

# Real-Time DSGE Model Density Forecasts During the Great Recession - A Post Mortem

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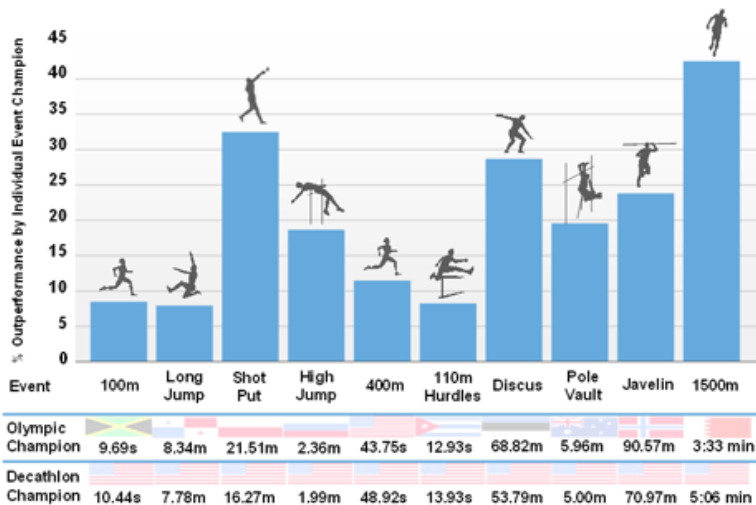
September, 2012

MFM Meeting

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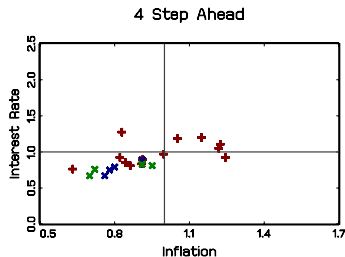
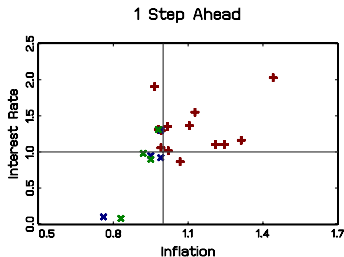
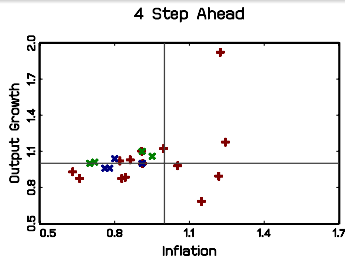
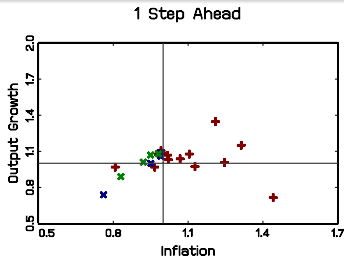
<sup>1</sup>The views expressed in this talk are those of the authors and do not necessarily reflect the views of the Federal Reserve Bank of New York or the Federal Reserve System.

# How to think about DSGE models...



Source: BBC, Beijing 2008 Olympic Games, men's event.

# One of the events: point forecasting under quadratic loss (RMSEs)



RMSE ratios: DSGE / AR(2).

# DSGE Model

- Starting point is **Smets and Wouters (2007) model**, modified to incorporate information from inflation expectation data.
- We add **financial frictions** along the lines of Bernanke, Gertler, and Gilchrist (1999).

# From SW to SW $\pi$ Model: Incorporating Inflation Expectations

- **Why?**
  - High-inflation rates from 1970-1982 lead to fairly large estimate of steady-state inflation rate (4 % annualized).  $\implies$  **Upward bias in current inflation forecasts.**
  - Information about stance of monetary policy at forecast origin.
- **How?** Anchor target inflation rate using long-run inflation expectations. Augment measurement equations:

$$\pi_t^{O,40} = \pi_* + \mathbb{E}_t \left[ \frac{1}{40} \sum_{k=1}^{40} \pi_{t+k} \right].$$

