

# Ranking Systemically Important Financial Institutions

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*A project supported by CIFR:E102*

Macquarie Financial Risk Day, March 2013

# Systemic Risk

- Two of the main themes emerging from Global Financial Crisis
  - *Systemic Risk:*
  - *Interlinkages of Financial Sector and Real Economy:*

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## Broad Definitions:

- 1 Problems which impede functioning of financial markets:  
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*Bank of England Survey of Systemic Risks*

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*Tarishv and Borio (2010)*
- 2 Asking people what they perceive the common risks are:  
*Bank of England Survey of Systemic Risks*
- 3 Expected capital shortages/defaults:  
*Acharya et al (2010), Moore and Zhuo (2012)*

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- 1 Interconnectedness:  
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- 2 Failure of an institution in response to a common shock which hits all simultaneously:  
*Allen and Babus (2010)*
- 3 Potential for a shock in one sector/firm to cause collapse or disruption in other sectors:  
*BIS (1992), Rochet and Tirole (1996), Trichet (2009)*



## Systemic Risk:

Jean-Claude Trichet, Clare Distinguished Lecture, Cambridge, 2009

### Definition

"Threat that developments in the financial system can cause a seizing-up or breakdown of this system and trigger massive damage to the real economy."

Four components:

- a system of risks
- linkages between financial sector and real economy
- shocks to risk
- common and idiosyncratic shocks

## Some existing rankings:

### ■ **BIS Bucketing approach**

- Identify globally systemically important institutions
- Equally weighted firm characteristics: size, cross-jurisdiction activity, interconnectedness, substitutability/financial institution infrastructure, complexity
- annual data, revised every 3 years
- implementation due from Jan 2016

### ■ **Minimum expected shortfall (MES)**

- How much capital would need to be injected if faced with a crisis?

$$\text{Capital Shortfall} = k(\text{debt}) + (1 - k)\text{capital} * \text{MES}$$

where  $k$  = prudential ratio of asset value to equity

- *Acharaya et al (2010), Brownlees and Engle (2011)*: Stern Vol-lab project

## US Banks identified as Systemically Important:

BIS Bucketing	Stern V-lab ranking	
	Dec 2009	Dec 2011
Bank of America	2	1
Bank of NY Mellon	>200	18
Citigroup	1	2
Goldman Sachs	9	4
JP Morgan Chase	3	3
Morgan Stanley	5	5
State Street	62	29
Wells Fargo	26	20

## Measuring a System of Risks:

- A **network** of risks - interconnected financial and real economy firms
- Modelling aims for the connections
  - Connections between firms vary through time
  - cross-section and time-varying aspects of the network

# Measuring a System of Risks:

- How do we measure the connections?
  - undirected weighted network
  - Model risk using volatility: *Diebold and Yilmaz (2011,2012)*
  - correlations of volatility risks are weights
  - volatilities are vertices
- Additional weights attributed to firm characteristics:
  - size, liquidity, leverage

## A Technicality on Risk Measures:

- We observe actual volatility,  $x_{i,t}$
- We want risk **shocks**,  $v_{i,t}$ , and these should be **unanticipated**
- We can view observed volatility as filtered result of all the shocks

$$x_{i,t} = C_i(L)v_{i,t}$$

- What is important is that the covariances between shocks and volatilities will be the same (conditional on information to time  $t - 1$ )

$$\text{Cov}(x_{i,t}, x_{j,t} | I_{t-1}) = \text{Cov}(v_{i,t}, v_{j,t} | I_{t-1})$$

- so we can use the network of correlations between observed volatilities

## SIFI rank:

### Definition

A firm is systemically important if it is highly connected with strong transmission channels to other firms, and particularly if its strongest linkages are with other companies which are also systemically important.

$$S_{k,t} = \sum_{j \in \mathbb{R}_{k,t}} S_{j,t} c_{k,j,t}$$

$S_{k,t}$  is systemic importance of firm that is ranked  $k^{\text{th}}$  position at time  $t$

$\mathbb{R}_{k,t}$  is all the companies which have a transmission to firm  $k$

$c_{k,j,t}$  is the transmission weight between firms  $j$  and  $k$

relates to *eigenvalue centrality* in network theory

## SIFI rank:

$c_{k,j,t}$  is the transmission weight between firms  $j$  and  $k$

$$c_{k,j,t} = \frac{\rho_{k,j,t}}{\sum_{i \in S_{j,t}} \rho_{i,j,t}}$$

- This is the transmission channel between companies  $k$  and  $j$  at time  $t$  scaled by all the transmission channels between company  $j$  and the rest of the system.



