DSGE Model-Based Forecasting

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Why bother with forecasting with DSGE models?

- DSGE models have been trashed, bashed, and abused during the Great Recession and after. One of the many reasons for the bashing was their alleged inability to forecast.
- In this paper we show that DSGE models forecasts' accuracy is comparable to, if not better than, that of Blue Chip forecasters (and Greenbook).
- What's new? (relative to Edge & Gürkaynak, BPEA 2010)
  - Sample is 1992-2011
  - Incorporate external information (long term surveys, nowcast)
  - ... and financial variables (spreads). In particular, document forecasting performance of a SW+BGG DSGE model during the Great Recession.
- Talk is based on a chapter for *Handbook of Economic Forecasting*

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Poverty of the econometrician's information set

- Quality of forecasts is constrained by quality of model, and the observables used by the econometrician. The "usual" set of observables (mostly NIPA based) falls short in two dimensions:

  1. Timeliness: NIPA data are available with a lag. Professional forecasters have current information that the DSGE econometrician is not using.

  2. Breadth: The "usual" set of observables may not convey enough information about the state of the economy.

- Augment the set of observables: Use nowcasts from professional forecasters, spreads, surveys ... $\rightarrow$ variables that may convey information about the state of the economy not contained in "usual" data set.

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Real time data sets

- Particularly important if DSGE model forecasts are compared to professional forecasts (Blue Chip)/Greenbook
- ... as opposed to basing forecast evaluations on the latest available data vintage at the time the study was conducted.
- Level the playing field: don't give the DSGE econometrician information that private forecasters do not possess at the time of the forecasts.
- Reference: Croushore and Stark (2001), Edge and Gürkaynak (2010)

Real time data sets

Quarter	Greenbook Date	End of Estimation Sample T	Initial Forecast Period $T+1$
Q1	Jan 21	2003:Q3 (F)	2003:Q4
	Mar 10	2003:Q4 (P)	2004:Q1
Q2	Apr 28	2003:Q4 (F)	2004:Q1
	June 23	2004:Q1 (P)	2004:Q2
Q3	Aug 4	2004:Q2 (A)	2004:Q3
	Sep 15	2004:Q2 (P)	2004:Q3
Q4	Nov 3	2004:Q3 (A)	2004:Q4
	Dec 8	2004:Q3 (P)	2004:Q4

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Generating forecasts with a DSGE model

- Linearized DSGE = state space model
  - Measurement equation:

$$y_t = \Psi_0(\theta) + \Psi_1(\theta)t + \Psi_2(\theta)s_t$$

  - Transition equation:

$$s_t = \Phi_1(\theta)s_{t-1} + \Phi_\epsilon(\theta)\epsilon_t$$

  where y_t and s_t are the vectors of observables and states, respectively.

- Use MCMC methods to generate draws from predictive distribution

$$p(y_{T+1:T+H}|y_{1:T}) = \int_{(s_T,\theta)} p(y_{T+1:T+H}|s_T,\theta,y_{1:T}) \underbrace{p(s_T|\theta,y_{1:T})}_{\text{posterior of } s_T|\theta} \underbrace{p(\theta|y_{1:T})}_{\text{posterior of } \theta} d(s_T,\theta)$$

where $p(\theta|y_{1:T}) = \frac{p(y_{1:T}|\theta)p(\theta)}{p(y_{1:T})}$, $p(s_T|\theta,y_{1:T})$ obtains from the Kalman filter, and

$$p(y_{T+1:T+H}|s_T,\theta,y_{1:T}) = \int_{s_{T+1:T+H}} p(y_{T+1:T+H}|s_{T+1:T+H}) p(s_{T+1:T+H}|s_T,\theta,y_{1:T}) ds_{T+1:T+H}$$

Baseline DSGE Model: SW (2007)

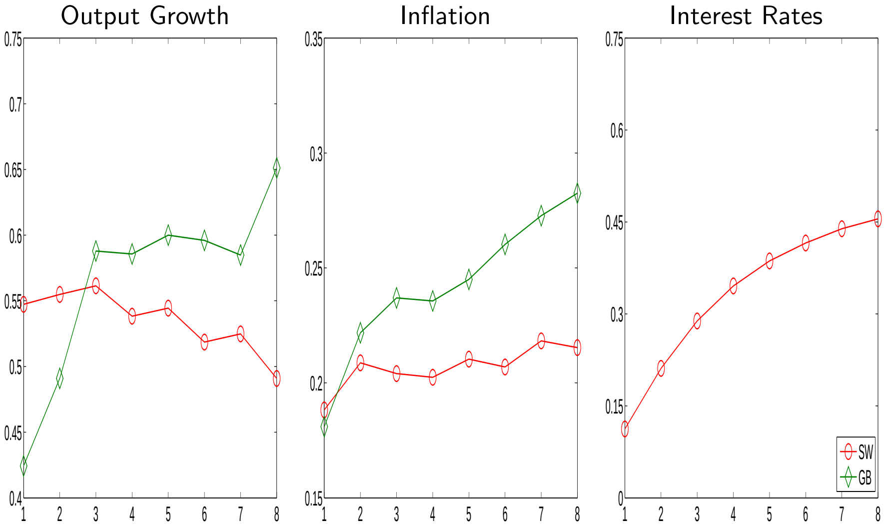
- Measurement equation:

