Capital Flows and the Risk-Taking Channel of Monetary Policy

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A Popular Narrative

- *"Low interest rates maintained by advanced economy central banks are key drivers of*
  - *Cross-border capital flows to emerging economies*
  - *Credit booms and overheating for capital recipient economies*
  - *Overshooting of real exchange rates"*

- Are these claims true?

- What are the mechanisms?

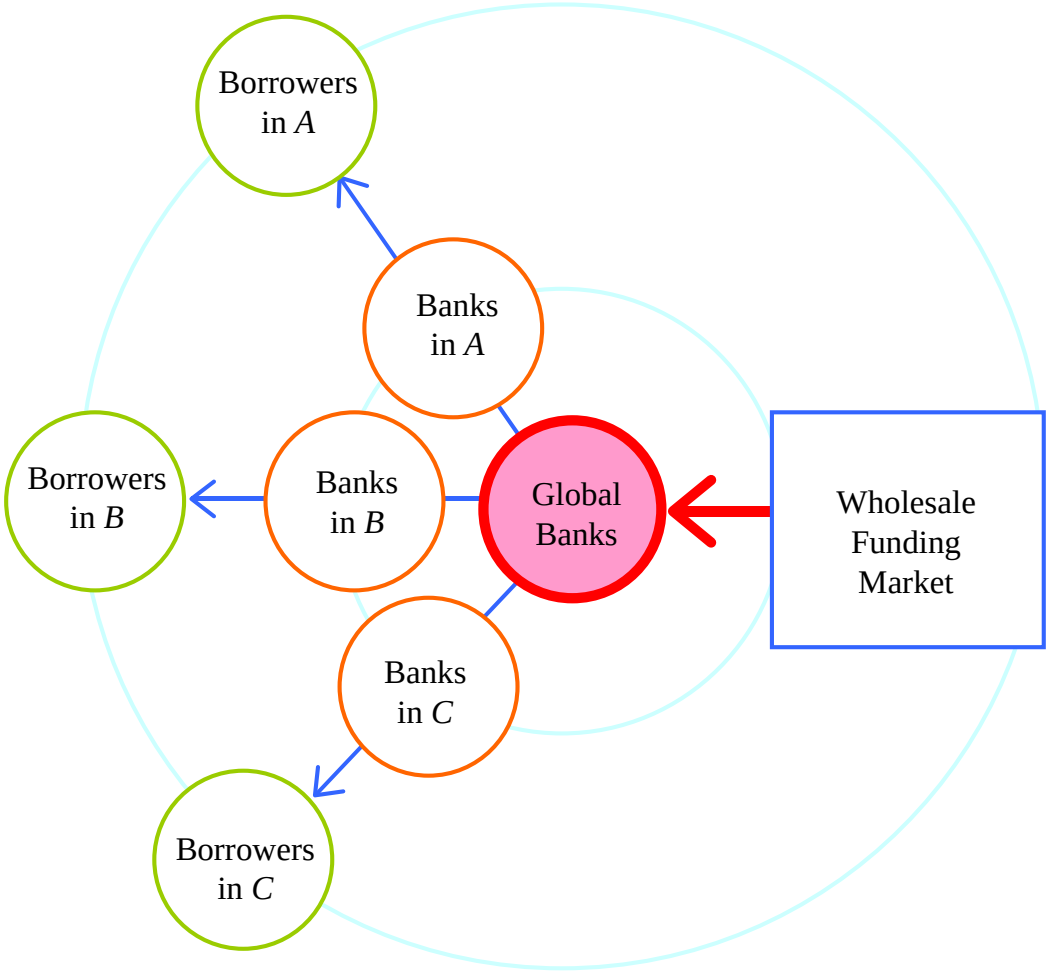


Figure 1. Topography of global liquidity

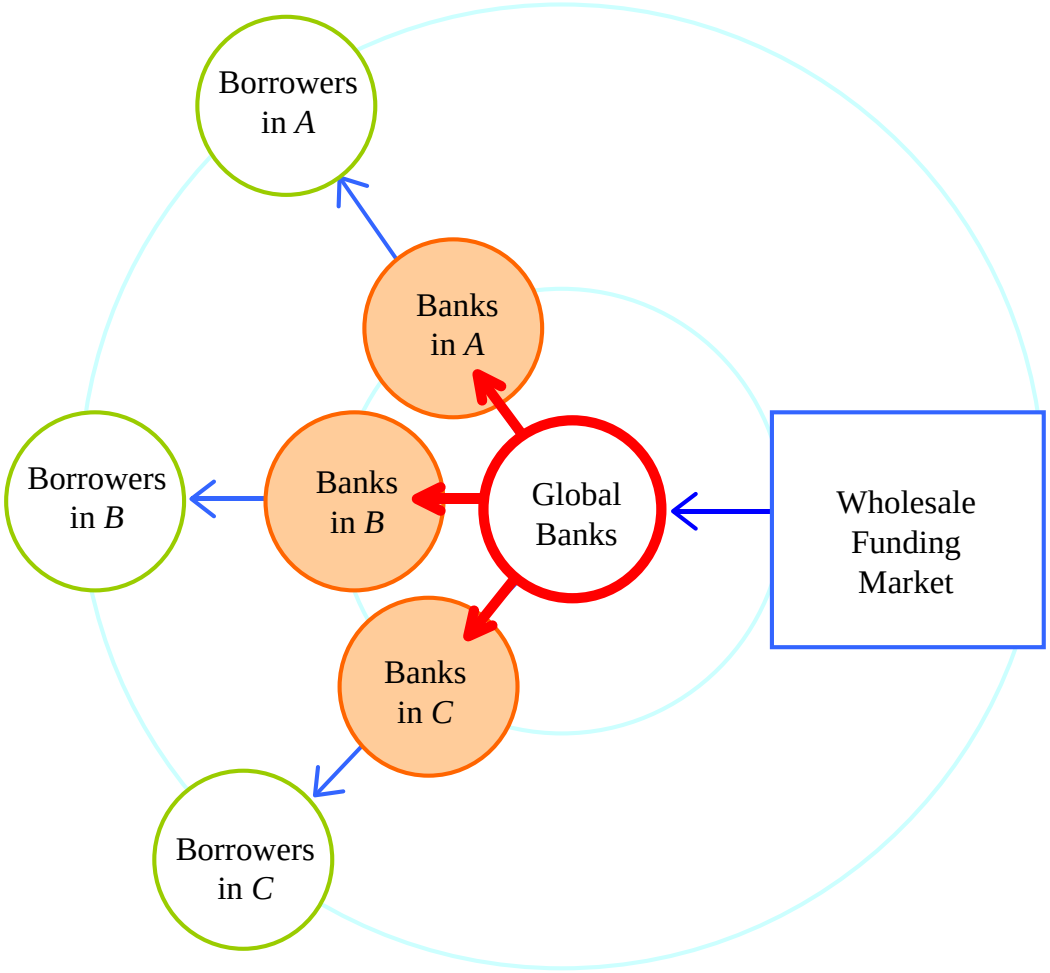


Figure 2. Topography of global liquidity

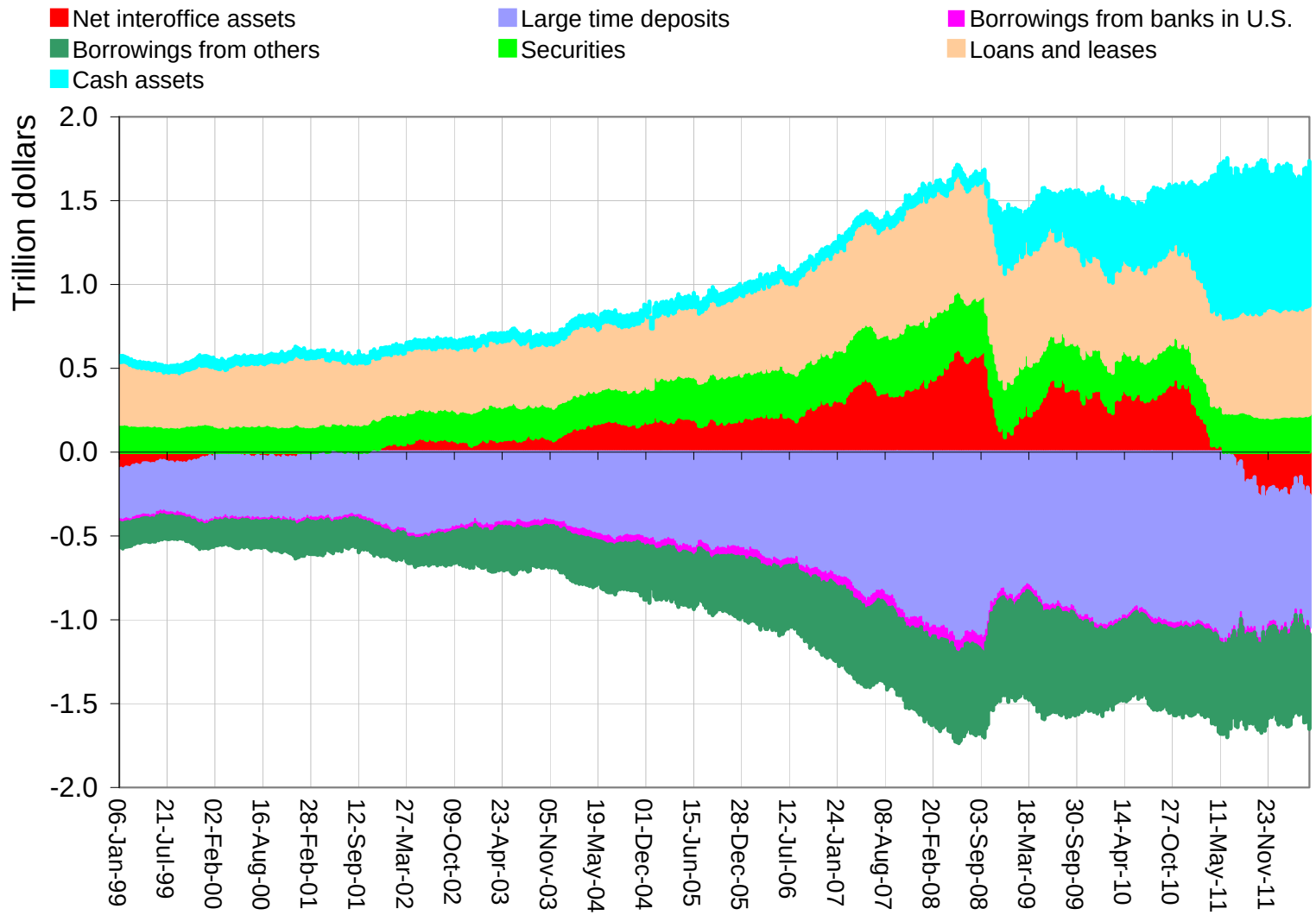


Figure 3. Assets and liabilities of foreign banks in the U.S. (Source: Federal Reserve H8 weekly series on assets and liabilities of foreign-related institutions)

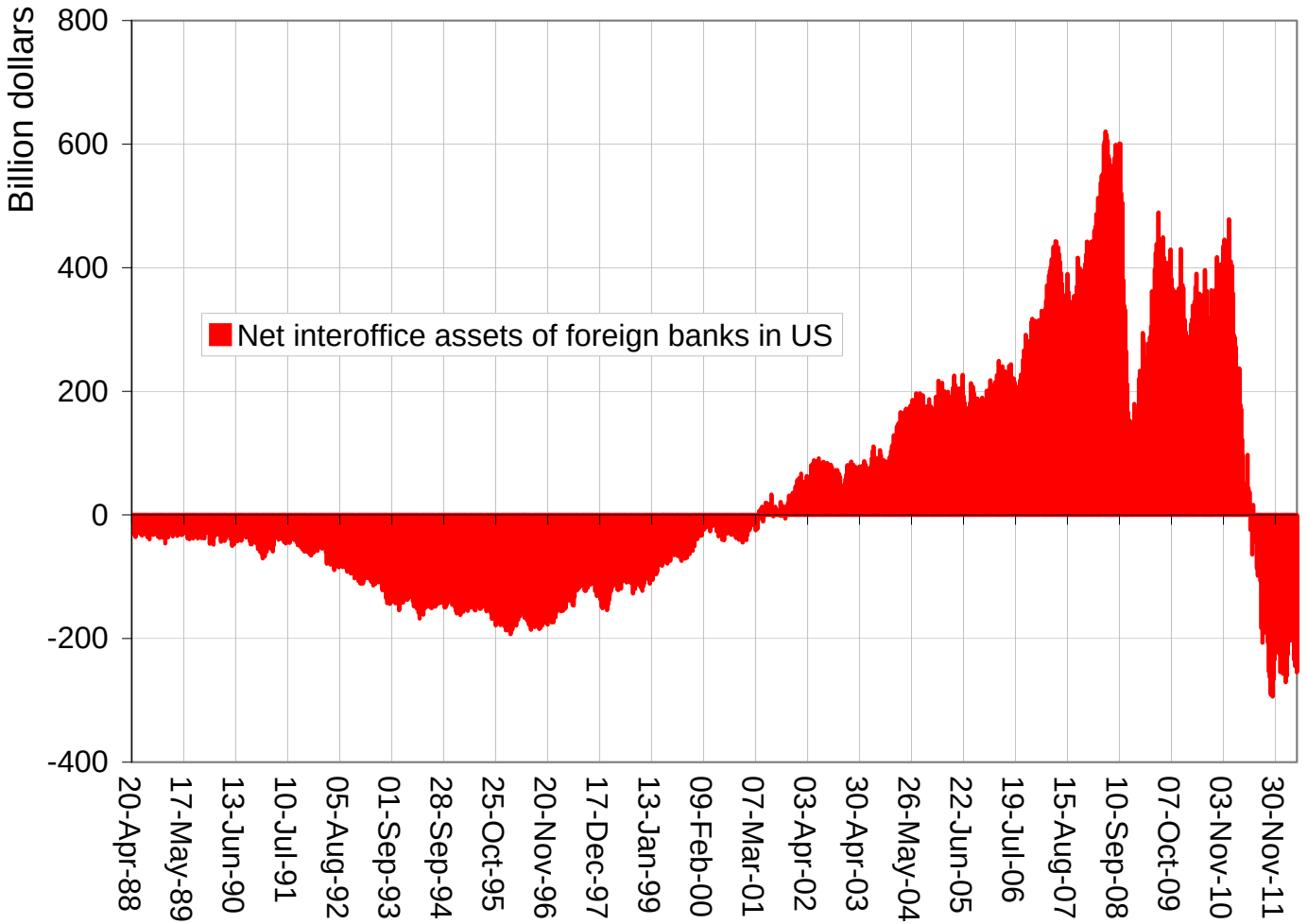


Figure 4. Net interoffice assets of foreign banks in U.S. given by negative of Federal Reserve weekly H8 series on "net due to related foreign offices of foreign-related institutions"