- Modify policy rule:

$$R_t = \rho_R R_{t-1} + (1 - \rho_R) (\psi_1 (\pi_t - \pi_t^*) + \dots)$$

Time-varying inflation target evolves according to:

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

# From $SW_{\pi}$ to $SW_{\pi}$ -FF: Incorporating Financial Frictions

- In addition to SW model, we consider a model with financial frictions along the lines of Bernanke, Gertler, Gilchrist (1999).
- Gross nominal return on capital:

$$\tilde{R}_t^k = \lambda r_t^k + (1 - \lambda)q_t^k - q_{t-1}^k + \pi_t$$

- SW model: arbitrage condition between return on capital and return on nominal bond:

$$\mathbb{E}_t[\tilde{R}_{t+1}^k] = R_t + b_t,$$

where  $\tilde{R}_t^k$  is **treated as latent** and  $b_t$  is a shock.

- SW-FF Model: arbitrage condition is

$$\mathbb{E}_t[\tilde{R}_{t+1}^k] = R_t + b_t + \zeta_{sp,b} (q_t^k + \bar{k}_t - n_t) + \tilde{\sigma}_{\omega,t}$$

where  $\tilde{R}_t^k - R_t$  is **treated as observed**,  $\tilde{\sigma}_{\omega,t}$  is an additional shock, and  $n_t$  is an additional endogenous variable.

# Generating Forecasts with a DSGE Model

- DSGE Model = State Space Model

- Measurement Eq:

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

- State Transition Eq:

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

- Posterior distribution of DSGE model parameters:

$$p(\theta | Y_{1:T}) = \frac{p(Y_{1:T}|\theta)p(\theta)}{p(Y_{1:T})}, \quad p(Y_{1:T}) = \int p(Y_{1:T}|\theta)p(\theta)d\theta.$$

- Objective of interest is predictive distribution:

$$p(Y_{T+1:T+H} | Y_{1:T}) = \int p(Y_{T+1:T+H} | \theta, Y_{1:T})p(\theta | Y_{1:T})d\theta.$$

- Use numerical methods to generate draws from predictive distribution.

# Using Real-Time Data

- **Observables:** output, consumption, investment, real wage growth, hours worked, inflation, Federal Funds rate, (Baa vs. 10-year treasury spread).
- Recursive out-of-sample forecasting; all estimation samples start in 1964.
- **Real time data**, following Edge and Gürkaynak (2010): forecast horizons and data vintages are aligned with **Blue Chip survey** publication dates: we consider January, April, July, and October, ending April 2011

Forecast Origin	End of Est. Sample $T$	Optional Spread & FFR from $T + 1$	Forecast	
			$h = 1$	$h = 2$
Apr 08	07:Q4	08:Q1	08:Q1	08:Q2
Jul 08	08:Q1	08:Q2	08:Q2	08:Q3
Oct 08	08:Q2	08:Q3	08:Q3	08:Q4
Jan 09	08:Q3	08:Q4	08:Q4	09:Q1

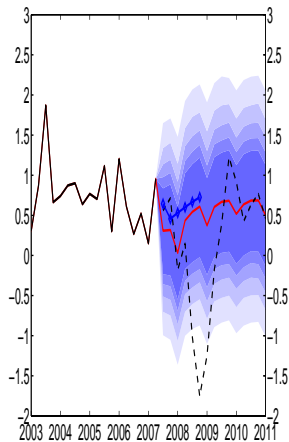


# Forecasting the Crisis: Model Versions

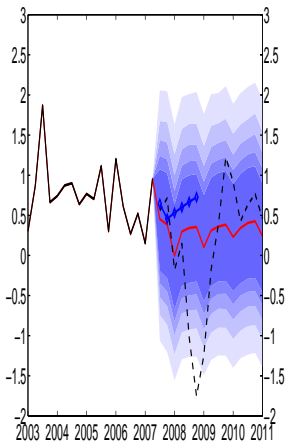
- $SW\pi$ : Smets-Wouters model with time-varying inflation target anchored by long-run inflation expectations.
- $SW\pi$ -FF: Smets-Wouters model with time-varying inflation target anchored by long-run inflation expectations and financial frictions. Utilizes data on spreads until period  $T$ .
- $SW\pi$ -FF-Current: Smets-Wouters model with time-varying inflation target anchored by long-run inflation expectations and financial frictions. Also use FFR and spread from current quarter  $T + 1$ .
- Spreads: based on Baa bonds versus 10-year treasury rate.

