Forecasting and Policy Making

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Goethe University Frankfurt

MONFISPOL conference
Frankfurt, September 19, 2011
Macroeconomic Model Database update

- Release version 1.2
- Dynare 3 and 4 compatibility
- 50 macroeconomic models
- Conduct model comparison easily, frequently, at low cost and on a large scale
- 2 Handbook articles based on the database

www.macromodelbase.com
Handbook Articles

• Forecasting and Policy Making
  Volker Wieland and Maik Wolters
  Editors: G. Elliott and A. Timmermann,
  Handbook of Economic Forecasting, Vol. 2.

• The New Keynesian Approach to Dynamic General
  Equilibrium Modeling: Models, Methods and
  Macroeconomic Policy Evaluation
  Schmidt, Sebastian and Volker Wieland,
  Editors: P. B. Dixon and D. W. Jorgenson,
  Handbook of Computational General Equilibrium Modeling.
Forecasting and policymaking

• Policy relies on forecasts
  – to project consequences for policy targets
  – to account for transmission lags

• Policymakers use forecasts, for example, to
  – set central bank interest rates
  – plan government budgets
  – plan major projects or policy changes in many other areas of policymaking (trade, infrastructure, traffic, social security, ....)
Some forecasts made by policy institutions

<table>
<thead>
<tr>
<th>Category</th>
<th>US</th>
<th>Euro Area</th>
<th>UK</th>
<th>International</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>fiscal policy</strong></td>
<td>CBO: Budget and Economic Outlook</td>
<td>European Commission: European Economic Forecast</td>
<td>Office for Budget Responsibility: Economic and Fiscal Outlook</td>
<td></td>
</tr>
<tr>
<td><strong>general</strong></td>
<td>Philadelphia Fed Survey of professional forecasters</td>
<td>ECB ECB Survey of Professional Forecasters</td>
<td>IMF World Economic Outlook OECD Economic Outlook</td>
<td></td>
</tr>
</tbody>
</table>
We will focus on the interaction of forecasting and monetary policy

1. Forecasting and policy: A basic framework
2. Empirical evidence for forecast-based policy
3. Forecasting methods and models
4. Optimal versus robust policy
5. Forecast accuracy and heterogeneity
1. Forecasting and policy: A basic framework

- Theil (1958) "A realistic analysis of the relationship between forecasts and policy must be based on the assumption of several variables, controlled and not controlled by the policy maker, of their inter-relationships, (and) of the policymaker’s preferences which serve to formalize the optimality criterion."

  ➔ Define objective function, target variables, instrument variables and macro model.
Objective and Targets

• No central bank has announced explicit objective function and preference parameters, but central bank laws define targets (often hierarchical).

• Research and technical policy analysis: long tradition of defining loss functions for policy evaluation.

\[ L = E \left[ \sum_{j=0}^{\infty} \beta^j \left[ (\pi_{t+j} - \pi^*)^2 + \lambda (y_{t+j} - y_{t+j}^*)^2 \right] \right] I_t \]  \hspace{1cm} (1)
Instrument and Target Variables

• Typical instrument is short-term interest rate.
  – Following Taylor (1993) central bank decisions often described by simple rule:

\[
\dot{i}_t = \bar{r} + \pi^* + \phi_\pi (\pi_t - \pi^*) + \phi_y (y_t - y_t^*).
\]  (2)

  – Note, coefficients may be optimized with respect to minimize expected/forecasted losses according to (1) s.t. to a model of the transmission process. (Taylor refers to Bryant et al 1993)
Outcome vs Forecast-Based Simple Rules

• Rules that **respond directly to forecasts**
  – used early-on at inflation targeting central banks to evaluate policy in models (Haldane (1995), Amano et al (1999)) w.r.t. (1).

\[
\dot{\pi}_t = \bar{r} + \pi^* + \phi_{\pi,h}(E[\pi_{t+h}|I_t] - \pi^*) - \\
+ \phi_{y,k}(E[y_{t+k} - y_{t+k}^*|I_t]).
\]  

(3)
Example Model: Phillips curve, IS, other

\[
\pi_{t+1} = \pi_t + \kappa(y_t - y_t) + \gamma z_{t+1} + \epsilon_{t+1} \quad (4)
\]

\[
y_{t+1} - \bar{y}_{t+1} = \alpha(y_t - \bar{y}_t) - \sigma(i_t - \pi_t - \bar{r}) + \delta z_{t+1} + \eta_{t+1} \quad (5)
\]

\[
z_{t+1} = \theta_1 \pi_t + \theta_2(y_t - \bar{y}_t) + \theta_3 z_t + \nu_{t+1}, \quad (6)
\]

- Choose \((\phi_\pi, \phi_y)\) or \((\phi_\pi, h, \phi_y, \kappa)\) to minimize expected future deviations of inflation and output form targets s.t. (1) and (4), (5), (6).
Alternative: Optimal Control Policy

• Choose optimal interest rate path that minimizes expected losses (1) s.t. model (4,5,6).

