FDIC Research Conference
October 12, 2012

VARIATION IN SYSTEMIC RISK AT US BANKS DURING 1974-2010

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**The views expressed here are my own and do not reflect those of the IMF or IMF Board*

Motivation

- Financial crisis has reinforced need to improve framework for monitoring and resolving losses at large, complex financial institutions
- Macroprudential risk is not simply sum of microprudential (stand-alone) risk
- Key problems include need to develop timely measures of systemic risk: the risk that individual institutions impose on the financial system as a whole
- Official definitions of systemic risk are vague, lack transparency, and cannot easily be replicated: "the risk that disruptions to financial services caused by impairment of all or parts of the financial system can have serious negative consequences for the real economy" (IMF-BIS-FSB, 2009)
- Moreover, they ignore channels through which financial safety-net management can mitigate or amplify financial instability
- Existence of a (subsidized) safety net incentivizes banks to raise their risk profiles, under-reserve for loss exposures, and to conceal actual losses (Kane, 1989; Demirguc-Kunt and Huizinga, 2004; Skinner, 2008)
- This incentive problem and the regulatory arbitrage it produces results in too-big-to-fail problem (Rochet, 2008)

This paper

- Propose a measure of systemic risk that is theoretically sound and easy to implement using publicly available financial and stock market data
- Build on Merton (1974) model of credit risk as a put option that stockholders write on a firm's assets, adapted for deposit insurance by Merton (1977, 1978)
- Model losses to which banking-sector activity exposes taxpayers through the safety net as value of put option written on portfolio of aggregate bank assets with exercise price equal to face value of aggregate bank debt
- Calculate each individual bank's "systemic risk" as its contribution to the value of banking sector's aggregate put, i.e., difference between insurance premium for the sectoral portfolio that includes the bank and insurance premium for portfolio that excludes it
- Provides a gross estimate of taxpayer cost of insuring banks, but given that benefits dwarf deposit insurance premiums in crisis circumstances, it is good approximation of net costs

Limitations of our measure

- Our measure of an individual bank's contribution to systemic risk reflects the spillovers imposed on other banks when the bank fails, as reflected in banks' stock prices, similar to other methods relying on stock prices to measure systemic risk (e.g. Marginal Expected Shortfall measure in Acharya et al., 2010)
- It does not measure externalities per se
- It does not capture knock-on effects on employment and economic growth and as such is likely to underestimate the true value of systemic risk

Modeling Safety-Net Benefits as a Function of the Volatility of Asset Quality and Capital

- Our modeling procedure follows Merton (1977) in portraying taxpayer credit support as a one-year European put option on the bank's assets
- As observable input variables, our models use the book value of debt (B), the market value of a bank's or bank holding company's equity (E), the standard deviation of the return on equity (σ_E) and the fraction of bank assets distributed yearly as dividends to stockholders (δ)
- Unique features of our analysis: (1) We distinguish a bank's stand-alone risk from its systemic risk and (2) we recognize that mischaracterizing insolvency issues as liquidity problems allows a flow of zombie-institution dividends to continue (dividend-forbearance)

Model Specifics

- The per-annum flow of stand-alone safety-net benefits that a bank enjoys can be defined as a **"fair" insurance premium percentage (IPP)** expressed per dollar of the institution's debt
- Merton (1977, 1978) shows that **IPP increases both with a bank's leverage and volatility of its return on assets**. Leverage is measured as the ratio of the market value (B) of deposits and other debt to the market value of a bank's assets (V). Volatility is defined as the standard deviation of the return on bank assets (σ_V)
- We extend and linearize Merton's model of deposit insurance, which portrays safety-net access as an option that allows bank owners to put the bank to safety-net managers for the face value of the bank's debt. We allow authorities to refuse to exercise taxpayer's side of the put **(forbearance**), following Kane(1986)
- Our work distinguishes two different opportunity-cost measures of the costs of taxpayer support:
  - The stand-alone IPP with prompt resolution: the IPD
  - The systemic-risk IPP that incorporates an implicit estimate of likely forbearance: the IPDS

Macroprudential Perspective

- We measure a bank's contribution to systemic risk relative to the IPP that our model implies quarter by quarter for the portfolio of sample banks taken together
- A bank's systemic risk (IPDS) is the difference between the IPD that arises for the "sectoral portfolio" when that particular bank is and is not included

Data and sample

- US commercial banks
- Daily stocks prices and returns from CRSP
- Quarterly balance-sheet accounting data from Compustat (Call report data)
- Macroeconomic data from the Federal Reserve Bank of St. Louis FRED database
- Total of 40,522 bank-quarter observations over the period 1974-2010, **27 years** of data
- Number of sample banks almost triples in the fourth quarter of 1993—analysis accounts for this

