Stress Test Modeling at the Bank of England: Past, Present and Future

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Stress testing the UK banking system:
2016 results
Outline

1. Capital requirements and capital buffers
2. Concurrent regulatory stress tests and disclosure
3. Modeling
   - Past: Scenario design
   - Present: Solvency contagion and fire sales
   - Future: Beyond the banking system?
The stylised capital framework

Buffers

Minimum requirements
Why have capital requirements?

1. Externalities
   - Financial crisis is estimated to have cost $12.8 trillion
   - Bank owners don’t take into account full cost of their behaviour
   - Have seen this in need for bail-outs
   - Transmission to real-economy through reduction in provision of financial services (ie lending)

2. Possibility of bank runs (Diamond and Dybvig 1983)

3. Banks’ reluctant to hold voluntary capital
   - Unlike other companies banks are mainly debt funded
   - Equity is particularly costly, because of how banks make money
   
   Avoid insolvency
Why have capital buffers?

Suppose we don’t: banks are required only to hold the minimum level of capital to be able to operate

• If a bank’s capital ratio falls below requirement, it has two options:
  1. Stop lending – large effects on real economy, causes instability
  2. Raise capital immediately
     – Reputational loss and transaction costs of raising capital repeatedly
     – Raising capital more costly in bad times due to debt overhang

• A bank’s capital ratio may fall due to economic shocks, uncertainty, imprecise models, etc.

• In the current system if a bank falls below its minimum requirement it goes into resolution: Avoid bankruptcy
Integrating stress tests into the capital framework

• Stress tests are there to reflect – and not recreate – the capital framework

• Stress tests are well placed to inform the setting of micro- and macro-prudential capital buffers

• Ben Bernanke (2015):

“I was certainly in favour of more capital… But I wouldn’t do it by an arbitrary number. What I would do is stress test it, because the amount of capital you should hold depends on the kind of assets and the kind of businesses you have.”
Integrating stress tests into the UK capital framework

- Buffers examined by stress test
  - PRA buffer (bank-specific)
  - Countercyclical capital buffer and sectoral capital requirements (system-wide)
- Buffers set with reference to the impact of failure
  - Capital conservation buffer [2.5% CET1]
  - Systemic buffers (bank-specific)
- Minimum requirements
  - Pillar 2A (bank-specific)
  - Pillar 1 [4.5% CET1]
What does the Bank of England do?

1. The Annual Cyclical Scenario:
   – Aim: assess the risks to the banking system emanating from the financial cycle
   – Severity reflects policymakers' assessment of the state of the financial cycle and their risk tolerance
   – Severity increases as risks build, and decrease as those risks crystalize or abate (countercyclical stress test)

2. The Biennial Exploratory Scenario:
   – Aim to shed light on dark corners
   – Could explore risks that are particularly unusual from a historical perspective, or more detailed test of specific sectors
   – Ensures unpredictability is retained
Why do concurrent stress tests?

Microprudential

• Setting bank specific buffers

• Address incentive problem: increase market discipline and transparency
  – Some principal agent problems arise from stress test due to asymmetric information and difference in objectives between banks and the regulator

• Fair comparisons across banks
Why do concurrent stress tests?

Macroprudential

• Incorporate network effects
  – For example contagion

• Model feedback and amplification mechanisms
  – For example fire sales

• Signalling device
  – Boosting trust in financial system

• Set system-wide buffers
What about disclosure of stress test results?

• Tool to boost confidence in financial markets
  – But: could cause bank runs and as a result may reduce risk sharing opportunities (Goldstein and Leitner 2015)

• Establish higher levels of confidence in financial markets - Bayesian persuasion (Williams 2015)

• Align perceived risk and actual risk (Danielsson 2016)

• More transparency, reduced information asymmetries

• More market discipline
  – But want to avoid model monoculture
Some open issues

- Internal model development (Leitner and Yilmaz 2016)
- Principal-Agent conflict related to banks’ modeling results
- Optimal stress test design (Williams 2015)
- Disclosure and financial stability (Goldstein and Sapra 2014)
- War time and Peace time stress testing (Schuermann 2016)
- Implications for competition (ie coverage and quality certification, facilitating collusion)
- Using a larger number of scenarios
- Moving beyond the banking system and moving beyond borders
- **Modeling systemic risk**
Why do we do *any* modeling in stress tests?

- **Federal reserve approach (33 banks)**
  - Banks supply large amounts of granular data
  - Regulator runs in-house models

- **EBA approach (52 banks)**
  - Banks do all the modeling
  - Regulator does ‘quality assurance’ on the results

- **Bank of England approach (7 banks)**
  - Banks supply raw data and projections
  - Regulator runs own challenger models, peer comparisons and top-down analysis
How do we use models in stress tests?

