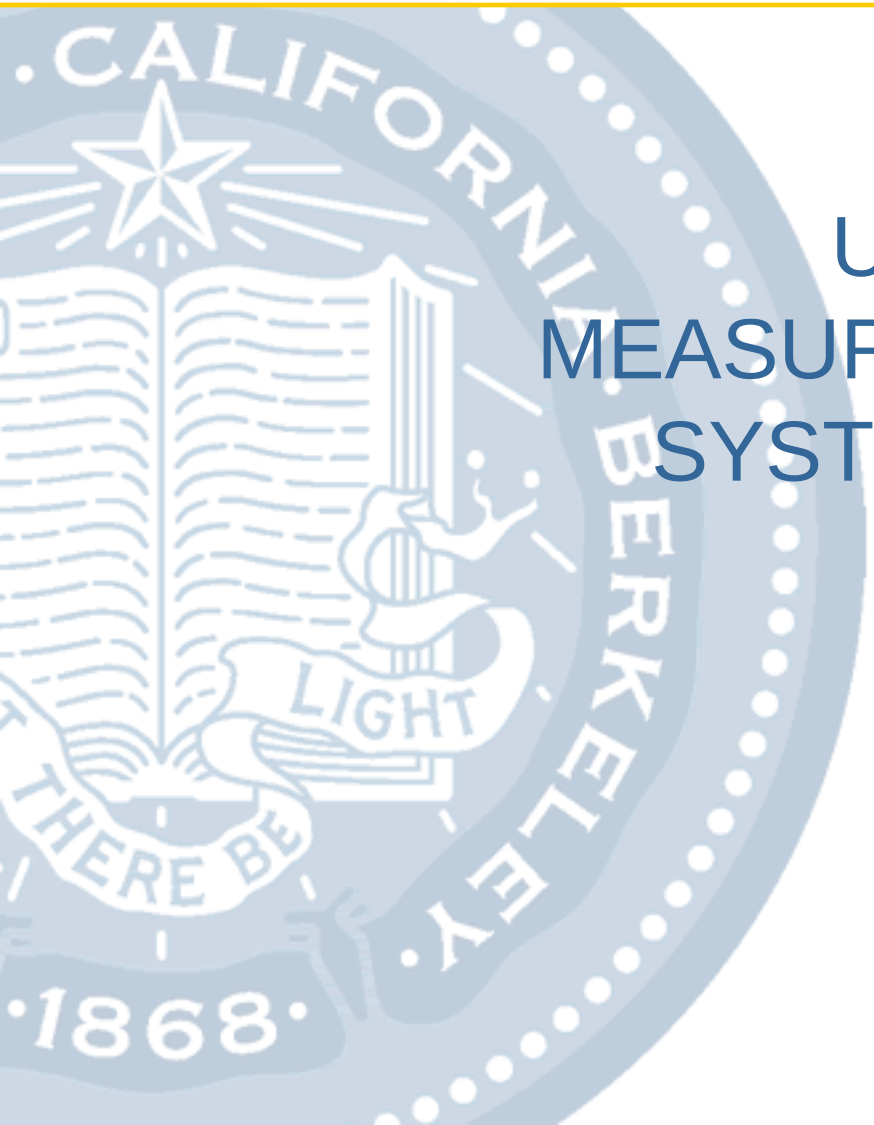

UNKNOWN UNKNOWNS: MEASURING AND REGULATING SYSTEMIC FINANCIAL RISKS

Eric Talley (Berkeley Law)

Financial / Systemic Risk Regulation Core Challenge

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Recurring problems of in quantifying / characterizing financial sector risk

1. Analytic Complexity (markets; products; actors)
2. Knightian/Ellsbergian Uncertainty (vs Risk)
3. Poor Public Information
4. Hard to Disclose / Audit Accuracy
5. Focal / Highly Politicized

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Core Implications?

- "Simplified" (but highly technical and nonlinear) models of financial risk, when combined with model uncertainty
- Decentralized information structures (perhaps unavoidably so)
- Regulatory Opacity (confidentiality, political stakes, CYA motives).

