Appendix 1. Data and Sources

Real U.S. Loans: Loans and leases in bank credit, all commercial banks (in billions of dollars, seasonally adjusted), divided by consumer price index. Source: Federal Reserve Bank of St. Louis (FRED).

Real S&P 500: S&P 500 Stock Price Index (not seasonally adjusted). Source: FRED.

Real Swiss Domestic Demand: Domestic demand (in millions of Swiss francs, at prices of preceding year, chained values, reference year 2005, seasonally adjusted). Source: State Secretariat for Economic Affairs (SECO).

Real Swiss Loans Denominated in U.S. Dollars: Domestic and foreign assets, claims against banks plus claims against customers denominated in U.S. dollars for all banks (in millions of Swiss francs), divided by consumer price index. Source: Monthly Balance Sheets, Monthly Bulletin of Banking Statistics, Swiss National Bank (SNB) and SECO.

Real Swiss Net Interest Payments: Net labor and investment income (in billions of Swiss francs), divided by consumer price index. Source: Swiss Balance of Payments, SNB, and SECO.

Real SMI: Swiss market index (not seasonally adjusted). Source: Monthly Statistical Bulletin, SNB.

Appendix 2. The Model

Physical Setup

I present the equations for home; unless otherwise specified, foreign is symmetric and its variables are marked with an asterisk (*).

The physical setup is described by the production function, the law of motion for capital, the CES aggregator for the final good, and the resource constraint:

$$X_t = A_t K_t^{\alpha} L_t^{1-\alpha}, \quad \text{with } 0 < \alpha < 1 \tag{A1}$$

$$S_t = I_t + (1-\delta)K_t \tag{A2}$$

$$K_{t+1} = S_t \Psi_{t+1} \tag{A3}$$

$$Y_t = \left[\nu^{\frac{1}{\eta}} {X_t^H}^{\frac{\eta-1}{\eta}} + (1-\nu)^{\frac{1}{\eta}} {X_t^F}^{\frac{\eta-1}{\eta}} \right]^{\frac{\eta}{\eta-1}} \tag{A4}$$

$$Y_t = C_t + I_t \left[1 + f\left(\frac{I_t}{I_{t-1}} \right) \right] + G_t. \tag{A5}$$

Households

The problem of the households is

$$\max_{C_t, L_t, D_t^h} U(C_t, L_t) = E_t \sum_{t=0}^{\infty} \beta^t \left[\ln C_t - \frac{\chi}{1+\gamma} L_t^{1+\gamma} \right] \tag{A6}$$

$$\text{s.t.} \quad C_t + D_{t+1}^h = W_t L_t + R_t D_t^h + \Pi_t - T_t.$$

The first-order conditions are

$$L_t : \frac{W_t}{C_t} = \chi L_t^{\gamma} \tag{A7}$$

$$D_{t+1}^h : E_t R_{t+1} \beta \frac{C_t}{C_{t+1}} = E_t R_{t+1} \Lambda_{t,t+1} = 1, \tag{A8}$$

where $\Lambda_{t,t+1}$ is the stochastic discount factor.

Non-Financial Firms

Goods Producers

From the problem of the goods producers, the wage is defined by

$$W_t = (1-\alpha) P_t^H K_t^{\alpha} {L_t}^{-\alpha} \quad \text{with } P_t^H = \nu^{\frac{1}{\eta}} Y_t^{-1} \left(X_t^H \right)^{\frac{-1}{\eta}}. \tag{A9}$$

I define the gross return on capital as

$$Z_t = \alpha P_t^H K_t^{1-\alpha} L_t^{\alpha}. \tag{A10}$$

The demands faced by the intermediate competitive goods producers are

$$X_t^H = \nu \left[\frac{P_t^H}{P_t} \right]^{-\eta} Y_t \tag{A11}$$

and

$$X_t^{H*} = \nu^* \left[\frac{P_t^{H*}}{P_t^*}\right]^{-\eta} Y_t^*,$$

where P_t is the price of the home final good, P_t^H the price of home goods at home, and P_t^{H*} the price of home goods abroad. The price of the final good is

$$P_t = \left[\nu(P_t^H)^{1-\eta} + (1-\nu)(P_t^F)^{1-\eta}\right]^{\frac{1}{1-\eta}}$$
$$\frac{P_t}{P_t^H} = [\nu + (1-\nu)\tau_t^{1-\eta}]^{\frac{1}{1-\eta}},$$

where τ_t is the terms of trade, the price of imports relative to exports. Because of home bias in the final good production, $P_t \neq P_t^* NER_t$.

Capital Producers

Capital producers maximize their expected discounted utility

$$\max_{I_t} E_t \sum_{\tau=t}^{\infty} \Lambda_{t,\tau} \left\{Q_\tau I_\tau - \left[1 + f\left(\frac{I_\tau}{I_{\tau-1}}\right)\right] I_\tau\right\}.$$

The first-order condition yields the price of capital goods, which equals the marginal cost of investment

$$Q_t = 1 + f\left(\frac{I_t}{I_{t-1}}\right) + \frac{I_t}{I_{t-1}} f'\left(\frac{I_t}{I_{t-1}}\right) - E_t \Lambda_{t,t+1} \left[\frac{I_{t+1}}{I_t}\right]^2 f'\left(\frac{I_{t+1}}{I_t}\right). \tag{A12}$$

Banks

Home Banks

The problem of the bank is to maximize the value of the bank

$$V(s_{t-1}, b_{t-1}, d_{t-1}) = E_{t-1}\Lambda_{t-1,t} \left\{(1-\sigma)n_t + \sigma \left[\max_{s_t, b_t, d_t} V(s_t, b_t, d_t)\right]\right\} \tag{A13}$$

subject to the borrowing constraint

$$V_t(s_t, b_t, d_t) \geq \theta(Q_t s_t + Q_{bt} b_t). \tag{A14}$$

I guess that the form of the value function of the Bellman equation is linear in assets and liabilities,

$$V(s_t, b_t, d_t) = \nu_{st} s_t + \nu_{bt} b_t - \nu_t d_t. \tag{A15}$$

Taking λ_t as the constraint multiplier, the problem yields the following first-order conditions:

$$\begin{gathered}
s_t : \nu_{st} - \lambda_t(\nu_{st} - \theta Q_t) = 0 \\
b_t : \nu_{bt} - \lambda_t(\nu_{bt} - \theta Q_{bt}) = 0 \\
d_t : \nu_t - \lambda_t \nu_t = 0 \\
\lambda_t : \theta(Q_t s_t + Q_{bt} b_t) - \{\nu_{st} s_t + \nu_{bt} b_t - \nu_t d_t\} = 0.
\end{gathered}$$

Rearranging terms yields

$$(\nu_{bt} - \nu_t)(1 + \lambda_t) = \lambda_t \theta Q_{bt} \tag{A16}$$

$$\left(\frac{\nu_{st}}{Q_t} - \frac{\nu_{bt}}{Q_{bt}}\right)(1 + \lambda_t) = 0 \tag{A17}$$

$$\left[\theta - \left(\frac{\nu_{st}}{Q_t} - \nu_t\right)\right] Q_t s_t + \left[\theta - \left(\frac{\nu_{bt}}{Q_{bt}} - \nu_t\right)\right] Q_{bt} b_t = \nu_t n_t. \tag{A18}$$

From equation (A17), I verify that the marginal value of lending in the international asset market is equal to the marginal value of assets in terms of the home final good. Let μ_t be the excess value of a unit of assets relative to deposits; equations (A16) and (A17) yield

$$\mu_t = \frac{\nu_{st}}{Q_t} - \nu_t.$$

Rewriting the incentive constraint (A18), I define the leverage ratio net of international borrowing as

$$\phi_t = \frac{\nu_t}{\theta - \mu_t}. \tag{A19}$$

Therefore, the balance sheet of the individual bank is written as

$$Q_t s_t + Q_{bt} b_t = \phi_t n_t. \tag{A20}$$

I verify the conjecture regarding the form of the value function using the Bellman equation (A13) and the guess (A15). For the conjecture to be correct, the cost of deposits and the excess value of bank assets have to satisfy

$$\nu_t = E_t \Lambda_{t,t+1} \Omega_{t+1} R_{t+1} \tag{A21}$$

$$\mu_t = E_t \Lambda_{t,t+1} \Omega_{t+1} \left[R_{kt+1} - R_{t+1} \right], \tag{A22}$$

where the shadow value of net worth at $t+1$ is

$$\Omega_{t+1} = (1 - \sigma) + \sigma(\nu_{t+1} + \phi_{t+1} \mu_{t+1}) \tag{A23}$$

and holds state by state. The gross rate of return on bank assets is

$$R_{kt+1} = \Psi_{t+1} \frac{Z_{t+1} + Q_{t+1}(1 - \delta)}{Q_t}. \tag{A24}$$

From equation (A16),

$$\frac{\nu_{st}}{Q_t} = \frac{\nu_{bt}}{Q_{bt}},$$

which implies that the discounted rate of return on home assets has to be equal to the discounted rate of return on global loans

$$E_t \Lambda_{t,t+1} \Omega_{t+1} R_{kt+1} = E_t \Lambda_{t,t+1} \Omega_{t+1} R_{bt+1}, \tag{A25}$$

where R_{bt} is defined in the next section.

Foreign Banks

Let $V_t^*(s_t^*, b_t^*, d_t^*)$ be the maximized value of V_t^*, given an asset and liability configuration at the end of period t. The following incentive constraint must hold for each individual bank to ensure that a bank does not divert funds:

$$V_t^*(s_t^*, b_t^*, d_t^*) \geq \theta^*(Q_t^* s_t^* - Q_{bt}^* b_t^*). \tag{A26}$$

At the end of period $t-1$, the value of the bank satisfies the following Bellman equation:

$$V_t^*(s_{t-1}^*, b_{t-1}^*, d_{t-1}^*)$$
$$= E_{t-1}\Lambda_{t-1,t}^* \left\{(1-\sigma^*)n_t^* + \sigma^* \left[\max_{s_t^*, b_t^*, d_t^*} V^*(s_t^*, b_t^*, d_t^*)\right]\right\}. \tag{A27}$$

The problem of the bank is to maximize equation (A67) subject to the borrowing constraint, equation (A26).

