How Does International Capital Flow?*

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February 29, 2024

Abstract

We develop a 2-country New Keynesian model with endogenous domestic and cross-border gross capital flows. It distinguishes physical saving and ledger-entry financing, which often move in opposite directions following shocks. This matters for key debates. First, global saving glut: Current account deficits are financed with (typically domestic) credit, not foreign saving. Second, sudden stops: In a crisis creditors stop financing debt, not current accounts. Third, Triffin's current account dilemma: Dollar creation requires dollar bank credit, not US current account deficits. Fourth, high correlation of gross capital inflows and outflows: An automatic consequence of double-entry bookkeeping, not an economic phenomenon.

JEL Codes: E44, E51, F41, F44.
Keywords: Bank lending, international capital flows, gross capital flows, current account, money creation, sudden stops, global saving glut, Triffin's dilemma.

*The authors would like to thank Stefan Avdjiev, Jaromir Benes, Claudio Borio, Stijn Classens, Piti Disyatat, Benoit Mojon, Ricardo Reis, Hyun Shin, and seminar participants at the Bank of England and the Bank for International Settlements for many helpful comments.

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1. Introduction

The open economy macroeconomics literature has for some time been emphasizing the importance of gross capital flows, and of gross asset and liability positions, for both financial and macroeconomic stability (Obstfeld (2010, 2012, 2013), Shin (2012)). On the empirical front, better data have allowed for an increasingly detailed study of cross-border (and domestic) gross flows and gross positions (Avdjiev et al. (2017), Davis et al. (2019)). However, on the theoretical front the majority of the literature continues to rely on net capital flow models that were first developed much earlier (Obstfeld and Rogoff (1995, 1996), Caballero et al. (2008), Ueda (2012), Dedola et al. (2013), Justiniano et al. (2014), Banerjee et al. (2016)). These are models of exchanges of physical resources (including services) in contemporaneous or intertemporal barter exchanges. In open economy models such exchanges represent *net* capital flows, and deferred payment claims on physical resources are typically referred to as international bonds.

There are several reasons why such models are not sufficiently detailed to represent *gross* capital flows and stocks. First, they lack a separate monetary-financial dimension whereby final settlement for any purchase of physical resources must use a financial (non-physical) medium of exchange, whose creation, circulation and destruction is separate from the creation, circulation and consumption of physical resources. In modern economies this medium of exchange function is performed by banks' gross liabilities, which we will refer to as deposits. Second, this medium of exchange is also required for trades in gross financial assets, which are far larger than trades in physical resources in modern economies. Third, an economy's banking system has the capacity not merely to facilitate the transfer of but also to create (and destroy) this medium of exchange, principally through the granting (calling in) of new loans. Fourth, any cross-border transaction requires settlement through interbank accounts, which need to be part of a complete model.

We address these issues by developing a 2-country New Keynesian DSGE model that fully integrates endogenously determined gross financial flows and stocks between domestic and foreign banks and households into a framework with the usual physical resource flows. Domestic banks extend domestic currency household loans to both domestic and foreign households, against the collateral of domestic or foreign land, and maintain interbank settlement accounts in both domestic and foreign currencies. Domestic and foreign currency bank loans create domestic and foreign currency bank deposits for a representative household that needs both currencies to lower the cost of purchasing consumption goods. The need to maintain deposit and therefore loan accounts in foreign banks gives rise to cross-border gross positions.

Because a clear distinction between cross-border payments for physical resources and cross-border financial asset transactions is at the heart of our analysis, we adopt a terminology that reflects this. A cross-border **payment flow** is the transfer of a medium of exchange whose inseparable counterpart is a flow of physical resources that crosses the border in the opposite direction.

In the balance of payments the physical resource flow is recorded in the current account, while the payment flow is recorded in the financial account. The existing net flows literature exclusively refers to payment flows as capital flows and omits all other flows. The receipt of a payment flow in exchange for resources is often referred to as a **saving flow**, and saving is therefore a goods market concept. A cross-border **financial flow** is the transfer of an existing or newly created medium of exchange whose inseparable counterpart is a flow of other gross financial assets that crosses the border in the opposite direction.[1] In the balance of payments, both legs of such a transaction are recorded in the financial account. As emphasized by Borio (2016), payment flows and financial flows are almost completely unrelated concepts, with payment flows mainly reflecting the global pattern of goods production and goods trade networks, and financial flows reflecting the global pattern of liquidity production and financing networks. Borio and Disyatat (2015) show that financial flows and stocks are generally far larger than payment flows and net foreign asset positions. A special case of a financial flow is a **financing flow**, which is an additional loan that creates an additional quantity of the medium of exchange. Unlike saving, this is a money market concept and not a goods market concept. New loans represent the outcome of the simultaneous solution of banks' and households' optimization problems over gross financial assets and liabilities rather than, as in typical net flow models, their preferences over net physical resource flows such as consumption and labor supply. Banks can therefore instantaneously increase loans and deposits by creating the necessary ledger entries, which are disconnected from any physical resources.[2] Borio and Disyatat (2011) refer to this much greater elasticity of preferences over gross balance sheet positions as the "excess elasticity" of the financial system. When banks do this for a foreign customer, the loan represents a capital outflow and the deposit a capital inflow.

We use our model to show that cross-border saving/payment flows, financial flows, and financing flows are entirely different concepts that for many shocks move in opposite directions. We do so by applying the model to four key policy debates in open economy macroeconomics. The recurring theme in these debates is the notion that "saving finances the current account" (Krugman (2007), Blanchard and Milesi-Ferretti (2009, 2011)), which treats saving and financing as identical. However, as mentioned above, saving is a goods market concept, it denotes output not consumed, while financing is a money market concept, it represents the creation of purchasing power. Borio (2016) explains that this is because the underlying modeling frameworks do not separately track monetary financing flows, and therefore implicitly represent goods themselves as the medium of exchange. When we depart from that paradigm, important new insights emerge.

[1] This is a general proposition. An example is when the foreign buyer of a domestic bond pays using a foreign bank deposit, the gross inflow is his increase in holdings of domestic bonds, while the gross outflow is the bond seller's increase in holdings of foreign bank deposits.

[2] Jakab and Kumhof (2020) show that, empirically, loan transactions are by far the most important mechanism affecting the size of banks' balance sheets, while securities transactions play a negligible role.

The **global saving glut hypothesis** (Bernanke, 2005) is that US households have been able to finance large current account deficits by using abundant physical saving provided by foreign households. Our argument is that *current account deficits are not financed with foreign physical saving (saving glut) but with digitally created purchasing power (credit glut), which is provided by banks that are more likely to be domestic than foreign.* As a result, the onus of adjustment for global imbalances would be on US lenders (and borrowers), not on foreign savers. **Sudden stops** (Calvo (1998)) express the idea that countries with large current account deficits are financially vulnerable because in a financial crisis creditors might stop financing their current accounts. Our argument is that *in a financial crisis creditors do not stop financing current accounts, they stop financing debt.* As a result, while current accounts are not completely uninformative about financial vulnerability, pre-crisis gross balance sheet positions are far more important, and post-crisis current accounts can only make a negligible contribution to the required instantaneous repayment of debts. **Triffin's current account dilemma** (citation????) posits that a growing world economy requires an increasing quantity of risk-free US dollars as its reserve currency, and that this requires potentially excessive US current account deficits. Our argument is that *the creation of US dollars does not require US current account deficits but US dollar credit creation, which can be performed by both US and non-US banks.* As a result, there is no current account dilemma. The **high correlation of gross capital inflows and outflows** (Broner et al. (2013)) has been empirically documented, and has been interpreted as requiring a theoretical explanation that can rationalize why investment decisions are synchronized across countries. Our argument is *financial flows are far larger than payment flows, and all financial flows necessarily consist of a pair of gross inflow and outflow components that are inseparable as a matter of accounting, and that are therefore necessarily perfectly correlated.* A theoretical explanation is therefore not required.

Bond portfolio holdings are an increasingly important part of gross financial positions, as debt securities issuance has risen strongly in the aftermath of the 2008 Great Financial Crisis (Aldasoro and Ehlers (2018)). Our model can be used to discuss the effects of additional bond issuance by non-banks. If the bonds are issued to banks, their effects are equivalent to loans. If the bonds are issued to other non-banks, they transfer existing bank deposits from the purchaser to the issuer, who then spends the deposits, thereby increasing their velocity of circulation. Shocks to velocity can be readily studied in our model, and result in a combination of higher output and smaller bank balance sheets.

The role of banks in money creation has recently been emphasized in many central bank publications, including Bank of England (McLeay et al. (2014a,b)), BIS (Borio and Disyatat (2011, 2015)), Bundesbank (2017) and Reserve Bank of Australia (Doherty et al. (2018)).[3] It has been formalized in closed economy settings by Goodfriend and McCallum (2007), Jakab and Kumhof

[3] See also the exposition of the credit mechanics approach in Decker and Goodhart (2018).

(2020), Kumhof and Wang (2019), and in the open economy by Cesa-Bianchi et al. (2023) and Rungcharoenkitkul et al. (2023). Such models can directly incorporate the many advances that the DSGE literature has recently made in the modelling of banks, because their critical feature is not banks' optimization problem, nor the labelling of bank liabilities as money, but the presence of both loans and deposits in the budget constraints of banks' customers.

Several recent papers have started to allow for cross-border gross positions between different asset classes. These include bonds issued in one currency to the foreign economy in order to acquire bonds issued in a different currency by the foreign economy (Devereux and Saito (2006), Devereux et al. (2018), Gabaix and Maggiori (2015)), bonds issued to the foreign economy in order to acquire equities issued by the foreign economy (Fostel et al. (2015), Gourinchas et al. (2017)), or equities issued to the foreign economy in order to acquire equities issued by the foreign economy (McGrattan and Prescott (2010), Caballero and Simsek (2019)). These analyses abstract from the role of the banking system. Incorporating banks yields two critical insights. First, any gross financial inflow must be matched by an inseparable gross outflow as a result of interbank settlement mechanics and double-entry bookkeeping. Second, the most important gross flows are financing flows, which create (or destroy) deposits through loans, in the same currency.

The rest of the paper is organized as follows. Section 2 presents the model and its calibration. Section 3 studies a canonical cross-border financial flow. Sections 4-7 discuss the four policy debates. Section 8 studies the effects of increased bond issuance. Section 9 concludes.

2. The Model

2.1. Overview

The world economy consists of two countries, Home and Foreign, with shares in the world population of n and $1-n$. Each country is populated by households, manufacturers, unions, a banking sector, and a government.

Households own the domestic stock of land, which serves as both an input, together with labor, and as loan collateral. Households consume a CES composite of domestic and foreign goods, and they purchase these goods using a CES composite of domestic and foreign currency deposits, which are created by banks through loans. Only domestic banks create domestic currency deposits and loans for households, who must therefore bank with banks in both countries. The resulting cross-border balance sheet positions, together with cross-border interbank positions, account for the economy's gross and net foreign asset positions. Manufacturers and unions set prices and wages subject to nominal rigidities. Monetary policy targets inflation by setting the risk-free interest rate. We abstract from fiscal policy.

The banking sector has three functions that are represented by three subsectors. Wholesale banks choose their balance sheet to maximize net worth, subject to minimum capital adequacy regulation, foreign exchange mismatch rules, and the need to maintain costly correspondent banking accounts. We can think of wholesale banks as treasury departments that treat the other two functions, retail lending and retail deposit issuance, as separate profit centers. Bank deposits serve as money based on a transactions cost technology.[4] Bank loans are subject to costly state verification as in Bernanke et al. (1999), but modified to allow for non-contingent lending rates.

Our model description mostly refers to Home. Where necessary, Foreign variables are identified by superscript asterisks. Nominal variables are represented by upper case letters, real variables are represented by lower case letters, and real normalized variables by lower case letters with a check mark. To arrive at real normalized variables, nominal variables are divided by the price level P_t, with $\pi_t^p = P_t/P_{t-1}$, and the level of global productivity T_t, with $x = T_t/T_{t-1}$. The nominal and real exchange rates are E_t and $e_t = (E_t P_t^*)/P_t$ (an increase indicates a depreciation), and $\varepsilon_t = E_t/E_{t-1}$. The real value of Home/Foreign currency assets is always expressed in terms of Home/Foreign goods. Home and Foreign goods and Home and Foreign currency balance sheet positions are indicated by the subscripts $X \in \{H, F\}$. Superscripts $x \in \{h, f, b\}$ indicate balance sheet positions of Home households, Foreign households and banks. We generally describe original optimization problems in nominal and agent-specific form, while optimality conditions are shown in real, normalized and aggregated form.

2.2. Banking Sector

2.2.1. Wholesale Banks

Wholesale banks have unit mass and are indexed by j. They are ex-ante identical in terms of ratios of all assets and liabilities to net worth, while they may differ in terms of the size of net worth. They issue wholesale loans $L_{H,t}^h(j)$ and $L_{H,t}^f(j)$ in domestic currency to two domestic retail lending bank sectors that in turn lend to domestic and foreign households. They issue wholesale deposits in domestic currency $D_t(j)$ to foreign wholesale banks and to domestic retail deposit banks, who in turn issue deposits to domestic and foreign households, $D_t(j) = D_{H,t}^h(j) + D_{H,t}^f(j) + D_{H,t}^b(j)$. Wholesale banks also issue interbank loans in domestic currency $L_{H,t}^b(j)$ to foreign wholesale banks, hold interbank deposits in foreign currency $D_{F,t}^b(j)$ at foreign wholesale banks, and receive interbank loans in foreign currency $L_{F,t}^b(j)$ from foreign wholesale banks.[5] With net worth denoted by $N_t^b(j)$, and substituting for $D_t(j)$, an individual wholesale bank's balance sheet is $L_{H,t}^h(j) + L_{H,t}^f(j) + L_{H,t}^b(j) + E_t D_{F,t}^b(j) = D_{H,t}^h(j) + D_{H,t}^f(j) + D_{H,t}^b(j) + E_t L_{F,t}^b(j) + N_t^b(j)$.

