Stress Testing the Banks

FINM 35000: Topics in Economics

November 8, 2023

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Agenda

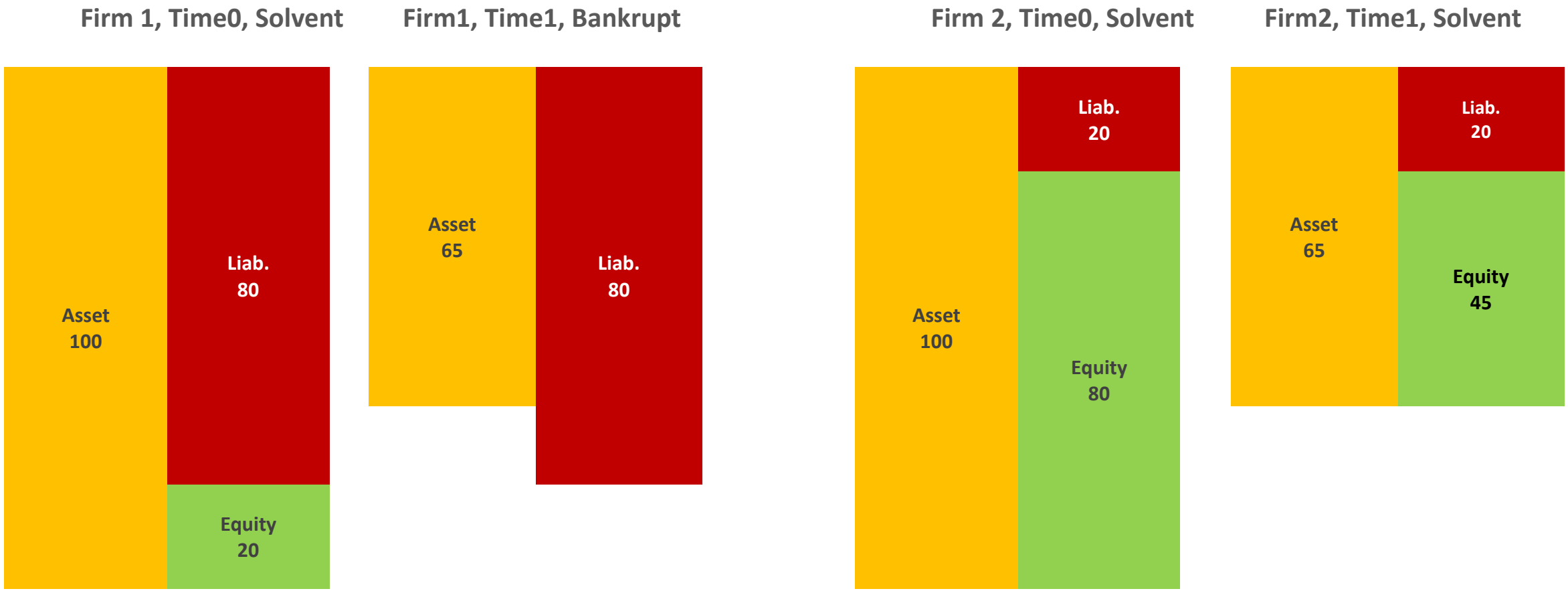
- Bank Solvency 101
- Motivation for bank stress testing
- Overview of bank stress testing process
- Challenges in bank stress testing

Basics of Banking

- Some examples of banks
  - Σ(Retail banks, commercial banks, investment banks, …) = Universals
  - Central banks

- Financial intermediary
  - Credit creation
  - Credit risk
  - Capital and liquidity

What Makes a Bank Solvent



- Equity = Asset – Liability; Bankruptcy when Equity≤0 (For simplicity, let Equity = Capital)
- Capital measures a bank's loss absorbing capacity
- The most concern for bankruptcy risk is too little capital

