Multivariate Forecast Errors and the Taylor Rule

Tara M. Sinclair, Edward N. Gamber,
H.O. Stekler, and Elizabeth Reid

Presented by: Tara M. Sinclair
Department of Economics
The George Washington University

1st Macroeconomic Forecasting Conference, Rome
27 March, 2009

THE GEORGE WASHINGTON UNIVERSITY
WASHINGTON DC

Motivation

"The success of monetary policy depends importantly on the quality of forecasting."

—Alan Greenspan (2004)

Traditional Forecast Evaluation

- Forecast evaluation has traditionally focused on univariate forecasts.
- Often, however, multiple series are forecast at the same time, perhaps with the same forecasting model.
- Some recent research has examined multivariate forecast evaluation taking into consideration the co-movement of the series (Hanson and Whitehorn, 2006 and Komunjer and Owyang, 2007).

Evaluating the Value of Forecasts

- We focus instead on the potential policy impact of the forecast errors, in the spirit of evaluating forecasts by considering the economic costs of prediction errors (see Clements, 2004; Granger and Pesaran, 2000a and 2000b; and Pesaran and Skouras, 2002).
- Our Question: **Given a specific policy rule, what is the impact of forecast errors on the policy decision?**

The Greenbook Forecasts

- Some of the most frequently evaluated forecasts have been those from the Greenbook of the Federal Reserve.
- These forecasts are prepared by the Federal Reserve staff before each FOMC meeting.
- Following the literature, we assume these forecasts of real GDP growth and inflation may be used by the FOMC in making policy decisions.
- **The purpose of this paper is to evaluate the size of the forecast errors in the context of the monetary policy decision.**

The Forecast-Based Taylor Rule

- Taylor (1993) proposed a monetary policy rule where the Fed sets a target federal funds rate, i^{Tf}:

$$i_t^{Tf} = r^* + \pi_{t+h}^f + 0.5(\pi_{t+h}^f - \pi^*) + 0.5(\ln(Y_{t+h}^f) - \ln(Y^*))$$

  - r* is the equilibrium real interest rate,
  - π* is the Fed's implicit target inflation rate,
  - and Y* is potential output.
  - The Fed forecasts both inflation and output (growth) *h* periods ahead to establish π^f and Y^f.
  - Note that even if the Fed uses current quarter values of inflation and output growth, they still have to "nowcast" them because the data have not yet been released.

The Policy Forecast Error (PFE) based on the Taylor Rule

- The policy forecast error (PFE) is determined by the difference between:
  - the policy action the Taylor rule predicts if the forecasts were equal to the actual data:

$$i_t^{Tf} = r^* + \pi_{t+h}^f + 0.5(\pi_{t+h}^f - \pi^*) + 0.5(\ln(Y_{t+h}^f) - \ln(Y^*))$$

  - and the policy action the Taylor rule predicts based on the forecasts reported in the Greenbook:

$$i_t^T = r^* + \pi_{t+i}^A + 0.5(\pi_{t+h}^A - \pi^*) + 0.5(\ln(Y_{t+h}^A) - \ln(Y^*))$$

- With the Taylor Rule, we can establish the PFE without knowing all of the variables in the policy rule.
  - It actually becomes a simple weighted sum of the univariate forecast errors.

$$PFE_t = i_t^T - i_t^{Tf} = 1.5(\pi_{t+h}^A - \pi_{t+h}^f) + 0.5(\ln(Y_{t+h}^A) - \ln(Y_{t+h}^f))$$

$$\approx 1.5(\pi_{t+h}^A - \pi_{t+h}^f) + 0.5(y_{t+h}^A - y_{t+h}^f)$$

Forecast Data

- Greenbook forecasts of inflation (based on GNP/GDP deflator) and real GNP/GDP growth.
- Forecasts made from 1965Q4 through 2002Q4.
  - Greenbook data are released with a 5 year lag.
  - Multiple observations per quarter depending on the number of FOMC meetings that quarter.
    - The FOMC met more frequently per quarter in the 1960s and 1970s than later in the sample.
  - Horizons 0, 1, and 2 are current quarter forecasts made in the last, middle, and first months of the quarter respectively.
  - Horizons 3, 4, and 5 are one quarter ahead forecasts.
  - Horizons 0 and 3 forecasts are made at the same time (similarly 1 and 4, 2 and 5).
  - We focus on short horizons to avoid possible feedback from monetary policy on the outcomes.

Actual Outcome Data

- Assume the objective is to forecast data released 90 days after the end of the quarter.
  - Avoids definitional and classification changes.
  - These are thus the modern “first final” releases by the Bureau of Economic Analysis.
  - These are the “real time data” used in modern forecast evaluation.