[4] As shown in Kumhof and Wang (2019), this is a shortcut for a more decentralized representation where banks serve as intermediaries between different spenders of bank deposits in circulation. The model merges these multiple spenders into a single representative household in the spirit of Lucas (1990) and Schmitt-Grohé and Uribe (2004).

[5] The terminology is that a deposit held (or loan made) by a domestic bank in a foreign bank is a nostro account, while a deposit received (loan obtained) by a domestic bank from a foreign bank is a vostro account.

Monetary foreign exchange costs (MONFX): Due to the absence of a lender of last resort in foreign currency, banks must maintain foreign currency funds in nostro correspondent accounts at foreign banks, to facilitate currency conversions when loans to foreigners are made or repaid. This is modelled as a cost $s_t^b(j)L_{H,t}^f(j) = (\varphi_b/\vartheta_b)\left(e_t d_{F,t}^b(j)\right)^{-\vartheta_b} L_{H,t}^f(j)$ that is increasing in loans to foreigners and decreasing in interbank foreign currency deposit balances.

Minimum capital adequacy ratio (MCAR): The MCAR limits wholesale banks' ability to create credit and money. Bank j faces a future penalty of $\chi\pi_{t+1}^p[L_{H,t}^h(j) + L_{H,t}^f(j) + L_{H,t}^b(j) + E_t D_{F,t}^b(j)]$ if next period net worth falls short of a fraction γ of the gross return on risk-weighted assets. Net worth equals the gross return on assets $(i_{\ell H,t}^h L_{H,t}^h(j) + i_{\ell H,t}^f L_{H,t}^f(j) + i_{\ell H,t}^b L_{H,t}^b(j) + E_{t+1} i_{dF,t}^b D_{F,t}^b(j))\omega_{t+1}^b$, minus the gross return on liabilities $i_{w,t}D_t(j) + E_{t+1} i_{\ell F,t}^b L_{F,t}^b(j)$, plus a pro-rated (by net worth) share of net profits of retail deposit banks $\Pi_{t+1}^R(j)$, minus a pro-rated share of net losses of retail lending banks $\Lambda_{t+1}^b(j)$, minus MONFX costs. The regulatory risk weights on loans to households and banks equal 1 and $\zeta < 1$. Here $i_{\ell X,t}^x$, $i_{w,t}$ and $i_{dX,t}^x$ are nominal wholesale lending and deposit rates. Gross returns on assets are subject to lognormally distributed idiosyncratic shocks ω_{t+1}^b with mean 1 and variance $(\sigma^b)^2$ that represent shocks to banks' non-interest earnings, and that give rise to ex-post differences across banks in terms of capital adequacy. We denote the pdf and cdf of these shocks by $f^b(\omega_{t+1}^b)$ and $F^b(\omega_{t+1}^b)$, the cutoff productivity shocks below which the MCAR is breached ex-post by $\bar{\omega}_t^b$, and we define $f_t^b = f^b(\bar{\omega}_t^b)$ and $F_t^b = F^b(\bar{\omega}_t^b)$.

Foreign exchange mismatch rules (FXMR): As pointed out in Aldasoro et al. (2020)[6], due to both risk management practices and prudential regulations, banks manage open foreign exchange positions. In the model there is a continuum of options, parameterized by $\phi_{fxmr} \in [0,1]$:

$$D_{F,t}^b(j) - L_{F,t}^b(j) = \phi_{fxmr}\left(D_{H,t}^f(j) - L_{H,t}^f(j)\right) . \tag{1}$$

We will distinguish three cases. *Accommodating FXMR* sets $\phi_{fxmr} = 1$ for both countries, which implies that banks take on exchange rate risk, and also that the net foreign asset position and the current account must remain unchanged (the latter at zero). This is as the algebraic representation of the automatic bookkeeping entries that must occur when foreign households' cross-border transfers are settled through correspondent banking accounts. *Strict FXMR* sets $\phi_{fxmr} = 0$ for both countries, which implies that banks take on no exchange rate risk, while the current account is not constrained to equal zero. This implies that cross-border transfers by one group of households must be accompanied by changes in the deposits of the remaining households, and in loans. Because such adjustments take more time, we view this as describing the longer-term response. *Asymmetric FXMR* sets $\phi_{fxmr} = 1$ and $\phi_{fxmr}^* = 0$, where we can think of Home as a small open economy and Foreign as including the US. This rules out bank exposures of Foreign to the Home currency, while it allows for bank exposures of Home to the US dollar.

[6] See also McGuire and von Peter (2009). Stigum and Crescenzi (2007) describe how banks use derivatives to hedge their international operations.

Net worth maximization involves taking first-order conditions with respect to all four asset side items, taking interest rates as given. Expected net worth includes the penalty payable in case of an MCAR breach, weighted by the probability of a breach. The optimization problem is:

$$\begin{aligned}\max \mathbb{E}_t \Big\{ & \left[i^h_{\ell H,t} L^h_{H,t}(j) + i^f_{\ell H,t} L^f_{H,t}(j) + i^b_{\ell H,t} L^b_{H,t}(j) + E_{t+1} i^b_{dF,t} D^b_{F,t}(j) \right] \omega^b_{t+1} \\ & - i_{w,t} D_t(j) - E_{t+1} i^b_{\ell F,t} L^b_{F,t}(j) - s^b_t(j) L^f_{H,t}(j) + \Pi^R_{t+1}(j) - \Lambda^b_{t+1}(j) \\ & - \int_0^{\bar{\omega}^b_{t+1}(j)} \chi \tfrac{P_{t+1}}{P_t} \left(L^h_{H,t}(j) + L^f_{H,t}(j) + L^b_{H,t}(j) + E_t D^b_{F,t}(j) \right) f^b\left(\omega^b_{t+1}\right) d\omega^b_{t+1} \Big\} \ . \end{aligned} \tag{2}$$

The deposit terms must be replaced using the balance sheet identity and the FXMR rule. Applying the "extended family" approach of Gertler and Karadi (2011), we arrive at post-dividend net worth by deducting dividends equal to a fixed and lump-sum fraction of net worth.

The first-order condition for loans to retail lenders to domestic households contains a *regulatory spread* between the wholesale lending and wholesale deposit rates, which prices the fact that at the margin an additional loan increases the penalty payable in case of a breach of MCAR. The size of this spread depends on the size of the MCAR (γ), the risk weight (1), the penalty payable in case of a breach (χ), and the likelihood of a breach given the riskiness of banks (F^b_{t+1} and f^b_{t+1}). For loans to retail lenders to foreign households, the regulatory spread is virtually identical. But there are two additional spreads. First, depending on FXMR, the spread can be partly relative to the interest rate on foreign currency wholesale interbank loans rather than the wholesale deposit rate, because such loans can be partly the marginal source of refinancing additional wholesale loans to foreigners. The difference between these two rates represents an additional *interbank borrowing spread*. Second, there is an additional *interbank monetary spread*, which arises because an increase in exposures to foreign households must be matched with a costly increase in foreign currency interbank deposits. For domestic currency interbank loans, the regulatory spread is significantly smaller, due to a lower risk weight (ζ). For foreign currency interbank deposits, the regulatory spread is virtually identical to that of domestic currency interbank loans. The interbank borrowing spread is not conditional on FXMR, because interbank loans are always the marginal source of refinancing interbank deposits. But these two spreads are more than offset by an *interbank monetary discount*, which arises because these deposits reduce the MONFX cost.

2.2.2. Retail Deposit Banks

Retail deposit banks have unit mass and are indexed by j. They issue retail deposit varieties $D^h_{H,t}(j)$ and $D^f_{H,t}(j)$ to domestic and foreign households, and interbank deposit varieties $D^b_{H,t}(j)$ to foreign wholesale banks. These deposits finance purchases of wholesale deposits $D_t(j)$ and government bonds $B_t(j)$ that are perfectly substitutable, so that arbitrage implies $i_{w,t} = i_t$. Retail deposit banks are monopolistic competitors vis-à-vis retail holders, who demand CES composites of varieties. This implies the pricing rules $i^x_{dH,t} = \mu^x_{dH} i_{w,t}$, with markdown terms $\mu^x_{dH} < 1$.

2.2.3. Retail Lending Banks

There are two retail lending bank sectors, for loans to domestic and foreign households, who each have unit mass and are indexed by j. Retail lending banks are homogenous, and each bank lends the same amount to a borrower j. The eligible loan collateral of Home borrowers (and similarly for Foreign borrowers) is the gross return to land $\mathbb{E}_t Ret_{k,t+1} Q_t k_t(j)$, where Q_t is the nominal price of land, $Ret_{k,t} = \left(Q_t + R_t^k\right)/Q_{t-1}$, R_t^k is the land rental, and $k_t(j)$ is the stock of land owned by j. The aggregate stock of land is fixed. The effective loan collateral of Home banks for $L_{H,t}^h(j)$ and $L_{H,t}^f(j)$ is determined by the fractions $\kappa_H^h S_t^{\kappa} S_t^{\kappa_H^h}$ and $\kappa_H^f S_t^{\kappa} S_t^{\kappa_H^f}$ of this collateral that the banks accept. These fractions are time-varying due to first-order autoregressive credit supply shocks. Domestic and foreign retail borrowers are subject to idiosyncratic productivity shocks $\omega_{H,t+1}^x$, $x \in \{h, f\}$, that are log-normally distributed with mean 1 and variance $(\sigma_H^x)^2$. The pdf and cdf of these shocks are $f^x(\omega_{H,t+1}^x)$ and $F^x(\omega_{H,t+1}^x)$, the cutoff productivity shocks below which bankruptcy occurs ex-post is $\bar{\omega}_{H,t}^x$, and $f_{H,t}^x = f^x(\bar{\omega}_{H,t}^x)$ and $F_{H,t}^x = F^x(\bar{\omega}_{H,t}^x)$. Retail lending banks' cost of funding is given by wholesale lending rates $i_{\ell H,t}^x$, while their loan contracts stipulate non-contingent retail lending rates $i_{rH,t}^x$ on loans that must be paid in full unless borrowers declare bankruptcy, which becomes advantageous when $\omega_{H,t}^x < \bar{\omega}_{H,t}^x$. In case of bankruptcy, because of monitoring costs, the bank can only recover a fraction $1 - \xi_H^x$ of collateral. The participation constraints for retail loans state that ex-ante net loan losses must equal zero,

$$\begin{aligned} \mathbb{E}_t \left[\kappa_H^h S_t^{\kappa} S_t^{\kappa_H^h} Ret_{k,t+1} Q_t k_t(j) \left(\Gamma_{H,t+1}^h(j) - \xi_H^h G_{H,t+1}^h(j) \right) - i_{\ell H,t}^h L_{H,t}^h(j) \right] &= 0 \,, \quad (3) \\ \mathbb{E}_t \left[\kappa_F^{h^*} S_t^{\kappa^*} S_t^{\kappa_F^{h^*}} Ret_{k,t+1} Q_t k_t(j) \left(\Gamma_{F,t+1}^{h^*}(j) - \xi_F^{h^*} G_{F,t+1}^{h^*}(j) \right) - E_{t+1} i_{\ell F,t}^h L_{F,t}^h(j) \right] &= 0 \,, \end{aligned}$$

where $\Gamma_{X,t+1}^x(j)$ denotes lenders' gross share in effective collateral, and $\xi_X^x G_{X,t+1}^x(j)$ denotes lenders' monitoring costs share in effective collateral.

2.3. Households

2.3.1. Preferences

Households have unit mass and are indexed by j. They maximize lifetime utility subject to sequences of intertemporal budget constraints and bank participation constraints, by choosing plans for consumption $c_t(j)$, hours worked $h_t(j)$, loans in both currencies $L_{X,t}^h(j)$, deposits in both currencies $D_{X,t}^h(j)$, and land holdings $k_t(j)$. Households demand a CES consumption bundle, with elasticity of substitution θ_c and home bias $b^c S_t^{imp}$ (where S_t^{imp} is a first-order autoregressive import demand shock), that includes domestic and foreign goods $c_{H,t}(j)$ and $c_{F,t}(j)$, and the corresponding utility-based price index is P_t. The Home and Foreign goods sub-aggregates are in turn given by CES bundles over continua of goods, with elasticities of substitution θ_p. The objective function for domestic household j is

$$\max \mathbb{E}_0 \sum_{t=0}^{\infty} \beta_{0,t} \left\{ \left(1 - \frac{\nu}{x}\right) S_t^c \log\left(c_t(j) - \nu c_{t-1}\right) - \frac{\psi}{1+\frac{1}{\eta}} h_t\left(j\right)^{1+\frac{1}{\eta}} \right\} , \tag{4}$$

where S_t^c is a first-order autoregressive consumption demand shock, $\beta_{0,t} = \Pi_{\tau=0}^{t-1} \beta_{\tau,\tau+1}$ for $t > 0$ (with $\beta_{-1,0} = 1$), and $\beta_{t,t+1}$ is a first-order autoregressive time preference shock.

2.3.2. Money Demands

Households demand a CES monetary aggregate $M_t(j)$, with elasticity of substitution θ_d and financial home bias $b^d S_t^{ccy}$ (where S_t^{ccy} is a first-order autoregressive currency demand shock), that includes domestic and foreign currencies $D_{H,t}^h(j)$ and $E_t D_{F,t}^h(j)$, with corresponding nominal interest rates $i_{dX,t}^h$:

$$M_t(j) = \left[\left(b^d S_t^{ccy}\right)^{1/\theta_d} \left(D_{H,t}^h(j)\right)^{\frac{\theta_d - 1}{\theta_d}} + \left(1 - b^d S_t^{ccy}\right)^{1/\theta_d} \left(E_t D_{F,t}^h(j)\right)^{\frac{\theta_d - 1}{\theta_d}} \right]^{\frac{\theta_d}{\theta_d - 1}} . \tag{5}$$

The derivatives of $M_t(j)$ with respect to its two arguments are denoted by $m_t^{X'}$. $M_t(j)$ reduces the transactions costs of purchasing the bundle of consumption goods,

$$s_t(j) = A^c \left(S_t^{mon} P_t c_t(j) / M_t(j)\right)^{\varpi} , \tag{6}$$

where A^c determines overall money demand and thereby the size of banks' balance sheet, S_t^{mon} is a first-order autoregressive money demand shock, and ϖ determines the interest elasticity of money demand.

