EUROPEAN CENTRAL BANK

EUROSYSTEM

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Stress testing and systemic risk

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Views expressed are solely my own and do not represent those of the ECB

Overview

A new territory: Macroprudential stress tests

"The macroprudential function has added a new dimension to stress testing. (…) The underlying framework has to embed spillovers – within the banking sector, to other sectors, including the real economy – also allowing for banks' own reactions that can also spillover to other segments of the economy."

"The role of stress testing in supervision and macroprudential policy"
Keynote address by Vítor Constâncio, Vice-President of the ECB,
at the London School of Economics, London 29 October 2015
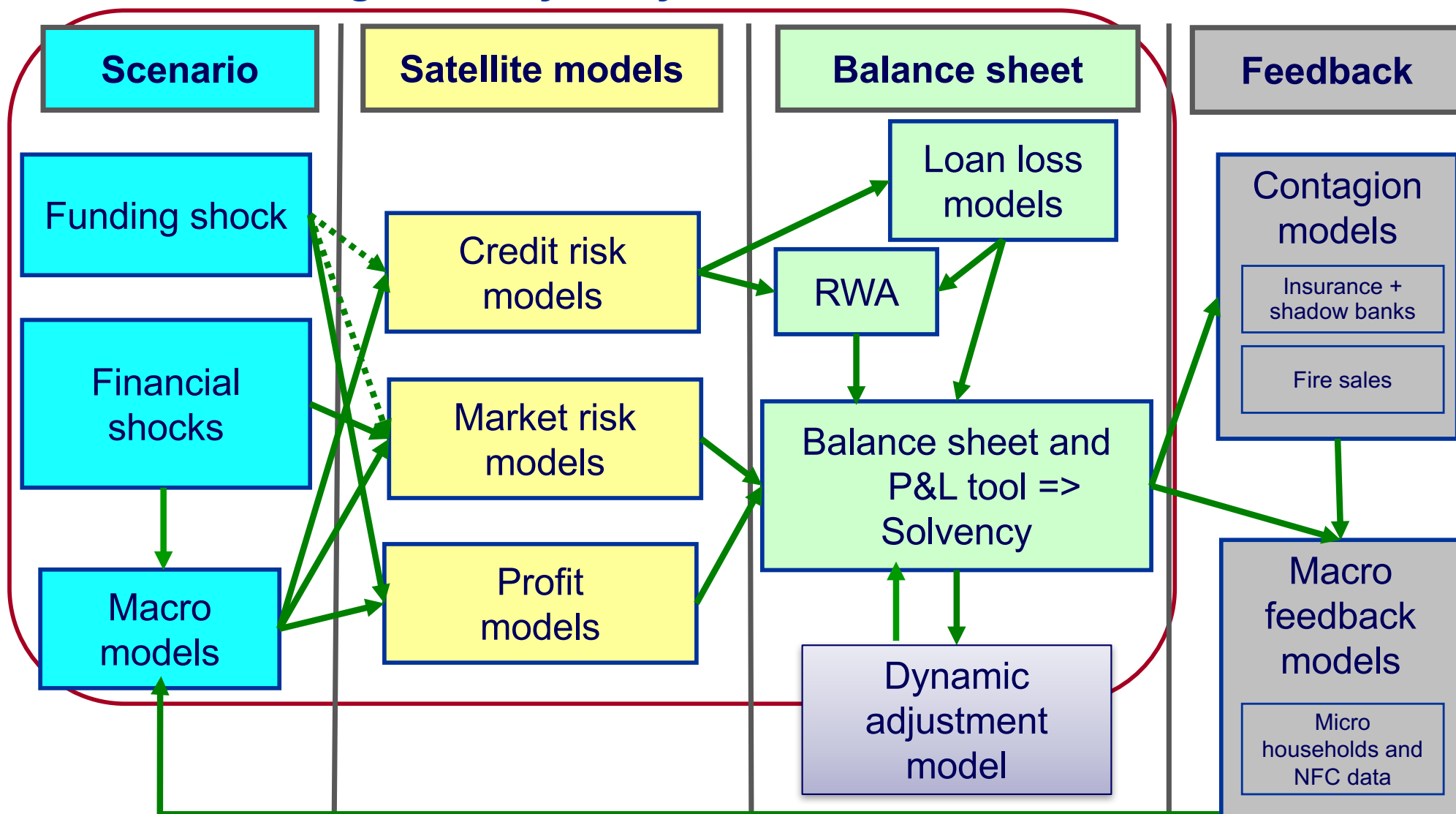
Macroprudential stress tests

- Microprudential stress tests focus on the capital buffers of individual banks

- Macroprudential stress tests focus on capital buffers of the banking system as a whole

- Prior to the crisis, microprudential stress tests were insufficiently dynamic (static balance sheet approach) and therefore underestimated the role of deleveraging, among others

- Macroprudential tests should account for:
  - Banks reaction function (dynamic dimension)
  - Interactions with the real economy
  - Interconnections among banks
  - Interactions with liquidity
  - Interactions with nonbank financial sector

- **Top-down – for *macroprudential* purposes**
  - Quarterly risk impact assessment for the ESRB (EU-wide)
  - Bi-annual exercise for the Financial Stability Review
  - Regular macroprudential impact assessment for the Eurosystem

- **Top-down – for *system-wide* exercises**
  - Country-specific and EBA/SSM-wide (Comprehensive Assessment 2014, EBA 2016)