I guess and verify that the form of the value function of the Bellman equation is linear in assets and liabilities,

$$V(s_t^*, b_t^*, d_t^*) = \nu_{st}^* s_t^* - \nu_{bt}^* b_t^* - \nu_t^* d_t^*. \tag{A28}$$

Maximizing the objective function (A67) with respect to (A26), with λ_t^* as the constraint multiplier, yields similar first-order conditions to the ones from home. If I rearrange the FOCs of the maximization problem of the foreign bank,

$$(\nu_{bt}^* - \nu_t^*)(1+\lambda_t^*) = \lambda_t^* \theta^* Q_{bt}^* \tag{A29}$$
$$\left(\frac{\nu_{st}^*}{Q_t^*} - \frac{\nu_{bt}^*}{Q_{bt}^*}\right)(1+\lambda_t^*) = 0 \tag{A30}$$
$$\left[\theta^* - \left(\frac{\nu_{st}^*}{Q_t^*} - \nu_t^*\right)\right] Q_t^* s_t^* - \left[\theta^* - \left(\frac{\nu_{bt}^*}{Q_{bt}^*} - \nu_t^*\right)\right] Q_{bt}^* b_t^* = \nu_t^* n_t^*. \tag{A31}$$

From the optimization problem of the foreign banks, the shadow value of global borrowing and domestic assets are equalized,

$$\frac{\nu_{st}^*}{Q_t^*} = \frac{\nu_{bt}^*}{Q_{bt}^*}; \tag{A32}$$

or, in terms of returns,

$$E_t \Lambda_{t,t+1}^* \Omega_{t+1}^* R_{kt+1}^* = E_t \Lambda_{t,t+1}^* \Omega_{t+1}^* R_{bt+1}^*. \tag{A33}$$

Let μ_t^* be the excess value of a unit of assets (or international borrowing) relative to deposits,

$$\mu_t^* = \frac{\nu_{st}^*}{Q_t^*} - \nu_t^*. \tag{A34}$$

With Ω^*_{t+1} as the shadow value of net worth at date $t+1$, and R^*_{kt+1} as the gross rate of return on bank assets, after verifying the conjecture of the value function, I define the marginal value of deposits and the excess return on assets as

$$\nu^*_t = E_t \Lambda^*_{t,t+1} \Omega^*_{t+1} R^*_{t+1}$$
$$\mu^*_t = E_t \Lambda^*_{t,t+1} \Omega^*_{t+1} \left[R^*_{kt+1} - R^*_{t+1} \right]$$

with

$$\Omega^*_{t+1} = 1 - \sigma^* + \sigma^* \left(\nu^*_{t+1} + \phi^*_{t+1} \mu^*_{t+1} \right)$$
$$R^*_{kt+1} = \Psi^*_{t+1} \frac{Z^*_{t+1} + Q^*_{t+1}(1-\delta)}{Q^*_t}. \tag{A35}$$

Aggregate Bank Net Worth

Finally, aggregating across home banks, from equation (A20),

$$Q_t S_t + Q_{bt} B_t = \phi_t N_t. \tag{A36}$$

Capital letters indicate aggregate variables. From the previous equation, I define the households' deposits

$$D_t = N_t (1 - \phi_t). \tag{A37}$$

Furthermore,

$$N_t = (\sigma + \xi) \left\{ R_{k,t} Q_{t-1} S_{t-1} + R_{b,t} Q_{b,t-1} B_{t-1} \right\} - \sigma R_t D_{t-1}. \tag{A38}$$

For foreign banks, the aggregation yields

$$N^*_t = (\sigma^* + \xi^*) R^*_{k,t} Q^*_{t-1} S^*_{t-1} - \sigma^* R^*_t D^*_{t-1} - \sigma^* R^*_{bt} Q^*_{bt-1} B^*_{t-1}, \tag{A39}$$

where R^*_{bt} equals R^*_{kt}, from equation (A33). The balance sheet of the aggregate foreign banking system can be written as

$$Q^*_t S^*_t - Q^*_{bt} B^*_t = \phi^*_t N^*_t. \tag{A40}$$

Global Interbank Market

The interest rate on the global interbank loan yields

$$R^*_{b,t+1} = \Psi^*_{t+1} \frac{Z^*_{t+1} + Q^*_{b,t+1}(1-\delta)}{Q^*_{bt}}. \tag{A41}$$

Equilibrium

To close the model, the different markets need to be in equilibrium:

$$Y_t = C_t + I_t \left[1 + f\left(\frac{I_t}{I_{t-1}}\right)\right] + G_t \tag{A42}$$

$$Y^*_t = C^*_t + I^*_t \left[1 + f\left(\frac{I^*_t}{I^*_{t-1}}\right)\right] + G^*_t \tag{A43}$$

$$X_t = X^H_t + X^{*H}_t \frac{1-m}{m} \quad \text{and} \quad X^*_t = X^F_t \frac{m}{1-m} + X^{*F}_t \tag{A44}$$

$$S_t = I_t + (1-\delta)K_t = \frac{K_{t+1}}{\Psi_{t+1}} \quad \text{and} \quad S^*_t = I^*_t + (1-\delta)K^*_t = \frac{K^*_{t+1}}{\Psi^*_{t+1}}$$

$$\chi L^\gamma_t = (1-\alpha)\frac{X_t}{L_t C_t} \quad \text{and} \quad \chi L^{*\gamma}_t = (1-\alpha)\frac{X^*_t}{L^*_t C^*_t}. \tag{A45}$$

If the economies are in financial autarky, the net exports for home are zero in every period; the current account results in

$$CA_t = 0 = \frac{1-m}{m} X^{H*}_t - \tau_t X^F_t. \tag{A46}$$

On the other hand, if there are global banks in the economy, the current account is

$$\begin{aligned} CA_t &= Q_{b,t}B_t - R_{bt}Q_{b,t-1}B_{t-1} \\ &= X^{*H}_t \frac{1-m}{m}\frac{P^H_t}{P_t} - X^F_t \tau_t \frac{P^H_t}{P_t} \end{aligned} \tag{A47}$$

$$B_t = B^*_t \frac{1-m}{m} \tag{A48}$$

$$D^h_t = D_t + \mathcal{D}_{gt} \quad \text{and} \quad D^{h*}_t = D^*_t + \mathcal{D}^*_{gt}. \tag{A49}$$

Appendix 3. Definition of Equilibria

Frictionless Economy

In a model without financial frictions, the competitive equilibrium is defined as a solution to the problem that involves choosing twenty-two quantities $(Y_t, X_t, L_t, C_t, I_t, X_t^H, X_t^{H*}, K_{t+1}, W_t, Z_t, S_t, Y_t^*, X_t^*, L_t^*, C_t^*, I_t^*, K_{t+1}^*, X_t^F, X_t^{F*}, W_t^*, Z_t^*, S_t^*)$, two interest rates (R_t, R_t^*), and five prices $(Q_t, P_t^H, Q_t^*, P_t^{F*}, \tau_t)$ as a function of the aggregate state $(I_{t-1}, K_t, A_t, \Psi_t, I_{t-1}^*, K_t^*, A_t^*, \Psi_t^*)$. There are twenty-nine variables and twenty-nine equations: equations (A1)–(A5), (A7)–(A12), and equation (A24) for home, where equation (A9) has two relations. These conditions also hold for foreign. I close the model with equations (A42–A44) and (A46).

Economy with Financial Frictions

The competitive banking equilibrium without government intervention is defined as a solution to the problem that involves choosing the same twenty-two quantities as in the frictionless economy (Y_t, X_t, L_t, C_t, I_t, X_t^H, $X_t^{H*}, K_{t+1}, W_t, Z_t, S_t, Y_t^*, X_t^*, L_t^*, C_t^*, I_t^*, K_{t+1}^*, X_t^F, X_t^{F*}, W_t^*, Z_t^*, S_t^*$) plus the fourteen variables related with banks (N_t, D_t, B_t, Ω_t, μ_t, ν_t, ϕ_t, N_t^*, D_t^*, B_t^*, Ω_t^*, $\mu_t^*, \nu_t^*, \phi_t^*$), five interest rates $(R_t, R_t^*, R_{kt}, R_{kt}^*, R_{bt}^*)$, and six prices $(Q_t, Q_{bt}^*, P_t^H, Q_t^*, P_t^{F*}, \tau_t)$ as a function of the aggregate state (I_{t-1}, K_t, A_t, Ψ_t, I_{t-1}^*, K_t^*, A_t^*, Ψ_t^*). There are forty-seven variables and forty-seven equations: equations (A1)–(A5) and (A7)–(A12) for home, where equation (A9) has two conditions. These twelve equations are equivalent for foreign. Equations (A19), (A21)–(A24), and (A36)–(A38) define part of the banking variables and interest rates and also hold for foreign. The equilibrium is completed with equations (A25), (A33), (A41), (A47), and (A48).

