What question are Staff and FOMC forecasts supposed to answer?

Martin Ellison and Thomas J. Sargent
Oxford and NYU

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Staff and FOMC forecasts

- Staff produce forecasts before each FOMC meeting
- FOMC produces its own forecast twice a year
- e.g. 1987Q3 forecasts:

		Staff	FOMC
Current year	π	3.5%	3.75%
	U	6.3%	6.3%
Next year	π	3.8%	4.0%
	U	6.3%	6.25%

- Staff forecasts not made public for 5 years

Romer-Romer analysis (*AER* 2008)

- Which forecast is closest to actual outcomes?
- Regress outcomes on forecasts

$$\pi_{t+1} = -\underset{(0.22)}{0.20} + \underset{(0.39)}{1.10}\, E_t \pi_{t+1} - \underset{(0.37)}{0.10}\, \hat{E}_t \pi_{t+1}$$

- Compare mean squared errors

$$\sigma = 0.71 << \hat{\sigma} = 0.89$$

- Do differences in forecasts predict policy shocks?

$$M_t = \underset{(0.06)}{0.04} + \underset{(0.20)}{0.31}\left(\hat{E}_t \pi_{t+1} - E_t \pi_{t+1}\right)$$

Romer-Romer conclusions (*AER* 2008)

Our results show that in constructing its forecasts, the FOMC is not using the information in the staff forecasts effectively

the narrative evidence, like the statistical analysis, is suggestive of a link between forecast differences and monetary policy actions. It appears that monetary policymakers may indeed act on information that is of little or negative value

a more effective division of labor within the Federal Reserve might be for the staff to present policymakers with policy options and related forecast outcomes, and for policymakers to take those forecasts as given. With this division, the role of the FOMC would be to choose among the suggested alternatives, not to debate the likely outcome of a given policy

A defence of the FOMC

- Romer and Romer's criticism makes sense in a world with a single-probability-density assumption and rational expectations
- What if FOMC is actually responding in a reasonable way to specification doubts?
- FOMC forecasts may be *worst case* scenarios that are important for a policymaker concerned that its model is only an approximation of reality
- Under this interpretation:
  - Staff forecasts will be better predictors than FOMC forecasts
  - $\sigma << \hat{\sigma}$
  - Difference in forecasts predicts monetary policy shocks
- FOMC forecasts should be biased towards worst case outcomes

Hidden Markov models

- Approximating model is a joint density $f(x^*, s^*, x)$ over next period's state $x^* \in X$, next period's signal s^*, and this period's state $x \in X$

$$f(x^*, s^*, x) = \int f(x^* | x) f(s^* | x) f(x) dx$$

- Assume x is only partially observable

$$f(x^* | s^*) = \frac{f(x^*, s^*)}{f(s^*)} = \frac{\int f(x^* | x) f(s^* | x) f(x) dx}{\int f(x^*, s^* | x) dx^*}$$

- Policymaker distrusts $f(x^* | x)$, $f(s^* | x)$ and $f(x)$

Robustness in hidden Markov models

- Associated value function

$$\begin{aligned}\check{W}(x) &= U(x) + \int \beta \check{W}^*(x^*) f(x^* | x) dx^* \\ W(f) &= \int \left\{ U(x) + \int \beta \check{W}^*(x^*) f(x^* | x) dx^* \right\} f(x) dx\end{aligned}$$

- Distorted value function

$$\begin{aligned}\check{W}(x) &= U(x) + \mathbf{T}^1(\beta \check{W}^*(x^*))(x) \\ Q(f) &= \mathbf{T}^2 \left(U(x) + \mathbf{T}^1(\beta \check{W}^*(x^*))(x) \right) (f)\end{aligned}$$

- $\mathbf{T}^1$ is risk-sensitivity operator that induces worst-case distortion of $f(x^* | x)$
- $\mathbf{T}^2$ is risk-sensitivity operator that induces worst-case distortion of $f(x)$.

