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?
Risk-Taking Channel

- Borio and Zhu (2008)

- Role of banking sector
  - Short-term interest rates and bank risk-taking
  - Leverage cycle

- Global liquidity
  - “Supply push” forces in cross-border banking sector credit
Figure 1. Cross-border claims (loans and deposits) of BIS reporting banks on counterparties listed on right (Source: BIS locational banking statistics Table 7A)
Figure 2. Cross-border claims (loans and deposits) of BIS reporting banks on counterparties listed on right
(Source: BIS locational banking statistics Table 7A)
Figure 3. Total Liabilities of Barclays (1992 - 2007) (Source: Bankscope)
Figure 4. Barclays, risk-weighted assets and total assets (Source: Bankscope)
Barclays: 2 year change in assets, equity, debt and risk-weighted assets (1992-2010)

Figure 5. Barclays: 2 year change in assets, equity and debt (1992-2010) (Source: Bankscope)
Figure 6. 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.
Figure 7. Timeline for model: dollar loans are granted at date 0 at the exchange $\theta_0$ and are repaid at date $T$ at exchange rate $\theta_T$. 
Figure 8. Consistency between (i) expected appreciation (ii) default probability of borrower and (iii) lending through cross-border banking sector inflows
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*

\[
C = \frac{E}{1 - \frac{1 + r}{1 + f} \varphi}, \quad \varphi \in (0, 1)
\]

\( \varphi \) is ratio of *notional debt to notional assets*
Credit Supply

Notation for balance sheet of bank

\[ C \quad E \]

\[ 1 + r \quad 1 + f \]
Borrowers

Many identical borrowers; debt with dollar face value $F$, maturing at $T$

$\theta_t$ is exchange rate (increase in $\theta_t$ is \textit{appreciation} of local currency). $\bar{\theta}_T$ is date 0 expected value of $\theta_T$.

Dollar value of project is

$$\theta_T V_T = \theta_0 V_0 \exp \left\{ \left( \mu (\bar{\theta}_T) - \frac{s^2}{2} \right) T + s \sqrt{T} W_j \right\}$$  \hspace{1cm} (1)

$W_j$ is a standard normal, $\mu (\cdot)$ is increasing function of $\bar{\theta}_T$.

Borrower defaults when

$$\theta_T V_T < F$$
Merton (1974) with Exchange Rate Risk

Figure 9. The borrower defaults when $\theta TV_T$ falls short of the notional debt $F$. The effect of a currency appreciation is to shift the outcome density upward, lowering the default probability.
Probability of default viewed from date 0 is

\[
\text{Prob} (\theta_T V_T < F) = \text{Prob} \left( W_j < - \frac{\ln(\theta_0 V_0 / F) + \left( \mu - \frac{s^2}{2} \right) T}{s \sqrt{T}} \right)
\]

\[
= \Phi (-d_j)
\]

where \(d_j\) is distance to default:

\[
d_j = \frac{\ln (\theta_0 V_0 / F') + \left( \mu (\bar{\theta}_T) - \frac{s^2}{2} \right) T}{s \sqrt{T}}
\]

Probability of default is falling in \(\bar{\theta}_T\).
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:

\[
Z_j = d_j + W_j \\
= d_j + \sqrt{\rho Y} + \sqrt{1 - \rho X_j} \\
= -\Phi^{-1}(\varepsilon) + \sqrt{\rho Y} + \sqrt{1 - \rho X_j}
\]
Realized value of assets at date 1

\[ w(Y) \equiv (1 + r) C \cdot \Pr (Z_j \geq 0|Y) \]

\[ = (1 + r) C \cdot \Pr \left( \sqrt{\rho}Y + \sqrt{1 - \rho}X_j \geq \Phi^{-1}(\varepsilon)|Y \right) \]

\[ = (1 + r) C \cdot \Phi \left( \frac{Y \sqrt{\rho} - \Phi^{-1}(\varepsilon)}{\sqrt{1 - \rho}} \right) \]
Figure 10. 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 $\varepsilon$ is varied from 0.1 to 0.3. The right hand chart plots the asset realization density when $\varepsilon = 0.2$ and $\rho$ varies from 0.01 to 0.3.
c.d.f. of $w$

$$F(z) = \Pr (w \leq z)$$

$$= \Pr (Y \leq w^{-1}(z))$$

$$= \Phi (w^{-1}(z))$$

$$= \Phi \left( \Phi^{-1}(\varepsilon) + \sqrt{1-\rho} \Phi^{-1}(z (1+rC)) \frac{1}{\sqrt{\rho}} \right)$$
**Value-at-Risk (VaR) Rule**

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

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

(2)

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 (2) and balance sheet identity $C = E + L$

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

Aggregation holds due to proportionality

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

- Consistency between:
  - Default probability $\varepsilon$
  - Cross-border lending $L$ and domestic credit $C$
  - Expected appreciation $\bar{\theta}_T/\theta_0$

- Local borrowers sell dollars on spot market to finance local assets
  - If $\bar{\theta}_T$ is increasing in $L$, then fall in funding rate $f$ has amplified effect

\[
\begin{align*}
C &= C\left(\sigma^2; f\right) \\
\sigma^2 &= \sigma^2\left(C\right)
\end{align*}
\]