Appendix 4. Deterministic Steady State

In table A1, I show the comparison between the average of Swiss data for 2002–8 and the deterministic steady state of the home economy. The first part of the table presents the ratios of the main variables with respect to GDP, while the second part shows the ratios with

Table A1. Comparison between Swiss Data and Deterministic Steady State

		Data	Model
A. Ratios with Regard to GDP			
$X^{H^*}\frac{1-m}{m} - X^F$	Net exports	0.0777	−0.0516
C	Consumption	0.5933	0.6945
I	Investment	0.2146	0.2243
G	Gov. Consumption	0.1140	0.1300
B + K	Total Assets	5.7288	10.7368
B	Global Asset	1.0246	1.7658
B. Ratios with Regard to Final Domestic Demand			
$X^{H^*}\frac{1-m}{m} - X^F$	Net exports	0.0848	−0.0492
C	Consumption	0.6435	0.6622
I	Investment	0.2329	0.2138
G	Gov. Consumption	0.1236	0.1240
B + K	Total Assets	6.2245	10.2373
B	Global Asset	1.1135	1.6836

Notes: The Swiss data is HP filtered and evaluated between 2002 and 2008. See sources in appendix 1.

respect to the final domestic demand. In both cases the ratios of the deterministic steady state of the real variables match the data. There are two caveats. First, the net exports of the model are negative, while in the data they are positive. To model a small economy with a big financial sector, I need a net importer home country. If I only included the data for goods, the net exports of Switzerland would be negative. Second, the financial variables of the model (total assets and assets from home banks with foreign counterparties) almost double the data. However, the ratio of global assets over the total assets matches the data, which is most relevant for the results.

The deterministic steady state also matches the ratio between the Swiss and the U.S. economy. In particular, for the period 2002–8, the U.S. GDP is almost twenty-nine times bigger than the Swiss GDP. In the model, foreign production is twenty-seven times bigger than home production.

Appendix 5. When Foreign Banks Lend to Home Banks

In this section, I allow for symmetry in the portfolio of the banks: foreign banks lend to home banks, and home banks lend to foreign banks. However, there is still a positive net asset position for home banks. I only specify the new problem of home and foreign banks; the rest of the model remains the same.

The Model

Home Banks

For an individual home bank, the balance sheet implies that the value of the loans funded in that period, $Q_t s_t$ plus $Q_{bt} b_t$, where Q_{bt} is the price of loans made to foreign banks, has to equal the sum of the bank's net worth, n_t, home deposits, d_t, and loans made by foreign banks $Q_{jt} j_t$. Then, the balance sheet of a home bank reads

$$Q_t s_t + Q_{bt} b_t = n_t + d_t + Q_{jt} j_t. \tag{A50}$$

Let R_{bt} be the global asset's rate of return from period $t-1$ to period t and R_{jt} the one on foreign banks' loans. The net worth of an individual home bank at period t is the payoff from assets funded at $t-1$, net borrowing costs:

$$\begin{aligned} n_t = {} & [Z_t + (1-\delta)Q_t] s_{t-1} \Psi_t + R_{b,t} Q_{b,t-1} b_{t-1} - R_t d_{t-1} \\ & - R_{jt} Q_{j,t-1} j_{t-1}, \end{aligned}$$

where Z_t is the dividend payment at t on loans funded in the previous period.

At the end of period t, the bank maximizes the present value of future dividends, taking into account the probability of continuing being a banker in the next periods; the value of the bank is defined by

$$V_t = E_t \sum_{i=1}^{\infty} (1-\sigma)\sigma^{i-1} \Lambda_{t,t+i} n_{t+i}.$$

Following the previous literature, I introduce a simple agency problem to motivate the ability of the bank to obtain funds. After the bank obtains funds, it may transfer a fraction θ of assets back to its own household. Households limit the funds lent to banks.

If a bank diverts assets, it defaults on its debt and shuts down. Its creditors can reclaim the remaining $1-\theta$ fraction of assets. Let $V_t(s_t, b_t, d_t, j_t)$ be the maximized value of V_t, given an asset and liability configuration at the end of period t. The following incentive constraint must hold for each bank individually to ensure that the bank does not divert funds:

$$V_t(s_t, b_t, d_t, j_t) \geq \theta(Q_t s_t + Q_{bt} b_t - Q_{jt} j_t). \tag{A51}$$

The borrowing constraint establishes that for households to be willing to supply funds to a bank, the value of the bank must be at least as large as the benefits from diverting funds. In this case, diverted funds correspond to total assets minus what home banks borrowed from foreign banks; I assume that home banks cannot run away with money from foreign banks.

At the end of period $t-1$, the value of the bank satisfies the following Bellman equation:

$$\begin{aligned} & V(s_{t-1}, b_{t-1}, d_{t-1}, j_{t-1}) \\ & \quad = E_{t-1}\Lambda_{t-1,t}\left\{(1-\sigma)n_t + \sigma\left[\max_{s_t, b_t, d_t, j_t} V(s_t, b_t, d_t, j_t)\right]\right\}. \end{aligned} \tag{A52}$$

The problem of the bank is to maximize equation (A52) subject to the borrowing constraint, equation (A51). As in the baseline model, I assume that the value function is linear with respect to home and foreign loans, deposits, and foreign borrowing. Taking λ_t as the constraint multiplier, the problem yields the following first-order conditions:

$$\begin{aligned} & s_t : \nu_{st} - \lambda_t(\nu_{st} - \theta Q_t) = 0 \\ & b_t : \nu_{bt} - \lambda_t(\nu_{bt} - \theta Q_{bt}) = 0 \\ & d_t : \nu_t - \lambda_t \nu_t = 0 \\ & j_t : \nu_{jt} - \lambda_t(\nu_{jt} - \theta Q_{jt}) = 0 \\ & \lambda_t : \theta(Q_t s_t + Q_{bt} b_t - Q_{jt} j_t) - \{\nu_{st} s_t + \nu_{bt} b_t - \nu_t d_t - \nu_{jt} j_t\} = 0. \end{aligned}$$

Rearranging terms yields

$$(\nu_{bt} - \nu_t)(1+\lambda_t) - \lambda_t \theta Q_{bt} = 0 \tag{A53}$$

$$\left(\frac{\nu_{st}}{Q_t} - \frac{\nu_{bt}}{Q_{bt}}\right)(1+\lambda_t) = 0 \tag{A54}$$

$$\left(\frac{\nu_{st}}{Q_t} - \frac{\nu_{jt}}{Q_{jt}}\right)(1+\lambda_t) = 0 \tag{A55}$$

$$\begin{aligned}\left[\theta - \left(\frac{\nu_{st}}{Q_t} - \nu_t\right)\right] Q_t s_t + \left[\theta - \left(\frac{\nu_{bt}}{Q_{bt}} - \nu_t\right)\right] Q_{bt} b_t \\ - \left[\theta - \left(\frac{\nu_{jt}}{Q_{jt}} - \nu_{jt}\right)\right] Q_{jt} j_t = \nu_t n_t.\end{aligned} \tag{A56}$$

From equation (A54), I verify that the marginal value of lending in the international asset market is equal to the marginal value of assets in terms of the home final good. Moreover, from equation (A55), the marginal cost of holding foreign debt is equal to the marginal benefit of domestic assets; this is the case because home banks cannot run away with money from foreign banks. Let μ_t be the excess value of a unit of assets relative to deposits; equations (A53) and (A54) yield

$$\mu_t = \frac{\nu_{st}}{Q_t} - \nu_t.$$

Rewriting the incentive constraint (A56), I define the leverage ratio net of international borrowing as

$$\phi_t = \frac{\nu_t}{\theta - \mu_t}. \tag{A57}$$

Therefore, the balance sheet of the individual bank is written as

$$Q_t s_t + Q_{bt} b_t - Q_{jt} j_t = \phi_t n_t. \tag{A58}$$

I verify the conjecture regarding the form of the value function using the Bellman equation (A52) and the guess:

$$V(s_t, b_t, d_t) = \nu_{st} s_t + \nu_{bt} b_t - \nu_t d_t - \nu_{jt} j_t, \tag{A59}$$

where ν_{st} is the marginal value of assets at the end of period t, ν_{bt} is the marginal value of global lending, ν_t is the marginal cost of deposits, and ν_{jt} is the marginal cost of holding foreign debt. For the conjecture to be correct, the cost of deposits and the excess value of bank assets have to satisfy

$$\nu_t = E_t \Lambda_{t,t+1} \Omega_{t+1} R_{t+1} \tag{A60}$$

$$\mu_t = E_t \Lambda_{t,t+1} \Omega_{t+1} \left[R_{kt+1} - R_{t+1} \right], \tag{A61}$$

where the shadow value of net worth at $t+1$ is

$$\Omega_{t+1} = (1-\sigma) + \sigma(\nu_{t+1} + \phi_{t+1}\mu_{t+1}) \tag{A62}$$

and holds state by state. The gross rate of return on bank assets is

$$R_{kt+1} = \Psi_{t+1} \frac{Z_{t+1} + Q_{t+1}(1-\delta)}{Q_t}. \tag{A63}$$

From equation (A53),

$$\frac{\nu_{st}}{Q_t} = \frac{\nu_{bt}}{Q_{bt}},$$

which implies that the discounted rate of return on home assets has to be equal to the discounted rate of return on global loans

$$E_t \Lambda_{t,t+1} \Omega_{t+1} R_{kt+1} = E_t \Lambda_{t,t+1} \Omega_{t+1} R_{bt+1}, \tag{A64}$$

where R_{bt} is defined in the next section.

And, from equation (A55),

$$\frac{\nu_{st}}{Q_t} = \frac{\nu_{jt}}{Q_{jt}},$$

which implies that the discounted rate of return on home assets has to be equal to the discounted rate on borrowing from foreign banks

$$E_t \Lambda_{t,t+1} \Omega_{t+1} R_{kt+1} = E_t \Lambda_{t,t+1} \Omega_{t+1} R_{jt+1} = E_t \Lambda_{t,t+1} \Omega_{t+1} R_{bt+1}. \tag{A65}$$

Equations (A57) and (A60)–(A64) are equal to the ones in the baseline model.

