Macro Model Comparison and Forecast Competition: New Tools and Results

Goethe University – Macroeconomics Seminar
January 21, 2021

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Sources for seminar talk

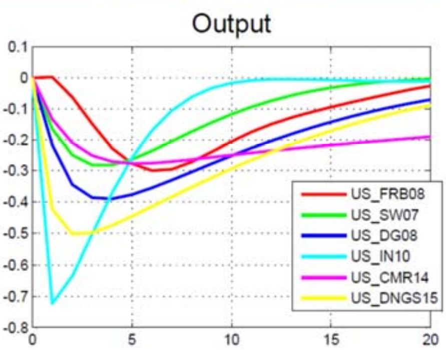
New model comparison tools in Macro Macro Model Data Base (MMB) 3.1 just released (www.macromodelbase.com)

Model comparison & robust policy: Cochrane, Taylor, Wieland (2019) „*Evaluating rules in the Fed‘s Report and Measuring Discretion*“, working paper.

Model comparison & forecast competition: Binder, Farkas, Taylor, Sun, Wolters, Wieland (2020) forthcoming, *Forecasting the Great Recession in the United States: First Results from a Forecasting Model Competition*.

1. New tools in MMB 3.1 just released

Make macro modeling



more reproducible

more collaborative

more comparative

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The Macroeconomic Model Comparison Initiative

The MMB is developed by contributors around the world under the auspices of the Macroeconomic Model Comparison Initiative (MMCI), a joint project of the **Hoover Institution at Stanford University** and the **Institute for Monetary and Financial Stability** (IMFS) **at Goethe University Frankfurt**, which is supported financially by the **Alfred P. Sloan Foundation**. The MMCI aims to facilitate the comparison of macroeconomic models, enable the reproducibility of macroeconomic research and bring together researchers in this area.

Learn more about project and initiative

Institute for Monetary and Financial Stability

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Macroeconomic Model Data Base

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Third Research Conference of the CEPR Network on Macroeconomic Modelling and Model Comparison (MMCN)

13 June 2019

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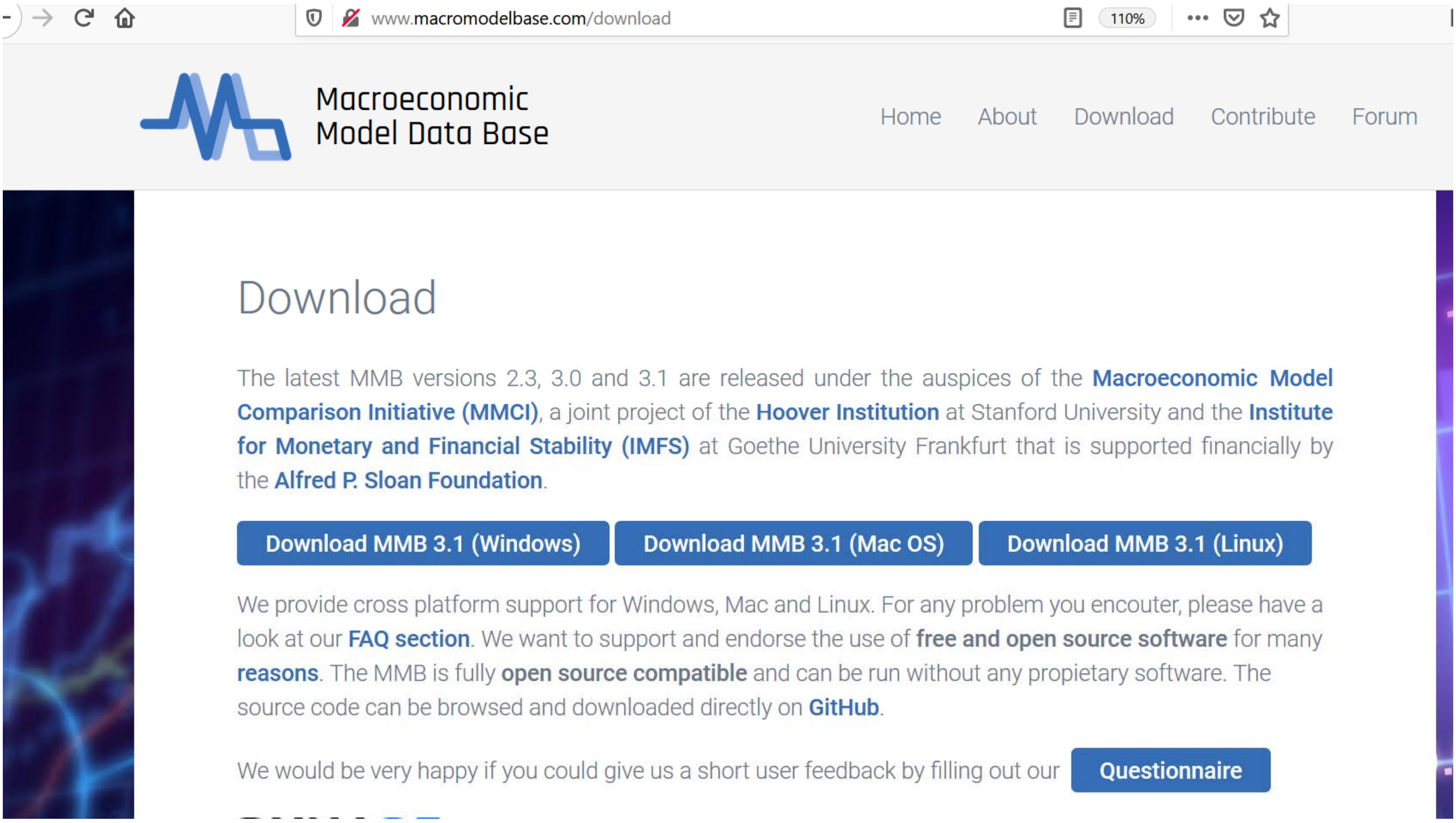
Get started by downloading the latest version of the MMB software.

Contribute

Guidelines and tools to contribute your model to the MMB.

Join the Discussion

Any suggestions or ideas? Spread your thoughts in the community.



MMCI: Make it easier to evaluate policy across models

Long tradition in monetary policy: Bryant, Hooper & Mann (Brookings 1993), Taylor (NBER 1999), Levin, Wieland & Williams (AER 2003).

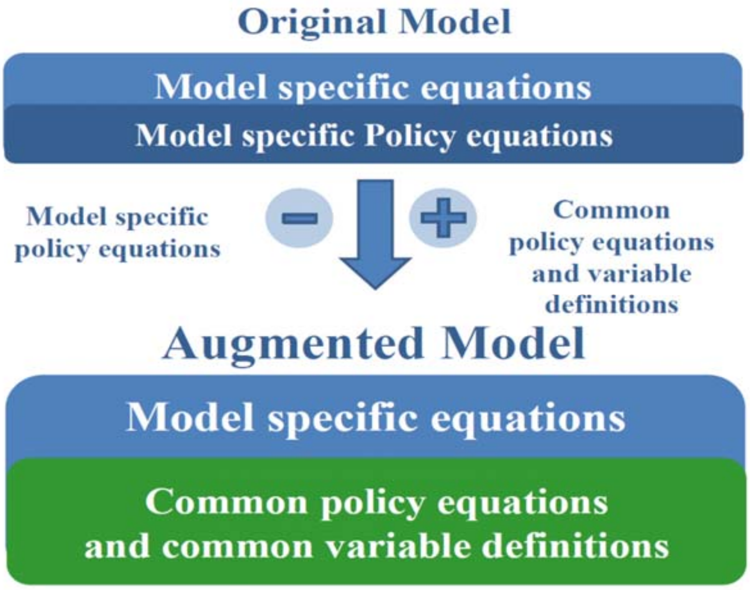
Also in fiscal policy: For example, IMF project - Coenen, Erceg, Freedman, Furceri, Kumhof, Lalonde, Laxton, Lindé, Mourougane, Muir, Mursula, Resende, Roberts, Roeger, Snudden, Trabandt, in't Veld, AEJ-Macro, 2012.

9 models: IMF, OECD, ECB, FRB (2), BoC,

EU Commission, 2 academic.

Similarly ECB on fiscal consolidation, 2015, 15 models.