$$
\begin{array}{lcl}
\textit{Output growth} & = & LN((GDPC)/LNSINDEX) * 100 \\
\textit{Consumption growth} & = & LN((PCEC/GDPDEF)/LNSINDEX) * 100 \\
\textit{Investment growth} & = & LN((FPI/GDPDEF)/LNSINDEX) * 100 \\
\textit{Real Wage growth} & = & LN(PRS85006103/GDPDEF) * 100 \\
\textit{Hours} & = & LN((PRS85006023 * CE16OV/100)/LNSINDEX) \\
 & & *100 \\
\textit{Inflation} & = & LN(GDPDEF/GDPDEF(-1)) * 100 \\
\textit{FFR} & = & FEDERAL\ FUNDS\ RATE/4
\end{array}
$$

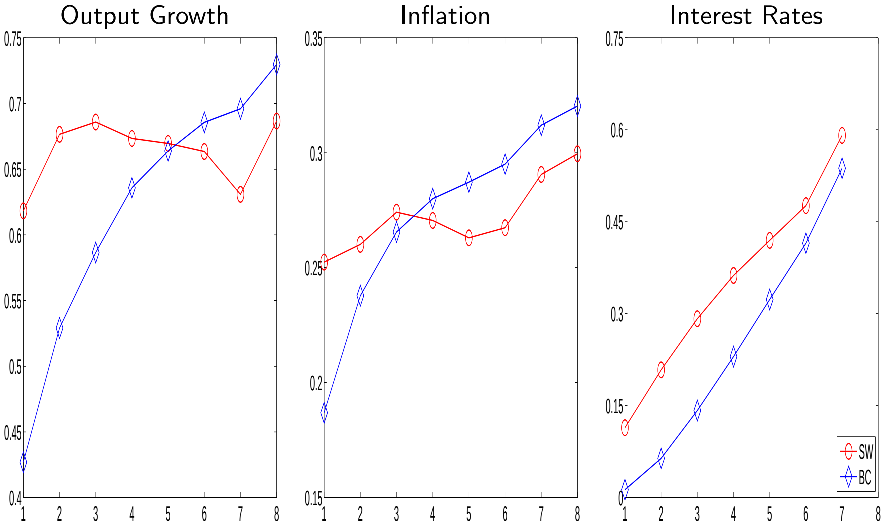
Sample starts in 1964:Q1

- Same prior on θ as SW.

SW vs Greenbook (March 1992-Sept 2004)



SW vs Blue Chip (Jan 1992-Apr 2011)



Incorporating 10-yrs inflation expectations from surveys

- SW forecasts inflation relatively well but ... somewhat tight prior on π^*:$\sim$ *Gamma*$(.62, .10)$.
- No need of such a prior: Use a loose prior ($\pi^* \sim$ *Gamma*$(.75, .40)$) and survey data as an observable:

$$\begin{aligned}\pi_t^{O,40} &= \pi_* + E_t\left[\frac{1}{40}\sum_{k=1}^{40}\pi_{t+k}\right] \\ &= \pi_* + \frac{1}{40}\Psi_2(\theta)_{(\pi,.)}(I - \Phi_1(\theta))^{-1}\left(\Phi_1(\theta) - \Phi_1(\theta)^{41}\right)s_t,\end{aligned}$$

- ... and change the model to be able to explain it:

$$\begin{aligned}R_t &= \rho_R R_{t-1} + (1-\rho_R)\left(\psi_1(\pi_t - \pi_t^*) + \psi_2(y_t - y_t^f)\right) \\ &\quad + \psi_3\left((y_t - y_t^f) - (y_{t-1} - y_{t-1}^f)\right) + r_t^m,\end{aligned}$$

where $\pi_t^* = \rho_{\pi^*}\pi_{t-1}^* + \sigma_{\pi^*}\epsilon_{\pi^*,t}$.

- Similar to Wright's "democratic prior" – but survey not used to form a prior.

