The Role of Liquidity, Risk and Economic Activity in the Global Transmission of the Financial Crisis

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Motivation

- Global reach of financial crisis with high degree of heterogeneity across countries and regions
- What are transmission mechanisms?
- Liquidity shocks
  - "liquidity squeeze" in credit markets and esp. inter-bank markets
  - collapse or near-collapse of financial institutions
  - massive central bank interventions, incl. cross-border through swap lines
- Pricing of risk & risk appetite
  - high leverage of financial institutions, though not in EMEs
  - deleveraging and "flight-to-safety" phenomena, esp. out of EMEs; into US treasuries
- Real economy shocks
  - de-coupling vs re-coupling
  - collapse in trade, esp. for more open EMEs
Motivation

- First step: Understanding the transmission mechanism
  - How does the transmission of shocks differ across economies?
  - Has the transmission mechanism changed in the crisis?

- Second step: Explaining the heterogeneity in the global transmission

- Potential transmission channels
  - real and financial exposure
  - idiosyncratic: country macro fundamentals
  - strength of domestic institutions
Methodology

- Challenge of identification of liquidity shocks, risk shocks and real activity shocks

- Financial market perspective
  - response of money markets as proxy for impact on financial conditions
  - response of equity markets as proxy for impact on real economy

- Global VAR (infinite-dimensional VARs) of Chudik and Pesaran (2009, 2010) allows addressing:
  - large dimension of VAR - for 26 economies - via concept of neighborhood effects
  - all variables treated as endogeneous
  - restrictions allow for rich spatial and temporal interactions among variables
  - identification of various shocks, with additional sign restrictions
  - distinguish US shocks from shocks to other economies
Main findings – transmission

1. Liquidity shocks key driver during crisis
   - primarily for advanced economies
   - for both money markets and equity markets

2. Risk shocks and real activity shocks also more important in crisis
   - mainly for EMEs

3. Effect on advanced economies more via financing conditions vs on EMEs more via real economy channel

4. Further cross-economy heterogeneity
   - Europe experienced highest increase in exposure to US shocks in crisis
   - Latin America and CEEC mainly via risk shocks, Emerg. Asia via liquidity
Main findings – channels

1. Bayesian Averaging of Classical Estimates (BACE) approach (Sala-i-Martin et al. 2004)
   - cross-sectional averaging with OLS
   - to deal with large number of potential determinants

2. During tranquil periods:
   - real and financial exposure to US more relevant for understanding heterogeneity in transmission of US shocks

2. During crisis:
   - domestic fundamentals, risk and quality of institutions more relevant
   - e.g. FX reserves, sovereign country rating
   - real and financial exposure less relevant
Literature – Crisis, global transmission

- **Current financial crisis**
  - Focus on US policy responses (Calomiris 2008, Taylor 2009)
  - Role of liquidity (Adrian et al. 2009, Heider, Hoerova and Holthausen 2009)
  - Financial constraints rather than demand in US (Tong & Wei 2008)
  - Little on global transmission (e.g. IMF 2009 on financial stress transmission)

- **Crisis and role of contagion for transmission**
  - Time-varying global market integration (Bekaert & Harvey 1995, 2000)
The methodological approach of the paper links to a broad literature focusing on Global VAR (GVAR) models.

GVAR was proposed by Pesaran, Schuermann and Weiner (2004). Since then, it has been developed further and used in various applications (Pesaran et al., 2006, Dees et al., 2007, Pesaran, Smith and Smith, 2007, among others).

Methodological foundations for the specification of country models were developed recently by Chudik and Pesaran (2010) and later extended by Pesaran and Chudik (2010) to allow for dominant units.
Methodology

- We follow strategy of Global VAR literature (2 steps):
  1. Estimation of country-specific models of small dimension
  2. Solving estimated country models in one large Global VAR

- We follow Chudik and Pesaran (2010) and Pesaran and Chudik (2010) to design individual country models.

