Leverage Constraints
International Transmission, and international financial integration

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Financial markets and international business cycles

• Typical IRBC models: financial linkages tend to reduce co-movement of business cycles
  – Remove income effects, enhance substitution effects

• Evidence tends to go the other way
  – Imbs (2004, 2006), and others

• Particularly, financial linkages heightened in crises times

• In crises, trade linkages offer only partial explanation of contagion
This paper

• Present theoretical model in which financial linkages tend to propagate shocks
  – Binding leverage constraints
  – Equity market integration
• Moving from financial segmentation to integrated financial markets implies
  – Risk sharing benefits
  – Costs in terms of high "portfolio contagion"
• Welfare gains from financial integration may be negative
Some intuition: Leverage and portfolio interdependence

• One highly levered investor gets negative returns shock
  – Sell assets to meet leverage constraints
• Fall in asset prices tighten all leverage constraints
• With financial integration, leverage constraints are interdependent across countries
  – Link through asset prices and capital flows
• Offers macro linkages independent of trade linkage
• One way to account for high co-movement
Real GDP growth OECD

Highly Synchronous downturn
Real GDP growth Asia + Australia-NZ

Synchronous but somewhat smaller
De-leveraging among banks

• US banks sharply reduced exposure to OECD and Asia following domestic balance sheet shocks
## Table 1b. Short term claims of US banks on OECD economies

$ millions.

<table>
<thead>
<tr>
<th>Destination of Funds</th>
<th>2007Q4</th>
<th>2008Q1</th>
<th>2008Q2</th>
<th>2008Q3</th>
<th>2008Q4</th>
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<tbody>
<tr>
<td>Austria</td>
<td>4179</td>
<td>4207</td>
<td>4841</td>
<td>3574</td>
<td>2256</td>
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<tr>
<td>Belgium</td>
<td>8742</td>
<td>13911</td>
<td>17453</td>
<td>15762</td>
<td>15567</td>
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<tr>
<td>Czech Rep</td>
<td>527</td>
<td>716</td>
<td>798</td>
<td>894</td>
<td>518</td>
</tr>
<tr>
<td>Finland</td>
<td>3191</td>
<td>2837</td>
<td>2386</td>
<td>3024</td>
<td>2928</td>
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<tr>
<td>France</td>
<td>57,952</td>
<td>69,098</td>
<td>41,790</td>
<td>44,355</td>
<td>55,287</td>
</tr>
<tr>
<td>Germany</td>
<td>56,910</td>
<td>65,933</td>
<td>48,407</td>
<td>41,295</td>
<td>39,266</td>
</tr>
<tr>
<td>Greece</td>
<td>3,947</td>
<td>4,857</td>
<td>3,005</td>
<td>2,310</td>
<td>2,428</td>
</tr>
<tr>
<td>Hungary</td>
<td>894</td>
<td>1,003</td>
<td>900</td>
<td>1,113</td>
<td>491</td>
</tr>
</tbody>
</table>

Source: BIS International Banking Statistics
De-leveraging: BIS reporting Banks

Table 1a. Short term claims of US banks on Asian economies, $ millions.

<table>
<thead>
<tr>
<th>Destination of Funds</th>
<th>2007Q4</th>
<th>2008Q1</th>
<th>2008Q2</th>
<th>2008Q3</th>
<th>2008Q4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hong Kong</td>
<td>10,079</td>
<td>10,066</td>
<td>12,900</td>
<td>11,366</td>
<td>8,837</td>
</tr>
<tr>
<td>Singapore</td>
<td>17,007</td>
<td>16,966</td>
<td>15,196</td>
<td>11,778</td>
<td>10,188</td>
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<tr>
<td>China</td>
<td>13,192</td>
<td>11,635</td>
<td>14,795</td>
<td>12,693</td>
<td>6,498</td>
</tr>
<tr>
<td>Chinese Taipei</td>
<td>7,845</td>
<td>9,689</td>
<td>8,929</td>
<td>7,155</td>
<td>3,795</td>
</tr>
<tr>
<td>India</td>
<td>25,722</td>
<td>20,779</td>
<td>16,582</td>
<td>17,093</td>
<td>13,801</td>
</tr>
<tr>
<td>Indonesia</td>
<td>6,007</td>
<td>5,902</td>
<td>5,286</td>
<td>6,782</td>
<td>5,313</td>
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<tr>
<td>South Korea</td>
<td>26,254</td>
<td>27,435</td>
<td>28,027</td>
<td>29,873</td>
<td>21,518</td>
</tr>
</tbody>
</table>

