impact, i.e. twice the size of the transfer. This is largely the result of the financial accelerator effect working through a general-equilibrium decline in the asset price q: lower aggregate net worth lowers investment and q, and the lower asset price works to diminish net worth further. In addition, in contrast to the simple model, now the drop in net worth now has adverse consequences for the real economy: aggregate investment falls by almost 2 percent, leading output to fall despite a rise in net exports.

The high dollarization economy is characterized by a very strong feedback between net worth and the real exchange rate: from equation (1), note that a realized depreciation (high $\mathcal{Q}_t/\mathcal{Q}_{t-1}$) lowers N_{it}, with the effect stronger the larger the stock of foreign liabilities $\mathcal{Q}_{t-1}D^*_{it-1}$. Thus, the adverse feedback loop between net worth and currency movements becomes much more powerful when banks' liabilities are heavily dollarized. This is reflected in the impact of the net worth transfer in the high-dollarization economy (shown by the blue solid lines in Figure 3): net worth now falls 20 percent on impact, about four times the size of the transfer shock. The currency risk premium skyrockets, and as a consequence the real

and nominal exchange rates depreciate about six percent on impact. The consequences for the real economy are much more severe than in the low dollarization case, with investment and output falling more than twice as much.

5.2 Domestic monetary shock

We next explore the consequences of a monetary policy tightening in the domestic economy, and how they differ depending on the degree of the extent of dollar borrowing in banks' balance sheets. The corresponding dynamic responses are are shown in Figure 4. The shock to ε_t^4 is sized to 1 percent per year, which would translate to a 1 percent rise in the policy rate R^n absent an endogenous movement in inflation and the output gap (given that the shock induces both variables to decline, R^n rises by about 80 basis points). For comparison, we also include the responses in an economy without financial frictions (shown by the yellow dotted line). In the frictionless case, the monetary shock induces familiar dynamics: output and investment decline in a hump-shaped manner, consistent with the empirical evidence, and the magnitudes of their decline roughly match the evidence as well (e.g. Christiano, Eichenbaum and Evans (2005)). Inflation drops, and the domestic currency appreciates by about 1 percent. Exports fall due to the stronger currency, while imports also decline due to the demand contraction at home.

Turning to the low dollarization case (red dash-dotted line), now the financial accelerator effect kicks in. The economy suffers larger declines in output and investment, amid falling net worth and rising credit spreads. Interestingly, the domestic currency now appreciates a little less in the short run compared to the frictionless economy, both in nominal and real terms. The reason, of course, is the rise in the currency risk premium, resulting from the drop in bank net worth. Still, the effect of the latter on the exchange rate is relatively small: the real exchange rate now appreciates by 70 basis points on impact, compared to about 1 percent in the frictionless case.

The adverse effect on the currency risk premium induced by a domestic monetary tightening becomes much larger in the high dollarization economy (blue solid line in 4). Now the rise in the currency risk premium is enormous, more than 200 basis points annually. As a consequence, the real and nominal exchange rate now *depreciate* on impact, and remain depreciated in the short run (for about 6 quarters). Thus, and in sharp contrast to standard monetary models (e.g. Gali and Monacelli (2005)), a hike in the policy rate leads to a weaker currency in the short run. On the other hand, the consequences of higher dollarization for

the real economy remain roughly unchanged relative to the low dollarization case: investment falls slightly more initially due to the higher increase in the credit spread, but output falls a bit less thanks to the boost from net exports.[4]

5.3 U.S. monetary shock

We now explore the effects of a monetary tightening in the U.S., and the magnitude of the spillovers to the home economy. Consider first the frictionless economy, again shown by the yellow dotted line. The effect of the foreign tightening on domestic output reflects the net effect of different forces. The expenditure switching effect due to the lower relative price of the home good dominates initially, and leads to a rise in consumption of the domestic good C_D (not shown) which accounts for the small initial rise in output. The response of the latter turns somewhat negative thereafter, largely reflecting an adverse drag from investment (which drops due to a sustained rise in real interest rates). Still, the response of output is quantitatively small—its decline at the trough (less than 2 basis points) is only a tiny fraction of the output drop in the U.S. itself, which falls about 45 basis points.