- **Bottom-up – for *microprudential* purposes**
  - SSM-wide for publication (CA 2014, EBA 2016)
  - Input into regular bank-specific supervision (SREP, ICAAP)

ECB Top-down stress testing framework

Forward-looking solvency analysis

Scenario	Satellite models	Balance sheet	Feedback
Funding shock	Credit risk models	Loan loss models	Contagion models
		RWA	Insurance + shadow banks
Financial shocks	Market risk models	Balance sheet and P&L tool => Solvency	Fire sales
Macro models	Profit models	Dynamic adjustment model	Macro feedback models
			Micro households and NFC data

Sources: Adapted from Henry and Kok (eds.), ECB Occasional Paper 152, October 2013.
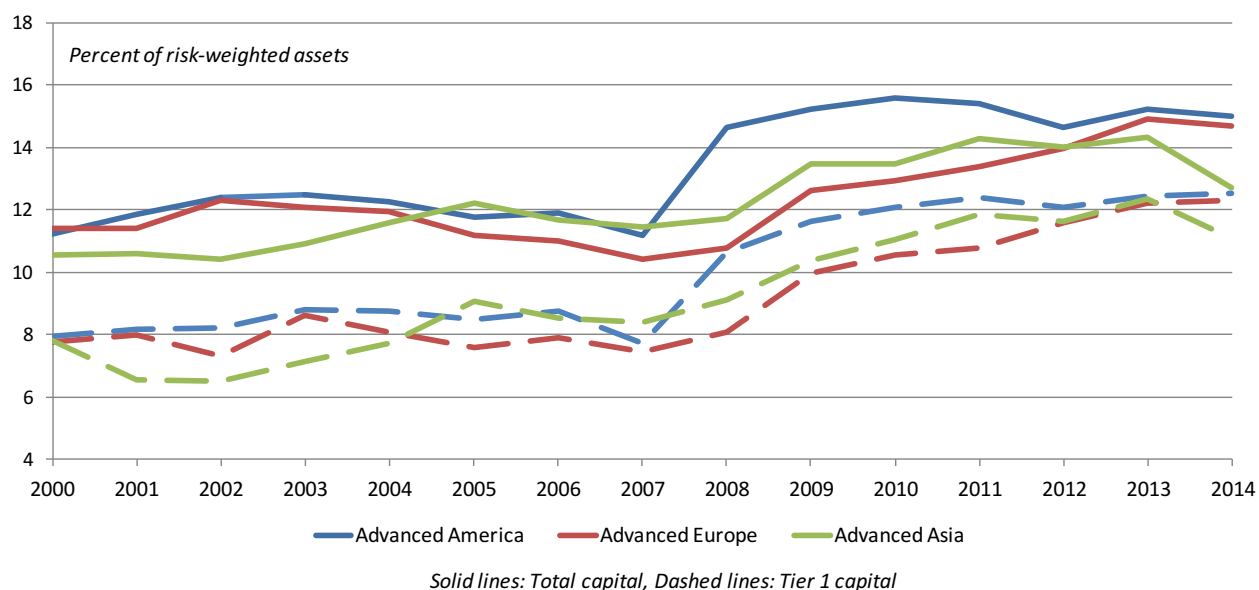
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Limitations of existing stress tests

- Stress tests during stressed times need to be accompanied by recapitalisation programs to ensure credibility and contain excessive deleveraging

- Complement stress tests with early warning models based on credit expansion and other measures of systemic risk

- Focus more on the role of capital as a risk mitigant, not only as a buffer against shocks: the role of **incentives**