Variation in Stand-Alone and Systemic Risks over Time: Aggregate Results

Figure 1. Mean value of stand-alone risk (IPD) assuming dividend forbearance for sample of U.S. bank holding companies, 1974-2010 (quarterly, in basis points)

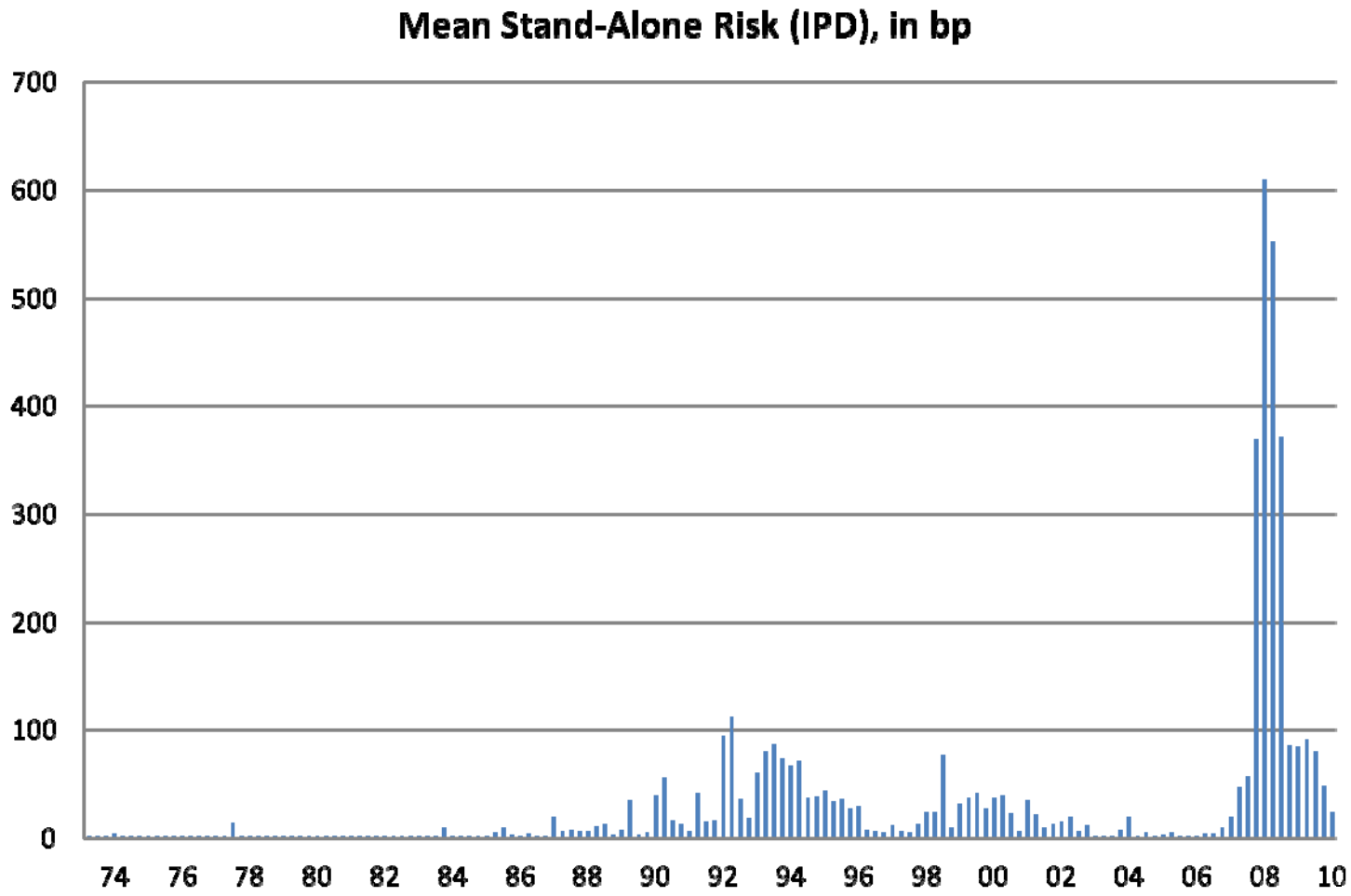


Figure 3. IPD has increased mainly because of increase in implied asset volatility, not leverage

