Available online at www.sciencedirect.com
ScienceDirect
Journal of Economic Dynamics & Control 32 (2008) 2460–2475
JOURNAL OF Economic Dynamics & Control
www.elsevier.com/locate/jedc

Improving monetary policy models ☆

Christopher A. Sims

Department of Economics, Princeton University, USA

Received 24 October 2006; accepted 10 May 2007
Available online 3 December 2007

Abstract

If macroeconomic models are to be useful in policy-making, where uncertainty is pervasive, the models must be treated as probability models, whether formally or informally. Use of explicit probability models allows us to learn systematically from past mistakes, to integrate model-based uncertainty with uncertain subjective judgment, and to bind data-based forecasting together with theory-based projection of policy effects. Yet in the last few decades policy models at central banks have steadily shed any claims to being believable probability models of the data to which they are fit. Here we describe the current state of policy modeling, suggest some reasons why we have reached this state, and assess some promising directions for future progress.

JEL classification: E5; C5

Keywords: Econometric models; Central bank models; Bayesian inference

1. Why do we need probability models?

Fifty years ago most economists thought that Tinbergen's original approach to macromodeling, which consisted of fitting many equations by single-equation OLS

☆This material may be reproduced for educational and research purposes so long as the copies are not sold, even to recover costs, the document is not altered, and this copyright notice is included in the copies. Research for this paper was supported by NSF Grant SES 0350686 and by Princeton's Center for Economic Policy Studies. This paper was presented at a December 2–3, 2005 conference at the Board of Governors of the Federal Reserve and may appear in a conference volume or journal special issue.

E-mail address: sims@princeton.edu

0165-1889/$ - see front matter © 2007 Elsevier B.V. All rights reserved.
doi:10.1016/j.jedc.2007.09.004

and assembling them into a multiple-equation model, had been shown to be internally inconsistent and an inadequate basis for scientific progress in macroeconomics.[1] The basic point, made at length by Haavelmo (1944), is that because in economics our theories do not make exact predictions, they can never be proved inadequate simply by showing that they make prediction errors. In order to allow models to be compared and improved, they must be formulated as probability models. That is, they must characterize the probability distribution of observations, rather than simply make point predictions. A model can then be judged on where observed data fall in the distribution the model predicts. For macroeconomic models, this means they must be probability models of the joint behavior of the time series they are meant to explain. If we use models that do not produce distributions, or do not produce reliable distributions, for the data, then in comparing the models or assessing how well a given model is doing, we are forced to rely on informal judgements about what errors are so big as to cast doubt on the model, or about what metric to use in comparing records of forecast errors for two models.

If we intend to use the models in decision-making we have to go beyond Haavelmo's proposal to use frequentist hypothesis testing as a way to detect false models and progress toward true models. Hypothesis testing, and indeed all of the apparatus of frequentist inference, fails to connect to the problem of making decisions under uncertainty. The frequentist approach to inference insists on a distinction between unknown 'parameters', which are never given probability distributions, and random variables, which are given distributions. The random variables are supposed, at least in principle, to be objects whose patterns of variation could be repeatedly observed, like repeated rolls of the dice or repeated forecast errors. Parameters are supposed to have single values. But a macroeconomic model is not complete, for decision-making purposes, unless it characterizes all sources of uncertainty, including the fact that we do not know parameter values. This means that attempts to limit probability statements to areas of uncertainty where the frequentist interpretation of probability is useful cannot be adequate. We need to think of our probability models as characterizing uncertainty from all sources and as capable of integrating uncertain information from sources other than the data – one aspect of what is sometimes called 'judgment'.

Most economists have learned a frequentist approach to inference and may think that frequentist inference does in fact characterize uncertainty about parameters. But this is an illusion. Frequentist data analysis often reports standard errors of estimates or confidence intervals for parameters. These are reported because they appear to satisfy a need to make probability statements about unknown parameters. But the standard errors describe the variability of the *estimators*, not the distribution of the unknown parameters, and the probabilities associated with confidence intervals are not probabilities that the unknown parameter is in the interval, based on the observed data, but instead probabilities that a similarly constructed interval would contain the true parameter if we repeatedly constructed such intervals. These probability statements about estimators and randomly fluctuating intervals

[1]These first few paragraphs cover much the same ground as parts of Sims (2002, 2004).