

Stress Testing U.S. Bank Holding Companies

A Dynamic Panel Quantile Regression Approach

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October 30, 2012

2nd Conference of the Macro-prudential Research
Network of the European System of Central Banks

European Central Bank

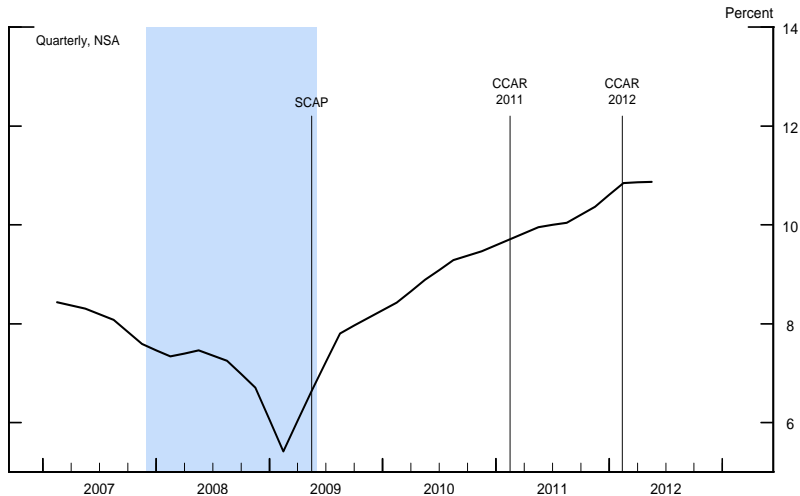
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MOTIVATION

- Macroprudential Supervision and Financial Stability
 - ▶ U.S. Stress Tests (SCAP 2009, CCAR 2011, CCAR 2012)
 - Simultaneous evaluation of capital adequacy plans of the 19 largest U.S. bank holding companies
 - Consistency of macro scenarios across banks
 - Multiple, independent estimates of losses, pre-provision net revenue and tier 1 common ratio under the adverse macro scenario
 - Goal: To ensure U.S. banks hold sufficient **high quality** capital to absorb losses without triggering an **excessive** reduction in assets

TIER 1 COMMON RATIO FOR THE 19 CCAR BANKS

Period: 2007:Q1 – 2012:Q2

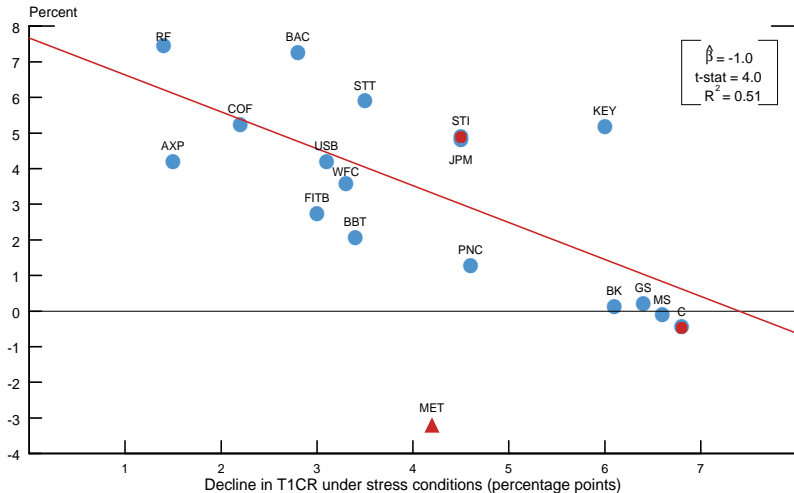


BANK OPACITY AND STRESS TESTS

- Bank-specific results of the stress tests are released to the public
- The release of the results provides new information to market participants
- Banks are opaque and market participants do not know the economic value of banks' portfolios ([Flannery et al. \[2010\]](#))
- Event type studies find that banks with larger capital shortfalls experience more negative idiosyncratic returns ([Peristiani et al. \[2010\]](#))
- For example, after the release of CCAR 2012 results banks with higher declines in tier 1 common ratios (T1CR) under stressed conditions experienced lower idiosyncratic returns

IDIOSYNCRATIC STOCK RETURNS FOR CCAR BANKS

Two-day window after announcement of CCAR 2012 results



OUR PAPER

- Evaluate the forecasting performance of “top-down” stress-testing models and construct density forecasts for T1CR
 1. Top-down models are useful to benchmark aggregated results of stress tests
 2. Can be used to evaluate banks’ capital adequacy plans under different macro scenarios
- Key features of our “top-down” stress testing approach:
 - ▶ Fixed Effects Quantile Autoregression (FE-QAR):
 - Variation in the coefficient on the lagged dependent variable allows for changes in the scale and shape of the conditional distribution - important feature that helps capturing the **fat tails** of credit losses
 - The impact of macro variables on the dependent variable is “time-varying” ([Schechtman et al. \[2012\]](#))