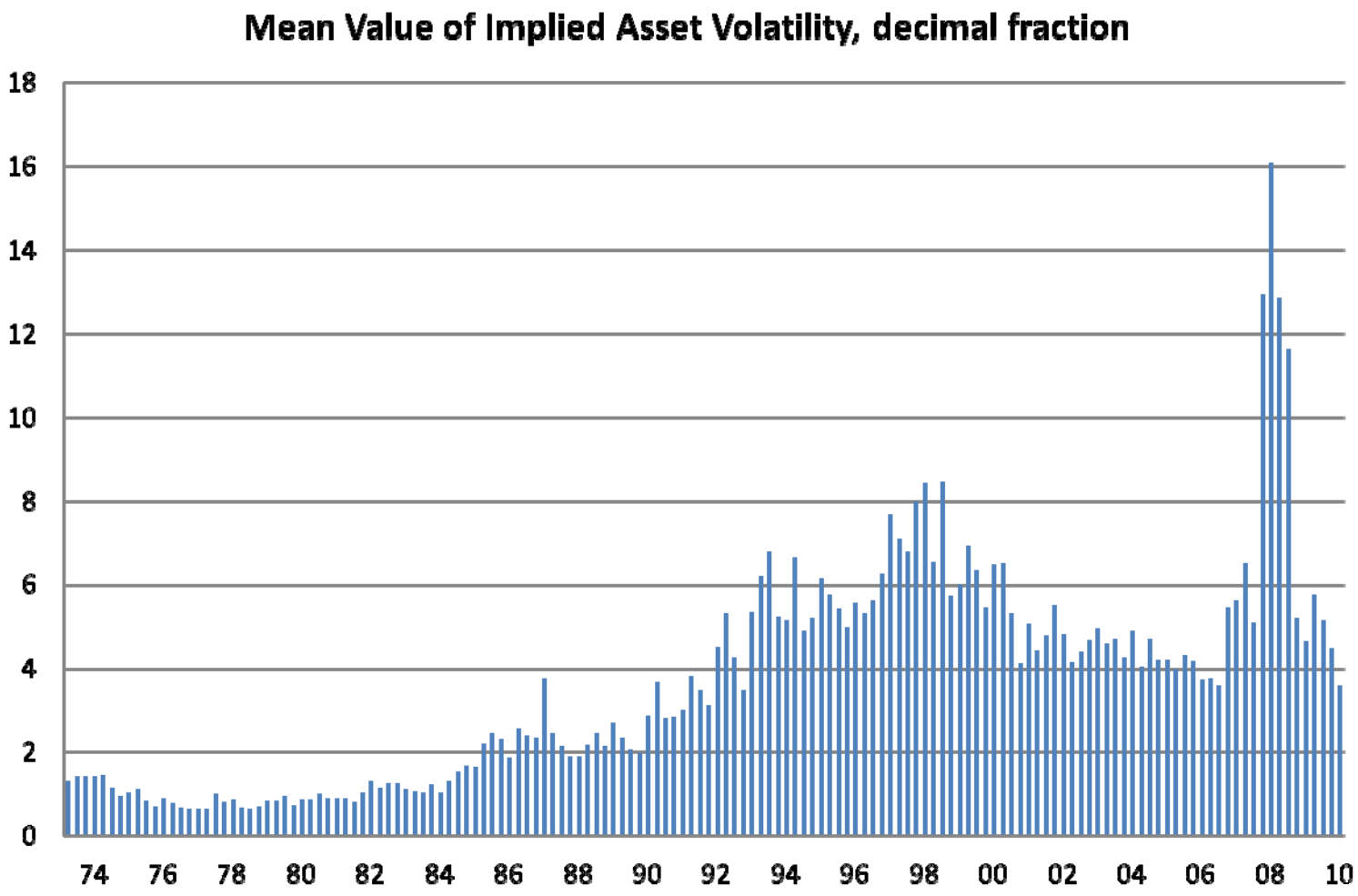


Figure 2. Mean Ratio of Model-Implied Equity Capital to Assets, 1974-2010 (quarterly, in percent)