Post-crisis call for higher capital requirements

Figure 1. Tier 1 and Total Capital Ratios for Large Global Banks since 2000

Percent of risk-weighted assets

Solid lines: Total capital, Dashed lines: Tier 1 capital

Legend: Advanced America, Advanced Europe, Advanced Asia

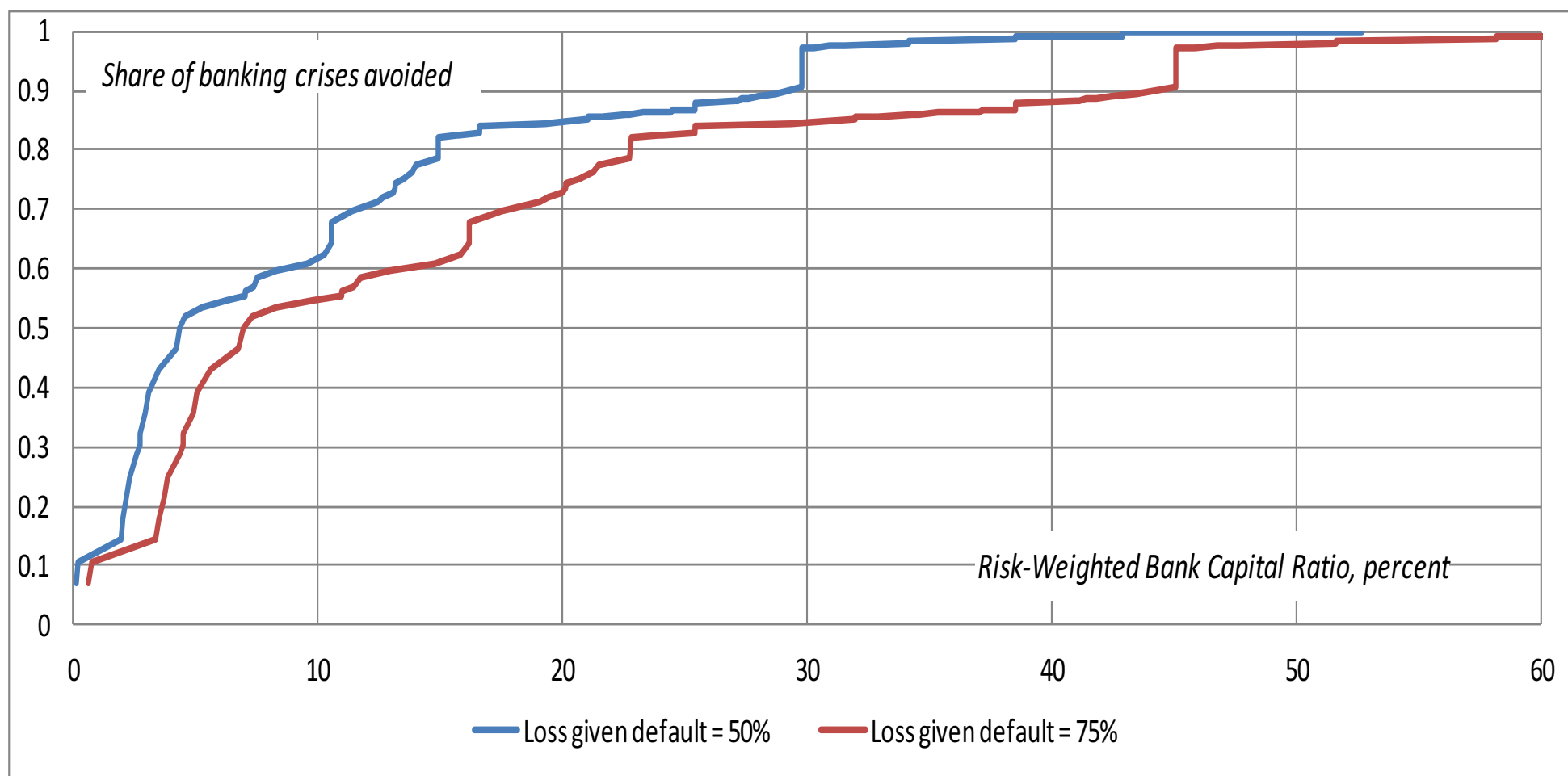Source: Bankscope and staff calculations.

Source: Dagher, Jihad, Giovanni Dell'Ariccia, Luc Laeven, Lev Ratnovski, and Hui Tong (2016), Benefits and Costs of Bank Capital, IMF Staff Discussion Note No. 16/4.

Benefits and costs of higher capital

- Capital acts as a **buffer** against losses

- Provides **incentives** against excessive risk taking

- But (if MM does not apply) it might increase a bank's costs

- Hence, it increases intermediation costs, and ultimately reduces growth

- Debate on how much capital needs to increase (very wide range: from banks to Admati/Hellwig)

Share of banking crises avoided, based on crisis NPL data in OECD economies

Source: Dagher, Jihad, Giovanni Dell'Ariccia, Luc Laeven, Lev Ratnovski, and Hui Tong (2016), Benefits and Costs of Bank Capital, IMF Staff Discussion Note No. 16/4.

Capital and bank risk taking: The role of incentives

- Banks with limited liability tend to take excessive risk – they do not internalize the losses they impose on depositors and bondholders

- Bank capital reduces this agency problem: higher capital lowers incentives for risk taking by reducing the downside protection offered by limited liability (Hellmann, Murdock, and Stiglitz 2000)

- When increasing capital requirements, financial firms will not only reduce leverage but also endogenously respond by lowering the riskiness of their assets, thus improving their survival rate

- More consideration should be given to the role of **incentives** in the financial sector, including in the design of stress tests and regulation

An aside: Quality of capital

- Focus has been on increasing the share of common equity in total regulatory capital, to increase loss absorption capacity

- With a view to reduce conflicts between shareholders and debtholders

- The general approach to capital regulation has been that more capital is better, irrespective of who provides this capital

- But this regulatory approach completely abstracts from **ownership structure and corporate governance**
  - Agency conflicts between managers and owners
  - Agency conflicts among shareholders

- A large literature in corporate finance suggests that ownership structure and corporate governance influence firm (bank) risk taking, holding the amount of capital constant

- These effects may be particularly large in highly leveraged institutions such as banks

Measures of systemic risk

- SRISK, MES, CoVaR, 10-by-10-by-10, et cetera (see Bisias, Flood, Lo, and Valavanis 2012)

- A major source of systemic risk is government guarantees/safety net→ HKL measure of systemic risk

Hovakimian, Kane and Laeven, 2015, Tracking Variation in Systemic Risk at US Banks During 1974-2013, NBER working paper 18043

Motivation of paper

- 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 government guarantees 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)

Overview of paper

- Propose 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 combination **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 on the financial safety net

- Provides gross estimate of taxpayer cost but given benefits dwarf deposit insurance premiums is good approximation of net costs

- If authorities are slow to see bank losses or reluctant to exercise the call, the **government** itself becomes a secondary source of systemic risk

- This notion of systemic risk is absent from most existing measures 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 model uses the book value of debt (B), the market value of a bank'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 (DIV)

- Unique features of our analysis: (1) We distinguish a bank's stand-alone risk from its systemic risk and (2) we allow for dividend forbearance (cf. Kane 1986)

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 (IPD)** expressed per dollar of the institution's debt

- Merton (1977, 1978) shows that **IPD 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)

