Fundamental Disagreement

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Disagreement About Future Economic Outcomes

- Well documented in every survey of financial analysts, households, professional forecasters, FOMC members. . .
- At odds with full information rational expectation setup.
- Heterogeneous beliefs: important role in models with info. frictions
  - Macro: Mankiw-Reis (2002), Sims (2003), Woodford (2003), Lorenzoni (2009), Mackowiak-Wiederholt (2009), Angeletos-Lao (2013), . . .
  - Finance: Scheinkman-Xiong (2003), Nimark (2009) . . .
- Empirical properties of disagreement informative about such models?

This Paper

- Document some new facts about forecasters' disagreement.
- Evaluate models' ability to match the facts.
- Consider two popular models of imperfect info:
    - **Noisy information model**: Sims (2003), Woodford (2003).
    - **Sticky information model**: Mankiw and Reis (2002).
- Consider setup where forecasts do not impact data generating process.

New Facts

- Use Blue Chip Financial Forecasts (BCFF) survey:
  - Forecasts about output growth, inflation, fed-funds rate.
  - Up to 6-11 years ahead horizon.
- We document:
  1. Forecasters disagree about fundamental (long-horizon) outcomes.
  2. Term-structure of disagreement differs markedly across variables.
  3. LT disagreement varies over time and co-varies across variables.

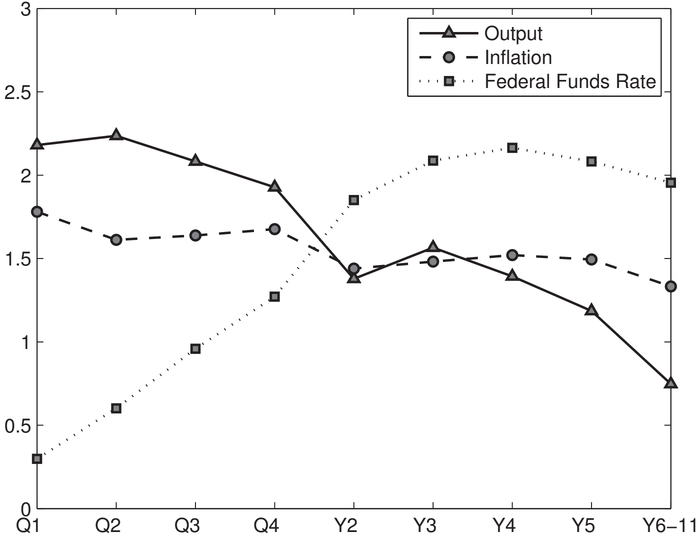
Replicating the Facts

- Independent of the model of info. frictions, key ingredients:
  1. Current state of the economy *imperfectly observed*.
  2. Unobserved *permanent* and *transitory* shocks.
  3. *Dynamic interactions* between variables.
- Minimal departure from full information setup: *symmetric* agents
  - No information advantage (consistent with evidence that hard to beat the consensus).
  - Forecasters agree on the parameters of the 'true' model but disagree about the unobserved states.

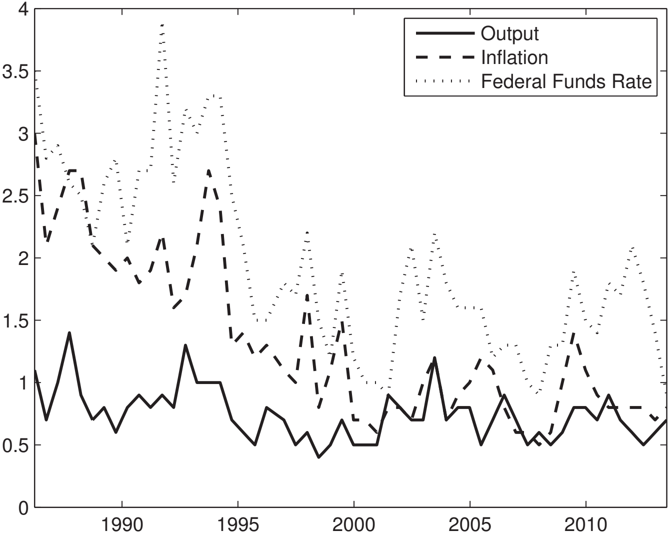
The Blue Chip Financial Forecasts Survey