Foreign Banks

The problem of foreign banks is similar to the one of home banks, except that now the interbank market assets, b_t^*, are loans from home banks and are on the liability side, and j_t^* are loans to home banks and are on the asset side of foreign banks. The balance sheet for an individual foreign bank is

$$Q_t^* s_t^* + Q_{jt}^* j_t^* = n_t^* + d_t^* + Q_{bt}^* b_t^*.$$

The net worth of the bank can also be thought of in terms of payoffs; then, the total net worth is the payoff from assets funded at $t-1$, net of borrowing costs which include the international loans,

$$\begin{aligned} n_t^* = {} & [Z_t^* + (1-\delta)Q_t^*] s_{t-1}^* \Psi_t^* + R_{jt}^* Q_{jt-1}^* j_{t-1}^* \\ & - R_t^* d_{t-1}^* - R_{bt}^* Q_{bt-1}^* b_{t-1}^*. \end{aligned}$$

Let $V_t^*(s_t^*, b_t^*, d_t^*, j_t^*)$ be the maximized value of V_t^*, given an asset and liability configuration at the end of period t. The following incentive constraint must hold for each bank individually to ensure that a bank does not divert funds:

$$V_t^*(s_t^*, b_t^*, d_t^*, j_t^*) \geq \theta^*(Q_t^* s_t^* + Q_{jt}^* j_t^* - Q_{bt}^* b_t^*). \tag{A66}$$

At the end of period $t-1$, the value of the bank satisfies the following Bellman equation:

$$\begin{aligned} & V_t^*(s_{t-1}^*, b_{t-1}^*, d_{t-1}^*, j_{t-1}^*) \\ & \quad = E_{t-1}\Lambda_{t-1,t}^* \left\{ (1-\sigma^*) n_t^* + \sigma^* \left[\max_{s_t^*, b_t^*, d_t^*, j_t^*} V^*(s_t^*, b_t^*, d_t^*, j_t^*) \right] \right\}. \end{aligned} \tag{A67}$$

The problem of the bank is to maximize equation (A67) subject to the borrowing constraint, equation (A66).

I guess and verify that the form of the value function of the Bellman equation is linear in assets and liabilities,

$$V(s_t^*, b_t^*, d_t^*) = \nu_{st}^* s_t^* + \nu_{jt}^* j_t^* - \nu_{bt}^* b_t^* - \nu_t^* d_t^*. \tag{A68}$$

Maximizing the objective function (A67) with respect to (A66), with λ_t^* as the constraint multiplier, yields similar first-order conditions to the ones from home. Rearranging the FOCs of the maximization problem of the foreign bank,

$$(\nu_{bt}^* - \nu_t^*)(1+\lambda_t^*) - \lambda_t^* \theta^* Q_{bt}^* = 0 \tag{A69}$$

$$\left(\frac{\nu_{st}^*}{Q_t^*} - \frac{\nu_{bt}^*}{Q_{bt}^*}\right)(1+\lambda_t^*) = 0 \tag{A70}$$

$$\left(\frac{\nu_{st}^*}{Q_t^*} - \frac{\nu_{jt}^*}{Q_{jt}^*}\right)(1+\lambda_t^*) = 0 \tag{A71}$$

$$\left[\theta^* - \left(\frac{\nu_{st}^*}{Q_t^*} - \nu_t^*\right)\right] Q_t^* s_t^* + \left[\theta^* - \left(\frac{\nu_{jt}^*}{Q_{jt}^*} - \nu_t^*\right)\right] Q_{jt}^* j_t^*$$
$$- \left[\theta^* - \left(\frac{\nu_{bt}^*}{Q_{bt}^*} - \nu_t^*\right)\right] Q_{bt}^* b_t^* = \nu_t^* n_t^*. \tag{A72}$$

From the optimization problem of the foreign banks, the shadow value of global borrowing and domestic assets are equalized,

$$\frac{\nu_{st}^*}{Q_t^*} = \frac{\nu_{bt}^*}{Q_{bt}^*}; \tag{A73}$$

or, in terms of returns,

$$E_t \Lambda_{t,t+1}^* \Omega_{t+1}^* R_{kt+1}^* = E_t \Lambda_{t,t+1}^* \Omega_{t+1}^* R_{bt+1}^*. \tag{A74}$$

Similarly, the marginal value of an extra unit of domestic asset and the marginal value of an extra unit of home asset equalize,

$$\frac{\nu_{st}^*}{Q_t^*} = \frac{\nu_{jt}^*}{Q_{jt}^*}; \tag{A75}$$

or, in terms of returns,

$$E_t \Lambda_{t,t+1}^* \Omega_{t+1}^* R_{kt+1}^* = E_t \Lambda_{t,t+1}^* \Omega_{t+1}^* R_{jt+1}^* = E_t \Lambda_{t,t+1}^* \Omega_{t+1}^* R_{bt+1}^*. \tag{A76}$$

Let μ_t^* be the excess value of a unit of assets (or international borrowing) relative to deposits,

$$\mu_t^* = \frac{\nu_{st}^*}{Q_t^*} - \nu_t^*. \tag{A77}$$

With Ω_{t+1}^* as the shadow value of net worth at date $t+1$, and R_{kt+1}^* as the gross rate of return on bank assets, after verifying the conjecture of the value function, I define the marginal value of deposits and the excess return on assets as

$$\nu_t^* = E_t \Lambda_{t,t+1}^* \Omega_{t+1}^* R_{t+1}^*$$
$$\mu_t^* = E_t \Lambda_{t,t+1}^* \Omega_{t+1}^* \left[R_{kt+1}^* - R_{t+1}^* \right]$$

with

$$\Omega_{t+1}^* = 1 - \sigma^* + \sigma^* \left(\nu_{t+1}^* + \phi_{t+1}^* \mu_{t+1}^* \right)$$
$$R_{kt+1}^* = \Psi_{t+1}^* \frac{Z_{t+1}^* + Q_{t+1}^*(1-\delta)}{Q_t^*}. \tag{A78}$$

The framework can be thought of as one with asset market integration because banks cannot divert funds financed by other banks. In particular, home banks can perfectly recover the interbank market loans. Foreign banks are only constrained on obtaining funds from foreign households.

Aggregate Bank Net Worth

Finally, aggregating across home banks, from equation (A58),

$$Q_t S_t + Q_{bt} B_t - Q_{jt} J_t = \phi_t N_t. \tag{A79}$$

Capital letters indicate aggregate variables. From the previous equation, I define the households' deposits,

$$D_t = N_t (1 - \phi_t). \tag{A80}$$

Furthermore,

$$N_t = \left(R_{k,t} Q_{t-1} S_{t-1} + R_{b,t} Q_{b,t-1} B_{t-1} \right) (\sigma + \xi)$$
$$- \sigma \left(R_t D_{t-1} + R_{jt} Q_{jt-1} J_{t-1} \right). \tag{A81}$$

The last equation specifies the law of motion of the home banking system's net worth. The first term in the brackets represents the return on loans made in the last period. The second term in the brackets is the return on funds that the household invested in the foreign economy. Both loans are scaled by the old bankers (that survived from the last period) plus the startup fraction of loans that young bankers receive. The last two terms in the equation are the total return on households' deposits that banks need to pay back and the total return on loans from foreign banks that home banks need to pay back, respectively.

For foreign banks, the aggregation yields

$$N_t^* = (\sigma^* + \xi^*)\left(R_{k,t}^* Q_{t-1}^* S_{t-1}^* + R_{j,t}^* Q_{j,t-1}^* J_{t-1}^*\right) \\ - \sigma^*(R_t^* D_{t-1}^* - R_{bt}^* Q_{bt-1}^* B_{t-1}^*), \tag{A82}$$

where R_{bt}^* equals R_{kt}^*, from equation (A74), and R_{jt}^* equals R_{kt}^*, from equation (A76). The balance sheet of the aggregate foreign banking system can be written as

$$Q_t^* S_t^* + Q_{jt}^* J_t^* - Q_{bt}^* B_t^* = \phi_t^* N_t^*. \tag{A83}$$

I define the deposits as in the original model:

$$D_t^* = N_t^*(1 - \phi_t^*). \tag{A84}$$

Moreover, $J_t^* n = J_t(1-n)$ and $B_t^* n = B_t(1-n)$.

Global Interbank Market

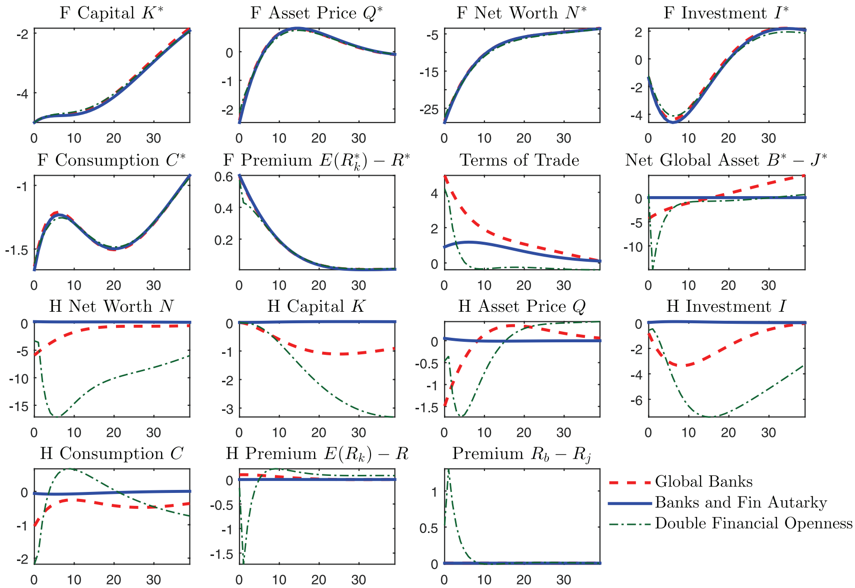
The return on loans to foreign banks made by home banks is $E_t(R_{bt+1}) = E_t(R_{bt+1}^* \frac{\varepsilon_{t+1}}{\varepsilon_t})$, and similarly for the return on loans from foreign to home banks, $E_t(R_{jt+1}) = E_t(R_{jt+1}^* \frac{\varepsilon_{t+1}}{\varepsilon_t})$. The rate on global loans is equalized to the return on loans to home firms, R_{kt}, in expected terms in equation (A65); home banks are indifferent between lending to home firms or to foreign banks. For foreign banks, equation (A76) equalizes the rate of return on global loans to the rate of return on foreign loans. The double equalization drives the asset market integration. In addition, the rate of return on the global asset market is related to the gross return on capital in the foreign country in the following way:

$$R_{b,t+1}^* = \Psi_{t+1}^* \frac{Z_{t+1}^* + Q_{b,t+1}^*(1-\delta)}{Q_{bt}^*}, \tag{A85}$$

which equalizes the returns on the international asset and the foreign lending. Moreover,

$$R_{j,t+1} = \Psi_{t+1} \frac{Z_{t+1} + Q_{j,t+1}(1-\delta)}{Q_{jt}}. \tag{A86}$$