Measure of systemic risk

- We measure a bank's contribution to systemic risk relative to the IPD 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 (IPDBS) and is not (IPDBS$_{-i}$) included

$$IPDS_{i,t} = IPDBS_t - IPDBS_{-i,t}.$$

Limitation of HKL measure of systemic risk

- As most measures of systemic risk 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

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 42,656 bank-quarter observations over the period 1974-2013, **30 years** of data

Figure 1. Mean value of stand-alone risk (IPD) assuming dividend forbearance for sample of U.S. bank holding companies, 1974-2013 (quarterly, in basis points)

Mean Stand-Alone Risk Premium (IPD)
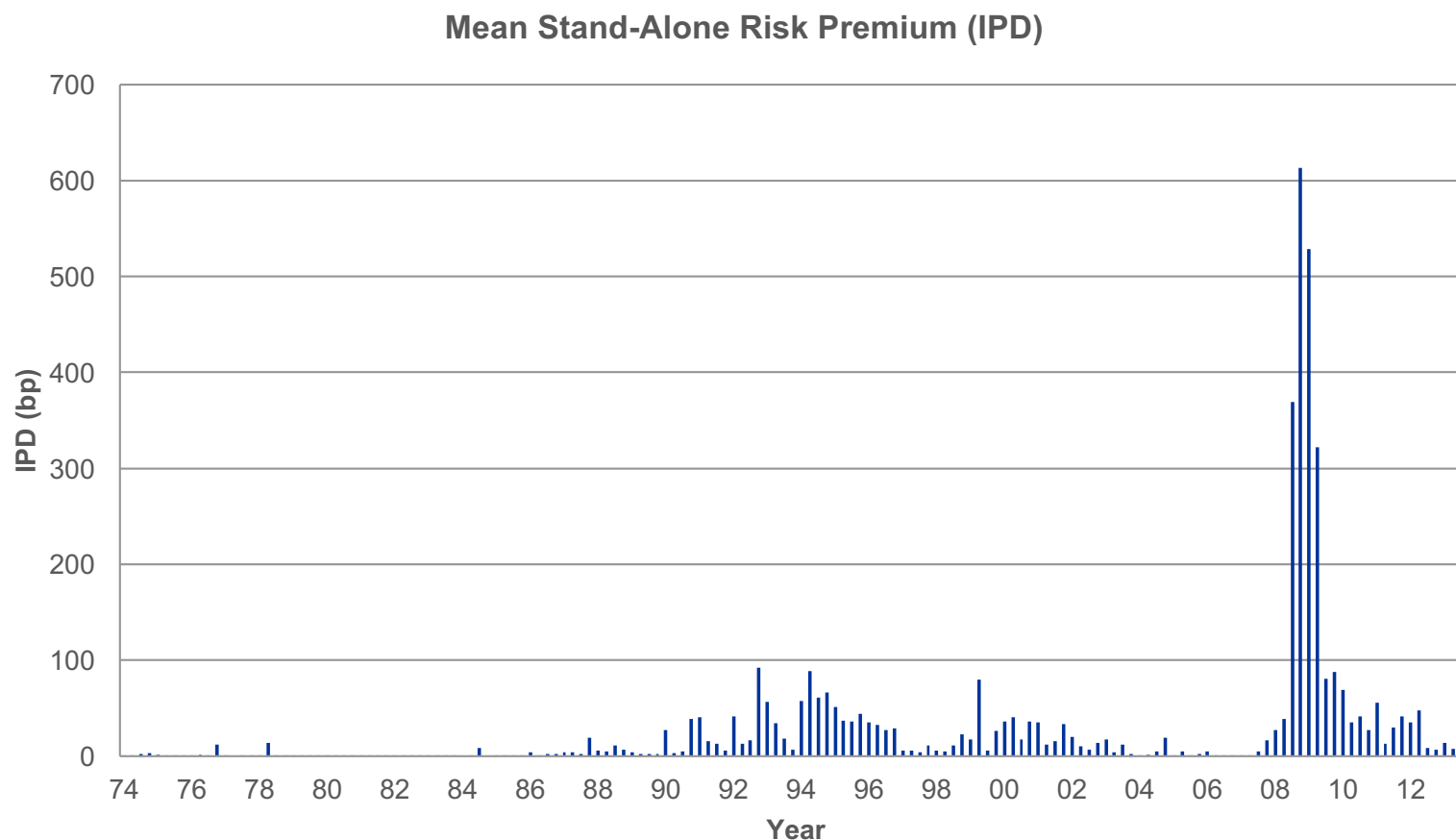
Figure 3. IPD has increased mainly because of increase in implied asset volatility, not leverage