- $\sim$ 50 professional forecasters.
- We look at forecasts for RGDP growth (g), CPI inflation (π), FFR (i).
- Sample period is 1986:Q1-2013:Q2.
- For 1Q, 2Q, 3Q, 4Q: observe individual forecasts.
- For 2Y, 3Y, 4Y, 5Y and long-term (6-to-11Y): observe average forecasts, top 10 average forecasts, and bottom 10 average forecasts.
- Our measure of disagreement: top 10 average $-$ bot 10 average.
  - strongly correlated with cross-section stdev or IQR at short horizons.

The Term Structure of Disagreement in the BCFF



The Time Series of Long Run Disagreement



Model

Underlying state

- True state $z = \{g, \pi, i\}$ where

$$\begin{aligned} z_t &= (I - \Phi)\mu_t + \Phi z_{t-1} + v_t^z, \\ \mu_t &= \mu_{t-1} + v_t^{\mu}, \end{aligned}$$

  with $v_t^z \sim iid\ N(0, \Sigma^z)$ and $v_t^{\mu} \sim iid\ N(0, \Sigma^{\mu})$.

- Parameters: $\theta = (\Phi, \Sigma^z, \Sigma^{\mu})$

Model

Information Friction: Noisy Information

- Forecaster j observes:

$$y_{jt} \quad = \quad z_t + \eta_{jt}$$

  with $\eta_{jt} \sim iid\ N(0, \Sigma^\eta)$, Σ^η diagonal.

- Individual j's optimal forecast computed using the Kalman filter.
- Model parameters: (θ, Σ^η).
- Disagreement driven by variance of observation errors Σ^η.

Model

Information Friction: Sticky Information

- At each date, a forecaster j observes k^{th} element of y_t with a fixed probability λ_k; otherwise sticks to latest observation of that variable.
- Individual j's optimal forecast computed using the Kalman filter with missing observations.
- Disagreement driven by different individual sequences of observations.
- Same number of parameters as in noisy info with λ's instead of Σ^η.

Calibration via Penalized MLE

Principle

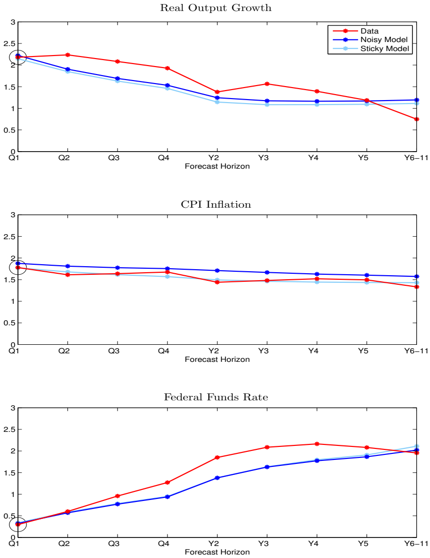
- Sample: realizations 1955Q1-2013Q2; survey 1986Q1-2013Q2.
- We minimize the Likelihood associated to true state + ...
- ... a penalty function measuring the distance between model implied moments (simulations) and their survey data counterpart.
- We choose 15 moments:
  - Std-dev of consensus forecasts for Q1, Q4, Y2 and Y6-11.
  - Disagreement about Q1 forecasts only.

Summary of Parameter Estimates

- Common parameters (θ) robust to type of info. friction considered.
- Long-run vol. (Σ^{μ}) much lower than short-run vol. (Σ^{z}).
- FFR is perfectly observed:
  - *Noisy*: observation error (Σ_{η}) for FFR is zero.
  - *Sticky*: probability of observing FFR (λ_i) is one.
- RGDP/CPI: degree of info frictions consistent with previous studies.