What Measuring Risk Means

- Risk = bank default likelihood
  - A pedagogical example:

$$\mathrm{K} = Capital\ Ratio = \frac{Capital}{Asset}$$

$$\mathrm{K}_{firm_1,T_0} = \frac{20}{100} = 20\%$$

$$\mathrm{K}_{firm_2,T_0} = \frac{80}{100} = 80\%$$

- What higher risk means
  - Assume $100 of asset earns $5 at both firms

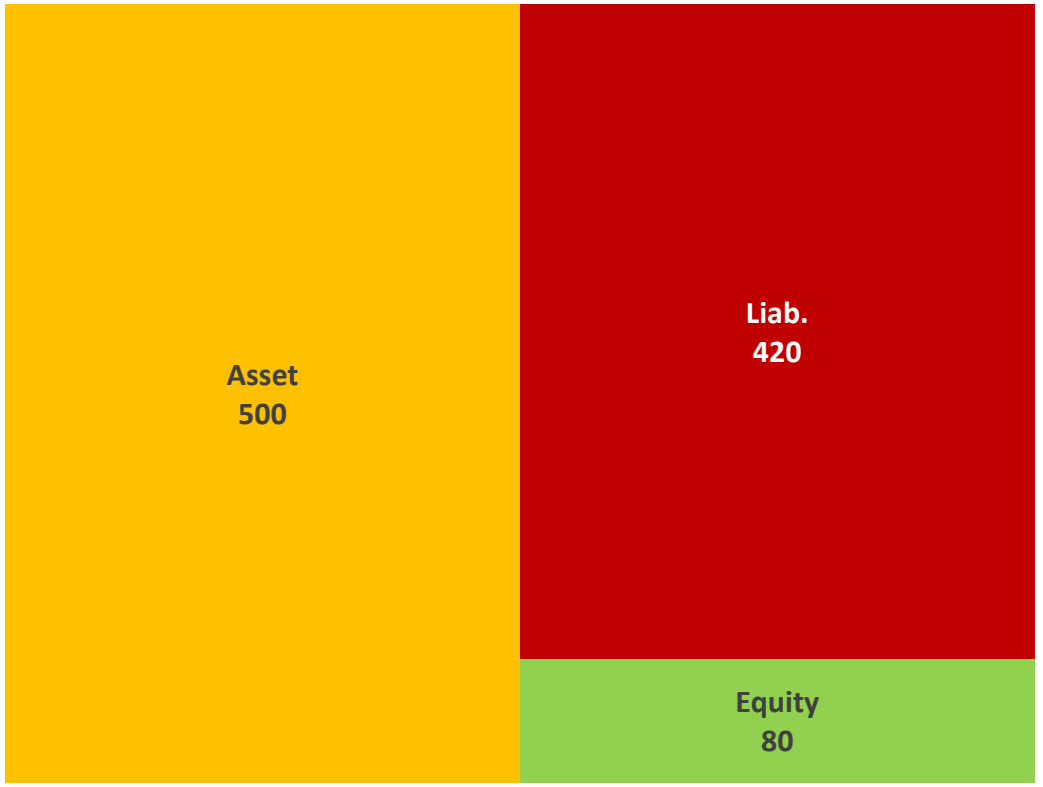
$$R_{asset,firm_1} = R_{asset,firm_2} = 5\%$$

$$R_{equity,firm_1} = \frac{5}{20} = 25\%$$

$$R_{equity,firm_2} = \frac{5}{80} = 6.25\%$$

Line Draw Scenario

Draw on credit line of $400 in loans => Total asset $100 -> $500. Assume deposit increases by $400 => liability is $420.



A Change in Risk-Return Profile

Draw on credit line of $400 in loans => Total asset 500. Assume deposit increases by $400 => liability is $420.