## SIFI Rank:

First measure *SIFIr*ank:

### Definition

Let  $S_t^{FIN}$  be the subset of  $S_t$  which are financial firms.

$$SIFIr\text{ank} = \text{rank}(S_t^{FIN}).$$

- Problem- this does not consider the overall level in the system (being top in a low period  $\neq$  being top in high risk period)
- Solution - rescale

## General Systemic Risk measure:

Second measure  $GS_t$ :

### Definition

The GS index ( $GS_t$ ) takes account of the fact that as the strength of the transmission channels increase, the network becomes more dense, which is measured by average importance

$$GS_t = \frac{1}{N} \sum_{k=1}^N \frac{S_{k,t}}{\max_{t' \leq t} (GS_{t'})}$$

The maximum  $GS_t$  occurs on the most systematically risky day in the sample history.

Set the denominator to a constant so everything is compared to that day - here September 11, 2008.

## SIFI ranks:

We can add firm characteristics at this point:

- 1 size: market value of equity
- 2 leverage: debt financing
- 3 liquidity: liquid assets on the book (measure with short term cash and short term investments)

Add the firm characteristics and give weight to the network ( $\alpha$ ) relative to the characteristics with vector of weights ( $\omega$ ).

$$S_{k,t} = \alpha \sum_{j \in \mathbb{R}_{k,t}} S_{j,t} c_{k,j,t} + \omega' \mathbf{f}_{k,t}$$

## Volatility Data:

- Daily realized volatilities for 504 firms from the S&P500 firms history on SIRCA
- 5 minutes sampling for 9:30 to 4:30 New York time; *Lahaye et al (2010)*
- January 2003 - December 2011
- Considerable data cleaning

## Volatility Data:

- We retain jumps:
- these are important to the common experiences we are trying to model and are particularly important in characterising crises; *Dungey et al (2011)*

$$RV_{i,t} = \sum_{k=1}^{1/\delta} \Delta^\delta X_{t+\delta k} \xrightarrow{p \text{ lim}} \text{quadratic variation} + \text{Jumps}^2$$

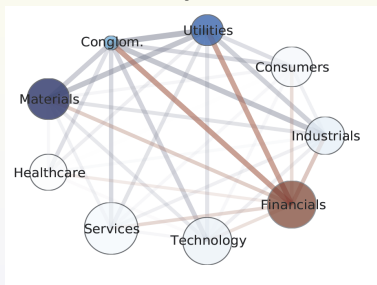
see eg *Barndorff-Neilson and Shephard (2004)*

## Implementation:

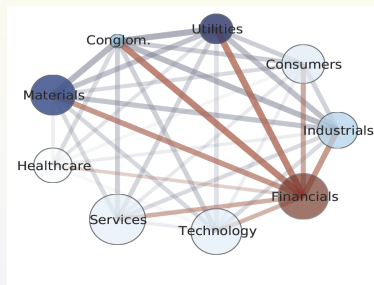
- Rolling window of 400 days (about 1.5 years)
- Begins: January 2, 2003 ends August 10, 2004
  - designed to capture the period prior to the last monetary policy cycle in US
- Compute the shocks, the correlations, the *SIFrank* and *GS*
- Roll forward 1 day at a time
- Last window: June 3, 2010 ends December 30, 2011.
- Total of 1863 windows