Mean Implied Asset Volatility
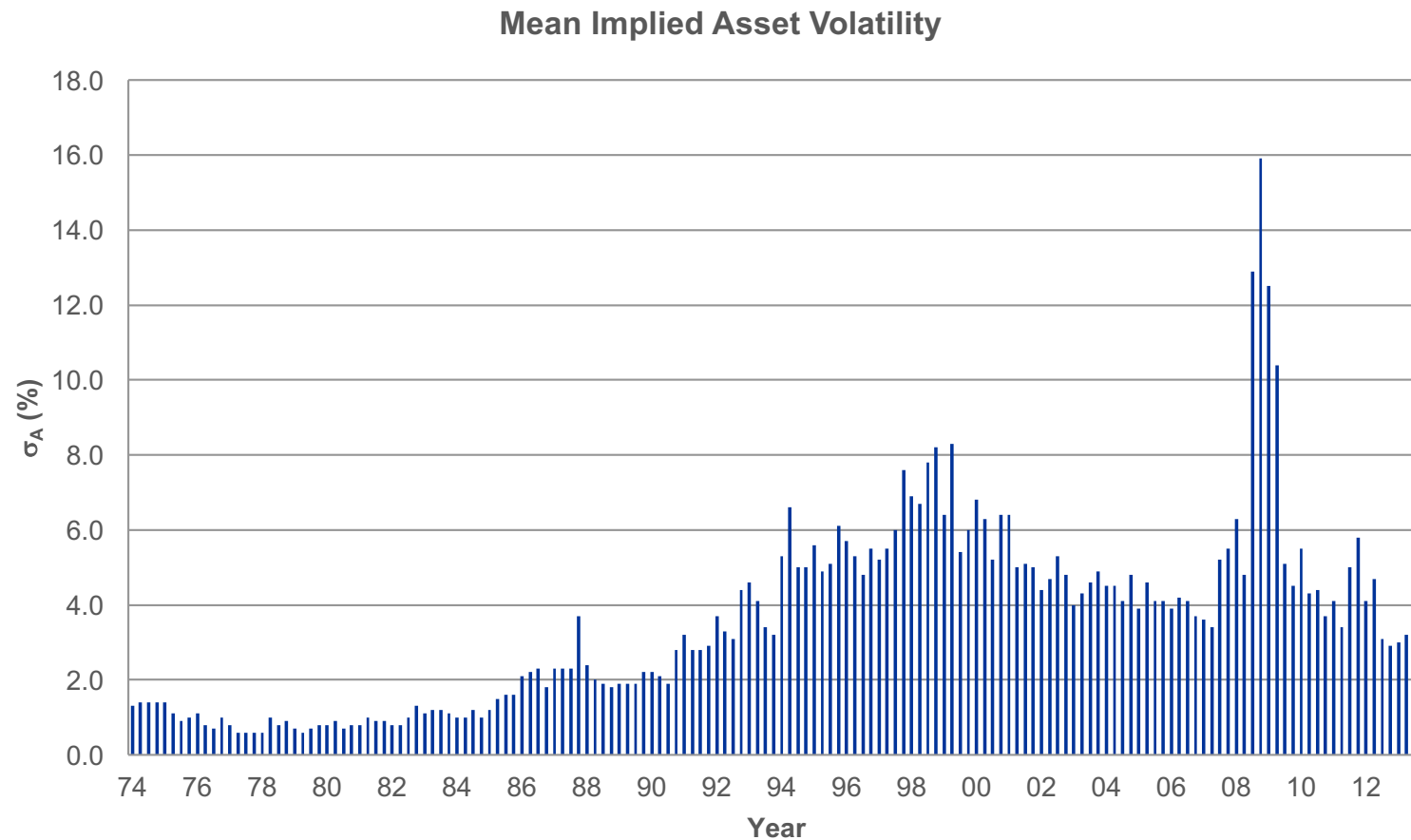
Figure 2. Mean ratio of model-implied equity capital to assets, 1974-2010 (quarterly, in percent)