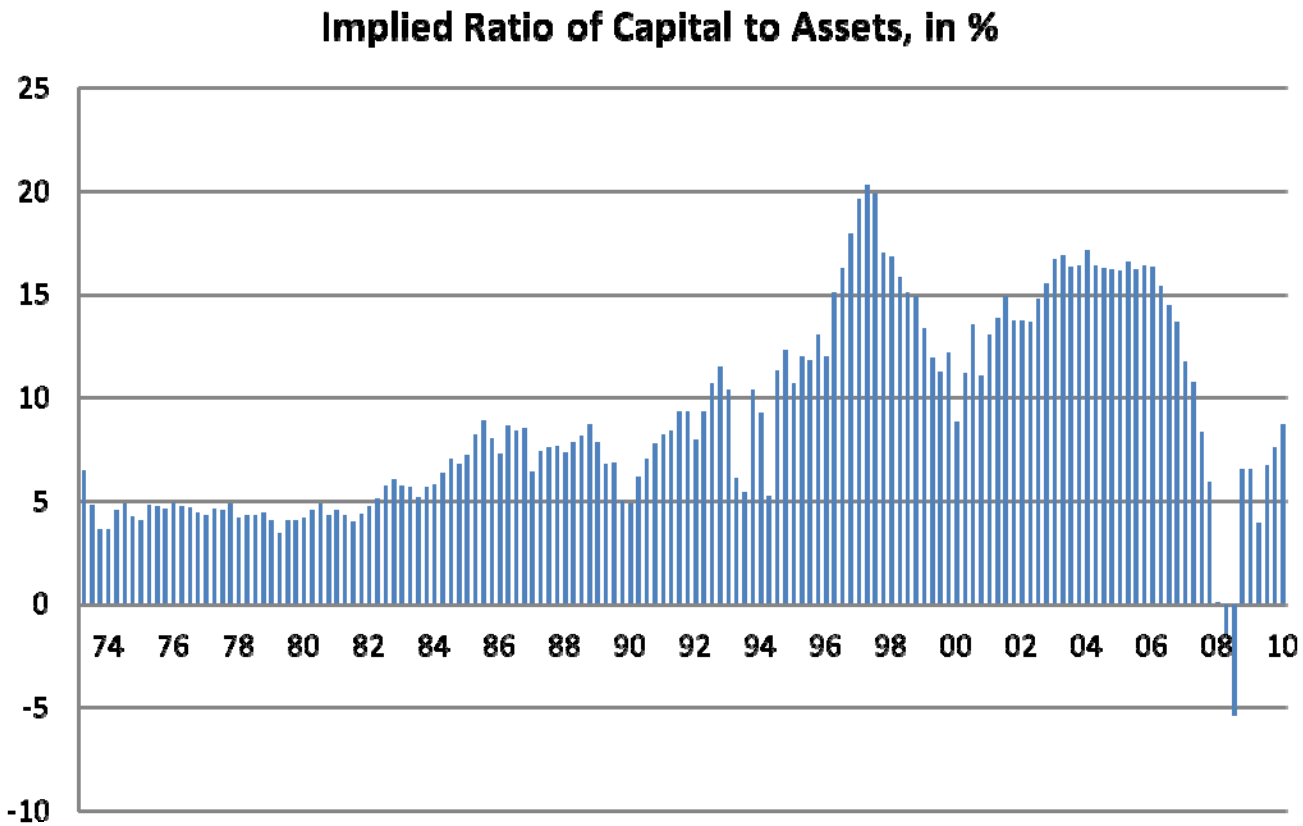
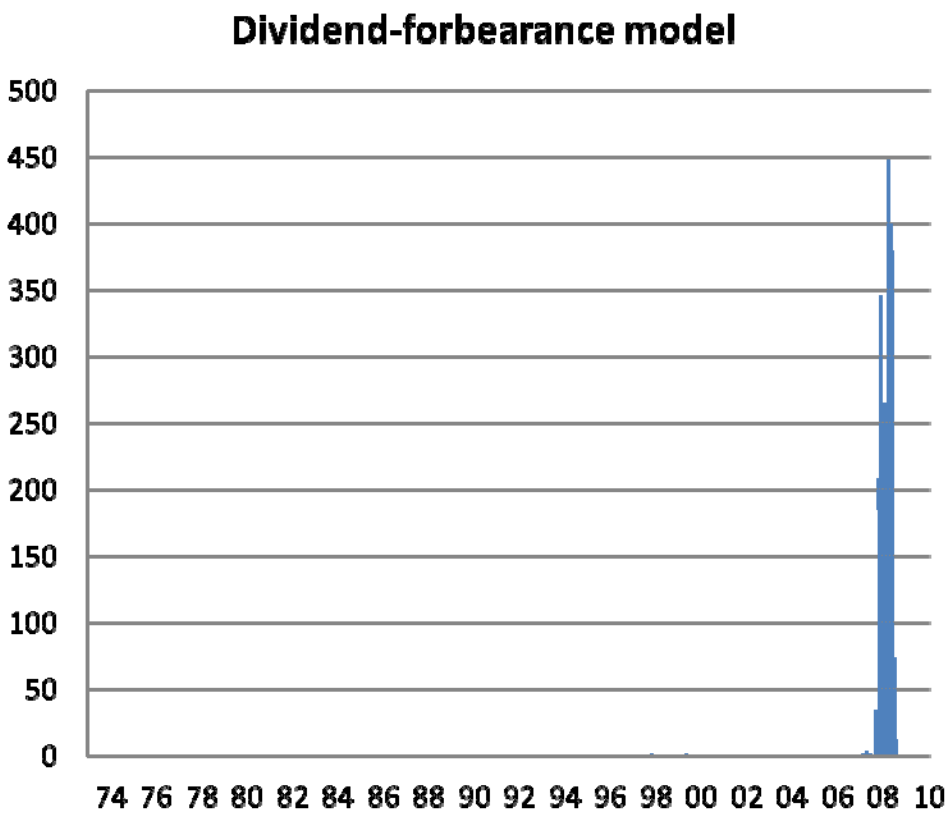