# Network Diagrammatically

1 May 2006

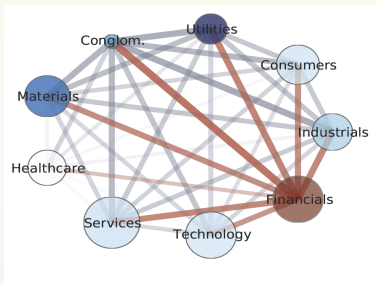


11 December 2007

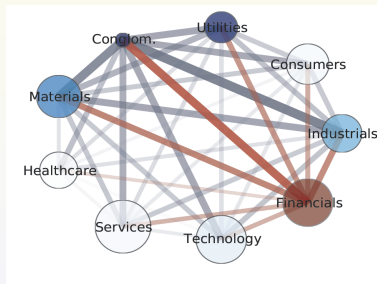


# Network Diagrammatically

9 September 2008

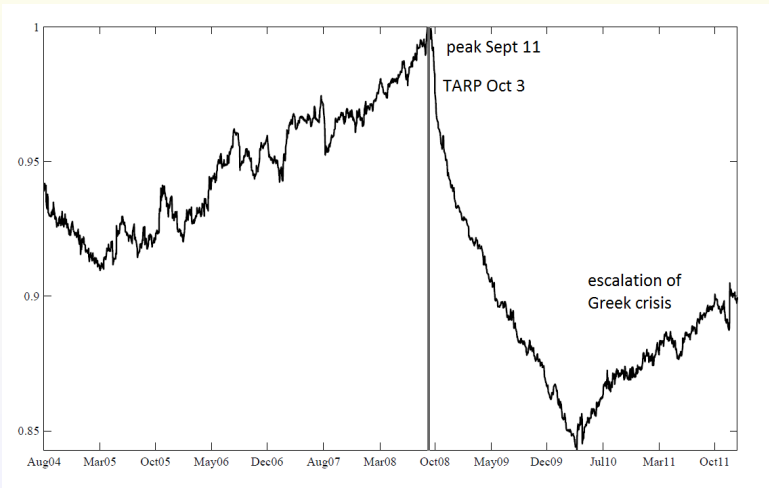


30 December 2011





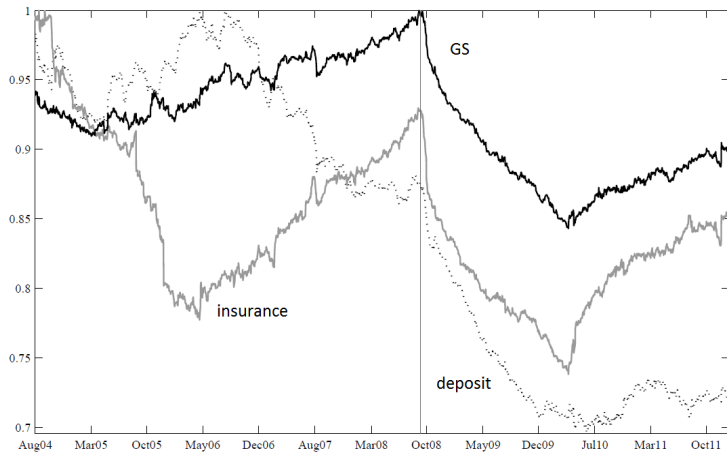
## Results: GS index



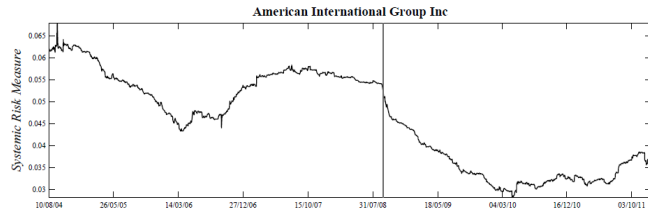
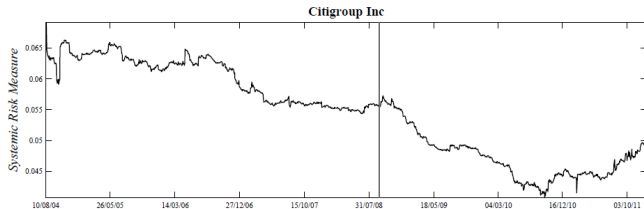
## Results: Institutional types

