

## **Forecasting Non-stationary Economic Time Series.**

Michael P. Clements, and David F. Hendry. Cambridge, MA: MIT Press, 1999.

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Forecasting macroeconomic time series is notoriously difficult. Previously unannounced changes in policy, natural and man-made disasters, institutional changes, new discoveries, new data definitions and revisions among others cause occasional large forecast errors in the standard constant-parameter models.

While much effort has been put into working out the theory of estimation, inference and identification in vector equilibrium correction models (VEQCMs), these have been proven largely unsuccessful for the purpose of out-of-sample forecasting (Watson, 2000). This book offers an thorough analysis of the main potential culprits, and what can be done to mitigate their effects.

The thesis of the book can be characterized as follows: “Economics forecasts are sometimes terribly wrong. Structural breaks in the deterministic components are the most damaging in VEQCMs, so these breaks must be the most serious in practice.” But this line of reasoning of course hinges on the VEQCM being the true data generating process (DGP). While one can dispute the approach referring to omitted variable biases for example, the many explicit and intuitive results derived in the book do seem to justify the rigid VEQCM structure imposed on the forecasting problem.

As shown in the book, forecasts from constant parameter VEQCMs can be terribly wrong if an unanticipated event (such as the ones listed above) occurs and causes the equilibrium to change in the out-of-sample forecast period. The model will interpret

the inevitable large error as a signal to drag the forecast in the direction of the old equilibrium, which unfortunately is no longer valid. So while the concept of equilibrium and adjustment to equilibrium has a natural interpretation in economic theory and policy analysis, it might be lethal to the empirical forecasting performance of the model.

All is not lost however. The book proceeds by bravely imposing a lot of structure on the forecaster's problem and considers a world where the data generating process in-sample indeed is a first-order VEQCM. However, during the forecast period, the parameters in the VEQCM are subject to a one-time change. After the change, the DGP possesses the same general stationarity and lag-order properties as before but the equilibrium has changed. The book presents a very intuitive forecast error taxonomy and illustrates that changes in the deterministic components are the most likely to cause serious forecast failures.

The book gives a thorough treatment of intercept correction and over-differencing as means to improve the forecasts from the in-sample constant parameter VEQCM when faced with changes in deterministic components. The intuition for intercept correction is to put the model back on track, but it can be tricky to implement. The intuition for over-differencing is that the deterministic component thereby cancels out, and that the equilibrium is no longer imposed explicitly when estimating and forecasting. While helpful in practical forecasting, over-differencing has the unfortunate consequence that the model loses much of its economic interpretation and thereby arguably its value for policy analysis. Intercept correction might therefore merit the added effort required in implementation.

Another obvious response to structural breaks in the form of parameter changes is to try to model them. But the book's chapter on the modeling of shifts in parameters is unfortunately rather short. Regime switching models are initially motivated by their ability to deliver better measures of uncertainty around the point forecast, however, only their ability to forecast the conditional mean is assessed, and it is found to be limited. In general, the book focuses mainly on point forecasting, whereas the risk of structural breaks should cause the forecast confidence intervals to be dramatically increased as well.

Thus, while the book clearly delivers the goods in the area of its primary focus of changes in deterministic terms in VEQCMs, I am still tempted to point out some additional areas which I would have liked to see covered:

First, evidence is mounting on the success of large-scale dynamics factor models in forecasting macroeconomic time series (Watson, 2000). Interesting theoretical advances in models where the number of time periods as well as the number of time series go to infinity are complemented by findings of forecasting success (Stock and Watson, 1999). These large-scale factor models do have an interesting reduced rank analogy to the small-scale cointegration models considered in the book. And nonstationary (regime-switching) factor models as in Diebold and Rudebusch (1996) would also fit nicely in the book's shift modeling chapter. Perhaps they will be covered in future work by the authors.

Second, state-space or time-varying-parameter models is another class of models one could entertain in the shift-modeling chapter. Allowing explicitly for parameter changes in transition and measurement equations could potentially capture the structural

breaks over time. While linear state space models might adjust too slowly, nonlinear versions could be considered. The idea that large outliers signal the shift to a new equilibrium rather than a large deviation from the current is modeled in a paper by Engle and Smith (1998), which seems relevant for the parameter shift modeling chapter.

Third, the book does not contain any discussion of Bayesian forecasting methods, despite their apparent success both in univariate forecast competitions and in vector autoregression environments (see e.g. West and Harrison, 1989). Recognizing the importance of density forecasts, rather than simple point forecasts, the Bayesian approach has clear advantages in terms of delivering posterior odds distributions—even across unit root regions of the parameter space.

Finally, Stock and Watson (1998) find that forecast combinations perform well in practice, and one wonders if progress could be made from combining the different methods considered in the book?

In terms of style, the book does a nice job of tying together the material in the different articles underlying the chapters. In particular, the summaries at the beginning of each chapter are very useful. I did find the many mid-sentence (self-) references to be a bit excessive though. These should probably have been collected in “further reading” sections at the end of each chapter. I would also liked to have seen more, clearly stated, precise definitions of key phrases such as “congruent model” and “forecast failure” which are used repeatedly throughout the book. As a final comment on style, it might be clear from the above discussion that the title of book is a bit too general. The main focus really is on structural breaks in vector equilibrium correction models and a title such as

“Forecasting across Structural Breaks with VEQCMs” might have been more appropriate.

The book points to many interesting directions for future research. One of my favorite is the evaluation of models for policy making versus simple forecasting. A large battery of tests have been developed for the evaluation of point, interval and density forecasts (see for example the November 1998 *International Economic Review* volume edited by Diebold and West), but how should one evaluate the policy advice from a model? Clearly, some of the models which fare well in forecasting are non-starters in policy making as they might not even contain the causal policy variable of interest. Furthermore, the book’s result that non-causal models might be superior—in a strict forecasting sense—to causal models under structural breaks underscores the need for separate model evaluation criteria for policy analysis purposes.

While the book does contain a brief review of standard forecast models, a level of knowledge corresponding to say Granger and Newbold's standard *Forecasting Economic Time Series* is realistically required. The sharp focus on forecast failure in VEQCMs is probably too narrow for a general graduate course on time series. But large parts of the book would clearly be useful in a topics course on the forecasting of macroeconomic time series. Thus, the book lends itself mostly to teachers of second year graduate courses, academic researchers, as well as seasoned forecasting professionals.

The book is the second volume of a trilogy by the authors on forecasting. The first volume considers the classic situation where the variables under study are stationary under some transformation—either differencing or cointegration. A third volume is intended on the issue of forecasting in large-scale open models. Together, the three

volumes will no-doubt constitute an important treatise on the state-of-the art in macroeconomic forecasting. This second volume is certainly a key contribution to explaining and improving on the lackluster forecast performance of small-scale Vector Equilibrium Correction Models. In summary, what is here is very good, and the profession has good reason to look forward to more. At \$35, the book is a bargain.

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