A systematic approach to model comparison



Model(-specific) elements

Table 1: Model-Specific Variables, Parameters, Shocks and Equations

Notation	Description
x_t^m	endogenous variables in model m
$x_t^{m,g}$	policy variables in model m (also included in x_t^m)
η_t^m	policy shocks in model m
ε_t^m	other economic shocks in model m
$g_m(.)$	policy rules in model m
$f_m(.)$	other model equations in model m
γ^m	policy rule parameters in model m
β^m	other economic parameters in model m
Σ^m	covariance matrix of shocks in model m

A particular model: Policy rules and other equations

$$(1) \qquad E_t[g_m(x_t^m, x_{t+1}^m, x_{t-1}^m, \eta_t^m, \gamma^m)] = 0$$

$$(2) \qquad E_t[f_m(x_t^m, x_{t+1}^m, x_{t-1}^m, \varepsilon_t^m, \beta^m)] = 0$$

Innovations/shocks

$$(3) \qquad E([\eta_t^m \varepsilon_t^m]') = 0$$

$$(4) \qquad E([\eta_t^{m\prime} \varepsilon_t^{m\prime}]'[\eta_t^{m\prime} \varepsilon_t^{m\prime}]) = \Sigma^m = \begin{pmatrix} \Sigma_\eta^m & \Sigma_{\eta\varepsilon}^m \\ \Sigma_{\eta\varepsilon}^m & \Sigma_\varepsilon^m \end{pmatrix}$$

Introducing common ingredients

Table 2: Comparable Common Variables, Parameters, Shocks and Equations

Notation	Description
z_t	common variables in all models
z_t^g	common policy variables in all models (also included in z_t)
η_t	common policy shocks in all models
$g(.)$	common policy rules
γ	common policy rule parameters

Augmented model

$$E_t[g(z_t, z_{t+1}, z_{t-1}, \eta_t, \gamma)] = 0 \quad (5)$$

$$E_t[h_m(z_t, x_t^m, x_{t+1}^m, x_{t-1}^m, \theta^m)] = 0 \quad (6)$$

$$E_t[f_m(x_t^m, x_{t+1}^m, x_{t-1}^m, \varepsilon_t^m, \beta^m)] = 0 \quad (7)$$

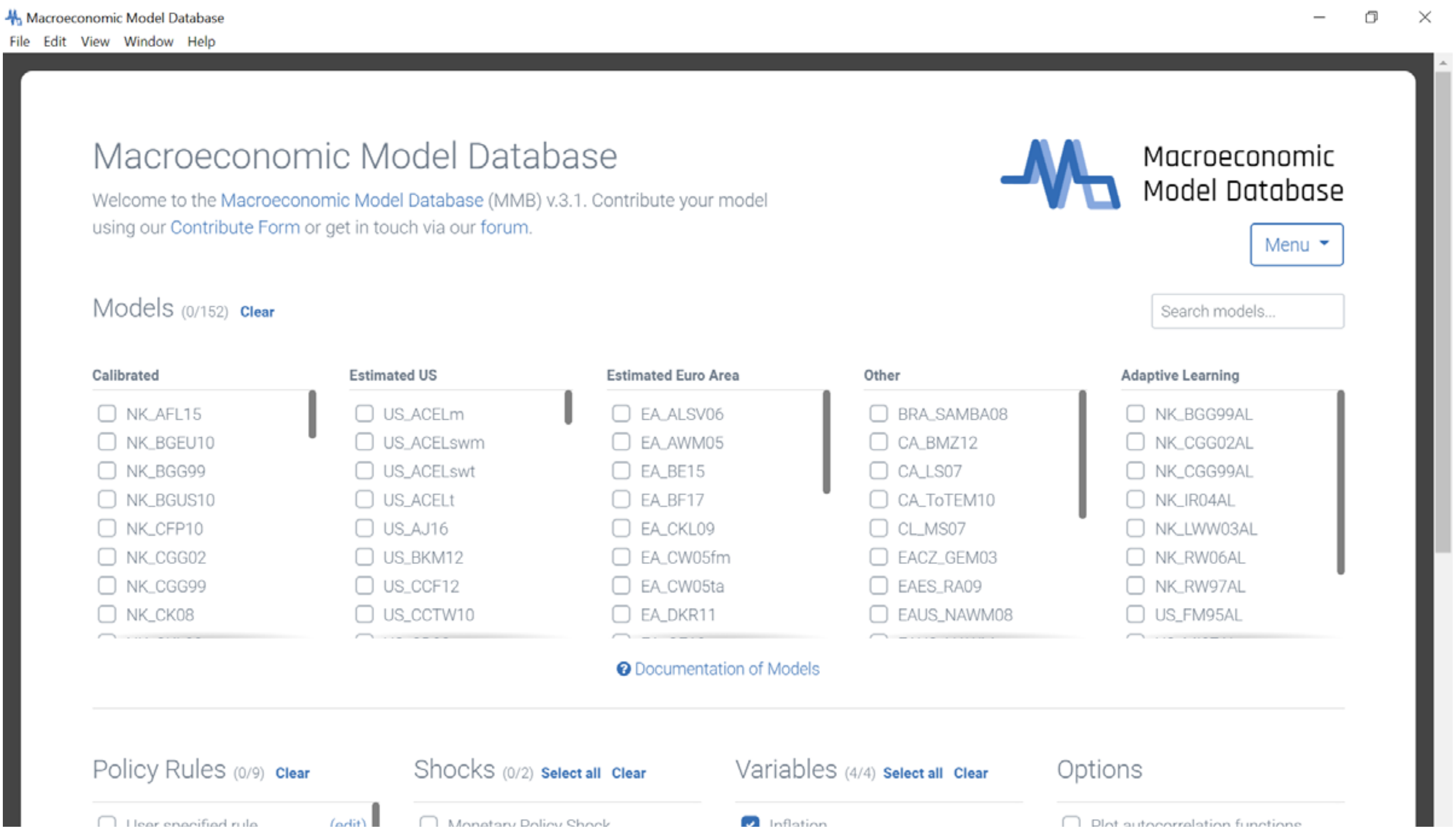
$h_m(.,\theta^m)$: model-specific equations defining common variables in terms of model-specific variables.

Solution

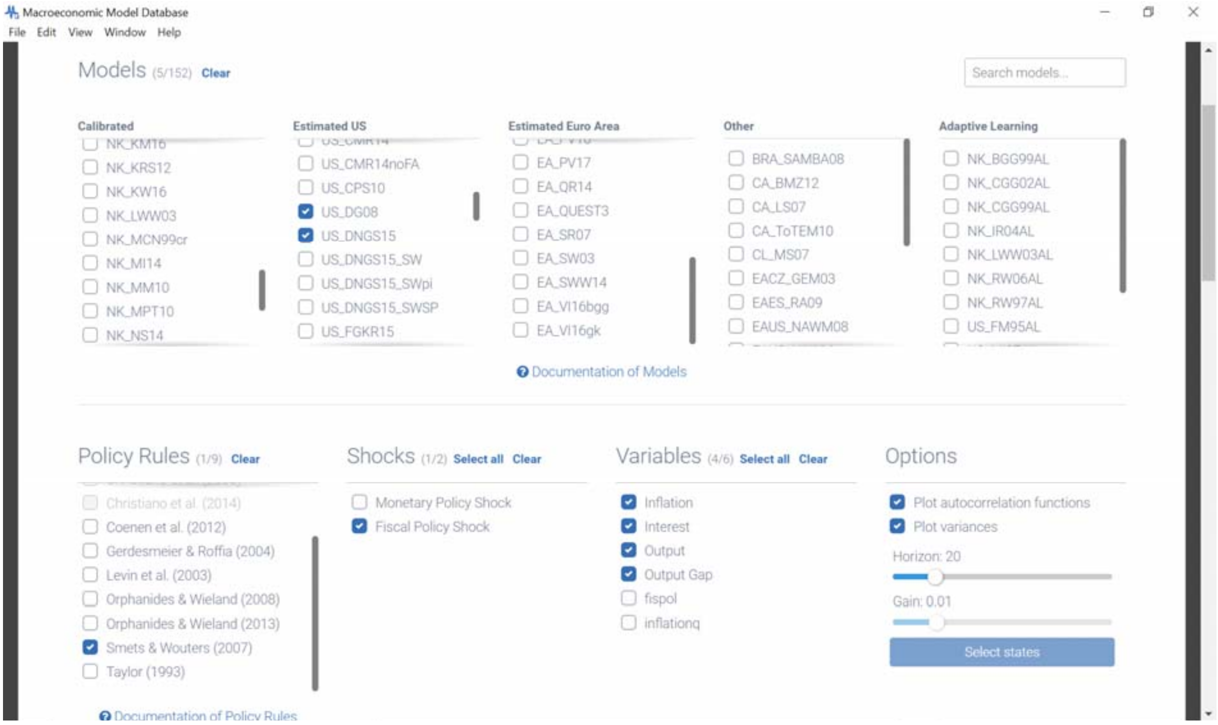
$$z_t = k_z(z_{t-1}, x^m_{t-1}, \eta_t, \varepsilon^m_t, \kappa_z) \qquad (8)$$

$$x^m_t = k_x(z_{t-1}, x^m_{t-1}, \eta_t, \varepsilon^m_t, \kappa_x) \qquad (9)$$