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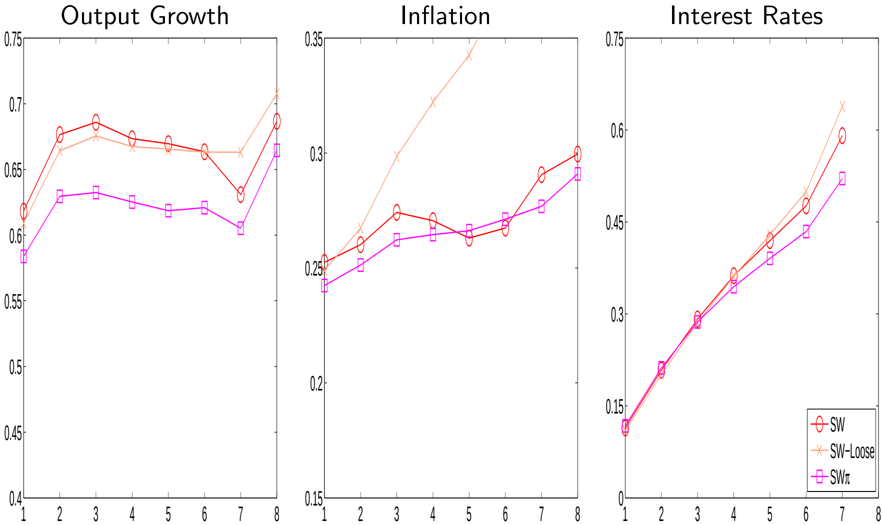
SW vs SW-Loose vs SWπ



Timeliness of information: Incorporating nowcasts

- Factor model literature (for DSGEs, Boivin and Giannoni (2007)) addresses the issue by using the current indicators observed by professional forecasters (confidence indexes, ISM, durable goods orders, . . .) as data.

- As a shortcut, we use those data as digested by professional forecasters → incorporate Blue Chip consensus nowcasts as (possibly noisy) observations on GDP, inflation, ...

Incorporating nowcasts

Forecast Origin	End of Est. Sample T	External Nowcast $T+1$	Forecast $h=1$	Forecast $h=2$
Apr 92	91:Q4	92:Q1 based on Apr 92 BC	92:Q1	92:Q2
Jul 92	92:Q1	92:Q2 based on Jul 92 BC	92:Q2	92:Q3
Oct 92	92:Q2	92:Q3 based on Oct 92 BC	92:Q3	92:Q4
Jan 93	92:Q3	92:Q4 based on Jan 93 BC	92:Q4	93:Q1

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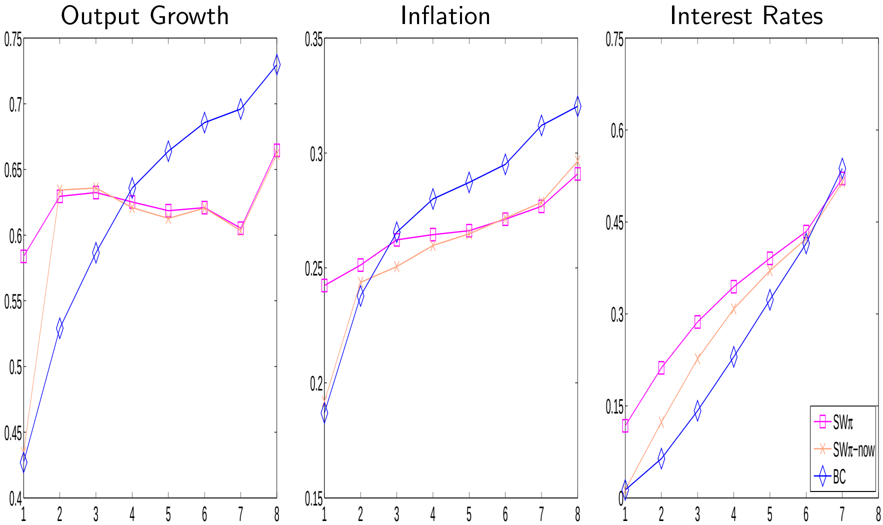

Incorporating interest rate expectations

- Add interest rate expectations $R^e_{T+1+k|T+1}$ (from Blue Chip Financial Survey, markets, ...) as observables:

$$R^e_{T+1+k|T+1} = R_* + \boldsymbol{E}_{T+1}\left[R_{T+1+k}\right]$$

- ... and add anticipated policy shocks (Laseen and Svensson (2008), but also Evans et al. (2012)) to give the model a chance to explain it:

$$r^m_t = \rho_{r^m} r^m_{t-1} + \sigma_{r^m}\epsilon^m_t + \sum_{k=1}^{K} \sigma_{r^m,k}\epsilon^m_{k,t-k}$$

where r^m_t is the exogenous component in the policy rule

$$\begin{aligned} R_t &= \rho_R R_{t-1} + (1-\rho_R)\left(\psi_1(\pi_t - \pi^*_t) + \psi_2(y_t - y^f_t)\right) \\ &\quad + \psi_3\left((y_t - y^f_t) - (y_{t-1} - y^f_{t-1})\right) + r^m_t, \end{aligned}$$

and the $\epsilon^m_{k,t-k}$ capture announcements about future monetary policy (“measured pace”, “considerable period”,...) .