In the low dollarization economy (red dash-dotted line), the drop in q now initiates a decline in banks' net worth, leading credit spreads to rise modestly. As a consequence, investment now falls significantly more than in the frictionless economy. The lower bank net worth also induces a small rise in the currency risk premium, and the nominal and real exchange rate depreciate by more as a consequence. This leads exports to fall a little less, and imports a little more, compared to the frictionless case. Still, the larger drag from investment on real activity dominates, and leads output to fall noticeably more than in the frictionless economy.

The spillovers from U.S. monetary tightening are significantly larger in the high dollarization economy (blue solid line). The currency depreciation arising from higher U.S. rates now induces a much larger drop in banks' net worth, triggering the adverse feedback between net worth and currency depreciation (via a higher currency risk premium) emphasized earlier. The end result is a 5 percent drop in net worth, more than five times the drop in the low dollarization economy, and a depreciation of the real exchange rate of 3 percent, three times as much as the low dollarization case. The decline in investment is much larger as well–almost 1.5 percent, and even larger than the decline in U.S. investment (not shown). As a result, now home output drops 0.15 percent—about four times as much as in the low

[4]Note that net worth falls by slightly less in the high dollarization economy, despite the larger drop in q. The reason is that overall leverage is somewhat lower in the high dollarization economy.

dollarization economy. The drop in home output is around a third of the U.S. decline, and it is more persistent. Thus, a high amount of dollar liabilities in domestic balance sheets works to significantly enhance the spillover effects of U.S. monetary tightening.

5.4 Spillovers from U.S. tightening and domestic monetary regimes

We next turn to the question of whether a high degree of banks' liability dollarization provides grounds for a domestic monetary policy which attempts to stabilize (to some extent) the nominal exchange rate (NER henceforth). To this end, we compare the effects on the home economy of a U.S. monetary tightening under the baseline Taylor rule (3) to those under a monetary regime characterized by the rule

$$R_t^n = \left(R_{t-1}^n\right)^{\gamma_r} \left[\overline{R}\pi_t^{\gamma_\pi} x_t^{\gamma_x} \left(\frac{e_t}{\overline{e}}\right)^{\gamma_e}\right]^{1-\gamma_r} \varepsilon_t^r \tag{4}$$

where $\overline{e}$ is the steady-state nominal exchange rate and $\gamma_e > 0$. According to rule (4), the domestic authority systematically raises R_t^n when the home currency depreciates (e_t rises). We calibrate γ_e to 0.25, implying that with output gap and inflation held constant, a 1 percent depreciation leads the monetary authority to rise the (annual) target nominal interest rate (the term in square brackets) by 100 basis points.

The top row of Figure 5 compares the outcomes following a U.S. tightening under the baseline policy rule (3) with the outcomes under rule (4). The NER-targeting rule is successful in moderating the depreciation of the latter: the home currency depreciates about 70 basis points on impact under rule 4, compared to 110 basis points under the baseline rule. The smaller exchange rate movement, however, comes at the cost of a much larger output contraction, of almost 25 basis points. This result accords with the findings by Gali and Monacelli (2005), who show that policy rules that entail lower output gap volatility (and thus higher welfare) also entail higher exchange rate volatility.