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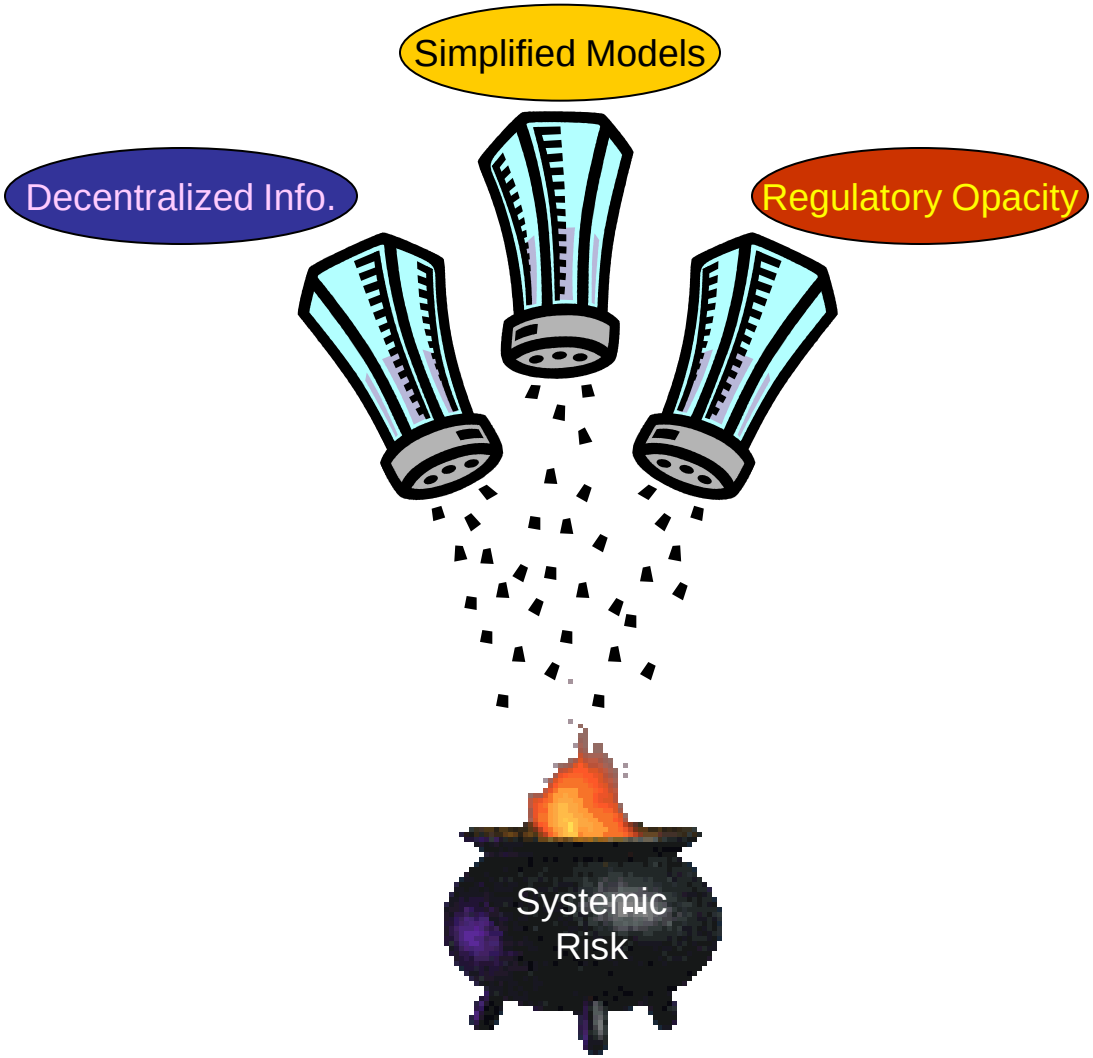
Recipe for Systemic Risk



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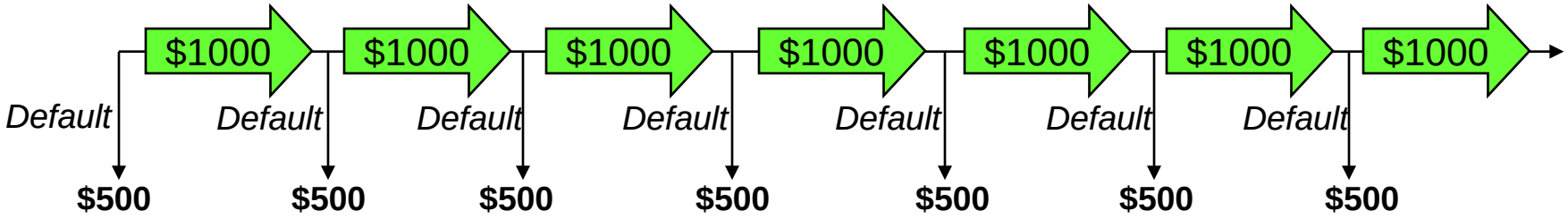
(1) "Simplified" Models and Systemic Risk Example: Securitized Credit Risk Modeling

- Problem: Understanding contributions of individual debt obligations in larger securitized pool of assets
  - E.g., each deb/account obligation represents a stream of contingent cash flow rights...
- PD/LGT Models
  - Conditional on default, creditor may not be washed out, but instead may recover some "residual" value



- If periodic payments occur in close enough proximity to one another, then one can approximate each cash flow stream as a "continuous" flow of rights…

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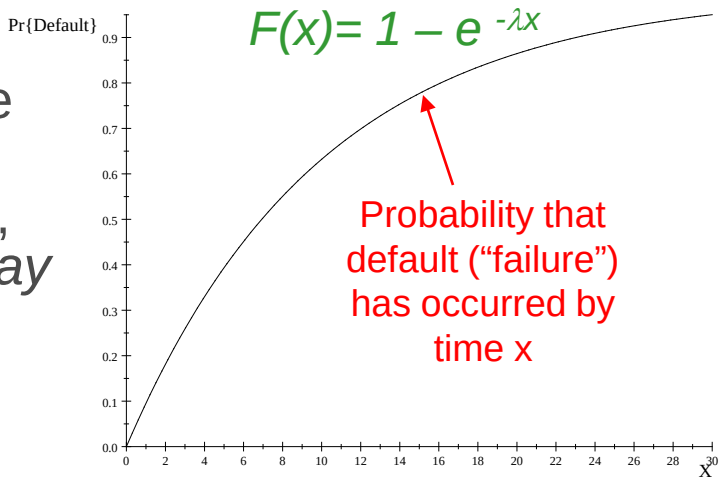
Continuous "Survivorship" Models and Portfolio Modeling

- Basic Idea:
  - Loan obligation represented as continuous flow of income, lasting up to the point that the obligor defaults or retires debt
  - Thus, if *X* denotes the (random) time of default, then the length of the cash flow stream is also *X*, with a cumulative probability distribution, *F(X)*

- A second loan obligation can also be conceived as a continuous cash flow whose time of default *Y* has a cumulative probability distribution *G(Y)*
- If we pool these two obligations together, then to value the pool (or its parts) *we may want to understand how / whether the component parts are related to one another*
  - **I.e., the joint distribution *H(X,Y)***
  - Problem: we often have reliable information mainly on the "marginal" distributions *F(X); G(Y)*



E.g.: Exponential Distribution:

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Key Concept: *Copula*

- A function that combines two (or more) marginal probability distributions into a the "true" joint distribution (*Sklar's Theorem:* such a function always exists)