Figure A1. Impulse Responses to a 5 Percent Decrease in Ψ_t^*, Models without Policy



Impulse Response Functions

I evaluate the model presented above up to a first-order approximation. The calibration is the same as in the baseline model. First, I compare the reaction of the model to the baseline framework when a quality-of-capital shock hits the economy. Second, I allow the policymakers to intervene; I let the central banks use direct lending and equity injections as explained in the main text.

No Policy

The results are in figure A1. The dashed line and the solid line are the same as in the main text, the model with global banks and with banks but in financial autarky, respectively. The dotted-dashed line is the model with double financial openness or double flows. The introduction of flows from foreign to home banks does not change the implications of the shock for foreign variables. However, because the foreign economy is relatively big for the home economy, this addition does change the spillover to the home economy.

I plot the net flows from home to foreign, $B_t - J_t$, under the global asset label. As in the previous model, the net flows decrease when foreign is hit by a negative quality-of-capital shock. Home banks decrease how much they lend to foreign because foreign banks are more financially constrained. The decrease in lending to foreign prompts a decrease in the net worth of home banks; it falls more than in the baseline model because net flows shrink more. Home banks are more financially constrained, foreign banks decrease lending to home banks, and this prompts the larger fall in the net international flows. Due to the further fall in home banks' net worth, loans and investment at home collapse. Consumption falls more on impact. Up to a first-order approximation, relaxing the assumption that foreign banks cannot hold claims on home banks prompts a larger spillover from foreign to home.

Policy Response—Unconventional Policy

As in the baseline model, I evaluate the consequences of introducing a central bank that carries out unconventional policy. First, I allow the foreign central bank to lend directly to non-financial firms or to inject equity into banks. The results are in figure A2. Second, I assume that both central banks carry out unconventional policy. The results are in figure A3.

In figure A2, the dotted-dashed line is the same model as in the previous figure: the model with double flows without policy. The dotted line is the model with loan policy carried out by the foreign central bank, and the solid line is the model with equity injections to the foreign banking system. The impact of the foreign policy in the big economy is similar to the baseline framework: the intervention reduces the impact of the shock on the asset price; the net worth of foreign banks falls less on impact and so does investment. Consumption, on the contrary, is hit more with the policy because households are paying for the policy. The home economy benefits from the policy through a lower drop, on impact, of the asset price; investment falls less on impact. The net global asset is also smoother due to the smaller reduction on lending from foreign to home, and so is the net worth. Consumption shows almost no changes.

Figure A2. Impulse Responses to a 5 Percent Decrease in Ψ_t^*, Double Flows Model with Policy by the F Central Bank

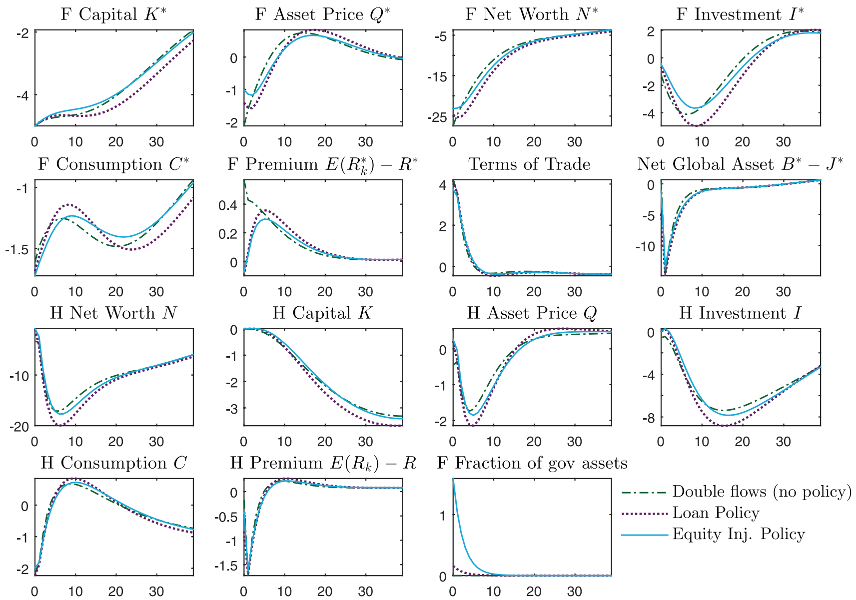
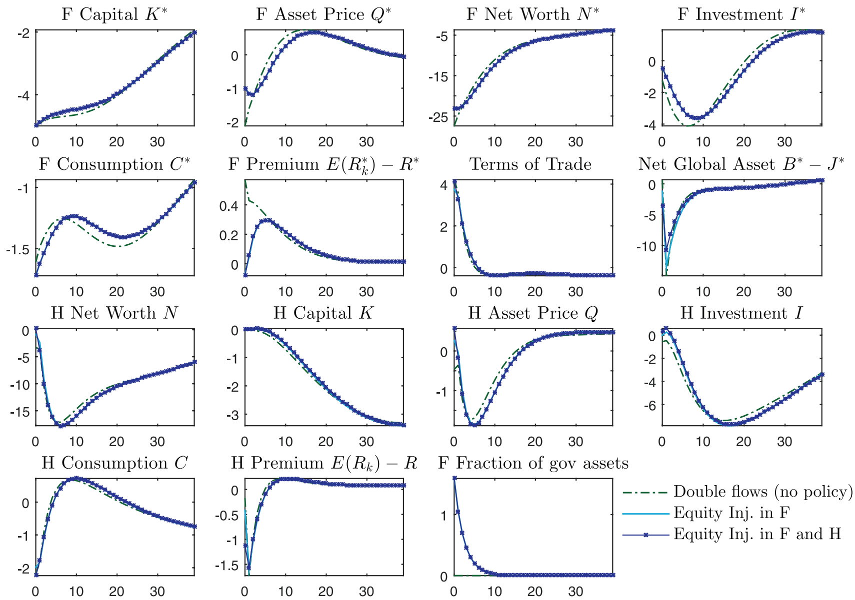


Figure A3 plots the case in which I allow both central banks to carry out unconventional policy—in particular, equity injections. The dotted-dashed and the solid lines are the same as before, the model without policy and with equity injections to the foreign banks, respectively. The solid line with asterisks is the model when both central banks intervene. The foreign economy adopts the policy and has the same reaction as in the previous figure. It seems that the home economy also behaves as in the previous policy, but this is not the case. The net global asset fall less due to a smoother behavior of the home asset price; the last effect also makes investment fall less on impact. Again, home consumption falls slightly more due to the intervention. The home economy presents a milder reaction to the shock when the home central bank carries out unconventional policy than when it does not; the foreign economy does not show major changes.

Figure A3. Impulse Responses to a 5 Percent Decrease in Ψ_t^*, Double Flows Model with Equity Injections by F and H Central Bank



Up to a first-order approximation, the model with double flows behaves in a similar fashion to the model with the assumption that foreign banks cannot hold claims on home banks. Unconventional policies are effective at reducing the impact on home and foreign of a negative quality-of-capital shock in foreign, but less effective than in the baseline model.

Welfare Analysis

As with the baseline model, I evaluate the second-order approximation of the model and the implications of loan market interventions. In this case, for simplicity, I only evaluate the unconditional welfare for one policy; I have shown that for the baseline model the simulations and the unconditional welfare give similar results.