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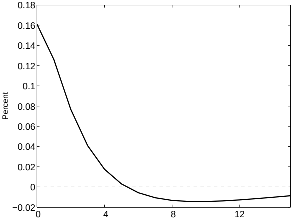
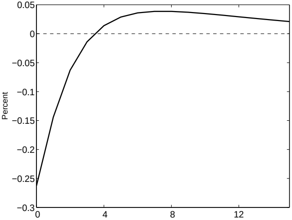
A detour: the effects of policy anticipation

Unanticipated policy shocks

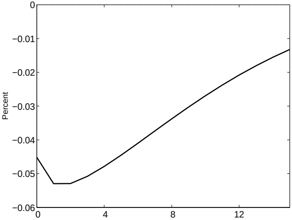
Interest Rates



Output Growth

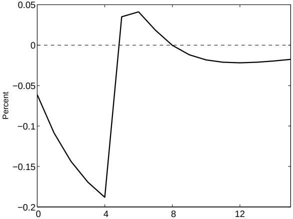


Inflation

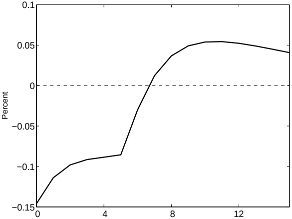


Six-periods ahead anticipated policy shocks

Interest Rates



Output Growth



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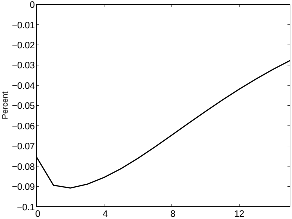
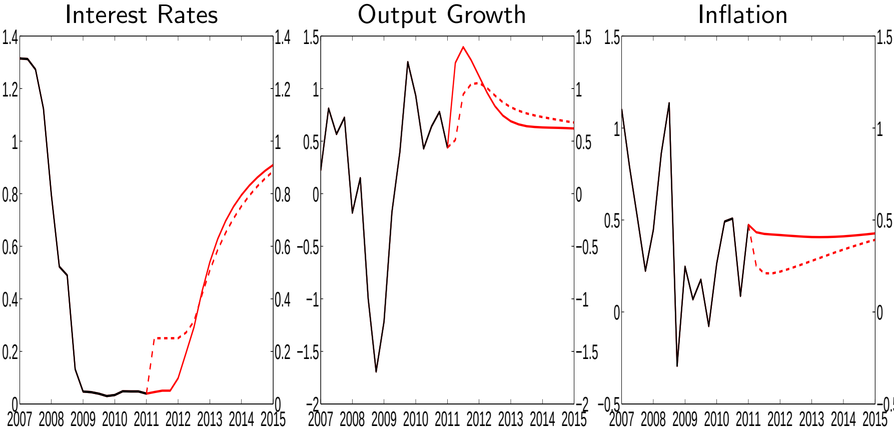