Source: BIS International Banking Statistics
De-leveraging in the aggregate

Figure 2
US capital inflows and outflows
In billions of US dollars
Plan of presentation

• Basic 2 country Model of Optimal Asset-Capital Allocation
• Combine with optimal portfolio choice
  – leveraged constrained multi-country setting
• Impact of macro shocks
  – International transmission mechanism
  – Impact of LC’s with financial integration
  – Impact of financial integration in presence of LCs
• Welfare effects of international financial integration
Related Literature

• Credit Channel
  – Carlstrom and Fuerst (1997)
  – Bernanke Gertler Gilchrist (2000)...
  – Mendoza Smith (2005), Benigno et al. (2009)...

• Portfolio Contagion
  – Calvo (2000)
  – Krugman (2008)

• Portfolio Choice in DSGE
  – Evans Hnatkovsaka (2008), Devereux-Sutherland (2009)
Modeling financial propagation

• 2 countries
• In each country
  – Investors (borrowers)
    • Access to investment options
  – Savers (lenders)
    • Lend at fixed rates
• Fixed asset can be owned by investors or savers
  – Investors transform fixed asset for use in production
  – Savers use it in home production
• Absence of commitment
  – leverage constraint on borrowers
International Dimension

• Investors in one country may own shares in other country’s fixed asset (equity holdings)
  – Choice of total fixed asset in production
  – Ownership of fixed asset used in production
• If returns are not perfectly correlated, then incentive for diversification
• Savers do not have access to equity markets
Investors problem (home)

• Population 1, investors size n

\[ E_t \sum_{s=t}^{\infty} \theta^I_s U(C^I_s) \]

– Endogenous discount factor

\[ \theta^I_{s+1} = \beta^I(C^I_s) \theta^I_s, \quad \beta^I'(C^I_s) \leq 0 \]
Investors problem

- Measure n of investors
- Hold equity claims, financed by debt
  - Also earn wage income from labour supply
  - Where $k_{1t}^I$ ($k_{2t}^I$) is holding of domestic (foreign) fixed asset

- No portfolio integration
  \[ C_t^I + q_{1t}k_{1t}^I = W_t^I + (q_{1t} + R_{1Kt})k_{1t-1}^I + B_t^I - R_{t-1}B_{t-1}^I \]

- With portfolio integration
  \[ C_t^I + q_{1t}k_{1t}^I + q_{2t}k_{2t}^I = W_t^I + (q_{1t} + R_{1Kt})k_{1t-1}^I + (q_{2t} + R_{2Kt})k_{2t-1}^I + B_t^I - R_{t-1}B_{t-1}^I \]
Investors problem

- Leverage constraint: no portfolio integration
  \[ B_t^I \leq \kappa q_{1t} k_{1t} \]
- With portfolio integration
  \[ B_t^I \leq \kappa(q_{1t} k_{1t}^I + q_{2t} k_{2t}^I) \]
- Maximum leverage ratio
  \[ \frac{1}{1-\kappa} \]
  – We assume this is always binding
- Here, \( \kappa \) is taken as given
Investors optimum: Portfolio diversification rule is unaffected

\[
E_t U'(C_{t+1}^I) \left( \frac{(q_{1t+1} + R_{1Kt+1})}{q_{1t}} - \frac{(q_{2t+1} + R_{2Kt+1})}{q_{2t}} \right) = 0
\]

Incentive to diversify is not affected by leverage constraints
Savers problem (home)

• Savers size 1-n

\[ E_t \sum_{s=t}^{\infty} \theta^S_s U(C^S_s) \]

– Savers are more patient

\[ \beta^S(x) > \beta^I(x) \]

– Ensures that in steady state without binding leverage, investors will be borrowers
Savers problem

- Savers are measure 1-n
- Savers earn wage income from labour supply
- Lend to investors

\[ C_t^S + q_{1t} k_{1t}^S = W_t^S + q_{1t} k_{1t-1}^S + G(k_{1t-1}^S) + B_t^S - R_{t-1} B_{t-1}^S \]

- Have `home production function’ for fixed asset
  - Fixed asset more productive in final goods sector
Portfolio choice and valuation effects