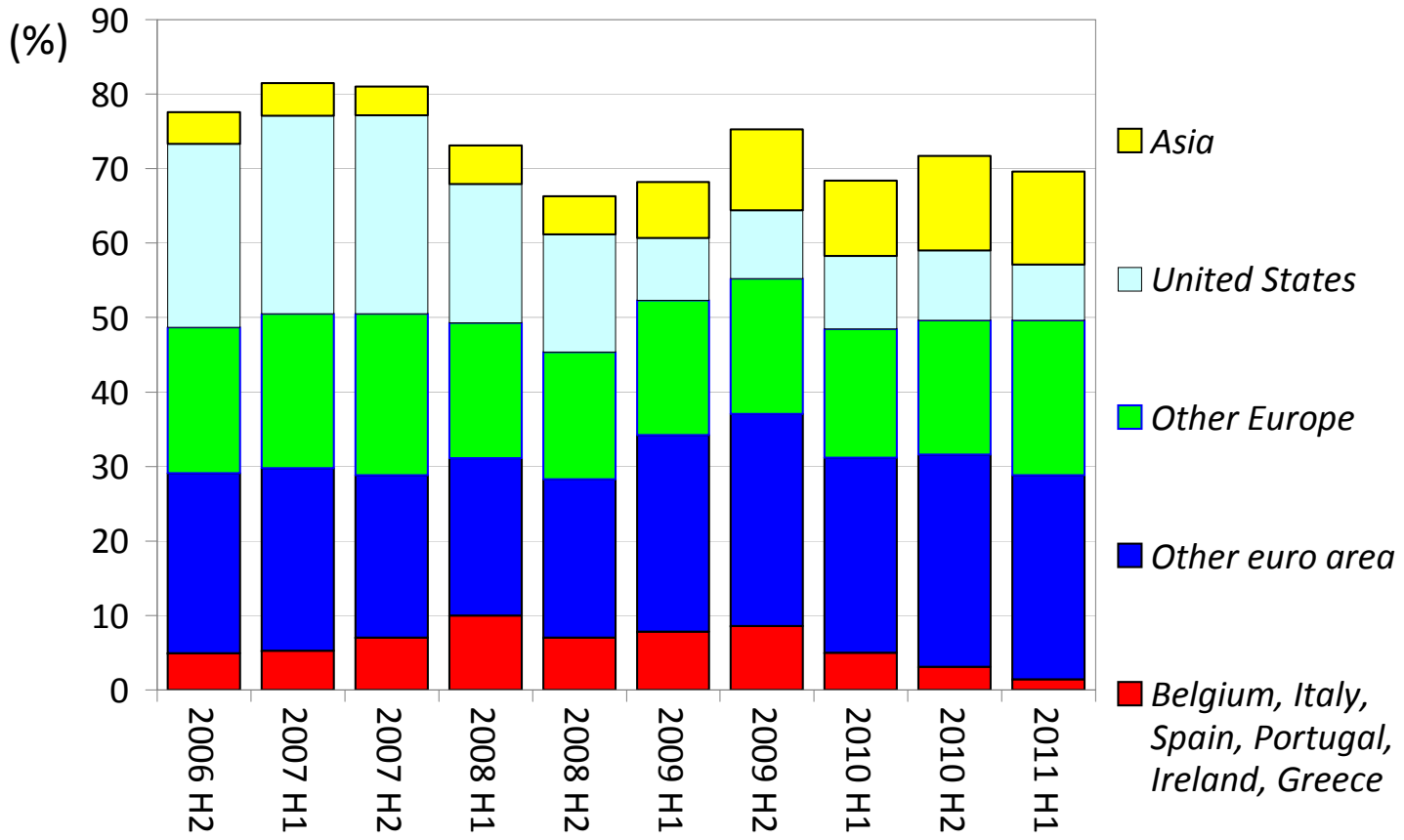


Figure 5. Amount owed by banks to US prime money market funds (% of total), based on top 10 prime MMFs, representing $755 bn of $1.66 trn total prime MMF assets (Source: IMF GFSR Sept 2011, data from Fitch).

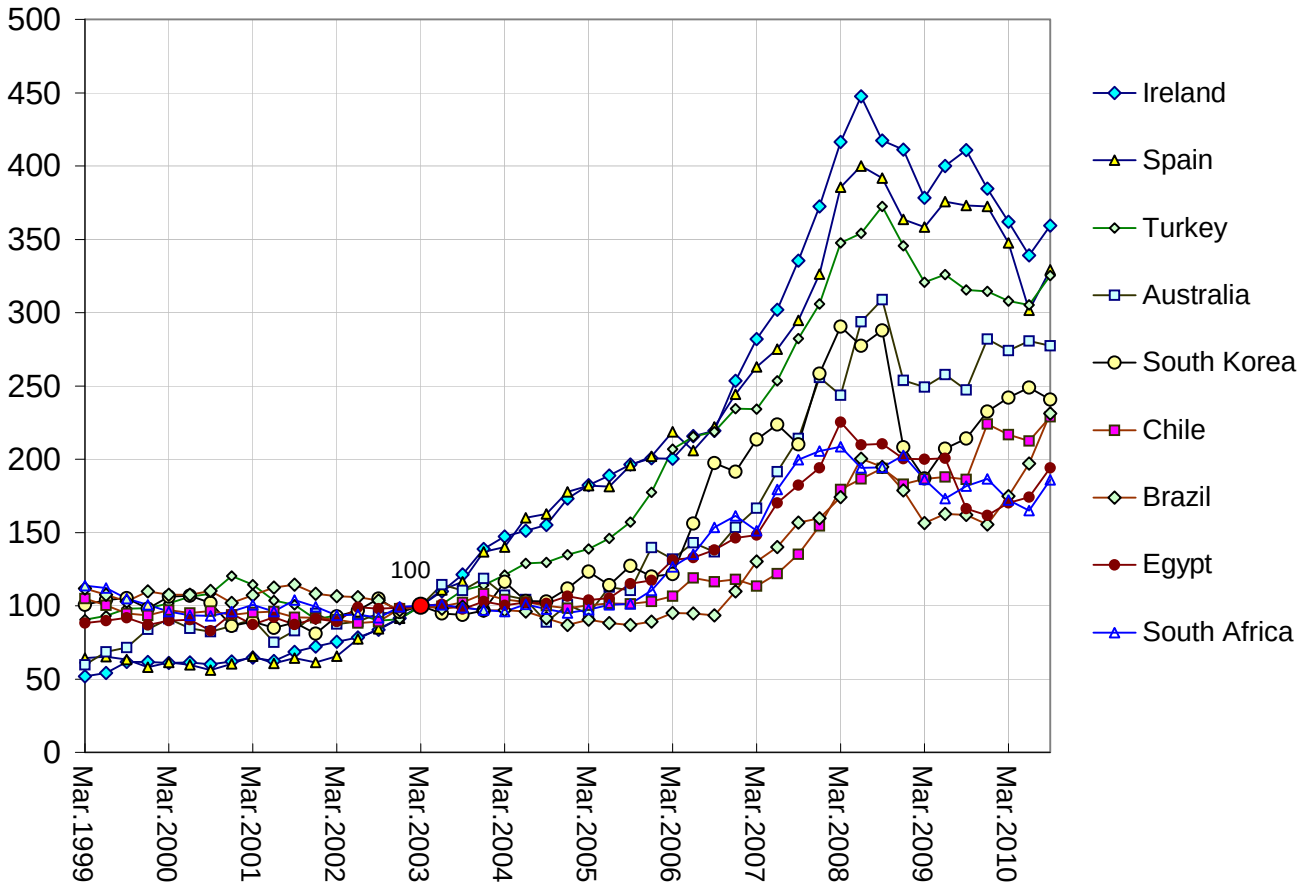


Figure 6. External claims (loans and deposits) of BIS reporting banks on counterparties listed on right (Source: BIS locational banking statistics Table 7A)

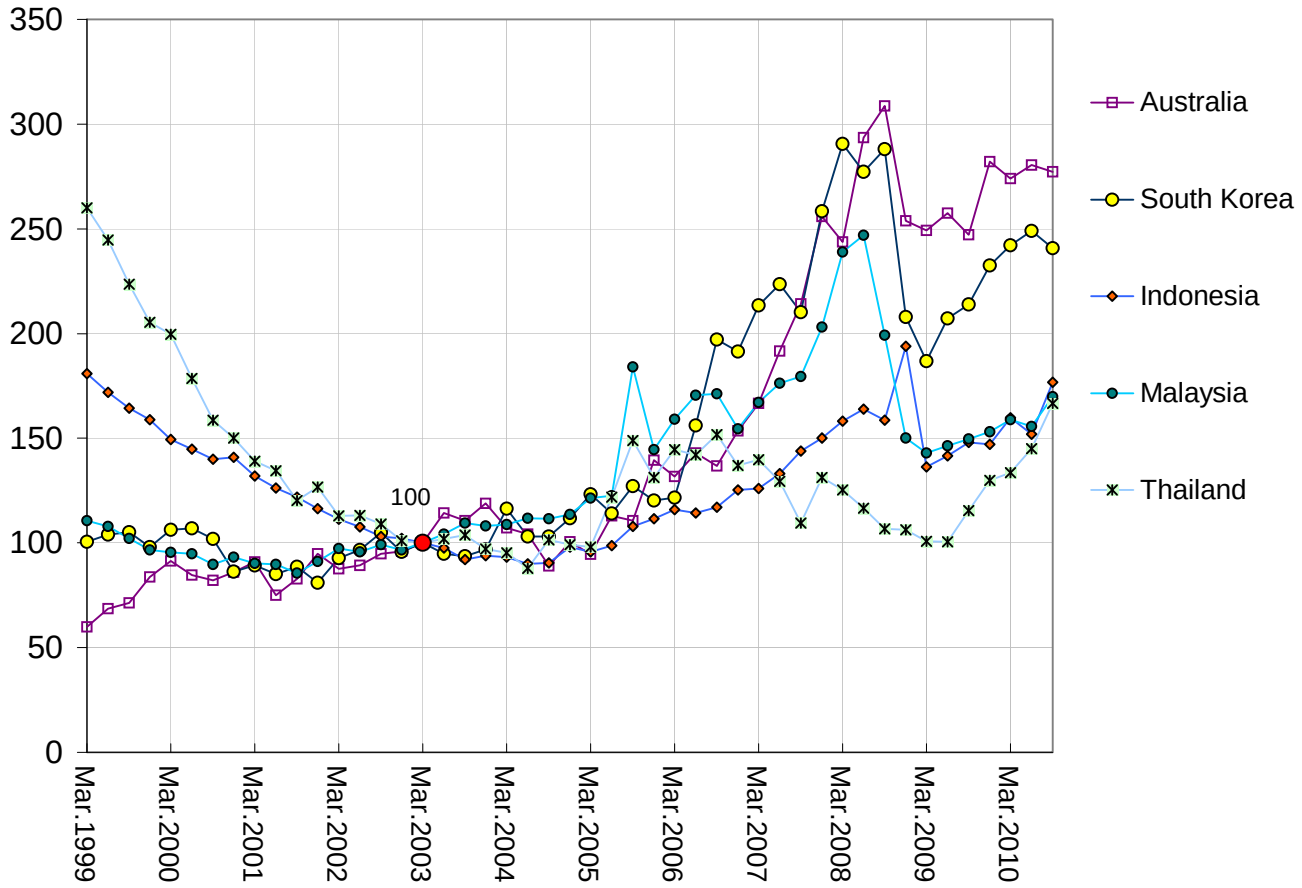


Figure 7. External claims (loans and deposits) of BIS reporting banks on counterparties listed on right (Source: BIS locational banking statistics Table 7A)

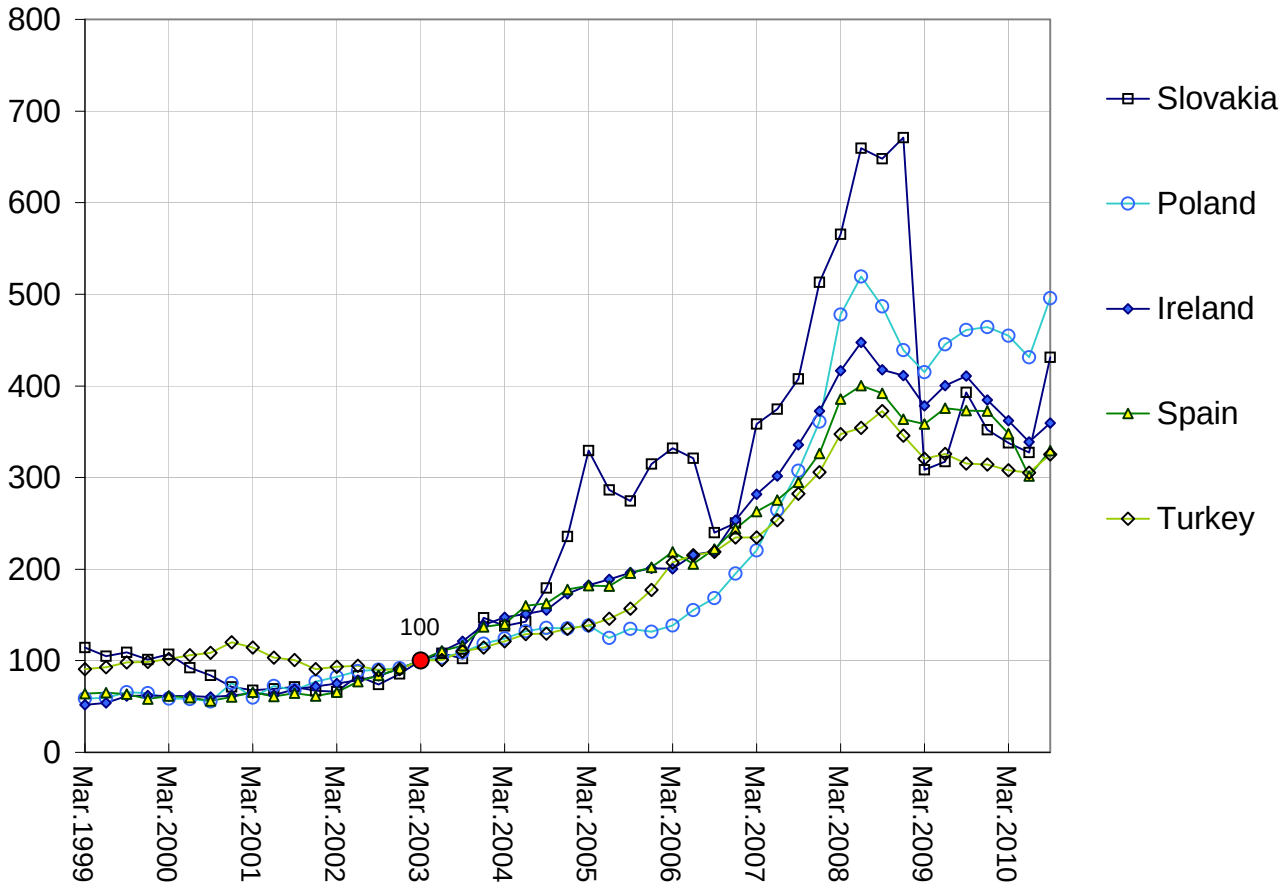


Figure 8. External claims (loans and deposits) of BIS reporting banks on counterparties listed on right (Source: BIS locational banking statistics Table 7A)