... forecasts conditional on an FFR path



Forecasting using interest rate expectations

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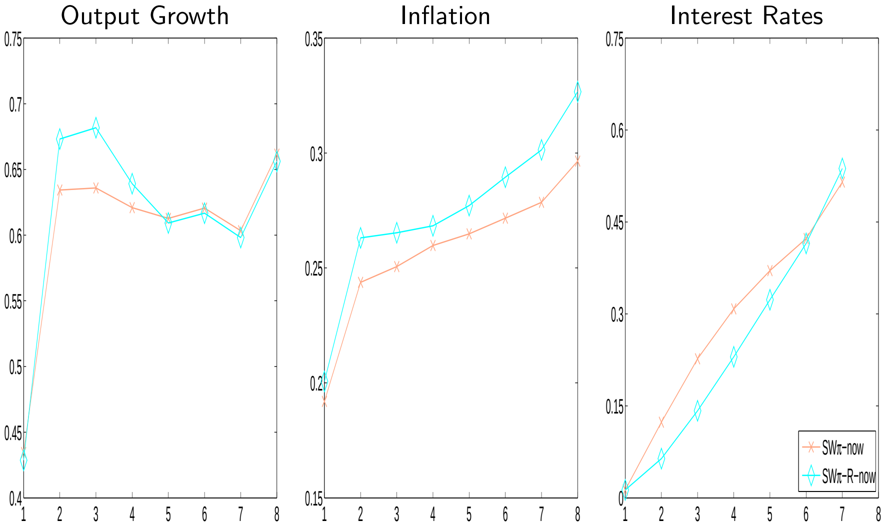
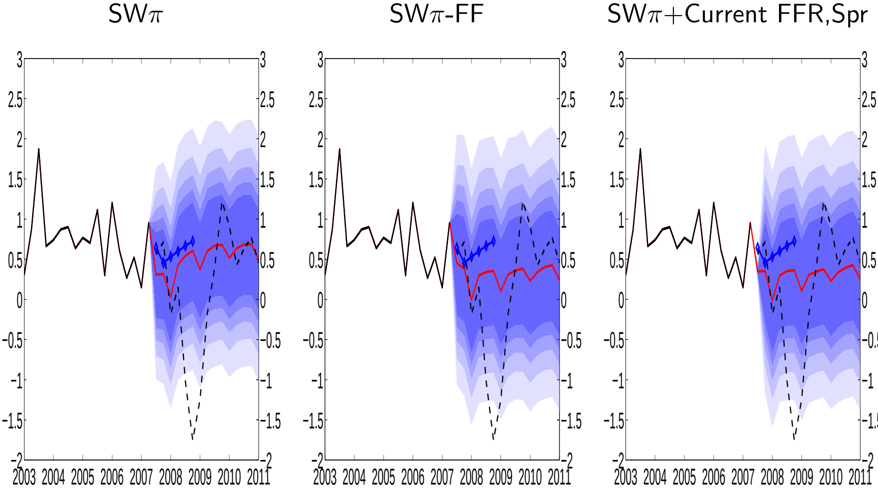
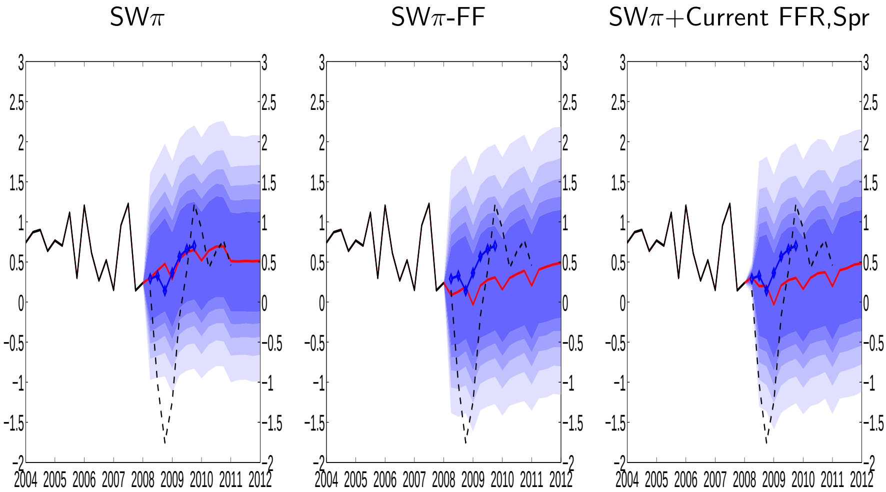


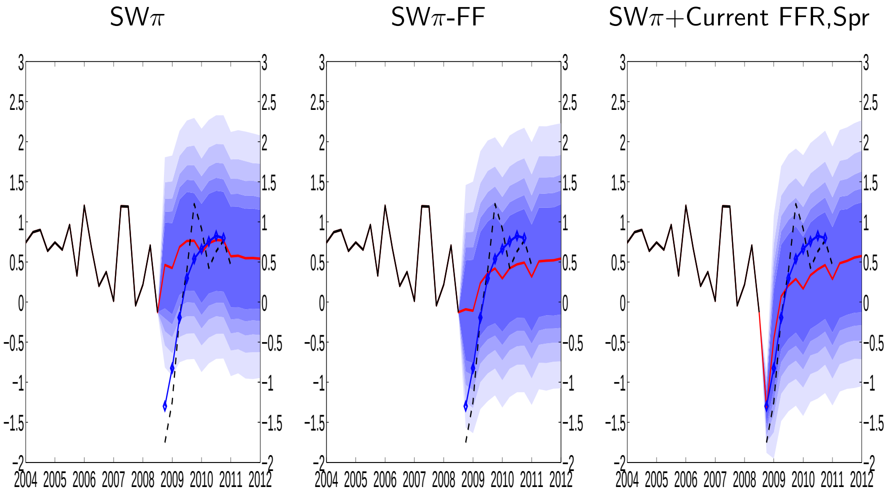
Forecasting the Great Recession: Oct 10, 2007 (2007Q2 data)