Mean Implied Capital Ratio
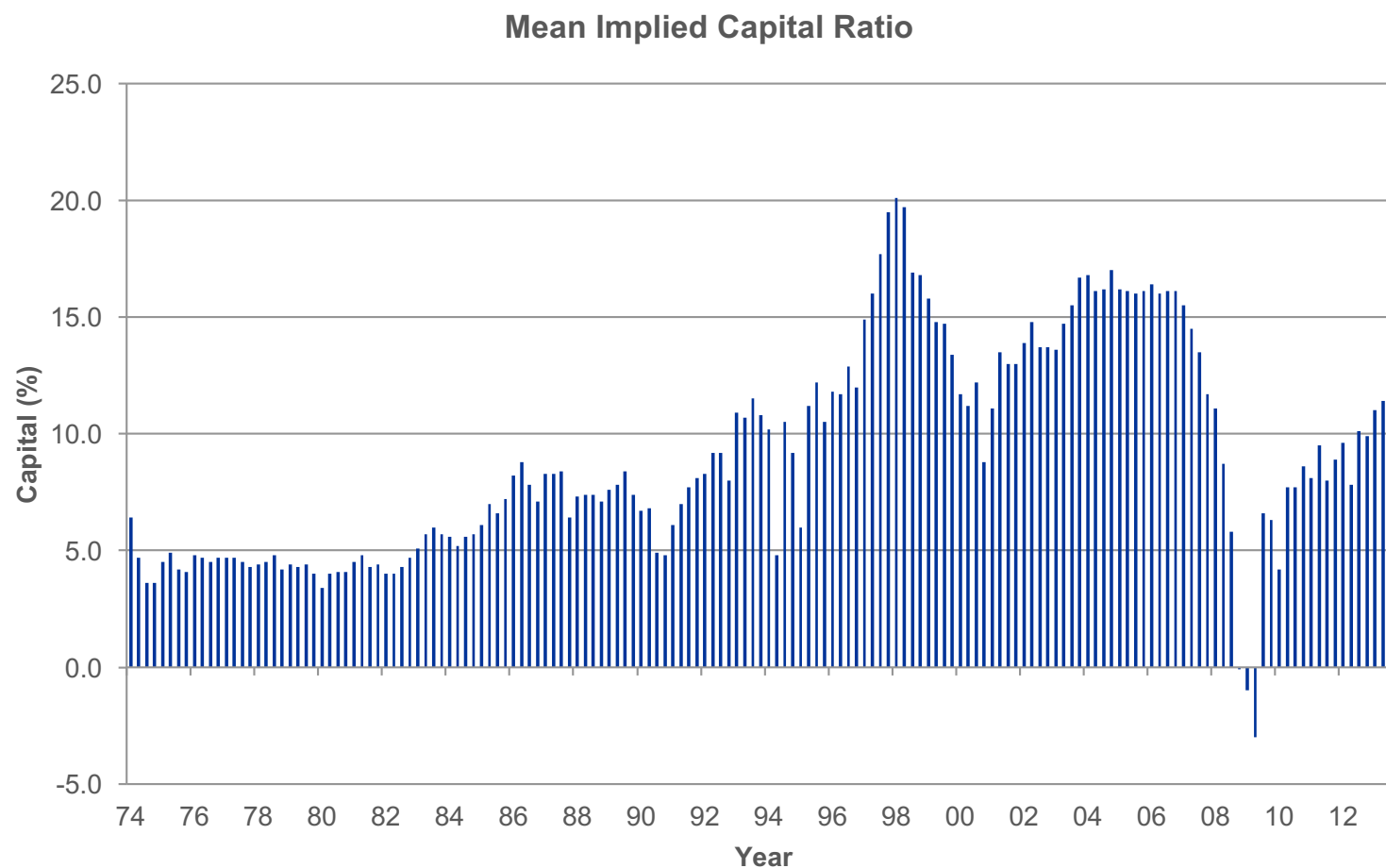
Figure 5. Sectoral risk premium (IPDBS), 1974-2013 (quarterly, in basis points)
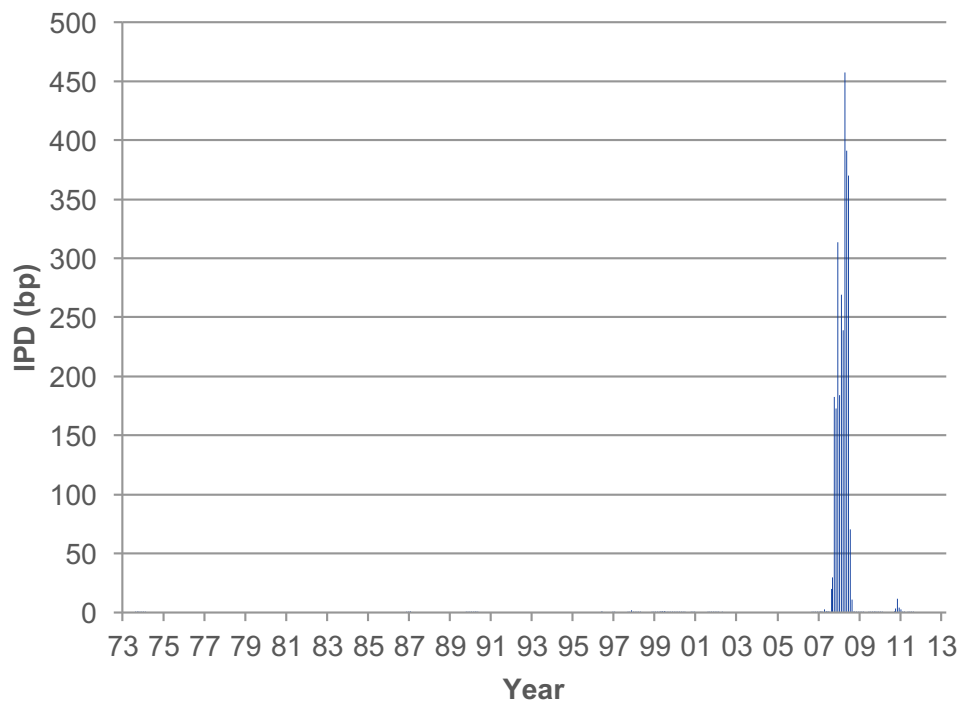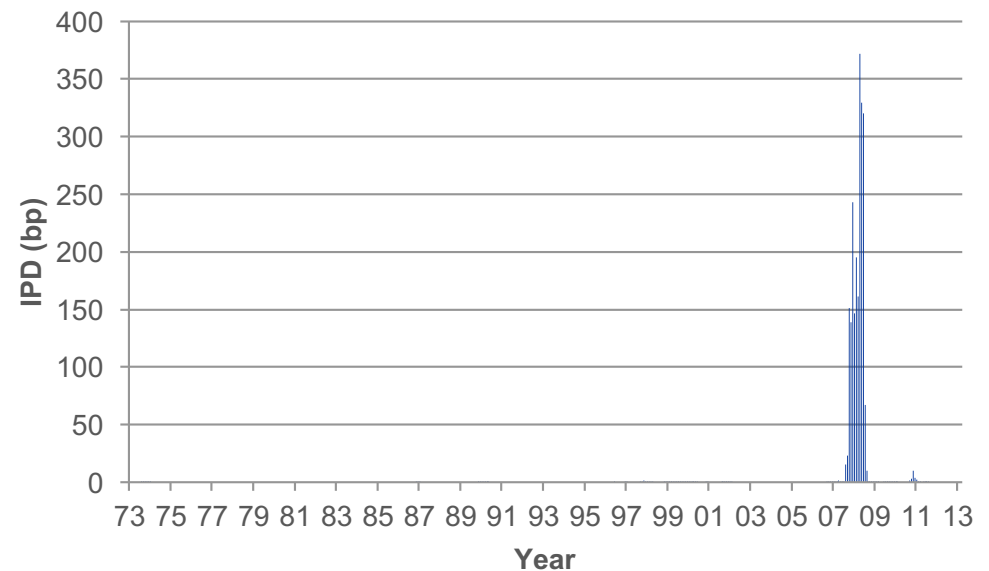
Figure 5A. Dividend-Forbearance Model