- Firm2, *before* the line draws

$$\mathrm{K}_{firm_2,before} = \frac{80}{100} = 80\%$$

$$L_{firm_2,before} = \frac{100}{80} = 1.25$$

$$R_{asset,firm_2} = \frac{5}{100} = 5\%$$

$$R_{equity,firm_2} = \frac{5}{80} = 6.25\%$$

- Firm2, *after* the line draws

$$\mathrm{K}_{firm_2,after} = \frac{80}{500} = 16\%$$

$$L_{firm_2,after} = \frac{500}{80} = 6.25$$

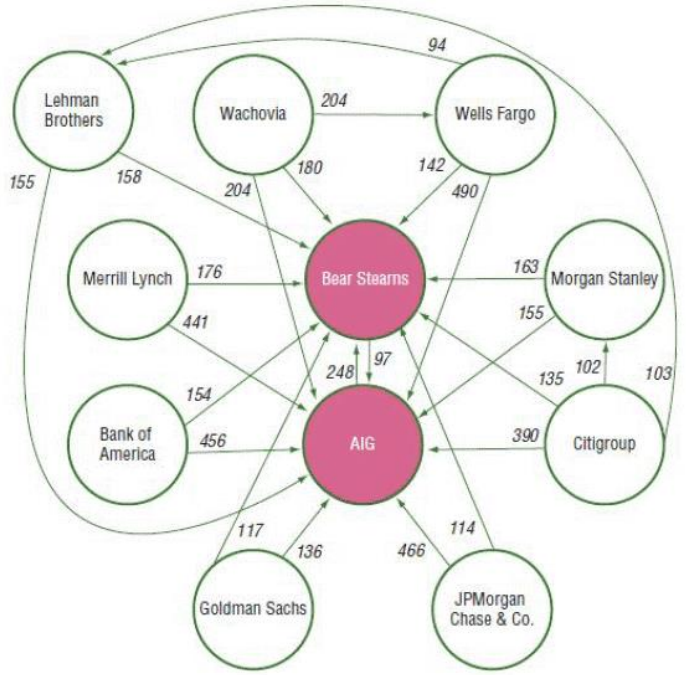
$$R_{asset,firm_2} = \frac{25}{500} = 5\%$$

$$R_{equity,firm_2} = \frac{25}{80} = 31.25\%$$

Systemic Risk: Character of G-SIBs

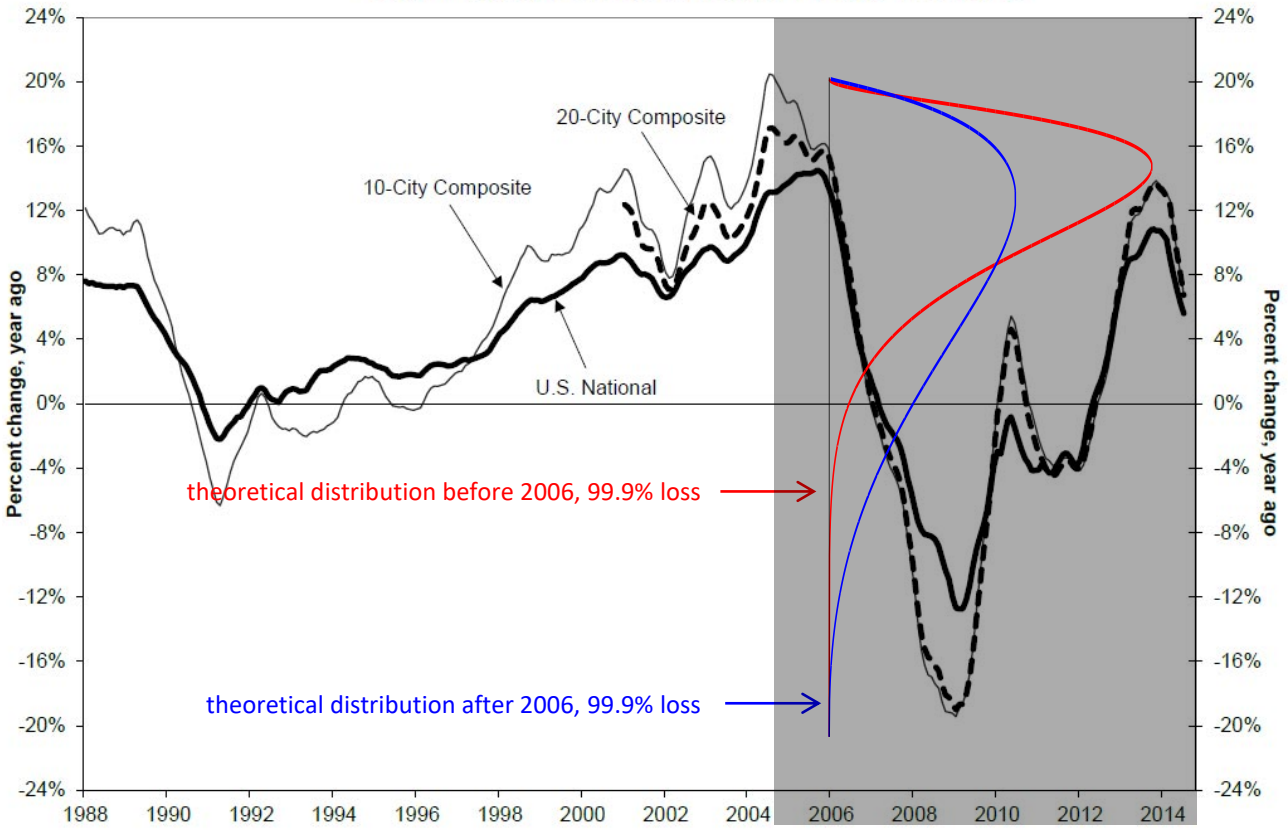
- Systemic risk = cascading bankruptcy
- Wall Street mega banks are huge, highly interconnected, and highly leveraged:
  - JPM = JPMorgan Chase, US$3.7 trillion
  - BAC = Bank of America, US$3.2 trillion
  - C = Citigroup, US$2.3 trillion
  - WFC = Wells Fargo, US$1.9 trillion
  - GS = Goldman Sachs, US$1.5 trillion
  - MS = Morgan Stanley, US$1.2 trillion
- Less capital = More Leverage = Higher Credit Risk = More Vulnerable to Stress Conditions