• Re-write investors problem in terms of NFA

\[ C_t^I + NFA_t = \]
\[ \hat{Y}_t^I + r_{2t} NFA_{t-1} + r_{xt} \left[ q_{1t-1} (k_{1t-1}^I - \hat{k}_{1t-1}^I) \right] + B_t - R_{t-1} B_{t-1} \]

\[ NFA_t = q_{2t} k_{2t}^I - q_{1t} (\hat{k}_{1t}^I - k_{1t}^I) \]

\[ r_{xt} = r_{1t} - r_{2t} \equiv \left( \frac{q_{1t} + R_{1K,t}}{q_{1t-1}} \right) - \left( \frac{q_{2t} + R_{2K,t}}{q_{2t-1}} \right) \]
Leverage constraints depend on NFA

• Financial flows (valuation changes) play two roles
  – Allow for consumption risk sharing
• Affect capital constraints of foreign investors

\[ B_t \leq \kappa (NFA_t + q_{1t} \hat{k}_{1t}^I) \]

  – Portfolio diversification – negative shock increases NFA for home, but tightens LC for foreign
Iceberg costs of financial trade

• When no costs, get full diversification

\[ E_t U'(C_{t+1}^I) \left( \frac{(q_{1t+1} + R_{1K_{t+1}})}{q_{1t}} - \frac{(q_{2t+1} + R_{2K_{t+1}})}{q_{2t}} \right) \exp(-\tau) = 0 \]

• Moving \( \tau \) allows us to scale up and down the portfolio

• Alternative would be to allow for endogenous terms of trade and debt
Calibration..solution..

• Look at low and high leverage ratios 2, 4

• Look at the impact of a shock to home country productivity in final goods production
## Calibration

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>( n )</td>
<td>Proportion of investors</td>
<td>0.5</td>
<td></td>
</tr>
<tr>
<td>( \eta )</td>
<td>Discount function</td>
<td>0.022</td>
<td></td>
</tr>
<tr>
<td>( \zeta )</td>
<td>Discount function</td>
<td>See text</td>
<td></td>
</tr>
<tr>
<td>( \kappa )</td>
<td>Leverage</td>
<td>0.5, 0.75</td>
<td></td>
</tr>
<tr>
<td>( \varepsilon )</td>
<td>Capital share in final goods production</td>
<td>0.36</td>
<td></td>
</tr>
<tr>
<td>( \omega )</td>
<td>Capital share in home production</td>
<td>0.1</td>
<td></td>
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<tr>
<td>( \sigma )</td>
<td>Coefficient of relative risk aversion</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>( \rho )</td>
<td>Productivity shock persistence</td>
<td>0.9</td>
<td></td>
</tr>
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</table>
Two experiments

A. Assume that financial (equity) markets are integrated
   – Look at international transmission of shocks with and without leverage constraints

B. Assume leverage constraints always bind
   – Look at integration of international financial markets

• In both cases, look at fall in productivity of home final goods sector
Without leverage constraints

• Fall in investment in home country
• Fall in home and foreign asset prices
• Portfolio diversification – fall in home and foreign consumption
• No de-leveraging – borrowing moves in opposite directions across countries
• Zero co-movement in final goods output
With Leverage Constraints

• Fall in home investment and asset prices
• Leads to fall in collateral value of assets
• Domestic balance sheet contraction – leads to foreign balance sheet contraction
  – Fall in foreign investment
• Again, fall in consumption in both countries
• Positive co-movement in final goods output
  – Varying degree of portfolio integration affects co-movements
Integration of Financial markets

• Look at case where bond markets integrated, but not financial markets
• Now, assume that leverage constraints bind at all times
• Again, negative shock to home productivity
Leverage constraints without financial market integration

• Negative home country shock
• Fall in wage income of savers investors
  – Increase in desire to borrow – raises interest rate
  – But fall in home asset prices – forcing reduction in borrowing of investors – reduces interest rates
• With high leverage constraints, second effect dominates
  – World interest rates fall
  – Increase in borrowing and investment in foreign country
• Causes negative international co-movement
Negative correlation of business cycles

• High gains from international portfolio integration
Integrated equity markets

- Investors are diversified against domestic shocks
- Clearly, consumption co-movements will rise
- Also, asset prices tend to move together
  - Standard results
- But in addition to that we have high correlation of investment, borrowing, output
  - This comes from leverage constraint channel
Post equity integration

- Much higher correlation of business cycle shocks
- Ex-post gains to integration much lower than ex-ante
### Unconditional moments