2.3.3. Budget Constraint

The nominal flow budget constraint, with multiplier $\Lambda_t(j)$, is

$$Q_t k_t\left(j\right) + D_{H,t}^h\left(j\right) - L_{H,t}^h\left(j\right) + E_t D_{F,t}^h\left(j\right) - E_t L_{F,t}^h\left(j\right) = i_{dH,t-1}^h D_{H,t-1}^h\left(j\right) + E_t i_{dF,t-1}^h D_{F,t-1}^h\left(j\right) \tag{7}$$

$$+ Ret_{k,t} Q_{t-1} k_{t-1}\left(j\right) \left(1 - \kappa_{H,t-1}^h \Gamma_{H,t}^h(j) - \kappa_{F,t-1}^{h^*} \Gamma_{F,t}^{h^*}(j)\right) - P_t\left(1 + s_t\left(j\right)\right) c_t\left(j\right) + W_t^{hh} h_t\left(j\right) + P_t \Upsilon_t(j) .$$

This states that households' net assets, land plus deposits minus loans, equal the gross return on deposits, the shares of the gross returns to land that do not go to banks to repay loans, minus consumption (including transaction costs $P_t s_t(j) c_t(j)$), plus labour income $W_t^{hh} h_t\left(j\right)$, plus lump-sum net income $P_t \Upsilon_t(j)$. The latter equals all of the economy's profits, adjustment costs, monitoring costs, and monetary transactions costs. Households also face the two bank participation constraints (3), with real normalized multipliers $\check{\lambda}_t \tilde{\lambda}_{H,t+1}^h$ and $\check{\lambda}_t \tilde{\lambda}_{F,t+1}^{h^*}$.

2.3.4. Optimality Conditions

We assume that each household holds identical initial stocks of all physical and financial assets and liabilities and receives identical net lump-sum transfers. Because all households face the same market prices, and ex-post set the same prices for their own product varieties, they remain symmetric at all times. The first-order conditions for consumption of individual goods varieties, consumption of Home and Foreign goods, hours worked, and the two Phillips curves are standard. The Euler equation for land has additional terms related to its use as loan collateral. The optimality condition for aggregate consumption is $S_t^c \left(1-\nu/x\right)/(\check{c}_t - \nu/x\check{c}_{t-1}) = \check{\lambda}_t p_t$, where the effective price p_t exceeds the direct purchase price of 1 by a monetary mark-up $\tau_t^{mon} = s_t + s_t' v_t$, $v_t = \check{c}_t/\left(S_t^{mon}\check{m}_t(j)\right)$, which is decreasing in the quantity of deposits. The effect of this "money tax rate" is equivalent to that of a consumption tax rate. The Euler equations for deposits are $1 = \left(s_t'/S_t^{mon}\right) v_t^2 m_t^{X\prime} + (\beta_{t,t+1}/x)\mathbb{E}_t(\check{\lambda}_{t+1}/\check{\lambda}_t) r_{dX,t+1}^h$, so that the asset returns include both an interest rate yield and a monetary convenience yield. The Euler equations for loans are $1 = (\beta_{t,t+1}/x)\mathbb{E}_t(\check{\lambda}_{t+1}/\check{\lambda}_t)\tilde{\lambda}_{X,t+1}^h r_{\ell X,t+1}^h$.

2.3.5. The Monetary UIP Condition (MUIP)

Our model predicts that relative excess demands of domestic and foreign currency deposits are key drivers of interest rates and exchange rates. To show this analytically, we use the optimality conditions to log-approximate a MUIP condition in the excess return of domestic over foreign currency assets xsr_t and the MUIP spread u_t:[7]

$$xsr_t = \mathbb{E}_t\left(\ln i_t - \ln i_t^* - \ln \varepsilon_{t+1}\right) = \mathbb{E}_t u_t \ , \tag{8}$$

$$u_t = \Xi_{t+1}\left(\left(\frac{1-b^d S_t^{ccy}}{b^d S_t^{ccy}}\frac{\check{d}_{H,t}^h}{e_t \check{d}_{F,t}^h}\right)^{\frac{1}{\theta_d}} - 1\right) \ . \tag{9}$$

The MUIP spread enters due to imperfect deposit substitutability, and represents the relative convenience yield of Foreign versus Home currency. As one currency becomes more abundant, its convenience yield drops, so that its financial return, which includes expected exchange rate depreciation, must increase. In other words, the market-clearing relative financial return on a currency is increasing in the relative quantity of that currency. We will refer to changes in the exchange rate caused by interest rate changes or by changes in the MUIP spread as UIP effects or MUIP effects, respectively. For the real exchange rate, we have $\ln(e_t) = \mathbb{E}_t \Sigma_{j=0}^{\infty}\left(\ln\left(r_{t+j+1}^*\right) - \ln\left(r_{t+j+1}\right) + u_{t+j}\right)$. Increases in the domestic real policy rate or decreases in the MUIP spread represent a greater attractiveness of the domestic currency in terms of its financial or non-financial return, and therefore appreciate the real exchange rate. Finally, we will make reference to the steady state elasticity $\epsilon^{opp} = d\log(\check{d}_H^h)/d\log(\tilde{r}_H^h)$, where $\tilde{r}_H^h = (r_{\ell H}^h \tilde{\lambda}_H^h)/r_{dH}^h$ is the opportunity cost of deposits.

[7] Arbitrage implies that $u_t + u_t^* = 0$.

2.4. Manufacturers and Unions

Manufacturers have unit mass and are indexed by j. A manufacturer optimally combines labor $h_t(j)$ at the wage rate W_t^{pr}, and land $k_t(j)$ at the rental rate R_t^k, to produce and price a variety of the domestic good $y_t(j)$. Price of output variety $P_t(j)$ are set subject to monopolistic competition and Rotemberg (1982) quadratic price adjustment costs. The production function for manufacturer j is given by $y_t(j) = T_t\left(S_t^a h_t(j)\right)^{1-\alpha}\left(k_t(j)\right)^{\alpha}$, where S_t^a is a first-order autoregressive technology shock. We assume that manufacturers adopt local currency pricing. Optimality conditions for factor demands and goods pricing are standard.

Unions have unit mass and are indexed by j. Unions buy labor from households at the competitive household wage rate W_t^{hh}. They set the price of their labor variety $W_t^{pr}(j)$ subject to monopolistic competition and quadratic wage adjustment costs, with manufacturers demanding a composite of labor varieties with elasticity of substitution θ_w. The wage optimality condition is standard.

2.5. Monetary Policy

Monetary policy is assumed to follow an inflation-forecast-based interest rate rule

$$i_t = \left(i_{t-1}\right)^{m_i}\left(\bar{r}\bar{\pi}\right)^{1-m_i}\left(\frac{\pi_{t+1}}{\bar{\pi}}\right)^{(1-m_i)m_\pi} S_t^{int}\ , \tag{10}$$

where $\bar{r}$ follows from the model's optimality conditions, $\bar{\pi}$ is the inflation target, and S_t^{int} is an iid monetary policy shock. The initial stock of government debt is assumed to equal zero, and both government spending and taxation equal zero at all times, so that government debt remains at zero at all times.

2.6. Goods Market Clearing and Balance of Payments

The goods market clearing condition is $\check{y}_t = \check{c}_{H,t} + \check{c}^*_{H,t}(1-n)/n$. Nominal GDP deflated by the CPI price index is $g\check{d}p_t = \check{c}_t + e\check{x}p_t - i\check{m}p_t$, where real exports are $e\check{x}p_t = e_t p^*_{H,t} c^*_{H,t}(1-n)/n$ and real imports are $i\check{m}p_t = p_{F,t}\check{c}_{F,t}$. The current account is

$$\begin{aligned}
&\check{\ell}^f_{H,t} + \check{\ell}^b_{H,t} + e_t\left(\check{d}^h_{F,t} + \check{d}^b_{F,t}\right) - \check{d}^f_{H,t} + \check{d}^b_{H,t} - e_t(\check{\ell}^h_{F,t} + \check{\ell}^b_{F,t}) = \\
&(1/x)(r^f_{\ell H,t}\check{\ell}^f_{H,t-1} + r^b_{\ell H,t}\check{\ell}^b_{H,t-1} + r^h_{dF,t}e_{t-1}\check{d}^h_{F,t-1} + r^b_{dF,t}e_{t-1}\check{d}^b_{F,t-1}) \\
&-(1/x)(r^f_{dH,t}\check{d}^f_{H,t-1} + r^b_{dH,t}\check{d}^b_{H,t-1} + r^h_{\ell F,t}e_{t-1}\check{\ell}^h_{F,t-1} + r^b_{\ell F,t}e_{t-1}\check{\ell}^b_{F,t-1}) \\
&+\check{\Lambda}^h_t - \check{\Lambda}^b_t + e_t p^*_{H,t}\check{c}^*_{H,t}(1-n)/n - p_{F,t}\check{c}_{F,t}\ ,
\end{aligned} \tag{11}$$

where the first line is the net foreign asset position, which consists of eight gross positions. This is the minimum needed for a model of gross cross-border positions, which requires the presence of loans and deposits, households and banks, and domestic and foreign currencies.

2.7. Calibration

The baseline calibration is for a symmetric 2-country model. For parameters that affect the steady state, we combine US data averages and established values from the literature. The exception is the currency composition of bank balance sheets, where we strike a balance between US and non-US data. For parameters that affect only the model dynamics, we rely on the estimation results of Kumhof et al. (2023).

Real Economy: The growth rate of world productivity and the CPI inflation target are calibrated at 2% p.a. We normalize hours worked and the prices of land to 1, and set the labor income shares and the imports to GDP ratios to 59.4% and 14%, both in line with US data. As discussed in Kumhof et al. (2021), the value of US physical capital equals around 240% of GDP, and the value of US land is slightly larger, and this pattern is repeated for several other industrialized economies. We therefore calibrate the value of non-labor inputs into production at 500% of GDP. The elasticity of substitution between domestic and foreign goods is set to 1.5, a common value in the open economy macro literature. Based on Kumhof et al. (2023), habit persistence and the elasticity of labour supply are set to 0.76 and 1.54, and the elasticity of substitution between domestic and foreign currencies to 1.75.[8] Price and wage gross markups are fixed at 1.1, again in line with much of the literature.

Risk and Regulation: The MCAR is fixed at 10.5%, based on the sum of the 8.0% Basel III total capital ratio and the 2.5% capital conservation buffer (see Basel Committee (2017)). The actual steady state capital adequacy ratio is fixed at 15.5%, based on the data in Federal Reserve Bank of New York (2018). The share of banks that violate MCAR in any quarter equals 2.5% (based on the frequency of banking crises in Jorda et al. (2011)), and borrower bankruptcy rates equal 1.5% (based on Brooks and Ueda (2011) and Albanesi et al. (2017)).

Spreads: The real policy rates are calibrated at 3% p.a. Interbank lending, wholesale lending and retail lending rates equal 3.25% (based on LIBOR rates), 3.46% (based on AAA commercial paper rates), and 5.15% (based on the maturity-adjusted credit spreads for all listed US non-financial firms in Anderson and Cesa-Bianchi (2020)). Interbank deposit and retail deposit rates equal 2.90% (based on LIBID rates) and 1.5% (based on FDIC data but taking into account that our deposits include wholesale as well as retail deposits). We calibrate the money demand elasticity parameter at $\varpi = 5$ to approximately obtain $\epsilon^{opp} = 2.5$. A low interest-sensitivity of retail deposits is consistent with a large empirical literature.[9]

Balance Sheets: Based on US Flow of Funds data, balance sheet ratios to GDP for loans to domestic and foreign households are fixed at 120% and 15%. Based on Allen et al. (????), and averaging over US and non-US values, balance sheet ratios to GDP for domestic and foreign

[8] With $\theta_d = 1.75$, we have $\epsilon^{int} = 22.5$, with $\theta_d = 0.5$ we have $\epsilon^{int} = 7.5$, while for the UIP alternative proxied by $\theta_d = 2500$ we have $\epsilon^{int} = 37500$.

[9] Citations here.

currency interbank positions are each fixed at 10%. FXMR then ensures that deposits from foreign households equal 15% of GDP. Based on our calibration of MCAR, bank net worth equals 21.7% of GDP. The residual item, deposits from domestic households, equals 98.3% of GDP.

Frictions and Policy Rules: We adopt the estimation results in Kumhof et al. (2023) for price and wage stickiness, $\phi_p = 304$ and $\phi_w = 315$. We do not adopt their estimation results for the monetary policy rule, as their estimates cover the ZLB period, which features extremely high interest rate smoothing and low inflation feedback. Instead we set $m_i = 0.5$ and $m_\pi = 2.0$.

2.8. Simulation Design

The exercises in the remainder of this paper are designed to highlight the importance of the distinction between gross and net capital flows for a number of important policy questions. To make these exercises transparent and comparable, we normalize the magnitudes. Specifically, in Figure 1 we normalize the gross Foreign capital inflow into Home currency at 10% of Home GDP on impact under accommodating FXMR. In the remaining figures we normalize the maximum of the Home current account at -1% (Figures 2, 3, and 6) and +1% (Figures 4 and 5) of Home GDP. Strict FXMR is represented by black lines and accommodating FXMR by red lines.

The variable "Foreign Saving" is the negative of the Home current account to GDP ratio. The variable "Net Foreign Financing" is the ratio to GDP of the difference between changes in Foreign bank loans to Home households and changes in Home bank loans to Foreign households. The variable "Loan Spread" is the difference between the retail lending rate on Home bank loans to Home households and the Home policy rate. We discuss the MUIP condition in terms of real yields and real exchange rates. The variable "MUIP Spread" is expressed in per cent per annum to make it comparable to interest rates. The bottom half of each figure shows the financial sector balance sheets of Home (left two columns) and of Foreign (right two columns), except for changes in net worth, which are generally small for the shocks we study. All Foreign balance sheet items are converted into Home currency and then scaled by Home GDP. When we focus exclusively on strict FXMR, the interbank positions, because they are generally small and matched, are not shown.