Fixed Effects Quantile Autoregression

- Y_{it} = variable forecasted for bank i in period t
- X_{it-1} = vector of portfolio shares for bank i in period $t - 1$
- Z_t = macroeconomic factors in period t
- The FE-QAR(p) model:

$$Q_{\pi}(Y_{it}|Y_{it-1}, \dots, Y_{it-k}, X_{it-1}, Z_t) = \alpha(\pi) + \eta_i + \sum_{k=1}^p \phi_k(\pi)Y_{it-k} + \beta(\pi)'X_{it-1} + \theta(\pi)'Z_t$$

- ▶ $\pi \in (0, 1) = \pi$ -quantile
- ▶ $Q_{\pi}(Y_{it}|Y_{it-1}, \dots, Y_{it-k}, X_{it-1}, Z_t) =$ conditional quantile function
- ▶ $\eta_i =$ fixed effect of bank i

DENSITY FORECASTS

- Use Monte Carlo simulation to generate density forecasts
 1. Use the estimated coefficients and the trajectory of the macro variables to generate a forecast path
 2. Use the individual forecast paths to calculate the evolution of T1CR
 3. Generate many paths for each bank, using a different sequence of idiosyncratic shocks for each path (ensemble forecasts)
 4. Aggregate the forecasts across all banks
 5. Shocks across subcomponents of credit losses and revenue are correlated (based on the estimated covariance matrix)
- Compare the density forecasts with the ones generated using a dynamic linear model with fixed effects

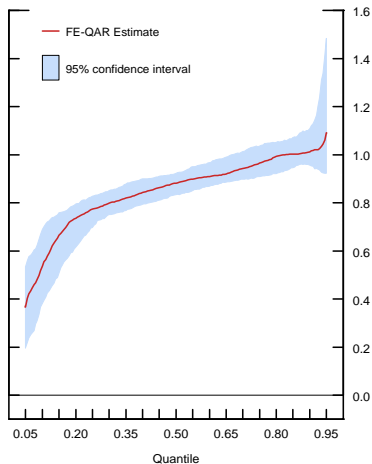
DATA

- Merger-adjusted FR Y-9C Reports
 1. Net charge-offs for eight major loan portfolios
 2. Six subcomponents of pre-provision net revenue
- Included 15 BHCs (Includes most largest BHCs, 900 Obs.)
- Sample period: 1997:Q1–2011:Q4
- Macroeconomic factors:
 1. Slope of yield curve
 2. Unemployment rate (4Q Change)
 3. Real Gross Domestic Product (4Q Log Change)
 4. CoreLogic house price index (4Q Log Change)
 5. Price index for commercial real estate (4Q Log Change)
 6. BBB-rated corporate bond spread

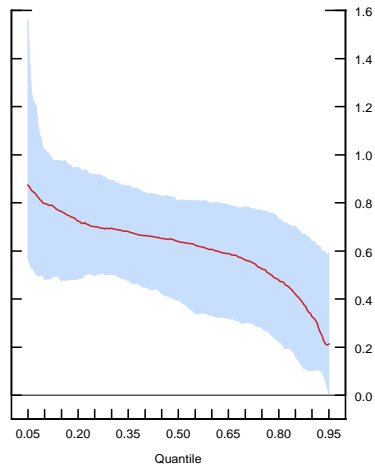
QUANTILE PROCESSES: PERSISTENCE

Period: 1997:Q1–2011:Q4

Sum of autoregressive coefficients in RRE NCO model



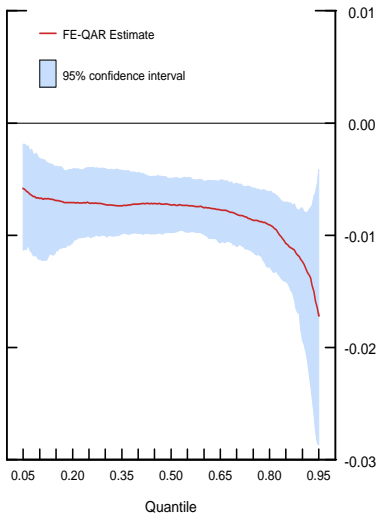
Sum of autoregressive coefficients in TI model