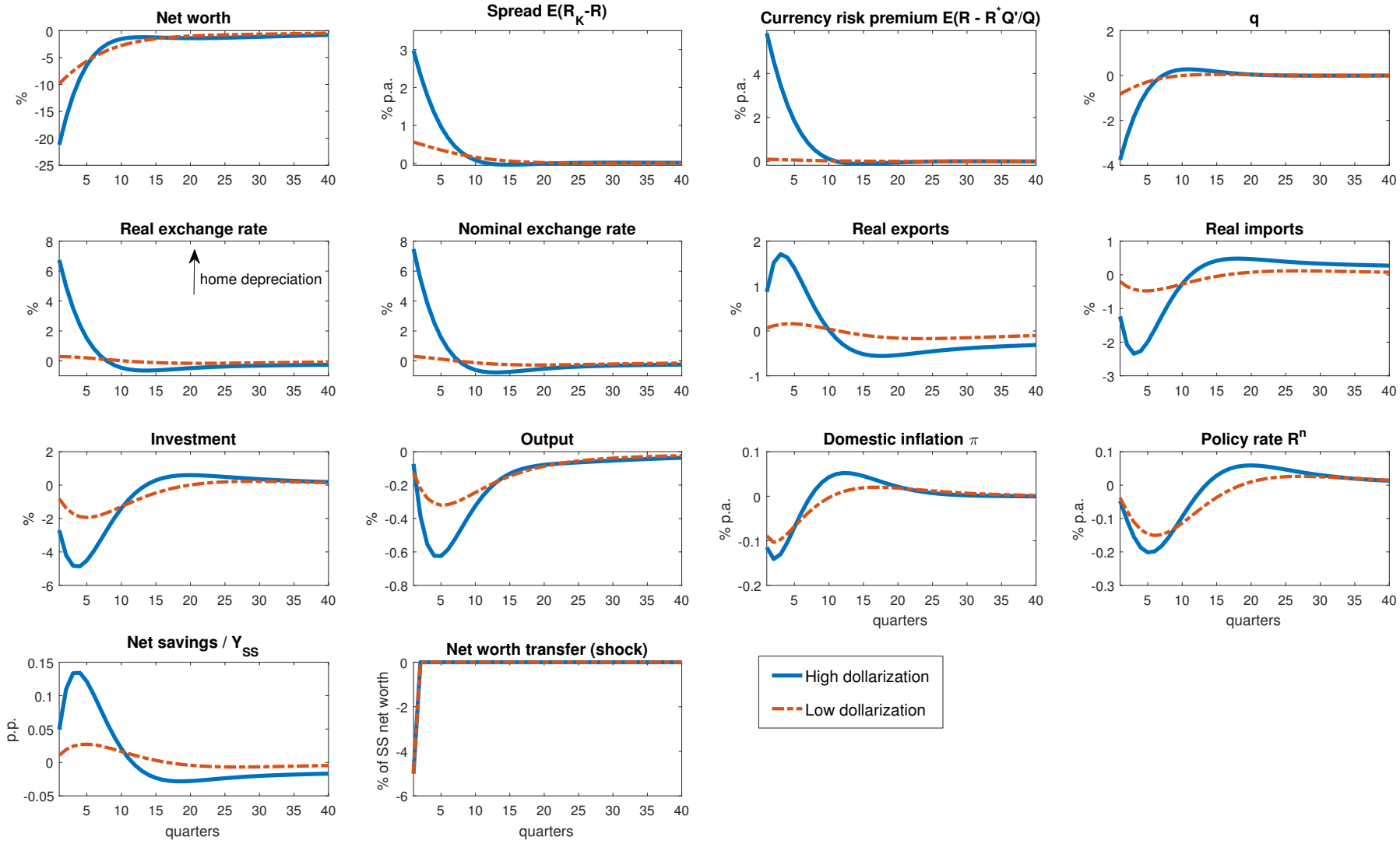
How does the degree of dollarization affect the consequences of following rule (4)? Consider first the low dollarization economy, shown in the middle row of Figure 5. The NER-targeting rule still helps moderate the movement in the exchange rate: the NER depreciates 80 basis points, somewhat more than in the frictionless economy, but still considerably less than under the baseline Taylor rule. The drop in output, however, is now much larger–almost twice as large as under the baseline Taylor rule. Thus, the output cost of stabilizing the NER

is much higher than in the frictionless economy. This is a consequence of two basic forces: first, because now domestic monetary tightening raises the currency risk premium, the policy rate needs to raise by more, *ceteris paribus*, to achieve a given appreciation. Second, the financial accelerator implies a larger output loss due to a rate hike of a given size.