Forecast Evaluation

- Three different criteria:
  1. Examine the policy forecast errors.
  2. Test for bias.
  3. Compare to other forecasts:
     - Naïve forecasts.
     - Other forecasts.

Examining the Policy Forecast Errors

- The policy forecast errors have a simple interpretation.
- They are the error in the policy action (i.e. the setting of the Federal Funds Rate) taken due to the forecast errors.
- In our case the errors are measured in percentage points of the Federal Funds Rate (FFR).
- When the PFE is negative, the FFR was set too high, when the PFE is positive, the FFR was set too low.

Figure 1: Policy Forecast Error in Percentage Points, Horizon 0

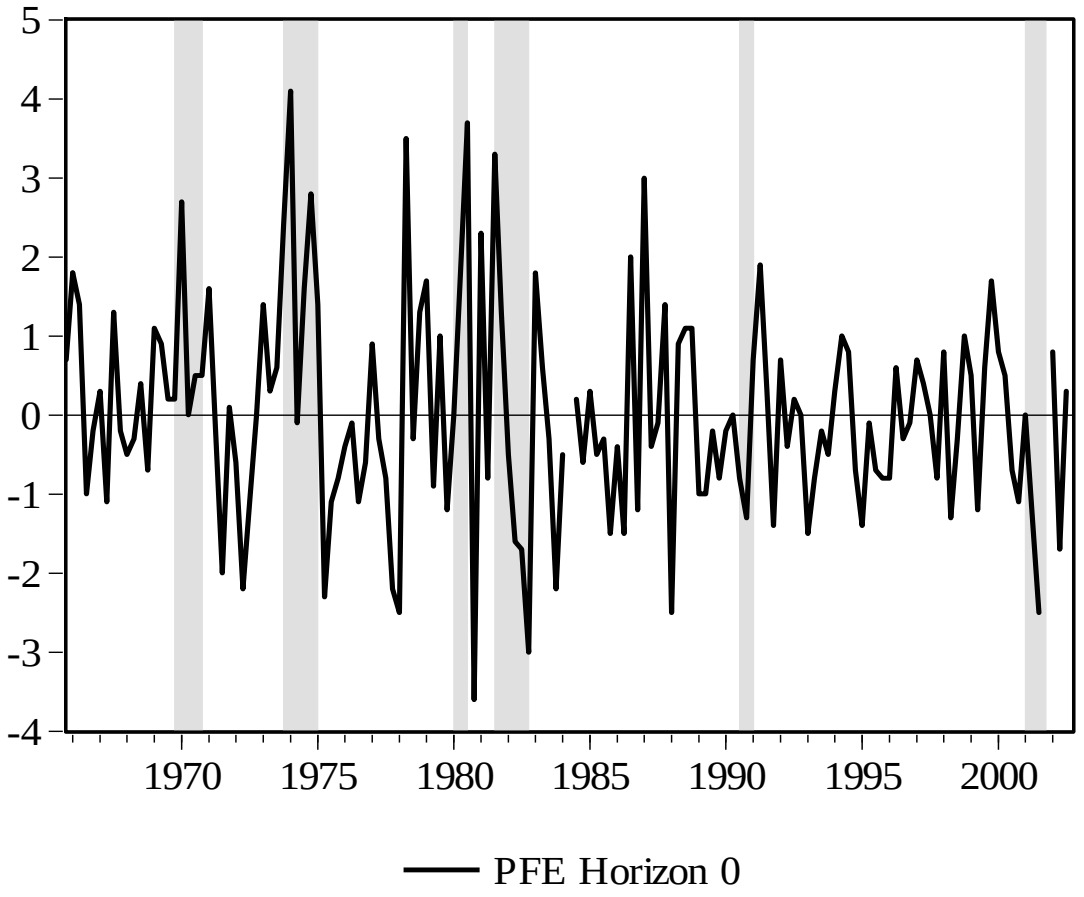

Table 1: Mean Absolute Policy Forecast Error (MAPFE) and Root Mean Squared Policy Forecast Error (RMSPFE)

Panel A: Full Sample (1965.4-2002.4) Fed Forecasts

horizon	$MAPFE_{Fed}$	$RMSPFE_{Fed}$	N
0	1.01	1.31	159
1	1.25	1.67	110
2	1.54	1.93	94
3	1.56	2.08	159
4	1.83	2.34	105
5	1.80	2.43	88

The Bad News:

On average the Fed is one full percentage point away from their intended target. This holds even if we look at the 4-quarter average of the forecasts instead of just the current quarter.