- Do results differ by institutional type - regulatory importance
  - Focus on banking systems: international effects *King (2011)*
  - Hedge funds: eg *Boyson, Staehl and Stulz (2010)*
  - Links between insurance and banking: *Billio et al (2010)*
  - Divisions into institutional types: *Brownlees and Engle (2011)*
- Deposit-taking (20) and insurance companies (22)

## Results: GS index for financial sector



## Results: Individual examples



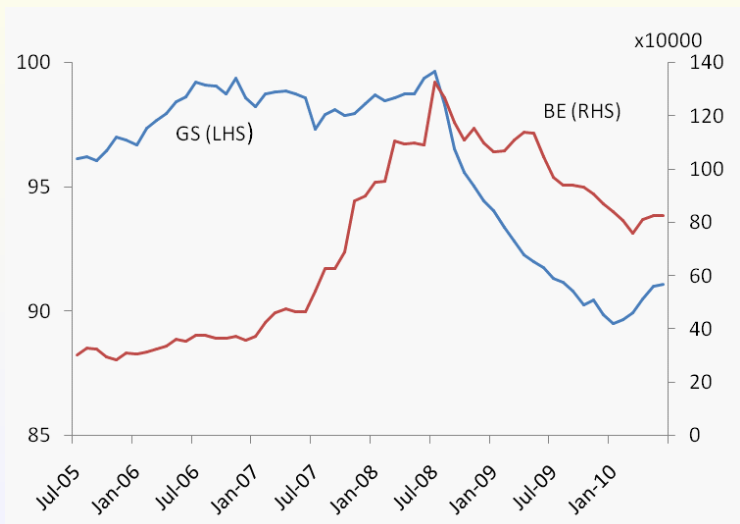
## Comparison with capital shortfall measures

### Definition

Marginal Expected Loss (MES): expected loss an equity investor in a financial firm would take if overall market declined substantially

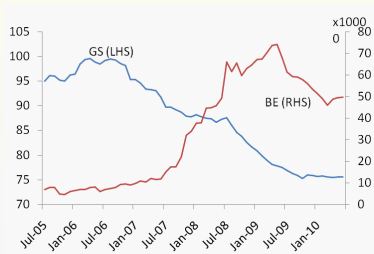
- Use timevarying volatility and correlation measures (TARCH and DCC)
  - MES is high for volatile firms
  - MES is high for non-diversified firms

## Compare with Brownlees Engle measure

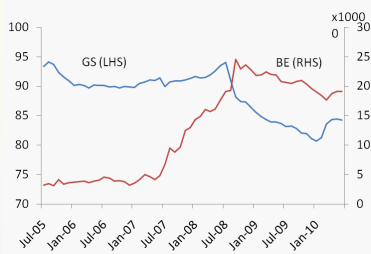


## Compare with BE: deposit-taking

### Deposit-taking



### Insurance



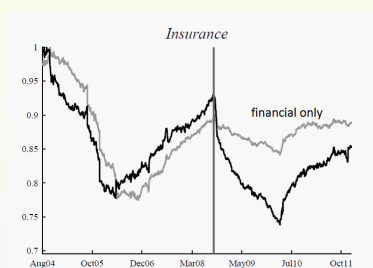
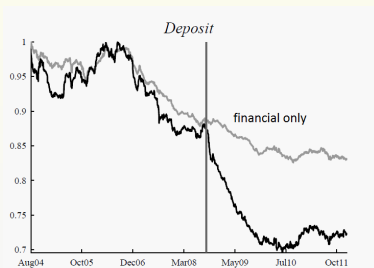
After September 2008: systemic risk by interconnectedness comes down (GS) but heightened capital shortfall (BE) remains

## Do real economy linkages make a difference?

- All the alternative classifications analysed so far have included only financial institutions
- Financial institutions are intrinsically linked to the real economy
- Our approach includes financial and real sectors
- How much difference does this make?
  
