Model Misspecification Risk in Stress Testing

September 2012

Stress Tests

October 3, 2012 7:35 pm

EU banks close gaps in capital shortfalls

By Patrick Jenkins in London

Europe's biggest banks have raised or received commitments for more than €200bn of fresh capital since their balance sheets were stress-tested by regulators for their exposure to eurozone peripheral sovereign debt last December – nearly double the amount they were ordered to raise.

August 19, 2013 7:25 pm

Fed advises US banks to lift capital targets

By Tracy Alloway in New York

The largest US banks should hold regulatory capital beyond their own internal targets to better prepare them for periods of market stress, according to a study published by the Federal Reserve on Monday.

May 1, 2013 11:39 pm

Public stress tests ahead for UK banks

By Brooke Masters and Patrick Jenkins in London

Publishable stress tests that could affect bonus and dividend payments are looming for UK banks now that regulators have enlisted the financial stability experts at the Bank of England to help them come up with "doomsday scenarios".

The Financial Times has learnt that the UK's new Financial Policy Committee last month told the BoE and the new Prudential Regulation Authority to "develop proposals for regular stress testing of the UK banking system" starting next year.

- Given the unexpected severity of events, stress testing has gained greater attention.
- Regulators looking towards regular bank stress tests to analyse systemic risk and ensure banks capital reserves are sufficient.
- Greater focus on banks capital planning (Pillar 2 capital planning stress tests)

- **Why is model misspecification for stress testing important?**

Regression Model
typical simple model

lm(formula = Possession rate ~ Unemployment + Household Saving Rate + HPI)

Coefficients:

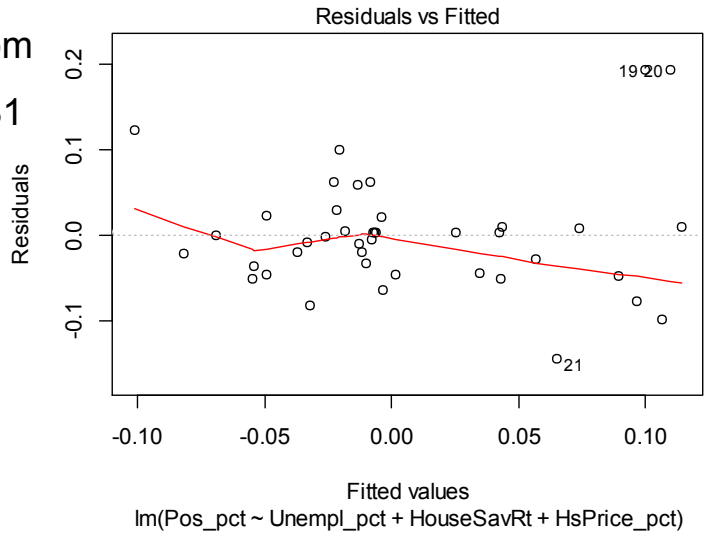
	Estimate	Std. Error	t value	Pr(>|t|)	
(Intercept)	0.003468	0.010853	0.320	0.7511	
Unemployment	0.031720	0.012127	2.616	0.0128	*
Household Saving Rate		0.008637	0.005907	1.462	0.1522
HPI	-0.002736	0.001340	-2.041	0.0485	*

Residual standard error: 0.06942 on 37 degrees of freedom

Multiple R-squared: 0.4063, Adjusted R-squared: 0.3581

F-statistic: 8.439 on 3 and 37 DF, p-value: 0.0002119

- Decent fit
- No dependence on Mortgage Rate or GDP?



Regression Model
introduce GDP

lm(formula = Possession rate ~ Unemployment + Household Saving Rate + GDP,)

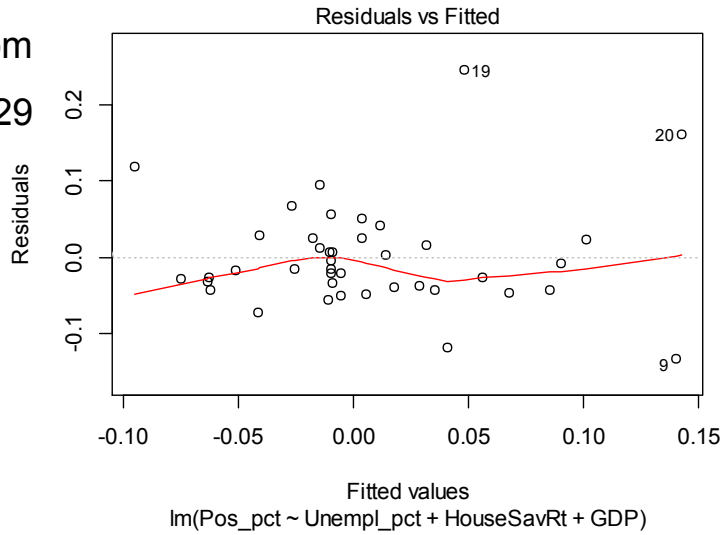
Coefficients:

	Estimate	Std. Error	t value	Pr(>|t|)
(Intercept)	0.003473	0.011064	0.314	0.75538
Unemployment	0.038493	0.011353	3.391	0.00167 **
Household Saving Rate	0.005930	0.006215	0.954	0.34617
GDP	-0.007768	0.004808	-1.616	0.11464

Residual standard error: 0.07077 on 37 degrees of freedom

Multiple R-squared: 0.3830, Adjusted R-squared: 0.3329

F-statistic: 7.655 on 3 and 37 DF, p-value: 0.0004208



- Very little difference in performance?
- Is GDP a better model to include or not?
- What is the model miss-specification error?

Regression Model

introduce Lags

	Estimate	Std. Error	t value	Pr(>|t|)	
(Intercept)	0.010844	0.528	0.6013		
Unemployment	0.033900	0.014294	2.372	0.0241	*
GDP	-0.008622	0.005027	-1.715	0.0963	.
RPI	-0.007480	0.005140	-1.455	0.1557	
Average Earnings	0.009405	0.005560	1.692	0.1007	
Lagged RPI	-0.008877	0.005365	-1.655	0.1081	
Lagged Average Earnings	0.009246	0.005444	1.699	0.0994	.
Lagged Household Saving Rate	0.010683	0.005984	1.785	0.0840	.
Lagged Mortgage Rate	-0.019369	0.007832	-2.473	0.0191	*

Multiple R-squared: 0.5219, Adjusted R-squared: 0.3986

F-statistic: 4.231 on 8 and 31 DF, p-value: 0.001615

- Even “better” model using lag of 1.
- But many of the parameter signs are reversed
- Only considered lag of 1 year (what about 2,3 etc.)

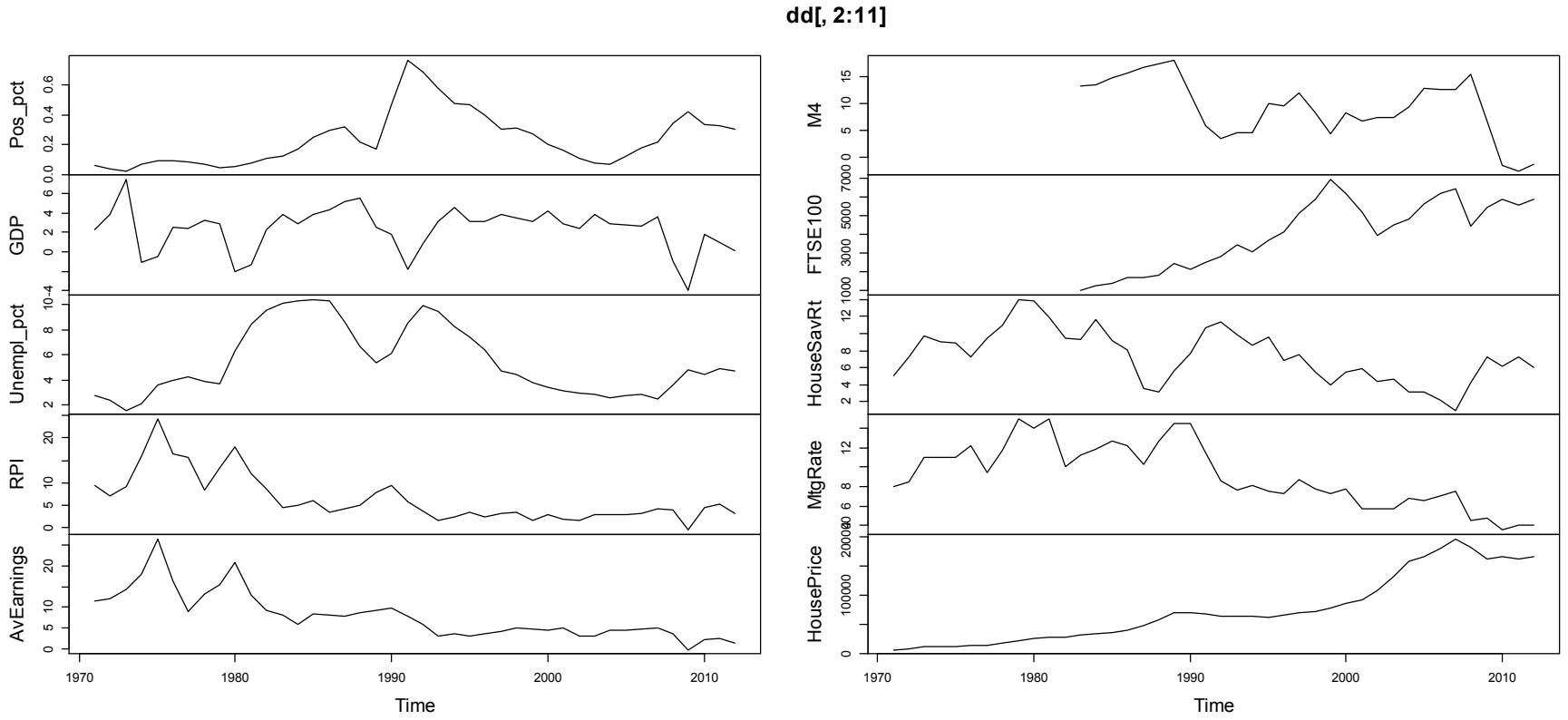
What have we learned?