- Our starting point is the following high-dimensional VAR model augmented with common factors,

\[ x_t = \alpha + \Phi x_{t-1} + \Gamma f_t + u_t, \quad \text{and} \quad u_t = R \varepsilon_t, \tag{1} \]

where \( \Phi \) is a large \( k \times k \) matrix of coefficients,
\( u_t = (u_{1t}', ..., u_{Nt}')' \) is an \( k \times 1 \) vector of reduced form errors,
\( f_t \) is \( m \times 1 \) vector of (strong) unobserved common factors,
and \( \Gamma \) is the corresponding \( k \times m \) matrix of factor loadings.
All coefficients in system (1) cannot be estimated due to curse of dimensionality (large number of endogenous variables).

Pesaran and Chudik propose economically intuitive solution to the curse of dimensionality based on concept of neighborhood effects.

- We are very generous on the possibilities of spatio-temporal linkages
- We allow for US dominance in financial markets, other sources of strong cross section dependence besides the US influence, and local neighborhood effects.

Our methodology treats all variables as endogenous. We do not rely on some of the restrictive assumptions in factor model literature (e.g. the assumption that unbounded eigenvalues cannot rise at a rate slower than N).
Global shocks enter the vector residuals in the US marginal model (featuring domestic variables and foreign cross section averages), but additional restrictions are needed if one wants to distinguish between US and foreign global shocks with non-US origin.

To accomplish this, we suppose that the US shocks come first.

Within the set of US shocks, we aim to distinguish between a **US macro surprise shock**, a **stock market shock**, an **interest rate shock**, a **risk aversion shock** and a **liquidity shock**. We combine sign restriction and partial ordering approaches to achieve identification.

Partial ordering of US shocks: (Group 1) a US macro surprise shock, (Group 2) risk aversion shock and a liquidity shock, and (Group 3) a stock market shock and an interest rate shock.
### Summary of sign restrictions.

<table>
<thead>
<tr>
<th></th>
<th>$i_{1t}$</th>
<th>$r_{1t}$</th>
<th>$vix_t$</th>
<th>$ted_t$</th>
<th>$news_t$</th>
<th>$\bar{i}_t$</th>
<th>$\bar{r}_t$</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>VIX shock</strong></td>
<td></td>
<td></td>
<td>+</td>
<td></td>
<td></td>
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<td></td>
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<tr>
<td><strong>TED shock</strong></td>
<td>+</td>
<td>-</td>
<td>.</td>
<td>+</td>
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<tr>
<td><strong>US interest rate shock</strong></td>
<td>+</td>
<td>-</td>
<td>.</td>
<td>.</td>
<td>.</td>
<td>+</td>
<td>-</td>
</tr>
<tr>
<td><strong>US stock market shock</strong></td>
<td>+</td>
<td>+</td>
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<td>.</td>
<td>.</td>
<td>+</td>
<td>+</td>
</tr>
</tbody>
</table>
Data

- 26 economies – open advanced economies and EMEs
- Weekly frequency – trade-off speed of transmission vs. non-overlapping trading times:
  - Liquidity - TED spread
  - Risk - VIX
  - Equity returns (MSCI, LC)
  - Money markets (3M interbank)
  - Real activity - US macro news
    - unweighted aggregate across GDP, IP, retail sales, NAPM/ISM, non-farm payroll employment, unemployment, consumer confidence, workweek
    - (a) normalizing by their standard deviation over the sample period, (b) then by aggregating by week
- Note: macroeconomic news are exogenous by definition (Andersen et al. 2003, Ehrmann & Fratzscher 2007)
Stock market indices

- US
- Advanced Europe
- Other Advanced
- EME Asia
- EME Europe
- Latam
VIX and TED spread
US macro surprise shocks
Estimation – transmission

- Variance decomposition
  - gauge how much of total variation in equity markets and money markets can be accounted for by various shocks

- Generalised impulse response functions (GIRF)
  - sensitivity of equity markets and money markets to a specific shock of a given magnitude

- Remark:
  - decrease in sensitivity of a particular market to a specific shock is not necessarily inconsistent with higher share of variance accounted for by that shock
  - changes in volatility of underlying shock
Main findings – transmission

1. Liquidity shocks key driver during crisis
   - primarily for advanced economies
   - for both money markets and equity markets

2. Risk shocks and real activity shocks also more important in crisis
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3. Effect on advanced economies more via financing conditions vs on EMEs more via real economy channel

4. Further cross-economy heterogeneity
   - Europe experienced highest increase in exposure to US shocks in crisis
   - Latin America and CEEC mainly via risk shocks, Emerg. Asia via liquidity
## Variance decomposition