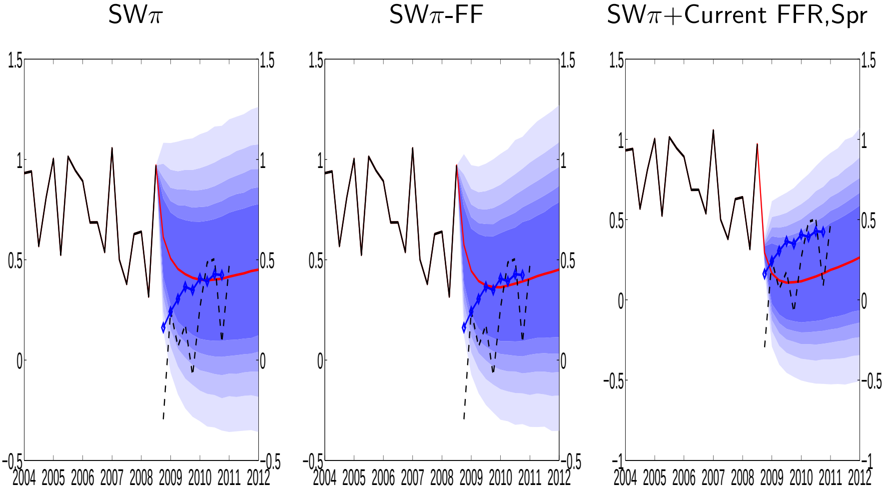
July 10, 2008 (2008Q1 data)



Jan 10, 2009 (2008Q3 data)



Forecasting the Great Recession: Inflation



Can the model explain the comovement of output and inflation in the aftermath of the Great Recession?

- Hall (AER 2011):

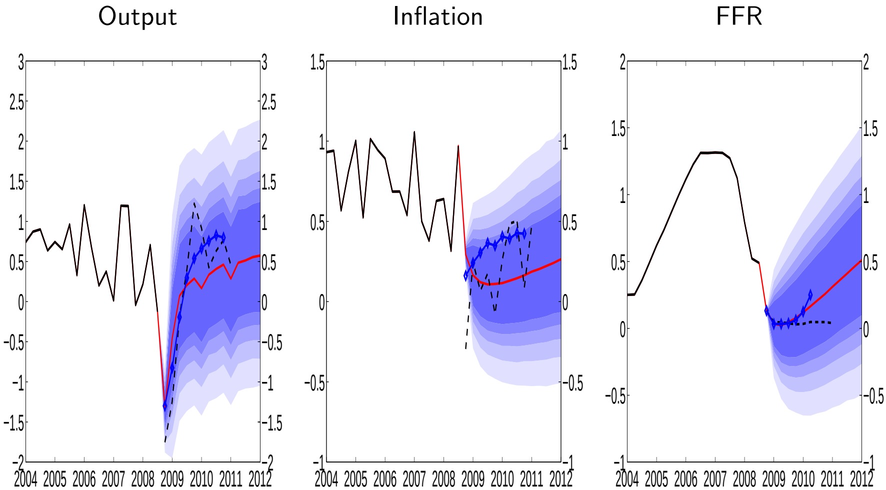
  The dominant model of inflation embedded in practical macro models today . . . cannot explain the stabilization of inflation at positive rates in the presence of long-lasting slack.

- Ball and Mazumder (BPEA 2011):

  A puzzle emerges when Phillips curves estimated over 1960-2007 are used to predict inflation over 2008-10: inflation should have fallen by more than it did . . . the Great Recession provides fresh evidence against the New Keynesian Phillips curve with rational expectations.

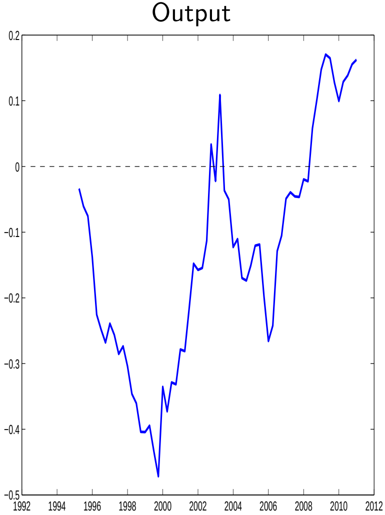
- Del Negro, Giannoni, Schorfheide (yet to be written): maybe not

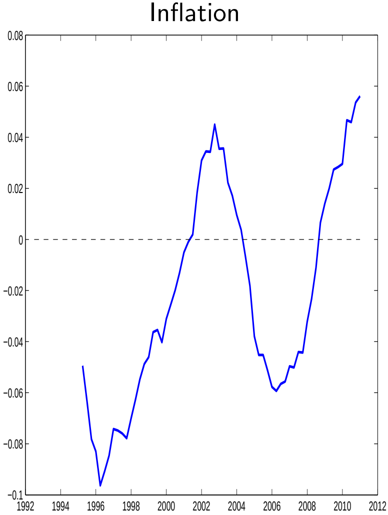
Output, inflation, and interest rates in the aftermath of the Great Recession



