Supervisory Stress Tests, Model Risk, and Model Disclosure: Lessons from OFHEO

W.S. Frame, K. Gerardi, and P. Willen

Federal Reserve Bank of Atlanta

Financial Markets Conference
April, 9 2013
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- The Atlanta Fed
- or the Federal Reserve System

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U.S. started this trend with its 2009 Supervisory Capital Assessment Program (SCAP) which targeted its 19 largest banking organizations.

SCAP was used as a confidence building tool at the time.

In 2010, the Federal Reserve introduced an annual Comprehensive Capital Assessment and Review (CCAR).

Stress testing framework to evaluate capital planning processes and capital adequacy at banking organizations with total assets > $100 billion.

Capital adequacy: Post-stress ratio of common equity to risk-weighted assets > 5%.
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Introduction of supervisory stress testing requirements may confer substantial benefits.

- Insight into the portfolio decisions and risk management practices of large financial institutions that could lead to enhanced risk measurement and management.
- Increased knowledge with respect to system-wide vulnerabilities.

But, there are inherent risks in stress-testing:
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Stress testing can fail because...

(1) Wrong scenario
(2) Modeling errors
Or both...
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Scenario 1: Falling House Prices

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Gerardi (FRB Atlanta) OFHEO Stress Test April, 9 2013
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OFHEO Risk-Based Capital Model
- Risk of insolvency was “effectively zero” (Stiglitz, Orszag, and Orszag 2002).
- FNMA and FHLMC failed, costing taxpayers > $100 billion.
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3. Stale data.

With (3) by far the most important.

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Actual HPA: -10% annualized from Q4, 2005 to Q4, 2008

Forecast losses as of 2/2009 in 2006-1 ABX from JPM: 23.44% (assuming -30% HPA in 2009!)
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Actual HPA: -10% annualized from Q4, 2005 to Q4, 2008

Forecast losses as of 2/2009 in 2006-1 ABX from JPM: 23.44% (assuming -30% HPA in 2009!)


“HEL Bond Profile Across HPA Scenarios”

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<th>Name</th>
<th>Scenario</th>
<th>Loss</th>
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<tr>
<td>1</td>
<td>Aggressive</td>
<td>11% HPA over the life of the pool</td>
<td>1.4%</td>
<td>15%</td>
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<tr>
<td>2</td>
<td>8% HPA for life</td>
<td></td>
<td>3.2%</td>
<td>15%</td>
</tr>
<tr>
<td>3</td>
<td>Base</td>
<td>HPA slows to 5% by end-2005</td>
<td>5.6%</td>
<td>50%</td>
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<tr>
<td>4</td>
<td>Pessimistic</td>
<td>0% HPA for the next 3 years 5% thereafter</td>
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Stress applied via house prices and interest rates.

House price scenario derived from “benchmark loss experience”.

- Based on worst cumulative credit losses originated during a period of two consecutive years in contiguous states with at least five percent of the population.

  AR + LA + MS + OK = ALMO during 1983-1984. 10-year default rate = 14.9%

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OFHEO Stress Test

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Focus on single-family, 30-year, FRMs (they account for the vast majority of loans guaranteed by the GSEs).

Evaluate model performance during the housing bust.

Determine if model re-estimation and/or the introduction of new predictors like credit scores would have improved forecasting ability.

Despite being used since 2002, OFHEO never re-estimated the model nor introduced new variables – even as the mortgage market evolved dramatically during the boom.

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- Data used to estimate original OFHEO model, proprietary GSE data from 1979–1999.

- We use loan-level data from Lender Processing Services (LPS).
  - Servicer-provided data that currently accounts for 75-80% of active mortgages.
  - Detailed mortgage characteristics (at origination) and payment behavior.
  - Able to identify mortgage holder – FHA/GNMA, FNMA/FHLMC, portfolio, or private-label MBS investor.

- Use GSE mortgages in LPS to forecast with OFHEO model and (random sample) to estimate new variants of model.

