Global Liquidity

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September 2011

Princeton Initiative in Macro, Money and Finance
Three Themes

• Banking sector as driver of global financial conditions

• Global banks (esp. European global banks) as transmission channel of global liquidity conditions

• US Dollar as currency underpinning global banking system
Mapping Global Liquidity

• Consequences of global liquidity for **United States** ("Global" flow of funds perspective)

• Consequences of global liquidity for **Europe** (very briefly...)

• Consequences of global liquidity for **emerging/developing economies**
Corporate Finance of Banking

A

<table>
<thead>
<tr>
<th>Assets</th>
<th>Equity</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Debt</td>
</tr>
</tbody>
</table>
AL

Assets

Equity

Debt

AL

Assets

Equity

Debt
Asset growth

Leverage growth

Slope = 1

Constant equity growth of $g$

Constant equity line

$g$

Leverage growth

0
Total Assets and Leverage

Lehman Brothers

Merrill Lynch

Morgan Stanley

Bear Sterns

Goldman Sachs

Citigroup Markets 98-04
Leverage and Total Assets Growth

Asset weighted, 1992Q3-2008Q1, Source: SEC

-2 -1 0 1 2
-2 -1 0 1 2

Leverage (log change)

Total Assets (log change)
What Drives the Leverage Cycle?

Value-at-Risk (VaR) is “approximate worst case loss” - smallest non-negative \( V \) such that

\[
\text{Prob} (A < A_0 - V) \leq \alpha \quad \text{for small } \alpha > 0
\]

**Value-at-Risk Rule (Basel).** Maintain equity \( E \) to limit failure prob to \( \alpha \)

\[
E = V = v \times A
\]

\( v \) is Unit VaR (Value-at-Risk per dollar of assets). Leverage \( L \) satisfies

\[
L \equiv \frac{A}{E} = \frac{1}{v}
\]
Empirical implication:

\[ \ln L = - \ln \nu \]

so that

\[ \ln L_t - \ln L_{t-1} = - (\ln \nu_t - \ln \nu_{t-1}) \] (*)

Scatter chart of leverage changes against unit VaR changes should have slope \(-1\).

Evidence?
Figure 1: Five (then four, three, then two) Wall Street banks, Adrian and Shin (2011) “Procyclical Leverage and Value-at-Risk”
Figure 2: Deleveraging keeps VaR in check: Adrian and Shin (2011) “Procyclical Leverage and Value-at-Risk”
Figure 3: Unit VaR tracks VIX with accounting lag: Adrian and Shin (2011) “Procyclical Leverage and Value-at-Risk”
Figure 4: Total Liabilities of Barclays (1992 - 2007) (Source: Bankscope)
Figure 5: Barclays, risk-weighted assets and total assets (Source: Bankscope)
Figure 6: Barclays, capital ratios (Source: Bankscope)
Figure 7: BNP Paribas total liabilities (Source: Bankscope)
Figure 8: BNP Paribas risk-weighted assets and total assets (Source: Bankscope)
Figure 9: BNP Paribas capital ratios (Source: Bankscope)
Credit Supply

Notation for balance sheet of bank

\[
\begin{array}{c}
\text{Bank} \\
\text{1+r} & C & E \\
L & & \\
& & \text{1+f}
\end{array}
\]
Bank Credit Supply and Value-at-Risk

Density over repayments

\[ w(Y) \]

Probability density over asset realizations

\[ 0 \quad (1+f)L \quad (1+r)C \]
• Turn credit risk model on its head and think of it as credit supply model
  – Fix $E$. Determine credit supply $C_S$

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

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

[\(\varphi\) is normalized leverage measure, with \(\varphi \in (0, 1)\)]
BIS Banking Statistics

- **BIS locational** banking statistics
  - Classification based on *residence*
  - Branches/subsidiaries of global banks classified under host country
  - Consistent with balance of payments and national income statistics
  - **Cross-border claims**