Relative forecasting accuracy over time: SW vs SW+BGG

Difference in 4-quarter-ahead Rolling RMSEs





Conclusions

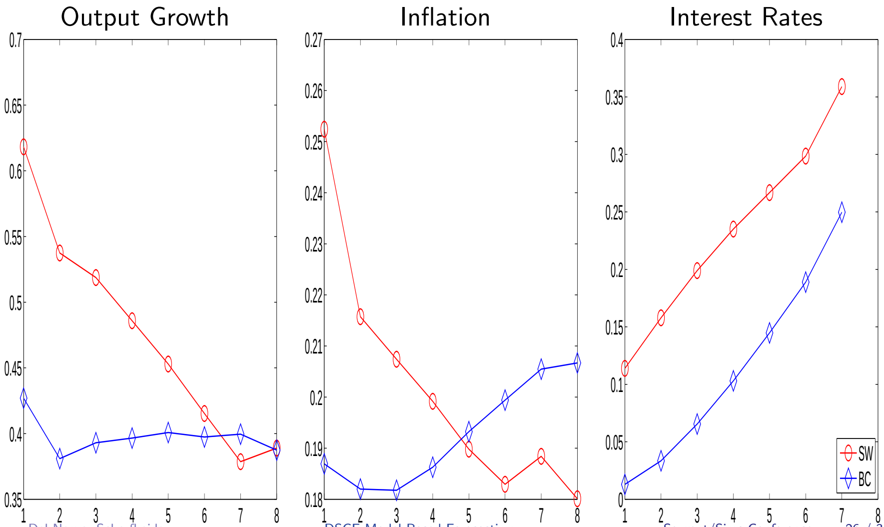
Congressman Brad Miller, Committee on Science and Technology, Subcommittee on Investigations and Oversight, U.S. House of Representatives:

> *Greenspan's fallen model of the market shares many assumptions with the model that's favored today, from academe to the world's central banks. The macroeconomic model is called the Dynamic Stochastic General Equilibrium model mercifully called DSGE for short. According to the model's most devoted acolytes, the model's insights rival the perfect knowledge Paul described in the First Letter to the Corinthians; but unlike the knowledge Paul described, DSGE's insights are available in the here and now.*

- That's right
- Seriously, there is a long way to go... but when given enough information, these model's forecasting performance may not be so bad, especially relative to the competition.

RSMEs: SW vs Blue Chip

Averages



Incorporating Long-Run Output Growth Expectations (SWπY)

- Add one more observable:

$$Growth_t^{O,40} = \gamma + \boldsymbol{E}_t \left[\frac{1}{40} \sum_{k=1}^{40} (y_{t+k} - y_{t+k-1} + z_{t+k}) \right],$$

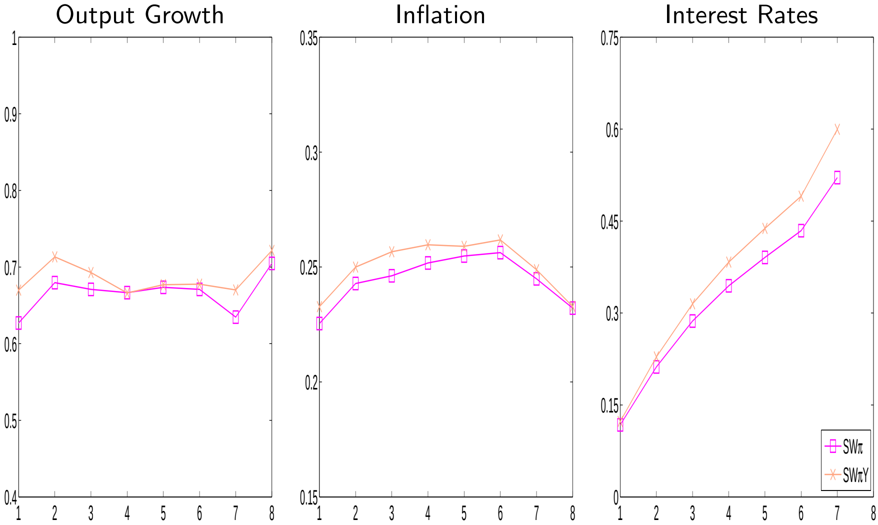
- ... and change the model to be able to explain it: growth rate of the stochastic trend Z_t in deviations from γ, follows the process:

$$z_t = \log(Z_t/Z_{t-1}) - \gamma = \frac{1}{1-\alpha}(\rho_z - 1)\tilde{z}_{t-1} + \frac{1}{1-\alpha}\sigma_z \epsilon_{z,t} + z_t^p$$