3. A Canonical Capital Inflow Shock

Figure 1 studies a shock that in common understanding represents a canonical capital inflow, namely the transfer of a financial balance from a foreign country's financial system to the domestic country's. This is a purely financial flow, and as such represents the vast majority of actual capital flows. But this is precisely the type of flow that is rarely considered in the literature on capital flows, which is almost exclusively concerned with payment flows. The specific shock is a decline in the home bias parameter $S_t^{ccy^*}$ in the Foreign monetary aggregate M_t^* that leads to an increase in Foreign households' demand for Home currency deposits equal to 10% of Home GDP on impact.

3.1. Accommodating FXMR

Accommodating FXMR accurately represents the effects of the incoming payment instrument and its settlement between banks. The Foreign household starts by writing a financial instrument that is drawn on its existing Foreign currency account in a Foreign bank, and then pays this instrument into a Home currency account in a Home bank. This instrument only has value because the deposit account on which it is drawn already exists, and has a positive balance. The instrument's receipt by the Home bank therefore does not represent net new savings, or an additional household deposit, for the global financial system. Furthermore, the Home bank does not receive any additional loanable funds, because it automatically and instantaneously lends the funds to the bank on which the instrument is drawn. This is because the counterpart of crediting the check to their customer's account (a debit and liability of the Home bank) is the acquisition of an accounts receivable claim, for settlement of the underlying check, on the Foreign bank (a credit and asset of the Home bank). In our model, without loss of generality, settlement is in the currency of the check, in this case in Foreign currency.[10] Under accommodating FXMR this could take the form of either an increase in Home banks' Foreign currency nostro deposit accounts or a decrease in their Foreign currency vostro loan accounts. In our model adjustments in the nostro accounts are constrained by the interbank money demand function, leaving most of the adjustment to be made through a decrease in the vostro accounts, which decrease by just under 10% of Home GDP, virtually the same amount as the increase in Foreign households' deposits. All other balance sheet adjustments are an order of magnitude smaller.

The movements in $D^{f^*}_{F,t}$ and $D^{f^*}_{H,t}$, facilitated by the movements in interbank settlement accounts, are so large that they nearly completely match the movement in the home bias parameter $S_t^{ccy^*} b^{d^*}$, with only small changes in the MUIP spread. Furthermore, due to the purely financial nature of the shock there are no direct effects on GDP, inflation, the real exchange rate, and the real policy rate, so that UIP effects are also small. As a result, the shock has negligible real effects. Accommodating FXMR therefore insulates the macroeconomy from even very large currency demand shocks. However, it does so at the cost of increasing financial stability risks, because the Home financial system is now significantly long Foreign currency. There is therefore a trade-off between financial and macroeconomic stability.

It can be shown that a small open Home economy with accommodating FXMR that faces a Foreign economy with strict FXMR experiences very similar effects to global accommodating FXMR. Figure 1 is therefore a realistic scenario for many small open economies, who may be unable to hedge their aggregate US dollar exposures.

[10] The settlement currency determines which bank ends up with an instantaneous currency mismatch as a result of the shock.

3.2. Strict FXMR

Strict FXMR prohibits currency mismatches in banks' correspondent banking accounts. All responses to the gross deposit inflow from Foreign households therefore have take the form of either changes in household loans, or additional changes in household deposits, that undo any initial currency mismatch. Price adjustments play a critical role in these adjustments. First, they make it optimal for Home banks to increase Home currency loans, and for Foreign banks to reduce Foreign currency loans. Second, they make it optimal for Home households to reduce their Home currency deposits, and for Foreign households to reduce the desired increase in their Home currency deposits.

The ability of banks to satisfy the changes in currency demands through loans alone is limited. For Home banks, the value of Foreign land collateral decreases, both because of lower demand for this collateral from its principal users, Foreign banks, and because of a real exchange rate appreciation (see below). Also, the collateral share that is available to secure such loans is far too small to secure a large increase in loans. As a result, on impact Home banks increase Home currency loans by only 1.1% of Home GDP, and most of these loans are extended to Home households (1.0%) rather than Foreign households (0.1%). At the same time, Foreign banks decrease Foreign currency loans by 2.6% of Home GDP, divided into decreases in loans to Foreign and Home households of 2.3% and 0.3%. The Foreign loan changes are larger due to the Home real appreciation. Loan supplies therefore create and destroy deposits in the desired currencies, but not in sufficient quantities, and mostly not for the households who require them.

The shortfall is met by Home households trading Home currency against Foreign currency with Foreign households. They do so because the increase in the relative convenience yield of Home currency decreases its relative financial yield. This can be seen in Figure 1 in a one percentage point decrease in the Home MUIP spread. For Foreign households, this moderates the desired changes in their holdings of Home and Foreign currencies, which reach only +4.0% and -5.8% of Home GDP. The corresponding changes for Home households, who do not experience a shock but who respond to the change in relative financial yields, are -2.9% and +3.5%. Therefore, of Foreign households' 4.0% of Home GDP increase in demand for Home currency, only 0.1% of GDP is satisfied by additional loans, with the remainder coming from an approximately 3.9% of GDP currency exchange with Home households, who obtain additional loans of 1.0% of GDP while their deposits drop by 2.9% of GDP. Home banks match their currency books by balancing the 4.0% of Home GDP increase in demand for Home currency deposits by Foreign households through a 1.1% of GDP increase in Home currency loans and a 2.9% of GDP decrease in Home currency deposits by Home households. Similarly, Foreign banks match a decrease in Foreign currency deposits held by Foreign households through a decrease in Foreign currency loans and an increase in Foreign currency deposits by Home households. For Home banks' interbank settlement balances, the large transfer of Home household deposits to Foreign banks leads to reserve losses that cancel out the

reserve gains that came with the original deposits by Foreign households.

The required changes in relative real financial yields are only partly accomplished through changes in real policy rates, especially on impact because policy rates are set with inertia. A major part is therefore accomplished by the real exchange rate, which on impact appreciates by 1.7% and then depreciates back to its unchanged steady state. This is an intuitive result - an increase in demand for Home currency leads to its appreciation. The appreciation is contractionary and disinflationary for the Home economy, and vice versa for the Foreign economy. This calls for a persistent decrease in the Home policy rate and a persistent increase in the Foreign policy rate. For Home, the cut in the policy rate and the wealth effect of the appreciating real exchange rate stimulate consumption. This deteriorates the current account and leads to a 0.12% decrease in Home GDP. Therefore a purely financial shock,which under accommodating FXMR has almost no effect on the real economy, can have more substantial effects when banks respond by eliminating currency mismatches. The size of this effect depends on the details of the calibration of the real economy. For example, in a comparable calibration but with sticky inflation rather than sticky prices, the Home GDP contraction can become significantly larger.

Foreign saving and net Foreign financing are shown in the second row of Figure 1. Under accommodating FXMR, we observe a very large gross capital inflow equal to 10% of GDP, but no change at all in foreign saving and minimal changes in net foreign financing. Under strict FXMR, Foreign saving does increase, but this is merely a by-product of the real exchange rate appreciation. Net Foreign financing is of similar magnitude but opposite sign to Foreign saving, as Foreign banks sharply cut back credit to all borrowers, including Home households. Home households can nevertheless pay for their increased imports, using a combination of existing deposits and deposits newly created for them by Home banks. Financial inflows, financing inflows, and saving inflows are therefore fundamentally different concepts.

3.3. The Role of Deposit Substitutability

We have studied the sensitivity of the strict FXMR results in Figure 1 to different assumptions about the elasticities of substitution between Home and Foreign currencies, $\theta_d, \theta_d^* \in \{L, 1.75, H\}$, with $L \to 0$ and $H \to \infty$. The reallocation of Foreign household deposits to Home currency deposits has the same basic pattern in all three scenarios, but with differences in the sources of the deposits.

Under low substitutability, changes in the MUIP spread, interest rates, the real exchange rate, and ultimately real variables, are larger than in the baseline, because the shock has a larger effect on the relative convenience yield of the two currencies. At the same time, Home households are less willing to supply Home currency out of their existing deposits. Instead, they supply them out of new deposits, created through new bank loans. As a result, in the limit the required deposits come exclusively from additional bank loans.

For the UIP case of $\theta_d = \theta_d^* = \infty$, there is no change in the MUIP spread, interest rates, the real exchange rate, and real variables, so that banks have no price incentives to change lending. At the same time, Home households are indifferent between the two currencies. As a result, in the limit the required deposits come exclusively from existing deposits.

The case of strict FXMR and UIP is therefore similar to accommodating FXMR, in that gross capital inflows into Home currency deposits have no effects on bank lending and the real economy. The difference is that with accommodating FXMR the matching gross outflow is an increase in Home banks' net interbank claims on Foreign banks, while with strict FXMR and UIP it is an increase in Home households' deposit claims on Foreign banks.

4. Global Saving Glut: Foreign Physical Glut or US Credit Glut?

4.1. Hypothesis and Discussion

The global saving glut hypothesis of Bernanke (2005) argues that over-abundant foreign saving has been financing US current account deficits and has thus contributed to widening them. Bernanke (2005) and the subsequent literature take for granted the equivalence between saving and financing, and focus on reasons why the true returns to *physical* capital in less developed countries may not be as high as their low capital to labor ratios suggest, thereby explaining why capital would flow from poorer economies to the US. Such explanations include weak institutions (Alfaro et al. (2008)), costly physical capital (Hsieh and Klenow (2007), Caselli and Feyrer (2007)), default risk (Reinhart and Rogoff (2004)), the absence of sufficiently attractive store-of-value assets in less developed countries (Caballero et al. (2008)), precautionary saving (Mendoza et al. (2009)) and greater risk tolerance in developed economies (Gourinchas et al. (2017)).

We note that foreign saving, a goods market concept that represents physical resources, cannot play a direct role in financing domestic imports. Foreign saving is a residual term in the national accounts, and therefore simply *is* the current account deficit by definition (ignoring investment for simplicity). And a definition, unlike an equilibrium condition, does not require prices (such as real interest rates) to adjust for it to hold. What is required to pay for a current account deficit is a payment medium, not physical resources set aside by foreigners. And in the real world that payment medium, overwhelmingly, is purchasing power created by banks.

Our framework is able to distinguish between current account deficits triggered by changes in preferences over foreign saving, foreign lending, domestic lending, foreign deposits, and domestic deposits. These five possibilities have very different policy implications, while in most of the net flows literature the role of gross financial variables, which is critical for all but the first possibility, is disregarded. This is very significant for the debate about options for correcting global imbalances. The global saving glut hypothesis puts the onus of adjustment on current account surplus countries, by encouraging them to boost aggregate demand and reduce their "excessive saving". But in

reality this might exacerbate existing domestic vulnerabilities, including the triggering of credit booms that increase financial vulnerability in surplus countries. Examples include not only China recently (Chen and Kang (2018)), but also Japan in the 1980s (Shiratsuka (2003)). Furthermore, it diverts attention from the possibility that the onus of adjustment should be on deficit countries, if their "excessive credit" is the main culprit behind their large current account deficits. Under this changed perspective, foreigners are no longer seen as investors of physical resources into the domestic economy, but as recipients of financial payments from that economy.

Similar arguments also apply to the 'Lucas paradox' that poor countries tend to run current account surpluses while rich ones run deficits. Given the distinction between saving and financing, this pattern says nothing about the direction of financing flows, which is determined by the location of financing banks rather than by the location of goods-producing non-banks. As clearly documented in Borio and Disyatat (2015), net bilateral financial flows generally do not correspond to net bilateral trade flows. If the binding constraint on capital accumulation in poor countries is less about access to physical resources than access to financing, the source for the paradox might be insufficient *domestic* credit, which is not constrained by saving.

4.2. Foreign Physical Glut

Figure 2 studies a shock to the Foreign discount factor $\beta^*_{t,t+1}$. Foreign real interest rates drop by almost 4 percentage points on impact, and Foreign households increase their saving through a combination of a large increase in their labor supply, which increases Foreign GDP by over 2% at the peak, and a smaller increase in consumption. The Home real policy rate drops by a maximum of around 50 basis points, and because of the interest rate gap between Foreign and Home rates, the Home real exchange rate appreciates by more than 6% on impact. Home consumption increases by around 0.75% due to a combination of lower a real policy rate and an appreciated real exchange rate. The appreciation eventually causes a modest drop in Home GDP, while inflation drops by around 75 basis points on impact.

As a result of this shock, Foreign saving increases by 1% of Home GDP. But net Foreign financing drops by 2% of Home GDP, mainly due to an increase in Home lending to Foreign households. In other words, while Home households find money to pay for increased current account deficits, Home banks provide additional financing to foreigners. The reason is a large increase in the value of Foreign collateral due to much lower Foreign interest rates, which also increases Foreign lending to Foreign households. Values of collateral and credit also increase in Home, but by less given the smaller drop in Home interest rates. The general picture is one of global expansion of gross asset and liability positions due to lower interest rates. However, these balance sheet changes are of a similar magnitude to changes in real variables, while during typical capital inflow episodes financial sector balance sheets tend to grow significantly relative to GDP.

The subsequent evolution of loan and deposit balances reflects the slow accumulation of Home net foreign liabilities. Home households' deposits decrease faster than their loans, while the opposite is true for Foreign. But these changes are much smaller than the changes in gross positions, and in fact not easy to discern in Figure 2. In other words, net payment flows are very small relative to financial flows even for real shocks.

4.3. US Credit Glut

Figure 3 studies a shock to the Home credit supply to Home households $S_t^{\kappa_H^h}$. Home loans to and deposits from Home households increase by 12.7% and 11.7% of Home GDP on impact, while Home and Foreign households reduce their borrowing in sectors where banks have not increased their credit supply. The large increase in available purchasing power lowers the Home effective price of consumption by 4% on impact, and this causes a more than 3% increase in Home consumption, a 2% increase in Home GDP, a 270 basis points increase in Home inflation, an eventual 220 basis points increase in the Home real policy rate, and a 2.5% real exchange rate appreciation.