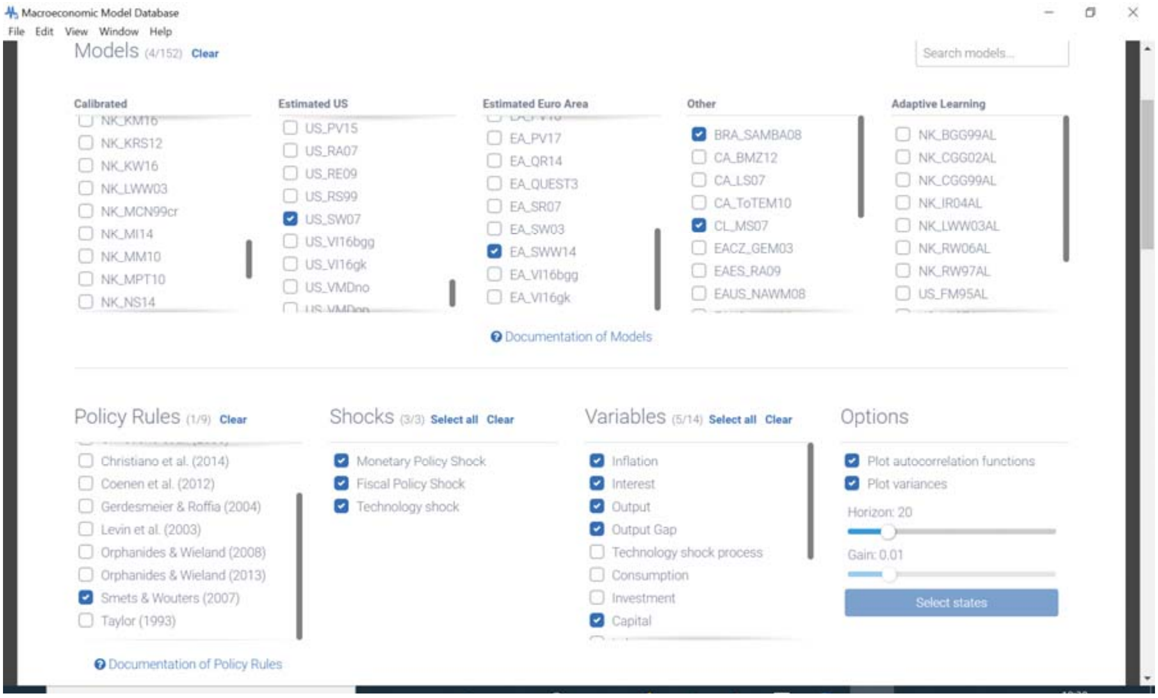
- Numerical approximation,
- Compute comparable objectives
  – IRF‘s of z‘s to η‘s, variances and correlations of z‘s given all shocks, etc.
- Compute metric measuring distance between different models.

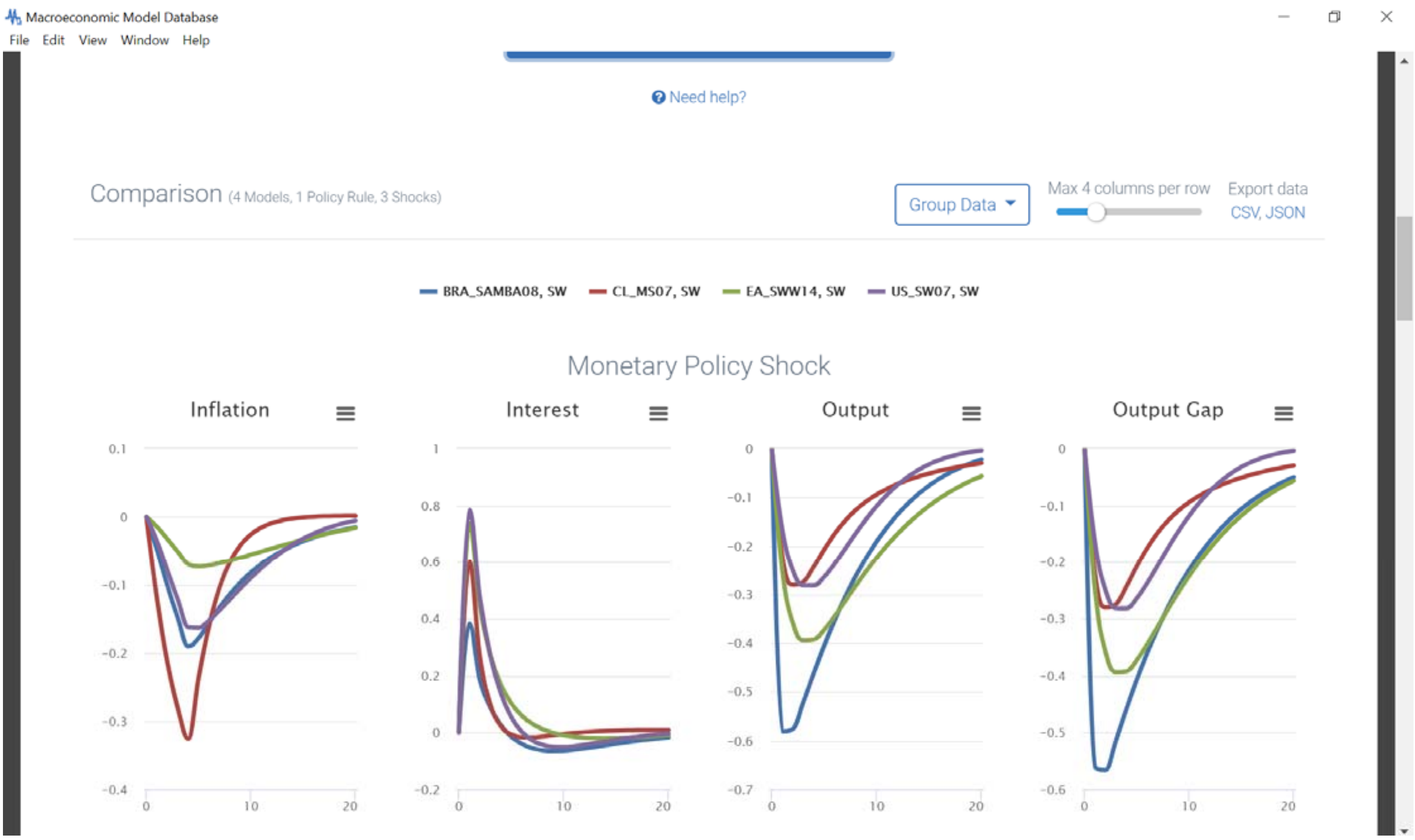


A comparison across model types



A comparison across economies

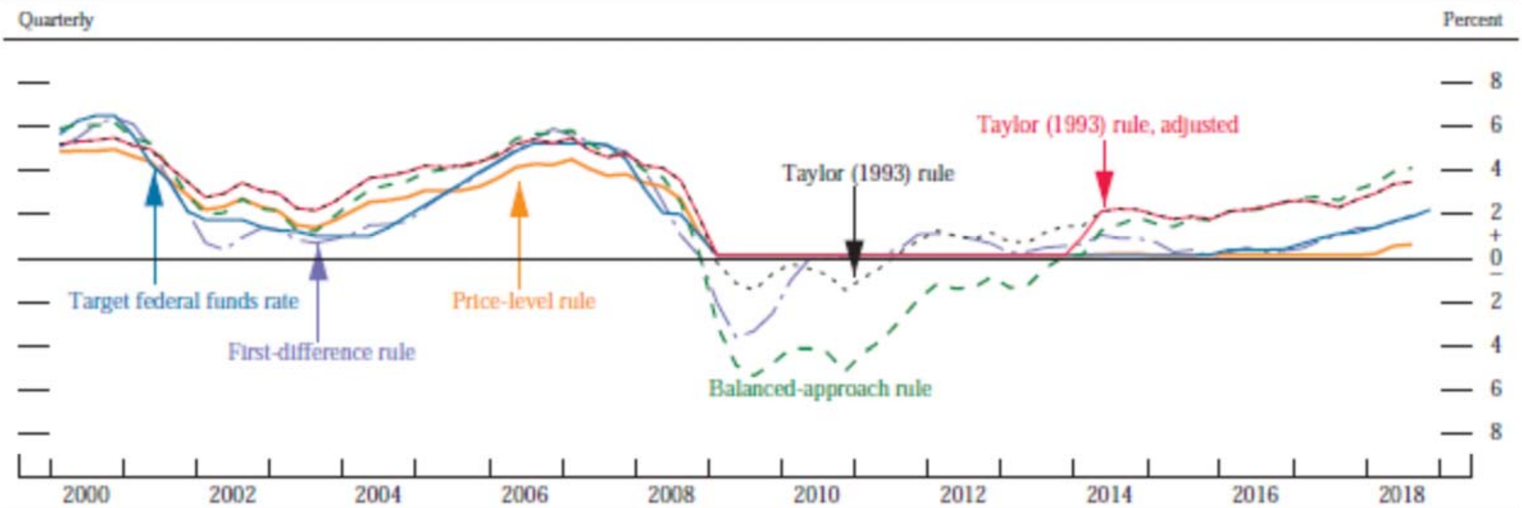




2. Model comparison & robust policy: Cochrane, Taylor, Wieland (2019) „Evaluating rules in the Fed‘s Report and Measuring Discretion“, working paper.