The unconditional welfare results for the double flows model with unconventional policy are in table A2. As in the baseline model,

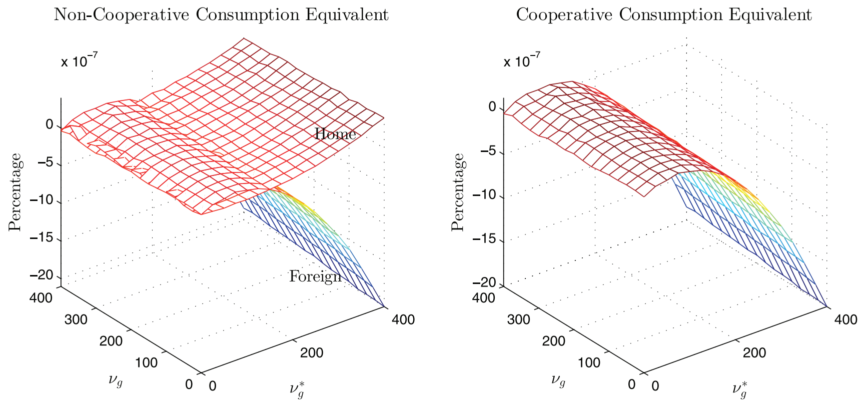
Table A2. Unconditional Moments: Deterministic and Stochastic Steady States Comparison, Policy in F and in H, $\upsilon_g^* = 0.25$ and $\upsilon_g = 0.25$

	Determ.	Stochastic Steady State Ψ*					
		No Policy		Loan Market F		Loan Market F H	
		Mean	SD	Mean	SD	Mean	SD
Y	0.6867	0.6866	0.0027	0.6866	0.0027	0.6867	0.0027
K	5.8471	5.8473	0.0055	5.8466	0.0055	5.8463	0.0055
C	0.4554	0.4553	0.0018	0.4553	0.0018	0.4554	0.0018
L	0.2283	0.2283	0.0028	0.2283	0.0028	0.2283	0.0028
Y^*	0.7622	0.7622	0.0022	0.7622	0.0022	0.7622	0.0022
K^*	6.6490	6.6489	0.0068	6.6489	0.0068	6.6490	0.0068
C^*	0.4436	0.4436	0.0024	0.4436	0.0024	0.4436	0.0024
L^*	0.2628	0.2628	0.0011	0.2628	0.0011	0.2628	0.0011
N	1.9811	1.9805	0.0190	1.9782	0.0190	1.9767	0.0190
N^*	1.6414	1.6412	0.0189	1.6412	0.0189	1.6412	0.0189
TOT	0.9519	0.9519	0.0017	0.9519	0.0017	0.9519	0.0017
Ψ^*	1.0000	1.0000	0.0013	1.0000	0.0013	1.0000	0.0013
B	1.3244	1.0729	0.6396	1.0636	0.6395	1.0652	0.6393
V^*	2.6838	2.6837	0.0065	2.6837	0.0065	2.6838	0.0065
J	0.0019	0.0000	18.0489	0.0000	18.0452	0.0000	18.0402
$\boldsymbol{\varphi}_g^*$				1.0000	0.0000	1.0000	0.0000
CE				−0.0010		−0.0009	
CE^*				0.0001		0.0004	

Notes: All the variables are in levels except for the consumption equivalents, which are in percentages. The first column, "Determ.," corresponds to the deterministic steady state; the third and fourth, "No Policy," are the mean and standard deviation of the stochastic steady state, respectively. The fifth and sixth, "Loan Market F," correspond to the loan market intervention in foreign. The last two columns, "Loan Market F H," are loan market interventions in foreign and home.

intervention implies a reduction in the standard deviation of the variables, which shows in the fifth digit. The intervention is zero at the steady state, and the shock has a very small standard deviation. The message from the intervention carried out only by the foreign central bank is similar to the baseline model: foreign consumers are better off and home consumers are worse off. The mechanism behind this is the same. However, when both central banks intervene, there is a Pareto improvement for the economy, with respect

Figure A4. Unconditional Utility: Non-Cooperative and Cooperative Consumption Equivalents under Quality-of-Capital Shocks in Foreign, Model with Flows from and to the Home Banking Sector



to only foreign intervening. The difference with the baseline model comes from relaxing the assumption that foreign banks cannot lend to home banks, even though in the model with the interventions these flows are reduced to almost zero. The intervention carried out by the home central bank does not hurt foreign consumers because they get the benefits from the loans that foreign banks hold in their balance sheet; the value of the foreign financial intermediaries, $V*$, is higher when both central banks intervene.

Non-Cooperative vs. Cooperative Policies

Finally, I evaluate the cooperation across countries. In the baseline model, the Nash equilibrium resulted in both central banks intervening, while the cooperative equilibrium implied that only the foreign central bank would intervene, while the home policymaker would do nothing. However, this was not Pareto improvement.

The results regarding the consumption equivalent for different levels of intervention are in figure A4. On the one hand, home intervention does not affect much the welfare of either foreign or home consumers. Home consumption equivalent increases very little when home intervenes, and foreign consumption equivalent also increases with home policy; this is the difference with the baseline model, in which home intervention would benefit home consumers but hurt foreign households. In this model, home policy benefits both countries. On the other hand, foreign intervention is much more effective. With low values, foreign consumers' welfare improves. However, when the intervention is aggressive, the foreign consumption equivalent falls due to the costs. Home consumers take advantage of the foreign intervention and their welfare improves. Then, the Nash equilibrium results in both central banks intervening, as we can see in the left-hand-side panel of the figure. The cooperative equilibrium, the sum of both welfares weighted by the countries' population, implies an active foreign and home central bank. This result is different from the baseline model because now, home policy benefits foreign consumers.

Relaxing the assumption that foreign financial intermediaries are not allowed to lend to home banks does not change, in general terms, the non-cooperative result: both central banks are active. This is the case because the net international flows are positive for the home economy, as in the baseline model. The difference with Dedola, Karadi, and Lombardo (2013) comes from the assumption of a relatively small economy, rather than two economies of similar size, and the effects of the real exchange rate that they abstract from. Nevertheless, the cooperative equilibrium in this model is different from the baseline one.

Appendix 6. Unconditional Welfare

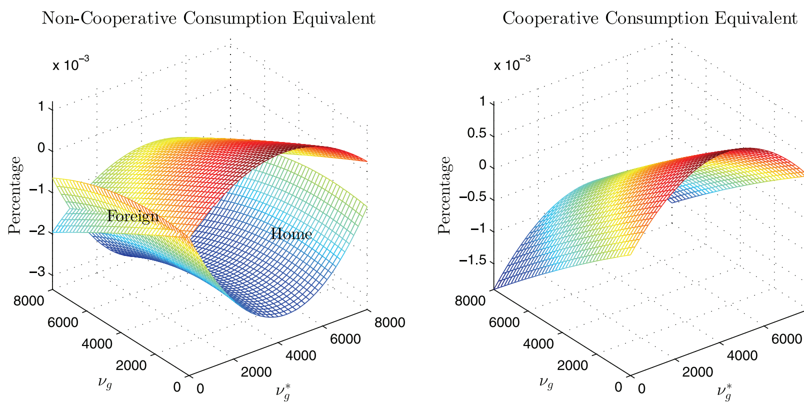
For comparison with the previous literature, I look at the unconditional moments of the second-order approximation of the model; the results are in table A3. Given that the volatility of the shock matches the volatility generated by the Poisson distribution, the size of the disturbance is very small and prompts a small reaction of the variables. In this case, it is the ergodic distribution of the variables' given positive and negative shocks which prompts negative and positive interventions, respectively. The government intervenes in every period using its unconventional policy. In comparison with the conditional moments, two aspects are relevant. First, the policies help reduce the volatility of the variables, as in the previous case. This is a very small difference that appears in the fifth digit. Second, the

Table A3. Unconditional Moments: Deterministic and Stochastic Steady States Comparison, Policy in F

	Determ.	Stochastic Steady State Ψ*							
		No Policy		**Loan Market**		**Intb. Market**		**Equity Injections**	
		Mean	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**
Y	0.7093	0.7124	0.0047	0.7124	0.0047	0.7123	0.0047	0.7123	0.0047
K	6.0671	6.0702	0.0018	6.0702	0.0018	6.0701	0.0018	6.0701	0.0018
C	0.4697	0.4723	0.0058	0.4723	0.0058	0.4722	0.0058	0.4722	0.0058
L	0.2295	0.2285	0.0048	0.2285	0.0048	0.2285	0.0048	0.2285	0.0048
Y^*	0.7612	0.7611	0.0022	0.7611	0.0022	0.7611	0.0022	0.7611	0.0022
K^*	6.6389	6.6393	0.0067	6.6393	0.0067	6.6393	0.0067	6.6393	0.0067
C^*	0.4430	0.4429	0.0024	0.4429	0.0024	0.4429	0.0024	0.4429	0.0024
L^*	0.2627	0.2628	0.0013	0.2628	0.0013	0.2628	0.0013	0.2628	0.0013
N	1.9806	2.0400	0.0317	2.0400	0.0317	2.0381	0.0317	2.0379	0.0317
N^*	1.6402	1.6381	0.0188	1.6381	0.0187	1.6382	0.0187	1.6382	0.0187
TOT	0.8274	0.8094	0.0232	0.8095	0.0232	0.8100	0.0232	0.8101	0.0232
Ψ^*	1.0000	1.0000	0.0013	1.0000	0.0013	1.0000	0.0013	1.0000	0.0013
B	1.1942	1.4604	0.2357	1.4602	0.2357	1.4502	0.2357	1.4490	0.2357
V^*		2.6785	0.0068	2.6785	0.0068	2.6786	0.0068	2.6786	0.0068
ϕ_g^*				1.0001	0.0000	1.0001	0.0000	1.0001	0.0000
CE				−0.0006		−0.0315		−0.0349	
CE^*				0.0001		0.0016		0.0017	

Notes: All the variables are in levels except for the consumption equivalents, which are in percentages.

Figure A5. Unconditional Utility: Non-Cooperative and Cooperative Consumption Equivalents under Quality-of-Capital Shocks in Foreign



ranking of the policies according to the consumption equivalent of foreign consumers is the opposite.

In the unconditional stochastic steady state, the policies prompt a higher price of the asset price, which is translated into a higher value of the foreign banks. This prompts an increase in domestic deposits and a reduction of loans from home banks. The terms of trade appreciate for foreign and depreciate for home. Then, foreign households consume more and work less; they are better off. Home households consume less and work more; they are worse off. These results are similar to the ones presented in the main text with the simulations.

I continue with the robustness checks. I plot the interactions between the two policymakers under the unconditional utility in figure A5. As in the results with the simulations, the Nash equilibrium implies active policymakers in both countries and the cooperative equilibrium where the foreign authority intervenes, while the home central bank does nothing.