- Limit sample to: single-family, first-lien, 30-year fixed-rate mortgages in the 48 contiguous states.
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<td>OFHEO</td>
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<td>80.1</td>
<td>79.5</td>
<td>101,518</td>
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<td>105,059</td>
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<tr>
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<td>76.2</td>
<td>78.0</td>
<td>122,646</td>
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<tr>
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<td>77.6</td>
<td>76.8</td>
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<td>2000</td>
<td>78.9</td>
<td>77.9</td>
<td>128,041</td>
</tr>
<tr>
<td>2001</td>
<td>76.2</td>
<td>74.9</td>
<td>145,435</td>
</tr>
<tr>
<td>2002</td>
<td>74.3</td>
<td>74.2</td>
<td>153,982</td>
</tr>
<tr>
<td>2003</td>
<td>72.2</td>
<td>72.4</td>
<td>162,743</td>
</tr>
<tr>
<td>2004</td>
<td>74.4</td>
<td>70.8</td>
<td>162,513</td>
</tr>
<tr>
<td>2005</td>
<td>73.8</td>
<td>72.4</td>
<td>175,886</td>
</tr>
</tbody>
</table>
Focus on quarterly 1-step ahead forecasts of 30-year FRM default and prepayments based on OFHEO model parameters using LPS data.

- Also can look at $k$-steps ahead forecasts, which are always significantly worse than the 1-step ahead forecasts.
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Compare predicted versus actual default/prepayment rate levels.
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Default Forecasts (1-Quarter Ahead)
Model Analysis

Prepayment Forecasts (1-Quarter Ahead)

- Actual Prepayments
- Predicted Prepayments

Prepayment Rate (%) - 1 Quarter Ahead

Gerardi (FRB Atlanta)
What if OFHEO had updated their model by simply re-estimating it with newer data?

- Re-estimate OFHEO model with LPS data using 7-year rolling windows (also tried 3 year windows).
- Assume perfect foresight regarding next quarter’s house prices and interest rates.

- Compare ratio of predicted versus actual default rates.
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Default Forecasts (1-Quarter Ahead)

![Graph showing the ratio of actual to predicted defaults over time. The graph includes two lines: one for Actual/Predicted Defaults (OFHEO Coefficients) and another for Actual/Predicted Defaults (Updated Coefficients). The y-axis represents the ratio of actual to predicted defaults, and the x-axis represents the dates from 3/1/2006 to 12/1/2009. Key values include 1.39, 3.9, 2.55, 0.64, 1.53, and 0.93 at specific dates.]

Gerardi (FRB Atlanta)
What if OFHEO had updated their model by including additional variables that have been found to be predictive of default rates?

- More disaggregated house prices (county-level Corelogic indices)
- FICO score at origination.
- Documentation levels
- Unemployment rates (county-level).
- Vintage effects to proxy for unobservable decline in underwriting standards.
- Also tried interaction terms to capture potential non-linearities.

Model with all of these variables actually *over-predicts* defaults during crisis.
Model Analysis

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Model Analysis

- Default Forecasts (1-Quarter Ahead)

Ratio of Actual to Predicted Defaults

- Baseline
- FICO added
- Documentation Type added
- Origination Years added
- Cumulative Change in Unemployment Rate added
- Unemployment Rate added

Date Range:
- 3/1/2006 to 12/1/2009

Values:
- 1.56
- 0.73
- 1.26
- 0.58
- 1.08
- 0.84
- 1.02
- 0.97

Gerardi (FRB Atlanta)
How stressful was the house price stress scenario used by OFHEO compared to what happened during the crisis?

OFHEO house price stress scenario:

- Realized path of house prices for the West South Central Census Region between 1984 and 1993.
- First 10 quarters, home prices increased approximately 2%.
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Stress Scenario

FHFA House Price Index Level

OFHEO Stress Scenario Path
Actual House Price Path

Gerardi (FRB Atlanta)
OFHEO Stress Test
April, 9 2013
Stress Scenario

Predicted Default Rate (2007 onwards FHFA HPI path)

Predicted Default Rate (OFHEO Stress Test HPI path)

Cumulative Default Rate (%) - 3 years ahead

0.88

0.74

0.59

0.43

0.48

Gerardi (FRB Atlanta)
Stress testing can provide valuable insights regarding financial health and risk exposures of large institutions.

However, stress tests, like any other forecasting exercise, are vulnerable to model risk.

OFHEO experience is an unfortunate example of what can go wrong without appropriate model validation.

Terrible forecasting performance of OFHEO mortgage default/prepayment model due to:

- Failure to update parameter estimates.
- Failure to incorporate important market developments into the model.

Open question as to why this occurred...
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Concluding Remarks

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