Too Big to Fail



Source: IMF (2009a).
The numbers on the arrows are the CoRisk measures between two institutions.

Stress Testing: A Historical Perspective



- The Basel Capital Accord requires the banks to set capital to 99.9% loss based on the *historical experience*
- Is there a problem here?
  - Defining the ex ante loss distributions using the ex post loss distribution
  - Basel bank capital requirement far exceeded by the actual capital needs during the Great Recession.
  - What is really wrong?

The Law of Small Numbers

- A.s.a. “hasty or forced generalization”, the tendency of drawing broad conclusions based on small data with coincidental mathematical relations.

  Imposed mathematical relations: model search

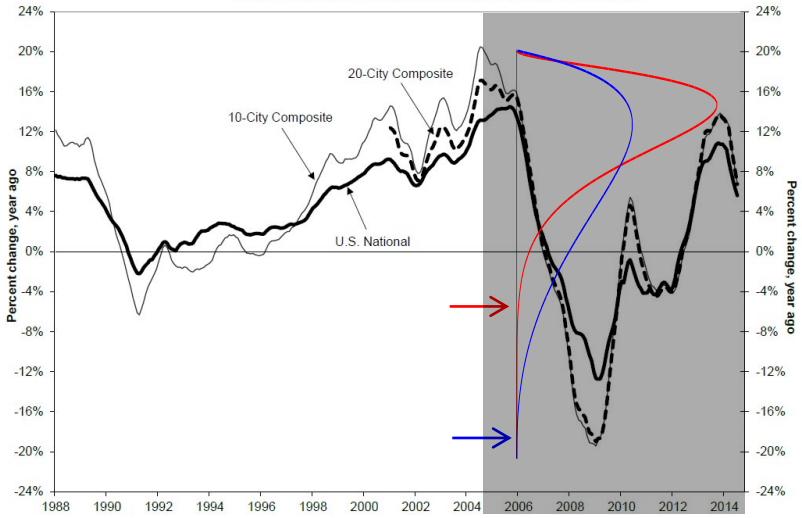
- “People have erroneous intuitions about the laws of chance. In particular, they regard a sample randomly drawn from a population as highly representative, I.e., similar to the population in all essential characteristics.”

