Modeling Your Stress Away

Friederike Niepmann and Viktors Stebunovs

Federal Reserve Board

2018 Global Research Forum on International Macroeconomics and Finance

Frankfurt, November 29, 2018

Approach to stress testing differs across countries

EBA:

- Constrained bottom-up approach: Banks run their own models under constraints set by authorities (EBA)
- Models are checked by authorities based on challenger models
- Final set of numbers agreed upon by authorities and banks
- No capital hurdles

FED:

- Dual approach: Banks run their own stress tests and FED runs its own models
- Bank-run stress tests inform mainly about quality of risk management; results are not disclosed
- Fed-run stress test: Based on industry-wide models; results are disclosed and banks are required to meet certain capital thresholds

This paper

- Highlight a potential disadvantage of stress tests that are run by banks: Scope for systematic adjustments of stress test models (results) to improve capital ratios under stress
- Apply and develop further methodology proposed by Phillipon et al. (2016) to compare 2014 and 2016 EBA stress tests
  - Estimate how macro scenarios map into banks' credit loss rates
  - Analyze how banks' credit losses and the mapping ("banks' models") change from 2014 to 2016
  - Explore factors that explain changes in the mapping ("model changes")

Findings

- Models are systematically adjusted to lower credit losses in stress tests: Banks that would have seen credit losses increase the most due to scenario changes saw the strongest decreases in credit losses from model changes in 2016
- Model adjustments were especially strong for
  - banks with more exposures subject to the internal risk based approach
  - better model performance
  - larger exposures
  - when scenario changes led to an increase in losses

$\Rightarrow$ Stress tests that allow for bank-specific models are prone to manipulation

$\Rightarrow$ Considerable flexibility calls into question bank-run stress tests as a tool to assess capital adequacy; stress tests run by regulators that follow an industry approach less prone to same issues

$\Rightarrow$ When results need to be checked by supervisors, weaker banks might be under greater scrutiny

Literature

Biases in stress tests and interal risk models:

- Philippon, Pessarossi, Camara (2017); Acharya, Engle, Pierret (2013); Achary and Richardson (2012); Steffen (2014); Steffen and Acharya (2014)
- Bird, Karolyi, Ruchti, Sudbury (2015); Glasserman and Tangirala (2015); Gallardo, Schuermann, Duane (2016)
- Behn, Haselmann, Vig (2014); Plosser and Santos (2014); Begley et al. (2017); Mariathasan and Merouche (2014); Vallascas and Hagendorff (2013)

Information production through stress tests:

- Petrella and Resti (2013); Flannery, Hirtle, Kovner (2017)

1. Backing out banks' stress test models

Strategy

- Back out bank-specific model that predicts how macro environment affects loan losses
- First step: Estimate via OLS

$$\log \frac{I_{ijt}^{p}}{(1 - I_{ijt}^{p})} = \alpha_i^p + \theta_{\mathbf{j}}^{\mathbf{p}} \mathbf{y_{jt}} + \epsilon_{ijt}^{p}, \tag{1}$$

where I_{ijt}^{p} is the impairment rate of bank i in forecast year t on portfolio p in country j; y_{jt} is a triple of inflation, GDP growth, and unemployment; $p \in \{retail, corporate\}$

- Obtain $F_{jt}^{p} = \hat{\theta}_{\mathbf{j}}^{\mathbf{p}} \mathbf{y_{jt}}$ from first step
- Second step: Estimate via OLS

$$\log \frac{I_{ijt}^{p}}{(1 - I_{ijt}^{p})} = \alpha_i^p + \beta_i^p \times F_{jt}^{p} + \epsilon_{ijt}^{p}. \tag{2}$$

to obtain the bank-specific loss model $\{\alpha_i^p, \beta_i^p\}$

Substantial variation in coefficients

- Estimation for 2014 and 2016 stress test data separately on same set of banks
- In the end, predictions for loss rates of 50 banks in 26 countries
- Average β_i^p close to 1 by construction but significant variation

Table: Summary of model coefficients

	mean	median	std.
GDP growth (2014)	-0.132	-0.125	0.076
GDP growth (2016)	-0.097	-0.094	0.105
inflation rate (2014)	-0.105	-0.062	0.180
inflation rate (2016)	-0.053	-0.058	0.134
unemployment rate (2014)	0.127	0.128	0.075
unemployment rate (2016)	0.115	0.109	0.085
β (2014)	0.990	0.974	0.728
β (2016)	0.958	0.932	0.533