Indirect utility functions

$$\mathbf{T}^1(\check{W}^*(x^*))(x) \equiv -\theta_1 \log \int \exp\left(\frac{-\check{W}^*(x^*)}{\theta_1}\right) f(x^* | x) dx^*$$

$$\mathbf{T}^2 Z(x) \equiv -\theta_2 \log \int \exp\left(\frac{-Z(x)}{\theta_2}\right) f(x) dx$$

$\mathbf{T}^2$ is an object that occurs in work on ambiguity aversion

Hidden Markov model for monetary policy

- Primiceri (QJE 2006) model with unobserved NAIRU.

$$\begin{aligned} \pi_{t+1} &= \pi_t + \gamma_0(U_t - u_t^N) + \gamma_1(U_{t-1} - u_{t-1}^N) + c_\pi w_{t+1} \\ (U_{t+1} - u_{t+1}^N) &= \rho_1(U_t - u_t^N) + \rho_2(U_{t-1} - u_{t-1}^N) + V_t + c_U w_{t+1} \end{aligned}$$

- V_t is a policy variable
- NAIRU believed to follow an AR(1) process

$$u_{t+1}^N = (1-\gamma)u^* + \gamma u_t^N + c_{U^*} w_{t+1}$$

- Policymaker has a joint estimation and decision process

Estimation process for policymaker

- State space form:

$$\begin{aligned} y_{t+1} &= A_{11} y_t + A_{12} z_t + B_1 a_t + C_1 w_{t+1} \\ z_{t+1} &= A_{21} y_t + A_{22} z_t + B_2 a_t + C_2 w_{t+1} \\ s_{t+1} &= D_1 y_t + D_2 z_t + H a_t + G w_{t+1} \end{aligned}$$

- This is a standard Kalman filter problem

$$\begin{aligned} y_{t+1} &= A_{11} y_t + A_{12} \check{z}_t + B_1 a_t + C_1 w_{t+1} + A_{12}(z_t - \check{z}_t) \\ \check{z}_{t+1} &= A_{21} y_t + A_{22} \check{z}_t + B_2 a_t + K_2(\Delta_t) G w_{t+1} + K_2(\Delta_t) D_2 (z_t - \check{z}_t) \\ \Delta_{t+1} &= C(\Delta_t) \end{aligned}$$

- Kalman gain satisfies

$$\begin{aligned} K_2(\Delta) &\equiv (A_{22} \Delta D_2' + C_2 G')(D_2 \Delta D_2' + G G')^{-1} \\ C(\Delta) &\equiv A_{22} \Delta A_{22} + C_2 C_2' - K_2 (A_{22} \Delta D_2' + C_2 G')' \end{aligned}$$

Objective for policymaker

$$-.5\sum_{t=0}^{\infty}\beta^t \left((\pi_t - \pi^*)^2 + \lambda (U_t - k u_t^N)^2 + \phi (V_t - V_{t-1})^2 \right)$$

Robust decision process

- A form of certainty equivalence holds in this class of models.
- Robust policy solves deterministic problem:

$$\max_a \min_u \left[\begin{array}{c} \tilde{U}(y, \check{z}, z - \check{z}, a) + \theta_2 \frac{u'\Delta^{-1}u}{2} \\ + \min_{\tilde{v}} \left(\beta W(y^*, \check{z}^*, \Delta^*, z^*) + \theta_1 \frac{\tilde{v}'\tilde{v}}{2} \right) \end{array} \right]$$

s.t.