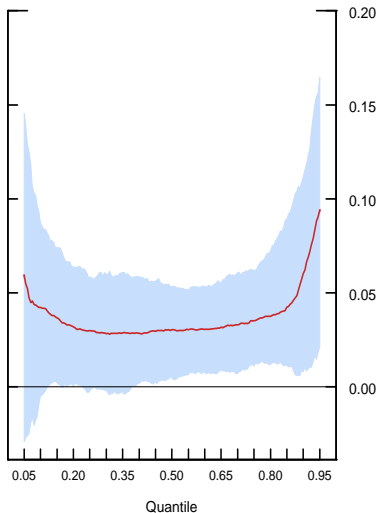
QUANTILE PROCESSES: MACRO VARIABLES

Period: 1997:Q1–2011:Q4

House price growth in RRE NCO model



Term spread in NIM model

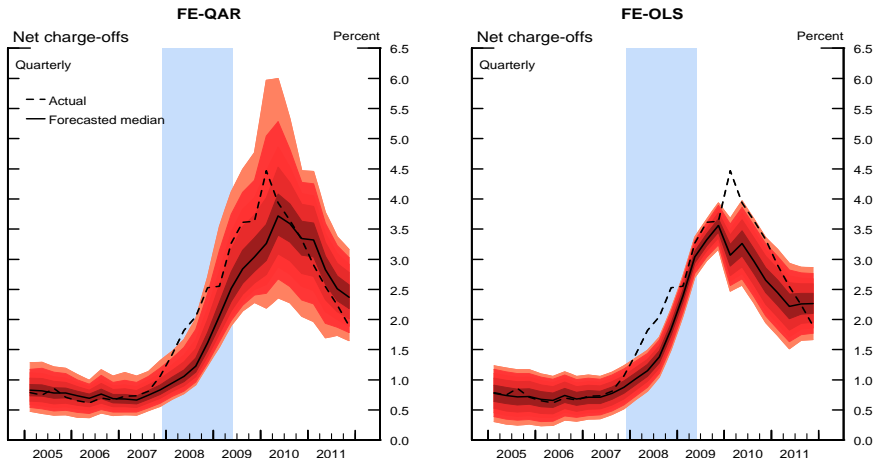


FORECAST EVALUATION

- Pseudo out-of-sample forecasts for aggregate net charge-offs and pre-provision net revenue
 - ▶ Period for out-of-sample forecasts is 2005:Q1–2011:Q4
 - ▶ Construct recursive 4-quarter-ahead forecasts (paper reports 1-, 2- and 3-quarters ahead as well)
 - ▶ Path of macro variables and assets shares are taken as given
- Formal tests for the optimality of the density forecasts indicate that short-term forecasts have desirable statistical properties