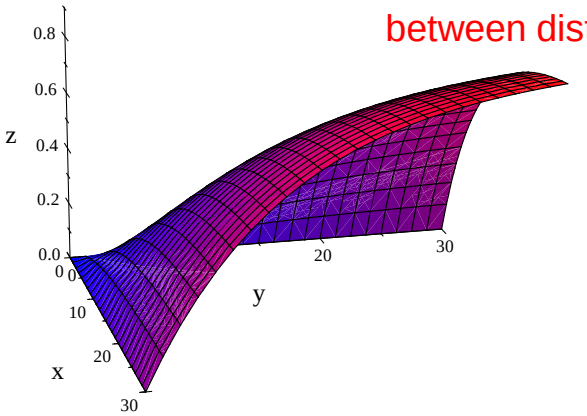
  $H(X,Y) = C(F(X), G(Y))$:

- Example: "FGM" copula with Exponential Distributions:

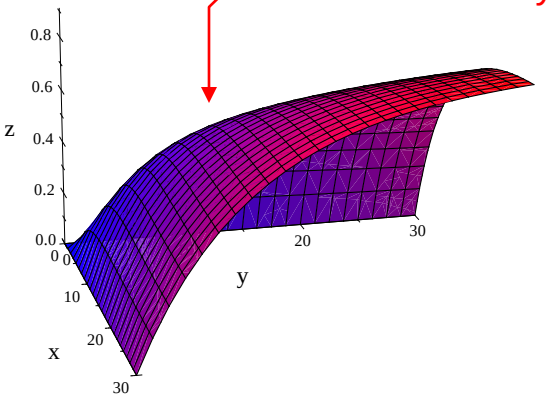
  $C = F(X)\ G(Y)\ (1+\delta\ (1-F(X))(1-G(Y))$

Degree of "interrelationship" between distributions

"Bulge": greater probability that both obligations have defaulted early – lower value



$\delta = 0$



$\delta > 0$

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A Cornucopia of Copulas

- FGM Copula
  $C = F(X)\ \ G(Y)\ \ (1+\delta\ \ (1-F(X))(1-G(Y))$
- Frank Copula
  $C = (1/\delta)\quad ln[\ 1 + (e^{\delta F(X)}-1)\ (e^{\delta G(Y)}-1)\ /\ (e^{\delta}-1)\ ]$
- Gaussian (Normal Distribution) Copula
  $C = \Phi\ (\ \Phi^{-1}(F(X)),\ \Phi^{-1}(G(Y)),\ \delta)$
- Many others…
- While there are infinitely many copulas out there, most finance quants have tended to use the "Gaussian" copula, as it has reasonably good mathematical (not to be confused with empirical) properties
  - One can also easily implement it for 3, 4, 5, …. 1000 different cash flow streams
  - One can make correlations arbitrarily high / low

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Do copula approaches work for valuing credit derivatives?

- Yes, they are good approximations…
- …but using them presupposes that you know:
  1. The right marginal distributions to use;
  2. The right copula function to use;
  3. The correct parameters to feed into the copula function (e.g., the value of δ)
- During the 2000s, researchers usually did an OK-ish job on (1), made very little progress on (2), and tended to ignore some pesky problems with (3)…

- E.g., nearly all copula-based credit risk models tended to presume that if a default occurs, there is a constant recovery rate on the loan, that does not vary systemically with aggregate default rates
  – This assumption has long been known to be false…

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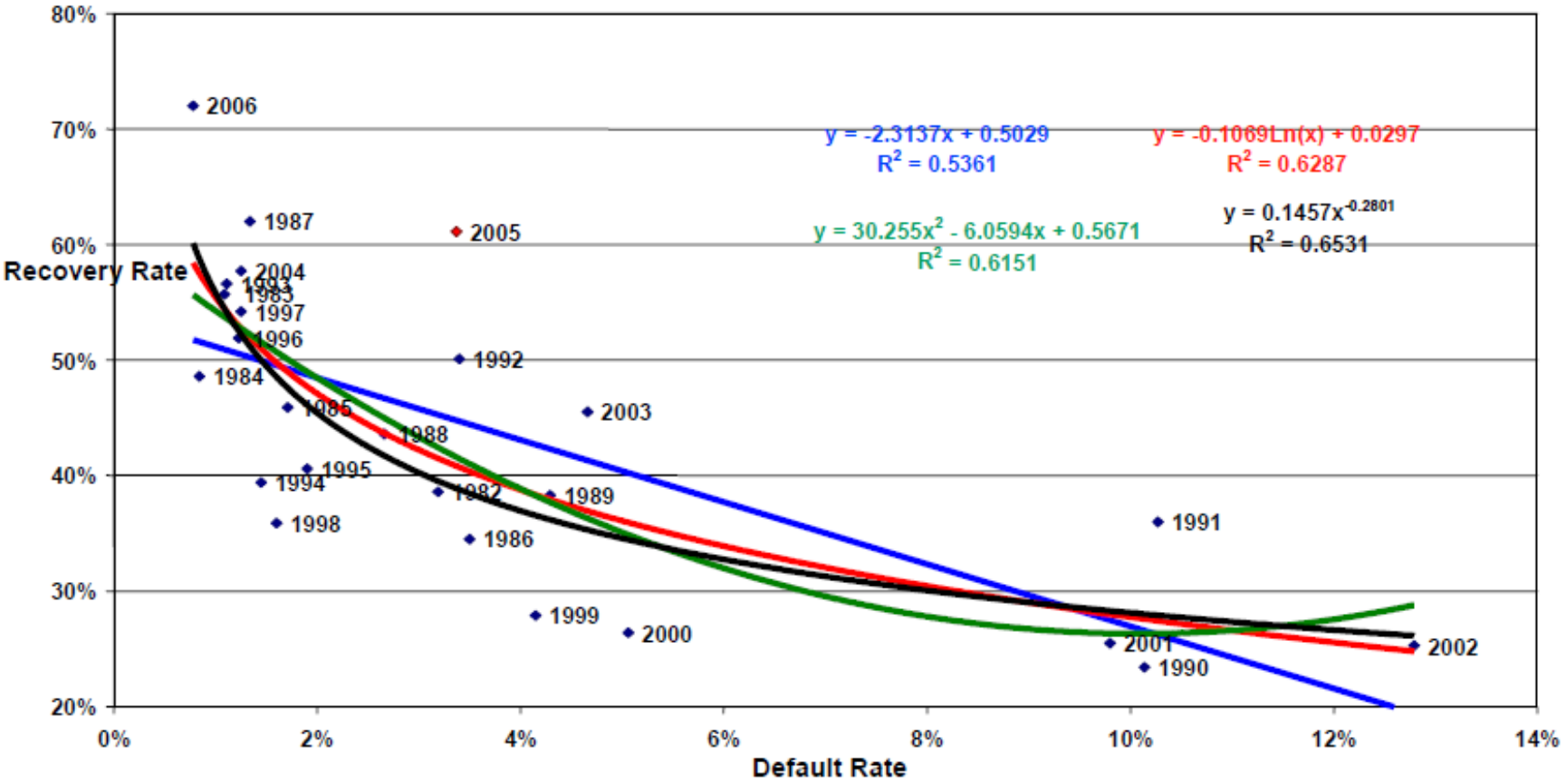
Average Recovery Rates & Default Rates (1982-2006; dollar weighted)



