Stress Testing: Challenges and Opportunities. A View from Academia

Peter Christoffersen

Rotman School of Management

University of Toronto

Overview

- Internal (Micro) Stress Testing
  - Goal: Manage bank risk
  - Portfolio is known, many scenarios
  - Opportunity: Scenario probabilities
- External (Macro) Stress Testing
  - Goal: Financial sector stability
  - Exact portfolio unknown, few scenarios
  - Challenge: Which scenario(s)?
  - Challenge: Scenario evaluation
  - Opportunity: Dynamic stress testing
  - Challenge: Linking security prices to real economy

Internal Stress Testing

- First generation stress testing
- Goal: Manage individual bank risk
- Designed to complement to HistSim VaR (think of 250-day 99% loss)
- If recent historical data has only few risk events then the resulting VaR will be uninformative about potential risks. We need more info.
- Stress testing is useful to learn about risk scenarios and risk factors' impact on P/L. (eg. Are we long yield-curve slope and/or convexity?)
- Key: Portfolio is known and it is typically large and complex.

Scenario Probabilities

- VaR and ES are proper probabilistic statements:
  - What is the loss such that I will loose more only 1% of the time (VaR)?
  - What is the expected loss when I violate my VaR (ES)?
- Standard stress testing does not tell the probability manager anything about the probability of the scenario happening, thus it is not clear what the portfolio management action (if any) should be.

Opportunity: Coherent Stress Testing

- If we are willing to assign scenario probabilities, then stress testing can be even more useful.
- To be explicit, consider a set of stress scenarios, which we define as a probability distribution $f_{stress}(*)$ of the portfolio returns.
- We simulate the portfolio returns from the risk model, call it $f(*)$ and we also simulate from the scenario distribution $f_{stress}(*)$.

Combining the Distributions

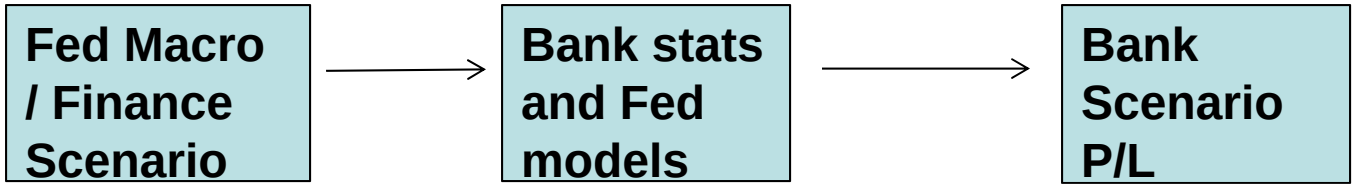
- If we assign a probability α of a draw from the scenario distribution occurring, then we can combine the two distributions as in

$$f_{comb}(*) = \begin{cases} f(*), \text{ with probability } (1-\alpha) \\ f_{stress}(*), \text{ with probability } \alpha \end{cases}$$

- VaR can be computed for combined distribution and thus used directly for risk limit and capital allocation purposes.

External Stress Testing

- Second generation stress testing
- Used to learn about systemic risks
- Goal: Financial sector stability
- Portfolio details are not known
- Scenarios are constructed and evaluated externally
- Single scenario in CCAR 2012

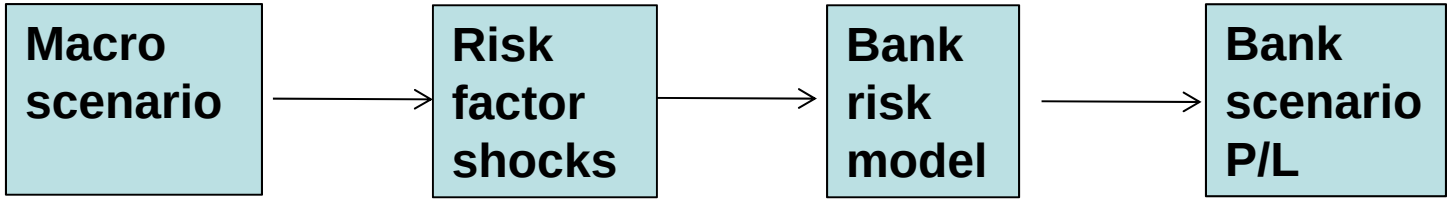


Challenges for the Fed: Choosing Scenario

- Choosing scenarios is tricky even in internal stress testing.
- Extremely tricky in external stress testing when exact bank portfolios are unknown:
  - Relevant risk factors may not be stressed: E.g. Certain geographical regions or industrial sectors.
  - Risk factors may be stressed the “wrong” direction (individually or in combination): E.g. inflation, interest rates.

Challenges for Fed/Banks: Scenario Evaluation

- Need to compute P/L for each large bank from Fed scenario. Currently done by Fed.
- Perhaps require bank internal models to use a standardized set of risk factors. This way banks can evaluation scenario(s) themselves.



- A adverse macro scenario could be generated by different sets of risk factor shocks.
- Each bank's P/L would differ across the sets of risk factor shocks.