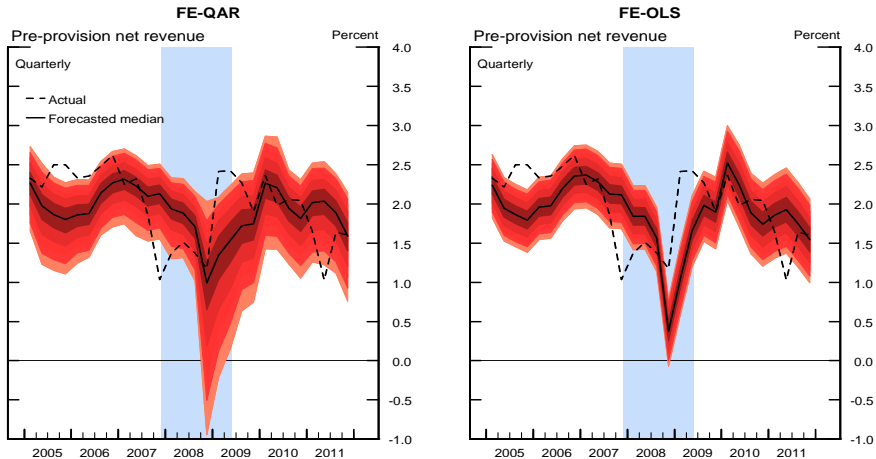
DENSITY FORECASTS FOR NET CHARGE-OFFS

Four-Quarter-Ahead: 2005:Q1 – 2011:Q4



DENSITY FORECASTS FOR PPNR

Four-Quarter-Ahead: 2005:Q1 – 2011:Q4

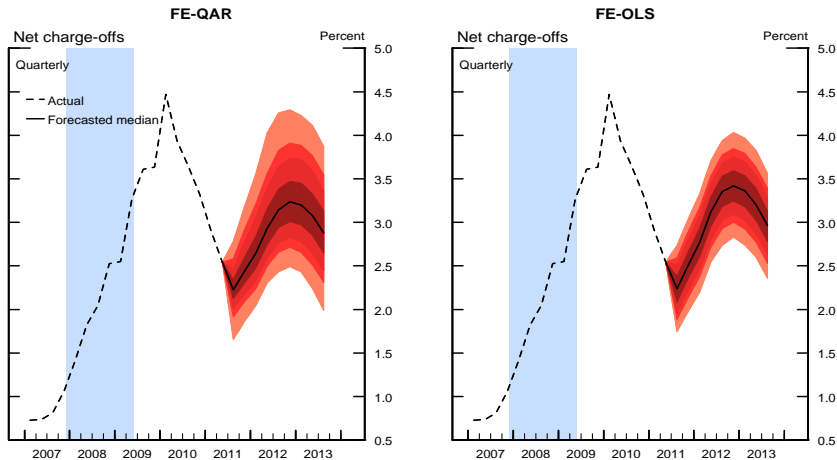


DENSITY FORECASTS FOR T1CR

- Ultimately, we are interested in constructing density forecasts for T1CR
- Use a simple capital calculator that takes as inputs the model projections for each revenue and loan loss subcomponents
- Use the CCAR 2012 adverse macro scenario to generate the density forecasts for aggregate net charge-offs, pre-provision net revenue and T1CR
- Due to the nonlinearities in loan losses and trading income the density forecast of T1CR has **fatter left tails** under the quantile model
- Thus, the quantile model generates higher capital shortfalls

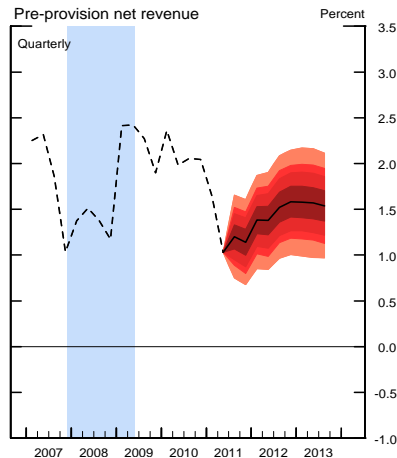
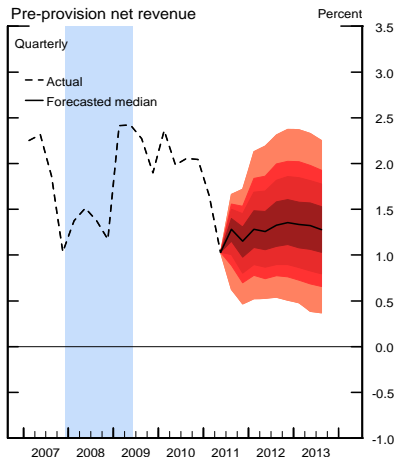
PROJECTIONS FOR NET CHARGE-OFFS