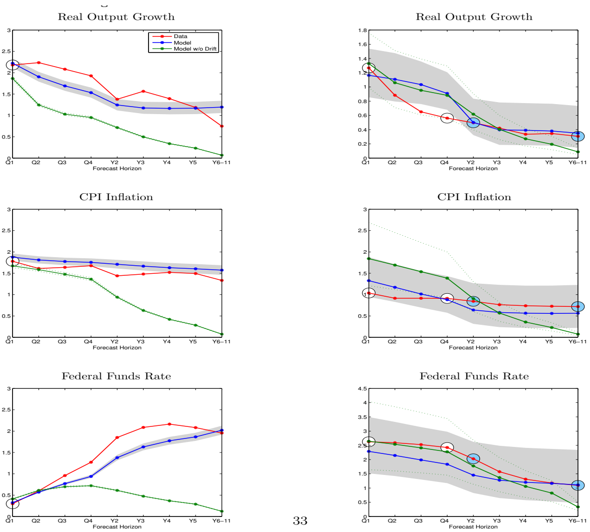
Data and Model-implied Term Structures of Disagreement

Noisy and Sticky



Disagreement and Consensus Volatility

Noisy (very similar patterns for sticky version)

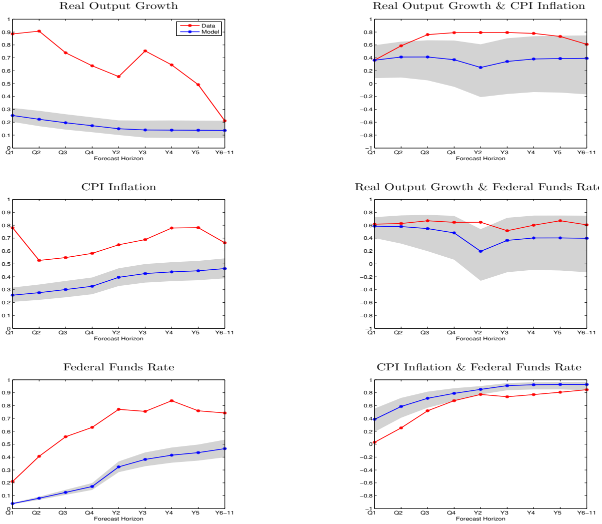


Role of Key Ingredients

- Decomposition into permanent and transitory components:
    - Needed to explain disagreement beyond the short/medium term.
- Multivariate model:
    - Needed to explain disagreement about future FFR even though perfectly observed.
    - Needed to generate upward-sloping disagreement.

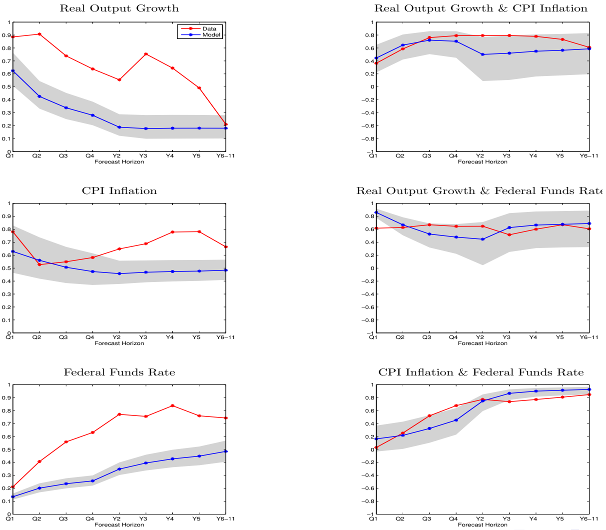
Time Variation & Co-movement in Disagreement

Noisy



Time Variation & Co-movement in Disagreement

Sticky



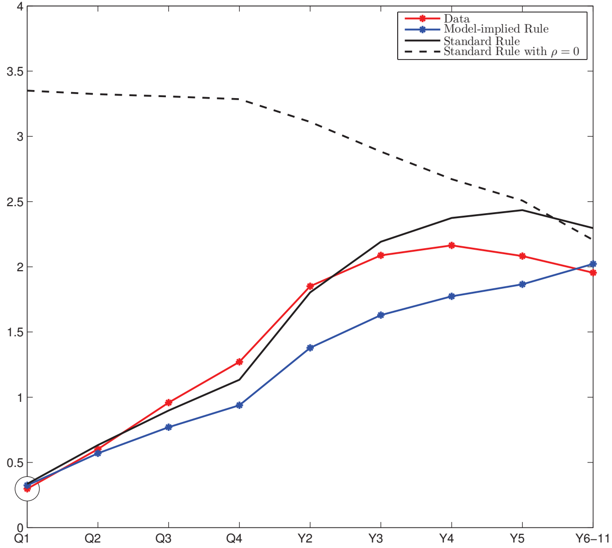
Is Disagreement about FFR Consistent with a Taylor Rule?