  Tversky, A., & Kahneman, D. (1971). Belief in the law of small numbers. Psychological Bulletin, 76(2), 105–110.

- How to resolve the capital regulation fallacy caused by this problem?

CCAR: A New Paradigm

- Requirement: a bank must have enough capital at <u>all</u> times
  - during the normal course of business;
  - and during extreme and adverse business condition(s)



- Meaning: a bank's capital must remain above the minimum threshold even <u>under extremely stressed conditions</u>

- Stress testing:
  - Project bank's ΔCapital (= ΔAsset – ΔLiability) given stress scenarios
  - If satisfactory[1], proceed with capital plans[2]; if not, take actions to conserve capital[3].

1. Based on regulator quantitative and qualitative review during Comprehensive Capital Analysis and Review (CCAR, /sē-kär/)
2. Bank capital plans can include paying dividends, share buyback, debt restructure, and etc.
3. Bank will need to reduce or stop paying dividends, issue more shares or even required to raise more capital.

CCAR/DFAST History in a Nutshell

- Defining the Severity of Stress Scenarios

Scenario	Real GDP		Unemployment Rate		Dow Jones		HPI		Total
	Ave % change	RANK	Ave % change	RANK	Ave % change	RANK	Ave % change	RANK	
2011	0.2	1	9.7	1	-11	1	-6.88	1	4
2012	-4	3.5	32.4	2.5	-40.8	4	-12.2	2.5	12.5
2013	-3.5	3.5	38.5	4	-40.8	4	-12.2	2.5	14
Hypothetical	-4.3	3.5	32.2	2.5	-39.7	4	-15.7	4.5	14.5
08 Recession	-2.8	3.5	62.2	5	-25.4	2	-15.5	4.5	15

Year 2009, SCAP

Supervisory Scenarios involving 19 Banks

Year 2010

No System-wide Stress Test

Year 2011-current, evolves each year

- Fed scenarios and firm's own scenarios
- Banks and frequency due to "tailoring"

Capital Loss Forecasting

X variables (12 macro variables)

- GDP
- Disposable income growth
- Unemployment
- CPI
- House price index
- Treasury bond yields
- Corporate bond yield
- Primary mortgage rate
- Bank prime lending rate
- Stock market index
- Stock market volatility index
- Commercial real estate price index