\[
\hat{i}_t = \bar{r} + \pi^* + \tilde{\phi}_{\pi}(\pi_t - \pi^*) + \tilde{\phi}_y(y_t - y^*_t) + \tilde{\phi}_z z_t;
\]

– Comparable to more complex outcome-based rule, better performance if model is known.
Forecast Targeting Rule

\[
E[\pi_t | j | 1 - \pi^* | I_t] = \frac{\lambda}{\beta \kappa} \left( \beta E[(y_t | j | 1 - y_{t+j+1}^*)
- (y_{t+j} - y_{t+j}^*) | I_t] \right);
\]

\( j \geq 0. \)


- **NOTE:** Equivalence result ((7) and (8) = (2) = (3)) under restrictive conditions on model (\( \gamma=\delta=0 \)).
2. Evidence for forecast-based policy

• Estimate the following rule for $h>0$ and $h=0$.

\[ i_t = \rho i_{t-1} + (1 - \rho)[i^* + \beta(E_t \pi_{t+h} - \pi^*) + \gamma E_t y_{t+h}] + \varepsilon_t. \]

– Are the coefficients reasonable? (Taylor principle)
– Empirical fit better with forecasts or outcomes?
– U.S. vs euro area.
Evidence for forecast-based policy (US)

No Interest Rate Smoothing

- Note: FOMC Forecasts, following Orphanides-Wieland (2008).
Evidence for forecast-based policy (US)

<table>
<thead>
<tr>
<th></th>
<th>$\pi_{t-1},u_{t-1}$</th>
<th>$\pi_{t+3},u_{t+3}$</th>
<th>$\pi_{t+3},u_{t-1}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\beta$</td>
<td>1.29</td>
<td>2.48</td>
<td>2.23</td>
</tr>
<tr>
<td></td>
<td>(-0.64,2.47)</td>
<td>(2.14,2.65)</td>
<td>(1.91,2.38)</td>
</tr>
<tr>
<td>$\gamma$</td>
<td>-1.70</td>
<td>-1.84</td>
<td>-1.46</td>
</tr>
<tr>
<td></td>
<td>(-3.93,-0.79)</td>
<td>(-2.17,-1.55)</td>
<td>(-1.67,-1.26)</td>
</tr>
<tr>
<td>$\rho$</td>
<td>0.69</td>
<td>0.39</td>
<td>0.24</td>
</tr>
<tr>
<td></td>
<td>(0.24,0.91)</td>
<td>(0.29,0.54)</td>
<td>(0.04,0.45)</td>
</tr>
<tr>
<td>$R^2$</td>
<td>0.85</td>
<td>0.96</td>
<td>0.95</td>
</tr>
</tbody>
</table>
Testing for forecast-based policy

• Nest the regressions with forecasts and outcomes as limiting cases:

\[ i_t = \alpha + \beta [(1 - \phi_\pi)\pi_{t-1} + \phi_\pi \pi_{t+3}] \\
+ \gamma [(1 - \phi_u)u_{t-1} + \phi_u u_{t+3}] + \varepsilon_t \]

\[ \phi_\pi, \phi_u = 1 \Rightarrow \text{forecast-based policy} \]

\[ \phi_\pi, \phi_u = 0 \Rightarrow \text{outcome-based policy} \]
## Evidence for forecast-based policy (US)

<table>
<thead>
<tr>
<th></th>
<th>$\phi_\pi = \phi_u$</th>
<th>$\phi_\pi \neq \phi_u$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\phi$</td>
<td>0.94</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.67, 1.00)</td>
<td></td>
</tr>
<tr>
<td>$\phi_\pi$</td>
<td></td>
<td>0.93</td>
</tr>
<tr>
<td></td>
<td>(0.65, 1.00)</td>
<td></td>
</tr>
<tr>
<td>$\phi_u$</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>(0.35, 1.00)</td>
<td></td>
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</table>

Parameters close to 1 $\rightarrow$ forecast-based policy
### Evidence for forecast-based policy (EA)

<table>
<thead>
<tr>
<th></th>
<th>$\phi_\pi = \phi_u$</th>
<th>$\phi_\pi \neq \phi_u$</th>
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</thead>
<tbody>
<tr>
<td>$\phi$</td>
<td>1.00</td>
<td>(0.00, 1.00)</td>
</tr>
<tr>
<td>$\phi_\pi$</td>
<td></td>
<td>1.00</td>
</tr>
<tr>
<td></td>
<td>(0.00, 1.00)</td>
<td>(0.12, 1.00)</td>
</tr>
</tbody>
</table>

- Point forecasts indicate forecast-based policy (Note: **ECB staff forecasts**)
- Confidence bands are wide (short sample)
3. Forecasting methods and models

- **Time series methods**
  - No structural interpretation
  - Essential to compute nowcasts

- **Structural models**
  - Small structural models
  - DSGE models
  - Large econometric models
Small structural models

• 3-5 Equations
• Example: IMF’s small quarterly projection model
  – Structure similar to New Keynesian, but more flexible (no explicit microfoundations)
  – Persistent stochastic processes for equilibrium variables
  – Bayesian Estimation
Interpretation of unobservable variables
Interpretable structural shocks