Monetary Policy Rules *(continued)*

B. Historical federal funds rate prescriptions from simple policy rules



NOTE: The rules use historical values of inflation, the federal funds rate, and the unemployment rate. Inflation is measured as the 4-quarter percent change in the price index for personal consumption expenditures (PCE) excluding food and energy. Quarterly projections of long-run values for the federal funds rate and the unemployment rate are derived through interpolations of biannual projections from Blue Chip Economic Indicators. The long-run value for inflation is taken as 2 percent. The target value of the price level is the average level of the price index for PCE excluding food and energy in 1998 extrapolated at 2 percent per year. The data extend through 2018:Q3, with the exception of the target federal funds rate data, which go through 2018:Q4.

SOURCE: Federal Reserve Bank of Philadelphia; Wolters Kluwer, Blue Chip Economic Indicators; Federal Reserve Board staff estimates.

Table 1: The Rules in the Monetary Policy Report

Taylor (1993) rule: *T93*	$i_t^{T93} = \pi_t + 0.5(\pi_t - \pi^*) + (u_t^* - u_t) + r_t^*$
Balanced-approach rule: *BA*	$i_t^{BA} = \pi_t + 0.5(\pi_t - \pi^*) + 2(u_t^* - u_t) + r_t^*$
First-difference rule: *FD*	$i_t^{FD} = i_{t-1} + 0.5(\pi_t - \pi^*) + (u_t^* - u_t) - (u_{t-4}^* - u_{t-4}) + r_t^*$
Taylor (1993) adjusted: *T93adj*	$i_t^{T93adj} = \max\{i_t^{T93} - Z_t, 0\}$
Price-level rule: *PL*	$i_t^{PL} = \max\{\pi_t + 0.5(PLgap_t) + (u_t^* - u_t) + r_t^*, 0\}$

Note to Table 1: i_t is the nominal federal funds rate, π_t is the inflation rate, for which the Fed uses core PCE inflation, u_t is the unemployment rate, π^* is the Fed's longer-run inflation objective of 2%, r_t^* is the Fed's estimate level of the neutral real federal funds rate in the longer-run, u_t^* is the Fed's estimate of rate of unemployment in the longer run. Z_t is the cumulative sum of past deviations from the Taylor rule forced by the zero bound, and $PLgap_t$ is the price level gap, defined as the percent deviation of the actual level of prices from a price level that rises 2 percent per year from its level in a specified starting period.

First 3 rules nested in

$$i_t = \varphi_\pi \pi_t + \varphi_y y_t + \varphi_{yl} y_{t-4} + \varphi_i i_{t-1} + \mu$$

TR93:	1.5	0.5	0	0
BA:	1.5	1.0	0	0
FD:	0.5	0.5	-0.5	1.0

Also, we consider an inflation-tilting rule as suggested by Nikolsko-Rzhevskyy, Papell, Prodan (2019)

NPP:	2.0	0.5	0	0

Use models to evaluate rules

Small New-Keynesian Model (NK):

Par's Levin, Wieland & Williams 2003

$$y_t = E_t y_{t+1} - 1.59(i_t - E_t \pi_{t+1} - r_t^*)$$

$$r_t^* = 0.35 r_{t-1}^* + \eta_t$$

$$\pi_t = .99 E_t \pi_{t+1} + .096 y_t + \varepsilon_t$$

Small Old-Keynesian Model (OK):

Par's Rudebusch & Svensson 1999

$$y_t = 1.16 y_{t-1} - .25 y_{t-2} - .1(i_{t-1}^{4q} - \pi_{t-1}) + \eta_t$$

$$\pi_t^q = .7\pi_{t-1}^q - .1\pi_{t-2}^q + .28\pi_{t-3}^q + .12\pi_{t-4}^q - .14 y_{t-1} + \varepsilon_t$$

Medium-Scale New Keyesian Model (SW): Smets & Wouters 2007

Table 2

Steady-State Standard Deviation of Inflation and Output Gap in the Models

Rules/Models	*OK*		*NK*		*SW*	
	Inflation	Output Gap	Inflation	Output Gap	Inflation	Output Gap
T93	3.45	2.27	0.90	4.24	4.50	4.27
BA	3.49	1.99	0.96	2.83	6.87	3.56
NPP	2.65	2.59	0.84	4.38	2.83	4.74
FD	∞	∞	0.88	3.12	1.39	4.62
E	2.33	2.80	0.86	2.78	2.22	4.61

Note to Table 2: The models are the small old-Keynesian (*OK*), small new-Keynesian (*NK*) and the medium-size policy model (SW). The rules are the Taylor (1993) rule (*T93*), the balanced approach rule (BA), the inflation-tilting Taylor rule proposed by Nikolsko-Rzhevskyy, Papell, and Prodan rule (NPP), the first-difference rule (FD). E refers to the outcome under the model's estimated rule with its residuals, when that rule and residual covariance matrix is available, or to sample standard deviations when not available.[4]

Four more models

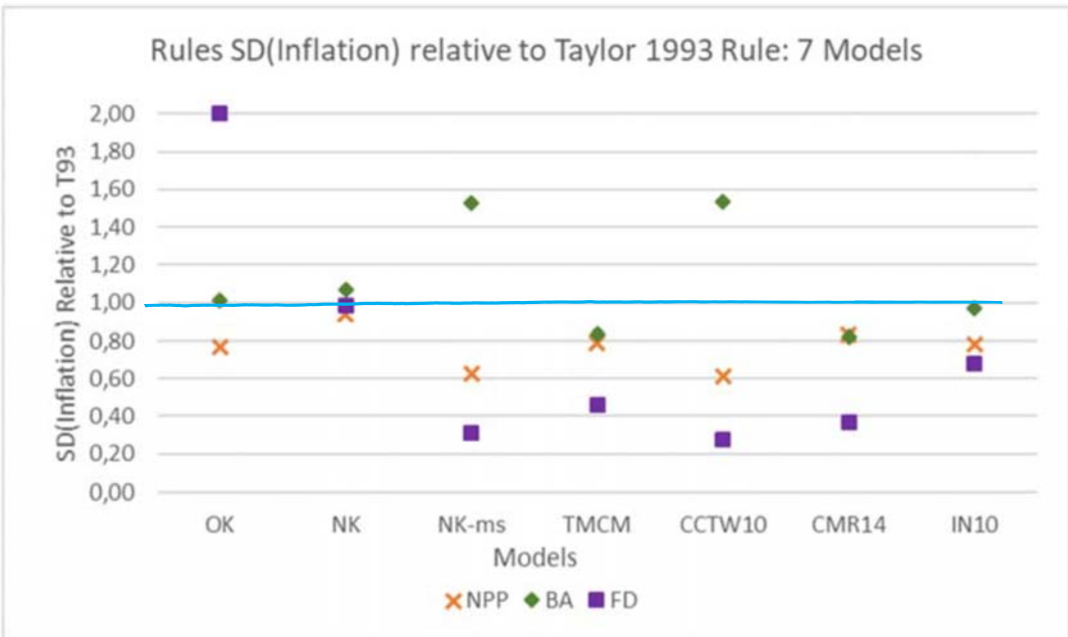
TMCM: A multi-country model due to Taylor (1993), which is a first-generation New Keynesian model. It is a model with rational expectations, nominal rigidities based on staggered contracts, and an interest-rate policy rule.

CCTW10: A model due to Cogan, Cwik, Taylor and Wieland (2010), which extends the SW model. It includes including Keynesian rule-of-thumb consumers. This modification affects, for example, the size of the fiscal multipliers, and improves fit a little bit.

CMR14: A model due to Christiano-Motto-Rostagno (2014), which adds financial frictions and considers post-crisis data.