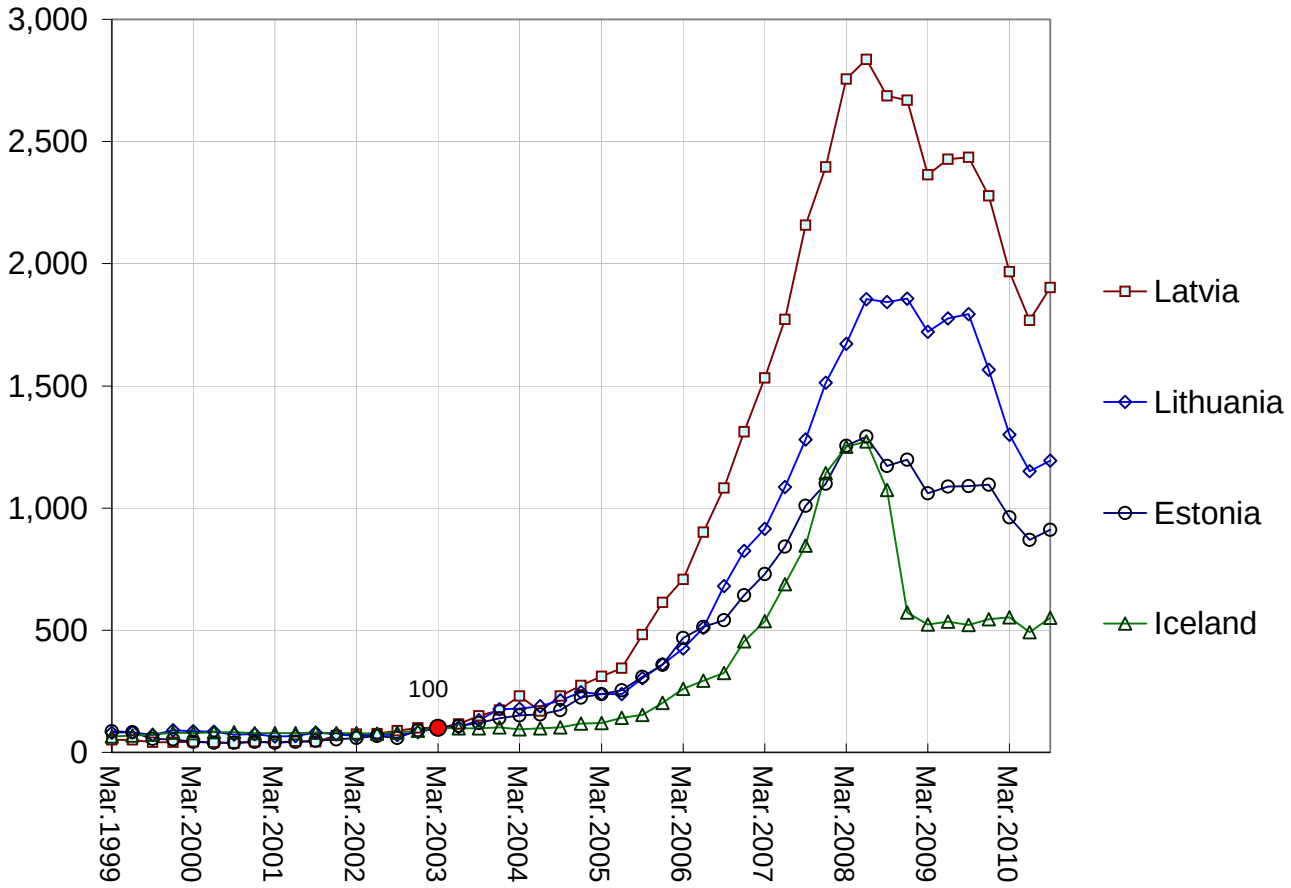


Figure 9. External claims (loans and deposits) of BIS reporting banks on counterparties listed on right (Source: BIS locational banking statistics Table 7A)

Risk-Taking Channel

- Pivotal role of banking sector
  - Short-term interest rates and term premium
- Leverage cycle
  - Expansion phase driven by low measured risks
  - Measured risks are dampened during expansions
  - "Excess elasticity" (Borio and Disyatat (2011))
- Global liquidity
  - US dollar wholesale bank funding market
  - European global banks
  - Monetary policy spillovers

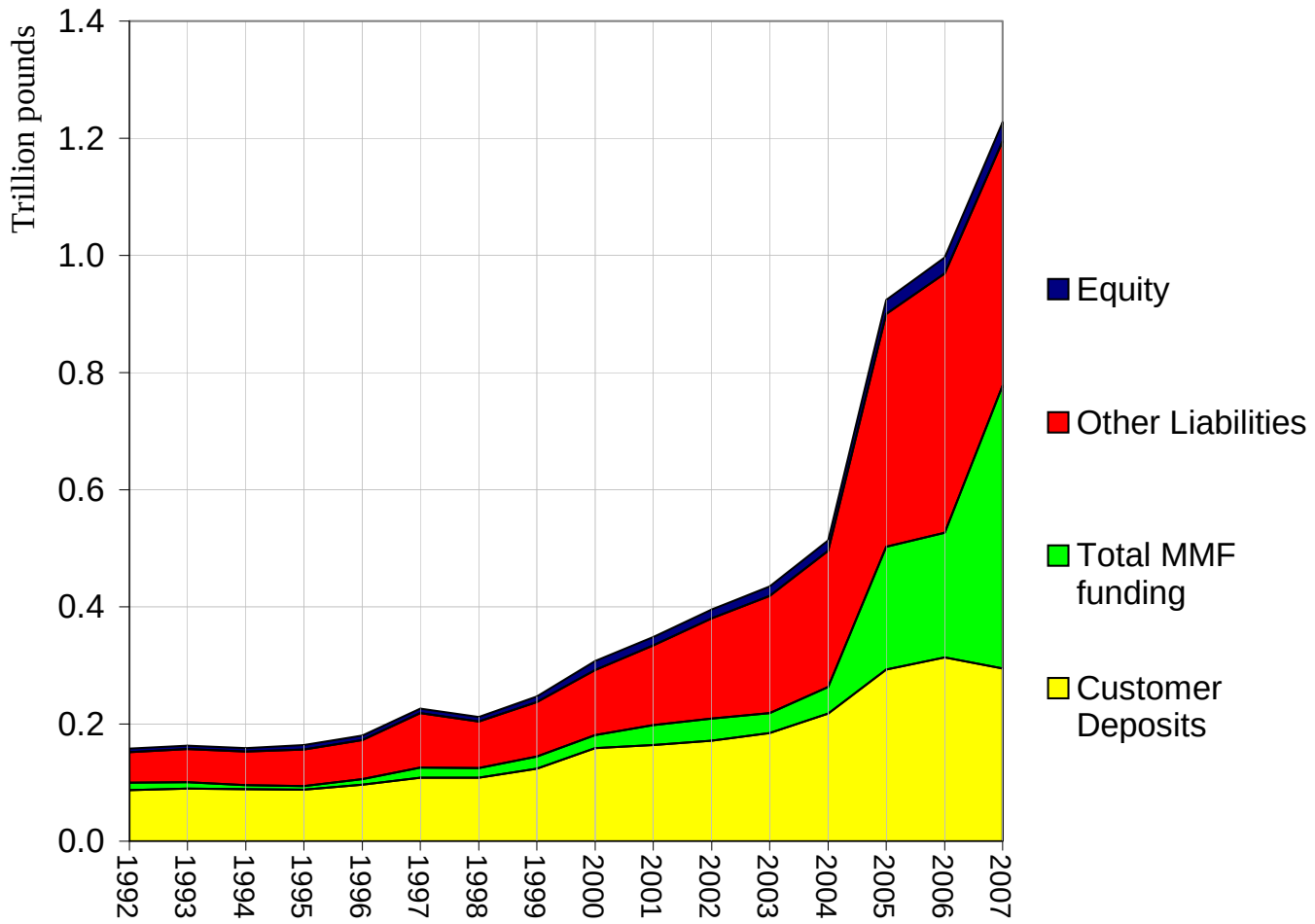


Figure 10. Total Liabilities of Barclays (1992 - 2007) (Source: Bankscope)

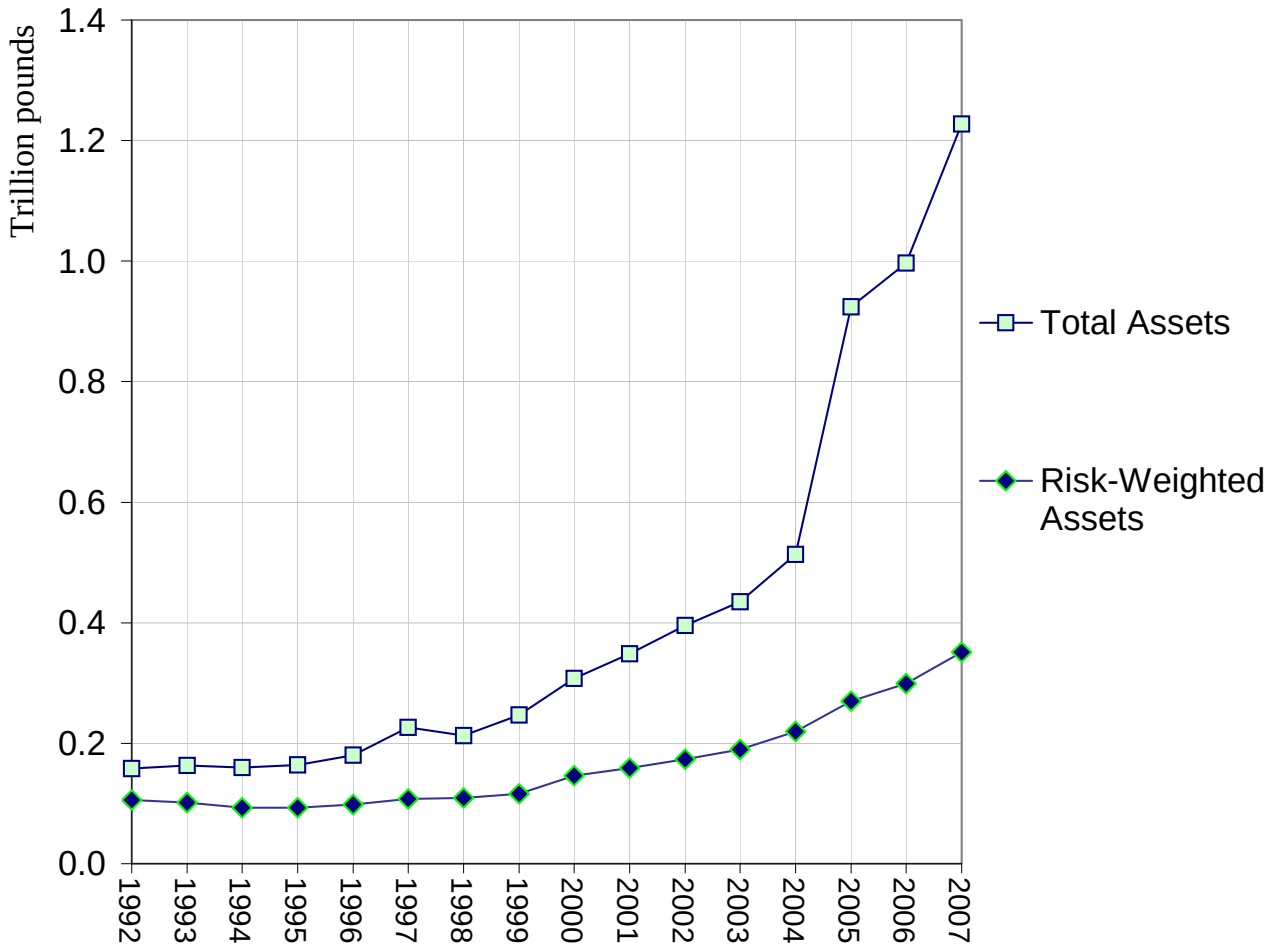


Figure 11. Barclays, risk-weighted assets and total assets (Source: Bankscope)

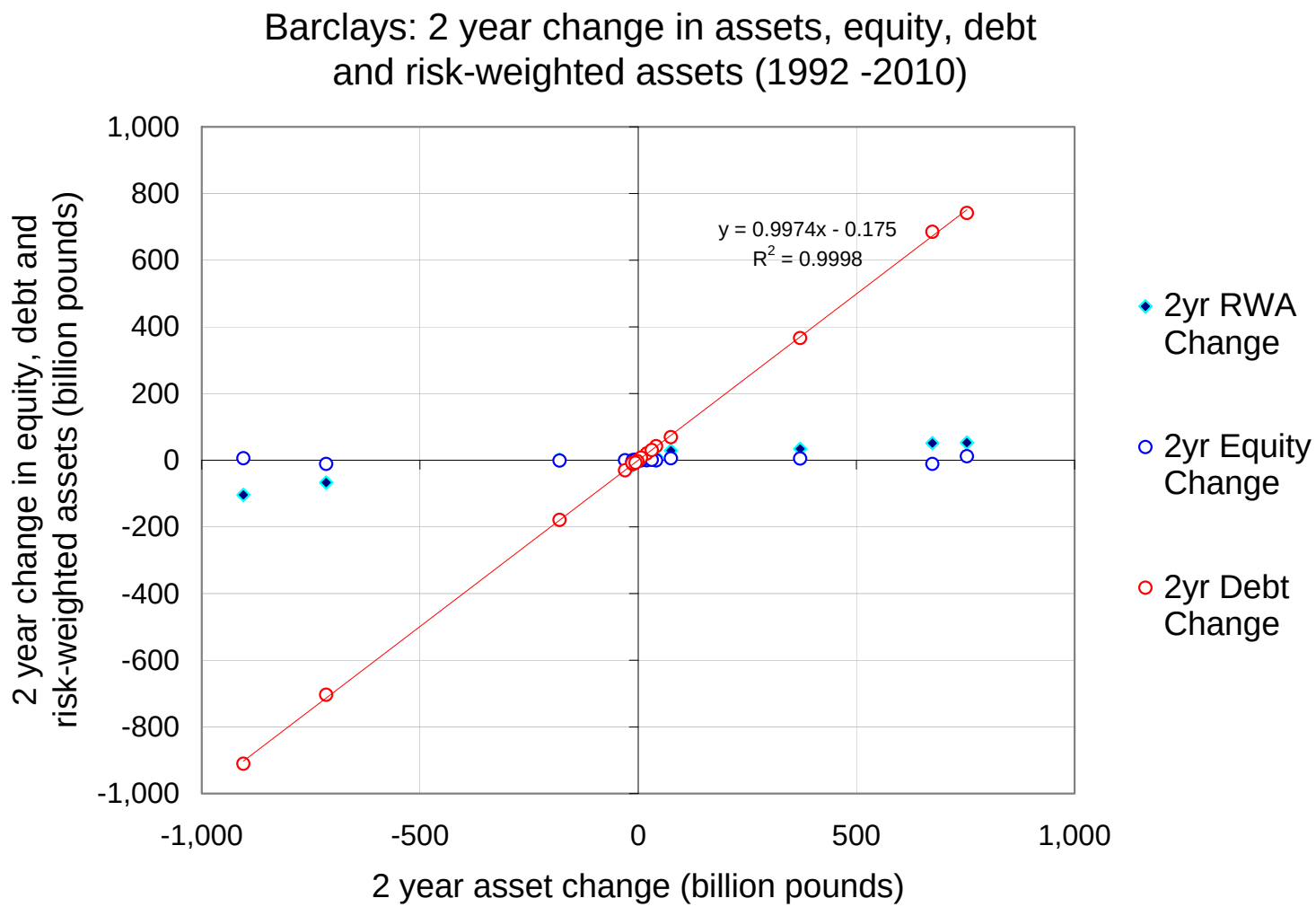


Figure 12. Barclays: 2 year change in assets, equity and debt (1992-2010) (Source: Bankscope)