Decent fit of the model to the stress test data

Table: Model estimation results: R^2

	corp	retail
	2016 Edition	
Observations	1,715	1,613
R^2	0.578	0.699
R^2, no FE in 2nd step	0.477	0.421
	2014 Edition	
Observations	1,791	1,641
R^2	0.694	0.703
R^2, no FE in 2nd step	0.592	0.507

- Slightly better fit in 2014
- Macroeconomic factors are a key driver of loss rates, although bank idiosyncrasies are also relevant

Good predictive power of 2014 and 2016 models

	All years, all banks	
	2014 model	2016 model
	(1)	(2)
R^2	0.484	**0.504**
Rank correlation	**0.6893**	0.6587
Sum of squared errors	0.25	**0.24**
Observations	129	129

- Realized loss rate: Loan loss reserves/gross loans, yearly (from SNL)
- Compared to overall model loss rate
- Sample period: 2013 to 2016
- Decent R^2 though fit varies across years
- Overall 2016 model performs slightly better

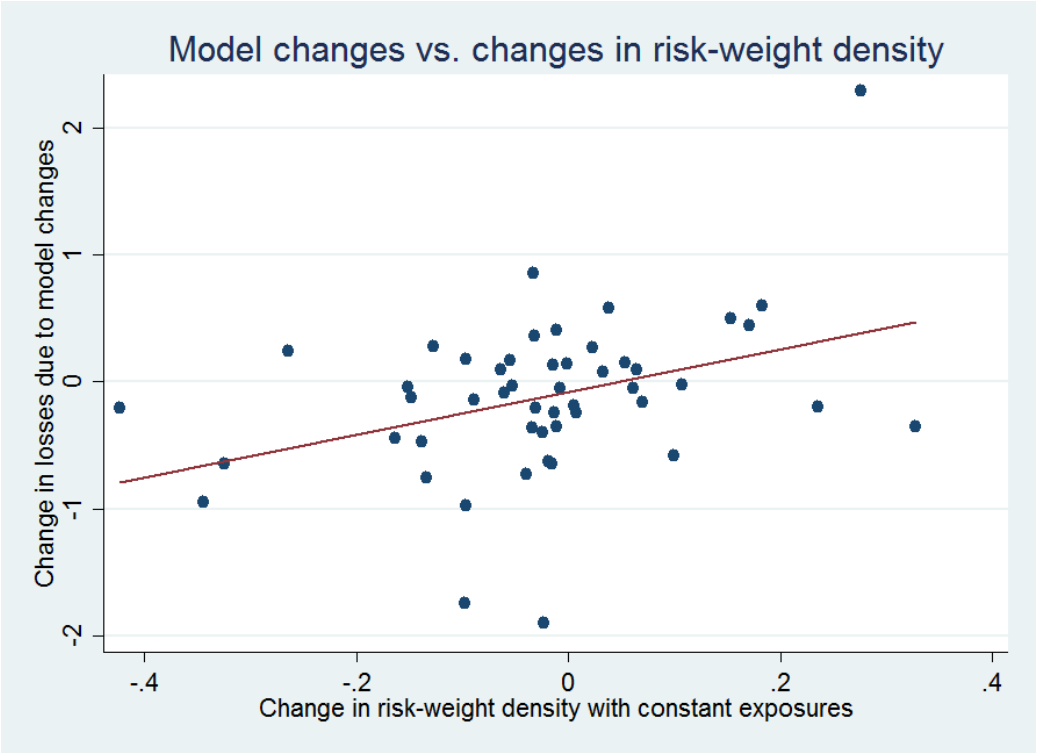
2. Decomposing changes in credit losses from 2014 to 2016

Models were tailored to each stress test edition

	model/scenario/exposure			
	(1)	(2)	(3)	(4)
	m16/s16/e16	m16/s16/e14	m16/s14/e16	m16/s14/e14
adverse	178,866	188,998	348,230	387,484
baseline	102,165	108,025	156,614	172,433
	m14/s14/e14	m14/s14/e16	m14/s16/e14	m14/s16/e16
adverse	253,764	236,812	246,372	237,138
baseline	124,580	115,593	105,297	100,679
	mb16/sf14/e14		mb14/sf16/e16	
adverse	212,451		240,237	

- Table shows hypothetical loss rates for different combinations of exposures, scenarios and models
- Each model produces the lowest losses given the exposures and scenario that applied in the corresponding stress test edition