- Construct GS indices on the subset of only financial sector firms

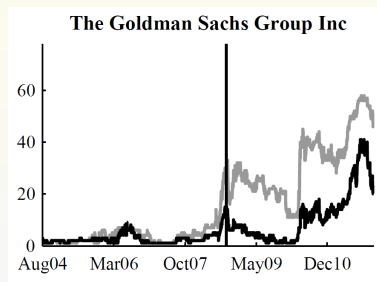
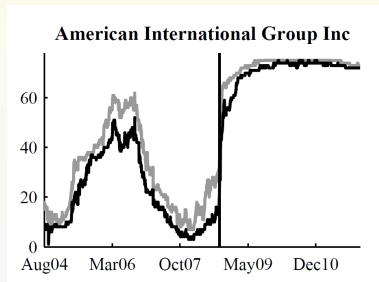


## Results: Do real economy linkages make a difference?



- interconnectedness shows an increasing gap post-crisis when real economy linkages are taken into account
- consistent with the reduction in perceived risk to the real economy after policy interventions

## Results: Do firm characteristics make a difference?



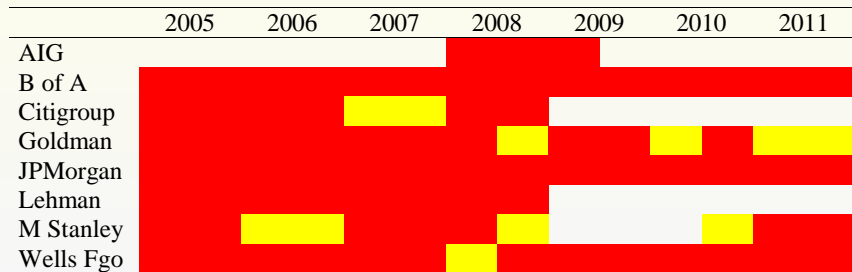
- Accounting for characteristics changes the GS measure - not always the same amount

## Which firms are systemically important?

BIS Bucketing	Stern V-lab ranking		DLV ranking	
	Dec 2009	Dec 2011	Dec 2009	Dec 2011
Bank of America	2	1	1	24
Bank of NY Mellon	>200	18	9	29
Citigroup	1	2	30	22
Goldman Sachs	9	4	2	26
JP Morgan Chase	3	3	4	4
Morgan Stanley	5	5	33	12
State Street	62	29	14	23
Wells Fargo	26	20	7	5

Why?? some of this is about including insurance companies

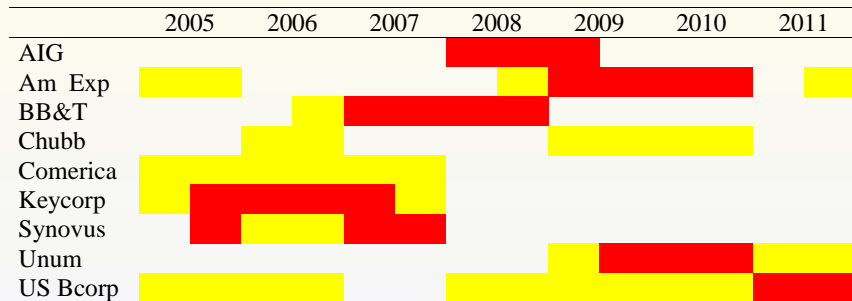
## Who are systemically important?



Red: top 10 in 80% of days in 6 month period

Yellow: top 20 in 80% of days in 6 month period

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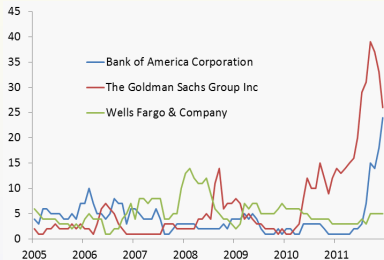