• Stresses are inherently difficult to model
  – Less focus on DSGE and historical relationships
  – More emphasis on nonlinearities and non-equilibrium models

• Modular approach – changed since pre-crisis
  – Suite of models
  – Plurality of views
  – Not used as a black box
  – Used to inform judgements by policymakers

• Leverage off research community
What is the focus of our model development?

Past
Designing counter-cyclical stress test scenarios

Present
Feedbacks and amplifications
Solvency contagion and fire sales

Future
Moving beyond the banking system
The Annual Cyclical Scenario

• Aim: assess the risks to the banking system emanating from the financial cycle

• Severity reflects policymakers’ assessment of the state of the financial cycle and their risk tolerance

• Severity increases as risks build, and decreases as those risks crystallise or abate: Schularick and Taylor (2012)

• In this way, stress testing will become countercyclical
Setting *risk tolerance*...

Severity reflects policymakers’ *risk tolerance* - what point in the tail they want to ensure the banking system is capitalised against.
...and letting severity evolve with risk environment...

In a boom, that point in the tail is associated with a worse outcome.
leads to countercyclical stress testing

Scenario becomes more severe in the upturn of the cycle, and less severe in a downturn

Estimate of equilibrium
And is supported by empirical evidence

![Graph showing the probability distribution of deviation in the level of GDP from its trend (in %)]

- **Subdued risks**
- **High risks**

The graph illustrates the probability distribution of deviation in the level of GDP from its trend, with two distinct peaks representing subdued and high risks.
Present: Feedbacks and amplifications

• Build additional models:
  – Solvency contagion
  – Fire sales

• Link them together under a single framework:
  – Modular approach
  – Decision engine
Present: Solvency contagion

- Based on Leveraging the network: a stress test framework based on Debt Rank, Battiston et al (2016)
Present: Solvency contagion

\[
E_i(t) = A_i^e(t) + \sum_{j=1}^{n} A_{ij} \mathbb{V}_{ij}(E(t) | \ldots) - L_i^e - \sum_{j=1}^{n} L_{ij}
\]
Present: Solvency contagion

- Eisenberg and Noe is represented by a step function for revaluation (red line)
- Equity holdings would be represented by a straight line (black line)
- We implement a Black and Cox credit risk model for debt contracts (green line)
- Forthcoming staff working paper: *The decline of solvency contagion*, Bardoscia, Brinley Codd and Hill (2017)
Present: Fire sales

Based on “Fire sales, indirect contagion, and systemic stress-testing”, Cont and Schaanning (2016)
Present: Fire sales

• Key assumptions:
  – Constraints:
    • Liquidity, Risk weighted assets, Leverage
  – Deleveraging strategy:
    • Proportional, most liquid, or least liquid first
  – Market impact:
    • Linear, concave, convex
How do we implement a model?

• Find the most appropriate data, or request it from banks
  – E.g. granular data on securities and exposures

• Calibrate key parameters to UK system
  – Constraints on banks
  – Behaviour and decision making
  – Market depth / price impact

• Linking to the process
  – What is included in banks’ projections?
  – What extra adjustments are necessary?
Future Aim: Feedbacks and amplifications

• Link these mechanisms in a single framework:

  Feedback Loops and Amplification Mechanisms Engine

• Separate out:
  – Impact on banks balance sheet
  – Impact of banks’ actions

• Draw out banks’ options and decisions
Future Aim: Feedbacks and amplifications
Future: Beyond the banking system?

Recent market developments further highlight the importance of the resilience of markets, and of market-based finance, to sharp market moves...

- The Bank is developing a system-wide stress simulation to assess the dynamics of markets under stress
- The FPC has assessed procyclicality in insurers’ investment activities
- The FPC has asked the Bank to complete an in-depth assessment of F5 risks associated with derivative transactions

FSB (2016):

Recommendation 9: “Where relevant, authorities should give consideration to system-wide stress testing that could potentially capture effects of collective selling by funds and other institutional investors on the resilience of financial markets and the financial system more generally”

(Source: November 2016 Financial Stability Report)
Future: Beyond the banking system?

- Purpose: To examine how the financial system behaves, and what this implies for systemic risk and the possibility of disruptions in the provision of financial services to the real economy.

- Not focused on testing the resilience of individual firms.

- Apply stress-testing techniques to analysis of interlinkages in the financial system to make that analysis more forward looking, systematic and coherent.

- Improve our understanding of how stresses can propagate through the financial system and create systemic risk.
References

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