The shock does trigger a Home current account deficit, but this is financed by US banks' additional credit, not by Foreign households "lending" additional physical resources. While Foreign physical saving increases, net Foreign financing decreases, mainly because Home households demand less credit from Foreign banks when Home banks offer easier credit. Home households do over time increase their net foreign liabilities by using their deposit balances to make payments, but as above these changes are comparatively small and gradual.

A key aspect of the saving glut was the "Greenspan bond conundrum" (Greenspan (2005)), the observation that US long-term bond yields declined during the height of the saving glut episode in 2004-2005 despite continuous policy interest rate increases. For the saving glut hypothesis in Figure 2, the opposite of the bond conundrum occurs - the real policy rate drops while the lending spread increases by around 10 basis points. By contrast, the credit glut hypothesis in Figure 3 is at least qualitatively consistent with the bond conundrum - the real policy rate increases while the lending spread decreases by almost 80 basis points in impact.

Figure 3 shows that credit supply shocks imply changes in balance sheet positions that are almost an order of magnitude larger than changes in real variables. The saving glut episode was indeed accompanied by large expansions in US financial sector balance sheets relative to GDP, so that at a minimum financial shocks should have an important role in explaining the joint evolution of real and financial variables. But beyond that, their role in triggering the so-called global saving glut deserves serious consideration.

We have also studied a contractionary shock to Foreign credit supply to Foreign households. This shock can be motivated by the comparatively weak domestic credit expansion of major current account surplus economies, including Germany and China, during the global saving glut episode.

The effects of this shock on relative credit conditions, and therefore on MUIP spreads, interest rate differentials and real exchange rates, are very similar to Figure 3. The key insight in both cases is that Home households can finance their current account deficit because they have access to more abundant Home purchasing power, not to more abundant Foreign physical resources.

5. Sudden Stops: Current Accounts or Debt Stocks?

5.1. Hypothesis and Discussion

A large literature, based on the net flow perspective of capital flows, interprets the current account, a goods market concept, as an indicator of the availability of foreign financing, and the net foreign liabilities position, also a goods market concept, as a sufficient statistic for an economy's financial vulnerability and the risk of "sudden stops" in external funding (Calvo (1998)).[11] Similarly, global imbalances are often treated as synonymous with current account imbalances (Group of 20 (2011)), and financial crises are deemed to require current account adjustments (International Monetary Fund (2014)).

This viewpoint is increasingly being challenged. For example, Obstfeld (2013) and Borio and Disyatat (2011, 2015) argue that the current account and net flows are generally a symptom of financial developments and of gross flows rather than their cause. More importantly, an economy's vulnerability to financial shocks is determined by the state of its balance sheets, which cannot be accurately assessed without distinguishing between foreign saving and foreign financing. An economy with very low net foreign liabilities can nevertheless be highly vulnerable if its gross foreign liabilities are very large. And in response to large financial shocks that require the immediate repayment of a sizeable volume of debt, changes in the current account cannot make any contribution on impact, and only a small contribution over time. Instead, they mostly reflect the macroeconomic adjustments to the price changes triggered by such shocks. At the same time, gross capital flows have zero immediate impact on current accounts, and in some cases even zero longer-run effects, while potentially completely changing the magnitude and risk profile of gross debt burdens.

An important caveat is that an economy that runs large current account deficits over many years must eventually acquire not only large net but also gross foreign liabilities. We therefore do not argue that the current account is necessarily irrelevant for an economy's financial vulnerability. Rather we argue that gross liabilities are far more important, that they can change very quickly and for reasons that are completely unrelated to the current account, and that they are often the driver of the current account rather than the reverse.

[11] Examples include Prasad et al. (2006), who claim that the current account is a "measure of total external capital financing available for investment in a country", Gourinchas and Rey (2013), who state that "the United States has been a net capital importer since 1982 and has been increasingly financed by fast growing emerging economies", or Bernanke (2005), who states that "... the large current account deficit of the United States, in particular, requires substantial flows of foreign financing".

Part of the empirical literature is supportive of a gross flow approach. Borio and Disyatat (2011) show that global gross flows tripled between the late 1990s and 2007, while during the GFC global current account imbalances narrowed only slightly, and by only $20 billion in the case of the US, while global gross capital inflows and outflows collapsed, by $1600 billion in the case of the US. Borio and Lowe (2002), Gourinchas and Obstfeld (2012), and Jorda et al. (2011a) show that credit booms, including cross-border but also domestic booms, are the best leading indicator of financial crises, and that the information content of current accounts tends to vanish once these booms are controlled for. McCauley et al. (2015) argue that external credit tends to outpace domestic credit in the later stages of credit booms, and that the eventual credit bust causes real activity to come to a halt. Chinn et al. (2014) find that credit booms cause weaker current accounts. Unger (2015) finds that increases in domestic gross credit, through money creation, increase demand and cause current account deficits. Lane and McQuade (2013) find, for European countries, that domestic credit growth is strongly positively correlated with current account deficits. Mendoza and Terrones (2012) find that credit booms are typically associated with net capital inflows. Finally, Acharya and Schnabl (2009) argue that the current account balance is not a good guide to the direction of bank-related capital flows.

5.2. Cross-Border Credit Crunch

Figure 4 studies a shock to the Foreign credit supply to Home households $S_t^{\kappa_F^{h^*}}$. Avdjiev et al. (2012) provide evidence that such "sudden stop" shocks to cross-border credit have played an important role in emerging market crises. They show that during sudden stops domestic bank credit only contracts little, while cross-border credit contracts sharply.

The shock implies that Foreign banks suddenly demand repayment of a large share of their cross-border loans, which drop by 9.1% of Home GDP on impact. Home households make part of the required immediate loan repayments by using their existing Foreign currency deposits, which drop by 3.2% of GDP. In order the obtain the missing repayment funds of 5.9% of GDP, Home households obtain additional Home currency loans and deposits of 4.3% of GDP, and then exchange these new deposits, together with part of their existing deposits equal to 1.6% of GDP, with Foreign households to generate the Foreign currency needed to repay the remaining loans.

The global shortage of Foreign currency deposits triggered by Foreign banks' repayment demand increases the convenience yield of Foreign currency, and therefore increases the Home currency excess financial return, or MUIP spread, by around 140 basis points. Foreign households obtain additional Foreign currency loans equal to 6.6% of Home GDP, and exchange the additional Foreign currency deposits created through these loans against Home currency deposits.

As for the real economy, we note that a Foreign credit supply shock does not affect Foreign household preferences over the supply of physical saving, meaning preferences over the production or

consumption of goods, but Foreign bank preferences over the supply of currency. This triggers a 2% increase in the effective price of consumption and a 3.5% real exchange rate depreciation. Mediated by these price changes, consumption drops by 1.6%, GDP drops by 0.8%, and the current account improves by 1% of GDP.

However, this current account surplus does not make a significant contribution to the required loan repayments, instead it is merely a symptom of the economy's adjustment to the exchange rate depreciation, which makes Home goods more competitive in world markets. Foreigners do not stop financing the current account, they stop financing debt, and debt repayments require an instantaneous stock adjustment in gross financial variables, while current accounts are flows that generate close to zero funds over the horizon of a sudden stop. Even thereafter, current accounts require years to produce significant changes in net foreign liabilities that are still far smaller than the required loan repayments. We can see this in Figure 4, where even over the first full quarter the required immediate adjustment in net foreign financing is more than 40 times larger than the current account surplus.

When studying a country's vulnerability to sudden stops, the key variables are therefore not the current account or net foreign liabilities, but rather gross foreign assets and especially liabilities. This includes not only their absolute size but also their composition and thus their susceptibility to reversals. In Figure 4, the initial net foreign liabilities position equals zero, and its subsequent changes are small and gradual, but this should not suggest low vulnerability. This is because initial gross foreign liabilities equal 50% of GDP (15% loans, 15% deposits, 20% interbank liabilities), and could be highly vulnerable to changes in sentiment by Foreign households or banks. During the sudden stop, loans and interbank liabilities decrease by 9.1% and 2.1% of GDP, while deposits increase by 5.8% of GDP. If deposits were less/more prone to sudden withdrawals than loans, this could contribute far more, and far more quickly, to reductions/increases in financial vulnerability than current account surpluses.

6. Triffin's Current Account Dilemma

6.1. Hypothesis and Discussion

The current account version of Triffin's dilemma posits that a growing world economy requires an increasing quantity of a risk-free global reserve currency to facilitate private sector goods and asset trades. This is taken to imply that the economy issuing the reserve currency must run persistent current account deficits to provide the rest of the world with enough of its currency, but that by doing so the country eventually becomes increasingly indebted, and the currency ceases to be risk-free. For examples of this view, see Zhou (2009), Camdessus and Icard (2011), Paul Volcker's statements in Feldstein (2013), and Prasad (2013). In the late 1990s, this dilemma was also held to be a risk for the forthcoming EMU (see Bergsten (1997) and Alagoskoufis and Portes

(1997)). A sizeable empirical literature is also based on this hypothesis. For example, Chinn et al. (2014) perform a panel analysis of current accounts, and interpret the pattern of wider-than-predicted US current account deficits as reflecting the US dollar's reserve role. Bayoumi et al. (2015) and Bergsten and Gagnon (2017) report related results.

But as Bordo and McCauley (2017), McCauley (2019), and Obstfeld (2013) point out, this version of Triffin's dilemma is flawed both in fact and in logic. In fact, the US ran persistent current account *surpluses* during the post-war period, and with brief interruptions until 1980, while global dollar reserves grew. In logic, the dilemma treats as equivalent changes in the quantity of physical resource flows, which are recorded in current accounts and *net* foreign liabilities, and in the quantity of currencies, which are recorded within financial accounts and in the stocks of public or private sector liquid *gross* liabilities. The creation of dollars for the purpose of efficient international trade only requires digital credit creation by US banks or the US government, and is independent of physical trade deficits incurred by households and firms. Furthermore, dollar credit can also be created by non-US banks, as long as they have adequate access to correspondent banking arrangements or central bank swap lines with the reserve currency economy. There is therefore no dilemma.

A closely related notion to Triffin's current account dilemma is the idea that current account surpluses "fund" the accumulation of foreign exchange reserves (Bernanke (2005), Bernanke et al. (2011), Gros (2009)). Because the accumulation of foreign exchange reserves (a gross financial outflow) is a purely financial transaction, it must be accompanied by a matching reduction/increase in private sector gross outflows/inflows, without requiring any changes to the current account. Consider a central bank that purchases foreign exchange by selling some of its domestic government securities. This gross outflow is offset either by a reduction in private-sector gross outflows if the counterparty is a domestic seller of foreign exchange, or an increase in gross inflows if the counterparty is a nonresident seller of foreign exchange.

6.2. Cross-Border Dollar Creation

Figure 5 studies a shock to the Home (US) credit supply to Foreign households $S_t^{\kappa_H^f}$ to illustrate the fallacy of Triffin's current account dilemma. The shock implies that US banks create a large stock of additional dollars, by expanding their cross-border loans and deposits by 10.3% and 6.8% of Home GDP on impact. Home households end up holding around a third of the newly created deposits because the dollar's relative convenience yield drops, so that its relative financial return increases. The world economy is therefore supplied with a large additional stock of dollars, despite the fact that this shock depreciates the real exchange rate by nearly 3% and thereby gives rise to a current account surplus, which by the logic of Triffin's current account dilemma should give rise to smaller, not larger, stock of dollars.

7. High Correlation of Gross Capital Inflows and Outflows

Broner et al. (2013) show empirically that gross capital inflows and outflows of individual economies are highly correlated. In the net flow literature, this presents a puzzle that requires an explanation, in the form of reasons for synchronized investment decisions. In the words of Broner et al. (2013), "when foreigners invest in a country, domestic agents invest abroad, and vice versa." But in fact, the high aggregate correlation of financial flows is not the result of an economic mechanism, and therefore does not require a theoretical explanation. Instead it is simply an automatic result of the balance of payment's double-entry bookkeeping. All financial flows involve two inseparable gross financial flows into and out of the economy. They involve one single investment decision by a single investor, with a zero net change and no flow of physical resources. The correlation of these financial outflows and inflows is one by construction. The only two reasons why overall gross capital inflows and outflows may exhibit a lower correlation are measurement errors ("errors and omissions"), where statisticians have not captured one leg of the transaction, and a significant role for net payment flows, where only one of the flows is financial while the other is physical.[12] This logic also partly accounts for the predominantly positive correlations between gross capital flows at the sectorial level documented by Rey (2018), but with the caveat that sectorial correlations are not exclusively determined by the mechanics of aggregate financial flows.

In the theoretical literature, Caballero and Simsek (2019) is a prominent recent example of the net flows perspective. In their model, fickleness and retrenchment represent two separate sets of decisions about physical resource flows by separate sets of domestic and foreign investors that end up being synchronized because of the model's economic mechanism. We argue here that fickleness alone (or retrenchment alone) give rise to perfectly correlated gross capital inflows and outflows. In this context, the observation by Avdjiev et al. (2017) that global banks are largely responsible for the fickleness and retrenchment patterns seen in the data acquires added significance.

To illustrate these arguments, we can simply refer back to our canonical capital inflow shock of Figure 1. The case of accommodating FXMR is a particularly clear illustration, with the inflow into domestic retail deposits almost exactly matched by an outflow into interbank settlement accounts. The case of strict FXMR looks less clear, but this is because the original inflow is followed by a number of other loan and deposit transactions that remove foreign exchange mismatches. However, it is easy to show that each of these transactions itself consists of matching gross capital inflow and outflow components. The reason why in this case inflows and outflows are no longer perfectly correlated is that the real exchange rate appreciation triggers a current account deficit and therefore some payment flows.

[12] Net payment flows accounted for a larger share of global capital flows during the age of capital controls. Consequently, Broner et al. (2013) find that the correlation between gross inflows and outflows became stronger between the 1970s and the 2000s. Today net payment flows are very small relative to financial flows.