- **BIS consolidated** banking statistics
  - Classification based on *nationality* of parent
  - **Foreign claims** = cross-border claims + local claims
  - **International claims** = cross-border claims + local claims in foreign currency
Figure 10: Cross-border foreign currency claims of BIS reporting banks by currency (Source: BIS locational banking statistics, Table 5A)
Figure 11: US dollar cross-border foreign currency claims and US commercial bank total assets (Source: Flow of Funds, Federal Reserve and BIS locational banking statistics, Table 5A)
Figure 12: US Dollar-denominated assets and liabilities of euro area banks (Source: ECB Financial Stability Review, June 2011, p. 102)
Figure 13: European global banks add intermediation capacity for connecting US savers and borrowers
Figure 14: International claims of European BIS reporting banks on US counterparties (Source: BIS consolidated banking statistics, Table 9D)
Figure 15: Claims outstanding on Federal Reserve Term Auction Facility (TAF) on US and non-US banks (Source: Federal Reserve disclosures on TAF)
Figure 16: Claims outstanding on Federal Reserve Term Auction Facility (TAF) on non-US banks (Source: Federal Reserve disclosures on TAF)
Figure 17: Top 30 claims outstanding on Federal Reserve Term Auction Facility (TAF) on non-US banks (Source: Federal Reserve disclosures on TAF)
Figure 18: Interoffice assets of foreign banks in the United States (Source: Federal Reserve, series on “Assets and Liabilities of U.S. Branches and Agencies of Foreign Banks”)
Figure 19: Interoffice assets of foreign banks in Japan (Source: Bank of Japan)
Figure 20: Net interoffice assets of foreign banks in Japan (Source: Bank of Japan)
<table>
<thead>
<tr>
<th>Fund</th>
<th>CDs and time deposits</th>
<th>Commercial paper</th>
<th>Corporate notes</th>
<th>Repos</th>
<th>Total</th>
<th>Net assets, $ billions</th>
</tr>
</thead>
<tbody>
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<td>Fidelity Cash Reserves</td>
<td>91 / 73</td>
<td>28 / 27</td>
<td>54 / 34</td>
<td>70 / 70</td>
<td>63 / 51</td>
<td>128</td>
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<td>JPMorgan Prime Money Market</td>
<td>98 / 94</td>
<td>35 / 31</td>
<td>57 / 39</td>
<td>73 / 73</td>
<td>67 / 62</td>
<td>120</td>
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<tr>
<td>Vanguard Prime Money Market</td>
<td>94 / 69</td>
<td>39 / 25</td>
<td>0 / 0</td>
<td>68 / 68</td>
<td>33 / 24</td>
<td>106</td>
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<td>BlackRock Liquidity Temp</td>
<td>95 / 91</td>
<td>4 / 4</td>
<td>37 / 17</td>
<td>13 / 13</td>
<td>51 / 47</td>
<td>68</td>
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<td>Reserve Primary</td>
<td>98 / 88</td>
<td>24 / 18</td>
<td>54 / 51</td>
<td>18 / 18</td>
<td>43 / 37</td>
<td>65</td>
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<td>Schwab Value Advantage</td>
<td>91 / 64</td>
<td>24 / 19</td>
<td>58 / 48</td>
<td>67 / 67</td>
<td>54 / 40</td>
<td>61</td>
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<td>GS FS Prime Obligations</td>
<td>0 / 0</td>
<td>0 / 0</td>
<td>0 / 0</td>
<td>2 / 2</td>
<td>0 / 0</td>
<td>56</td>
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<td>Dreyfus Inst Cash Advantage</td>
<td>85 / 71</td>
<td>32 / 25</td>
<td>33 / 24</td>
<td>0 / 0</td>
<td>62 / 51</td>
<td>49</td>
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<td>Fidelity Inst Money Market</td>
<td>100 / 91</td>
<td>44 / 44</td>
<td>51 / 36</td>
<td>45 / 45</td>
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<td>Morgan Stanley Inst Liq Prime</td>
<td>4 / 4</td>
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<td>0 / 0</td>
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<td>Dreyfus Cash Management</td>
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<td>AIM STIT Liquid Assets</td>
<td>95 / 69</td>
<td>25 / 20</td>
<td>27 / 16</td>
<td>84 / 84</td>
<td>57 / 45</td>
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<td>Barclays Inst Money Market</td>
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<td>Merrill Lynch Premier Inst Portfolio</td>
<td>92 / 80</td>
<td>32 / 25</td>
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<td>45 / 45</td>
<td>60 / 51</td>
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<td>Fidelity Inst Money Market: Prime</td>
<td>100 / 90</td>
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<td>51 / 34</td>
<td>15 / 15</td>
<td>56 / 47</td>
<td>21</td>
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<tr>
<td><strong>Total</strong></td>
<td>92 / 78</td>
<td>26 / 22</td>
<td>47 / 33</td>
<td>51 / 51</td>
<td>50 / 42</td>
<td><strong>878</strong></td>
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</tbody>
</table>