Opportunity: Dynamic Stress Testing

- Proper risk management requires dynamic risk models capturing volatility and spread dynamics.
- A dynamic risk factor model can be used for dynamic stress testing.
- A stress scenario is a shock to a risk factor. A dynamic risk model will allow us to compute the scenario impulse responses and equivalently the term structure of the stress scenario.

Challenge for Academics: Security Prices and the Real Economy

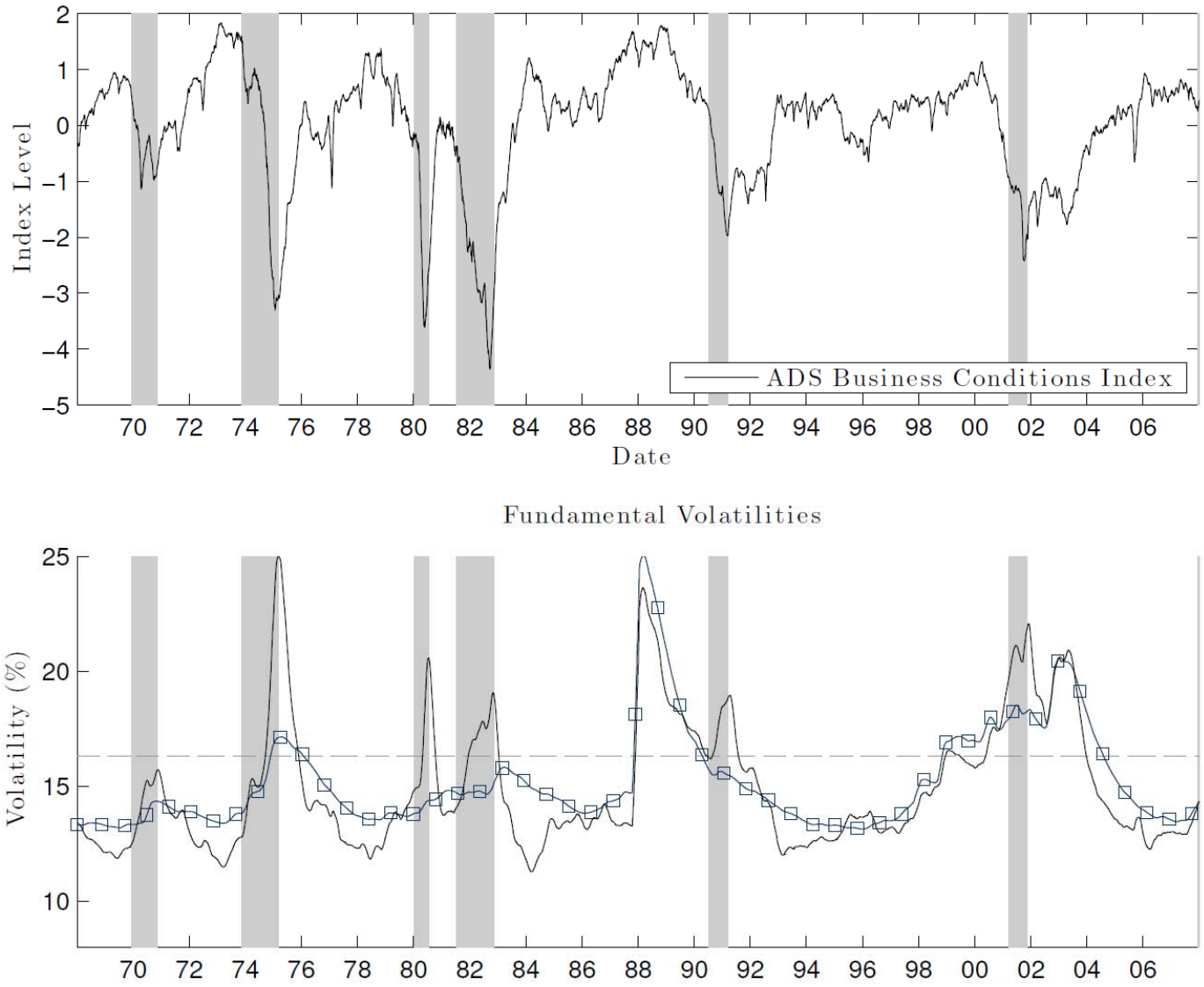
- Understanding the link between security prices and the real economy is a Holy Grail in academia. The links are not well understood.
- Stress testing highlights the need for understanding these links better.
- What drives market volatility? Engle and Rangel (RFS, 2008), Dorion (WP, 2011)
- What drives credit spreads, default probabilities and LGD? Chen (JF, 2010)