Source: Altman et al (2007)

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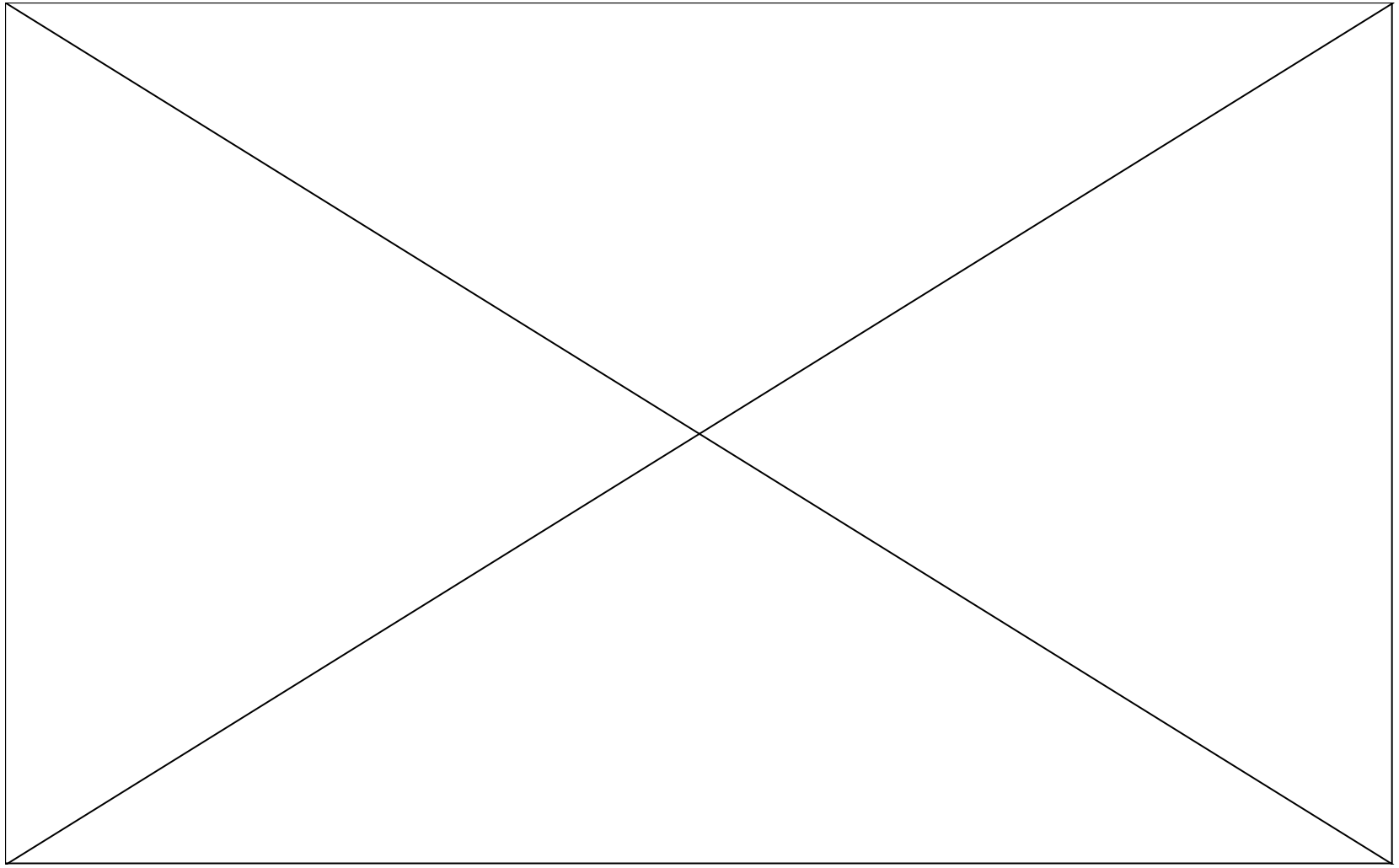
(2) Decentralized Information Structures (Unavoidably So?)



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(3) Regulatory Opacity

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DealB%k Edited by Andrew Ross Sorkin

MARCH 2, 2011, 3:03 PM THE TRADE

A Test Where the Banks Had the Questions and the Answers

BY JESSE EISINGER, PROPUBLICA

Later this month, the Federal Reserve is going to let banks know how they did on its most recent round of "stress tests."