Red: top 10 in 80% of days in 6 month period

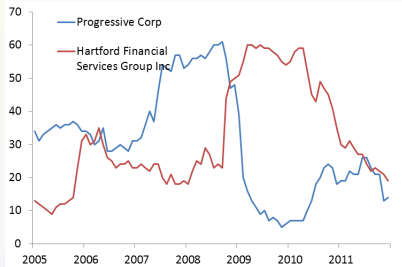
Yellow: top 20 in 80% of days in 6 month period

# Ranking Institutions: Some examples

## Banks

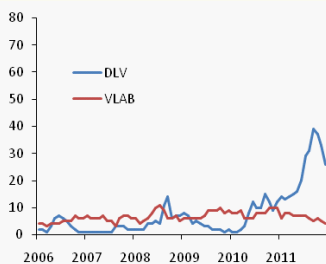


## Insurance Companies

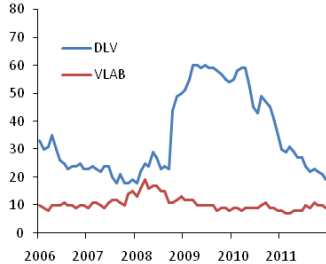


# Ranking Institutions

## Goldman Sachs

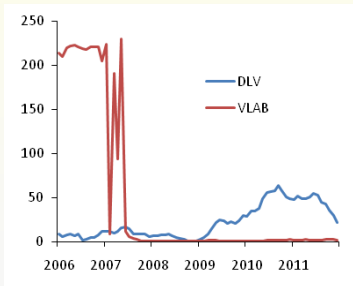


## Hartford

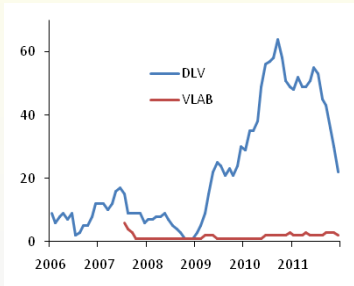


## Ranking Institutions

Citigroup: from 2006



Citigroup: from mid-2007

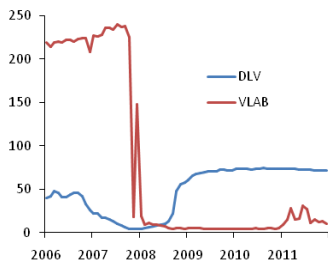


- gaps where Citi ranks  $> 250$  in BE
- Drop in market cap following Goldman earnings announcement Summer 2007
- Citi lost 25% of capital between Sept and Nov 2007 (from \$234.8b to \$174.7b)

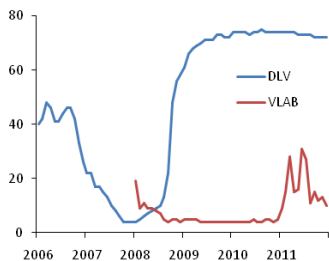


## Ranking Institutions

AIG: from 2006



AIG: from mid-2007



- mid-2007 due to collateral posting for credit-default swaps:
- August 2007: Goldman demanded posting of extra \$1.5b
- Dec 2007: disclosed approx \$1.5 b unrealized losses on swaps portfolio
- Feb 2008: total posting of collateral \$5.3b; unrealized loss \$11.5b

# Conclusions

- Interconnectedness between firms provides a measure of systemic risk
- Overall systemic risk rose in lead up to September 2008
  - Dramatic drops began with TARP (consistent with *King, 2011*)
  - Deposit taking institutions systemic risk peaked in late 2007 (housing cycle)
  - Insurance firms systemic risk rose until AIG rescue
  - All rising again with heightened European debt crisis

# Conclusions

- Systemic risk via interconnectedness fell after TARP, capital shortfall based measures did not.
  - Two complementary sources of information.
  - What aspects are policy interventions targeting?
- Including linkages with the real economy influences analytical results importantly
  - Breaking connections may improve confidence (DLV)
  - Has it addressed underlying problems? (BE)

## Next steps

- Results for interconnectedness of different sectors
- Application to Australasian region
- How would one extend to consider international linkages;  
*Cerutti et al (2012)*