Appendix 7. Additional Tables on Welfare

Table A4. Deterministic and Stochastic Steady States Comparison: Policy in F, $v_g^* = 100$

	Determ.	Stochastic Steady State Ψ^*							
		No Policy		Loan Market		Intb. Market		Equity Injections	
		Mean	SD	Mean	SD	Mean	SD	Mean	SD
K	6.0671	6.0569	0.0016	6.0260	0.0021	6.0261	0.0021	6.0261	0.0021
C	0.4697	0.4714	0.0036	0.4695	0.0012	0.4696	0.0012	0.4696	0.0012
L	0.2295	0.2286	0.0031	0.2290	0.0009	0.2290	0.0009	0.2290	0.0009
K^*	6.6389	6.6013	0.0063	6.6038	0.0063	6.6029	0.0062	6.6027	0.0062
C^*	0.4430	0.4420	0.0022	0.4421	0.0022	0.4421	0.0022	0.4421	0.0022
L^*	0.2627	0.2628	0.0012	0.2628	0.0013	0.2628	0.0013	0.2628	0.0013
N	1.9806	2.0349	0.0196	1.9514	0.0059	1.9520	0.0058	1.9521	0.0058
N^*	1.6402	1.6228	0.0183	1.6526	0.0189	1.6539	0.0186	1.6540	0.0186
TOT	0.8274	0.8139	0.0149	0.8223	0.0057	0.8223	0.0056	0.8223	0.0057
Ψ^*	1.0000	0.9999	0.0013	0.9999	0.0013	0.9999	0.0013	0.9999	0.0013
B	1.1942	1.5362	0.1474	1.2815	0.0384	1.2820	0.0385	1.2822	0.0386
V^*	2.6829	2.6627	0.0064	2.6709	0.0062	2.6705	0.0061	2.6704	0.0061
φ_g^*				1.0001	0.0003	1.0001	0.0003	1.0001	0.0003
CE				−0.8695		−0.8700		−0.8696	
CE^*				0.0170		0.0138		0.0132	

Notes: All the variables are in levels except for the consumption equivalents, which are in percentages.

Table A5. Deterministic and Stochastic Steady States Comparison: Technology, Government Expenditure, and Quality-of-Capital Shocks

	Determ.	Stochastic Steady State Ψ, Ψ^*, A, A^*, G, and G^* Shocks							
		No Policy		Loan Market		Intb. Market		Equity Injections	
		Mean	SD	Mean	SD	Mean	SD	Mean	SD
K	6.0671	6.0269	0.0247	5.9938	0.0248	5.9960	0.0247	5.9960	0.0247
C	0.4697	0.4691	0.0110	0.4672	0.0112	0.4673	0.0112	0.4673	0.0112
L	0.2295	0.2293	0.0138	0.2297	0.0139	0.2297	0.0139	0.2297	0.0139
K^*	6.6389	6.5836	0.0311	6.5843	0.0313	6.5853	0.0311	6.5853	0.0311
C^*	0.4430	0.4418	0.0144	0.4418	0.0145	0.4419	0.0144	0.4419	0.0144
L^*	0.2627	0.2627	0.0205	0.2627	0.0204	0.2627	0.0205	0.2627	0.0205
N	1.9806	1.9743	0.0632	1.8914	0.0641	1.8930	0.0641	1.8930	0.0641
N^*	1.6402	1.6176	0.0924	1.6466	0.0925	1.6490	0.0924	1.6490	0.0924
TOT	0.8274	0.8240	0.0314	0.8324	0.0320	0.8325	0.0319	0.8325	0.0319
Ψ^*	1.0000	0.9999	0.0013	0.9999	0.0013	0.9999	0.0013	0.9999	0.0013
B	1.1942	1.2559	0.0748	1.0466	0.0989	1.0458	0.0990	1.0459	0.0990
V^*	2.6829	2.6604	0.0299	2.6680	0.0301	2.6683	0.0299	2.6683	0.0299
ϕ_g^*				1.0001	0.0006	1.0001	0.0006	1.0001	0.0006
CE				−0.8802		−0.8802		−0.8801	
CE^*				0.0016		0.0141		0.0140	

Notes: All the variables are in levels except for the consumption equivalents, which are in percentages.

Table A6. Deterministic and Stochastic Steady States Comparison: Policy in F and H, $\upsilon_g^* = 100$ and $\upsilon_g = 100$

		Stochastic Steady State Ψ*							
		No Policy		Loan Market		Intb. Market		Equity Injections	
	Determ.	Mean	SD	Mean	SD	Mean	SD	Mean	SD
K	6.0671	6.0569	0.0016	6.0304	0.0020	6.0303	0.0019	6.0301	0.0019
C	0.4697	0.4714	0.0036	0.4698	0.0015	0.4698	0.0015	0.4698	0.0015
L	0.2295	0.2286	0.0031	0.2289	0.0012	0.2289	0.0012	0.2289	0.0012
K^*	6.6389	6.6013	0.0063	6.6043	0.0062	6.6027	0.0062	6.6025	0.0062
C^*	0.4430	0.4420	0.0022	0.4421	0.0022	0.4421	0.0022	0.4421	0.0022
L^*	0.2627	0.2628	0.0012	0.2628	0.0013	0.2628	0.0013	0.2628	0.0013
N	1.9806	2.0349	0.0196	1.9682	0.0074	1.9689	0.0075	1.9691	0.0075
N^*	1.6402	1.6228	0.0183	1.6525	0.0186	1.6535	0.0186	1.6536	0.0186
TOT	0.8274	0.8139	0.0149	0.8210	0.0068	0.8209	0.0069	0.8209	0.0069
Ψ^*	1.0000	0.9999	0.0013	0.9999	0.0013	0.9999	0.0013	0.9999	0.0013
B	1.1942	1.5362	0.1474	1.3174	0.0545	1.3187	0.0551	1.3190	0.0553
V^*	2.6829	2.6627	0.0063	2.6706	0.0061	2.6699	0.0061	2.6698	0.0061
φ_g^*				1.0001	0.0003	1.0001	0.0003	1.0001	0.0003
φ_g				1.0000	0.0001	1.0000	0.0001	1.0000	0.0001
CE				−0.7433		−0.7409		−0.7402	
CE^*				0.0120		0.0071		0.0065	

Notes: All the variables are in levels except for the consumption equivalents, which are in percentages.

Appendix 8. Additional Figures

Figure A6. Impulse Responses to a 5 Percent Decrease in Ψ_t^*, Comparison across Models without Policy Intervention, More Variables

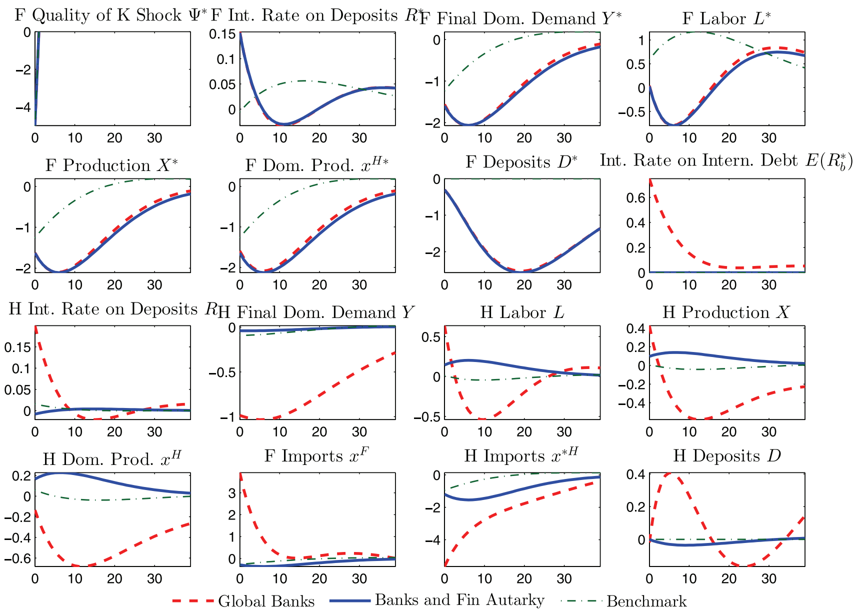


Figure A7. Impulse Responses to a 5 Percent Decrease in Ψ_t^*, Unconventional Policies by F Central Bank

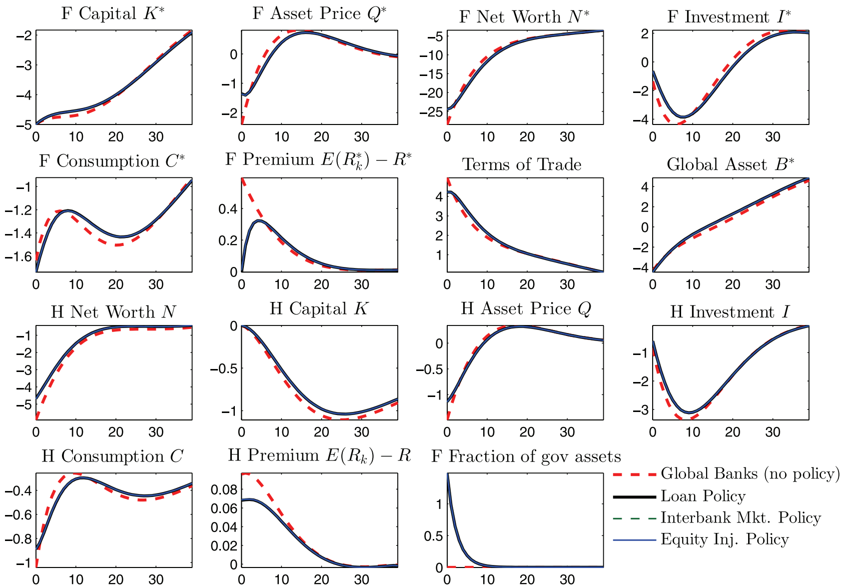


Figure A8. Impulse Responses to a 5 Percent Decrease in Ψ_t^*, Unconventional Policies by F Central Bank, More Variables