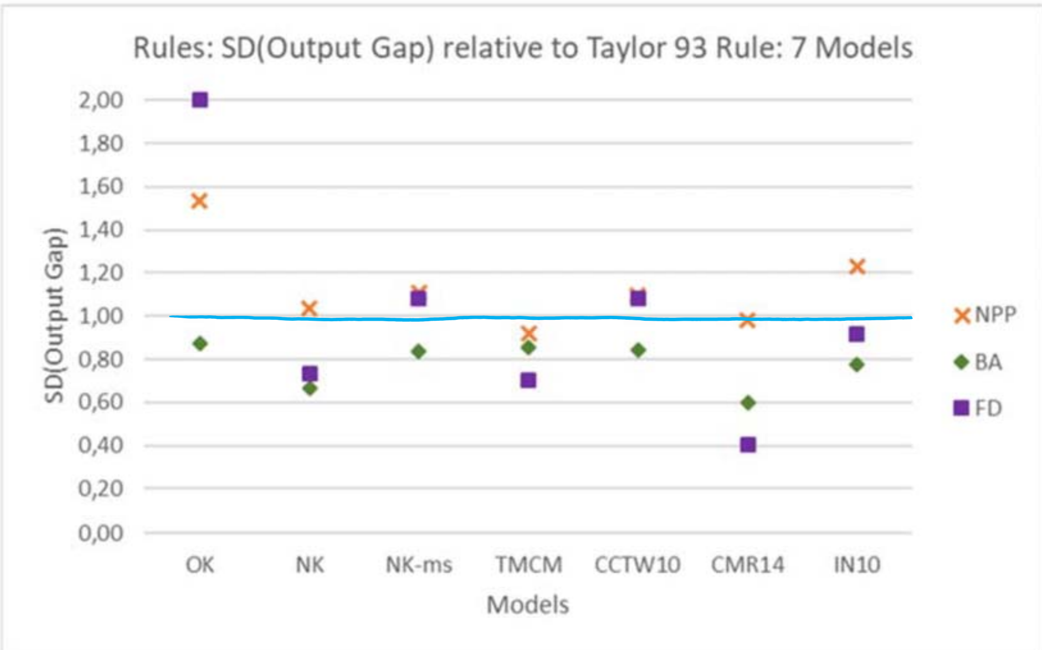
IN10: A model of Iacoviello and Neri (2010), which adds a housing market as well as financial frictions.

Figure 1. Standard deviation of inflation and output gap



Note: The figure shows the standard deviations of inflation and the output gap of each of the rules relative to the Taylor 1993 rule in 7 different models. The rules shown are the balanced approach rule (BA), the first difference rule (FD) and the inflation-tilting rule (NPP). The models are as follows: (1) *OK Model* – specification from Rudebusch and Svensson (1999), (2) *NK Model* - specification from Levin, Wieland and Williams (2003), (3) *SW Model* from Smets and Wouters (2007)), (4) *TMCM Model* from Taylor (1993), (5) *CCTW10 Model* from Cogan, Cwik, Taylor and Wieland (2010), (6) *CMR14 Model* from Christiano, Motto and Rostagno (2014), and (7) *IN10 Model* from Iacoviello and Neri (2010).

Figure 1. Standard deviation of inflation and output gap



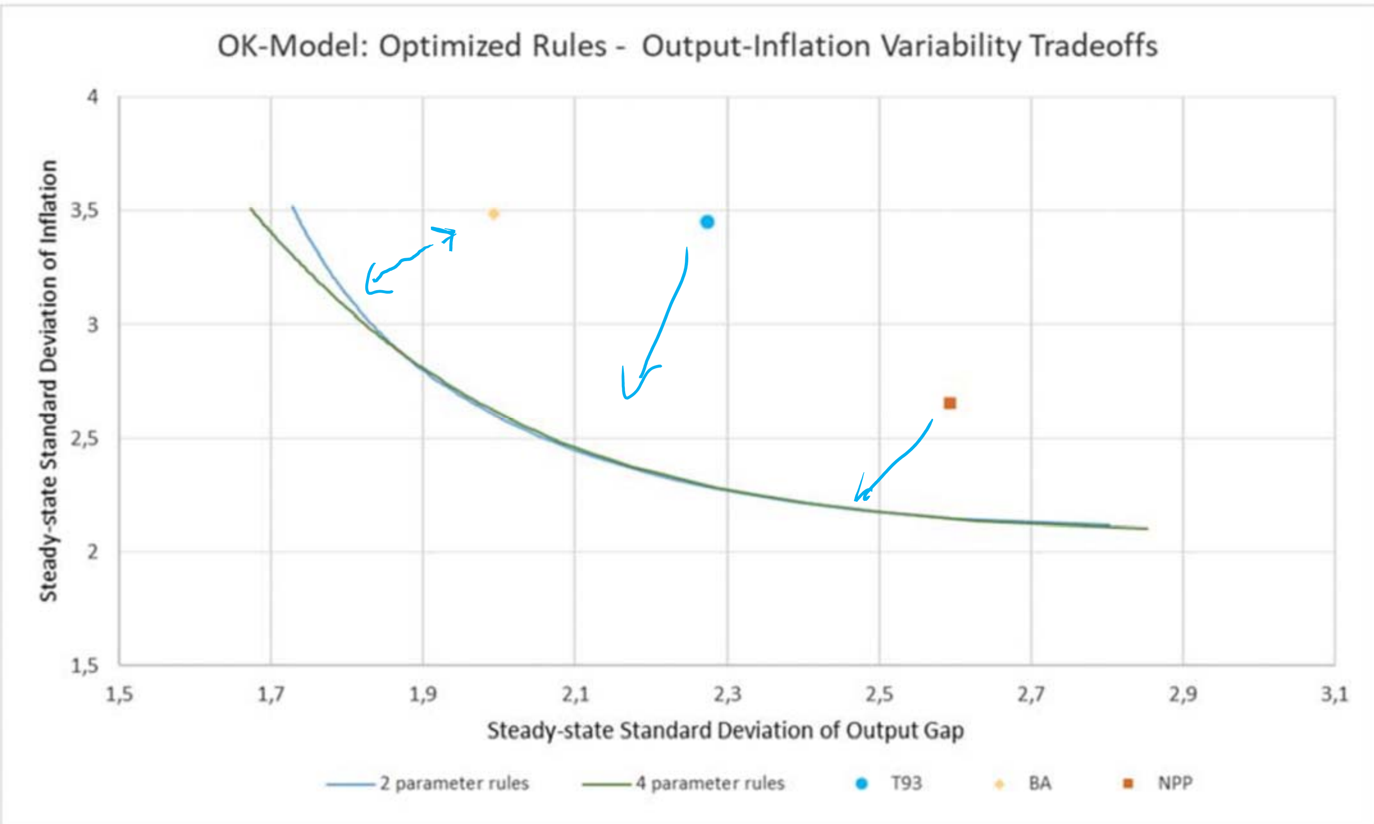
How close to optimal?

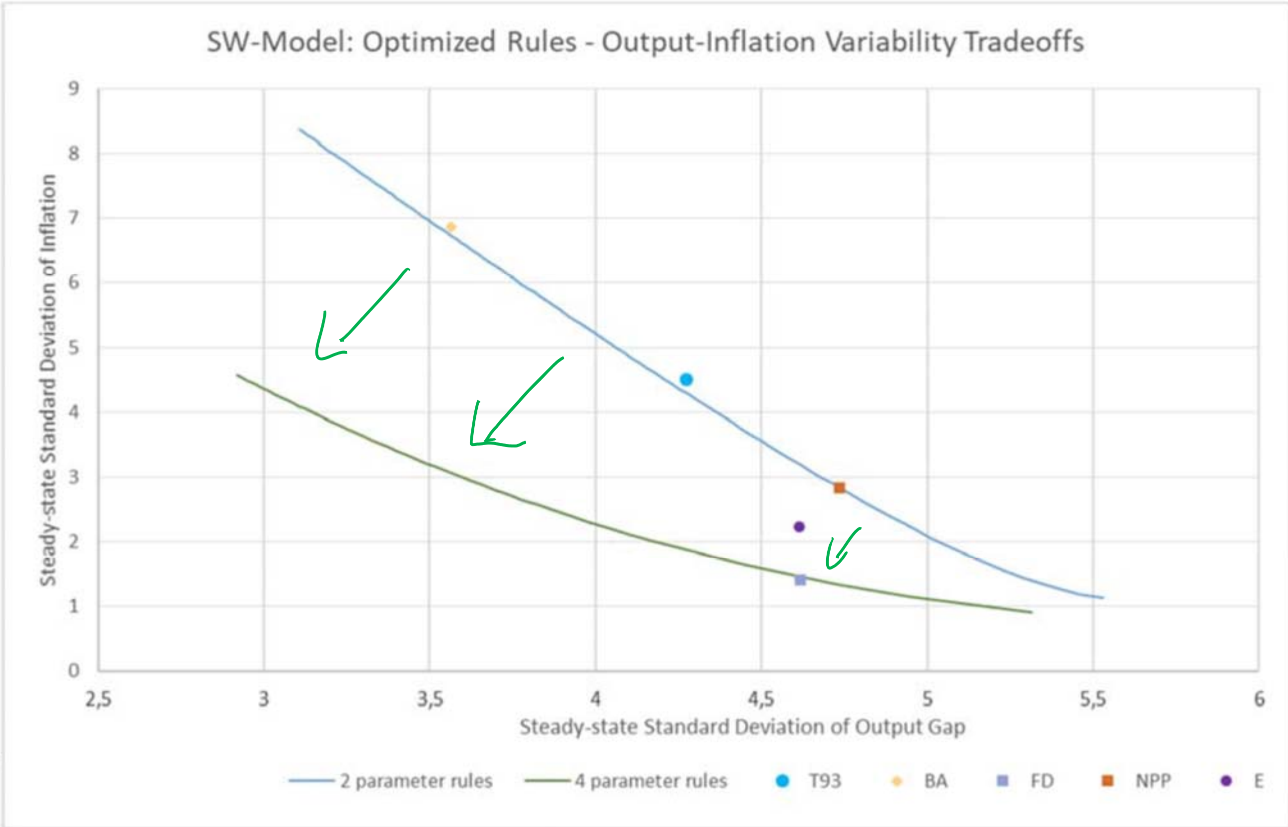
We find optimal response coefficients that solve in a given model:

$\lambda \in [0, \bar{\lambda}]$

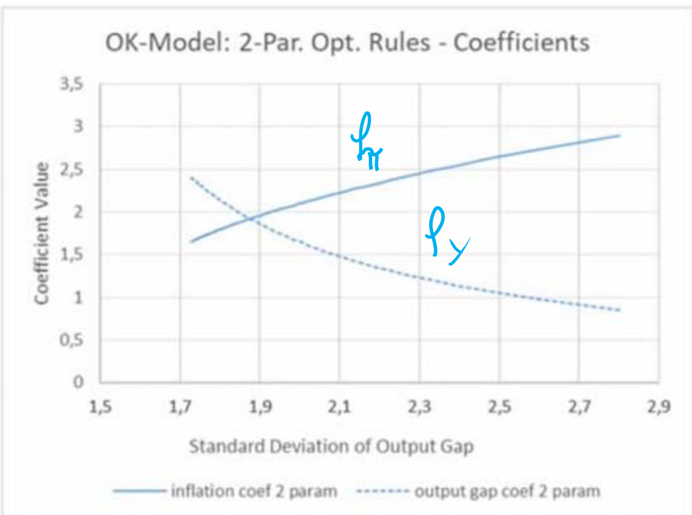
$$\min_{\varphi} \; Var(\pi) + \lambda Var(y) + Var(\Delta i)$$

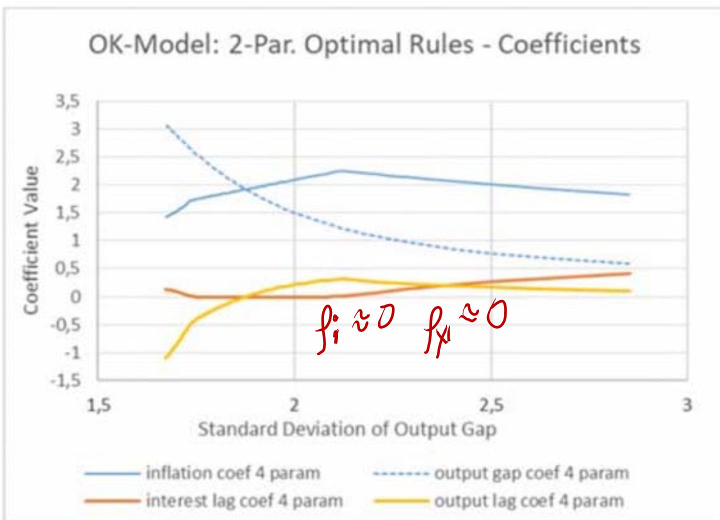
$$s.t. \qquad i_t = \varphi_\pi \pi_t + \varphi_y y_t + \varphi_{yl} y_{t-1} + \varphi_i i_{t-1}$$

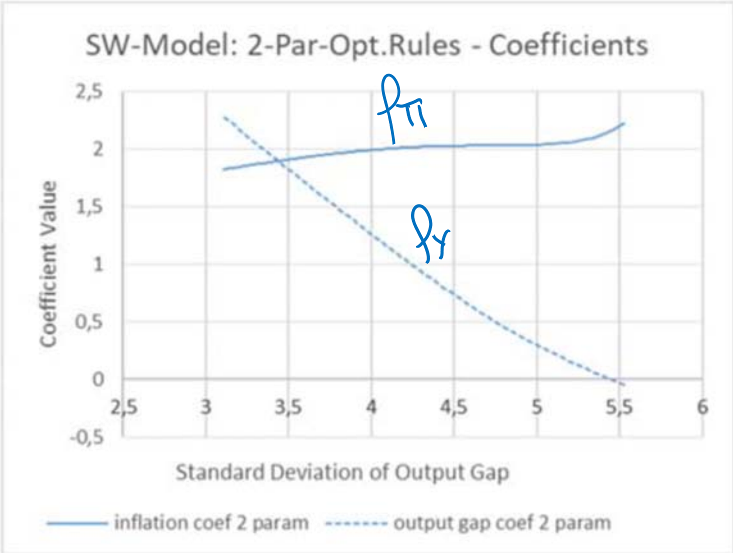


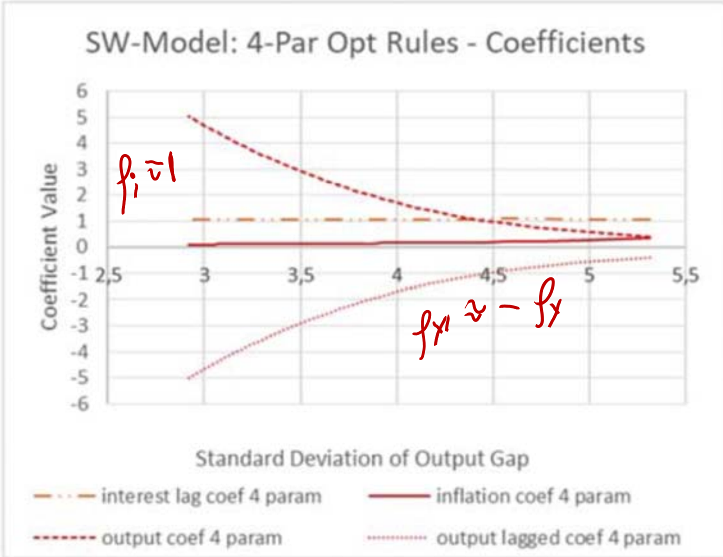


OK Model: Optimized Coefficients









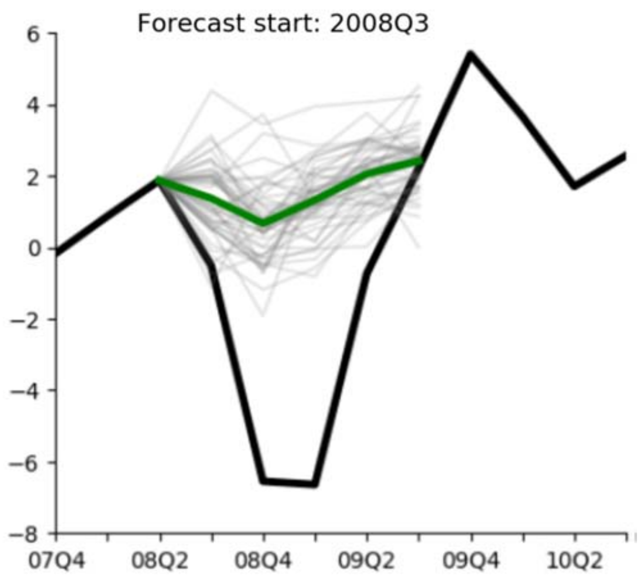
4. A model competition: Forecasting the Great Recession.

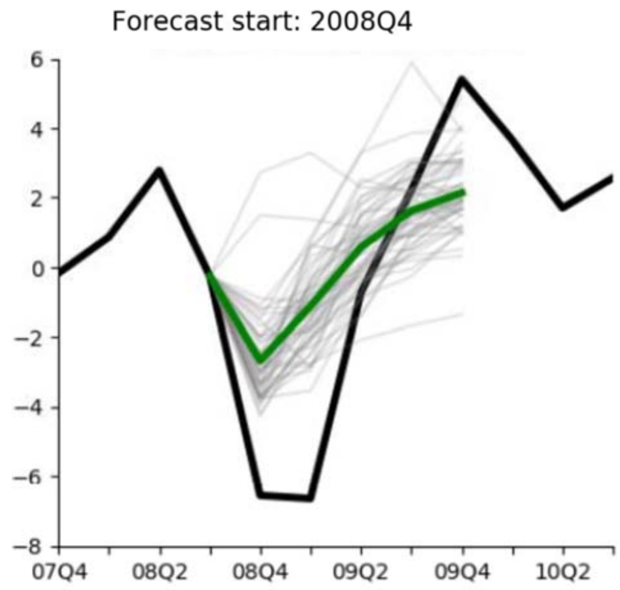
Would new post-crisis macro-financial models have performed better in forecasting the recession of 08/09?

First results: Binder, Farkas, Sun , Taylor, Wieland, Wolters (2020), (in preparation).