Model changes and changes in risk



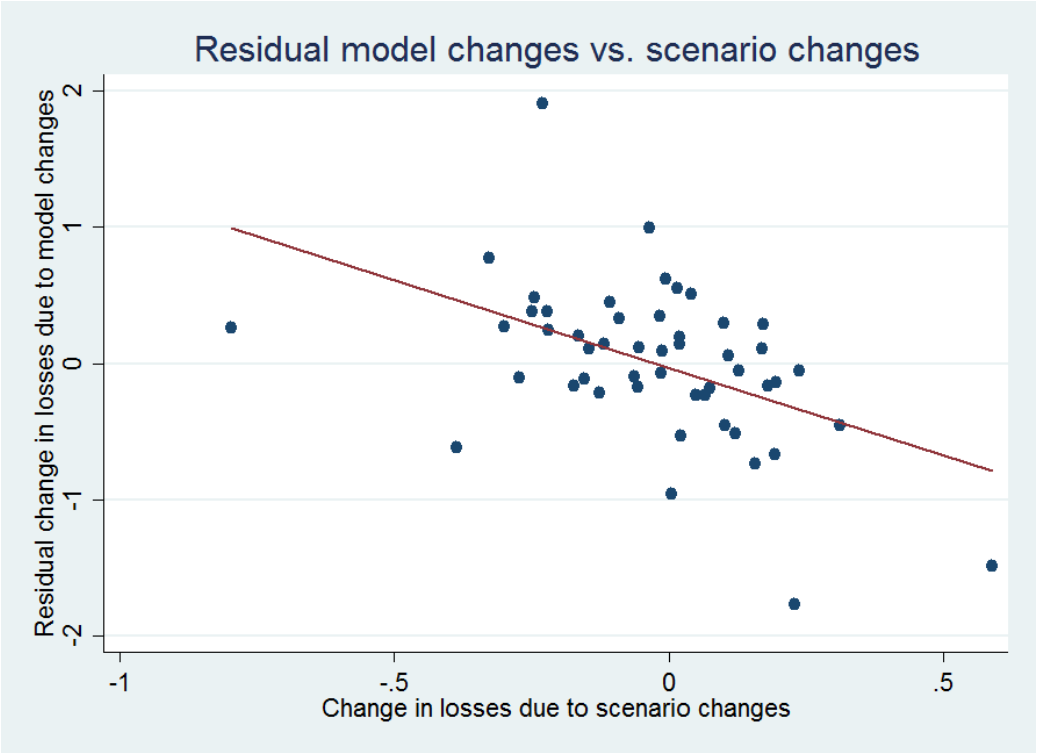
- Plot shows change in banks' risk-weight densities (constant exposures) plotted against change in losses because of model changes
- As it should be the case, banks with an increase in risk saw an increase in credit losses because of model changes

Model changes and scenario changes

- Even controlling for changes in the riskiness of bank portfolios, scenario changes predict model changes
- If models had not been adjusted (except for as justified by changes in risk), losses would have been higher by 1.7 percent of a bank's CET1 capital on average in adverse scenario; for top 10 banks, 15 percent of bank's CET1 capital on average

	(1) ΔM_i^{16}	(2) ΔM_i^{16}	(3) ΔE_i^{14}	(4) ΔM_i^{16}	(5) ΔM_i^{16}
Δ RWD$_i^*$	1.686**	1.495*	-1.368**	1.239	0.631
	(0.780)	(0.839)	(0.510)	(0.773)	(0.732)
ΔE_i^{14}		-0.140		0.0778	
		(0.361)		(0.278)	
ΔS_i^{14}				-1.429***	
				(0.417)	
ΔES_i^{14}					-0.592**
					(0.268)
Constant	-0.0812	-0.0971	-0.114***	-0.123	-0.167*
	(0.0911)	(0.0965)	(0.0388)	(0.0847)	(0.0942)
Observations	50	50	50	50	50
R-squared	0.145	0.148	0.379	0.363	0.254

Systematic model adjustments



- Plot shows change in losses because of scenarios changes plotted again residual change in losses because of model changes
- Banks with a bigger increase in losses because of scenario changes saw losses decrease more due to model changes