# Forecasting the crisis: Oct 10, 2007 (2007:Q2 data)

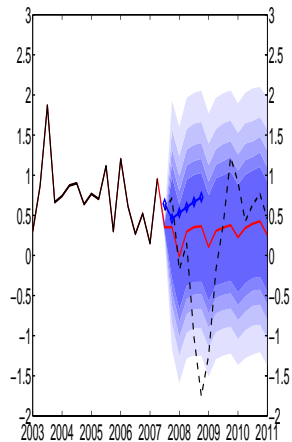
$SW\pi$



$SW\pi$ -FF

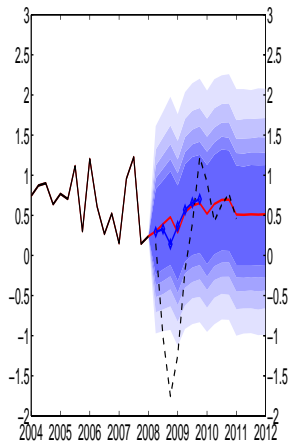


$SW\pi$ -FF-Current

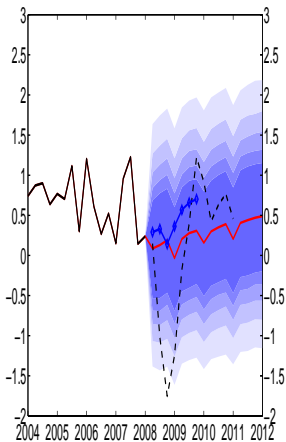


# Forecasting the crisis: July 10, 2008 (2008:Q1 data)

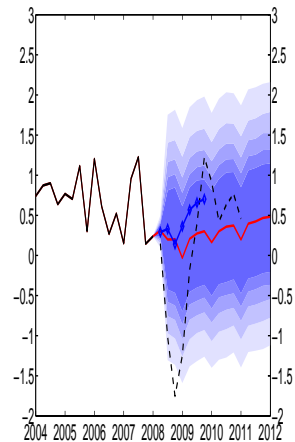
$SW\pi$



$SW\pi$ -FF

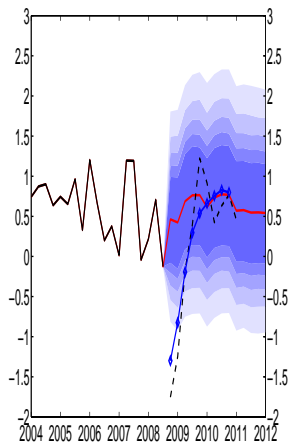


$SW\pi$ -FF-Current

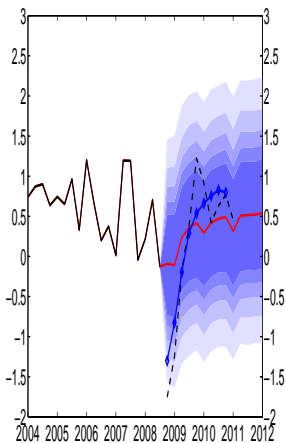