CCAR 2012 Projection Period: 2011:Q4–2013:Q4



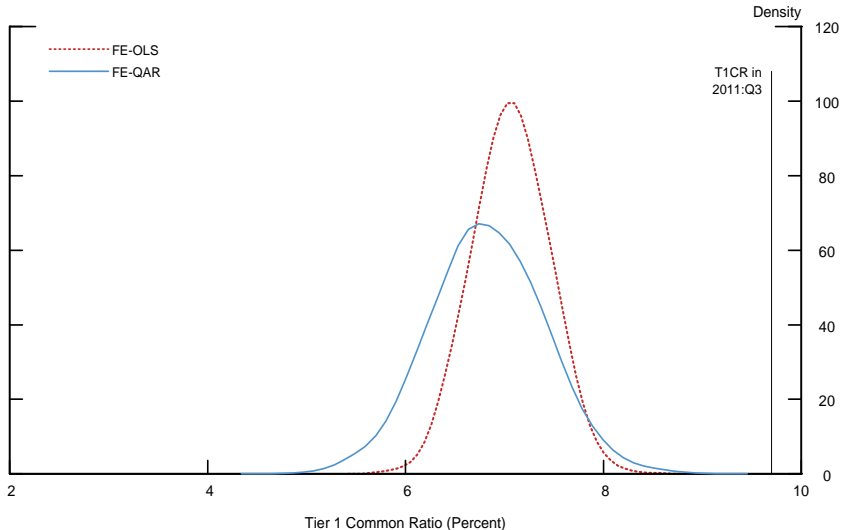
PROJECTIONS FOR PRE-PROVISION NET REVERAGE

CCAR 2012 Projection Period: 2011:Q4–2013:Q4



DENSITY FORECASTS FOR TIER 1 COMMON RATIO

Under CCAR 2012 Adverse Macro Scenario as of 2013:Q4

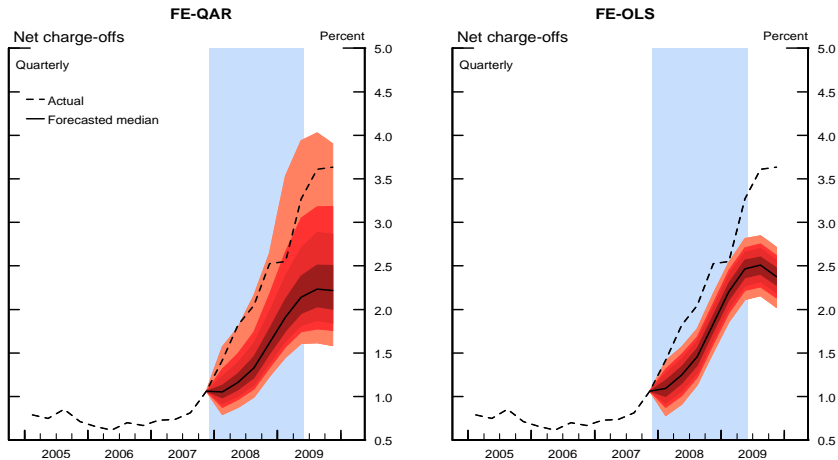


FINANCIAL CRISIS IN 2008-2009

- How would these models perform at the onset of the last financial crisis?
- Estimate both the quantile and linear models until the end of 2007
- Project losses and revenues over the next two years, taking as given the realized values of the macro variables and portfolio shares
- Evaluate capital shortfalls using the density forecast for T1CR at the end of 2009:Q4

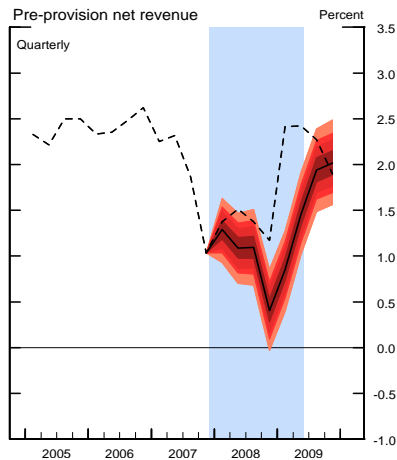
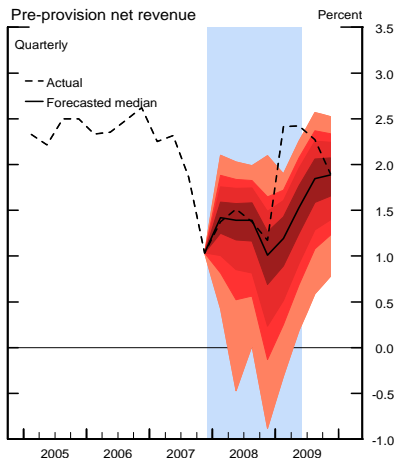
PROJECTIONS FOR NET CHARGE-OFFS

Projection Period: 2008:Q1–2009:Q4



PROJECTIONS FOR PRE-PROVISION NET REVENUE

Projection Period: 2008:Q1–2009:Q4



CAPITAL SHORTFALLS IN 2007:Q4

	% Violations		Expected Shortfall	
	FE-QAR	FE-OLS	FE-QAR	FE-OLS
All banks	2.74	1.30	6.9	0.9
BAC	3.06	0.02	15.2	0.6
C	22.82	17.32	24.4	5.1
JPM	4.04	0	15.2	0
WFC	0.12	0	14.6	0

NOTE: Projection period: 2008:Q1–2009:Q4. Results are relative a tier 1 common target of 2 percent. Expected shortfall is in billions of dollars. Bank names: BAC = Bank of America Corporation; C = Citigroup, Inc.; JPM = JPMorgan Chase & Co.; and WFC = Wells Fargo & Company.

CONCLUSIONS

- Expand the existing top-down stress-testing methodologies in two dimensions:
 1. Density forecasts
 2. Quantile regressions
- Top-down model that can be used as a macroprudential tool:
 1. Calibration of Macroeconomic scenarios for stress-testing
 2. Identification of vulnerabilities during good times
 3. Time-varying capital buffers
 4. Restrictions on distributions
- Work in progress: incorporate BHCs with short-time series (need to use IV quantile regression)