**Share of asset class in assets**

<table>
<thead>
<tr>
<th>CDs and time deposits</th>
<th>Commercial paper</th>
<th>Corporate notes</th>
<th>Repos</th>
<th>Total</th>
<th>Net assets, $ billions</th>
</tr>
</thead>
<tbody>
<tr>
<td>34</td>
<td>26</td>
<td>13</td>
<td>11</td>
<td>100</td>
<td></td>
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<tr>
<td>Currency / Sponsor Location</td>
<td>U.S. dollars</td>
<td>Euro</td>
<td>Yen</td>
<td>Other</td>
<td>Total</td>
</tr>
<tr>
<td>-----------------------------</td>
<td>-------------</td>
<td>-------</td>
<td>------</td>
<td>-------</td>
<td>---------</td>
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<tr>
<td>Belgium</td>
<td>30,473</td>
<td>4,729</td>
<td>0</td>
<td>0</td>
<td>35,202</td>
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<tr>
<td>Denmark</td>
<td>1,796</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1,796</td>
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<tr>
<td>France</td>
<td>51,237</td>
<td>23,670</td>
<td>228</td>
<td>557</td>
<td>75,692</td>
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<td>139,068</td>
<td>62,885</td>
<td>0</td>
<td>2,566</td>
<td>204,519</td>
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<td>Italy</td>
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<td>0</td>
<td>0</td>
<td>0</td>
<td>1,365</td>
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<td>Japan</td>
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<td>0</td>
<td>22,713</td>
<td>0</td>
<td>40,820</td>
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<td>Netherlands</td>
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<td>65,859</td>
<td>0</td>
<td>3,116</td>
<td>125,765</td>
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<tr>
<td>Sweden</td>
<td>1,719</td>
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<td>1,719</td>
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<tr>
<td>Switzerland</td>
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<td>13,082</td>
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<tr>
<td>United Kingdom</td>
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<td>62,298</td>
<td>0</td>
<td>3,209</td>
<td>158,349</td>
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<td>United States</td>
<td>302,054</td>
<td>0</td>
<td>0</td>
<td>2,996</td>
<td>305,050</td>
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<tr>
<td><strong>Total</strong></td>
<td><strong>714,871</strong></td>
<td><strong>219,441</strong></td>
<td><strong>22,941</strong></td>
<td><strong>12,444</strong></td>
<td><strong>969,697</strong></td>
</tr>
</tbody>
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Figure 22: ABCP sponsor location and funding currency January 1, 2007 (Source: Acharya and Schnabel, IMF Economic Review 2009, data from Moody’s)
Figure 23: US Money market mutual fund assets (Source: Federal Reserve, Flow of Funds)
Figure 24: Expanding lending capacity of European banks draw USD funding to finance increased USD lending through shadow banking system.
<table>
<thead>
<tr>
<th>USD Billion</th>
<th>Total Bond Holdings</th>
<th>Treasury</th>
<th>Agency</th>
<th>Corporate</th>
<th>Corporate MBS</th>
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<tr>
<td>Total</td>
<td>6,642</td>
<td>2,194</td>
<td>1,413</td>
<td>3,035</td>
<td>594</td>
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<tr>
<td>Advanced</td>
<td>3,508</td>
<td>963</td>
<td>508</td>
<td>2,037</td>
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<td>Offshore</td>
<td>762</td>
<td>85</td>
<td>111</td>
<td>566</td>
<td>204</td>
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<td>Emerging/developing</td>
<td>2,373</td>
<td>1,147</td>
<td>794</td>
<td>432</td>
<td>40</td>
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<tr>
<td>China</td>
<td>894</td>
<td>477</td>
<td>387</td>
<td>29</td>
<td>9</td>
</tr>
<tr>
<td>Japan</td>
<td>976</td>
<td>622</td>
<td>231</td>
<td>123</td>
<td>17</td>
</tr>
<tr>
<td>Cayman Islands</td>
<td>461</td>
<td>29</td>
<td>56</td>
<td>376</td>
<td>157</td>
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<tr>
<td>United Kingdom</td>
<td>500</td>
<td>48</td>
<td>28</td>
<td>424</td>
<td>90</td>
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<tr>
<td>Luxembourg</td>
<td>469</td>
<td>56</td>
<td>42</td>
<td>371</td>
<td>39</td>
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<tr>
<td>Belgium</td>
<td>372</td>
<td>15</td>
<td>33</td>
<td>323</td>
<td>19</td>
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<tr>
<td>Ireland</td>
<td>261</td>
<td>16</td>
<td>30</td>
<td>215</td>
<td>33</td>
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<td>Switzerland</td>
<td>155</td>
<td>40</td>
<td>18</td>
<td>97</td>
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<tr>
<td>Germany</td>
<td>166</td>
<td>46</td>
<td>15</td>
<td>105</td>
<td>33</td>
</tr>
<tr>
<td>Netherlands</td>
<td>136</td>
<td>17</td>
<td>24</td>
<td>96</td>
<td>32</td>
</tr>
<tr>
<td>France</td>
<td>90</td>
<td>17</td>
<td>11</td>
<td>62</td>
<td>31</td>
</tr>
</tbody>
</table>