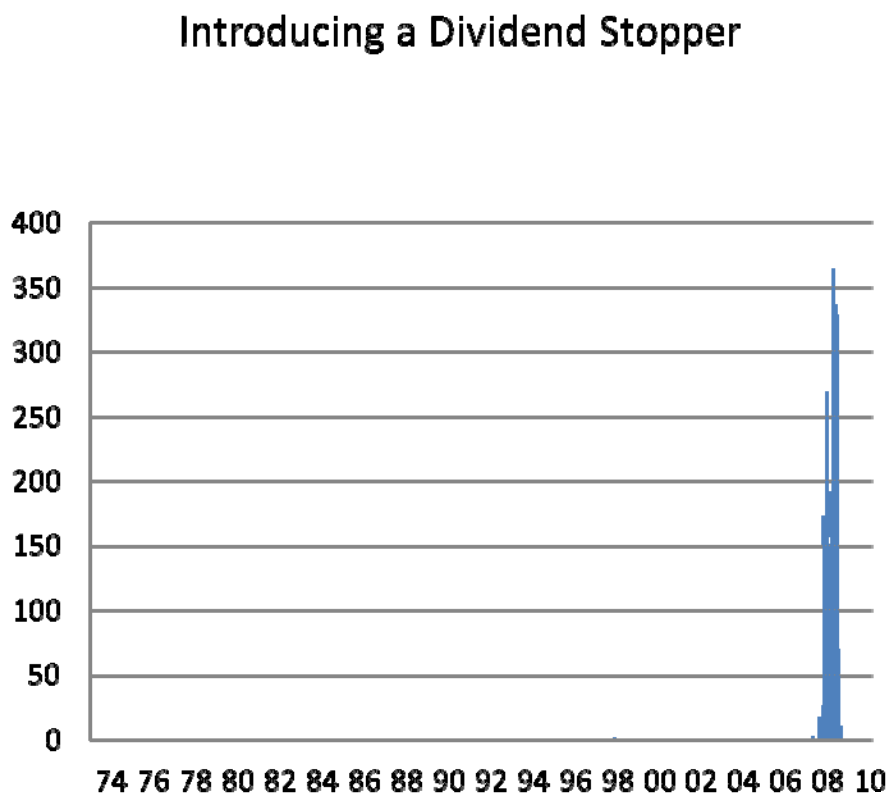