These basic forces play out in a much more dramatic way in the high dollarization case, shown in the bottom row. Because raising the domestic policy rate now induces a currency *depreciation* in the short run (due to an enormous upward movement in the currency risk premium), attempting to defend the currency turns out to be disastrous in this case. The monetary authority raises rates sharply, by almost 200 basis points, inducing an enormous output decline; and it still does not succeed in halting the depreciation, with the currency falling by almost ten percent in the short run, more than twice as much as under the baseline rule (3).

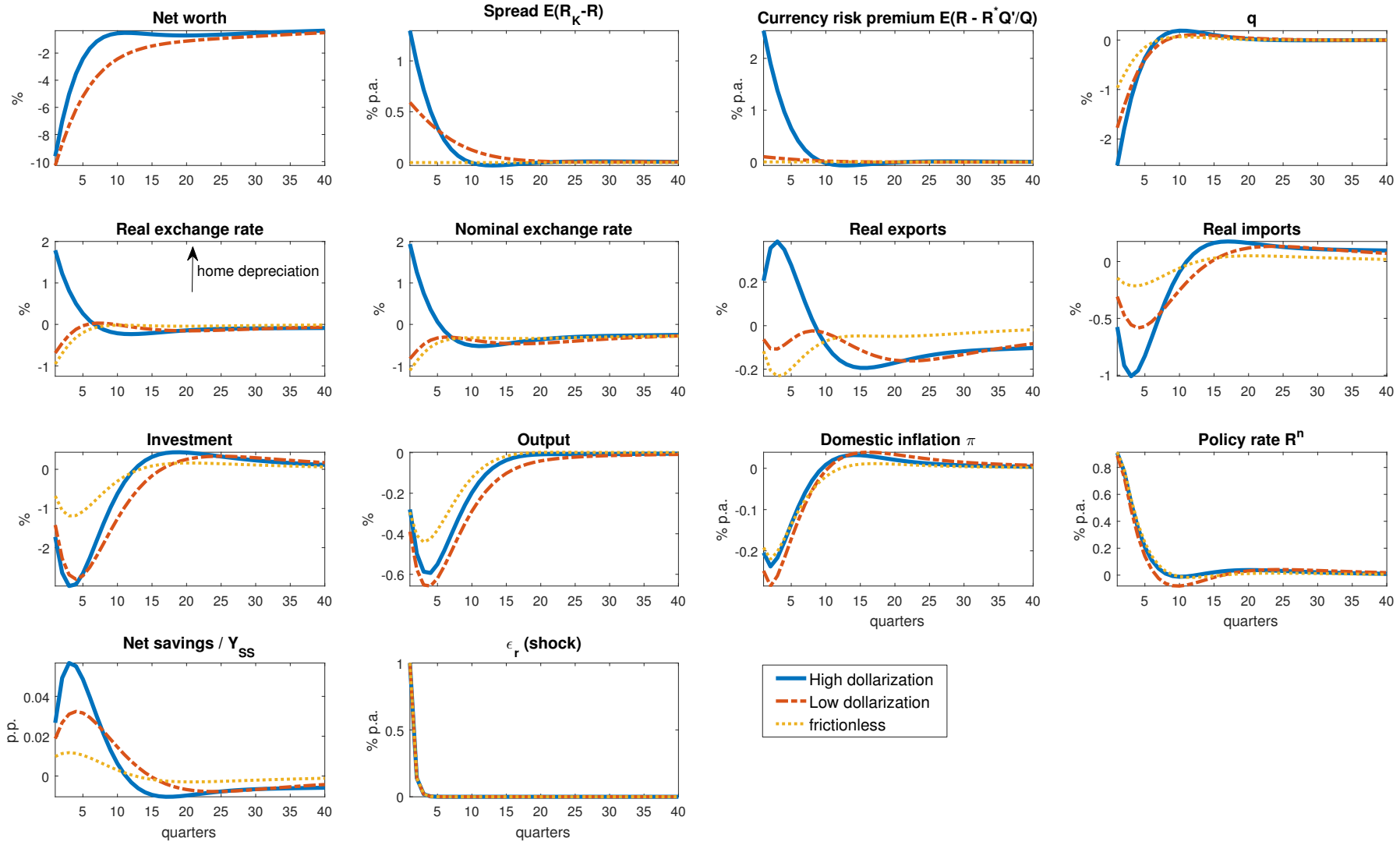
Taken together, the findings above cast doubt on the conventional argument that liability dollarization provides grounds for a rule such as (4): even when the degree of dollarization is low, the rule stabilizes the NER by less (compared to a frictionless economy) at the cost of a larger decline in output. In the more extreme case of high dollarization, the rule implies an enormous output drop, and actually fails at moderating the short-run depreciation.