<table>
<thead>
<tr>
<th>Stock Markets</th>
<th>Pre-crisis period</th>
<th>Crisis period</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>US macro news</td>
<td>TED shock</td>
</tr>
<tr>
<td>US</td>
<td>0.00</td>
<td>24.34</td>
</tr>
<tr>
<td>Advanced</td>
<td>0.35</td>
<td>9.63</td>
</tr>
<tr>
<td>Emerging</td>
<td>0.44</td>
<td>8.23</td>
</tr>
<tr>
<td></td>
<td>7.26</td>
<td>33.57</td>
</tr>
<tr>
<td>Advanced</td>
<td>3.29</td>
<td>25.81</td>
</tr>
<tr>
<td>Emerging</td>
<td>3.99</td>
<td>19.81</td>
</tr>
</tbody>
</table>
**Variance decomposition (Ctd.)**

<table>
<thead>
<tr>
<th></th>
<th>US macro news</th>
<th>TED shock</th>
<th>VIX shock</th>
<th>US stock m.</th>
<th>US money m.</th>
<th>Rest</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Money Markets</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Pre-crisis period</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>US</td>
<td>1.94</td>
<td>0.58</td>
<td>2.90</td>
<td>3.70</td>
<td>21.04</td>
<td>69.84</td>
</tr>
<tr>
<td>Advanced</td>
<td>0.42</td>
<td>0.67</td>
<td>1.96</td>
<td>0.22</td>
<td>0.15</td>
<td>96.59</td>
</tr>
<tr>
<td>Emerging</td>
<td>0.64</td>
<td>0.59</td>
<td>0.67</td>
<td>1.26</td>
<td>5.17</td>
<td>91.68</td>
</tr>
<tr>
<td><strong>Crisis period</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>US</td>
<td>0.02</td>
<td>29.48</td>
<td>14.61</td>
<td>21.37</td>
<td>19.78</td>
<td>14.74</td>
</tr>
<tr>
<td>Advanced</td>
<td>0.74</td>
<td>9.73</td>
<td>6.20</td>
<td>4.20</td>
<td>0.89</td>
<td>78.24</td>
</tr>
<tr>
<td>Emerging</td>
<td>1.13</td>
<td>4.59</td>
<td>3.21</td>
<td>3.21</td>
<td>2.78</td>
<td>85.07</td>
</tr>
</tbody>
</table>
Impulse response functions

Impulse response function of a shock to US TED spread, impact on stock markets. Dashed lines correspond to crisis period.
Impulse response function of a shock to VIX, impact on stock markets.
Dashed lines correspond to crisis period.
Impulse response function of US macro news shock, impact on stock markets. Dashed lines correspond to crisis period.
Impulse response function of US stock market shock, impact on stock markets. Dashed lines correspond to crisis period.
Impulse response function of US money market shock, impact on stock markets. Dashed lines correspond to crisis period.
Contemporaneous impact of a shock to US TED spread on stock markets and 25-75% bootstrap error bands. Dark/brown bars correspond to crisis period; light/green bars to pre-crisis period.
Contemporaneous impact of a shock to VIX on stock markets and 25-75% bootstrap error bands. Dark/brown bars correspond to crisis period; light/green bars to pre-crisis period.
Contemporaneous impact of US macro news shock on stock markets and 25-75% bootstrap error bands. Dark/brown bars correspond to crisis period; light/green bars to pre-crisis period.
Analysis of cross-country differences in the transmission of shocks - Methodology

- To shed light on the cross-section heterogeneity in the transmission of US shocks to the rest of the world, we estimate the following cross-section regression

\[ y^{(s)}_i = c^{(s)} + \sum_{\ell=1}^{K} \beta^{(s)}_{\ell} x_{i\ell} + \zeta^{(s)}_i, \text{ for } i = 2, ..., N, \]

where \( y^{(s)}_i \) is the contemporaneous impact of a US shock \( s \) (to US macro news, VIX, TED, US money market or US stock market) on the stock market or the money market of country \( i \), and \( x_{i\ell} \) for \( i = 2, ..., N \) and \( \ell = 1, 2, ..., K \) is the set of \( K \) fundamentals specific to country \( i \).
We have relatively limited number of countries, yet the potential set of country fundamentals is large (We have compiled $K = 14$ fundamentals)

Therefore we follow Bayesian Averaging of Classical Estimates (BACE) approach of Sala-i-Martin et. al (2004), which was originally developed to analyze determinants of growth.