Figure 25: Foreign holding of US bonds in mid 2007 (Source: US Treasury and Milesi-Ferretti (2009), G20 Mumbai Volume)
Gross Positions versus Net Positions

- Large **gross positions** created by European banks impact on US financial conditions.

- But **net positions** (current account imbalances) are small since assets and liabilities net out.
  - Eurzone has near-balanced current account
  - UK has current account deficit
  - Borio and Disyatat (BIS working paper, 2011)

- Focusing on **Global Savings Glut** (net positions) misses the **Global Banking Glut** (gross positions)
Why did European banks expand so much?

Two candidate explanations:

- Basel II and EU Capital Adequacy Directive (CAD) allowed European banks to expand assets without incurring rising risk-weighted assets

- Advent of Euro opened up cross-border banking market within the eurozone

Implications for Current Conjuncture in Europe

• Europe has a **twin crisis**, combining **banking crisis** with **sovereign debt crisis**
  - Emerging economy crises of 1990s were **twin crises**, combining **banking crisis** with **currency crisis**

• Deleveraging by European banks will impact not only eurozone, but also
  - US shadow banking system
  - Capital flows to emerging economies (see below)
  - Emerging Europe, especially
Landscape of Global Banking

Borrowers in A

Banks in A

Banks in B

Banks in C

Borrowers in B

Borrowers in C

Global Banks

Wholesale Funding Market
Figure 26: External claims (loans and deposits) of BIS reporting banks on counterparties listed on right (Source: BIS locational banking statistics Table 7A)
Figure 27: External claims (loans and deposits) of BIS reporting banks on counterparties listed on right (Source: BIS locational banking statistics Table 7A)
Figure 28: External claims (loans and deposits) of BIS reporting banks on counterparties listed on right (Source: BIS locational banking statistics Table 7A)
Figure 29: External claims (loans and deposits) of BIS reporting banks on counterparties listed on right (Source: BIS locational banking statistics Table 7A)
Figure 30: International claims of BIS reporting banks on counterparties in countries listed on right (Dec 2010) (Source: BIS consolidated banking statistics Table 9D)
Figure 31: International claims (by percent) of BIS reporting banks on counterparties in countries listed on right (Dec 2010) (Source: BIS consolidated banking statistics Table 9D)
Figure 32: International claims of European BIS-reporting banks on counterparties in Korea (Source: BIS consolidated banking statistics Table 9D)
Credit Supply

Notation for balance sheet of bank

Bank

\[
\begin{array}{c}
C \\
E \\
L
\end{array}
\]

\[
\begin{array}{c}
1+r \\
1+f
\end{array}
\]
Credit Supply as Flip Side of Credit Risk Model

Vasicek (2002) model, backbone of Basel capital requirements.\(^1\)

Borrower \(j\) repays the loan when \(Z_j > 0\), where

\[
Z_j = -\Phi^{-1}(\varepsilon) + \sqrt{\rho}Y + \sqrt{1-\rho}X_j
\]

\(\Phi(\cdot)\) c.d.f. of standard normal, \(Y\) and \(\{X_j\}\) independent standard normals.

\[
\Pr(Z_j < 0) = \Pr\left(\sqrt{\rho}Y + \sqrt{1-\rho}X_j < \Phi^{-1}(\varepsilon)\right) \\
= \Phi\left(\Phi^{-1}(\varepsilon)\right) = \varepsilon
\]

\(^1\)http://www.moodyskmv.com/conf04/pdf/papers/dist_loan_port_val.pdf
Bank diversifies away idiosyncratic risk

Conditional on $Y$, defaults are independent.