8. Bond Issuance, Velocity, and Capital Flows

As discussed in the introduction, in our model household bond issuance to banks is equivalent to bank loans, while household bond issuance to other households transfers bank deposits from bond buyer to bond issuer, where the latter presumably has a higher propensity to spend. An increased reliance of bond issuance is therefore equivalent to an increase in the velocity of circulation of bank deposits.

Figure 6 therefore studies a shock to Home velocity S_t^{mon}. The shock implies that households can perform more real economic activity with fewer deposits. It therefore results in drops of Home loans to and deposits of Home households of approximately 13%, and the latter causes a 5% drop in the effective price of consumption, an over 3% increase in consumption, and an over 2% increase in GDP. The stimulus to demand increases inflation and the real policy rate, and this in turn appreciates the real exchange rate and causes a current account deficit. However, this increase in Foreign saving is accompanied by a decrease in Foreign financing of roughly equal size, principally because domestic households demand fewer loans from Foreign as well as Home banks.

We observe that the effects of this US money demand shock on real variables, saving and financing, and most balance sheet variables, are very similar to those of the US money supply shock in Figure 3. In both cases the change in excess money demand is the driver of the results. Loan issuance increases money supply, while bond issuance decreases money demand.

9. Conclusions

We have developed an open economy model that embeds endogenous gross capital flows within and between countries in an otherwise standard New Keynesian environment. The model allows us to study the mechanics and economic significance of gross capital flows. We use this analytical framework to revisit several well-known policy debates in open economy macroeconomics. At the heart of the analysis is the distinction between cross-border payment or saving flows, which are the financial account mirror image of the physical resource flows of the current account, and cross-border financial flows, which consist of two matching and inseparable gross capital inflows and outflows, both of which are recorded in the financial account.

The key distinctive features of the model are creation of the domestic currency by each economy's banking system on the basis of risky collateralized loans, the necessity for cross-border capital flows because households require both imperfectly substitutable currencies for transactions, and settlement of cross-border capital flows through interbank settlement accounts.

We demonstrate that foreign saving (domestic current account deficits) and net foreign financing (net foreign loans) are entirely different concepts, and that for many shocks they move in opposite directions. We turn the policy conclusions of the global saving glut hypothesis on their

head, by suggesting that US current account deficits have not been financed by excessive foreign saving, which would suggest less excessive foreign saving as a policy prescription, but instead by excessive US credit, which would suggest less excessive US credit as a policy prescription. On the subject of a country's vulnerability to sudden stops, we discuss that net and gross foreign liabilities can send very different signals, with gross liabilities being far more important because in a crisis lenders do not stop financing current accounts but rather stop financing debt. Furthermore, the contribution of current accounts to restoring sustainability in response to sudden stops must be zero on impact when it matters most, and is negligible even over the longer run. We are able to dismiss Triffin's current account dilemma as a non-dilemma, because the creation of dollar reserves requires dollar bank credit, not US current account deficits. Finally, we are able to demonstrate that the high correlation of gross capital inflows and outflows are not an economic but an accounting phenomenon, because most capital flows are financial flows, and financial flows necessarily consist of a pair of gross inflows and gross outflows that are inseparable as a matter of balance of payments accounting.

Four of the most central topics in open economy macroeconomics therefore clearly benefit from a reexamination in light of a gross flows model. We are confident that this far from exhausts the list of topics that would benefit from a similar exercise.

References

Acharya, V. and Schnabl, P. (2009), "Do Global Banks Spread Global Imbalances? The Case of Asset-Backed Commercial Paper During the Financial Crisis", paper presented at the IMF Jaques Polak Annual Research Conference.

Alagoskoufis, G. and Portes, R. (1997), "The Euro, the Dollar, and the International Monetary System", in: P. Masson, T. Krueger and B. Turtelboom, eds., *EMU and the International Monetary System*, Washington, DC: IMF, pp. 58-89.

Albanesi, S., Giorgi, G. D. and Nosal, J. (2017), "Credit Growth and the Financial Crisis: A New Narrative", NBER Working Papers, No. 23740.

Aldasoro, I. and Ehlers, T. (2018), "Global Liquidity: Changing Instrument and Currency Patterns", *BIS Quarterly Review*, 17-27.

Alfaro, L., Kalemli-Özcan, S. and Volosovych, V. (2008), "Why Doesn't Capital Flow from Rich to Poor Countries: An Empirical Investigation", *Review of Economics and Statistics*, **90(2)**, 347–68.

Anderson, G. and Cesa-Bianchi, A. (2020), "Crossing the Credit Channel: Credit Spreads and Firm Heterogeneity", Bank of England Staff Working Papers, No. 854.

Anderson, R.G., Duca, J.V. and Jones, B.E. (2018), "Financial Innovation, Shadow Banking, Risk Premia and Divisia Velocity", Working Paper, Federal Reserve Bank of Dallas and Binghampton University.

Ashcraft, A.B. and Steindel, C. (2008), "Measuring the Impact of Securitization on Imputed Bank Output", Working Paper, Federal Reserve Bank of New York.

Avdjiev, S., Hardy, B., Kalemli-Ozcan, S. and Servén, L. (2017), "Gross Capital Flows by Banks, Corporates and Sovereigns", NBER Working Papers, No. 23116.

Avdjiev, S., McCauley, R. and McGuire, P. (2012), "Rapid Credit Growth and International Credit: Challenges for Asia", BIS Working Papers, No. 377.

Banerjee, R., Devereux, M. and Lombardo, G. (2016), "Self-Oriented Monetary Policy, Global Financial Markets and Excess Volatility of International Capital Flows", BIS Working Papers, No. 540.

Barnett, W., Offenbacher E. and Spindt, P. (1984), "The New Divisia Aggregates", *Journal of Political Economy*, **92(6)**, 1049-1085.

Basel Committee on Banking Supervision (2017), "Basel III: Finalizing Postcrisis Reforms", Technical Report, Bank for International Settlements.

Bayoumi, T., Gagnon, J. and Saborowski, C. (2015), "Official Financial Flows, Capital Mobility, and Global Imbalances", *Journal of International Money and Finance*, **52**, 146-174.

Bergsten, F. (1997), "The Impact of the Euro on Exchange Rates and International Policy Cooperation", in: P. Masson, T. Krueger and B. Turtelboom, eds., *EMU and the International Monetary System*, Washington, DC: IMF, pp. 17-48.

Bergsten, F. and Gagnon, J. (2017), *Currency Conflict and Trade Policy*, Washington, DC: Peterson Institute for International Economics.

Bernanke, B. (2005), "The Global Saving Glut and the U.S. Current Account Deficit", Remarks by Governor Ben S. Bernanke at the Sandridge Lecture, Virginia Association of Economists, Richmond, Virginia, March 10, 2005.

Bernanke, B., Bertaut, C., DeMarco, L. and Kamin, S. (2011), "International Capital Flows and the Returns to Safe Assets in the United States, 2003-2007", Federal Reserve Board of Governors, International Finance Discussion Papers, No. 1014.

Bernanke, B., Gertler, M. and Gilchrist, S. (1999), "The Financial Accelerator in a Quantitative Business Cycle Framework", in: J.B. Taylor and M. Woodford (eds.), *Handbook of Macroeconomics, Volume 1C*. Amsterdam: Elsevier, pp. 1341-1393.

Blanchard, O. and Milesi-Ferretti, G.-M. (2009), "Global Imbalances: In Midstream?", IMF Staff Position Note, SPN/09/29.

Blanchard, O. and Milesi-Ferretti, G.-M. (2011), "(Why) Should Current Account Balances Be Reduced?", IMF Staff Discussion Note, SDN/11/03.

Bordo, M. and McCauley, R. (2017), "Triffin: Dilemma or Myth?", BIS Working Papers, No. 684.

Borio, C. (2016), "On the Centrality of the Current Account in International Economics", *Journal of International Money and Finance*, **68**, 266-274.

Borio, C. and Disyatat, P. (2011), "Global Imbalances and the Financial Crisis: Link or no Link?", BIS Working Papers, No. 346.

Borio, C. and Disyatat, P. (2015), "Capital Flow Puzzles and the Current Account: Taking Financing (More) Seriously", BIS Working Papers, No. 525.

Borio, C. and Lowe, P. (2002), "Assessing the Risk of Banking Crisis", BIS Quarterly Review, December, 43-54.

Borio, C., McCauley, R. and McGuire, P. (2017), "FX Swaps and Forwards: Missing Global Debt", BIS Quarterly Review, September, 37-54.

Broner, F., Didier, T., Erce, A. and Schmukler, S. (2013), "Gross Capital Flows: Dynamics and Crises", *Journal of Monetary Economics*, **60**, 113-133.

Bruno, V. and Shin, H.S. (2015), "Cross-Border Banking and Global Liquidity", *The Review of Economic Studies*, **82(2)**, 535–564.

Bundesbank (2017), "The Role of Banks, Non-Banks and the Central Bank in the Money Creation Process", Monthly Report, April 2017.

Burnside, C. (2011), "Carry Trades and Risk", NBER Working Papers, No. 17278.

Caballero, R. and Farhi, E. (2016), "The Safety Trap", Working Paper.

Caballero, R., Farhi, E. and Gourinchas, P.-O. (2008), "An Equilibrium Model of 'Global Imbalances' and Low Interest Rates", *American Economic Review*, **98(1)**, 358-393.

Caballero, R., Farhi, E. and Gourinchas, P.-O. (2017), "The Safe Assets Shortage Conundrum", *Journal of Economic Perspectives*, **31(3)**, 29-46.

Caballero, R. and Krishnamurthy, A. (2009), "Global Imbalances and Financial Fragility", *American Economic Review: Papers and Proceedings*, **99(2)**, 584-588.

Caballero, R. and Simsek, A. (2019), "A Model of Fickle Capital Flows and Retrenchment", *Journal of Political Economy* (forthcoming).

Calvo, G.A. (1983), "Staggered Prices in a Utility-Maximizing Framework", *Journal of Monetary Economics*, **12**, 383-398.

Calvo, G. (1998), "Capital Flows and Capital Market Crises: The Simple Analytics of Sudden Stops", *Journal of Applied Economics*, **1(1)**, 35-54.

Camdessus, M. and Icard, A. (2011), "Toward an Orderly Supply of Reserve Currencies", in: J. Boorman and A. Icard (eds.), *Reform of the International Monetary System: The Palais Royal Initiative*, New Delhi: Sage Press, pp. 75-81.

Caselli, F. and Feyrer, J. (2007), "The Marginal Product of Capital", *Quarterly Journal of Economics*, **122(2)**, 535–68.

Cesa-Bianchi, A., Eguren-Martin, F. and Thwaites, G. (2019), "Foreign Booms, Domestic Busts: The Global Dimension of Banking Crises", *Journal of Financial Intermediation*, **37(c)**, 58-74.

Cesa-Bianchi, A., Kumhof, M., Sokol, A. and Thwaites, G. (2019), "Towards a New Monetary Theory of Exchange Rate Determination", Bank of England Staff Working Papers, No. 817.

Chen, S. and Kang, J. S. (2018), "Credit Boom - Is China Different? ", IMF Working Papers, WP/18/2.

Chinn, M., Eichengreen, B. and Ito, H. (2014), "A Forensic Analysis of Global Imbalances", *Oxford Economic Papers*, **66**, 465-490.

Christiano, L., Motto, R. and Rostagno, M. (2014), "Risk Shocks", *American Economic Review*, **104(1)**, 27-65.

Davis, J. S., Valente, G. and van Wincoop, E. (2019), "Global Capital Flows Cycle: Impact on Gross and Net Flows", NBER Working Papers, No. 25721.

Decker, F. and Goodhart, C. (2018), "Credit Mechanics - A Precursor to the Current Money Supply Debate", CEPR Discussion Papers, No. 13233.

Dedola, L., Karadi, P. and Lombardo, G. (2013), "Global Implications of National Unconventional Policies", *Journal of Monetary Economics*, **60**, 66-85.

Devereux, M. and Saito, M. (2006), "A Portfolio Theory of International Capital Flows", HKIMR Working Papers, No. 11/2006.

Devereux, M., Saito, M. and Yu, C. (2018), "International Capital Flows, Portfolio Composition, and the Stability of External Imbalances", Working Paper.

Doherty, E., Jackman, B. and Perry, E. (2018), "Money in the Australian Economy", Reserve Bank of Australia Bulletin, September.

Engel, C. (2016), "Exchange Rates, Interest Rates, and the Risk Premium", *American Economic Review*, **106(2)**, 436-474.

Fama (1984), "Forward and Spot Exchange Rates", *Journal of Monetary Economics*, **14(3)**, 319-338.

Farhi, E., Gourinchas, P.-O. and Rey, H. (2011), "Reforming the International Monetary System", CEPR.

Federal Reserve Bank of New York (2018), "Quarterly Trends for Consolidated U.S. Banking Organizations, First Quarter 2018".

Feldstein, M. (2013), "An Interview with Paul Volcker", *Journal of Economic Perspectives*, **27(4)**, 105-120.

Fostel, A., Geanakoplos, J. and Phelan, G. (2015), "Global Collateral: How Financial Innovation Drives Capital Flows and Increases Financial Instability", Cowles Foundation Discussion Papers, No. 2076.

Gabaix, X. and Maggiori, M. (2015), "International Liquidity and Exchange Rate Dynamics", *Quarterly Journal of Economics*, **130**, 1369–1420.

Gertler, M. and Karadi, P. (2011), "A Model of Unconventional Monetary Policy", *Journal of Monetary Economics*, **58(1)**, 17-34.

Goodfriend, M. and McCallum, B.T. (2007), "Banking and Interest Rates in Monetary Policy Analysis: A Quantitative Exploration", *Journal of Monetary Economics*, **54**, 1480–1507.

Gourinchas, P.-O. and Jeanne, O. (2012), "Global Safe Assets", BIS Working Papers, No. 399.

