Model based economic forecasting

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**Dynamic econometric models and alternatives I**

- HN Ch 21.
- Forecasting is a time oriented activity. And adjustment of economic variables is usually non-instantaneous. Imply that models have to be *dynamic* to be suited for forecasting.
- Obvious today, but if we draw a time-line of macro economic models, a surprising long segment of that line would be dominated by models where time played no essential role (ie, they were static models), cf. Granger and Newbold (1986) in spite of early offerings like Haavelmo (1940).

The alternatives to econometric models are:
- Expert judgement
Dynamic econometric models and alternatives II

- Statistical time series models

In practice: few purists.

One advantage of using econometric models for forecasting is that they can be seen as restricted statistical time series models, and it is easy to incorporate expert judgement in the model based forecasts, by the use of add-factors, aka intercept-correction.

In the following: Look a little at the “pure case’, it is easy to think of a long list of ‘pros’ for model based forecasting in macroeconomics
Advantages of forecasting with economic models I

1. *Interpretability*: In particular the clarification of initial and equilibrium condition provided by a model, makes the model based forecast more interpretable than statistical forecasts.

2. *Consistency with definitional relationships*: For example forecasted total demand must equal total total supply.

3. *Internally consistent multivariate forecasts*. Forecasting from a macro model implies that the forecasting function of all variables contains a common set of key *parameters*: Characteristic roots of the companion form.

4. *Co-integration* Cointegrating relationships also hold for forecasts, and give additional interpretability to initial conditions.
Advantages of forecasting with economic models II

5. **Forecasting and policy analysis with the same model.** Policy analysis and forecasting can be separately validated and it takes *super structural breaks* to damage both forecasts, and to invalidate policy analysis.

6. **Cost effective:** There are fixed costs and variable cost of establishing an operational model, but marginal cost of preparing a “forecast round” can be very low, also for alternative future scenarios.

7. **Contingency planning.** Probabilistic forecasts can be useful for contingency planning, also when prediction intervals are wide.

8. **Optimality** According to standard textbooks in econometrics, model based forecasts are optimal: have the lowest *MSFE*, Mean Squared Forecast Error.
But optimality is derived from assumptions:

1. The forecast is conditioned on period $T$
2. Perfect measurement of initial conditions;
3. The model is linear in parameters and correctly specified.
4. Disturbances for $T+1, T+2,...$ are unpredictable based on period $T$-information.
5. Parameters are known (no estimation problem), up until $T$.
6. The preference function of the forecaster is quadratic
7. The structure of the economy remain relatively unchanged in the forecast period (ie., parameter constancy)

If 1-6 are OK, the optimal forecast of $Y_{T+h}, h = 1, 2, .., H$ is the conditional expectation from the model: $E(Y_{t+h} \mid \text{Model})$. It has lowest MSFE.
Example model

- $C_t$ private consumption in period $t$, in fixed prices.
- $GDP_t$, $S_t$ and $J_t$ represent GDP, tax revenue and exogenous expenditures (gross capital formation; and government consumption)
- $a - e$ are parameters
- $\epsilon_{Ct}$, $\epsilon_{Jt}$ and $\epsilon_{Tt}$ are mean-zero, constant variance independent white-noise processes.

\begin{align*}
C_t &= a + b(GDP_t - S_t) + cC_{t-1} + \epsilon_{Ct} \\
S_t &= d + eGDP_t + \epsilon_{St} \\
GDP_t &= C_t + J_t \\
J_t &= J^* + \epsilon_{Jt}
\end{align*}
Optimal forecasts, h-periods ahead, from period T

\[ \hat{C}_{T+h|T} = C^* + \lambda^h (C_T - C^*) - 1 < \lambda < 1 \quad (5) \]

\[ \hat{GDP}_{T+h|T} = GDP^* + \lambda^h (GDP_T - GDP^*) \quad (6) \]

\[ \hat{J}_{T+h|T} = J^*, \quad h = 1, 2, .., H \quad (7) \]

- $0 < \lambda < 1$ under conventional assumptions about parameters $b, c$ and $e$
- $C^*, GDP^*$ og $J^*$ are equilibrium values of $C_t, GDP_t$ and $J_t$.
- The forecasts equilibrium correct
- Could have said: expectation correct, since $C^* = E(C_t) = \mu_C$ etc
That was the forecast. But what does the economy do?