Keep $C'$ fixed but diversify: increase number of borrowers, reduce face value of individual loans

In the limit, realized value of assets is function of $Y$ only

\[
w(Y) \equiv (1 + r) C \cdot \Pr(Z_j \geq 0|Y) \\
= (1 + r) C \cdot \Pr\left(\sqrt{\rho} Y + \sqrt{1 - \rho} X_j \geq \Phi^{-1}(\varepsilon)|Y\right) \\
= (1 + r) C \cdot \Phi\left(\frac{Y \sqrt{\rho} - \Phi^{-1}(\varepsilon)}{\sqrt{1 - \rho}}\right)
\]
Asset realization densities for three values of $\rho$ [$\varepsilon = 0.1$, $C(1 + r) = 1$]
Asset realization densities for three values of \( \varepsilon \) \([\rho = 0.2, C (1 + r) = 1]\)
c.d.f. of \( w \)

\[
F(z) = \Pr(w \leq z) \\
= \Pr(Y \leq w^{-1}(z)) \\
= \Phi(w^{-1}(z)) \\
= \Phi \left( \frac{1}{\sqrt{\rho}} \left( \Phi^{-1}(\varepsilon) + \sqrt{1-\rho} \Phi^{-1} \left( \frac{z}{(1+r)C} \right) \right) \right)
\]

Common risk factor \( \rho \) determines shape of the density, with larger \( \rho \) implying fatter tail.

**Value-at-Risk (VaR) rule:** keep enough equity to limit insolvency probability to \( \alpha > 0 \)
Private credit $C'$ determined from

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

Notional liabilities

Notional assets

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

where

$$\varphi (\alpha, \varepsilon, \rho) \equiv \Phi \left( \frac{\sqrt{\rho} \Phi^{-1}(\alpha) - \Phi^{-1}(\varepsilon)}{\sqrt{1 - \rho}} \right)$$
Figure 33: **Plot of notional debt to assets ratio** $\varphi(\alpha, \varepsilon, \rho)$. This chart plots $\varphi$ as a function of $\rho$ with $\alpha = 0.001$. Dark line is when $\varepsilon = 0.01$. Light line is when $\varepsilon = 0.005$. 
Supply of Credit

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

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

Aggregation holds due to proportionality

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

Risk premium is well-defined

$$\text{Risk premium} = (1 - \varepsilon) (1 + r) - 1$$
Risk premium is decreasing as assets expand by sliding down the credit demand curve. Lending standards are eroded in this sense.
Double-decker model of Global Liquidity

Figure 34: Bruno and Shin (2011) “Capital Flows, Cross-Border Banking and Global Liquidity”
Diversified loan portfolio from region $k$

Borrower $j$ in region $k$

Regions

Diversified loan portfolio across regional banks

Borrowers

Figure 35: Global and regional banks
Global, Regional and Idiosyncratic Risk Factors

\[ Z_{k,j} \equiv -\Phi^{-1}(\varepsilon) + \sqrt{\rho} Y_k + \sqrt{1 - \rho} X_{k,j} \]

\[ Y_k = \sqrt{\beta} G + \sqrt{1 - \beta} R_k \]

Regional bank \( k \) defaults when

\[ Y_k < w^{-1} ((1 + f) L) = \frac{1}{\sqrt{\rho}} \left( \Phi^{-1}(\varepsilon) + \sqrt{1 - \rho} \Phi^{-1}(\varphi) \right) \]