Figure 5. Sectoral Risk Premium (IPDBS), 1993-2010 (quarterly, in basis points)





IPDS reduced significantly when introducing a **dividend stopper**

Takeaways From These Graphs?

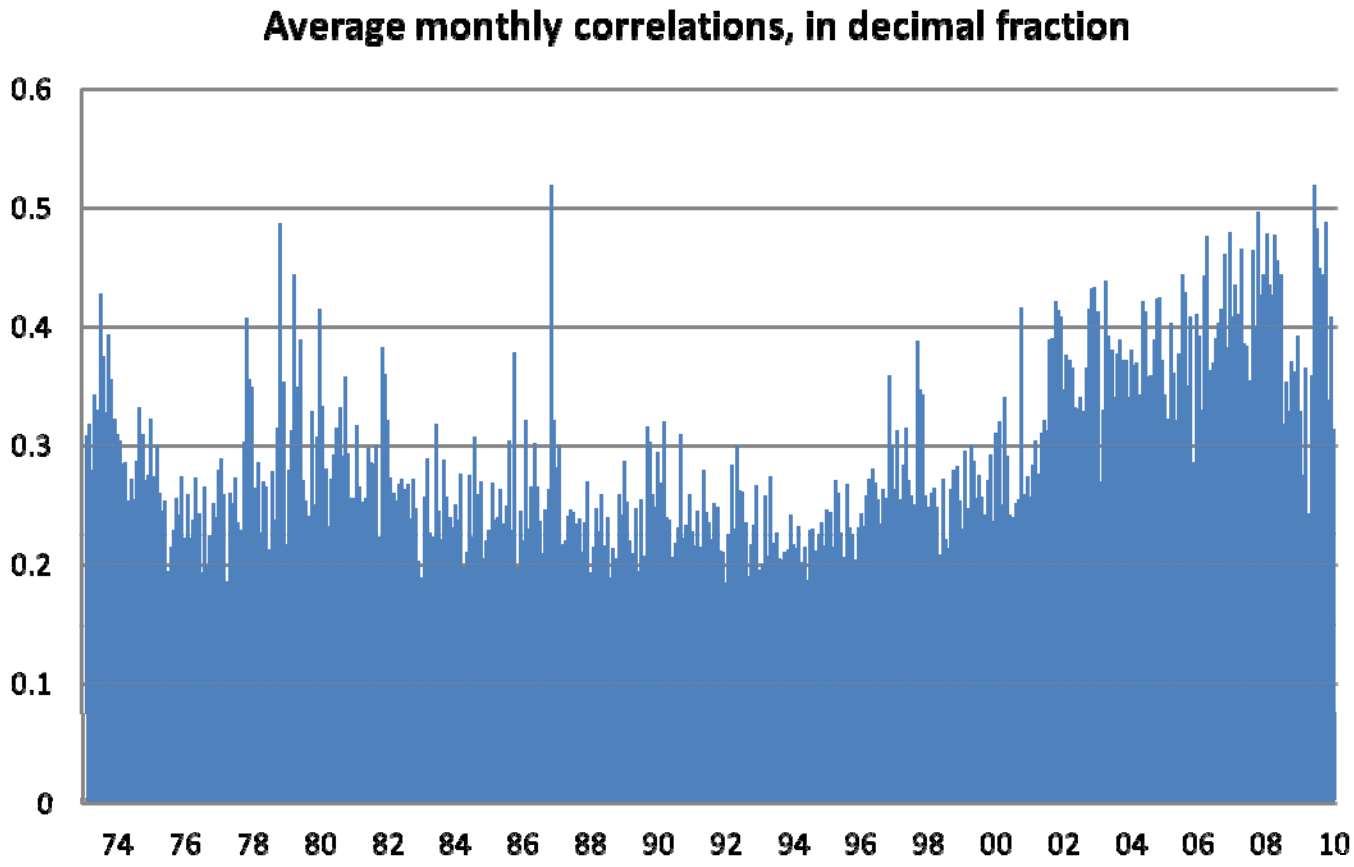
- Bank risk-taking increases in late booms and gets worked down again as economic recovery takes hold
- Bank risk-taking increased markedly after the S&L mess: Too-big-to-fail problem
- Sectoral risk lower than average stand-alone risk
- But not imposing dividend stoppers in rescue programs cost taxpayers a lot on average

Our Methods also Show the Lengthy Buildup of Systemic Risk

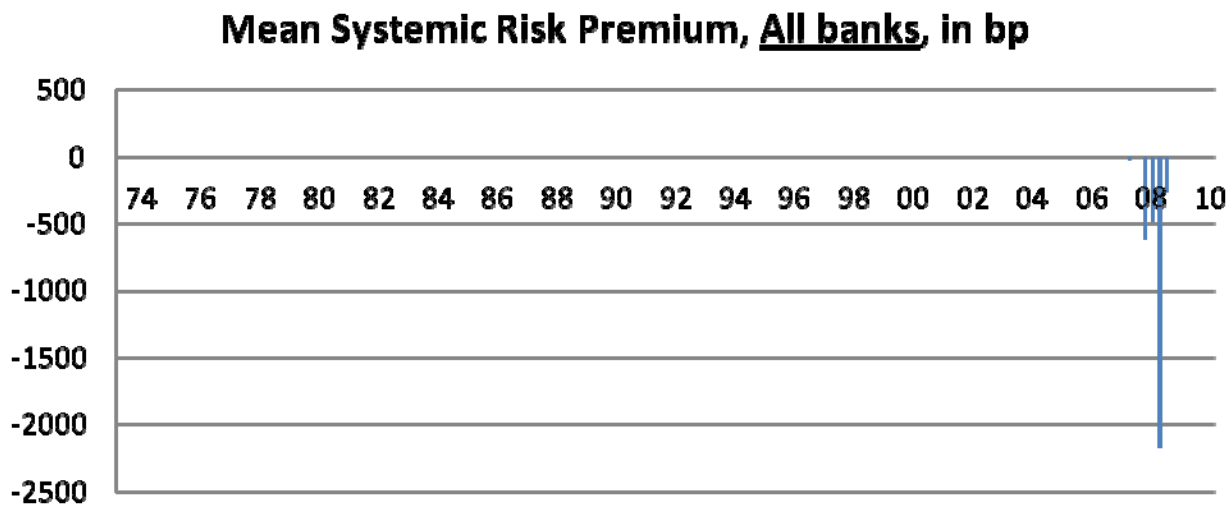
- Although accounting and Tier-1 capital ratios remain stable, model-implied ratio of **market value** of equity to assets went down sharply from 2006 on, especially following Lehman-AIG event
- Highlights importance of regulatory forbearance, consistent with work by Laeven and Huizinga (2012)
- Our straightforward and easy-to-calculate measures could have been used to uncover and mitigate the efforts to arbitrage capital requirements (early warning)