Credit Supply Model

- Vasicek credit risk model (backbone of Basel II)
- Turn on its head as *credit supply model*
  - Given sticky equity, **credit supply is determined by risk-taking decision**

$$C = \frac{E}{1 - \frac{1+r}{1+f}\varphi}, \qquad \varphi \in (0,1)$$

φ is ratio of **notional assets** to **notional debt**

Amplification Channel

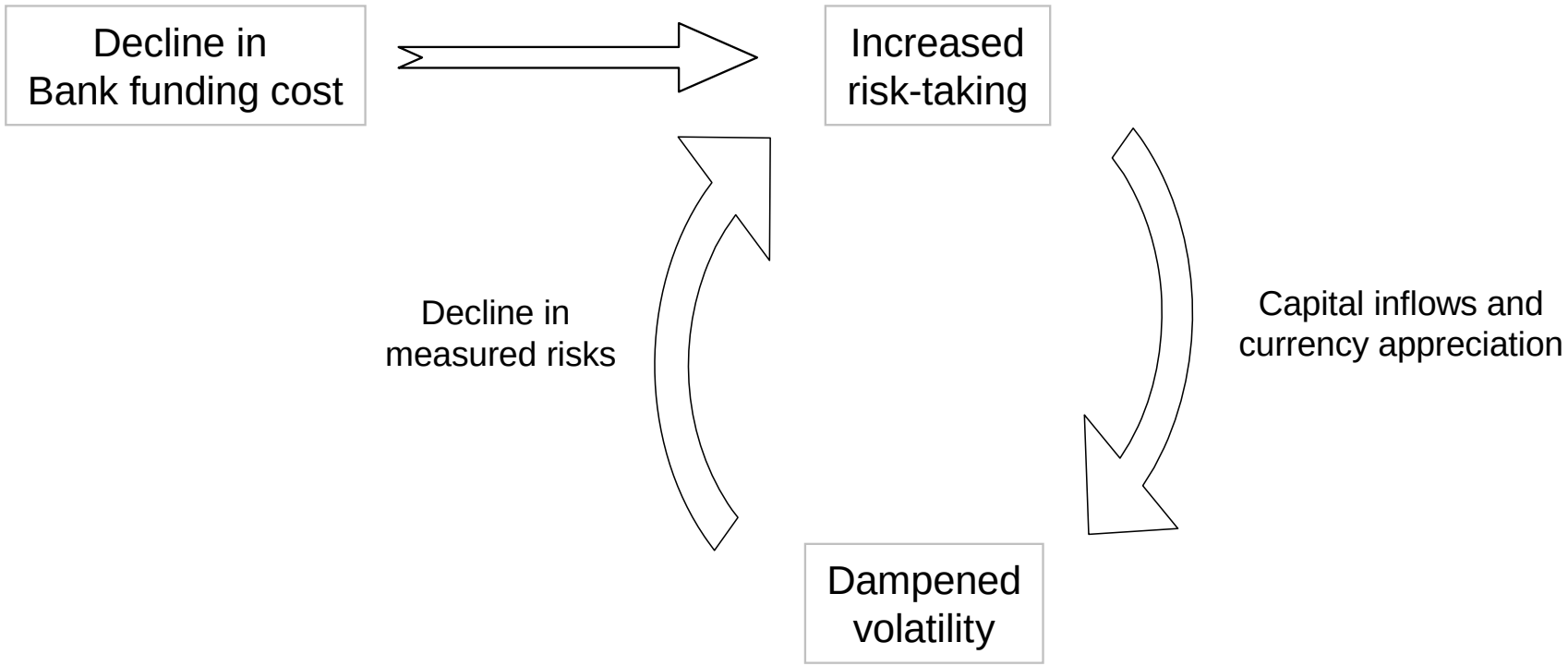


Figure 13. Risk-taking channel of monetary policy in the cross-border context

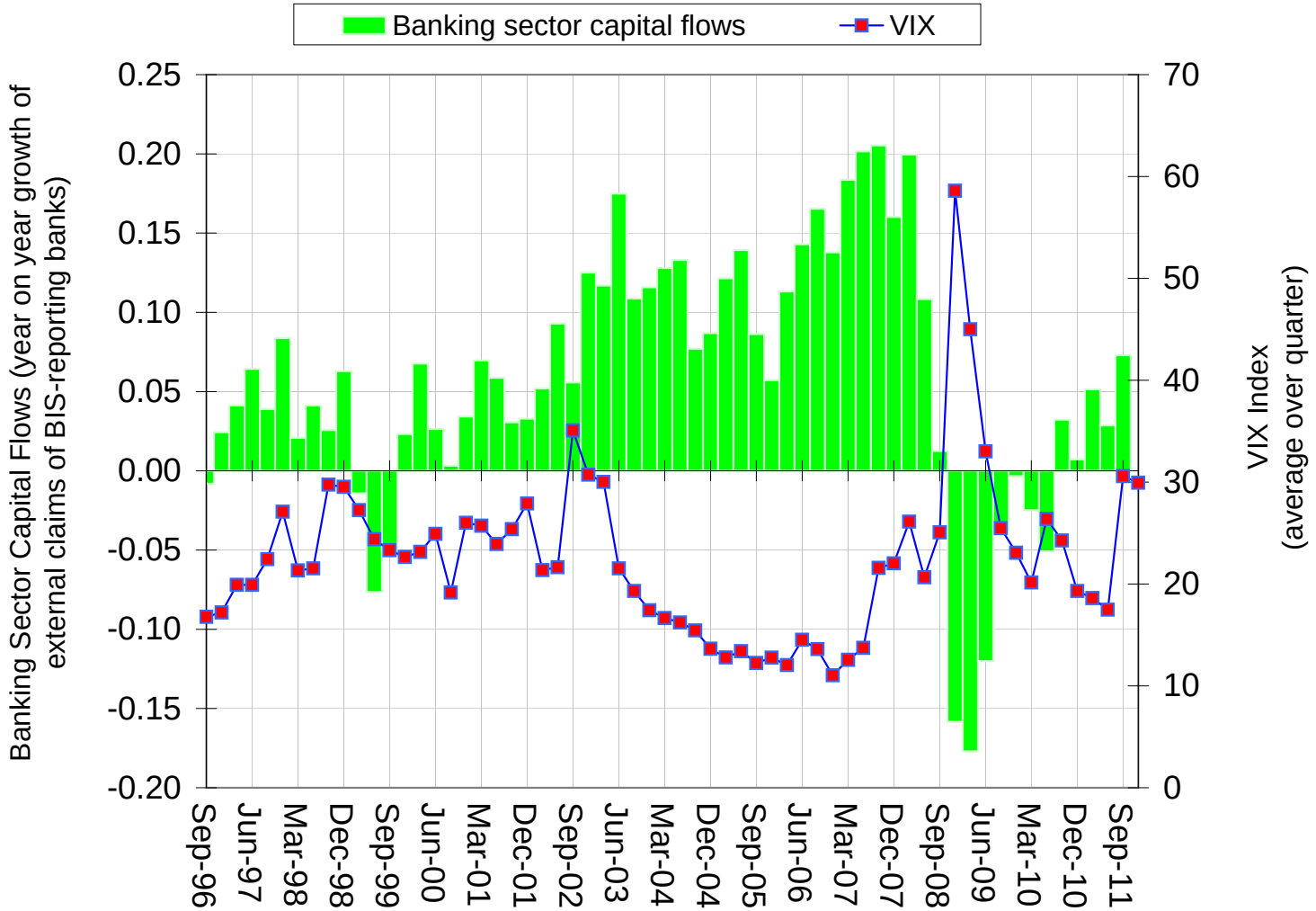


Figure 14. This figure plots cross-border banking sector capital flows as year-on-year growth in external claims of BIS-reporting banks (Table 7A). The VIX series is the quarterly average of CBOE VIX index.

Model Sketch

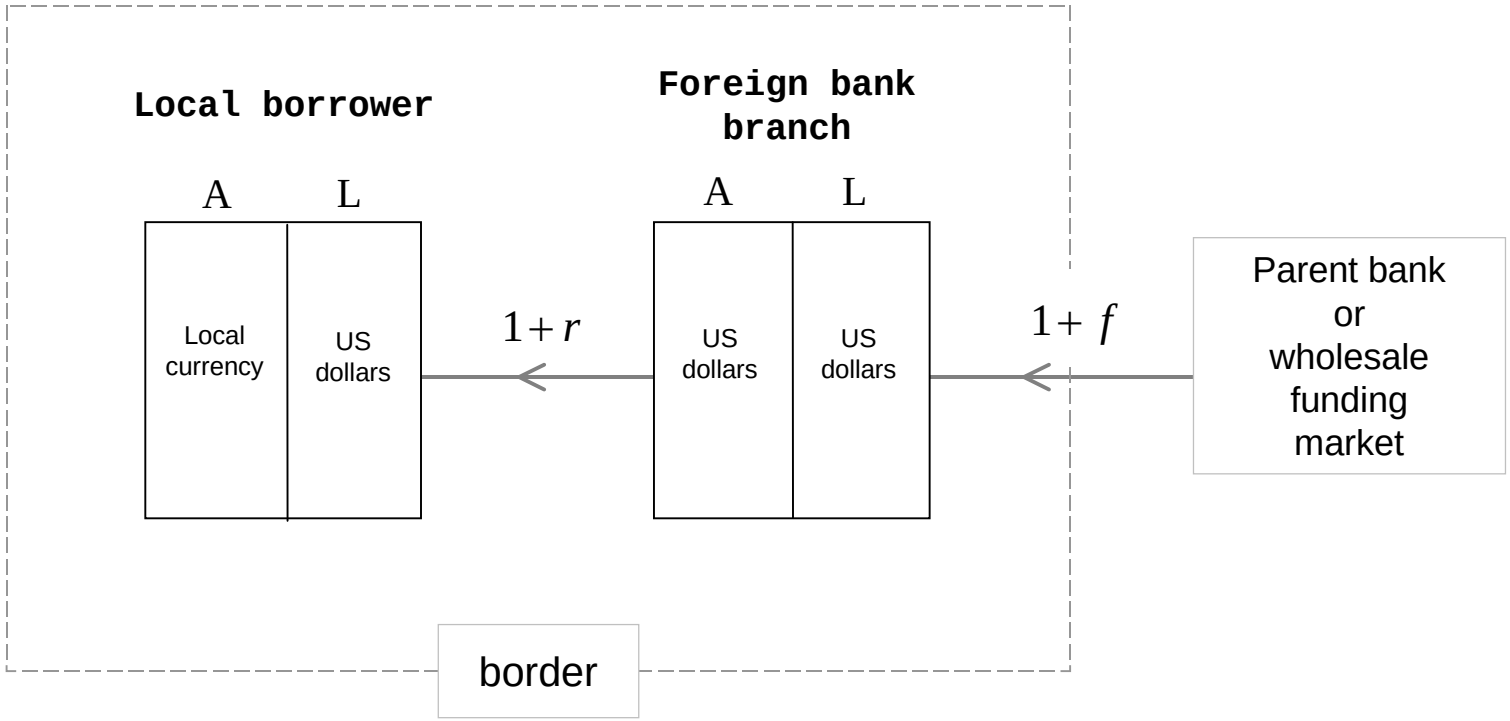
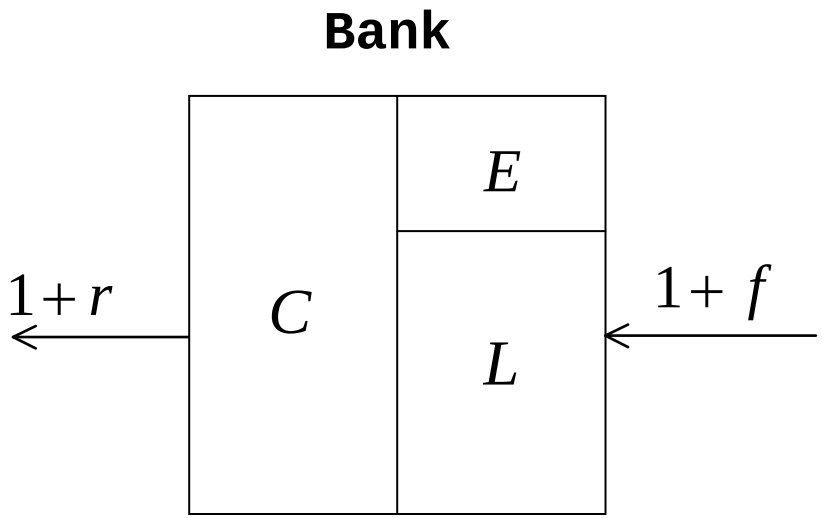


Figure 15. This figure depicts the lending relationships examined in the model. A foreign bank branch lends to local borrowers in dollars and finances its lending from the wholesale dollar funding market.

Credit Supply

Notation for balance sheet of bank



Borrowers

F is debt with dollar face value F, maturing at date T.