Figure 3: One-time drop in bank net worth



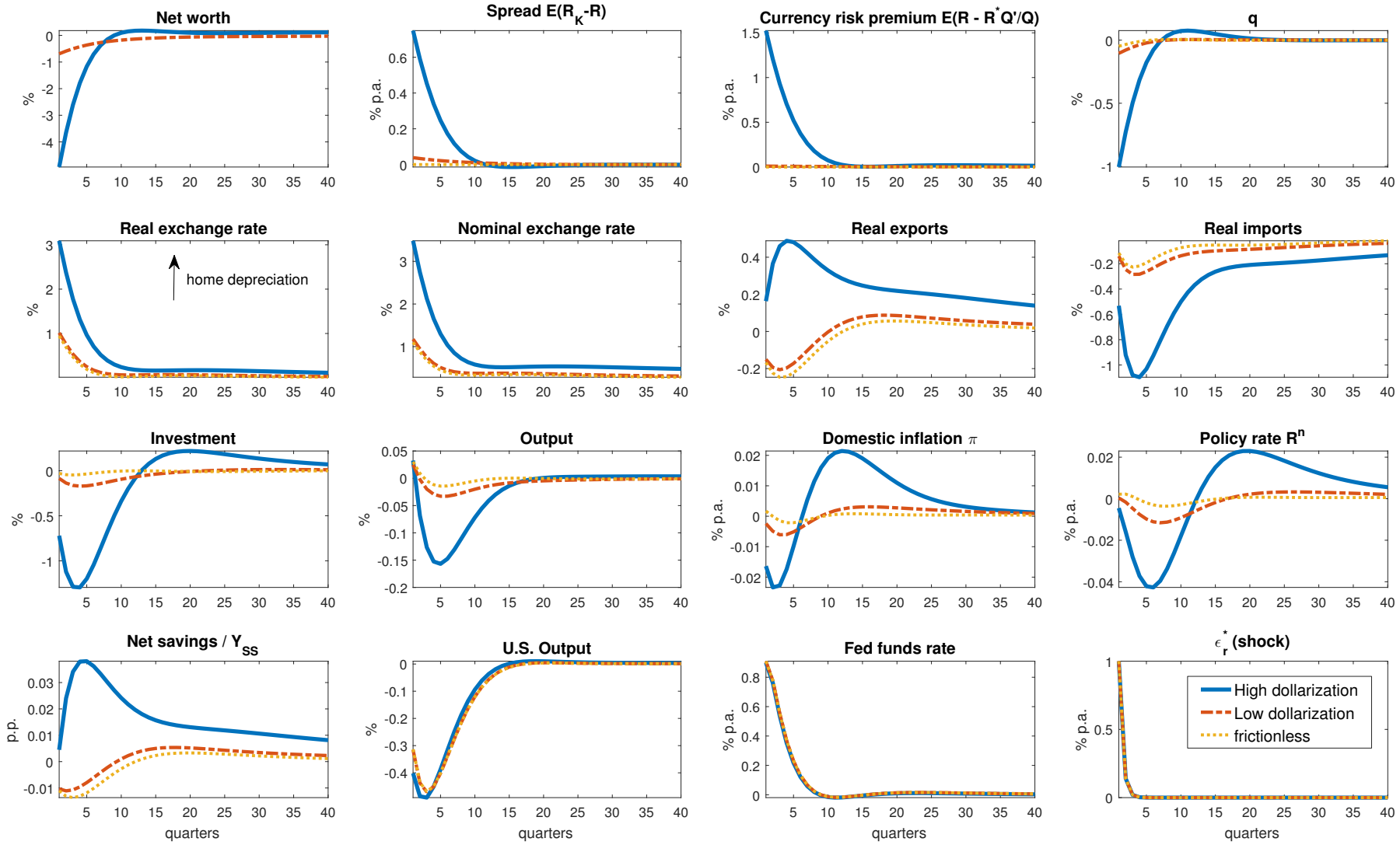
Note: The Figure shows the effects of one-time net worth transfer from bankers to households (sized at 5 percent of steady-state net worth) in the low dollarization (red dash-dotted line) and high dollarization (blue solid line) economies. All variables shown relative to steady state.