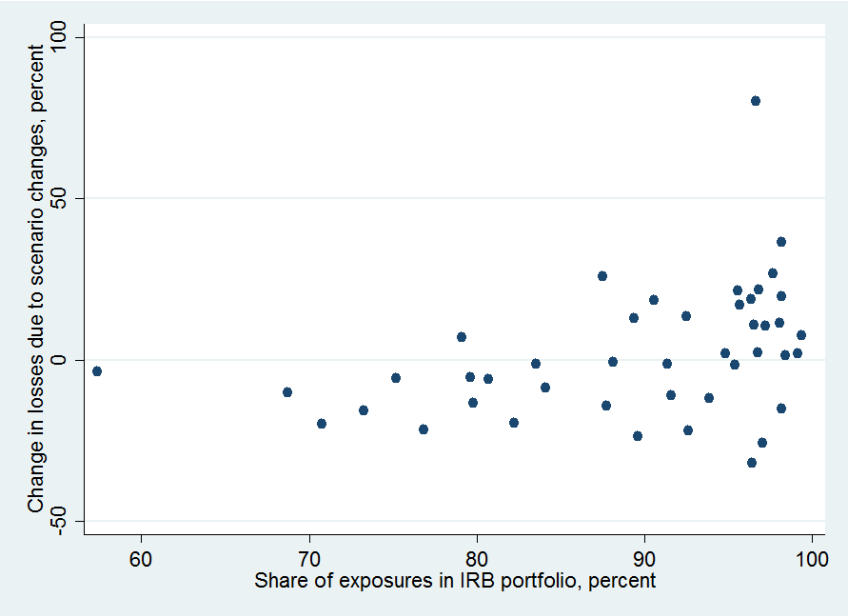
Model changes at the bank-country level

	(1) ΔM_{ij}^{16}	(2) ΔM_{ij}^{16}	(3) ΔM_{ij}^{16}	(4) ΔM_{ij}^{16}	(5) ΔM_{ij}^{16}
Δ RWD$_{ij}$	0.166*	0.107	0.133	0.138*	0.127
	(0.0991)	(0.106)	(0.0850)	(0.0811)	(0.0801)
ΔE_{ij}^{14}		-0.180**	-0.0277	-0.0238	-0.0427
		(0.0885)	(0.0859)	(0.0823)	(0.0787)
ΔS_{ij}^{14}			-0.842***	-0.731***	-0.362
			(0.0863)	(0.0931)	(0.248)
exp. share$_{ij}$ $\times$ ΔS_{ij}^{14}				-1.162**	-1.358***
				(0.532)	(0.523)
exp. share$_{ij}$				0.175	0.140
				(0.111)	(0.113)
Dummy$_{ij}$ $\times$ ΔS_{ij}^{14}					-0.516*
					(0.293)
Dummy$_{ij}$					0.000206
					(0.0939)
Constant	-0.243***	-0.251***	-0.220***	-0.257***	-0.186**
	(0.0373)	(0.0373)	(0.0314)	(0.0377)	(0.0760)
Observations	257	257	257	257	257
R-squared	0.009	0.029	0.316	0.346	0.357

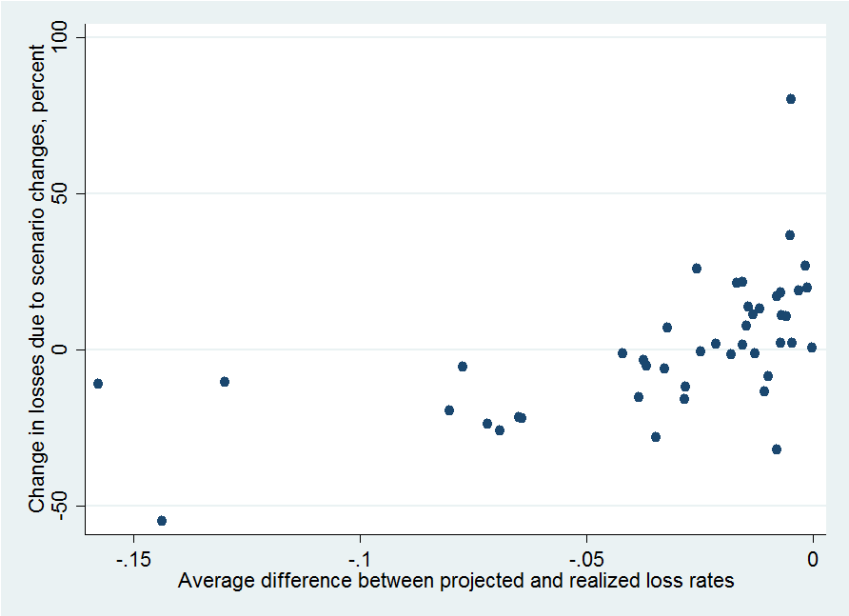
- Adjustments stronger for larger exposures and when scenario change led to an increase in losses
- Asymmetries are additional evidence for systematic nature of the adjustments