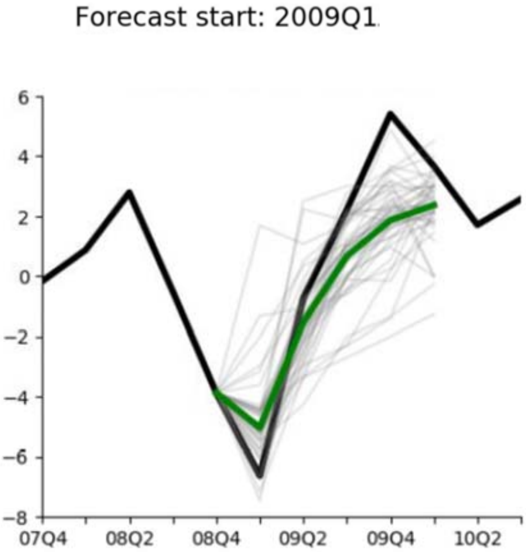
- Benchmark: Survey of professional forecasters in 2008/09
- Data: Quarterly real-time data vintages for U.S. economy
- Models:
  - Bayesian Vector Autoregressions (B-VARs)
  - Pre-crisis structural models
  - Post-crisis structural models

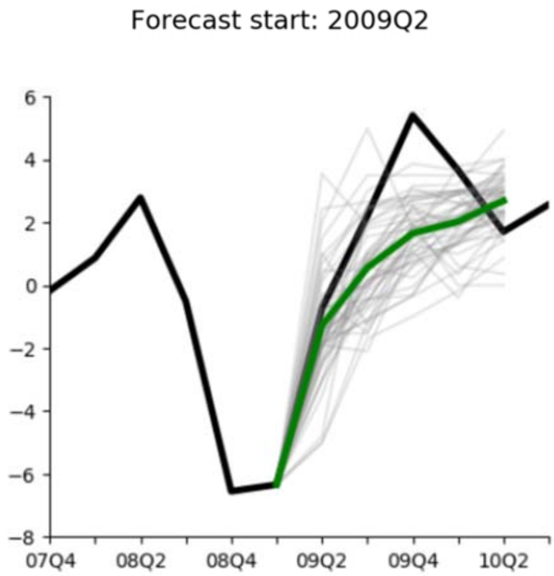
SPF Forecasts 2008:Q3 and 2008:Q4





SPF Forecasts 2009:Q1 and 2009:Q2





Pre-Crisis Models

Del Negro and Schorfheide (2004)	NK-DS04	3: output growth, inflation, interest rate
Wieland and Wolters (2011)	NK-WW11	3: output growth, inflation, interest rate
Smets and Wouters (2007)	DSGE-SW07	7: output growth, consumption growth, investment growth, wages, hours, interest rate
Edge et al. (2008)	DSGE-FRBEDO	11: output growth, inflation, interest rate, consumption of nor and services, consumption of durables, residential investment investment, hours, wages, inflation for consumer nondurable vices, inflation for consumer durables
Giannone et al. (2015)	BVAR3, BVAR7, BVAR11	3, 7 or 11
Fair (2018)	CC-F18	more than 100

Post-Crisis Macro-Financial Models

Bernanke et al. (1999)	FF-BGG99	5: output growth, inflation, interest rate, investment, credit sp
Del Negro and Schorfheide (2013), Del Negro et al. (2015)	FA-SW07	8: output growth, consumption growth, investment growth, wages, hours, interest rate, credit spread
Kolasa and Rubaszek (2015)	FF-DSSW07-FA1	9: output growth, consumption growth, investment growth, wages, hours, interest rate, credit spread, loan growth
Kolasa and Rubaszek (2015)	FF-DSSW07-CC	11: output growth, consumption growth, investment grov tion, wages, hours, interest rate, residential investment, mortg house prices, mortgage loan spread
Carabenciov et al. (2008)	FF-IMFQP	6: unemployment rate, output growth, inflation, interest rate, l ing tightness

Model-based forecasts: 4 different information sets

Scenarios:

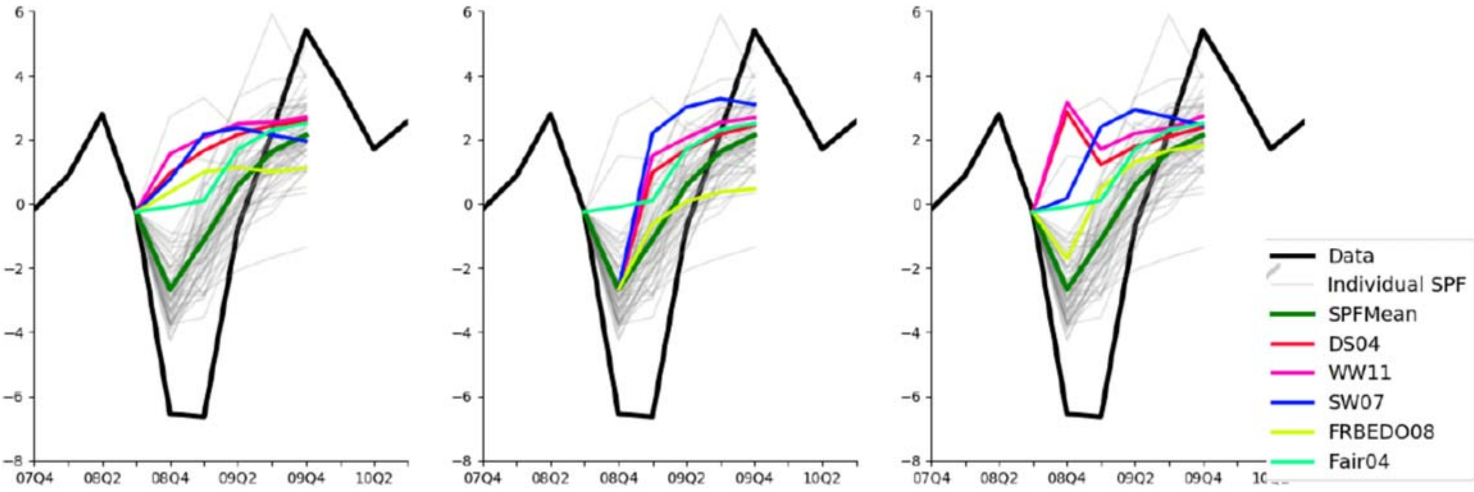
(1) Forecast based exclusively on information from preceding quarter

(2) Condition on *current quarter SPF nowcasts* of output growth, unemployment rate, non-residential investment, residential investment

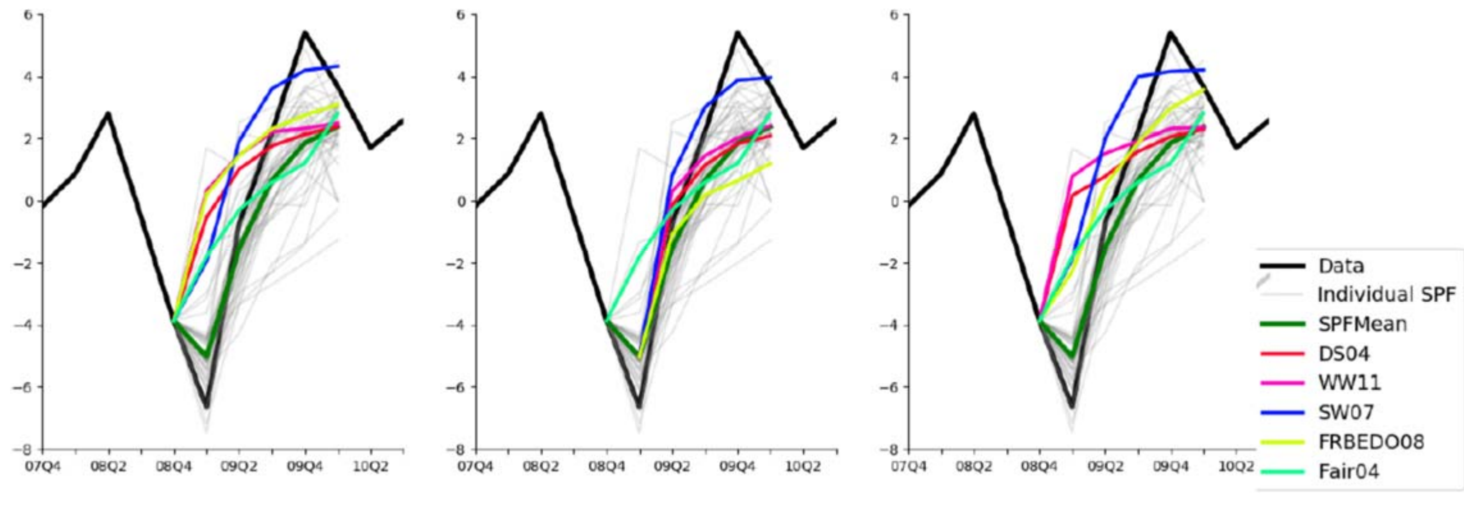
(3) Condition on *current quarter data*: interest rates, credit spreads, mortgage spreads, and monthly observations such as inflation, unemployment, hours.

(4) Condition on (2) and (3).