$$y^* = A_{11} y + A_{12} \check{z} + B_1 a + C_1 \tilde{v} + A_{12} u$$

$$z^* = A_{21} y + A_{22} \check{z} + B_2 a + C_2 \tilde{v} + A_{22} u$$

$$\check{z}^* = A_{21} y + A_{22} \check{z} + B_2 a + K_2(\Delta) \tilde{v} + K_2(\Delta) D_2 u$$

$$\Delta^* = C(\Delta)$$

Optimal policy

- Optimal robust policy is simple linear feedback rule

$$a = -\begin{bmatrix} F_y & F_z \end{bmatrix} \begin{bmatrix} y \\ \check{z} \end{bmatrix}$$

$$\tilde{v} = -\begin{bmatrix} K_y & K_z \end{bmatrix} \begin{bmatrix} y \\ \check{z} \end{bmatrix}$$

$$u = -\begin{bmatrix} L_y & L_z \end{bmatrix} \begin{bmatrix} y \\ \check{z} \end{bmatrix}$$

Forecasts

- Modified model

$$y^* = A_{11} y + A_{12} \check{z} + B_1 a + C_1 \tilde{v} + A_{12} u$$

- Forecasts under the approximating model

$$E\left[y^* \,|y, \check{z}\right] = (A_{11} - B_1 F_y) y + (A_{12} - B_1 F_z) \check{z}$$

- Forecasts under the worst-case model

$$\hat{E}\left[y^* \,|y, \check{z}\right] = (A_{11} - B_1 F_y + C_1 K_y + A_{12} L_y) y + (A_{12} - B_1 F_z + C_1 K_z + A_{12} L_z) \check{z}$$

Numerical example

- Primiceri (QJE 2006) empirical estimates

$$\pi_{t+1} = \pi_t - 1.02(U_t - u_t^N) + 0.903(U_{t-1} - u_{t-1}^N) + c_\pi w_{t+1}$$
$$(U_{t+1} - u_{t+1}^N) = 1.756(U_t - u_t^N) - 0.779(U_{t-1} - u_{t-1}^N) + V_t + c_U w_{t+1}$$

$$-.5\sum_{t=0}^{\infty} 0.99^t \left((\pi_t - 2)^2 + (U_t - 0.2u_t^N)^2 + 475(V_t - V_{t-1})^2 \right)$$

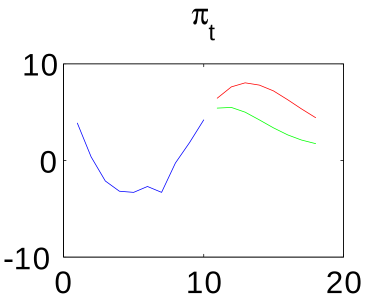
- NAIRU process

$$u_{t+1}^N = 0.5u^* + 0.95u_t^N + c_{U^*} w_{t+1}$$

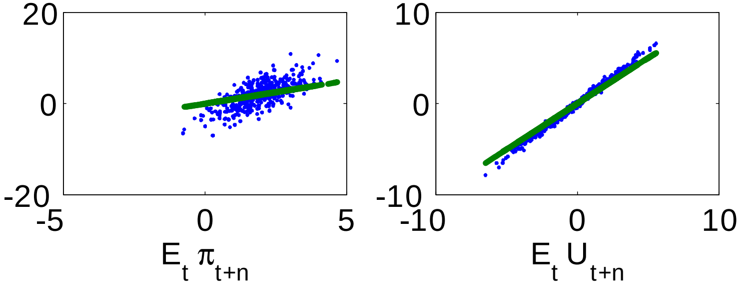
- Preferences for robustness

$$\max_a \min_u \left[\begin{array}{c} \tilde{U}(y, \check{z}, z - \check{z}, a) + 25\frac{u'\Delta^{-1}u}{2} \\ +\min_{\tilde{v}} \left(\beta W(y^*, \check{z}^*, \Delta^*, z^*) + 80\frac{\tilde{v}'\tilde{v}}{2} \right) \end{array} \right]$$

Example forecasts



Approximating versus worst case forecasts



Estimation

- Our model has the *potential* to explain the different forecasts of the Staff and the FOMC
- Whether the model *actually* explains forecast differences is a question of estimation
- MLE vs Bayesian estimation