Gourinchas, P.-O. and Obstfeld, M. (2012), "Stories of the Twentieth Century for the Twenty-First", *American Economic Journal: Macroeconomics*, **4(1)**, 226-265.

Gourinchas, P.-O. and Rey, H. (2013), "External Adjustment, Global Imbalances and Valuation Effects", NBER Working Papers, No. 19240.

Gourinchas, P.-O., Rey, H. and Govillot, N. (2017), "Exorbitant Privilege and Exorbitant Duty", Working Paper.

Greenspan, A. (2005), "Testimony of Chairman Alan Greenspan", Federal Reserve Board's Semiannual Monetary Policy Report to the Congress, Before the Committee on Banking, Housing, and Urban Affairs, U.S. Senate, February 16, available at https://www.federalreserve.gov/boarddocs/hh/2005/february/testimony.htm.

Gros, D. (2009), "Global Imbalances and the Accumulation of Risk", Centre for European Policy Studies Briefs, No. 189.

Group of 20 (2011), "G20 Mutual Assessment Process: From Pittsburgh to Cannes - IMF Umbrella Report", Washington, DC: International Monetary Fund.

Hsieh, C. and Klenow, P. (2007), "Relative Prices and Relative Prosperity", *American Economic Review*, **97(3)**, 562–85.

International Monetary Fund (1993), *Balance of Payments Manual*.

International Monetary Fund (2014), "Chapter 4: Are Global Imbalances at a Turning Point?", World Economic Outlook, October.

Itskhoki, O. and Mukhin, D. (2017), "Exchange Rate Disconnect in General Equilibrium", NBER Working Papers, No. 23401.

Jakab, Z. and Kumhof, M. (2020), "Banks Are not Intermediaries of Loanable Funds - Facts, Theory and Evidence", Bank of England Staff Working Papers, No. 761.

Jeanne, O. (2012), "The Dollar and Its Discontents", *Journal of International Money and Finance*, **31**, 1976-1981.

Jorda, O., Schularick, M. and Taylor, A. (2011a), "Financial Crises, Credit Booms, and External Imbalances: 140 Years of Lessons", *IMF Economic Review*, **59(2)**, 340-378.

Jorda, O., Schularick, M. and Taylor, A. (2011b), "When Credit Bites Back: Leverage, Business Cycles, and Crises", Federal Reserve Bank of San Francisco Working Papers, No. 27.

Justiniano, A., Primiceri, G. and Tambalotti, A. (2014), "The Effects of the Saving and Banking Glut on the U.S. Economy", *Journal of International Economics*, **92**, 552-567.

Krishnamurthy, A. and Vissing-Jorgensen (2012), "The Aggregate Demand for Treasury Debt", *Journal of Political Economy*, **120(2)**, 233-267.

Krugman, P. (2007), "Will there be a Dollar Crisis?", *Economic Policy*, July, 435-467.

Kumhof, M., and Wang, X. (2019), "Banks, Money and the Zero Lower Bound on Deposit Rates", Bank of England Staff Working Papers, No. 752.

Lane, P. and McQuade, P. (2013), "Domestic Credit Growth and International Capital Flows", *Scandinavian Journal of Economics*, **116(1)**, 218-252.

Lane, P. and Milesi-Ferretti, G.-M. (2008), "The Drivers of Financial Globalization", *American Economic Review*, **98(2)**, 327-332.

Lane, P. and Milesi-Ferretti, G.-M. (2018), "The External Wealth of Nations Revisited: International Financial Integration in the Aftermath of the Global Financial Crisis", *IMF Economic Review*, **66**, 189-222.

Lucas, R. (1990), "Liquidity and Interest Rates", *Journal of Economic Theory*, **50**, 237-264.

McCauley, R. (2019), "Safe Assets: Made, Not Just Born", BIS Working Papers, No. 769.

McCauley, R., McGuire, P. and Sushko, V. (2015), "Global Dollar Credit: Links to US Monetary Policy and Leverage", BIS Working Papers, No. 483.

McCauley, R., McGuire, P. and von Peter, G. (2010), "The Architecture of Global Banking: From International to Multinational?", BIS Quarterly Review, 25-37.

McGrattan, E. and Prescott, E. (2010), "Technology Capital and the US Current Account", *American Economic Review*, **100(4)**, 1493-1522.

McLeay, M., Radia, A. and Thomas, R. (2014a), "Money in the Modern Economy: An Introduction", *Bank of England Quarterly Bulletin*, **54(1)**, 4-13.

McLeay, M., Radia, A. and Thomas, R. (2014b), "Money Creation in the Modern Economy", *Bank of England Quarterly Bulletin*, **54(1)**, 14-27.

Meese, R. and Rogoff, K. (1983), "Empirical Exchange Rate Models of the Seventies: Do They Fit Out of Sample?", *Journal of International Economics*, **14(1)**, 3-24.

Mendoza, E., Quadrini, V. and Rios-Rull, J.-V. (2009), "Financial Integration, Financial Development, and Global Imbalances", *Journal of Political Economy*, **117(3)**, 371-416.

Mendoza, E. and Terrones, M. (2012), "An Anatomy of Credits Booms and their Demise", *Economía Chilena*, **15(2)**, 4-32.

Milesi-Ferretti, G.M. and Tille, C. (2011), "The Great Retrenchment: International Capital Flows During the Global Financial Crisis", *Economic Policy*, **26(66)**, 285-342.

Obstfeld, M. (2010), "Expanding Gross Asset Positions and the International Monetary System", Proceedings - Economic Policy Symposium - Jackson Hole, Federal Reserve Bank of Kansas City, 463-478.

Obstfeld, M. (2012), "Does the Current Account Still Matter?", *American Economic Review: Papers and Proceedings*, **102(3)**, 1-23.

Obstfeld, M. (2013), "The International Monetary System: Living with Asymmetry", in: R.C. Feenstra and A.M. Taylor (eds.), *Globalization in an Age of Crisis: Multilateral Economic Cooperation in the Twenty-First Century*, Chicago: University of Chicago Press.

Obstfeld, M. and Rogoff, K. (1995), "Exchange Rate Dynamics Redux", *Journal of Political Economy*, **103(3)**, 624-660.

Obstfeld, M. and Rogoff, K. (1996), *Foundations of International Macroeconomics*, Cambridge: MIT Press.

Pozsar, Z. (2014), "Shadow Banking: The Money View", OFR Working Papers.

Prasad, E., Rajan, R. and Subramanian, A. (2006), "Patterns of International Capital Flows and Their Implications for Economic Development", paper presented at the Federal Reserve Bank of Kansas City Economic Policy Symposium *The New Economic Geography: Effects and Policy Implications*, Jackson Hole, 24–26 August.

Prasad, E. (2013), *The Dollar Trap: How the US Dollar Tightened Its Grip on Global Finance*, Princeton: Princeton University Press.

Reinhart, C. and Rogoff, K. (2004), "Serial Default and the 'Paradox' of Rich-to-Poor Capital Flows", *American Economic Review*, **94(2)**, 53–8.

Rey, H. (2018), "Dilemma not Trilemma: The Global Financial Cycle and Monetary Policy Independence", NBER Working Papers, No. 21162.

Rotemberg, J.J., (1982), "Monopolistic Price Adjustment and Aggregate Output", *Review of Economic Studies*, **49(4)**, 517-31.

Rungcharoenkitkul, P., Borio, C. and Disyatat, P. (2019), "Monetary Policy Hysteresis and the Financial Cycle", BIS Working Papers, No. 817.

Schmitt-Grohé, S. and Uribe, M. (2004), "Optimal Fiscal and Monetary Policy under Sticky Prices", *Journal of Economic Theory*, **114**, 198-230.

Schularick, M. and Taylor, A. (2012), "Credit Booms Gone Bust: Monetary Policy, Leverage Cycles, and Financial Crises, 1870-2008", *American Economic Review*, **102(2)**, 1029-61.

Shin, H.S. (2012), "Global Banking Glut and Loan Risk Premium", *IMF Economic Review*, **60(4)**, 155-192.

Shiratsuka, S. (2003), "The Asset Price Bubble in Japan in the 1980s: Lessons for Financial and Macroeconomic Stability", BIS Working Papers, No. 21.

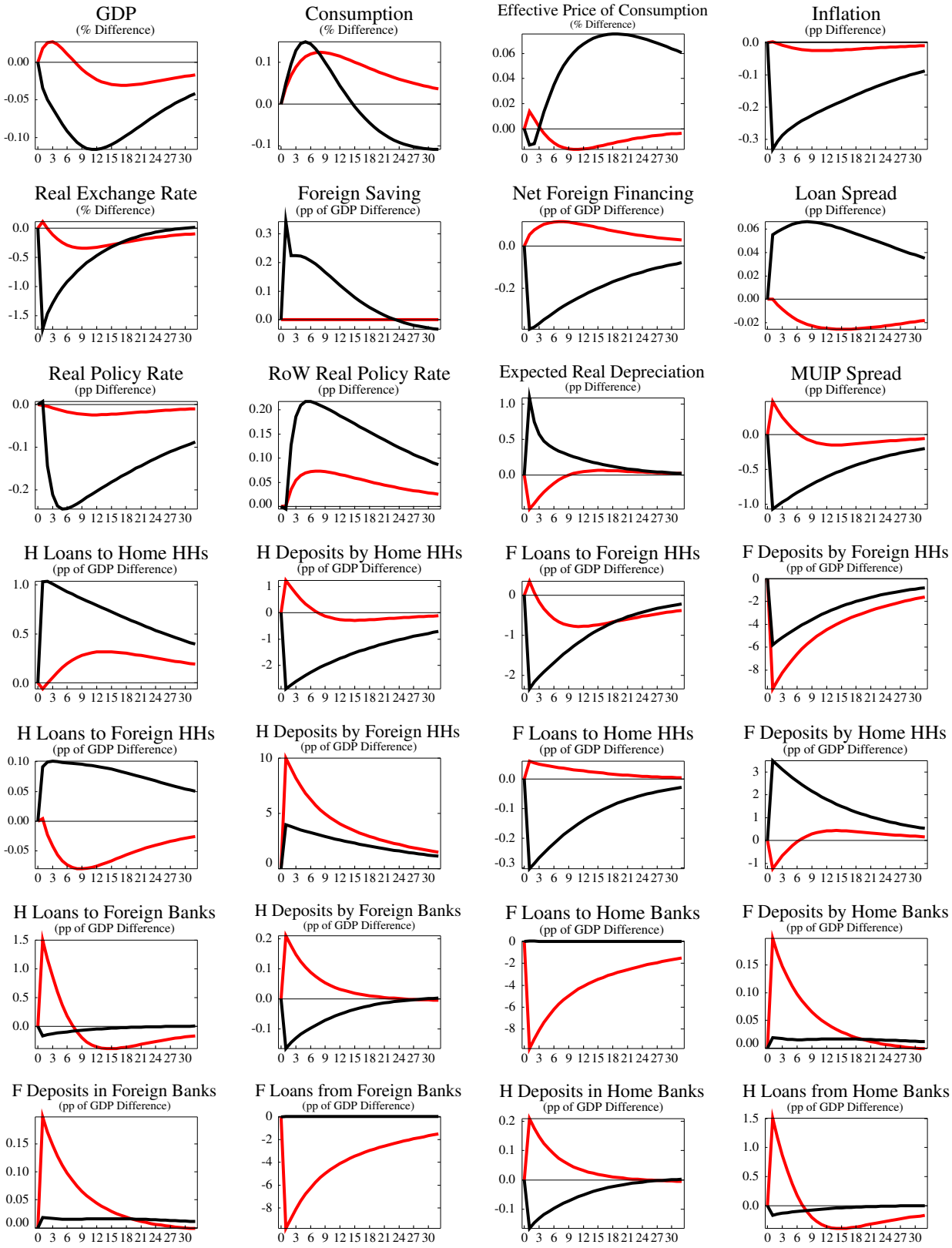
Ueda, K. (2012), "Banking Globalization and International Business Cycles: Cross-Border Chained Credit Contracts and Financial Accelerators", *Journal of International Economics*, **86**, 1-16.

Ueda, K. and Brooks, R. (2011), *User Manual for the Corporate Vulnerability Utility: The 4th Edition*, International Monetary Fund.

Unger, R. (2015), "Asymmetric Credit Growth and Current Account Imbalances in the Euro Area", Deutsche Bundesbank Discussion Papers, No. 36/2015.

Zhou, X. (2009), "Reform of the International Monetary System", Beijing: People's Bank of China, available at: http://www.pbc.gov.cn/publish/english/.