Risk Identification & Variable Expansion

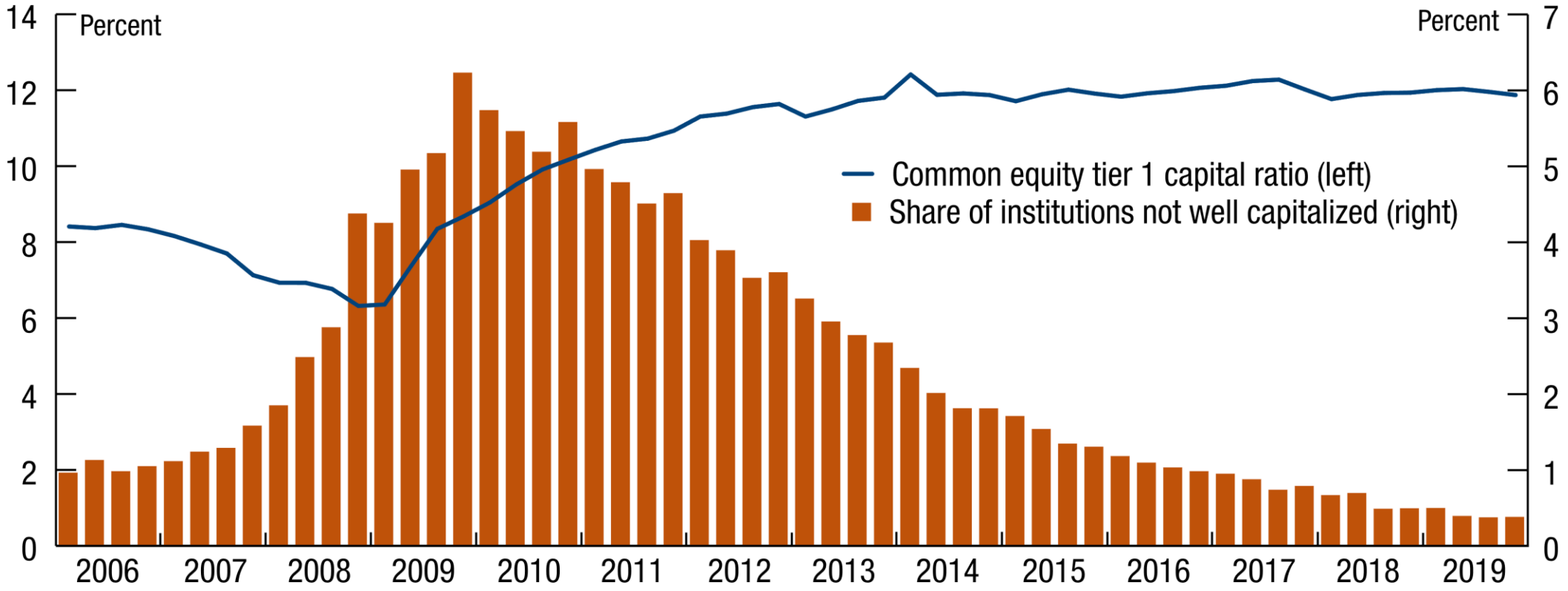
Y variables =>

- Paper impacts on capital ratio through
  - Revenues and expenses
  - Security valuations
  - Credit losses
  - Trading and CVA losses
- Numerator: Available Capital
- Denominator: RWA (risk weighted asset)

Loss translation and aggregation

$$Capital\ ratio_{scn,PQ} = \frac{Available\ Capital_{scn,PQ}}{RWA_{scn,PQ}}$$

Improving Capital Levels in Banking System



Loss Translation Dilemma

CCAR is highly quantitative

- Out-of-sample projections
  - Noise and bias
  - Model search
- Models assumes certainty
  - Assumptions
  - $f: \mathbb{R} \to \mathbb{R}, e.g., \ z = f(y)$
- Imposing the mapping relationship implies causality
  - The Law of Small Number applies
  - Watch out for "model risk"