Two factors that might have helped model changes

Share of IRB exposure



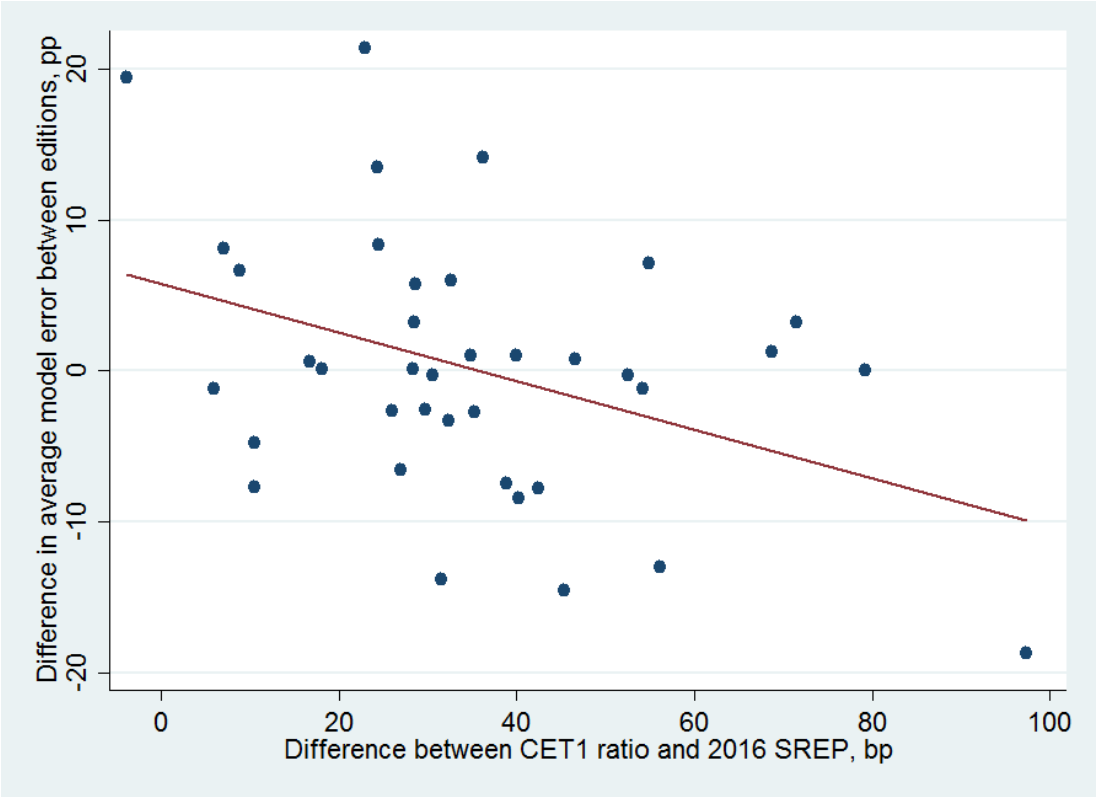
Average forecast error



Higher increase in losses from scenario changes for banks

- with larger share of exposures subject to IRB approach
- with better performing models