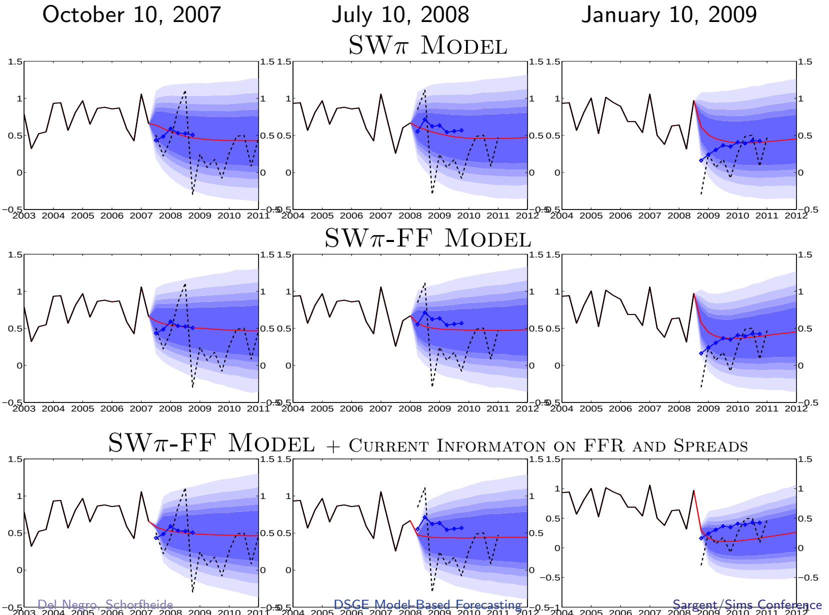
where

$$z_t^p = \rho_{z^p} z_{t-1}^p + \sigma_{z^p} \epsilon_{z^p,t}.$$

SWπ vs SWπY



Forecasting the Great Recession: Inflation



Evaluation

- Question: are predictive densities are well calibrated?
- Roughly: in a sequential forecasting setting events that are predicted to have 20% probability, should roughly occur 20% of the time.
- Probability Integral Transforms:
  - If Y is cdf $F(y)$, then

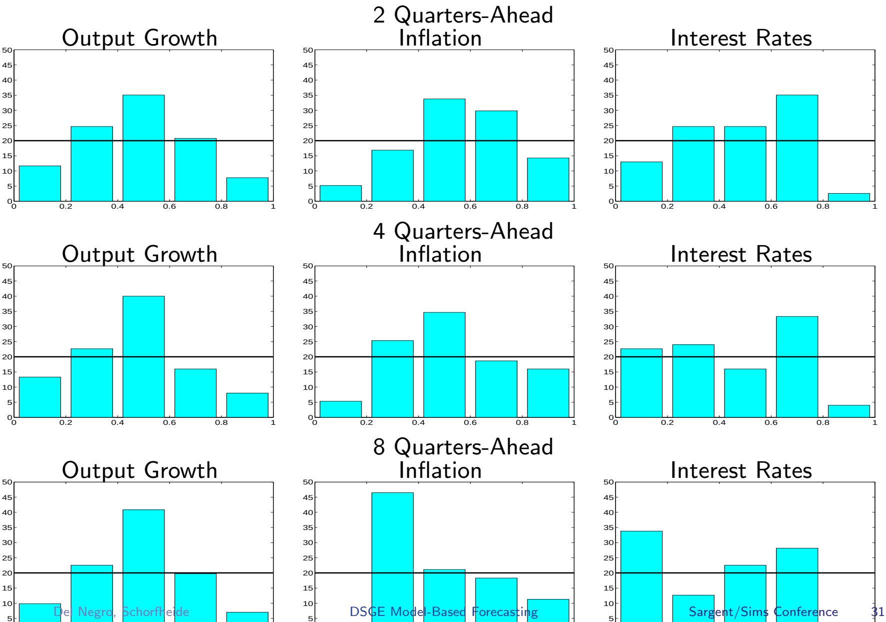
$$\mathbb{P}\{F(Y) \leq z\} = \mathbb{P}\{Y \leq F^{-1}(z)\} = F\big(F^{-1}(z)\big) = z$$

  - PITs

$$z_{i,t,h} = \int_{-\infty}^{y_{i,t+h}} p(\tilde{y}_{i,t+h}|Y_{1:T})d\tilde{y}_{i,t+h}.$$

References for PITs: Rosenblatt (1952), Dawid (1984), Kling and Bessler (1989), Diebold, Gunther, and Tay (1998), Diebold, Hahn, and Tay (1999), ..., Geweke and Amisano (2010), Herbst and Schorfheide (2011).

PITs


2 Quarters-Ahead
Output Growth
Inflation
Interest Rates
4 Quarters-Ahead
Output Growth
Inflation
Interest Rates
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Inflation
Interest Rates