Saul Loeb/Agence France-Presse — Getty Images

Jamie Dimon, chief executive of JPMorgan Chase

Banks are eager to bring doctors' notes to their meetings with investors, displaying their bills of health. They want regulators to allow them to start paying, or increasing, dividends to investors or to initiate stock buyback programs.

This set of exams, announced in November, is Son of Stress Test 2009, a followup to tests the Fed conducted in the wake of the financial crisis.

But something seems different this time around. It's almost as if the banks knew their results, even before the testing was complete.

Since the end of last year, banks have been bragging about their rude health. Bank of America's chief executive, Brian T. Moynihan, suggested that the bank would raise its dividend above its current token amount. Jamie Dimon, JPMorgan Chase's leader, did the same. Warren E. Buffett suggested in his shareholder letter that Wells Fargo was about to pass with flying colors.

Of course, banks ought to have a good idea of the results. They came up with the questions — and the answers.

The Fed gave the banks one economic assumption — a recession — to test their books against, but otherwise the measures were chosen by banks themselves. The Fed just vetted them. Seems like a low bar.

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"It's a take-home exam where you supply the math and then it's pass/fail," said Joshua Rosner, an analyst with the independent research firm Graham-Fisher & Company.

Though the Fed isn't labeling these exams an official banking system stress test, it could be every bit as consequential. Just as the 2009 tests required some banks to raise money — and the most fragile improved their capital to the tune of about $77 billion — this Stress Test Lite could allow some banks to slough off capital.

Unfortunately, declarations of banking system vigor seem premature. Housing has resumed its fall, and many analysts expect national prices to fall on average this year. Commercial real estate is a looming problem. Unemployment remains obdurately high.

In 2009, critics complained that the stress tests were driven by appearances and that the government's true, and thinly disguised, goal was to shore up confidence in the markets. The conclusion — that, over all, the system was sound — was inevitable.

"The stress tests were designed to reassure the capital markets that the government was not going to restructure the banks," said Damon A. Silvers, who serves on the Congressional Oversight Panel, which monitors the Troubled Asset Relief Program. "But the capital raises compared to the problem assets were not that big."

In the first round, the Fed disclosed the economic assumptions, a baseline and an "adverse" situation, which the banks had to test against. (In that event, even the adverse situation for 2009 wasn't as dire as reality.)

Unfortunately, the central bank didn't disclose enough information to actually judge the results. The Congressional Oversight Panel enlisted two University of California, Berkeley professors who specialized in banking and risk assessment to judge the tests. They had to throw up their hands.

The two "were interpreting shapes on the wall," said Eric Talley, a professor of law at Berkeley, who worked on the project. "We couldn't see what the shapes were, so had to look at residue to see if those were the shapes you would normally want to use."

Consequence 3: Regulatory Opacity

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Congressional Oversight Panel

June 9, 2009

JUNE OVERSIGHT REPORT*

Stress Testing and Shoring Up Bank Capital

*Submitted under Section 125(b)(1) of Title 1 of the Emergency Economic Stabilization Act of 2008, Pub. L. No. 110-343

The Supervisory Capital Assessment Program: An Appraisal

Eric Talley* & Johan Walden†
June, 2009

Executive Summary

This report covers three topical domains. First, we offer a survey of risk modeling, including conventional statistical measures of risk, the characteristics of competing risk models, and the strengths and weaknesses of each. Second, we draw from this overview a set of core criteria that are (in our estimation) critical in evaluating the Federal Reserve Board's approach to risk assessment in the context of the Supervisory Capital Assessment Program (SCAP, or "stress tests"). Finally, we use these insights and desiderata to assess the relative merits of the SCAP analysis, as reflected in two reports published by the Federal Reserve Board of Governors on April 24 and May 7.

Our survey of competing risk assessment models covers a relatively broad swath of approaches, ranging from static systematic risk modeling, to dynamic structural models (including Merton and first-passage models), to more data-driven reduced form models. Each class of models has relative strengths and weaknesses which we describe within our report. Ultimately, the choice of risk model often turns on tradeoffs between (a) the simplicity/richness of the theoretical account; (b) the practical availability of data; (c) the reliability of the data; and (d) the underdetermined identity of a single appropriate model to use to assess financial risk (*i.e.*, "model uncertainty").

*U.C. Berkeley School of Law (Boalt Hall). Harvard Law School (AY 2008-09).
†U.C. Berkeley Haas School of Business. We thank our colleagues Dwight Jaffee and Christine Parlour for helpful discussions.

Normative / policy implications?

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- Reg. Transparency / Replicability
- Enhanced Regulatory Expertise
- Condition for Bailouts(?)
- Condition for lower CAR(?)

- Well specified problem(?)
- Regulatory capacities (rel. to financial sector)
- Required remuneration
- Susceptible to politics / Monday morning charlatans

University of California, Berkeley

END

Regulatory Response to Financial Meltdowns

Supervisory Capital Assessment Program: An Appraisal

Eric Talley (Berkeley Law)
Johan Walden (Haas Finance)

Outline

- Background
  - Traditional Bank Regulation: A Primer
  - CAR, RWA, Tier 1 & 2 Capital
- The Federal Reserves SCAP “stress test” program
  - Description & Overview
  - Results
  - Analysis / critique of program
- What Now?
  - Current status of tested Bank Holding Companies
    - New proposed regulations on BHCs
  - Grading the government’s role in dealing with crisis

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Traditional Approach to Capital Adequacy

- Capital Adequacy Ratio (CAR):

  CAR = C/A, where:

  C = Total amount of capital available to absorb losses

  A = "Risk-weighted" assets (a.k.a., "RWA") Calculating A:

  – Take face value of each asset, and multiply by a weight that reflects underlying risk:

$$A = \omega_1 A_1 + \omega_2 A_2 + \cdots + \omega_N A_N$$

  – Note: Riskier assets get larger weights, & require more buffer

- What Comprises C? Common distinction b/t Tier 1 and Tiet 2 Capital measures
  – Tier 1 Capital: "Liquid" capital, predom. consisting of reserves, common stock, and sometimes preferred stock (non-cumulative)
  – Tier 2 Capital: Less liquid forms of capital, usually consisting of undisclosed reserves, revaluation reserves, hybrid instruments, cumulative preferred stock and subordinated term debt.