- Building time series models for robust stress testing is difficult
  - Models are poorly specified – that is it is possible to choose two similar performing and plausible models with quite different parameters
  - Better models statistically often don't make sense in practice
- These are manifestations of model misspecification risk.
- Misspecified models lose some or all of the desirable properties of our estimators: unbiasedness, efficiency and consistency

- The rest of this paper **investigates the effect of minimising model misspecification risk on future scenario forecasts**

Model Misspecification

time series data



- Raw time series data 1970-2012
- Differenced time series used for modelling
- Non linear relationships not considered

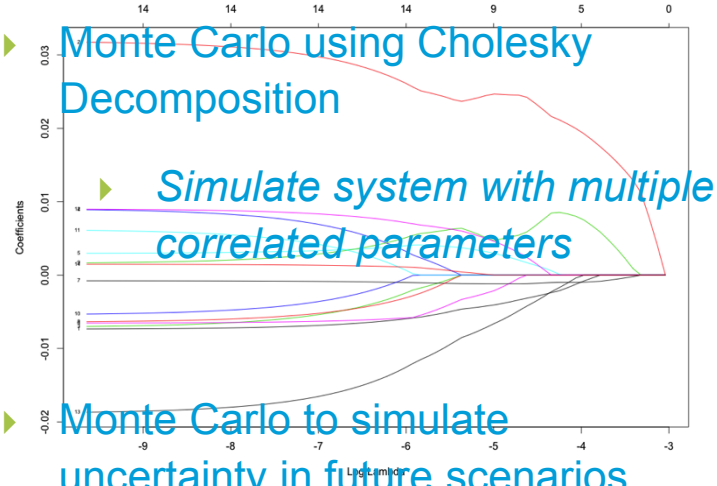
Model Misspecification
approach

Macroeconomic model

- Least Absolute Shrinkage and Selection Operation (“LASSO”) regression
  - *Shrinkage and Selection process to produce models of varying complexity*
- Bootstrapped to simulate uncertainty in model parameters