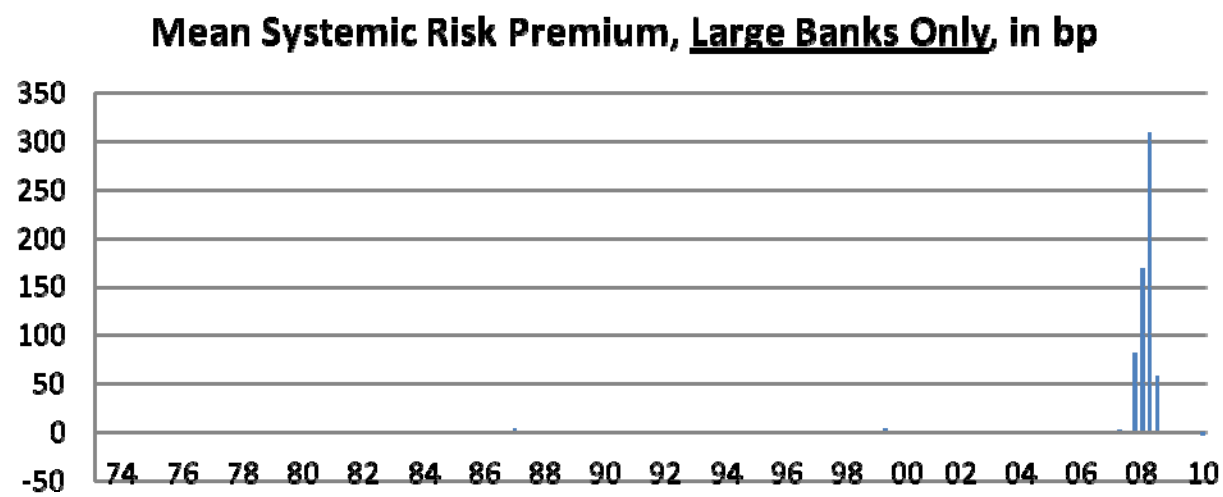
Macroprudential Perspective

Figure 6. Average correlation between returns on an individual bank stock and bank sectoral portfolio, 1974-2000 (by quarter, decimal fraction)



Figures 7+8. Mean individual-bank systemic risk premium (IPDS) using dividend-forbearance model, 1974-2010 (in basis points)





Negative values for systemic risk?

- A negative mean value for individual-bank systemic risk during crisis years indicates that some banks – mostly smaller, community banks – give more support to the safety net than the safety net gives them in return
- Even though the contribution to mean systemic risk becomes negative during the recent crisis period, the systemic risk of particular sample banks – **notably large banks** – and the sector as a whole became positive and very large during this period

Time-Series Forecasts of Commercial Banking Sector Risk

Time-series forecasts of commercial banking sector risk

Strong predictive power at one and up to eight month horizons: early-warning indicator

Forecast horizon	Coef.	t	R^2	Observations
1 month	0.863**	35.9	0.745	443
2 months	0.766**	25.0	0.587	442
3 months	0.570**	14.5	0.325	441
4 months	0.527**	13.0	0.278	440
5 months	0.423**	9.8	0.179	439
6 months	0.368**	8.3	0.135	438
7 months	0.218**	4.7	0.047	437
8 months	0.123*	2.6	0.015	436
9 months	0.027	0.6	0.001	435
10 months	-0.003	-0.1	0.000	434
11 months	-0.016	-0.3	0.000	433
12 months	-0.018	-0.4	0.000	432

Bank-Level Results

Time-series regression predicting sectoral risk using business cycle and banking structure variables

- Recessions, low GDP growth, and increased banking concentration predict sectoral risk
- Note that concentration has risen dramatically over past ten years – Herfindahl index of banking assets has increased from 0.05 in 2000 to 0.15 in 2010, together with increased sectoral risk