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Traditional Approach to Capital Adequacy II

- Measuring / Prescribing Risk Weights
  - Varies by jurisdiction (though general similarity). E.g.,
    - Cash and Government Bonds Weight: 0%
    - Credit Card Portfolio Weight = 40%
    - Other assets tend to be put into cubbyholes receiving weights that are (ostensibly) related to their risk
  - Typically, these weights were prescribed by statute / regulations, and were not the product of detailed risk models
    - (but they can be…see below)

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Traditional Approach to Capital Adequacy III

- Traditionally, bank regulators have placed different CAR thresholds on banks
- In the US:
  - CAR (Tier 1 & 2) > 8%
  - CAR (Tier 1) > 4%
  - CAR (Tier 1 Common Equity) > 2%
- 2009 Stress Tests:
  - CAR (Tier 1) > 6%
  - CAR (Tier 1 Common Equity) > 4%

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More sophisticated risk weights?

- Prescribed regulatory "risk bucket" weights have obvious problems
  - Bureaucratic; completeley insensitive to objectively measurable risk attributes; systemic risk
  - Many potential ways to improve. E.g.,
    - Capital Asset Pricing Model (CAPM)
    - "Merton" & First Passage Models
    - Reduced Form Statistical Models
    - Value at Risk ("VaR") Models
  - Large focus of Basel II Accords: Reg. Self-Governance
    - Heterogeneous approaches introduce **model risk**
- The Fed's SCAP stress tests undertook a type of scenario-conditional loss approach…

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The Federal Reserve's Supervisory Capital Assessment Program (SCAP)

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- What Was It?
  - A specialized umbrella stress test applied to the 19 largest domestic bank holding companies (assets > $100 billion)
  - Different from conventional stress tests: Ostensibly more rigorous attempt to consider risks / asset weights as function of risk.
  - Computed across all major asset classes; more "horizontal."
  - Ultimate Use: Public consumption; criterion for future survival; prospective TARP eligibility
- Who Implemented it?
  - Coordination: Federal Reserve Board (Fed)
  - Analysis: Collaboration among the Fed, the Federal Reserve Banks, the Comptroller of the Currency, and the FDIC
  - No involvement by Dept. of Treasury (official story)
- Oversight:
  - Since many BHCs had received TARP funds (and more funds might turn on outcome of SCAP), the Congressional Oversight Panel for TARP (COP) had jurisdiction to evaluate SCAP's design / implementation
  - Commissioned Report from Eric Talley (UC Berkeley Law) and Johan Walden (UCB / Haas), on which the COP partially relied…

SCAP Basic Approach: Scenario/Conditional Loss Risk Assessment

- Stage 1: Project three key macro-economic variables to over 2 year horizon; "baseline" & "more adverse" cases;
  - (1) GDP Growth; (2) Unemployment, (3) Housing Prices.
- Stage 2: For each scenario/asset class, statistical models forecasted an expected indicative lose rate (ILR) ranges.
  - ILRs would functionally would serve as RWA "weights" in each class
  - Ostensibly conducted across regulators, w/o input from the banks
- Stage 3: Tailoring: Harvest / analyze granular data from 19 BHCs on risk/performance attributes in each asset class
  - Analysis of granular data + interactions with banks => allowed readjustment of BHCs' loss rates away from ILRs
- Stage 4: Under "more adverse case," assess capital adequacy against two conjunctive sizing buffers:
  - Tier 1 capital > 6% of RWAs
  - Tier 1 common capital > 4% of RWAs
  - (Recall historical practice: Tier 1 > 4% of RWAs; maj. common)

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SCAP Basic Approach: Scenario/Conditional Loss Risk Assessment

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  - (1) GDP Growth; (2) Unemployment, (3) Housing Prices.
- sset class, statistical models ative lose rate (ILR) ranges.
- erve as RWA "weights" in each

Table 1

Economic Scenarios: Baseline and More Adverse Alternatives

(Minus signs indicate negative values)

	2009	2010
Real GDP[1]		
Average Baseline[2]	-2.0	2.1
Consensus Forecasts	-2.1	2.0
Blue Chip	-1.9	2.1
Survey of Professional Forecasters	-2.0	2.2
Alternative More Adverse	-3.3	0.5
Civilian unemployment rate[3]		
Average Baseline[2]	8.4	8.8
Consensus Forecasts	8.4	9.0
Blue Chip	8.3	8.7
Survey of Professional Forecasters	8.4	8.8
Alternative More Adverse	8.9	10.3
House prices[4]		
Baseline	-14	-4
Alternative More Adverse	-22	-7

[1] Percent change in annual average.
[2] Baseline forecasts for real GDP and the unemployment rate equal the average of projections released by Consensus Forecasts, Blue Chip, and Survey of Professional Forecasters in February.
[3] Annual average.
[4] Case-Shiller 10-City Composite, percent change, fourth quarter of the previous year to fourth quarter of the year indicated.