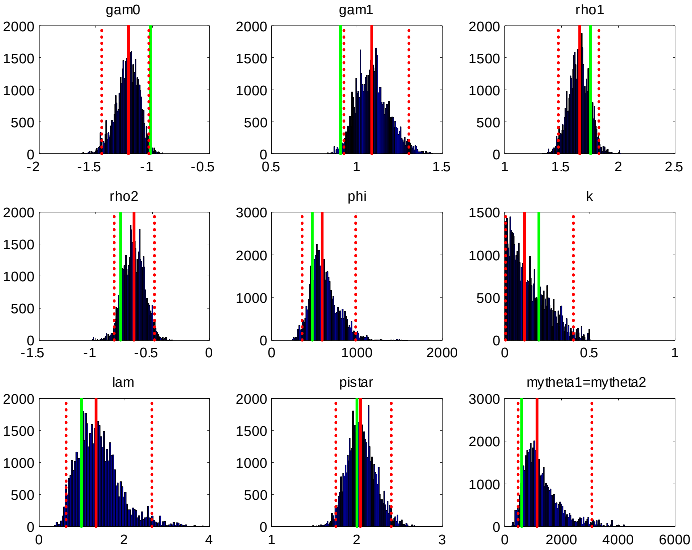
State space form for estimation

- Inflation, unemployment and Staff forecasts are observed every period
- FOMC forecasts are observed occasionally
- Econometrician's measurement equation

$$o_{t+1} = G_t \begin{bmatrix} y_t \\ z_t \\ \check{z} \end{bmatrix} + H_t \begin{bmatrix} w_{t+1} \\ \tilde{w}_{t+1} \end{bmatrix}$$

- $\tilde{w}_{t+1}$ are measurement errors
- G_t and H_t are time-varying according to availability of FOMC forecasts
- "Kalman filter within a Kalman filter"

Identification check by estimating with simulated data

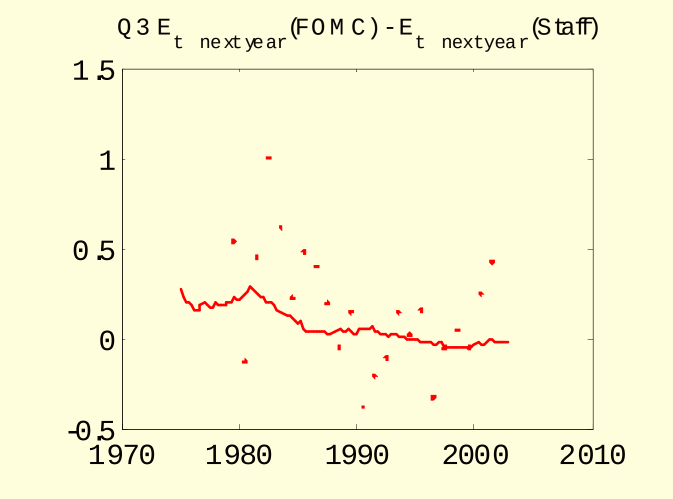


Preliminary MLE estimates

- Structural parameters similar to Primiceri (*QJE* 2006)
- Objective function parameters similar to Primiceri (*QJE* 2006)
- Preference for robustness low

$$\max_a \min_u \left[\begin{array}{c} \tilde{U}(y, \check{z}, z - \check{z}, a) + 881 \frac{u' \Delta^{-1} u}{2} \\ + \min_{\tilde{v}} \left(\beta W(y^*, \check{z}^*, \Delta^*, z^*) + 31022 \frac{\tilde{v}' \tilde{v}}{2} \right) \end{array} \right]$$

Fit of preliminary MLE estimates to forecast differences



Conclusions

- Differences between Staff and FOMC forecasts consistent with a rational response of FOMC to model misspecification
- Empirical estimates are promising
- Small misspecifications can create neurotic breakdown of system