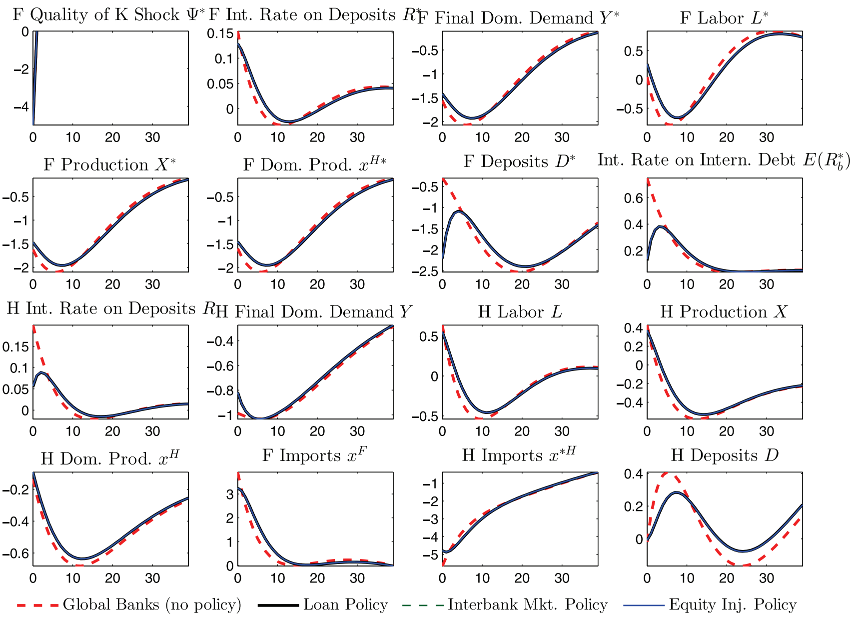


Figure A9. Impulse Responses to a 5 Percent Decrease in Ψ_t^*, Loan Market Intervention by F and H Central Bank

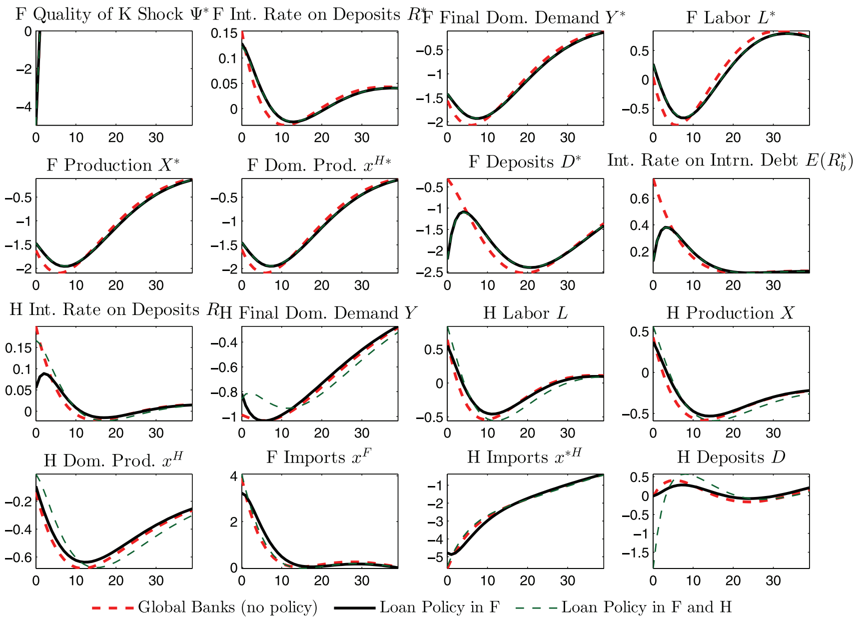


Figure A10. Impulse Responses to a 5 Percent Decrease in Ψ_t^*, Unconventional Policies by F and H Central Bank

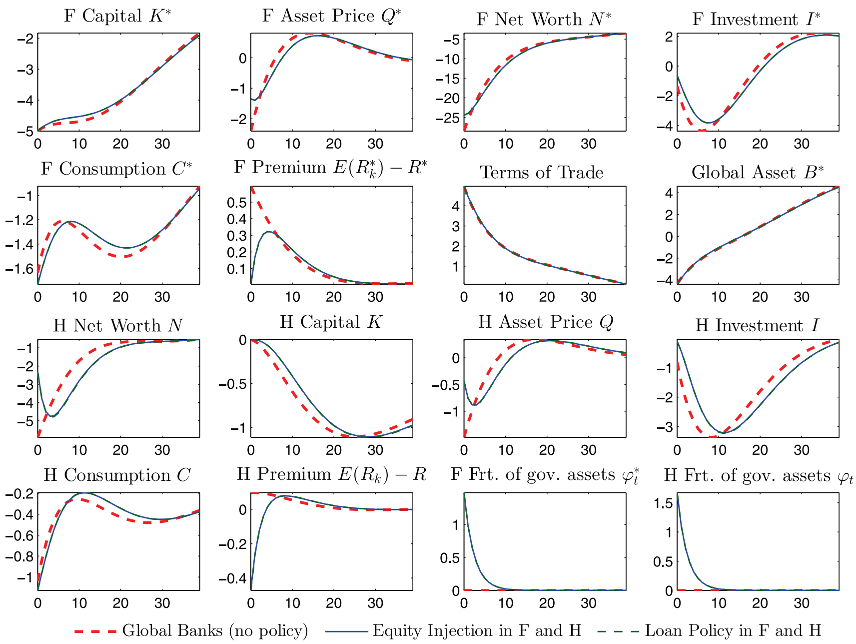


Figure A11. Impulse Responses to a 5 Percent Decrease in Ψ_t^*, Unconventional Policies by F and H Central Bank, More Variables

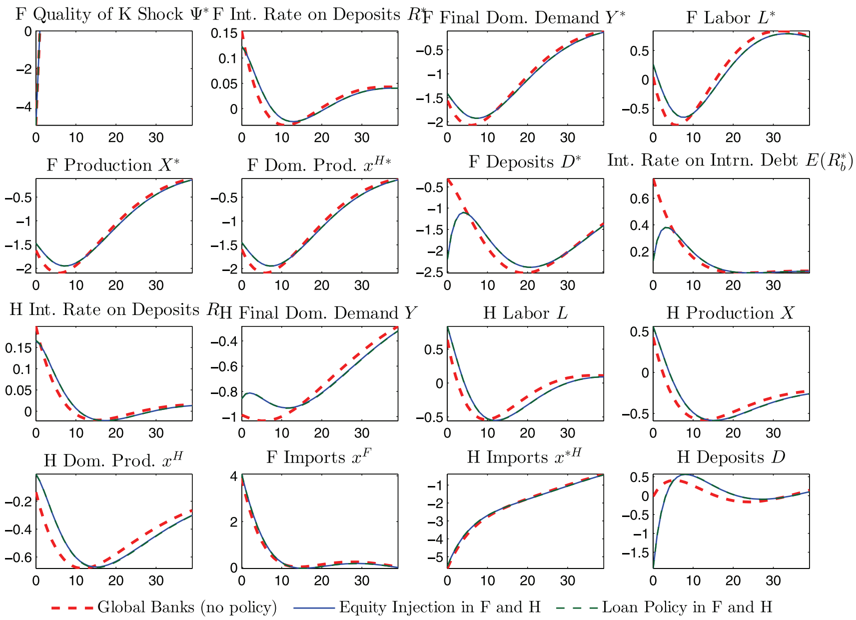
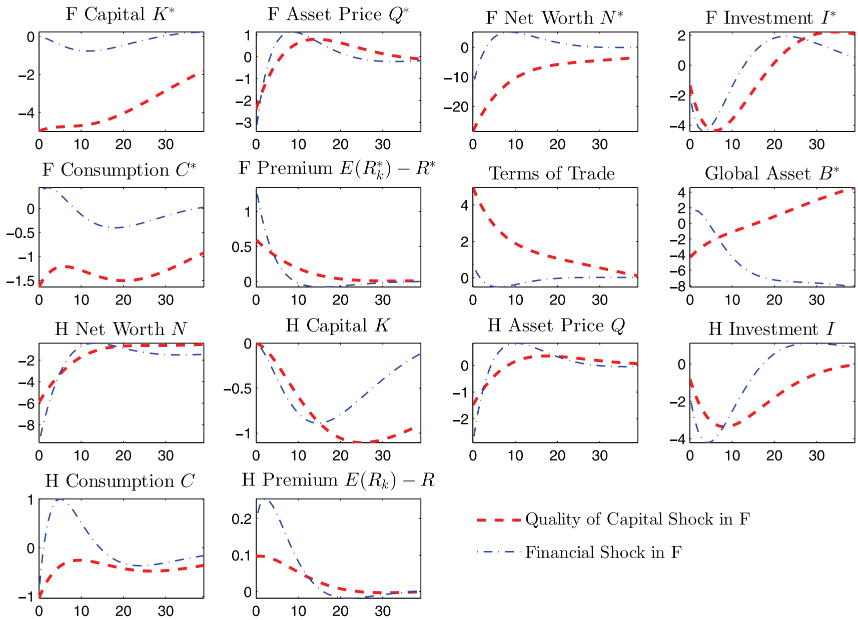


Figure A12. Comparison between a Quality-of-Capital Shock and a Financial Shock



Reference

Dedola, L., P. Karadi, and G. Lombardo. 2013. "Global Implications of National Unconventional Policies." *Journal of Monetary Economics* 60 (1): 66–85.