Value of the borrower's project (in local currency) at date T is

$$V_T = V_0 \exp\left\{\left(\mu - \frac{s^2}{2}\right)T + s\sqrt{T}W\right\}$$

W_j is a standard normal

Borrower defaults when

$$\theta_T V_T < F$$

θ_T is value of local currency against dollars

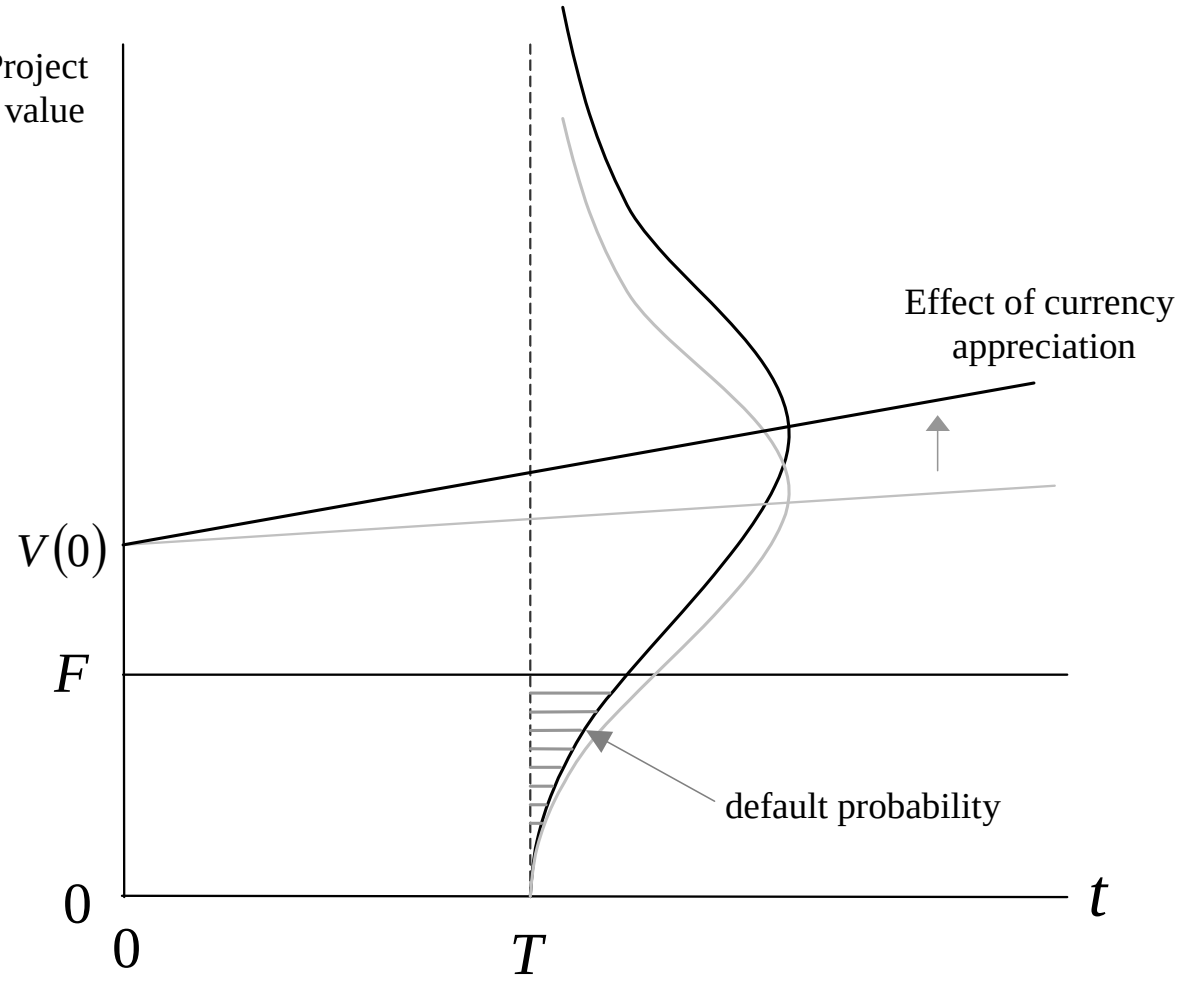


Figure 16. Project value V_T and notional debt F for local borrowers. The borrower defaults when V_T falls short of the notional debt F. The effect of a currency appreciation is to shift the outcome density upward, lowering the default probability.

$$\begin{aligned}\text{Prob}\left(\theta_T V_T < F\right) &= \text{Prob}\left(W < -\frac{\ln\left(\theta_T V_0/F\right) + \left(\mu - \frac{s^2}{2}\right)T}{s\sqrt{T}}\right) \\ &= \Phi\left(-d\right)\end{aligned}$$

d is the *distance to default*

$$d = \frac{\ln\left(\theta_T V_0/F\right) + \left(\mu - \frac{s^2}{2}\right)T}{s\sqrt{T}}$$

Loan Portfolio of Banks

Each bank has a well diversified loan portfolio consisting of loans to many borrowers.

$$W_j = \sqrt{\rho}Y + \sqrt{1-\rho}X_j$$

where Y and $\{X_j\}$ are mutually independent standard normals.

Then borrower j repays the loan when $Z_j \geq 0$, where Z_j is the random variable:

$$\begin{aligned} Z_j &= d_j + W_j \\ &= d_j + \sqrt{\rho}Y + \sqrt{1-\rho}X_j \\ &= -\Phi^{-1}(\varepsilon) + \sqrt{\rho}Y + \sqrt{1-\rho}X_j \end{aligned}$$

Realized value of assets at date 1

$$\begin{aligned} w(Y) &\equiv (1+r)\,C \cdot \Pr\left(Z_j \geq 0 | Y\right) \\ &= (1+r)\,C \cdot \Pr\left(\sqrt{\rho}Y + \sqrt{1-\rho}X_j \geq \Phi^{-1}(\varepsilon)\,|Y\right) \\ &= (1+r)\,C \cdot \Phi\left(\frac{Y\sqrt{\rho}-\Phi^{-1}(\varepsilon)}{\sqrt{1-\rho}}\right) \end{aligned}$$

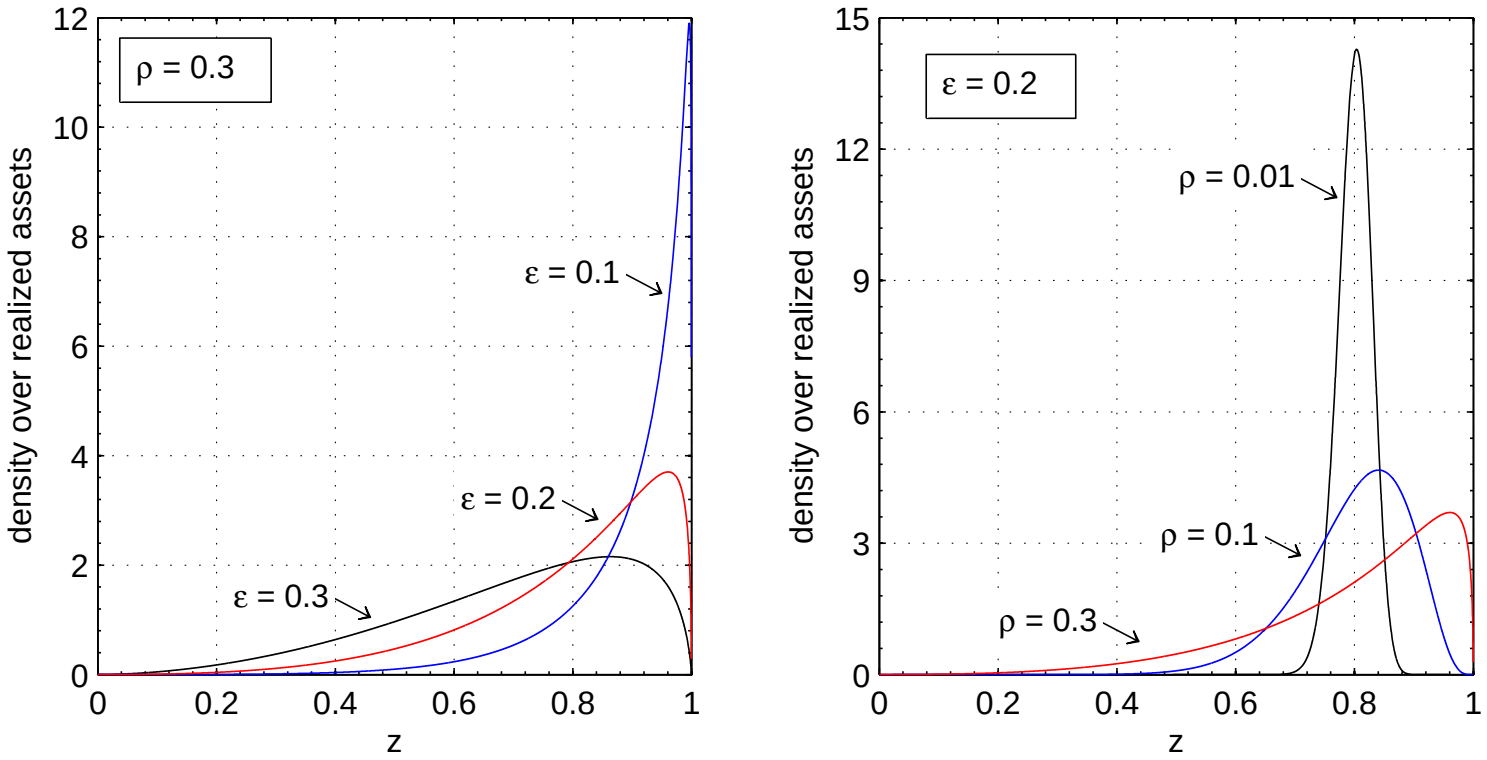


Figure 17. The two charts plot the densities over realized assets when $C(1+r)=1$. The left hand charts plots the density over asset realizations of the bank when $\rho = 0.1$ and ε is varied from 0.1 to 0.3. The right hand chart plots the asset realization density when $\varepsilon = 0.2$ and ρ varies from 0.01 to 0.3.

c.d.f. of w

$$
\begin{aligned}
F(z) &= \Pr(w \leq z) \\
&= \Pr\left(Y \leq w^{-1}(z)\right) \\
&= \Phi\left(w^{-1}(z)\right) \\
&= \Phi\left(\frac{\Phi^{-1}(\varepsilon)+\sqrt{1-\rho}\Phi^{-1}\left(\frac{z}{(1+r)C}\right)}{\sqrt{\rho}}\right)
\end{aligned}
$$

Value-at-Risk (VaR) rule with insolvency probability to $\alpha > 0$ when notional liability is $(1+f)\,L$.

$$\Pr\left(w < (1+f)\,L\right) = \Phi\left(\frac{\Phi^{-1}(\varepsilon) + \sqrt{1-\rho}\,\Phi^{-1}\left(\frac{(1+f)L}{(1+r)C}\right)}{\sqrt{\rho}}\right) = \alpha$$

$$\frac{\text{Notional liabilities}}{\text{Notional assets}} = \frac{(1+f)\,L}{(1+r)\,C} = \Phi\left(\frac{\sqrt{\rho}\Phi^{-1}(\alpha) - \Phi^{-1}(\varepsilon)}{\sqrt{1-\rho}}\right) \qquad (1)$$

where

$$\varphi(\alpha, \varepsilon, \rho) \equiv \Phi\left(\frac{\sqrt{\rho}\Phi^{-1}(\alpha) - \Phi^{-1}(\varepsilon)}{\sqrt{1-\rho}}\right)$$

Supply of Credit

Credit supply C and demand for funding L is obtained from (1) and balance sheet identity $C = E + L$

$$C = \frac{E}{1 - \frac{1+r}{1+f} \cdot \varphi}, \qquad L = \frac{E}{\frac{1+f}{1+r} \cdot \frac{1}{\varphi} - 1}$$

Aggregation holds due to proportionality

$$\text{Leverage} = \frac{1}{1 - \frac{1+r}{1+f} \cdot \varphi}$$

Amplification Channel

- Suppose θ_T is increasing in L (capital inflows exert upward pressure on exchange rate)

- Fall in funding cost f has
  - *initial impact*
  - *amplification effect*

- Lending depends on measured risks; and risks are dampened by lending

$$\begin{cases} C = C\left(\sigma^2; f\right) \\ \sigma^2 = \sigma^2\left(C\right) \end{cases}$$

Both downward-sloping

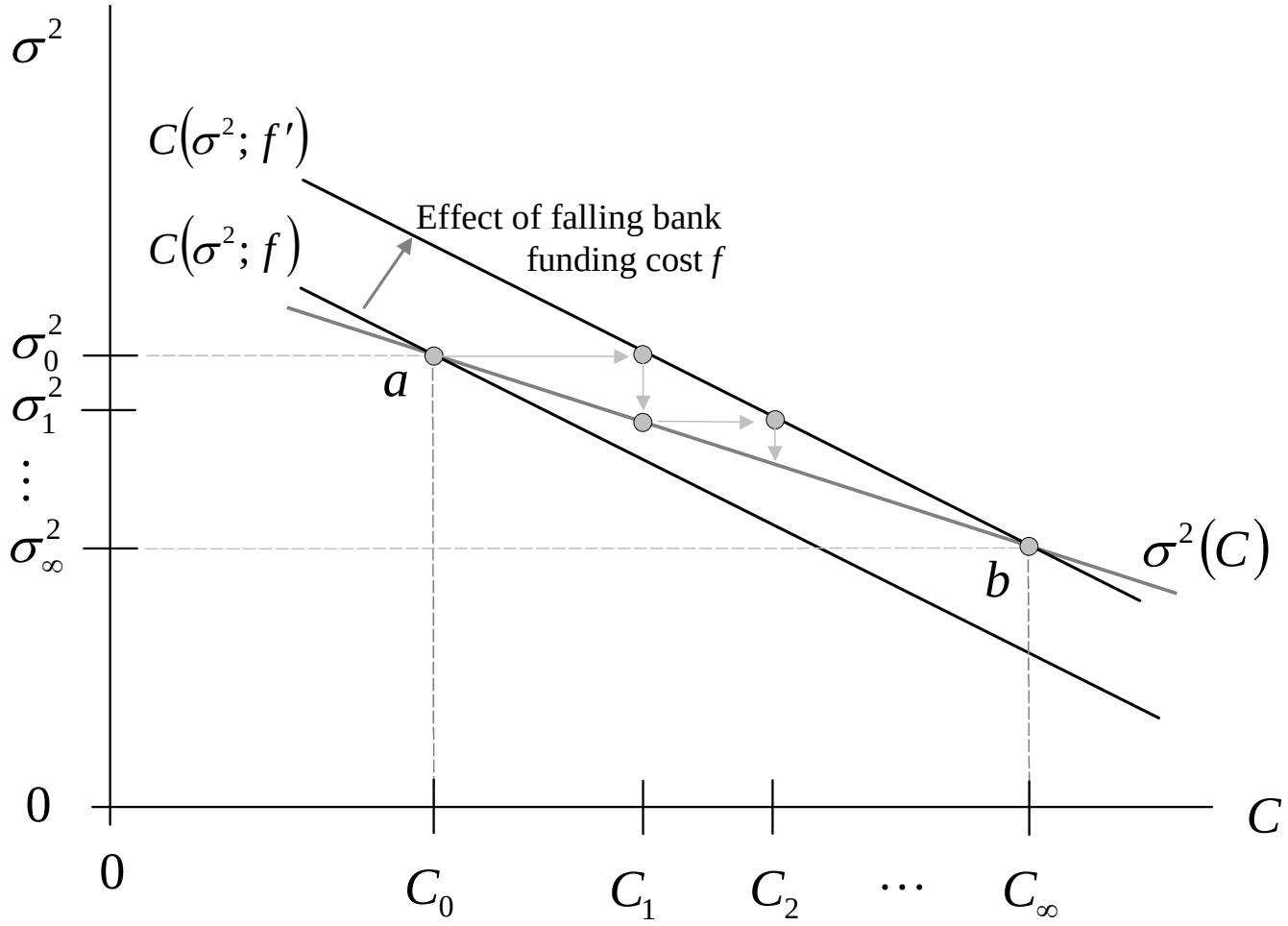


Figure 18. Impact of a decline in bank funding cost f consisting of the initial impact and the amplification effect.

$$\frac{dC}{df}\frac{1+f}{C} = -\frac{1}{\frac{1+f}{1+r}\frac{1}{\varphi} - \left(1 + C \cdot \frac{\varphi'}{\varphi}\frac{d\varepsilon}{dC}\right)}$$

$$\begin{aligned}
\frac{d\varepsilon}{dC} &= \frac{d\varepsilon}{d\theta} \cdot \frac{d\theta}{dL} \cdot \frac{dL}{dC} \\
&= \frac{dG\left(z^*/\theta\right)}{d\theta} \cdot \frac{d\theta}{dL} \\
&= -\frac{z^*}{\theta^2} \cdot g\left(\frac{z^*}{\theta}\right) \cdot \frac{d\theta}{dL}
\end{aligned}$$