	Baseline	More Adverse
First Lien Mortgages	5 – 6	7 – 8.5
Prime	1.5 – 2.5	3 – 4
Alt-A	7.5 – 9.5	9.5 – 13
Subprime	15 – 20	21 – 28
Second/Junior Lien Mortgages	9 – 12	12 – 16
Closed-end Junior Liens	18 – 20	22 – 25
HELOCs	6 – 8	8 – 11
C&I Loans	3 – 4	5 – 8
CRE	5 – 7.5	9 – 12
Construction	8 – 12	15 – 18
Multifamily	3.5 – 6.5	10 – 11
Nonfarm, Non-residential	4 – 5	7 – 9
Credit Cards	12 – 17	18 – 20
Other Consumer	4 – 6	8 – 12
Other Loans	2 – 4	4 – 10

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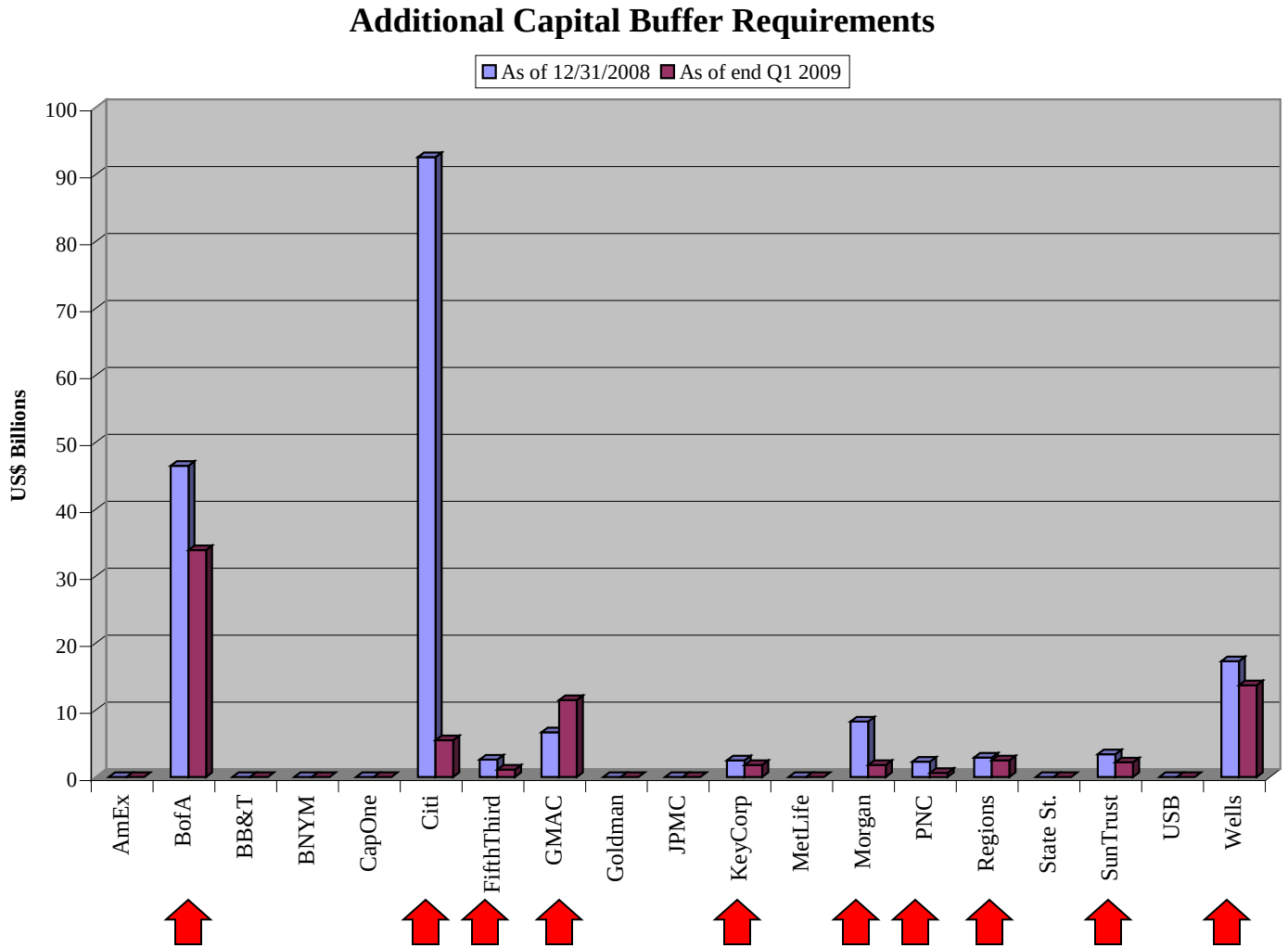
Results: Of the 19 largest BHCs, 10 found to need additional capital buffer, while 9 did not



- *Non-complying BHCs given until June to develop a plan to meet capital adequacy standards, and November to implement it*

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Were these tests meaningful litmus tests for BHC financial health (Talley/Walden)?

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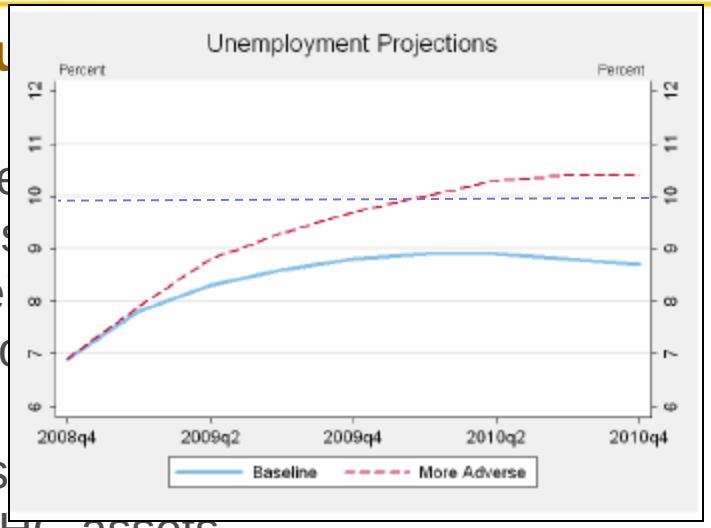
Three Possible Answers: Yes; No; No Clu