- It also equilibrium corrects; But not always to the same equilibrium as the forecast!
- In our example model, if $J^* \to J^{**}$ in period $T + 1, T + 2, \ldots$ then $\Rightarrow C^* \to C^{**}$:

$$C_{T+h} = C^{**} + \lambda^h(C_T - C^{**}) + e_{T+h}$$

where $e_{T+h}$ is an ‘average’ of future disturbances. The forecast errors become

$$C_{T+h} - \hat{C}_{T+h} = dC^* - \lambda^h dC^* + e_{T+h} \quad (8)$$

$$dC^* = C^{**} - C^* \quad (9)$$

Unbiased forecasts as long as the economy and the model agrees about what the equilibrium is in the forecast period.
Forecasts for consumption (C) when economy and model agree
Structural break

► $dC^*$ “large” means that there is regime-shift in the forecast period
► Not one Black Swan (Taleb), but a whole flock (Hendry)
► It is the location shifts that represent the real obstacle to forecasting with our discipline models
► Intermittent location-shifts also explain why “naive” forecasts can do well in forecast contests.
'Location shift' in the forecast period

A drop in investment after the preparation and publication of the forecast
The model based forecast do not error-correct

- Breaks that take place in period $T + 1$ or later will damage the forecast that conditioned on period $T$ information.
- Of course, after one period, we will update the forecast, by conditioning on period $T + 1$ information.
- The break is now in the information set used for forecasting.
- But the forecast nevertheless glides towards the old (pre-break) end-point:

$$\hat{C}_{T+2+h|T+1} = C^* + \lambda^h(C_{T+1} - C^*),$$

and not towards the new equilibrium $C^{**}$.

- Model based forecasts are therefore vulnerable to breaks that happen in the forecast period, and to breaks that have happened before we make the forecast.
A DROP IN INVESTMENT BEFORE THE PREPARATION OF THE FORECAST
Implications for policy analysis?

▶ Exactly the same properties that make the model forecasts vulnerable to breaks makes is relevant for policy analysis:
▶ “What is the effect on $C$ and $GDP$ if there are shock to investments?”
▶ Hence, models that fail in forecasting need not be discredited as models for policy analysis Castle and Hendry (2015)
▶ *Invariance* of derivative parameters (not intercepts) with respect to shocks to $J$ is the relevant property for policy analysis.
Implications for modeled based forecasting I

- When doing forecasting, the parameters that you care least about when estimating and testing, become the main parameters of interest

- Namely: Constant terms that affect equilibrium means and autonomous growth rates

- When those parameters are estimated with little bias, and are stable over time, there are low costs, and several benefits from forecasting by the use of econometric discipline models

- But there is no “fix” (within current family of discipline models) for breaks that occur after the forecast has been prepared
Implications for modeled based forecasting II

- Hence, at the time of the break, and immediately after, will need correction by model user and/or objective methods for correctly detecting breaks
- In the medium-term perspective, model surveillance and adaptation to known breaks certainly help.

Forecast, measure, revise. Repeat. It’s a never-ending process of incremental improvement that explains why weather forecasts are good and slowly getting better. Tetlock and Gardner (2015)
Implications for modeled based forecasting III

and, speaking about the practical need of model maintenance:

By the time a system has been designed to give explicit display to a variable that has appeared to be important, the econometrician may find that some new variable, formerly submerged in aggregation, is now important. ... Every two or three years the model must be revised to keep it up to date. Klein (1962, p.269)

- Conversely, keeping a model specification unchanged, will quickly reduce the forecast performance, Nymoen (2002)
- An intriguing perspective is that the intermittent structural breaks that damage the forecasts of our linear(ized) equilibrium correction models, may be symptoms of a deeper weakness.
Implications for modeled based forecasting IV

- And that our models are not descriptive accurate enough for the complex dynamics of real world of economics system, cf. Buchanan (2013)
- In that perspective, the future of economic forecasting is linked to the future of economic modelling.
- Almost certainly too much simple equilibrium (correction) dynamics in current discipline models.
Implications for modeled based forecasting

- Whether the road to improvement lies in the direction of
  - complex dynamics, or
  - behavioural economics, or
  - “learning the art or superforecasting”, cf, Tetlock and Gardner (2015), one does not know.

- But for certain, it does not lie in playing down the importance of economic forecasts and of their evaluations.
A big forecast evaluation project (from Tetlock (2005))

- VARs og ARDLs are the winners (foxes) in this contest.
- Not the experts’ ('talking heads') judgement (they are hedgehogs).
References I