<table>
<thead>
<tr>
<th>Leverage constraints</th>
<th>Not binding</th>
<th>binding</th>
</tr>
</thead>
<tbody>
<tr>
<td>SDEV(C)</td>
<td>1.9</td>
<td>2.8</td>
</tr>
<tr>
<td>SDEV(q₁)</td>
<td>2.2</td>
<td>2.1</td>
</tr>
<tr>
<td>SDEV(R)</td>
<td>0.2</td>
<td>1.0</td>
</tr>
<tr>
<td>SDEV(\hat{k}^I₁)</td>
<td>0.3</td>
<td>3.5</td>
</tr>
<tr>
<td>CORR(C,C̄)</td>
<td>0.87</td>
<td>0.89</td>
</tr>
<tr>
<td>CORR(q₁,q₂)</td>
<td>0.94</td>
<td>0.93</td>
</tr>
<tr>
<td>CORR(\hat{k}^I₁,\hat{k}^I₂)</td>
<td>-0.03</td>
<td>0.96</td>
</tr>
<tr>
<td>CORR(R,R̄)</td>
<td>1.00</td>
<td>0.99</td>
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Unconditional moments

<table>
<thead>
<tr>
<th></th>
<th>Bond</th>
<th>Bond and Equity</th>
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<tbody>
<tr>
<td><strong>Asset markets</strong></td>
<td></td>
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<tr>
<td>$\text{SDEV}(C')$</td>
<td>4.7</td>
<td>2.8</td>
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<tr>
<td>$\text{SDEV}(q_1)$</td>
<td>3.2</td>
<td>2.2</td>
</tr>
<tr>
<td>$\text{SDEV}(R)$</td>
<td>1.0</td>
<td>1.0</td>
</tr>
<tr>
<td>$\text{SDEV}(\hat{k}_1^I)$</td>
<td>7.7</td>
<td>3.4</td>
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<tr>
<td><strong>CORR</strong></td>
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<tr>
<td>$\text{CORR}(C,C^*)$</td>
<td>-0.37</td>
<td>0.98</td>
</tr>
<tr>
<td>$\text{CORR}(q_1,q_2)$</td>
<td>-0.26</td>
<td>0.92</td>
</tr>
<tr>
<td>$\text{CORR}(\hat{k}_1^I,\hat{k}_2^I)$</td>
<td>-0.63</td>
<td>0.98</td>
</tr>
<tr>
<td>$\text{CORR}(R,R^*)$</td>
<td>1.00</td>
<td>1.00</td>
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</table>
Alternative shocks

• Financial shocks
  – (Dedola and Lombardo 2009, Quadrini and Perri 2010)

• Let there be a shock to the degree of leverage placed on borrowers

• With bond markets only, generates negative correlation again

• With equity markets – perfect positive correlation
Evaluating Welfare Effects

• Indirect impact of financial decisions on leverage constraints not internalized by private agents (Korinek, 2009)
• Implication is that financial integration may not increase welfare
• Compute unconditional welfare under alternative financial market arrangements
Welfare computations

- Autarky
- Bond Trade
- Equity Trade
  - Unrestricted
  - Restricted
## Welfare evaluation

<table>
<thead>
<tr>
<th></th>
<th>Leverage</th>
<th>Low</th>
<th>High</th>
<th>Financial Shocks</th>
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<tr>
<td><strong>Autarky</strong></td>
<td>U(I)</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>U(S)</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td><strong>Bond Trade</strong></td>
<td>U(I)</td>
<td>1.01</td>
<td>.98</td>
<td>.7</td>
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<tr>
<td></td>
<td>U(S)</td>
<td>.95</td>
<td>.9</td>
<td>1.3</td>
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<tr>
<td><strong>Full equity</strong></td>
<td>U(I)</td>
<td>1.06</td>
<td>1.1</td>
<td>.98</td>
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<tr>
<td></td>
<td>U(S)</td>
<td>.98</td>
<td>.99</td>
<td>1.28</td>
</tr>
<tr>
<td><strong>Restricted Equity</strong></td>
<td>U(I)</td>
<td>1.01</td>
<td>.99</td>
<td></td>
</tr>
<tr>
<td></td>
<td>U(S)</td>
<td>1.02</td>
<td>.99</td>
<td></td>
</tr>
</tbody>
</table>
Conclusions

• Model is sparse – absence of many IRBC mechanisms

• But highlights a key channel of international transmission

• Adding on to a DSGE model retains this channel
  – Can offset forces for negative correlation in DSGE models

• Clear implications for policy – financial market interventions