Cross-Country Volatility Drivers

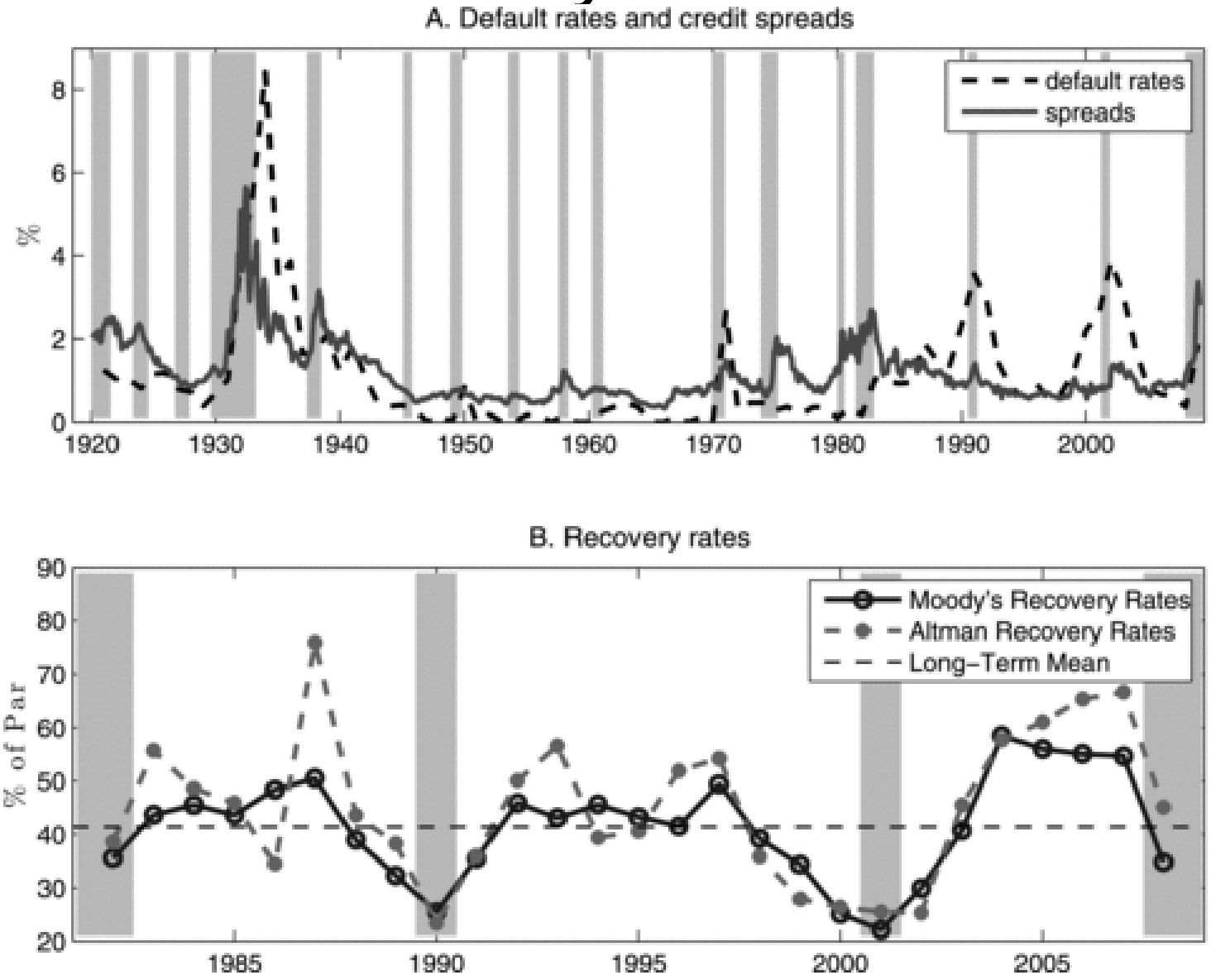
- Market development has negative effect
- Economy size has positive effect
- Inflation has positive effect
- Volatility of GDP growth has positive effect
- Volatility of inflation has positive effect
- Volatility of interest rate has positive effect
- Others
  - GDP growth has negative effect (insignificant)
  - Volatility of FX rate has no effect

Volatility and the Business Cycle

Figure 1: *Business Conditions and Fundamental Volatility Processes*



Credit Spreads, Default Rates and Recovery Rates



Summary

- O1: Internal stress testing will be much more informative with scenario probabilities.
- O2: Dynamic risk models can deliver richer stress testing results.
- C1: External stress scenario generation is very difficult when portfolios are not known.
- C2: External scenario evaluation is tricky.
- O3: Common risk factors across banks. Multiple external scenarios.
- C3: Stress testing requires better understanding of the links between real and financial variables.

References

- Berkowitz, J., 2004, A Coherent Framework for Stress Testing, J. of Risk
- Chen, H., 2010, Macroeconomic Conditions and the Puzzles of Credit Spreads and Capital Structure, J. Fin.
- Christoffersen, P., 2012, Elements of Financial Risk Management, 2nd Edition.
- Federal Reserve Board (2012), Comprehensive Capital Analysis and Review 2012: Methodology for Stress Scenario Projections.
- Dorion, C., 2011, Business Conditions, Market Volatility and Option Prices, WP, HEC Montreal.
- Prittsker, M., 2012, Enhanced Stress Testing and Financial Stability, WP, Boston Fed.
- Rebonato, R., 2010, Coherent Stress Testing.