Figure 1
A Canonical Capital Inflow Shock



(red = accommodating FXMR, black = strict FXMR)

Figure 2
Global Saving Glut: Foreign Physical Glut

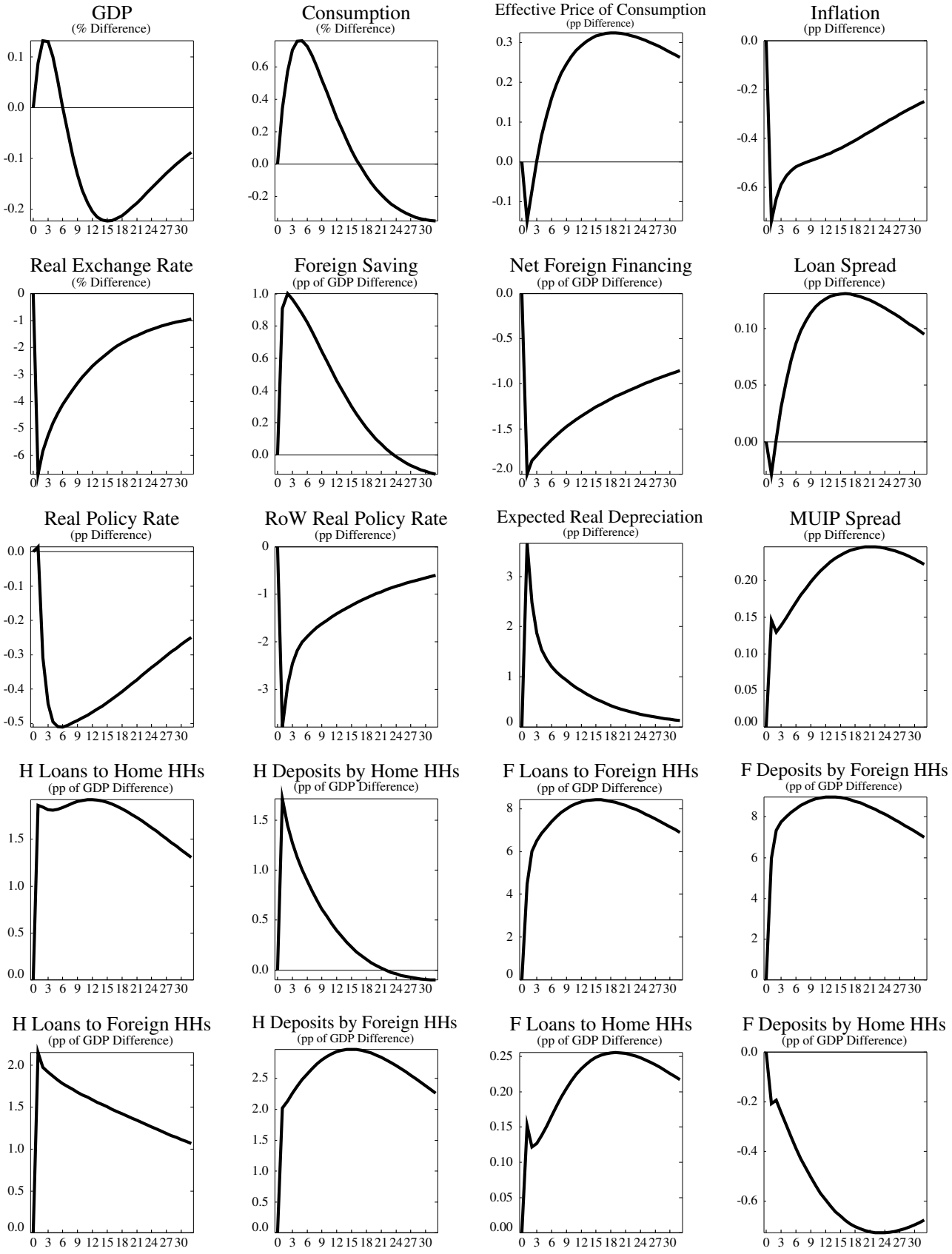


Figure 3
Global Saving Glut: US Credit Glut

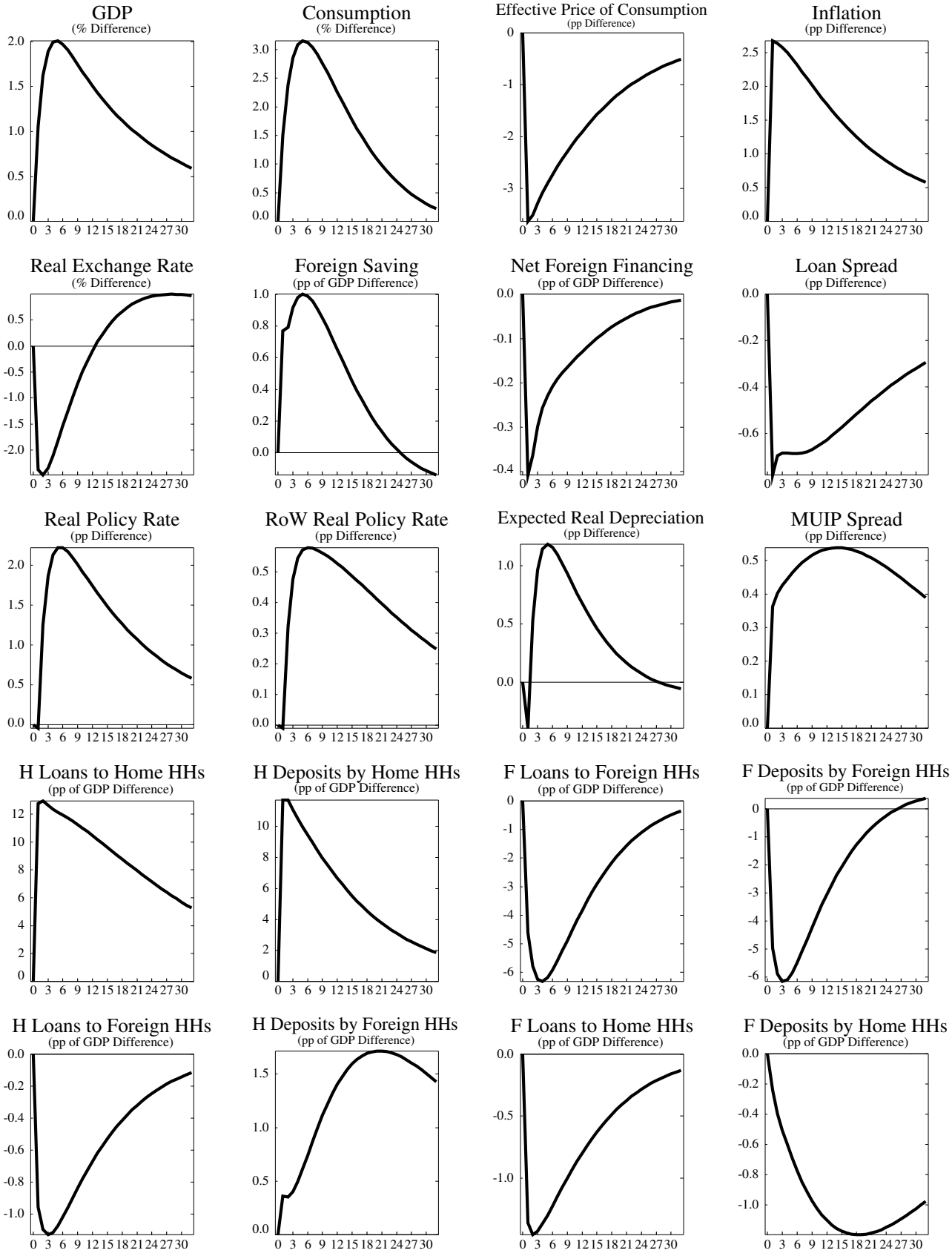


Figure 4
Sudden Stops: Cross-Border Credit Crunch

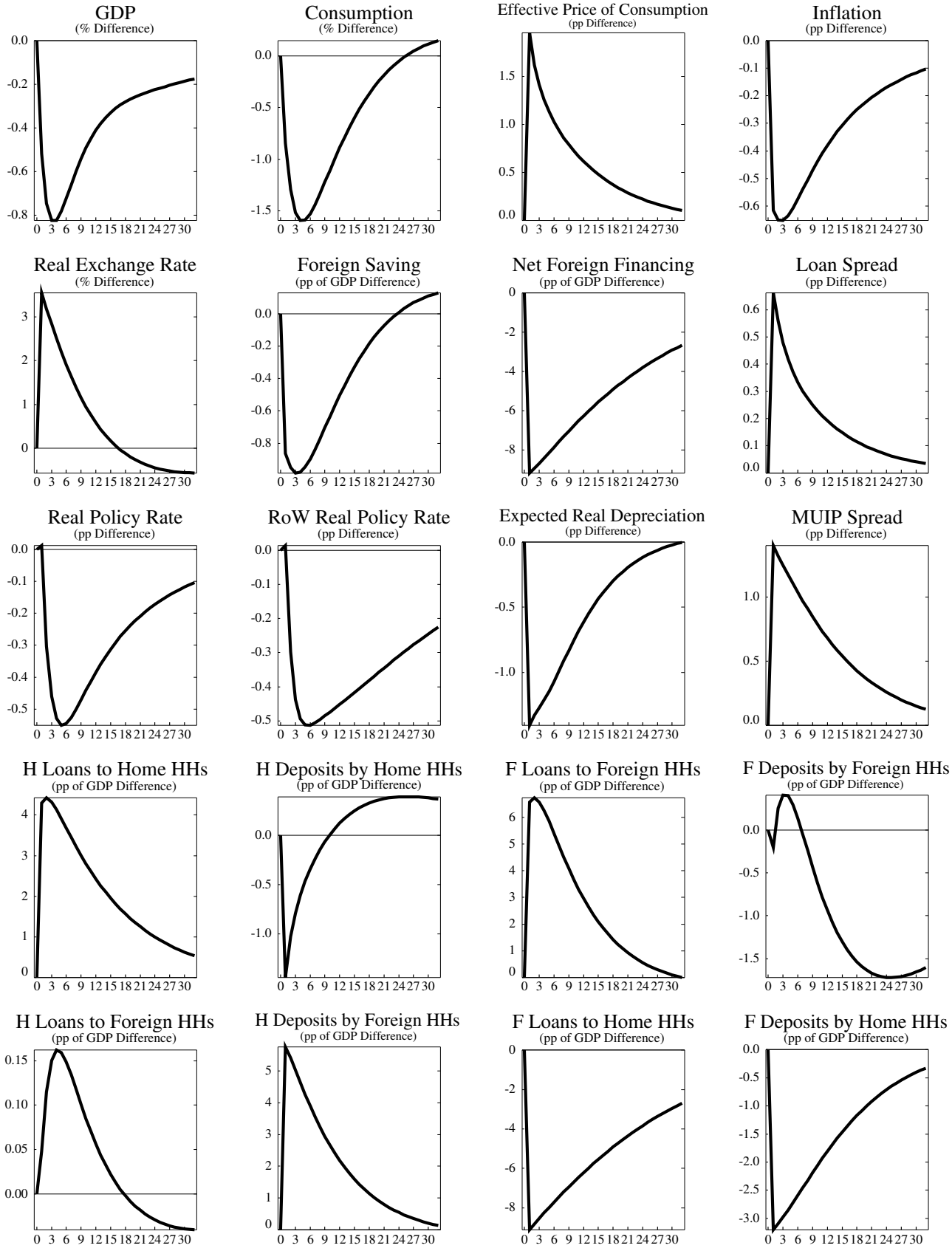


Figure 5
Triffin's Current Account Dilemma: Cross-Border Dollar Creation

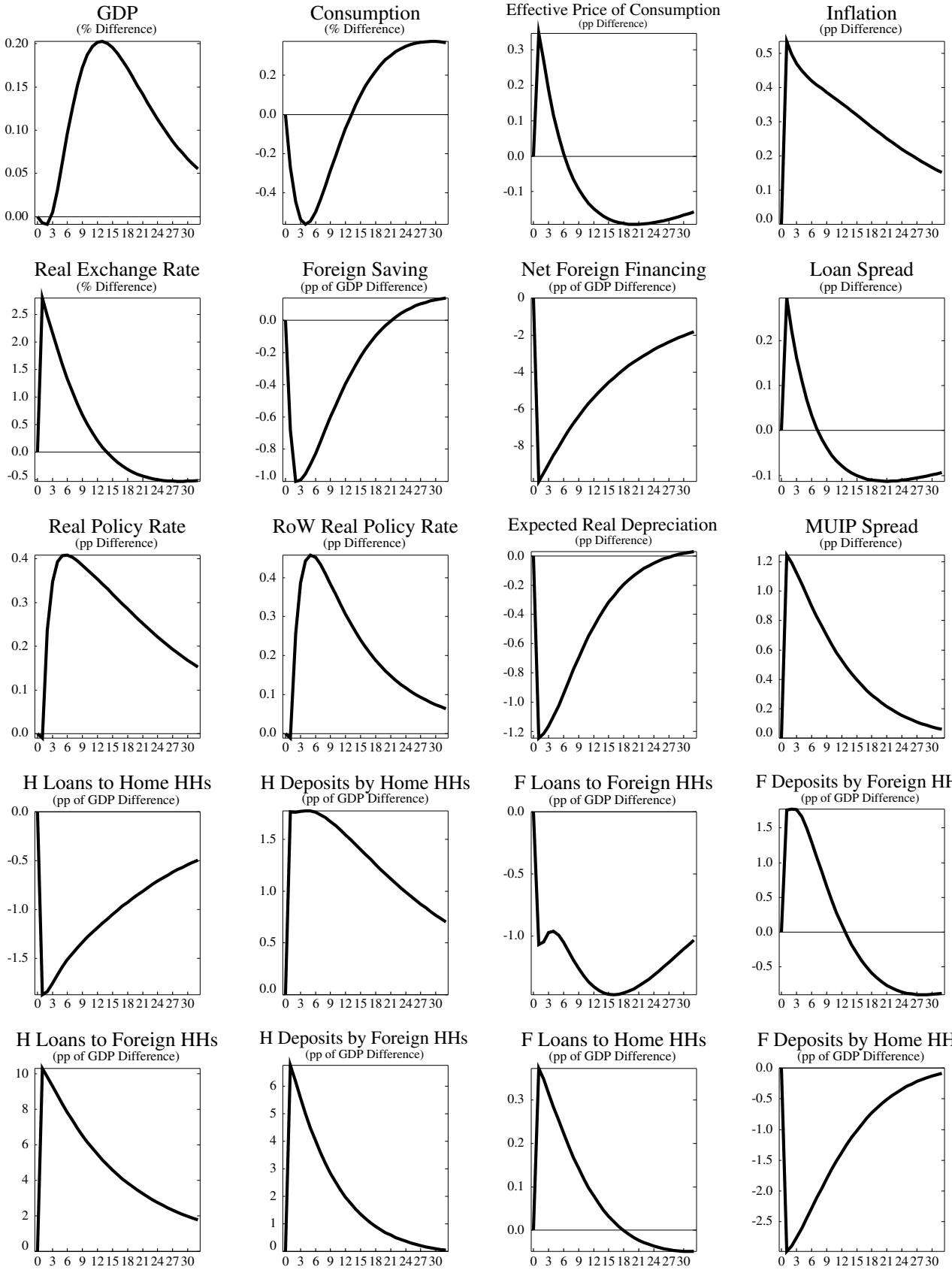


Figure 6
Increased Domestic Bond Issuance