# Forecasting the crisis: Jan 10, 2009 (2008:Q3 data)

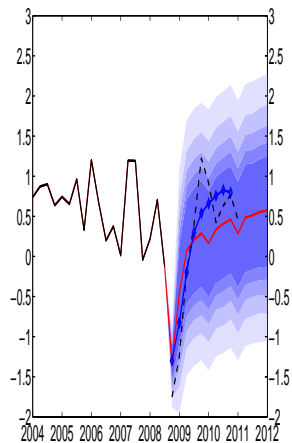
$SW\pi$



$SW\pi$ -FF

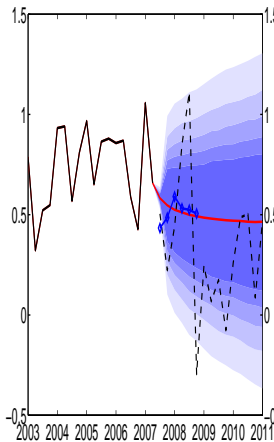


$SW\pi$ -FF-Current

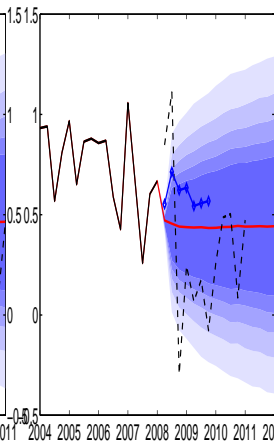


# Forecasting the Crisis: Inflation with $SW\pi$ -FF-Current

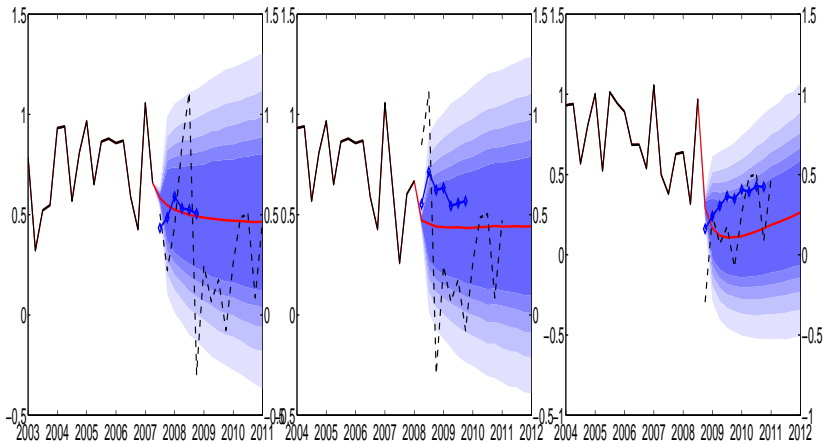
October 10, 2007



July 10, 2008

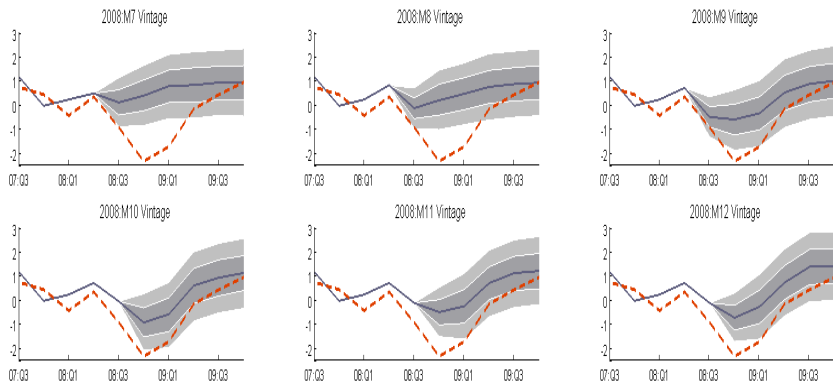


January 10, 2009



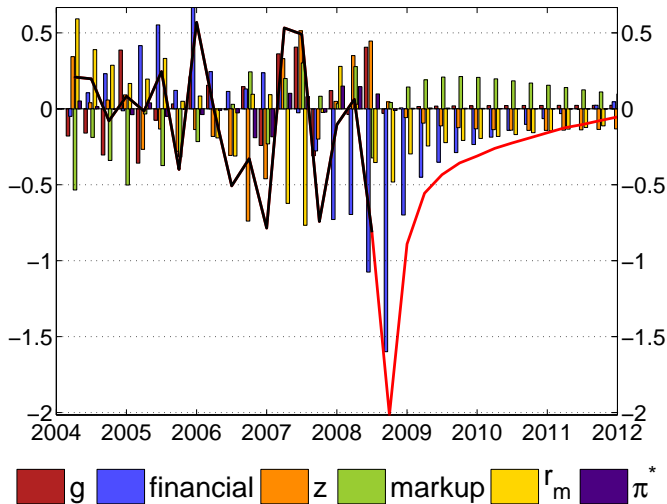
# What about GDP Growth Forecasts from an 11-variable VAR?