Comparison of our measures of stand-alone and systemic risk (Table 6)

- The nations' largest banks feature prominently among banks with largest systemic risk premium
- Little overlap between banks with highest stand-alone risk and those with highest systemic risk

Comparison of our measure of systemic risk with other measures of capital shortage (Table 8)

- Compare our measure of stand-alone and systemic risk with other measures of capital shortage for financial institutions subjected to Fed's stress tests in early 2009
  - Supervisory Capital Assessment Program (SCAP) measure of capital shortfall in February 2009
  - Marginal Expected Shortfall (MES) from Acharya et al. (2009) based on data in periods during which stock-market returns lie below their fifth percentile
- High correlation between our measure (computed over April-June 2009) and SCAP capital shortfall (0.8) ; lower correlation with Acharya et al. MES measure

Table 8. Comparison with Measures of Capital Shortfall

	Other measures		Our measures (April-June 2009)	
	SCAP ($billions)	Acharya et al. MES ($billions)	Value of stand-alone support ($billions)	Value of systemic risk support ($billions)
Bank of America Corp	33.9	15.1	93.7	20.2
Wells Fargo & Co	13.7	10.6	57.7	25.1
Citigroup Inc	5.5	15.0	4.0	1.8
Regions Financial Corp	2.5	14.8	9.2	1.0
Suntrust Banks Inc	2.2	12.9	9.8	2.1
Keycorp	1.8	15.4	3.0	0.9
Morgan Stanley Dean Witter	1.8	15.2	1.5	3.5
Fifth Third Bancorp	1.1	14.4	32.2	1.8
PNC Financial Services	0.6	10.6	5.2	3.2
American Express Co	0	9.8	3.7	2.1
Bank New York Inc	0	11.1	0.5	-6.0
JPMorgan Chase & Co	0	10.5	10.5	5.4
US Bancorp	0	8.5	6.1	4.2
State Street Corp	0	14.8	3.1	1.6
BB&T Corp	0	9.6	3.1	1.9
Capital One Financial Corp	0	10.5	10.7	1.0
Goldman Sachs Group Inc	0	10.0	0.4	5.1
Metlife Inc	0	10.3	2.7	2.3

Notes: SCAP is capital shortfall calculated in the supervisory Capital Assessment Program conducted in February 2009 and MES is Marginal Expected Shortfall calculated by Acharya et al. (2010) from data in periods during which stock-market returns lie below their fifth percentile

Table 9: Mean coefficient of cross-sectional models for stand-alone and systemic risk

	Full sample			1974-2007			2008-2010		
	Coef.	z-stat.	Same sign	Coef.	z-stat.	Same sign	Coef.	z-stat.	Same sign
Panel A: Determinants of stand-alone risk (IPD)									
Size	-0.071	-0.8	92/148	-0.087	-1.4	88/136	0.115*	2.0	8/12
Deposits	-0.097**	-3.4	87/148	-0.205**	-4.1	82/136	1.128	1.3	7/12
Asset volatility	18.241**	10.6	148/148	15.942**	10.1	136/136	44.300**	3.1	12/12
Implied capital	-6.393**	-10.0	145/148	-5.901**	-9.9	135/136	-11.962*	-2.7	10/12
R^2	0.604			0.576			0.913		
Observations	263			255			357		
Panel B: Determinants of systemic risk (IPDS)									
Size	0.031**	9.4	135/148	0.002**	9.0	124/136	0.357**	3.0	11/12
Deposits	-0.486**	-4.2	104/148	-0.003**	-2.9	92/136	-5.961**	-3.1	12/12
Asset volatility	-0.205	1.3	61/148	0.007*	2.2	81/136	-2.608	-1.0	9/12
Implied capital	-0.230**	-5.0	115/148	-0.011**	-4.5	105/136	-2.709	-1.6	10/12
R^2	0.283			0.294			0.156		
Observations	263			255			357		

Empirical Findings (Tables 9 and 10)

- Systemic risk does not arise as a simple aggregation of individual-bank risk
- Systemic risk is related to asset risk and leverage in a substantial way
- Size is a key driver of systemic risk but not of stand-alone credit risk (after controlling for the effects of leverage and asset risk)

Conclusions

- We propose a simple measure of systemic risk that is theoretically sound and easy to implement using publicly available financial and stock market data
- Bank size is a key driver of systemic risk
- Our aggregate and individual measures of systemic risk are consistent with the outcome of formal stress tests
- We think they provide a useful starting point for monitoring the buildup of systemic risk and identifying institutions whose activities contribute most to this