- Demand Shock
- Potential Output Growth Shock
- Monetary Policy Shock

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DSGE models

- Microeconomic foundations
- More variables than small structural models
- Structural interpretation of observed and unobserved variables and shocks
- Example: Smets & Wouters version by Cogan, Cwik, Taylor and Wieland (2009)
Structural interpretation of forecasts
Conditional forecasts

• path of policy itself has a direct effect on projections of macroeconomic aggregates
  → compute conditional forecasts

• Important input for policy committees

• Closer to simulations than to forecasting
  → Natural role for structural models
Computing conditional forecasts

• Different implementation techniques of the same conditioning assumption yield different forecasts

• Choose policy shocks that yield a constant future interest rate path. Two possibilities:
  1. Agents are surprised by these policy shocks (stochastic case)
  2. Agents know in advance that the interest rate will be kept constant (deterministic case)
Condition on interest rate path

![Graphs showing annualized real quarterly output growth, external spending, federal funds rate, and annualized quarterly inflation.](Image)
4. Optimal versus robust policy

• Compare optimal policy rules with different forecast horizons

• Minimize loss function: \( L = \sigma^2_\pi + \lambda \sigma^2_y \)

• Use three models:
  1. Smets & Wouters (CCTW version)
  2. Small IMF model
  3. Linearized FRB/US
Forecast horizons and determinacy

Smets & Wouters model (CCTW version, reestimated)

IMF model, reestimated

FRB/US model (linearized 2003 version)
Optimized outcome- vs forecast-based rules

<table>
<thead>
<tr>
<th>Model</th>
<th>$\lambda$</th>
<th>$h_\pi$</th>
<th>$h_y$</th>
<th>$%\Delta L$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Smets &amp; Wouters</td>
<td>$1/3$</td>
<td>$0$</td>
<td>$0$</td>
<td>$0.00$</td>
</tr>
<tr>
<td>IMF-Model</td>
<td>$1/3$</td>
<td>$1$</td>
<td>$3$</td>
<td>$-11.10$</td>
</tr>
<tr>
<td>FRB/US</td>
<td>$1/3$</td>
<td>$18$</td>
<td>$0$</td>
<td>$-3.78$</td>
</tr>
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</table>
## Robustness of forecast-based rules

<table>
<thead>
<tr>
<th>model used for optimization</th>
<th>$\rho$</th>
<th>$\beta$</th>
<th>$\gamma$</th>
<th>$%\Delta L$</th>
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<tbody>
<tr>
<td>Rules evaluated in Smets &amp; Wouters model</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SW</td>
<td>0.99</td>
<td>3.00</td>
<td>0.09</td>
<td>0</td>
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<tr>
<td>IMF</td>
<td>0.65</td>
<td>2.33</td>
<td>0.00</td>
<td>4</td>
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<tr>
<td>FRB</td>
<td>0.94</td>
<td>2.99</td>
<td>0.24</td>
<td>6</td>
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<tr>
<td>Rules evaluated in IMF model</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SW</td>
<td>0.99</td>
<td>3.00</td>
<td>0.09</td>
<td>117</td>
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<tr>
<td>IMF</td>
<td>0.65</td>
<td>2.33</td>
<td>0.00</td>
<td>0</td>
</tr>
<tr>
<td>FRB</td>
<td>0.94</td>
<td>2.99</td>
<td>0.24</td>
<td>26</td>
</tr>
<tr>
<td>Rules evaluated in FRB/US model</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>SW</td>
<td>0.99</td>
<td>3.00</td>
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<td>44</td>
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<tr>
<td>IMF</td>
<td>0.65</td>
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<tr>
<td>FRB</td>
<td>0.94</td>
<td>2.99</td>
<td>0.24</td>
<td>0</td>
</tr>
</tbody>
</table>

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5. Forecast accuracy and heterogeneity

Inflation, nowcast

Output growth, nowcast

Inflation, horizon 4

Output growth, horizon 4
Accuracy & Heterogeneity: Models vs SPF

Forecast start: 2008Q4

Forecast start: 2009Q1
Conclusions

• Central bank interest rates largely set in response to forecasts
• Methods: Structural models useful to interpret forecasts. Conditional forecasts of interest to policymakers.
• Forecast-based feedback rules tend to be less robust than outcome-based rules?
Conclusion cont.

• Accuracy and heterogeneity: Experts and model-based forecasts miss recessions. Perform both relatively well in recoveries.
U.S. Example: Estimated transmission lags
Condition on interest rate and fiscal spending (ARRA) path
Time-varying heterogeneity: SPF
5. Forecast accuracy and heterogeneity

Evaluate forecast bias:

- Inflation, nowcast
- Output growth, nowcast
- Inflation, horizon 4
- Output growth, horizon 4
Informational content of forecasts (mean SPF)

Inflation, nowcast

Output growth, nowcast

Inflation, horizon 4

Output growth, horizon 4