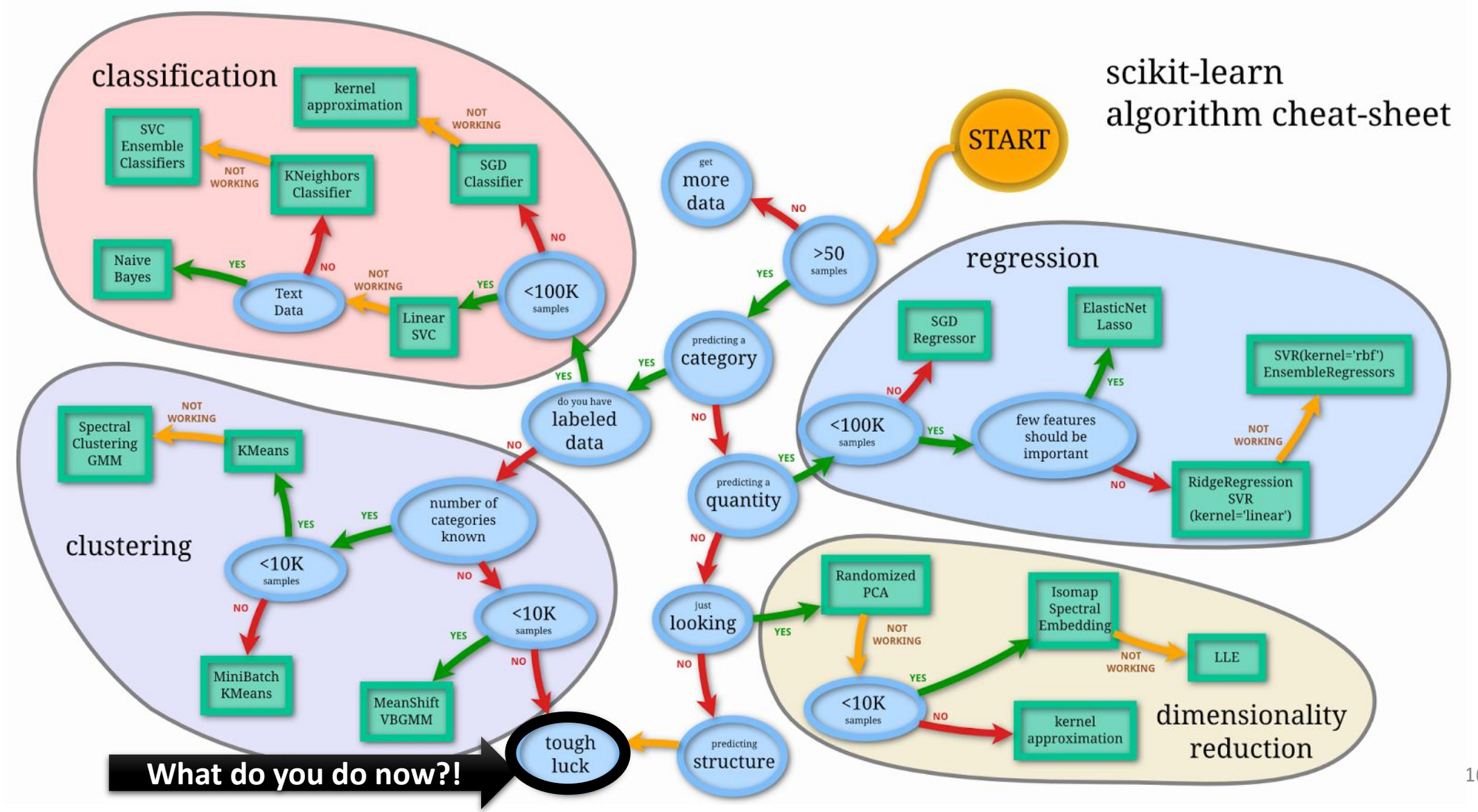
To achieve reasonable forecasts

- The process involves significant amount of resources at the banks
- One of bank's high profile exercises each year
- But the "right answer" is not guaranteed

Trails to walk

- Horizon
- Scenario
- Consistency
- Granularity
- Conservatism
- Materiality

What to Do When Math Fails?



Role of Model Risk Management

- Banks project capital levels and compare to regulatory thresholds
  - Projections are expected to be supportable and repeatable
  - Projections are based on models and assumptions
- Model risks potentially impair the credibility of projections
  - Bad models
  - Bad uses of models
- SR 11-7, a framework of principle-based* supervisory guidance:
  - Model risk governance, policy and controls (tone at the top defines the robustness of the projection framework)
  - Model development, implementation and use (model building)
  - Model validation (checking the model)

Federal Reserve's CCAR 2021 Scenarios

- Macroeconomic (macro) scenarios for the "banking book"
  - **CCAR 2021 Historic Domestic (CSV)**
  - CCAR 2021 Historic International (CSV)
  - **CCAR 2021 Supervisory Baseline Domestic (CSV)**
  - CCAR 2021 Supervisory Baseline International (CSV)
  - **CCAR 2021 Supervisory Severely Adverse Domestic (CSV)**
  - CCAR 2021 Supervisory Severely Adverse International (CSV)
- Global market shock (GMS) scenarios for the "trading book"
  - CCAR 2021 Severely Adverse Market Shocks (Excel)
- Note that the Macro scenarios and the GMS scenarios differ in design and specification in several ways.
  - The CCAR data dictionary could potentially help to provide more context.