Figure 5B. Introducing a Dividend Stopper

IPDBS 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)

Figure 6. Average correlation between returns on an individual bank stock and bank sectoral portfolio, 1974-2013 (by quarter, decimal fraction)

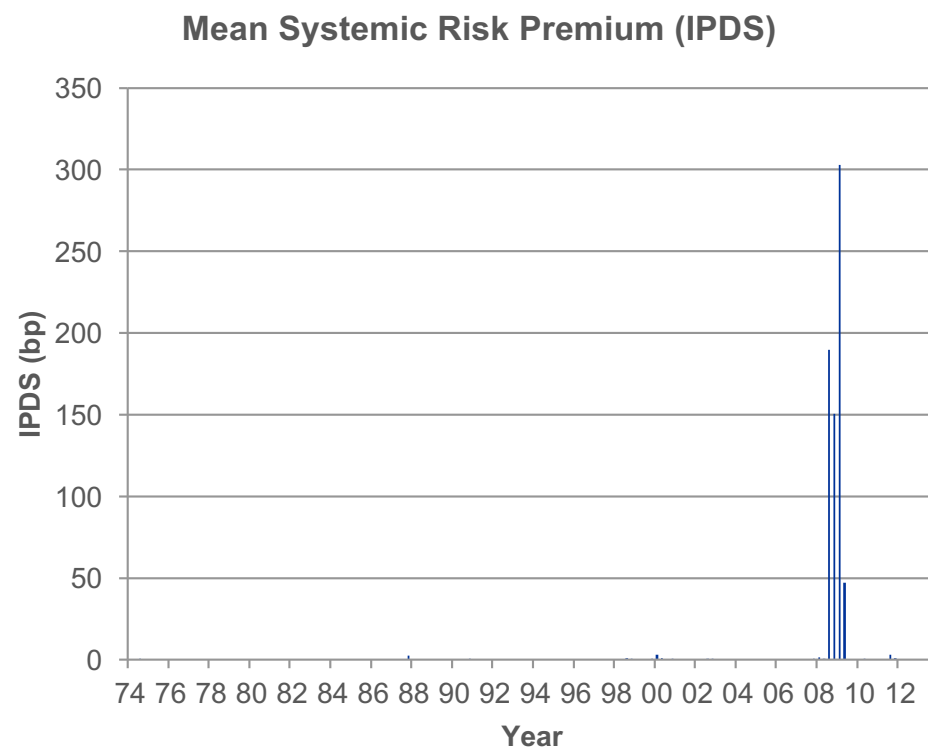**Mean Monthly Correlations**
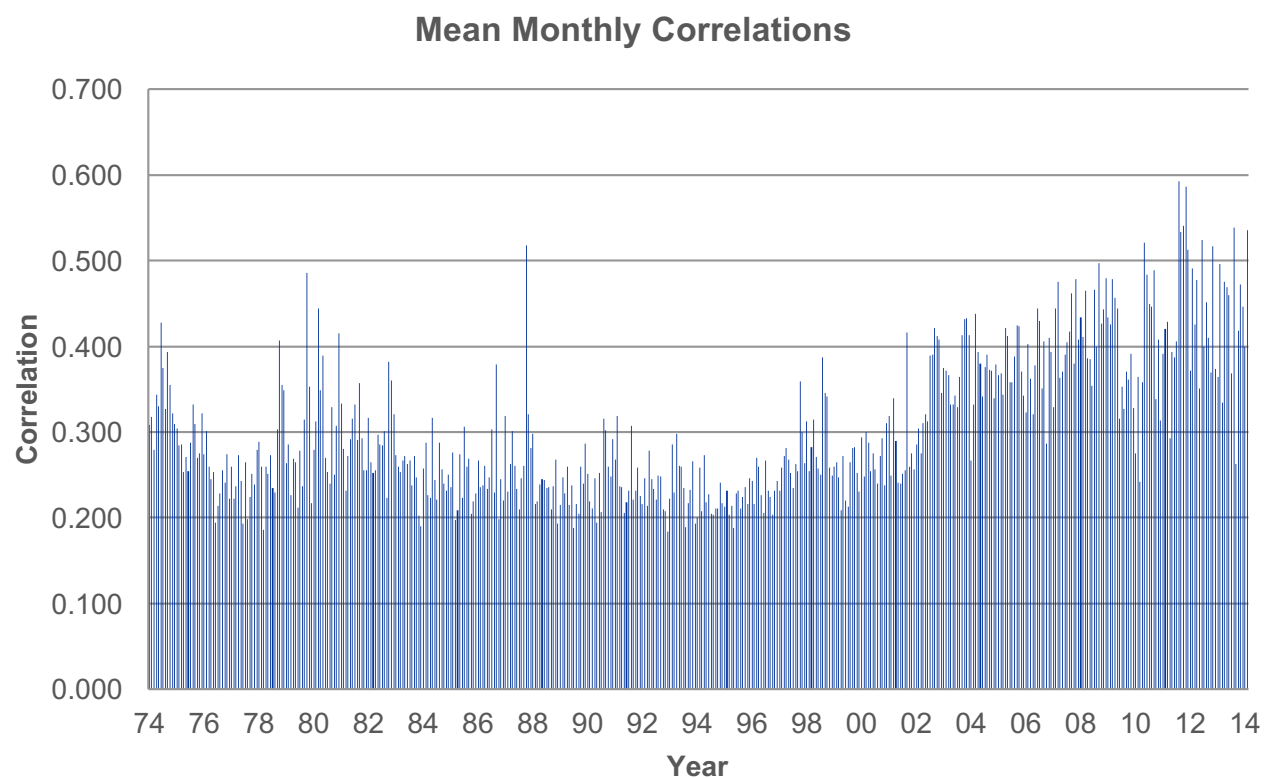
Figures 7+8. Mean individual-bank systemic risk premium (IPDS) using dividend-forbearance model, 1974-2013 (in bp)