Bigger model improvements for weaker banks

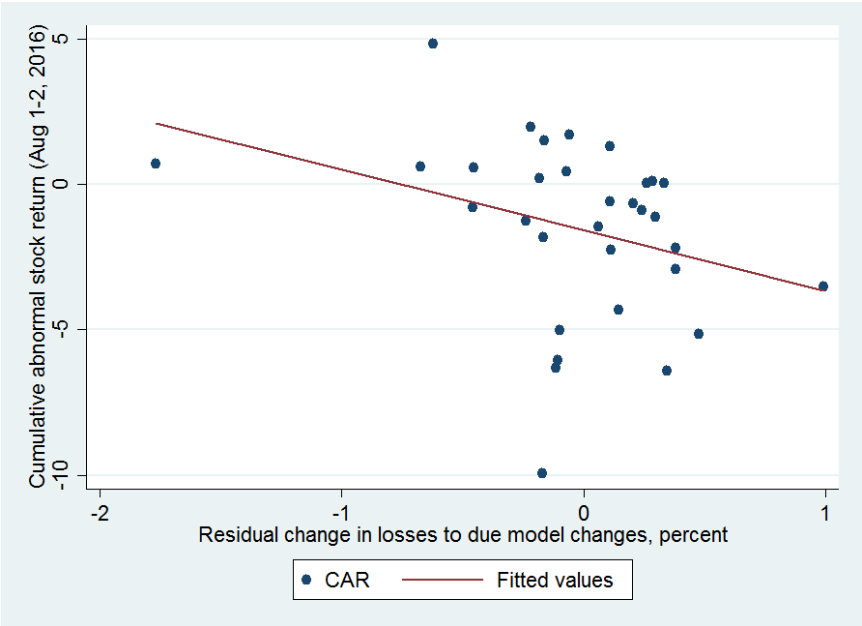


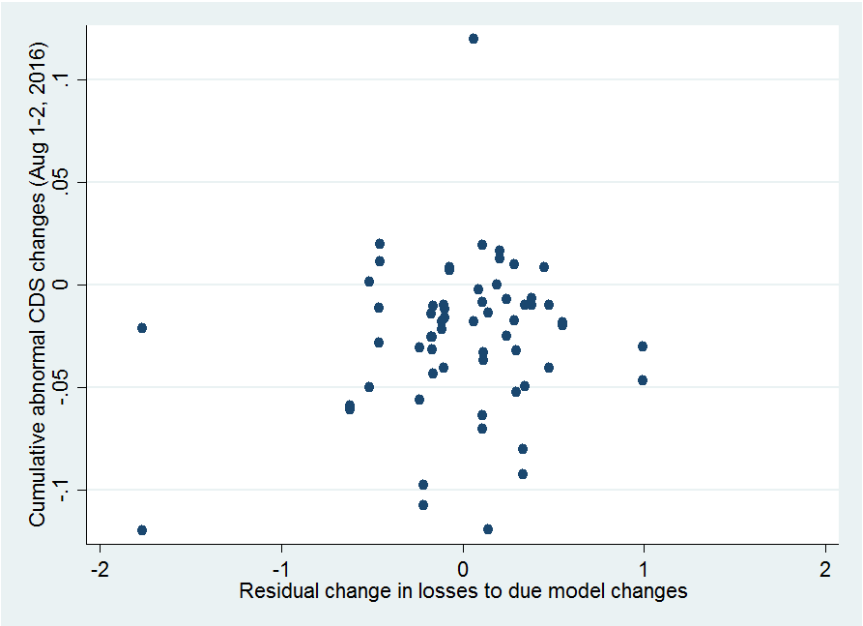
- Model performance tended to improve at banks with lower capital buffers
  $\Rightarrow$ Weaker banks and their models might have been under greater scrutiny by authorities
- Bottom line: Model fit stayed roughly the same overall, with improvements for weaker banks despite systematic model adjustments

3. Model changes and the market response

Response of stock prices and CDS spreads

- Abnormal stock price and CDS spread changes on the first two days after the publication of the stress test results (Aug 1-2, 2017)
- 120 day window to compute abnormal changes





Response implies lower capital buffers expected

	stock prices	CDS spreads	
	(1)	(2)	(3)
ΔM_i^{16}	-2.055**	0.0135	-0.0435*
	(0.753)	(0.0118)	(0.0251)
Δ RWD$^*{}_i$	-0.733	-0.0296	0.00917
	(3.187)	(0.0354)	(0.0337)
Capital buffer			0.000632
			(0.000442)
$\Delta M_i^{16} \times$ cap buf			0.00148*
			(0.000767)
Observations	32	61	57
R-squared	0.127	0.029	0.092

- Results are consistent with expectation of lower capital requirements due to decrease in losses from model changes; higher capital is good news for investors, bad news for bond holders
- No indication that changes in losses from model changes (beyond what can be explained by changes in risk) were interpreted as changes in risk: Lower credit losses led to an increase in CDS spreads, with a stronger increase for weaker banks

Summary

- Strong evidence that credit loss models were systematically adjusted to reduce losses/smooth losses from 2014 to 2016 stress tests
- Magnitude of the adjustments quantitatively significant
- Difficult to detect because model performance remained roughly the same overall; also model changes were associated with changes in risk as it should be
- Stress tests that rely on bank-internal models appear prone to such manipulation, in particular when results are tied to outcomes for investors
- Flexibility that banks have questions the usefulness of bank-run stress tests as a tool to assess capital adequacy
- Stress tests run by regulators that follow an industry-wide approach (as is the case in the United States) appear less prone to same issues

Thank you!