- Yes:
  - Broad perspective, across all asset classe
  - More rigorous sizing buffer for CAR than s
  - Used intra-agency risk model heterogene
  - Research staff appeared professionally c
- No:
  - Insufficient sources of macroeconomic ris
  - 2-yr horizon mismatched with illiquid of BHC assets
    - Compare: 10 year Fannie & Freddie stress tests in late 1990s
  - Accounting treatment of various illiquid assets
    - Loans held to maturity; FASB mark-to-model rules
  - Adverse case "caught up" with baseline as spring progressed (unemp)
- No Clue:
  - Little transparency in macro modeling to generate ILRs
  - Nearly complete opacity in process of tailoring loss ranges by BHC
  - Considerable model uncertainty (despite attempts to calibrate)
  - Is BHC the correct unit of analysis?
    - "Source of Strength" Doctrine: Reg. Y, BHCA, 12 U.S.C. 225 et seq.; *Bd of Governors v. 1st Lincolnwood Corp.,* 439 U.S. 234 (1978).

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What's Next?

- BHCs that flunked SCAP were requred to inject more capital by November 2009
- In 10 failing BHCs, T1 common capital increased by $77B
  - New common equity / eligible securities of $39 billion;
  - Conversion of $23 billion in existing preferred equity to common;
  - Sales of businesses or portfolios of assets that increased common equity by $9 billion.
- As of the Nov. 9 deadline, 9 of the 10 firms had (evidently) increased capital sufficiently
  - Exception: GMAC (currently in protracted 'negotiations' with Fed, which 2 weeks ago injected another $3.8 billion)
- Many BHCs have redeemed the government's holdings
  - Most Recent Example: B of A ($45 Billion)
- Still, tremendous ongoing concern that stress test scenarios have already become obsolete. Stay tuned!

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Grading the regulatory response along three dimensions…

- Competence: Good
  - Basic skill sets of gov't regulators seemed (surprisingly?) good
  - [E.g., clever use of intra-governmental heterogeneity to confront model risk]
- Clarity: Terrible
  - Though coherently explained from a distance, the Fed's actual process (ILRs, post-hoc adjustments) was frustratingly opaque
  - Odd, considering other governmental stress tests were far more transparent.
- Commitment: Mixed Bag
  - On one hand, SCAP was a form of activist SH monitoring, and gov't *qua* SH has been relatively demanding elsewhere too (e.g., pay czar Ken Feinberg) – good ex ante effects(?)
  - GMAC experience makes it unclear what SCAP was for; calls for SCAP II already loud; possibly

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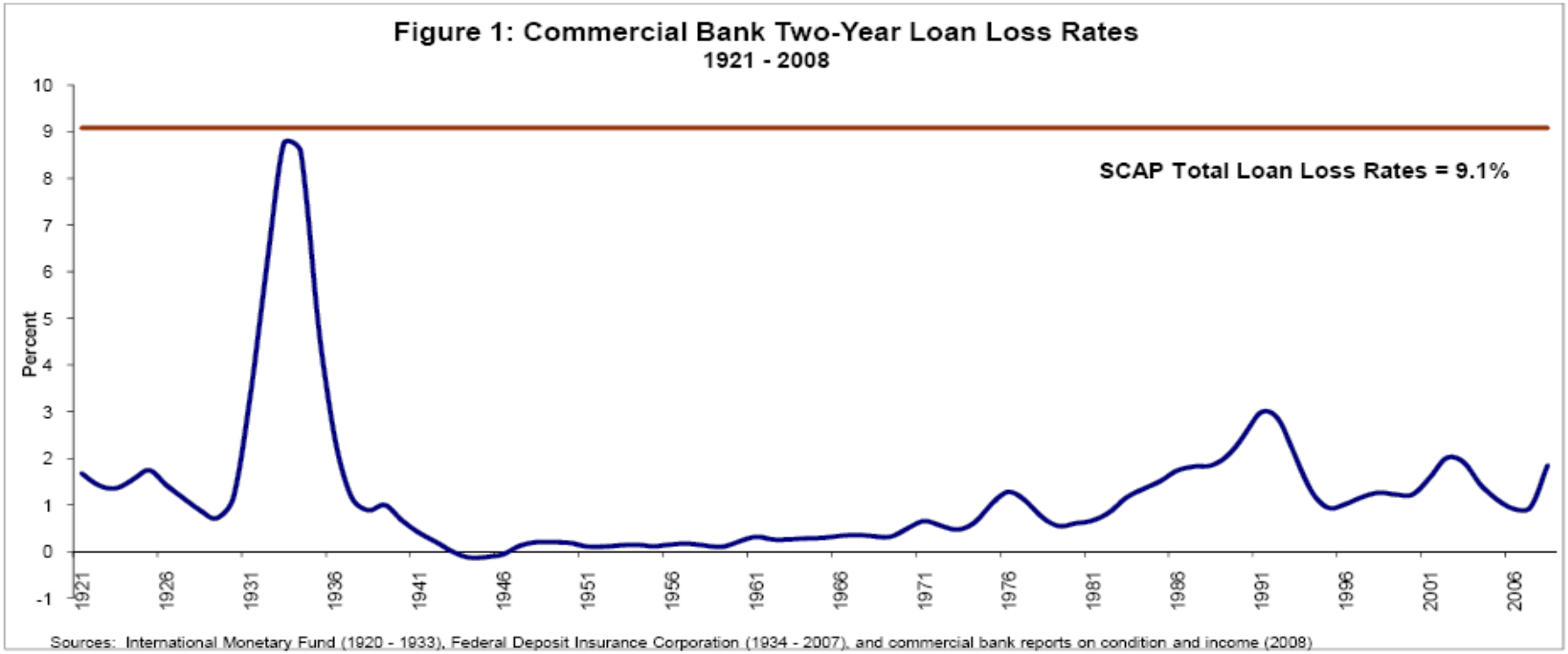
Agg. Loan Loss Rate: 9.1% in Adverse Case Historical Comparison



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