$g\left(.\right)$ is density of project outcomes

z^* is default threshold in domestic currency

Effect of Currency Intervention

Intervention can dampen amplification channel

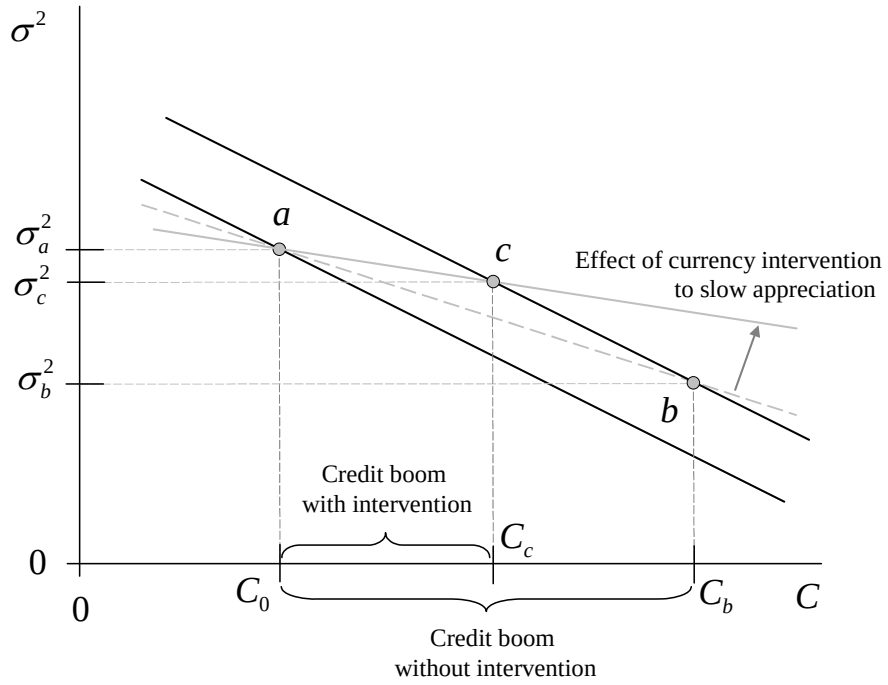


Figure 19. Effect of intervention to mitigate currency appreciation

Empirical Analysis

Four-variable vector autoregression (VAR)

- VIX index of implied volatility on equity index options
- Forward term premium between the 10 year and 3 month US treasury rates (Gurkaynak, Sack, and Wright (2006))
- Feds Funds target rate
- Cross-border banking sector flows (BIS locational statistics, Table 7A)

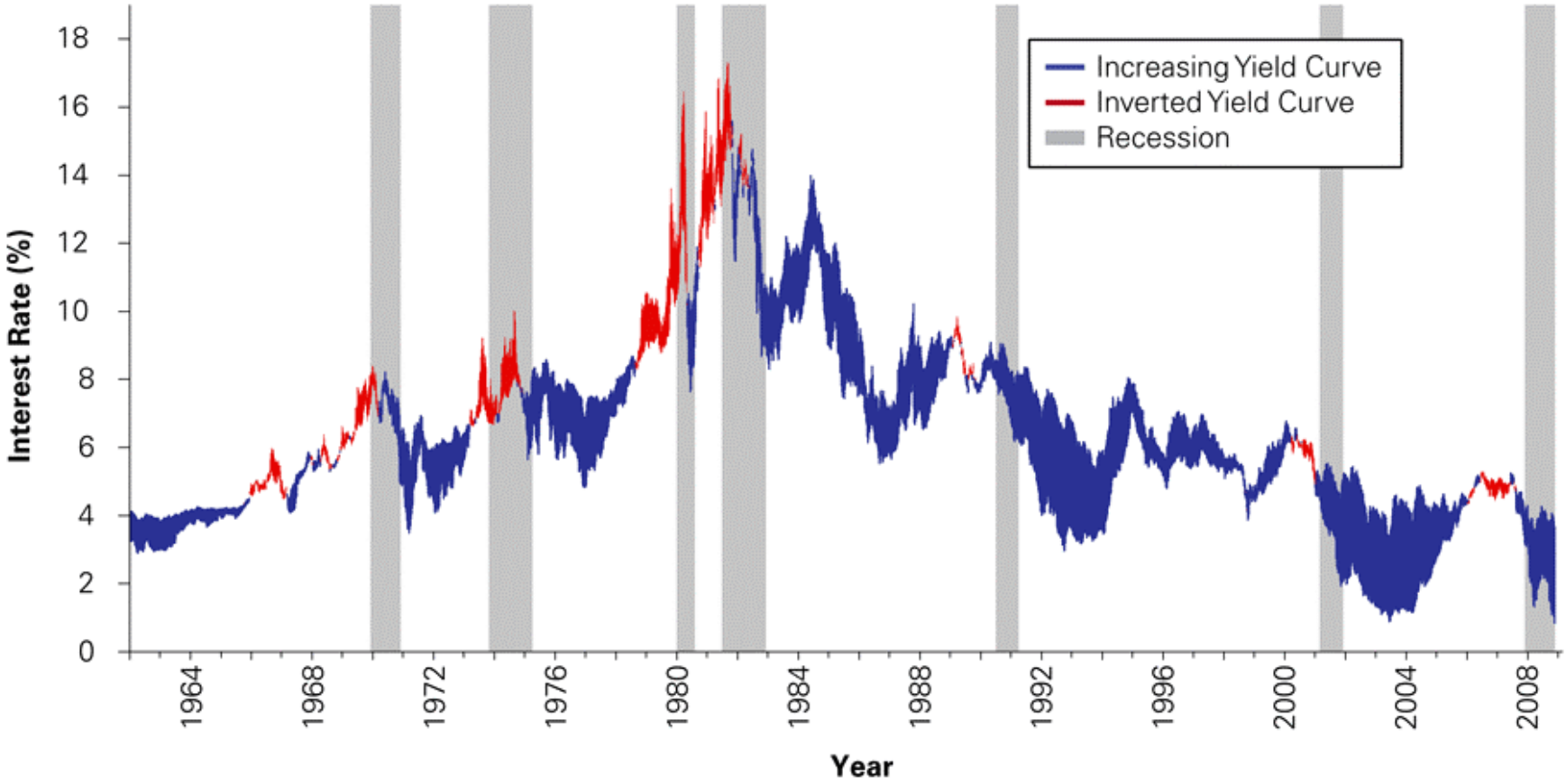


Figure 20. Term premium beween 10 year and 3 month US Treasury rates (Source: Berk and DeMarzo (2010))

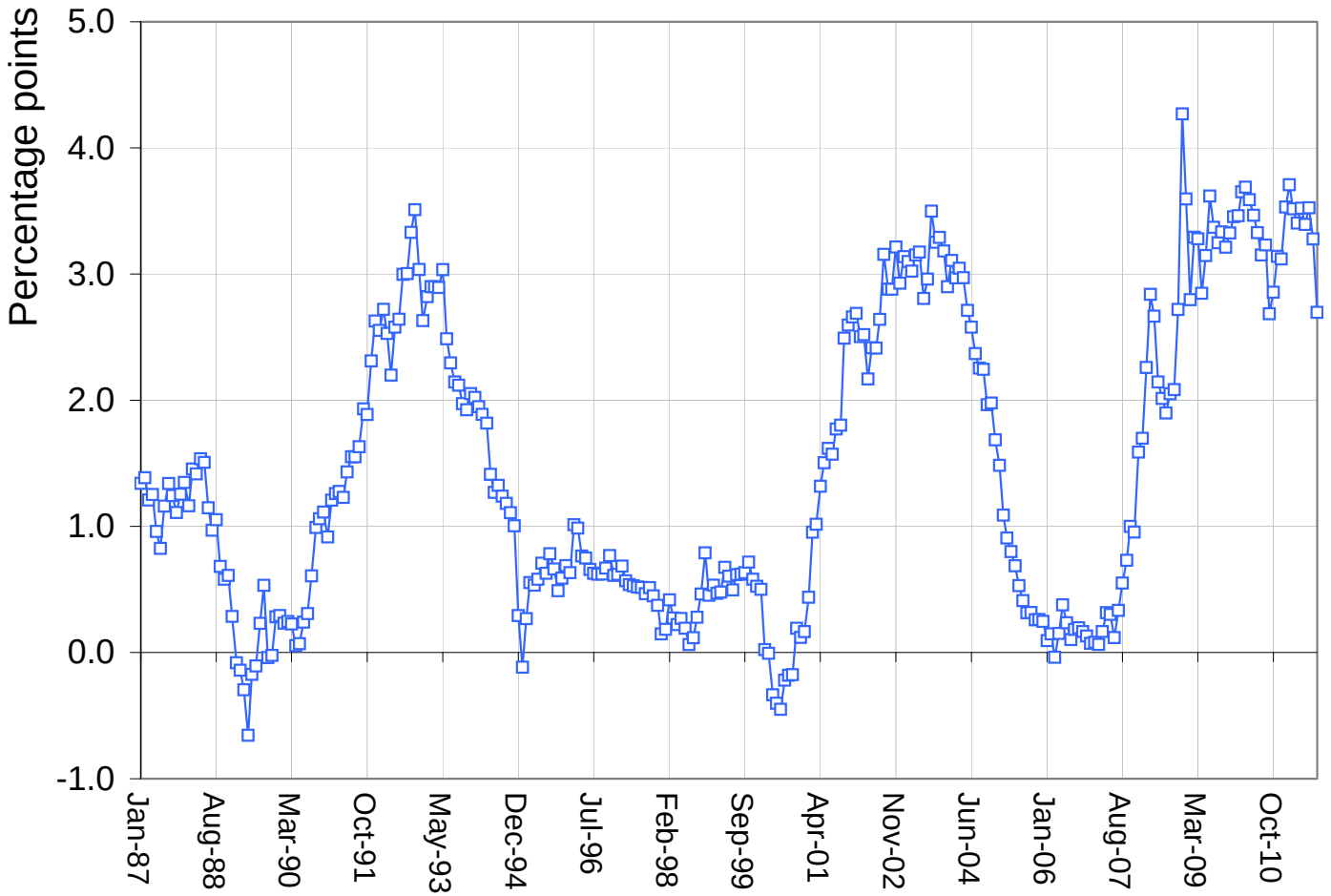


Figure 21. Twelve month forward term premium between 10 year and 3 month US Treasury rates. The series is computed following the methodology of Gurkaynak, Sack, and Wright (2006)

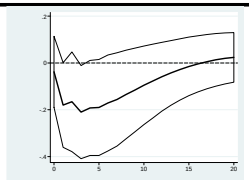
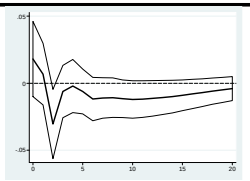
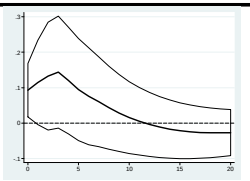
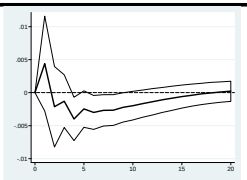
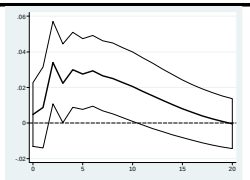
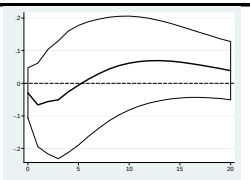
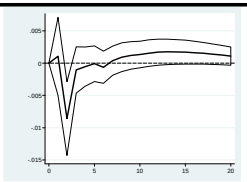
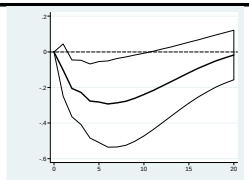
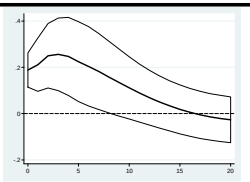
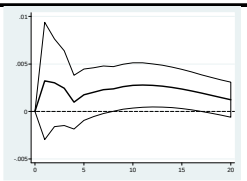
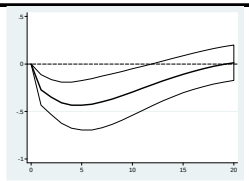
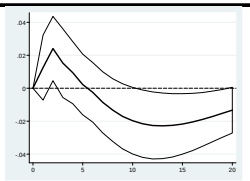
Structural VAR	Cholesky ordering 1	2	3	4
Impact of ($\downarrow$)	On LOANS	On Fed Funds	On VIX	On FTP
LOANS				
Fed Funds				
VIX				
FTP				

Figure 22. **Impulse response functions in Structual VAR.** This figure presents estimated structural impulse-response functions for the four variable structual VAR (LOANS, FEFU, VIX, FTP) and 90 percent bootstrapped confidence intervals for the model with two lags, based on 1000 replications.

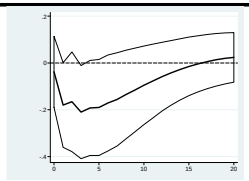
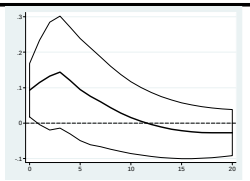
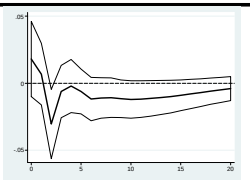
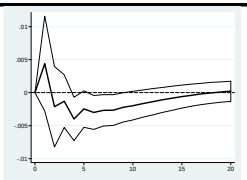
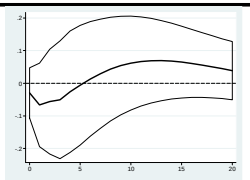
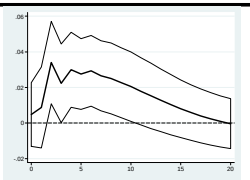
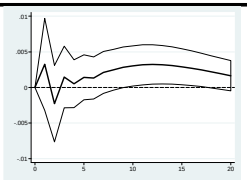
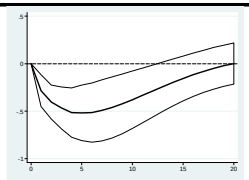
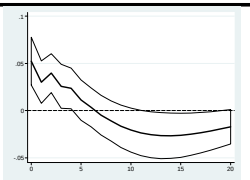
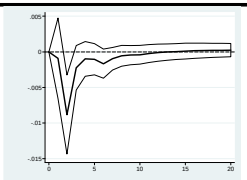
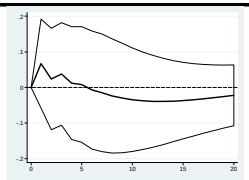
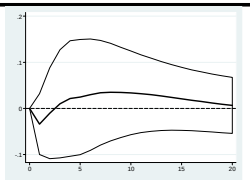
Structural VAR	Cholesky ordering 1	2	3	4
Impact of ($\downarrow$)	On LOANS	On Fed Funds	On FTP	On VIX
LOANS				
Fed Funds				
FTP				
VIX				

Figure 23. **Impulse response functions in Structual VAR.** This figure presents estimated structural impulse-response functions for the four variable structual VAR (LOANS, FEFU, FTP, VIX) and 90 percent bootstrapped confidence intervals for the model with two lags, based on 1000 replications.