Figure 4: Domestic monetary tightening



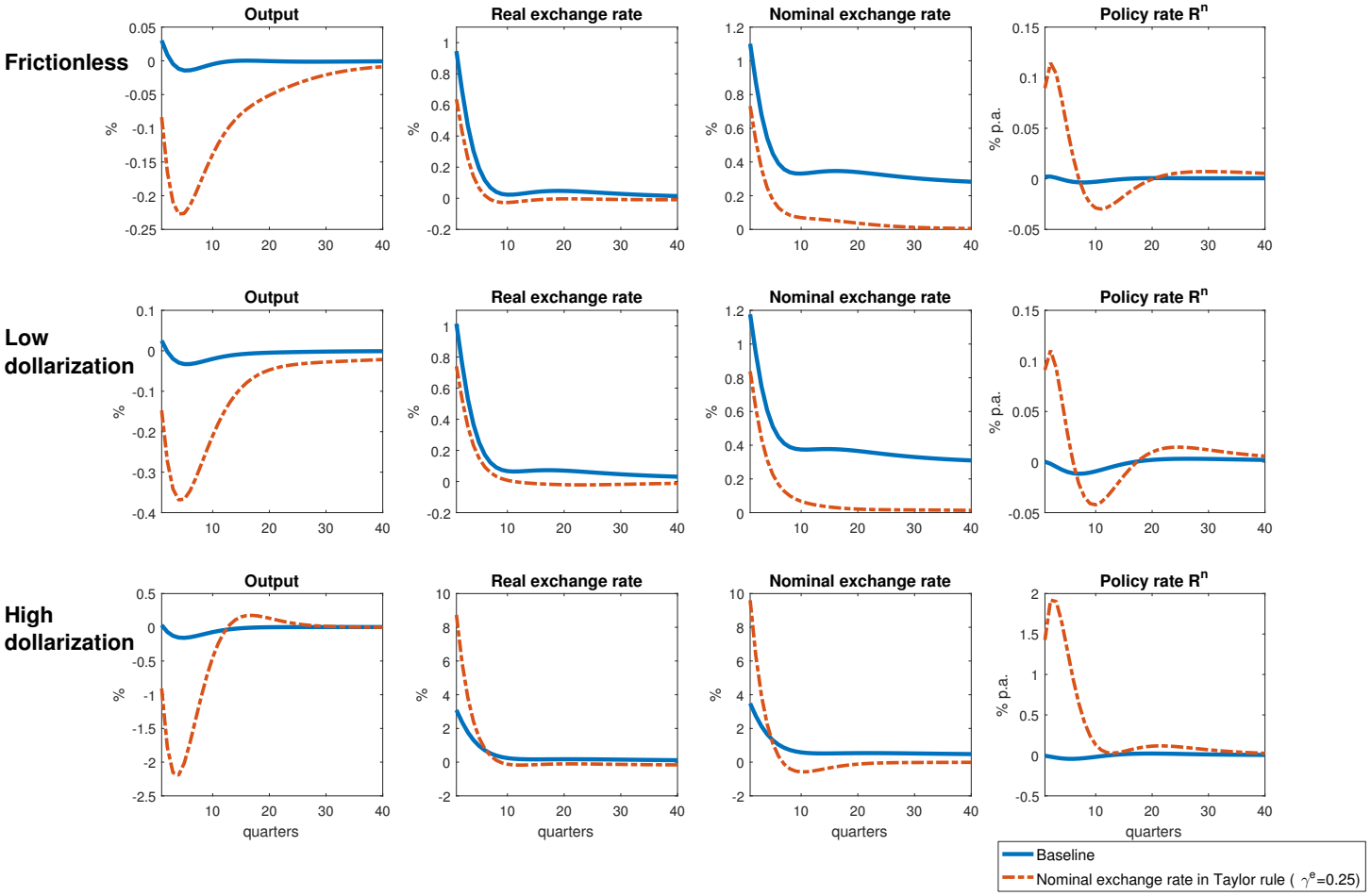
Note: The Figure shows the effects of a domestic monetary tightening in a frictionless economy (yellow dotted line), in the low dollarization economy (red dash-dotted line) and in the high dollarization economy (blue solid line) . All variables shown relative to steady state.