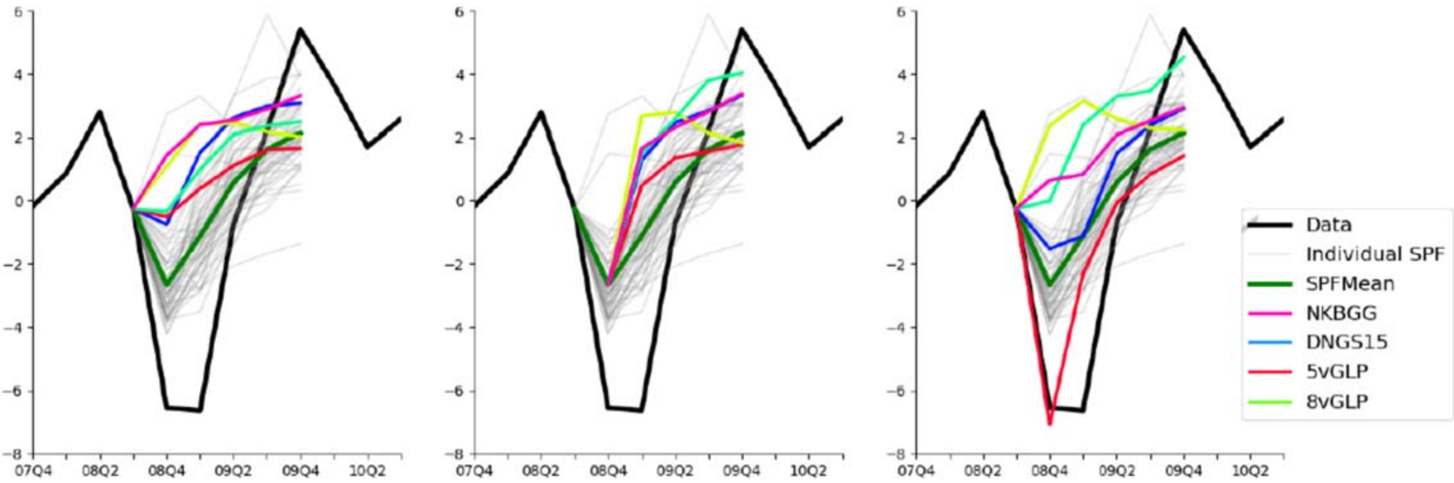
Pre-Crisis Models: Forecast 2008:Q4 , Scenario 1, 2 & 3



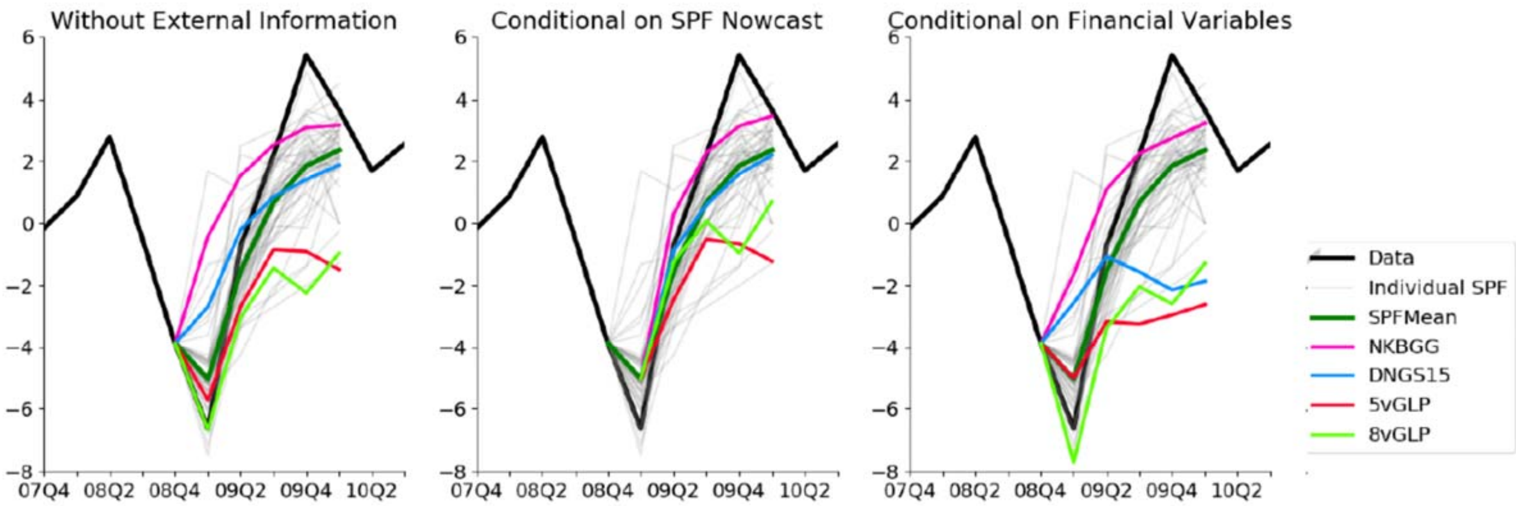
Pre-Crisis Models: Forecast 2009:Q1 , Scenario 1, 2 & 3

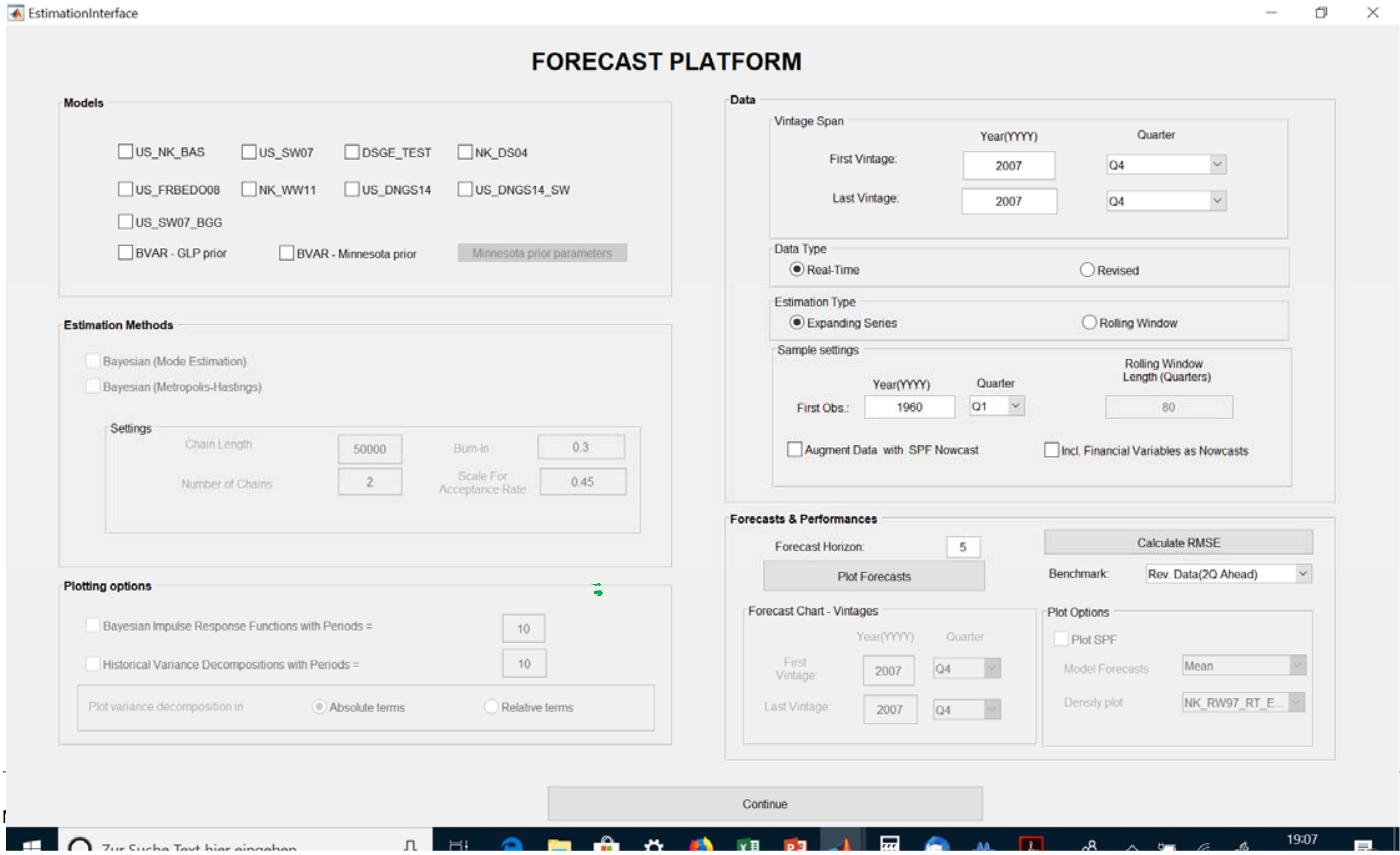


Post-Crisis Models: Forecast 2008:Q4 , Scenario 1, 2 & 3



Post-Crisis Models: Forecast 2009:Q1 , Scenario 1, 2 & 3





Conclusions

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