Tentative Conclusions

- US monetary policy has spillover effects through
  - Activity of global banks
  - Interplay between **risk-taking** and **measured risks**
  - **Global liquidity** is a meaningful concept
- Domestic credit conditions depend on global liquidity conditions
- Need to broaden discussions about exchange rates and global rebalancing in multilateral forums (e.g. G20) beyond narrowly mercantilist debates
  - Global rebalancing has financial stability component, as well as trade

Global Liquidity and China

- China has closed capital account
- But China is a highly open economy
  - Trade/GDP $\simeq$ 50%
- Incentives for non-financial firms to hedge receivables, just as in Korea

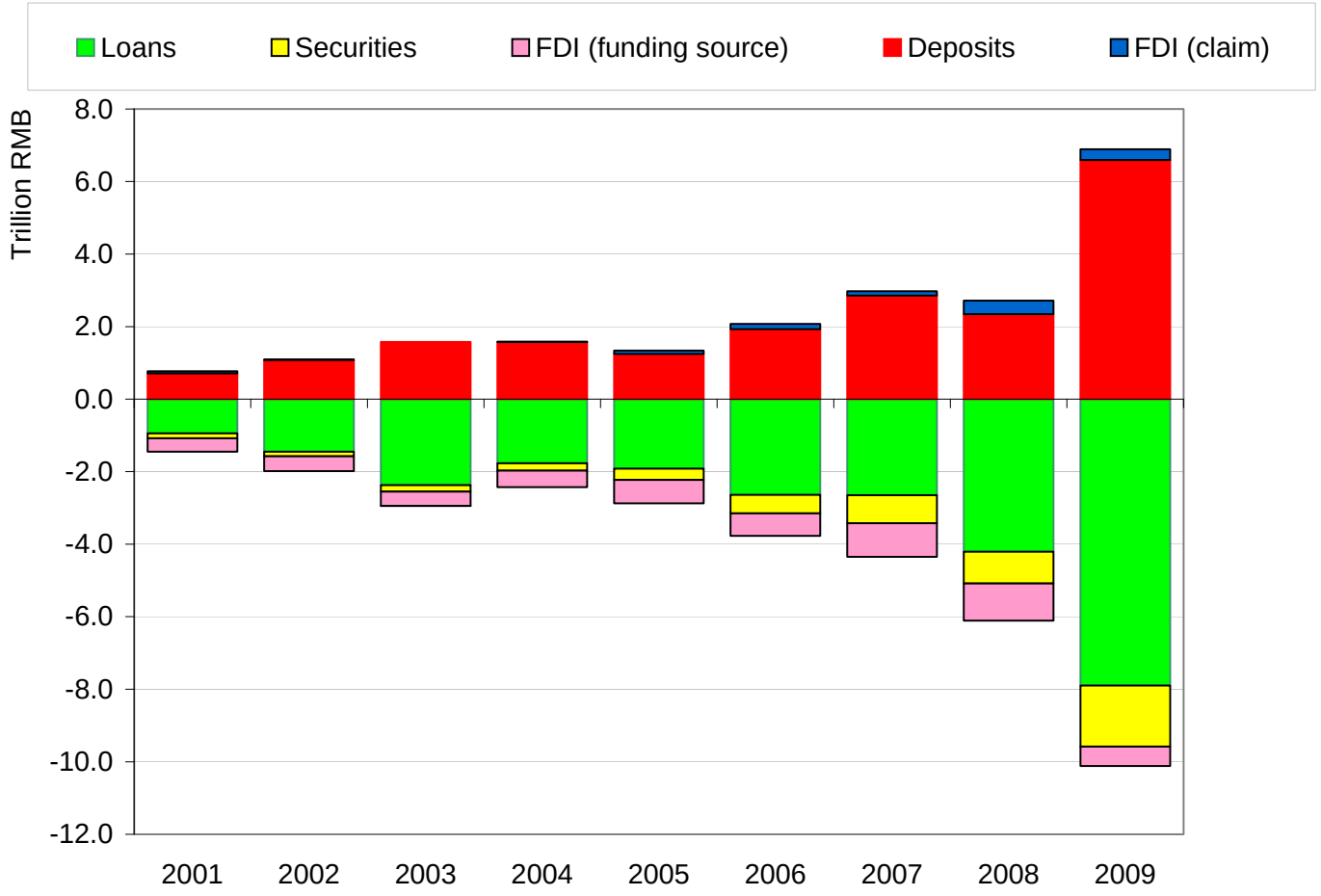


Figure 24. China: non-financial corporate sector financial assets and liabilities (Source: China Statistical Yearbook, Flow of Funds of Chinese Corporations)

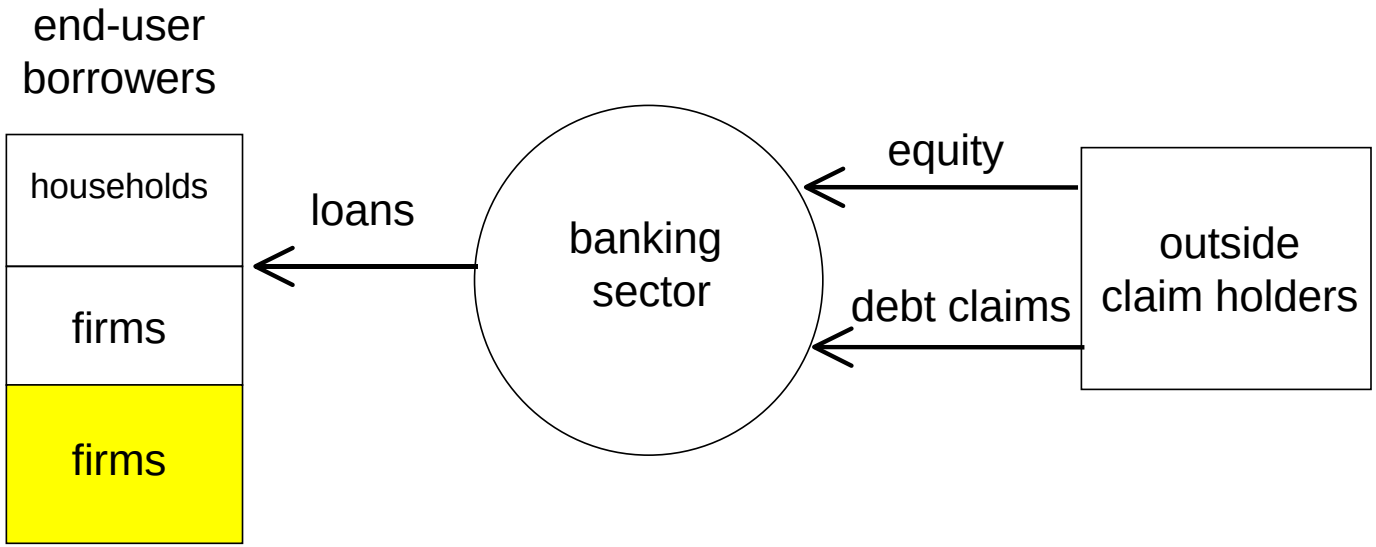


Figure 25. Stylized financial system before inflow of global liquidity (Source: Hattori, Shin and Takahashi (2009))

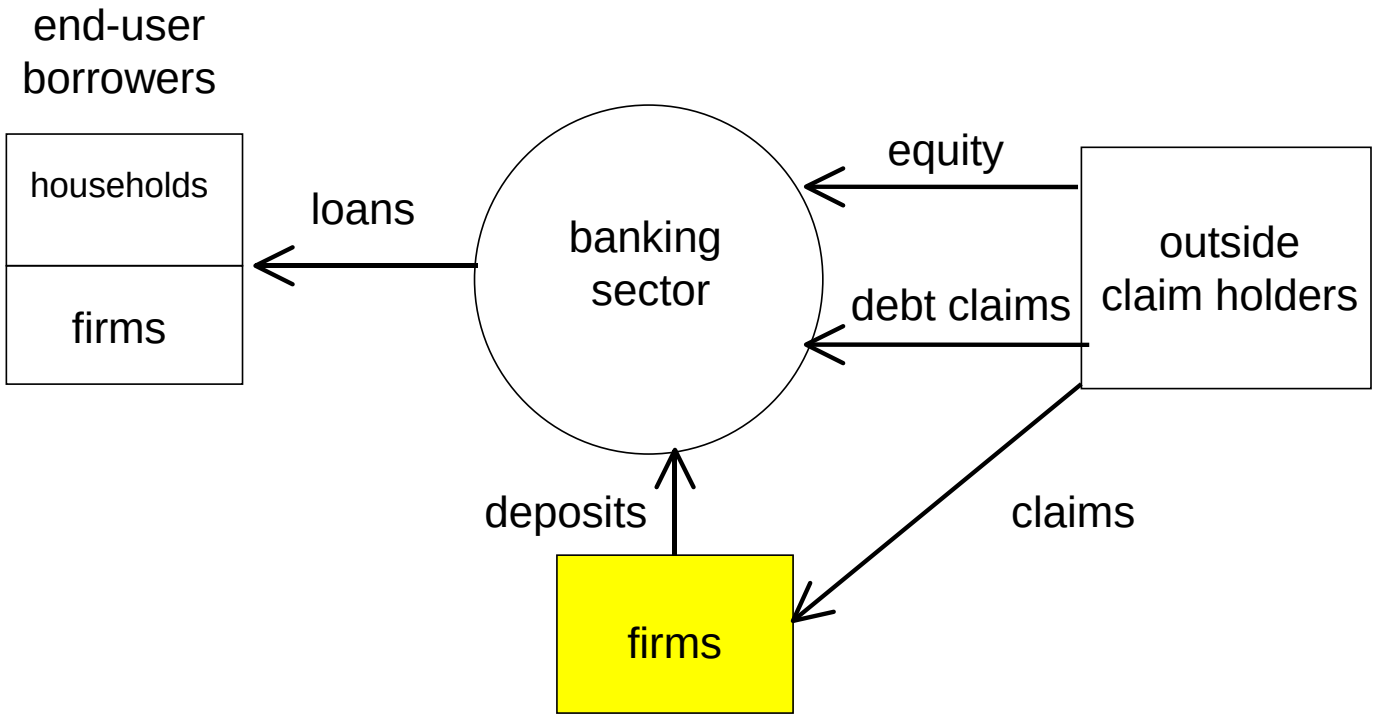


Figure 26. Stylized financial system with non-financial corporates channeling global liquidity (Source: Hattori, Shin and Takahashi (2009))

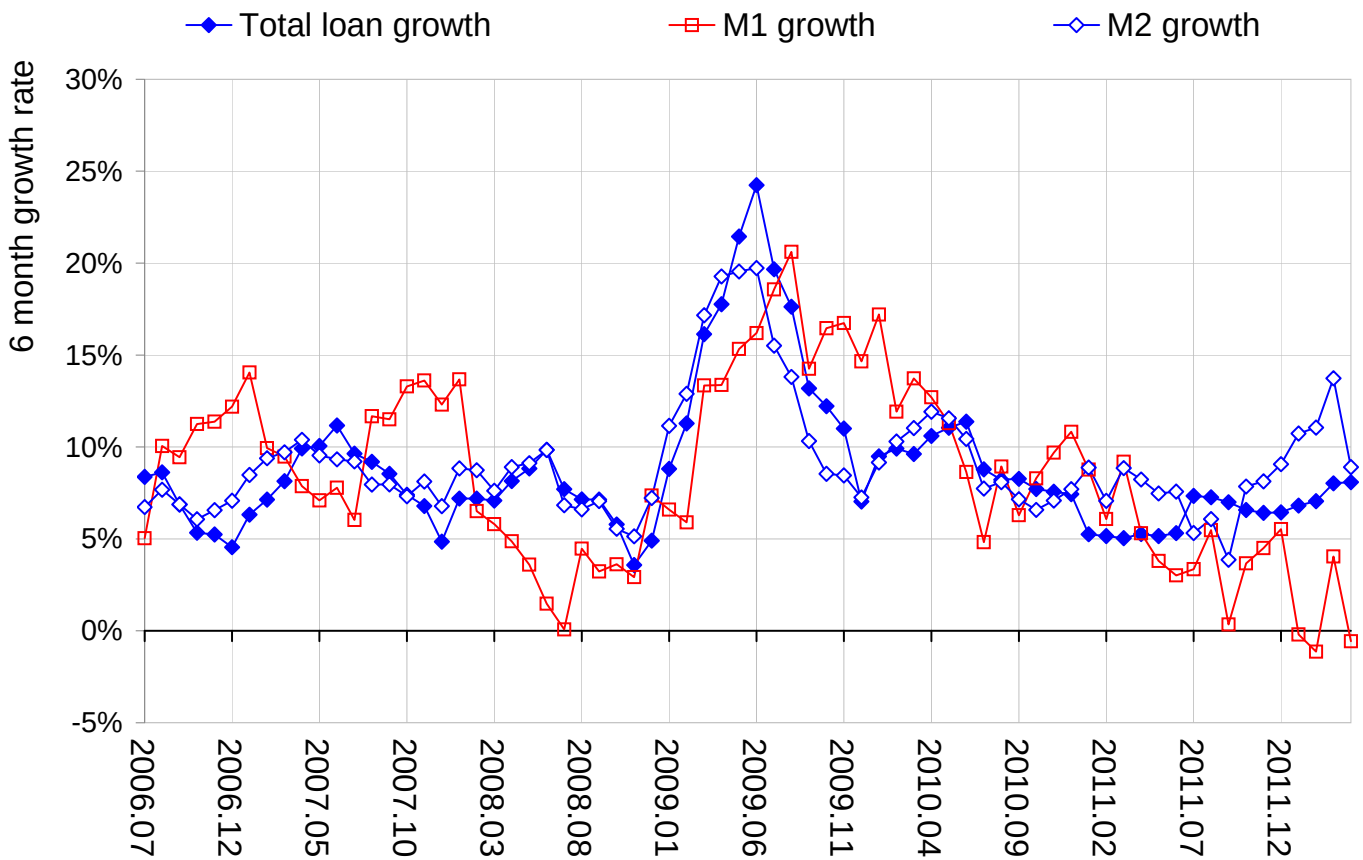


Figure 27. Six month growth rate of money stock (Source: People's Bank of China)