Testing for Bias (Table 2 in Paper)

- Holden and Peel (1990) showed that a necessary condition for bias is that the mean error be significantly different from zero.
- We test for bias in the traditional way by regressing the PFE on a constant and use a t-test that the constant is zero.
- The null of no bias (zero mean) in the PFE is not rejected at the 5% level for any horizon for the full sample.
  - Horizons 4 and 5 appear biased in the pre-Volcker sample.
- **The good news: positive and negative errors cancel so that on average the Fed is on target for the full sample and the recent sample (1979.3-2002.4).**

Standards for Comparison

- PFEs that would have occurred if naïve forecasts had been used to set the policy (NPFE).
- PFEs that would have occurred if other forecasts had been used to set the policy.
- Test for significant differences using modified Diebold-Mariano test statistics.

Comparison with Other Forecasts

- The naïve forecast assumes that the output growth rate and the inflation rate will be the same as the last rate observed by the forecaster.
- For horizons 1 and 4, we also have the median forecast produced from the Survey of Professional Forecasters starting in 1968.4.

Table 3: Modified DM Test of Equal Predictive Ability: Fed versus Naïve

Horizon	1965.4 – 2002.4 Average Gap |Naïve PFE|-|Fed PFE| (M. DM stat)	1965.4 – 1979.2 Average Gap |Naïve PFE|-|Fed PFE| (M. DM stat)	1979.3 – 2002.4 Average Gap |Naïve PFE|-|Fed PFE| (M. DM stat)
0	.94** (6.17)	1.03** (4.05)	0.87** (4.71)
1	.83** (4.96)	0.87** (2.86)	0.79** (5.46)
2	.45** (2.51)	0.50* (1.87)	0.39* (1.73)
3	.75** (4.31)	0.87** (2.57)	0.66** (4.10)
4	.58** (2.98)	0.65* (1.69)	0.52** (3.18)
5	.57** (2.54)	0.42 (1.01)	0.72** (4.26)

** denotes significance at 1%, * denotes significance at 5%.

Table 3: Modified DM Test of Equal Predictive Ability: Fed versus SPF

Horizon	1968.4 – 2002.4 Average Gap |SPF PFE|-|Fed PFE| (M. DM stat)	1968.4 – 1979.2 Average Gap |SPF PFE|-|Fed PFE| (M. DM stat)	1979.3 – 2002.4 Average Gap |SPF PFE|-|Fed PFE| (M. DM stat)
1	.22* (2.09)	.40* (2.22)	.10 (0.92)
4	.32** (3.13)	.50** (3.09)	.19 (1.54)

** denotes significance at 1%, * denotes significance at 5%.

Robustness

- Are the weights from the basic Taylor Rule the right weights to use?
- A large literature has focused on estimating the weights, e.g. Clarida, Gali, and Gertler (2000).
- To examine the robustness of our findings, we found the weights that minimized the RMSPFE (very similar results if we instead minimize the MAPFE).

Table 4: Weights that Minimize the RMSPFE for the Fed Forecasts

	Full Sample Weights		Split-Sample Weights			
Hor	GDP Weight	Inflation Weight	GDP Weight		Inflation Weight	
			1965.4 1979.2	1979.3 2002.4	1965.4 1979.2	1979.3 2002.4
0	0.69	1.31	0.77	0.56	1.23	1.44
1	0.57	1.43	0.69	0.37	1.31	1.63
2	0.55	1.45	0.65	0.34	1.35	1.66
3	0.52	1.48	0.69	0.31	1.31	1.69
4	0.49	1.51	0.65	0.21	1.35	1.79
5	0.64	1.36	0.74	0.39	1.26	1.61

Table 5: MAPFE for Different Weights

horizon	Taylor $MAPFE_{Fed}$	Full Sample Min Weights $MAPFE_{Fed}$	Split Sample Min Weights $MAPFE_{Fed}$
0	1.01	0.97	0.96
1	1.25	1.23	1.19
2	1.54	1.56	1.46
3	1.56	1.56	1.50
4	1.83	1.83	1.67
5	1.80	1.79	1.66

Even with weights that minimize the impact of the forecast errors, the Fed is averaging one full percentage point away from their intended target.

Conclusions

- We developed a simple method for joint evaluations of quantitative forecasts.
- We find in our application that our methodology gives us new insight into the impact of forecast errors on monetary policy.
  - The Fed's policy forecast error is in general unbiased and significantly smaller than the errors that would have resulted from naïve forecasts but not always from the SPF predictions (particularly for the recent sample).
  - Nevertheless, the mean absolute policy forecast error of the Fed is nearly 100 basis points.
- Caveat: If the Fed smoothes the Taylor rule, then the impact of the forecast errors is less.