Figure 5: U.S. monetary tightening



Note: The Figure shows the effects of a U.S. monetary tightening in a frictionless economy (yellow dotted line), in the low dollarization economy (red dash-dotted line) and in the high dollarization economy (blue solid line) . All variables shown relative to steady state.

Figure 6: U.S. monetary tightening, baseline v. nominal exchange rate in Taylor rule



Note: U.S. monetary tightening, baseline economy v. economy with nominal exchange rate in the Taylor rule.

6 Empirical Analysis: Credit Spreads and Exchange Rates

Standard open economy macroeconomic models with either complete or incomplete international financial markets, such as Gali and Monacelli (2005), assume the uncovered interest parity (UIP) condition holds. This means that expected exchange rate depreciation in one country has to be equal to the difference between its short term interest rate on its deposits and the corresponding interest rate that a typical investor would earn if he invested in short term deposits in the other country; i.e, there are no ex ante excess returns from holding deposits in one country relative to another.[5] However, the failure of the UIP condition in the data is a long-standing and well documented puzzle in international finance (see, for example, the seminal contribution of Fama (1984) and the excellent survey paper by Engel (2014)). As has been showed in detail before, the UIP wedge (or foreign exchange rate risk premium) in our model arises endogenously due to balance sheet constraints faced by banks, and it is strongly linked to the credit spreads in the economy. This section aims to provide some empirical support for the main predictions of the model; namely, the role of credit spreads in the determination of the foreign exchange risk premium and hence the exchange rate.

The starting point of our empirical analysis is the Fama regression (Fama (1984)) as used in Engel (2016). It is usually reported as a regression of the change in the log of the nominal exchange rate between time t and t+1 on the time t interest rate differential:

$$e_t - e_{t+1} = a + b\left(i_t^* - i_t\right) + u_{t+1} \tag{5}$$

where i_t is the home one period nominal interest for deposits that pay off in period $t+1$ and i_t^* is the corresponding US interest rates. We denote nominal exchange as e_t, the log of the foreign exchange rate, expressed as home currency price of the US dollar (increase means a depreciation of home currency). Under the UIP condition the intercept coefficient of the above equation, a, has to be equal zero, and the slope coefficient, b, has to be 1. Following

[5]Note that open economy macroeconomic models with incomplete financial market models assume an ad-hoc foreign exchange risk premium solely for the purpose of rendering stationarity which does not play significant role in the determination of exchange rates.

Engel (2016) we can rewrite this equation as:

$$\underbrace{e_t - e_{t+1} + (i_t - i_t^*)}_{\Lambda_{t+1}} = a + \tilde{b}\,(i_t - i_t^*) + u_{t+1} \tag{6}$$

where $\tilde{b} \equiv 1 - b$. We define the left hand side of the above equation, Λ, as the currency risk premium (i.e., the UIP wedge). The first column Table 3 present our estimation results for the above standard Fama regression (equation 6) for the 1972-2017 period using quarterly data on exchange rate and short term interest rates.[6] In line with the earlier results reported in the literature, the points estimates of $\tilde{b}$ is positive and significant (note that under the UIP condition this coefficient is expected to be zero). As it has been discussed in detail, our model, however, predicts that foreign currency excess returns are tightly linked to credit spreads. To provide evidence that there is empirical connection between the UIP spreads and credit spreads, we run the following augmented Fama regression:

$$\underbrace{e_t - e_{t+1} + (i_t - i_t^*)}_{\Lambda_{t+1}} = a + \tilde{b}\,(i_t - i_t^*) + c\,CS_t + u_{t+1} \tag{7}$$

where the variable, CS_t, stands for corporate credit spreads. As corporate credit spread data is available for shorter time period, we first re-run the standard Fama regression, equation 6, for the period 1997-2017. As shown in the second column of Table 3 the points estimates of $\tilde{b}$ continues to be positive and significant, contrary to what would be implied by the UIP condition (i.e., $\tilde{b}$ be zero). Interestingly, however, the augmented Fama regression predicts that there is very tight and significant empirical relationship between the UIP wedge and the credit spreads. Importantly, once the credit spreads data are used in the estimation interest rate differential ceases being statistically significant from zero and its role is taken up by the credit spreads, largely supporting the theoretical predictions of the model.

7 Conclusion

[to be completed]

[6] Engel (2016) estimates equation 6 for the 1979 and 2009 period using monthly data, and documents the failure of the UIP condition which we could replicate with our data.

Table 3: Foreign Currency Risk Premium and Credit Spreads

Explanatory Variables	**(1)**	**(2)**	**(3)**
Interest Rate diff., $(i_t - i_t^*)$	1.09^{***}	1.07^{***}	0.53
	(0.16)	(0.23)	(0.45)
Credit Spreads, CS_t			3.18^{***}
			1.39
Constant	-1.43^{***}	-1.03^{***}	-1.45^{***}
	(0.32)	(0.29)	(0.26)
Time Fixed Effect	Yes	Yes	Yes
Method	Pooled OLS	Pooled OLS	Pooled OLS
R-squared	0.31	0.36	0.37
Number of Observations	1398	777	777

Notes: Countries included in the pooled OLS regression are the UK, Canada, Japan, Euro Area, Italy, Germany, Spain, France, Korea, Colombia, Thailand, Turkey and the Philippines. This table presents estimates of a, $\tilde{b}$ and c from the regression $e_t - e_{t+1} + (i_t - i_t^*) = a + \tilde{b}\,(i_t - i_t^*) + cCS_t + u_{t+1}$. The standard errors for the panel estimations are computed according to the Driscoll and Kraay (1998) method that is robust to heteroskedasticity, serial correlation and contemporaneous correlation across equations.

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Data Appendix

This section review the data sources used in analysis of section 6. More specifically, below is information on the exchange rates, interest rates and corporate spread data used in the empirical analysis. Countries are included in the data set when the currencies have a flexible currency regime. The start data of the data is different for each country. Data ends in November 2017. For Fama regressions, data sets are constructed using the last trading day of the month (quarter) for if the regression is monthly (quarter).

Exchange Rates

Exchange rates are end of day spot rates from Bloomberg and are measured in units of foreign country / USD. For example, the US-UK exchange rate is measured in pounds per dollar (pounds/dollar).

Interest Rates

Interest rates are 1M deposit rates and follow conventions from Exchange Rates, Interest Rates, and the Risk Premium paper by Engel (2016). For the US, Euro area, Australia, Canada, Japan, Norway, UK, South Africa and New Zealand, data are the average of offer and bid rate of 1M annual Eurorates. This data comes from DataStream. For Turkey, Brazil, Indonesia, Singapore, interest rates are the average of offer and bid rates of 1Month Deposit rates. For Chile, Colombia, Thailand, Korea and Mexico, Uruguay and the Philippines data are 1 Month deposit rates from Haver.

Corporate Spread Data

- BBB corporate spread data: Canada, Euro area, Japan, UK, Brazil, Korea, Mexico
- EMBI: Chile, Indonesia, Thailand, Uruguay
- Gilchrist and Mojon credit spread data: Spain, Italy, Germany and France.
- EMBI+: Colombia, Philippines, South Africa, Turkey (J.P. Morgan EMBI+ data are retrieved from Bloomberg).