All banks

Large banks only

Mean Systemic Risk Premium (IPDS)

Mean Systemic Risk Premium (IPDS)
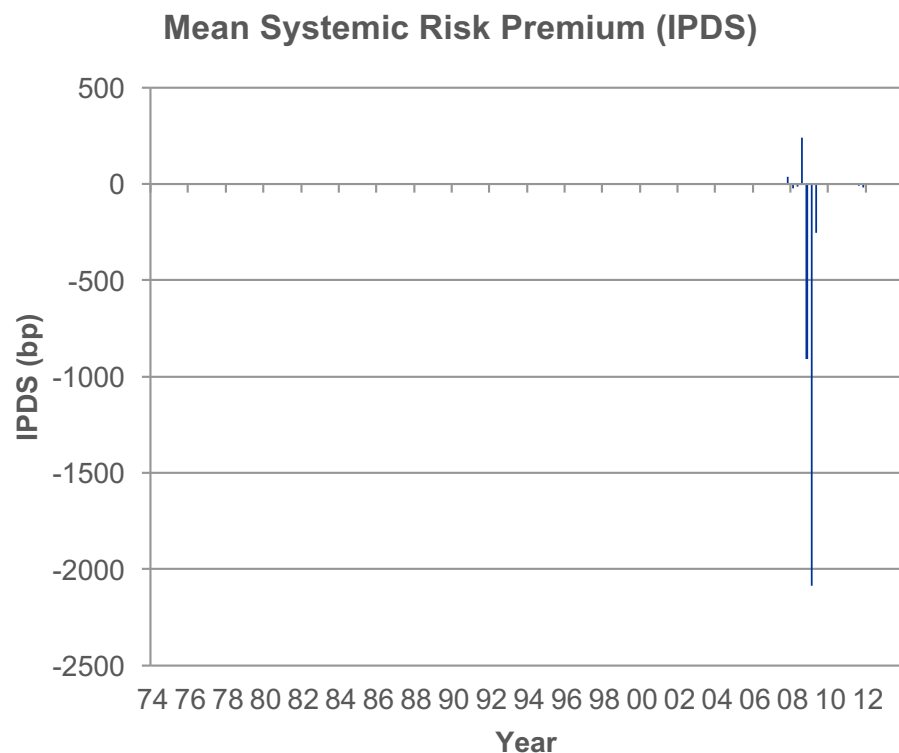
Negative values for systemic risk?

- 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

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
  - SRISK measure of Brownlees and Engle (2010)

- High correlation between our measure and SCAP capital shortfall (0.8); lower correlation with SRISK (0.46); and even lower correlation with Acharya et al. MES measure (0.20)

Table 8. Comparison with measures of capital shortfall

Financial institution	Other measures				Our measures			
	SCAP ($bn)	SCAP/Tier1 Capital (%)	Acharya et al. MES ($bn)	Brownlees and Engle SRISK (%)	Value of stand-alone support ($bn)	Stand-alone risk premium IPD (bp)	Value of systemic risk support ($bn)	Systemic risk premium IDPS (bp)
Bank of America Corp	33.9	19.6	15.1	14.14	258	1,304	65	341
Wells Fargo & Co	13.7	15.9	10.6	8.51	119	1,049	53	482
Citigroup Inc	5.5	4.6	15.0	17.50	269	1,474	35	192
Regions Financial Corp	2.5	20.7	14.8		26	2,053	4	297
Suntrust Banks Inc	2.2	12.5	12.9		13	780	4	260
Keycorp	1.8	15.5	15.4		12	1,228	3	279
Morgan Stanley Dean Witter & Co	1.8	3.8	15.2	4.44	138	2,202	5	86
Fifth Third Bancorp	1.1	9.2	14.4		18	1,657	3	262
PNC Financial Services Group Inc	0.6	2.5	10.6		21	803	7	266
American Express Co	0	0.0	9.8		4	328	-4	-389
Bank New York Inc	0	0.0	11.1		12	582	1	37
JPMorgan Chase & Co	0	0.0	10.5	13.58	74	371	45	228
US Bancorp	0	0.0	8.5		9	376	0	12
State Street Corp	0	0.0	14.8		19	1,303	6	455
BB&T Corp	0	0.0	9.6		4	319	0	33
Capital One Financial Corp	0	0.0	10.5		11	777	3	186
Goldman Sachs Group Inc	0	0.0	10.0	4.27	13	151	-4	-43
Metlife Inc	0	0.0	10.3	3.63	42	878	6	130

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, and SRISK is from Brownlees and Engle (2015).

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, consistent with TBTF

- 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

- **Government guarantees** and **incentives** matter a great deal in the financial sector, and measures of systemic risk and stress tests should account for both