Or when \( \xi_k < 0 \)

\[ \xi_k \equiv \sqrt{\rho} Y_k - \Phi^{-1}(\varepsilon) - \sqrt{1 - \rho} \Phi^{-1}(\varphi) \]

\[ = \sqrt{\rho \beta} G + \sqrt{\rho (1 - \beta)} R_k - \Phi^{-1}(\varepsilon) - \sqrt{1 - \rho} \Phi^{-1}(\varphi) \]
Asset realization is deterministic function of global risk factor $G$

\[
w(G) = (1 + f) L \cdot \Pr(\xi_k \geq 0 | G)
\]

\[
= (1 + f) L \cdot \Pr \left( R_k \geq \Phi^{-1}(\varepsilon) + \sqrt{1 - \rho} \Phi^{-1}(\varphi) \right) - \sqrt{\frac{\beta}{1 - \beta}} G | G
\]

\[
= (1 + f) L \cdot \Phi \left( \sqrt{\frac{\beta}{1 - \beta}} G - \frac{\Phi^{-1}(\varepsilon) + \sqrt{1 - \rho} \Phi^{-1}(\varphi)}{\sqrt{\rho(1 - \beta)}} \right)
\]

Quantiles follow from the c.d.f. of $w(G)$.

\[
F(z) = \Pr(w(G) \leq z)
\]

\[
= \Pr(G \leq w^{-1}(z))
\]

\[
= \Phi(w^{-1}(z))
\]
where

\[ w^{-1}(z) = \sqrt{\frac{1-\beta}{\beta}} \left[ \Phi^{-1}\left( \frac{z}{(1+f)L} \right) + \frac{\Phi^{-1}(\varepsilon) + \sqrt{1-\rho \Phi^{-1}(\varphi)}}{\sqrt{\rho(1-\beta)}} \right] \]

Global bank Value-at-Risk (VaR) rule with insolvency probability \( \gamma > 0 \). Notional liability of the global bank is \((1 + i)M\).

\[
\gamma = \Pr (w(G) < (1 + i)M) \\
= \Phi \left( \sqrt{\frac{1-\beta}{\beta}} \left[ \Phi^{-1}\left( \frac{(1+i)M}{(1+f)L} \right) + \frac{\Phi^{-1}(\varepsilon) + \sqrt{1-\rho \Phi^{-1}(\varphi)}}{\sqrt{\rho(1-\beta)}} \right] \right)
\]
Notional liabilities \[ \frac{M}{L} \] = \frac{(1 + i) M}{(1 + f) L} \\
\equiv \Phi \left( \frac{\sqrt{\rho \beta \Phi^{-1}(\gamma) - \Phi^{-1}(\epsilon) - \sqrt{1 - \rho \Phi^{-1}(\phi)}}}{\sqrt{\rho (1 - \beta)}} \right) \\
\equiv \psi (\gamma, \alpha, \beta, \epsilon, \rho)

Cross-border loan supply

\[ L = \frac{E_G}{1 - \frac{1 + f}{1 + i} \psi} \]
Figure 36: Equilibrium cross-border lending $L$
Capital Flows and Domestic Credit

Market clearing for $L$

\[
\frac{E_R}{1 + \frac{f}{1 + r} \cdot \frac{1}{\varphi} - 1} = \frac{E_G}{1 - \frac{1 + f}{1 + i} \psi}
\]

Private credit

\[
C = \frac{E_G + E_R}{1 - \frac{1 + r}{1 + i} \varphi \psi}
\]

Total private credit

\[
\text{Aggregate bank capital (regional + global)}
= \frac{1 - \text{spread} \times \text{regional leverage}}{\text{global leverage}}
\]
Risk premium in recipient economy

\[ \pi \equiv (1 - \varepsilon)(1 + r) - 1 \]

Equilibrium stock of cross-border lending \( L \)

\[ L = \frac{E_G + E_R \cdot \frac{1+r}{1+i} \varphi \psi}{1 - \frac{1+r}{1+i} \varphi \psi} \]

Total cross-border lending \( = \frac{\text{Global and weighted regional bank capital}}{1 - \text{spread} \times \text{regional leverage} \times \text{global leverage}} \)
Comparative Statics

Banking sector capital flows:

- increase with $\Delta E_R$ (bank ROE)
- increase with bank leverage (fall with VIX)
- increase in change in bank leverage (fall with $\Delta VIX$)
- fall with interaction between ROE and VIX

(Explored empirically in Bruno and Shin (2011))