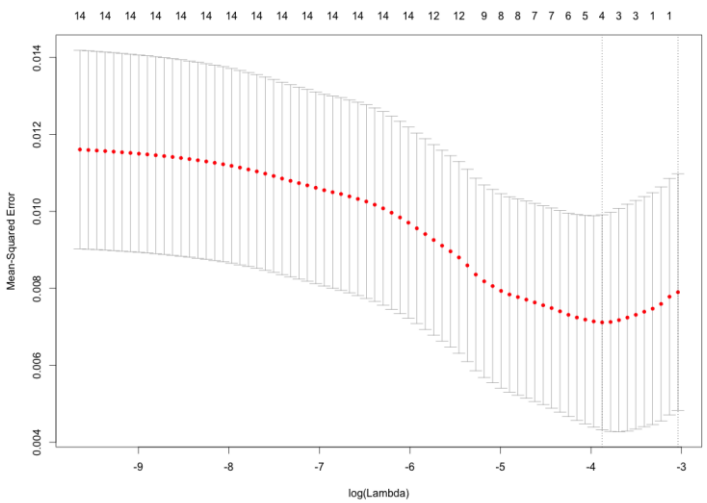
Scenario Simulation

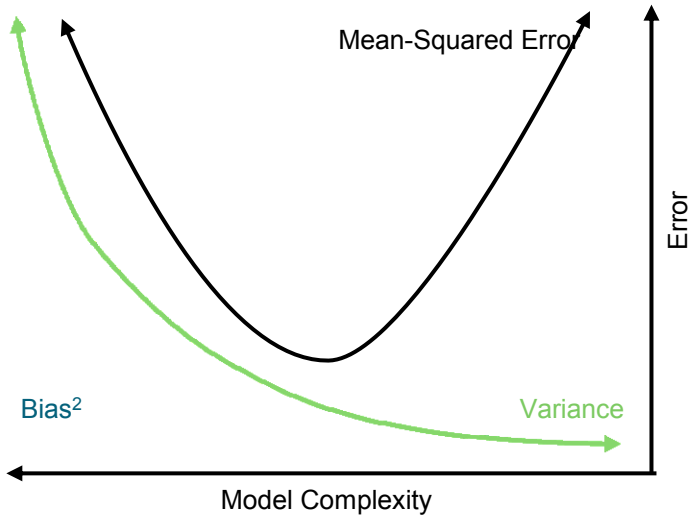
- Monte Carlo using Cholesky Decomposition
  - *Simulate system with multiple correlated parameters*
- Monte Carlo to simulate uncertainty in future scenarios



Model Misspecification

macroeconomic models

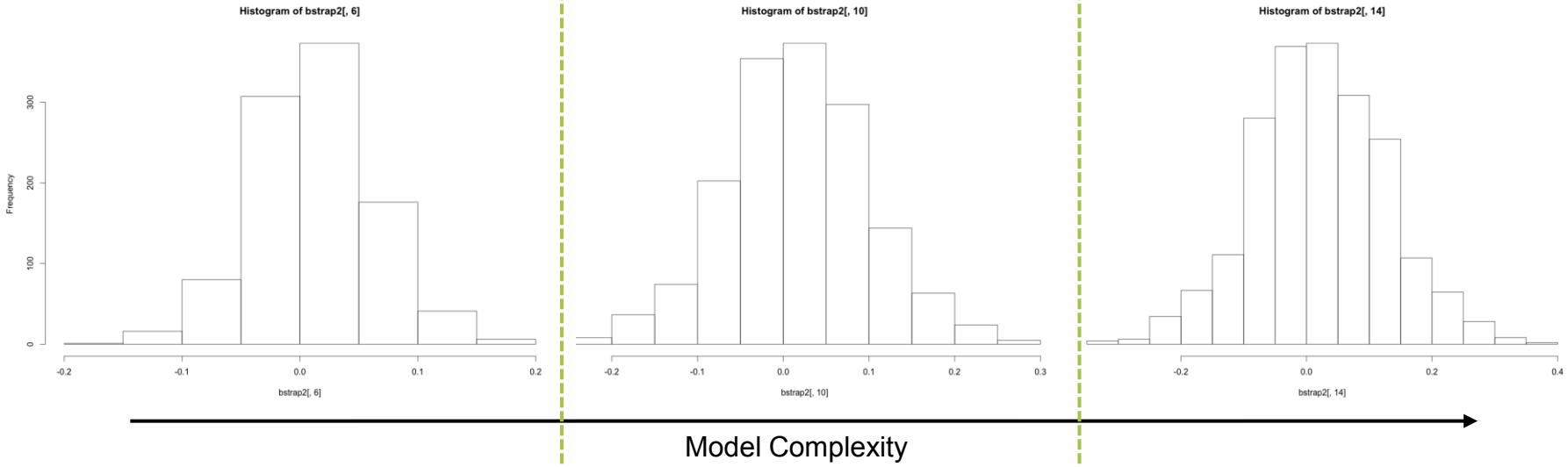




- Mean-Squared Error (MSE) as measure to assess models
- Optimum model complexity with lowest MSE:
  - GDP, Unemployment, Lagged Unemployment, HPI
- Bias-variance trade off
  - MSE = bias^2 + variance + noise

Model Misspecification

scenario simulation



- Higher model complexity / Lower bias in estimator
- Higher variance
- Lagged Unemployment is best estimate
- Simple model – low variation, low forecast estimates => understate forecast
- Complex model – high variation, high forecast estimates => overstate forecast

Parameters:
Unemployment
Lagged Unemployment
HPI

MSE : 0.007311

Parameters:
GDP
Unemployment
Lagged Unemployment
HPI

MSE : 0.007114

Parameters:
GDP
Unemployment
Lagged Unemployment
HPI
Household Saving Rate
Mortgage Rate

MSE : 0.007311

Conclusion

- Minimising model misspecification error (in terms of bias) may potentially overstate credit-losses, however:
  - Minimising MSE produces a simple model based on GDP, Unemployment and HPI – this will not capture variation
  - Introduce model misspecification error by selecting parameters that are not well defined within future stress scenarios
  - And given the recent crisis, overstating credit-losses may not be such a bad thing!
- Balance between model robustness and model misspecification error