Both downward-sloping
Figure 11. Impact of a decline in bank funding cost $f$ consisting of the initial impact and the amplification effect.
\[
\frac{dC}{df} \frac{1 + f}{C} = - \frac{1}{1 + r \phi} - \left( 1 + C \cdot \frac{\phi'}{\phi} \frac{d\epsilon}{dC} \right)
\]

\[
\frac{d\epsilon}{dC} = \frac{d\epsilon}{d\theta} \cdot \frac{d\theta}{dL} \cdot \frac{dL}{dC}
\]

\[
= \frac{dG(z^*/\theta)}{d\theta} \cdot \frac{d\theta}{dL}
\]

\[
= - \frac{z^*}{\theta^2} \cdot g\left( \frac{z^*}{\theta} \right) \cdot \frac{d\theta}{dL}
\]

\(g(.\) is density of project outcomes

\(z^*\) is default threshold in domestic currency
Amplification Channel

Decline in Bank funding cost

Increased risk-taking

Decline in measured risks

Dampened volatility

Capital inflows and currency appreciation

Figure 12. Risk-taking channel of monetary policy in the cross-border context
Figure 13. 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.
Effect of Currency Intervention

Intervention can dampen amplification channel

Figure 14. Effect of intervention to mitigate currency appreciation
Uncovered Interest Parity

Uncovered Interest Parity (UIP):

\[(1 + \hat{r}) \frac{\bar{\theta}_T}{\theta_0} = 1 + f\]  

\(\hat{r}\) is the local currency interest rate.

Model contradicts (*)

When \(f\) declines, feedback effect leads to **increase** in \(\bar{\theta}_T\), not decrease as predicted by UIP
Recursive VAR

- Four- or five-variable recursive vector autoregression (VAR):

1. US dollar real effective exchange rate (REER)

2. US broker dealer leverage (proxy for $\varphi$)

3. Feds Funds target rate (proxy for $f$)

4. Cross-border banking sector flows (BIS locational statistics, Table 7A) (proxy for $L$)

5. VIX index of implied volatility on equity index options (proxy for $\sigma^2$)
Figure 15. The left panel plots the leverage of the US broker dealer sector from the Federal Reserve’s Flow of Funds series (1995Q4 - 2012Q2).
<table>
<thead>
<tr>
<th>Recursive VAR</th>
<th>Ordering</th>
<th>2</th>
<th>3</th>
<th>4</th>
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</thead>
<tbody>
<tr>
<td>Impact of (↓)</td>
<td>On Fed Funds</td>
<td>On BD Leverage</td>
<td>On VIX</td>
<td>On US dollar REER</td>
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<td>Fed Funds</td>
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<td><img src="image3" alt="Graph" /></td>
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<td>BD Leverage</td>
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<td><img src="image6" alt="Graph" /></td>
<td><img src="image7" alt="Graph" /></td>
<td><img src="image8" alt="Graph" /></td>
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<td>VIX</td>
<td><img src="image9" alt="Graph" /></td>
<td><img src="image10" alt="Graph" /></td>
<td><img src="image11" alt="Graph" /></td>
<td><img src="image12" alt="Graph" /></td>
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<tr>
<td>US dollar REER</td>
<td><img src="image13" alt="Graph" /></td>
<td><img src="image14" alt="Graph" /></td>
<td><img src="image15" alt="Graph" /></td>
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Figure 16. **Impulse response functions in recursive VAR.**
Impulse Responses from Four Variable VAR

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<thead>
<tr>
<th>Impact of Fed Funds</th>
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<tr>
<td>on BD Leverage</td>
<td>on US dollar REER</td>
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![Graphs showing impulse responses](image-url)
Impact of monetary policy shocks

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<thead>
<tr>
<th></th>
<th>On Exchange Rate</th>
<th>On VIX</th>
<th>On BD Leverage</th>
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<tbody>
<tr>
<td>Taylor Rule residual</td>
<td><img src="chart1.png" alt="Chart" /></td>
<td><img src="chart2.png" alt="Chart" /></td>
<td><img src="chart3.png" alt="Chart" /></td>
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<tr>
<td>M1 growth</td>
<td><img src="chart4.png" alt="Chart" /></td>
<td><img src="chart5.png" alt="Chart" /></td>
<td><img src="chart6.png" alt="Chart" /></td>
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<tr>
<td>Nominal effective Fed Funds rate</td>
<td><img src="chart7.png" alt="Chart" /></td>
<td><img src="chart8.png" alt="Chart" /></td>
<td><img src="chart9.png" alt="Chart" /></td>
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</table>
### Figure 17. Impulse response functions in recursive VAR.
Impulse Responses from Five Variable VAR

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<tr>
<th>Impact of Fed Funds on BD Leverage</th>
<th>Impact of BD Leverage on BIS bank flows</th>
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- **Impact of Fed Funds on BD Leverage**

- **Impact of BD Leverage on BIS bank flows**

- **Impact of Fed Funds on BIS bank flows**
Summary of Findings

- When dollar bank funding rate declines, there follows a **depreciation of the dollar**, not an appreciation as predicted by UIP.

- When dollar rate declines, there follows an **increase in the leverage** of the banking sector and **increased capital flows** as measured by BIS banking statistics.

- Loosening of monetary policy **quells VIX** and thereby facilitate the greater leverage of the banking sector; pointing to **Value-at-Risk driven leverage cycles**.
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
  - BIS report on global liquidity (Dec 2011) chaired by Jean-Pierre Landau