This approach combines the averaging of estimates across models estimated by classical ordinary least squares (OLS) and is particularly useful for understanding which of the large set of determinants (if any) might play a role empirically.
### Country Fundamentals

<table>
<thead>
<tr>
<th><strong>Macroeconomic</strong></th>
<th></th>
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</thead>
<tbody>
<tr>
<td>Openness, financial integration, rating notches, reserves as a share of GDP</td>
<td></td>
</tr>
<tr>
<td>unemployment, growth, current account as a share of GDP</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Quality of institutions</strong></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>ICRG institutional measures: political category index, financial category index, economic category index</td>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Bilateral exposure to US</strong></th>
<th></th>
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</thead>
<tbody>
<tr>
<td>trade exposure, financial debt exposure, financial equity exposure</td>
<td></td>
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</tbody>
</table>
Cross section regression results: Posterior probabilities of variable relevance and posterior means.

<table>
<thead>
<tr>
<th>US shock</th>
<th>Crisis period, impact on stock prices</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>vix</td>
</tr>
<tr>
<td>openness</td>
<td>19% (0.07)</td>
</tr>
<tr>
<td>financial int.</td>
<td>19% (-0.01)</td>
</tr>
<tr>
<td>trade exposure</td>
<td>57% (-2.32)</td>
</tr>
<tr>
<td>equity exposure</td>
<td>29% (-1.44)</td>
</tr>
<tr>
<td>financial debt exposure</td>
<td>40% (2.59)</td>
</tr>
<tr>
<td>rating notches</td>
<td>59% (0.11)</td>
</tr>
<tr>
<td>icrg- political</td>
<td>59% (-0.05)</td>
</tr>
<tr>
<td>icrg- financial</td>
<td>24% (0.02)</td>
</tr>
<tr>
<td>icrg - economic</td>
<td>39% (0.06)</td>
</tr>
<tr>
<td>market cap</td>
<td>22% (0.00)</td>
</tr>
<tr>
<td>reserves</td>
<td>19% (-0.00)</td>
</tr>
<tr>
<td>unemployment</td>
<td>18% (-0.01)</td>
</tr>
<tr>
<td>growth</td>
<td>21% (0.04)</td>
</tr>
<tr>
<td>current account</td>
<td>26% (0.01)</td>
</tr>
</tbody>
</table>
I. Trade openness (Dark/brown lines correspond to countries above median; light/green bars to the group below median. Dotted lines correspond to the crisis period. Impact of VIX and US macro news shocks on stock markets.)
II. Rating notches (Dark/brown lines correspond to countries above median; light/green bars to the group below median. Dotted lines correspond to the crisis period. Impact of VIX and US macro news shocks on stock markets.)
III. Political institutions (Dark/brown lines correspond to countries above median; light/green bars to the group below median. Dotted lines correspond to the crisis period. Impact of VIX and US macro news shocks on stock markets.)
IV. Reserves (Dark/brown lines correspond to countries above median; light/green bars to the group below median. Dotted lines correspond to the crisis period. Impact of VIX and US macro news shocks on stock markets.)
Conclusions

- Focus on global transmission of financial crisis, across advanced economies and EMEs
- Global VAR approach; 26 economies and 2 financial market segments
- Objective to better understand role of three distinct types of shocks as culprits:
  - a tightening in liquidity conditions and credit markets $\rightarrow$ mattered more for advanced, esp. in Europe
  - a severe re-pricing of risk and flight of investors into safe asset classes $\rightarrow$ EMEs, esp. CEEC
  - a strong and synchronous collapse of economic activity $\rightarrow$ EMEs, esp. Latin America & CEEC
- Factors accounting for cross-country differences
  - role of country-specific fundamentals versus external exposure
Implications

- Complexity of global transmission of the crisis; cannot be reduced to a single dimension
- Countries were not innocent bystanders, but severity of transmission not only related to real and financial exposure...
- But to a substantial extent also to domestic macroeconomic fundamentals and institutions
- Role for economic policy, though controversy about specifics (e.g. self-insurance/reserves vs. institutions)