- Generate ind. FFR forecasts given model ind. forecasts of g and π

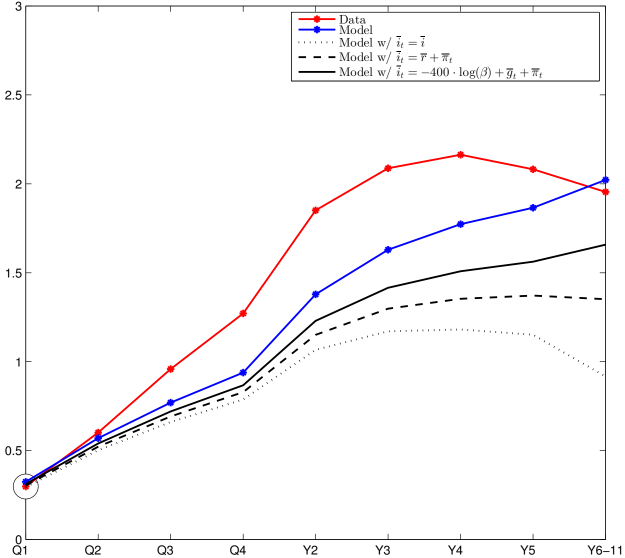
$$
\begin{aligned}
i_t &= \rho \cdot i_{t-1} + (1-\rho) \cdot i_t^\star + \epsilon_t \\
i_t^\star &= \bar{i}_t + \varphi_\pi \cdot (\pi_t - \bar{\pi}_t) + \varphi_g \cdot (g_t - \bar{g}_t)
\end{aligned}
$$

- Find parameters $\{\rho, \varphi_\pi, \varphi_g\}$ giving best fit of FFR term structure of disagreement obtained with previous reduced form model.
  - $\rho = 0.98$, $(1-\rho)\varphi_\pi = .26$, $(1-\rho)\varphi_g = 0.30$.
- Compare with various parametric restrictions.
  - Std Taylor rule parameters: $\rho = 0.9$, $\varphi_\pi = 2$, $\varphi_g = 0.50$.
  - No policy smoothing $\rho = 0$.
  - Restrictions on time varying components of $\bar{i}_t$.

‘Standard’ Taylor Rule



Role of Components in the Time-Varying Intercept



Conclusion

- Present new facts about forecaster disagreement.
    - Identify key features needed to replicate them.
- Models of imperfect info can account for complex facts for sound parameter values.
    - Minimal departure from REH: agents know and agree on true model/params.
- Disagreement informative about both degree of imperfect info and underlying DGPs.
    - Results underline importance of uncertain long-run component in macro-variable (implications for macro & finance).
    - Informative about perceived structural relationships (e.g. Taylor rule).

Extensions / Future Research

- Accounting for time variance of disagreement:
    - Stochastic volatility.
    - State-dependent imperfect info / inattention.
- More structure...