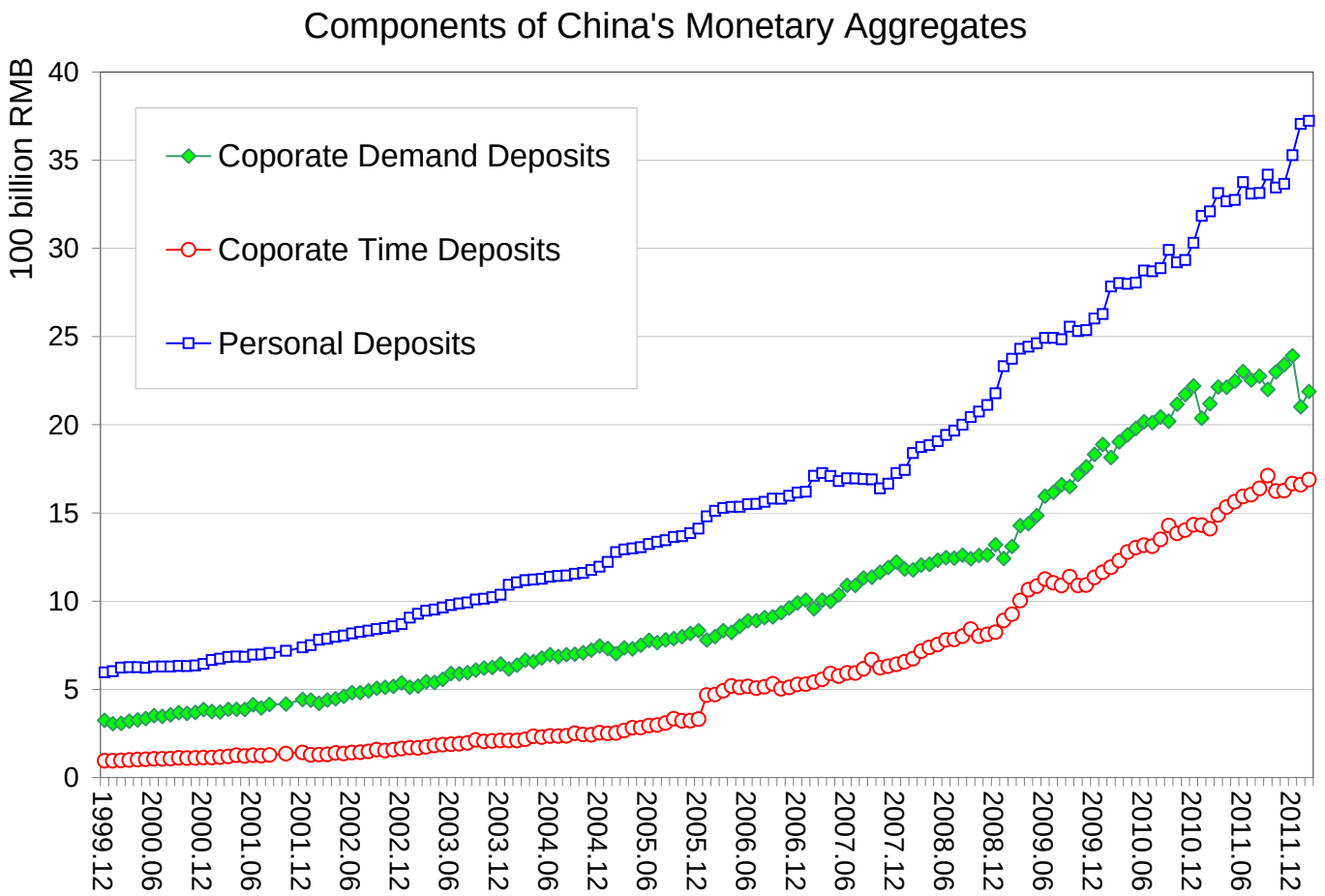


Figure 28. China: corporate and personal deposits of banking sector (Source: People's Bank of China monetary statistics)

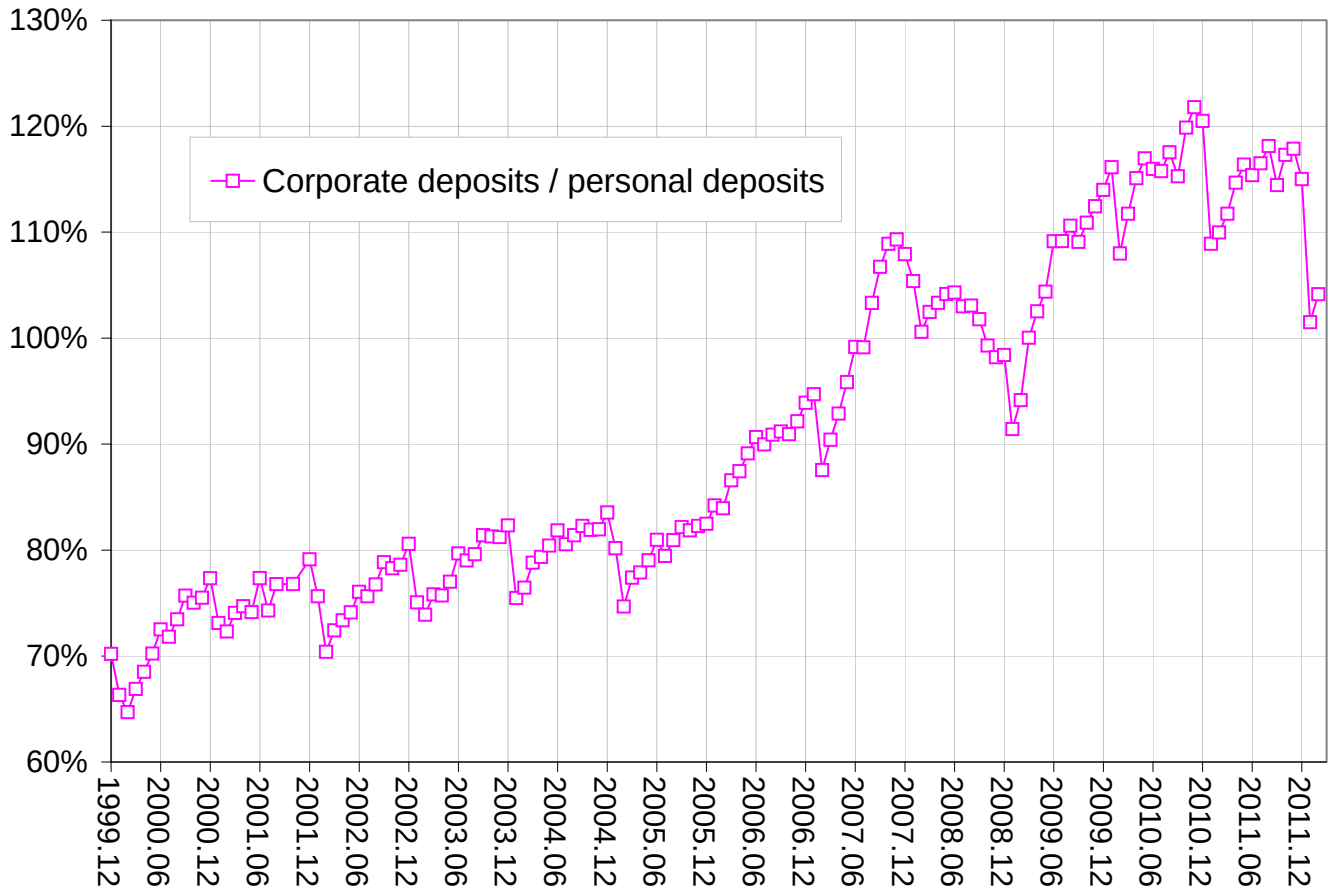


Figure 29. China: ratio of corporate to personal deposits of banking sector (Source: People's Bank of China monetary statistics)

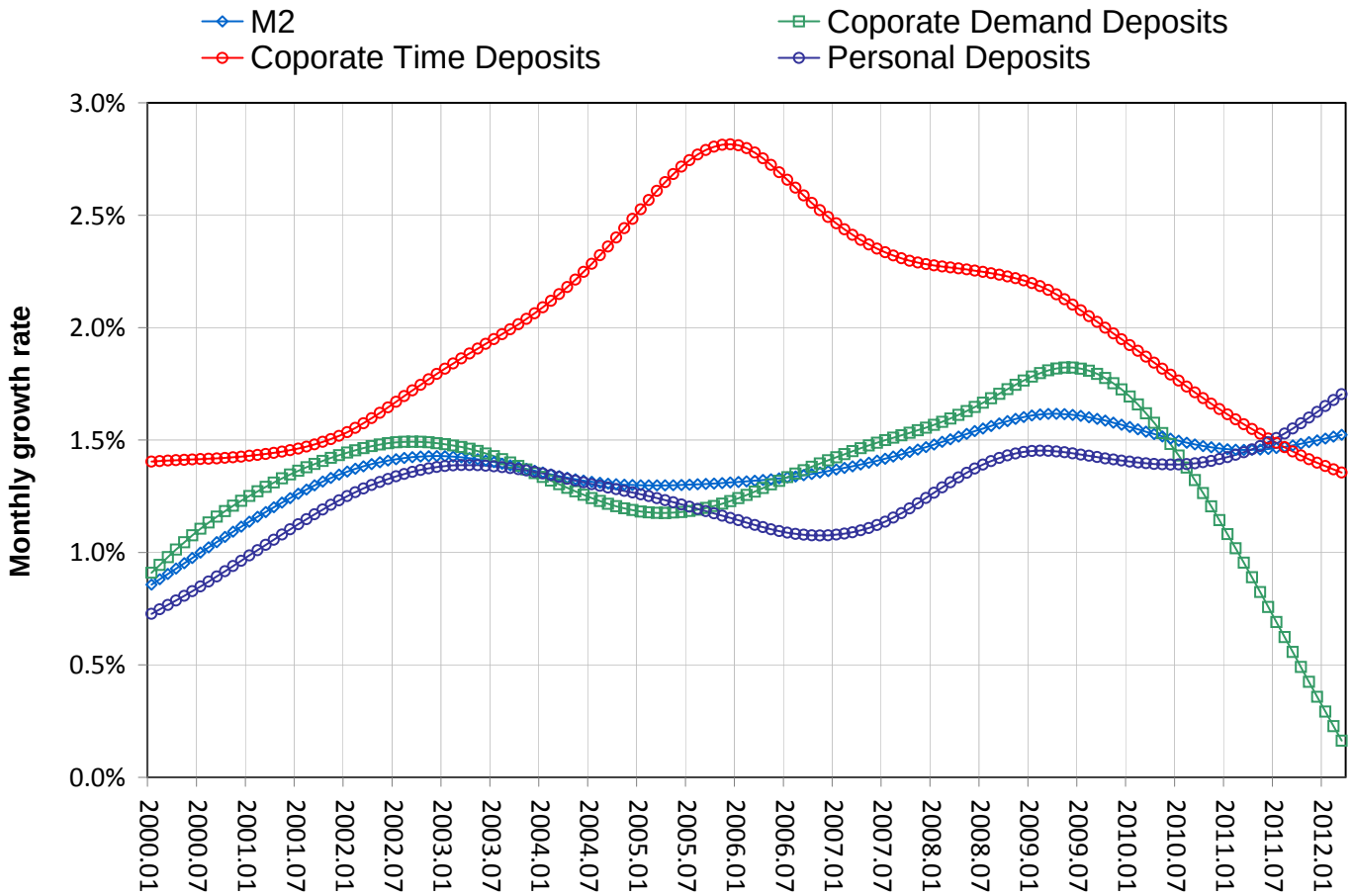


Figure 30. Monthly growth rates of monetary components in China, filtered through Hodrick-Prescott filter ($\lambda = 14400$)

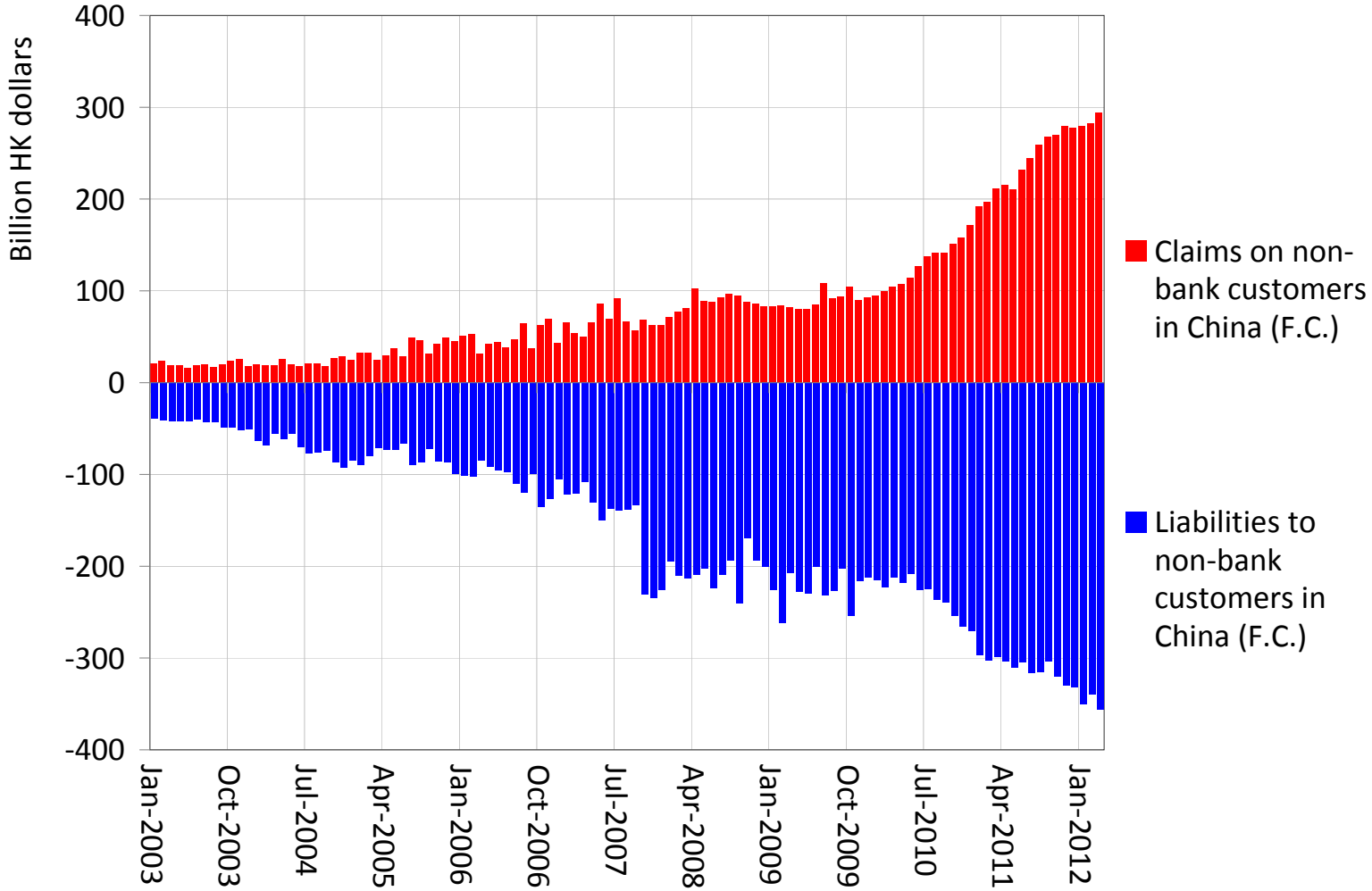


Figure 31. HK Banks' Positions vis-à-vis Non-Bank Customers in Mainland China in Foreign Currencies (Source: Hong Kong Monetary Authority)

Ebbing of Global Liquidity in China

- Dollar funding shortages reflecting:
  - US dollar claims are official claims
  - Corporate liabilities
- Build-up phase has close parallels with 1980s experience in Japan
  - Role of large Japanese manufacturing firms
  - Hattori, Shin and Takahashi (2009)
- Deleveraging of global banks will affect liquidity conditions in China