## Mixed frequency (monthly and quarterly) VAR



- No evidence that DSGE models have forecast worse during the Great recession than professional forecasters who may or may not have used them and had access to a wealth of additional information.
- Empirical DSGE models with financial frictions have been around at least since Christiano, Motto, and Rostagno (2003).
- What about the story?
  - While the BGG mechanism generates amplification of shocks, the explanation for the Great Recession is mainly one of large adverse shocks,
  - some of them originating on the financial side.
  - Let's take a look...

# Output Historical Decomp: Jan 10, 2009 (2008:Q3 data)

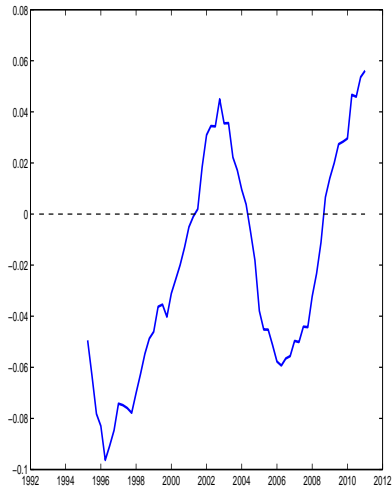
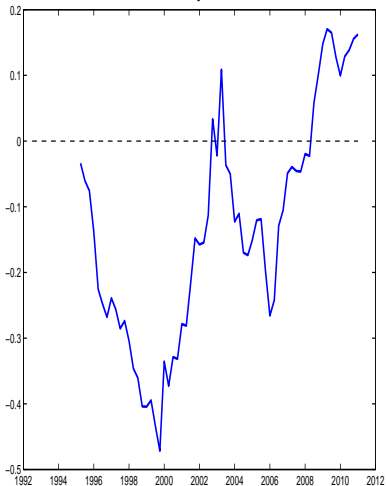




- Is the DSGE community to blame for not having incorporated financial frictions into their *standard* model prior to the crisis?

# Difference in Forecasting Accuracy Over Time: $SW_{\pi}$ and $SW_{\pi}FF$ -Current

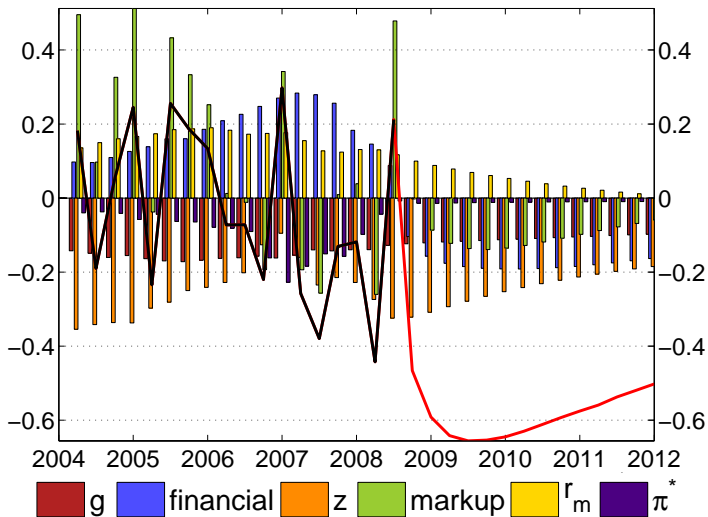
Difference in 4-quarter-ahead Rolling RMSEs  
Output                      Inflation



# In Closing...

- Early warning?
- Compelling, parsimonious economic story?
- Good policy prescriptions?

# Inflation Historical Decomp: Jan 10, 2009 (2008:Q3 data)



# Inflation Historical Decomp: Jan 10, 2009 (2008:Q3 data)