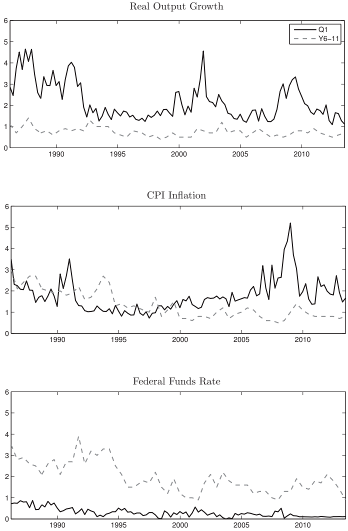
Noisy Information Model

Φ	Σ^z	$\text{sqrt}(\text{diag}(\tilde{\Sigma}^\eta))$
$\begin{bmatrix} 0.378 & -0.503 & -0.153 \\ 0.125 & 0.974 & -0.033 \\ 0.147 & 0.104 & 0.924 \end{bmatrix}$	$\begin{bmatrix} 3.419 & -0.019 & 0.561 \\ -0.019 & 0.645 & 0.365 \\ 0.561 & 0.365 & 0.632 \end{bmatrix}$	$\begin{bmatrix} 2.592 \\ 1.429 \\ 0.000 \end{bmatrix}$
$\lvert\text{eig}(\Phi)\rvert$	Σ^μ	$\text{sqrt}(\text{diag}(\Sigma^\eta))$
$\begin{bmatrix} 0.920 \\ 0.711 \\ 0.646 \end{bmatrix}$	$\begin{bmatrix} 0.008 & 0.014 & 0.026 \\ 0.014 & 0.024 & 0.045 \\ 0.026 & 0.045 & 0.085 \end{bmatrix}$	$\begin{bmatrix} 4.317 \\ 2.731 \\ 0.000 \end{bmatrix}$

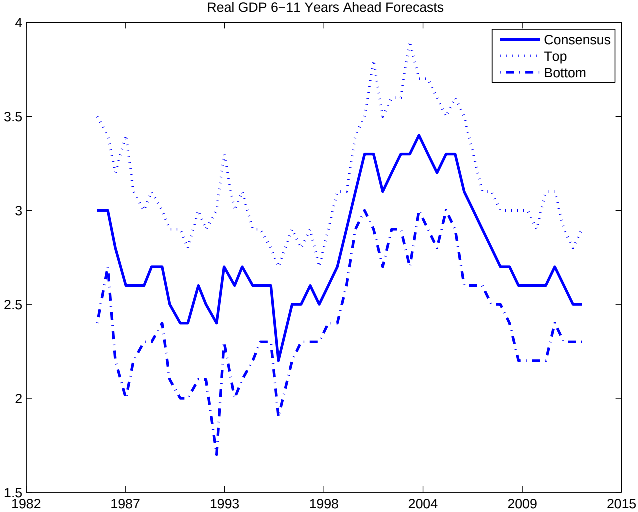
Sticky Information Model

Φ	Σ^z	$\text{sqrt}(\text{diag}(\tilde{\Sigma}^\eta))$
$\begin{bmatrix} 0.392 & -0.478 & -0.142 \\ 0.122 & 0.939 & -0.024 \\ 0.146 & 0.087 & 0.931 \end{bmatrix}$	$\begin{bmatrix} 3.736 & -0.065 & 0.564 \\ -0.065 & 0.911 & 0.347 \\ 0.564 & 0.347 & 0.635 \end{bmatrix}$	$\begin{bmatrix} 2.586 \\ 1.355 \\ 0.000 \end{bmatrix}$
$\lvert \text{eig}(\Phi) \rvert$	Σ^μ	λ
$\begin{bmatrix} 0.920 \\ 0.674 \\ 0.674 \end{bmatrix}$	$\begin{bmatrix} 0.007 & 0.012 & 0.022 \\ 0.012 & 0.021 & 0.039 \\ 0.022 & 0.039 & 0.073 \end{bmatrix}$	$\begin{bmatrix} 0.260 \\ 0.260 \\ 1.000 \end{bmatrix}$

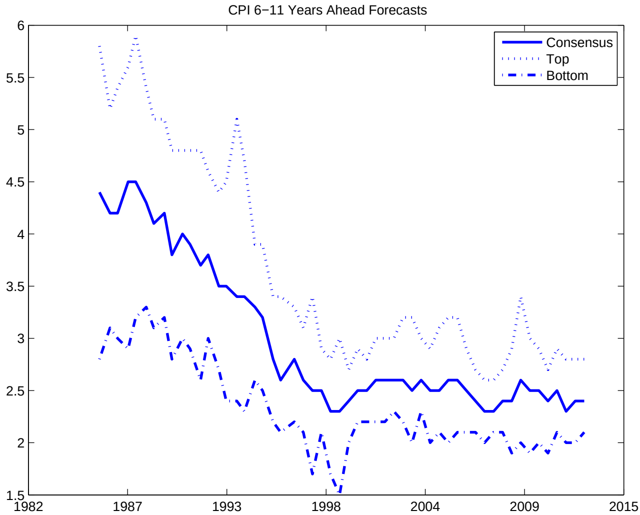
ST/LT Disagreement



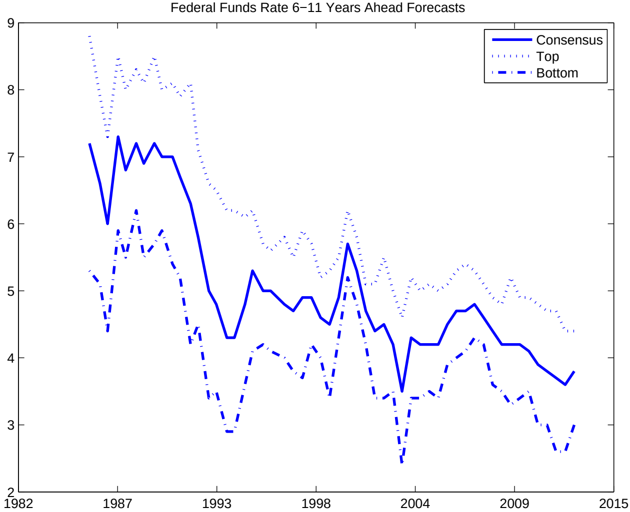
Long-Term Forecasts: GDP/GNP



Long-Term Forecasts: CPI



Long-Term Forecasts: FFR



Calibration via Penalized MLE

Details (1/2)

- Consider realizations as signals about z_t: $\mathcal{Y}_t = z_t + \widetilde{\eta}_t$ with $\widetilde{\eta}_t \sim iid\ N(0, \widetilde{\Sigma}^\eta)$.
- $-\mathcal{L}\left(\mathcal{Y}_1, \cdots, \mathcal{Y}_T; \theta, \widetilde{\Sigma}^\eta\right) =$ likelihood obtained with Kalman filter.

Calibration via Penalized MLE

Details (2/2)

- Given (θ, Σ^η), we generate individual forecasts f_{jt}^h and minimize distance between simulated moments $S(\theta, \Sigma^\eta)$ and their survey data counterparts $\mathcal{S}_t$.

- distance between model implied expectation moments and their survey data counterpart, $\mathcal{P}\left(\mathcal{S}_1, \cdots, \mathcal{S}_T; \theta, \Sigma^\eta\right)$

$$\mathcal{P} = \left[S(\theta, \Sigma^\eta) - \frac{1}{T}\sum_t \mathcal{S}_t\right]' W \left[S(\theta, \Sigma^\eta) - \frac{1}{T}\sum_t \mathcal{S}_t\right]$$

- We minimize the penalized likelihood:

$$\mathcal{C}\left(\theta, \Sigma^\eta, \widetilde{\Sigma}^\eta\right) = \mathcal{L}\left(\mathcal{Y}_1, \cdots, \mathcal{Y}_T; \theta, \widetilde{\Sigma}^\eta\right) + \alpha\mathcal{P}\left(\mathcal{S}_1, \cdots, \mathcal{S}_T; \theta, \Sigma^\eta\right).$$

Calibration in Practice

- Sample: realizations 1955Q1-2013Q2; survey 1986Q1-2013Q2.
- Simulate $R = 100$ histories of shocks ϵ_t and observation noises η_t^j with $T = 120$ (nb of dates) and $N = 50$ (nb of forecasters).
- We choose 15 moments:
  - Std-dev of consensus forecasts for Q1, Q4, Y2 and Y6-11.
  - Disagreement about Q1 forecasts only.
  - Strong weight on Q1 disagreement in the penalty criterion ("normalisation").
- Penalty parameter $\alpha = 50$.

Robustness

- Various penalty parameters $\alpha = 1$, $\alpha = 10$.
- Initial conditions.
- Econometrician perfectly observing the state $(\widetilde{\Sigma}^{\eta}) = 0$).