Specification, Estimation, and Analysis of Macroeconometric Models

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To my children, Emily and Stephen, without whom
considerable time would have been saved
in completion of this book—
but so much joy lost

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Contents

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Abbreviations

ARMC	Autoregressive model (MC)
ARUS	Autoregressive model (US)
BFGS	Broyden-Fletcher-Goldfarb-Shanno nonlinear maximization algorithm
DFP	Davidon-Fletcher-Powell nonlinear maximization algorithm
DW	Durbin-Watson statistic
Fed	Federal Reserve Bank of the United States
FFA	Flow of Funds Accounts
FIML	Full information maximum likelihood
FSR	First-stage regressor
LAD	Least absolute deviations
LHS	Left-hand side
LINUS	A twelve-equation linear model (US)
MAE	Mean absolute error
MC	Multicountry
NIA	National Income and Product Accounts
OLS	Ordinary least squares
RHS	Right-hand side
RMSE	Root mean squared error
SARUS	Sargent's classical macroeconomic model (US)
SE	Estimated standard error of an equation
S&L	State and local
US	United States
USRE1	US model with rational expectations in the bond market
USRE2	US model with rational expectations in the bond and stock markets
VAR1US	Vector autoregressive model 1 (US)
VAR2US	Vector autoregressive model 2 (US)
2SLAD	Two-stage least absolute deviations
2SLS	Two-stage least squares
3SLS	Three-stage least squares

Notes

3. A Theoretical Model

The single-country model in Section 3.1 is similar to the model in Fair (1974d). The main differences between the two models are the following. (1) The earlier model took account of both labor and loan constraints, whereas the present model considers only labor constraints. I have been unable to find in my empirical work much evidence of the effects of loan constraints on the economy, and this is the main reason they have been dropped from the theoretical model. Eliminating the loan constraints greatly simplifies the model. The household and firm maximization problems are easier to specify, and it is no longer necessary to specify a maximization problem for banks. If financial markets always clear, as is assumed here, banks can be specified to play a passive role in the economy. In the earlier model a rather complicated model of bank behavior had to be specified to explain the possible existence of credit rationing. Also, a bond dealer had to be postulated in the earlier model, which is now no longer necessary. (2) The model of household behavior now includes another decision variable, the amount of time spent taking care of money holdings. It provides a choice-theoretic explanation of the interest sensitivity of the demand for money. (3) Some slight changes in the specification of adjustment costs in the model of firm behavior have been made. (4) An option has been added to allow monetary policy to be endogenous, which is to postulate the possible existence of an interest rate reaction function of the government. In my empirical work I have estimated and used such a function, and it is now part of the theoretical model. (5) The length of the decision horizon for the solution of the household and firm maximization problems is now taken to be three rather than thirty. This change lessens the cost of solving the model, and it allows more accurate algorithms to be written. The first-order conditions have been obtained explicitly for the household problem, and a more accurate algorithm has been written for the firm problem. The cost of solving the earlier model was large enough to require that a "condensed" version of the model be used for many of the simulations. In the present case a condensed version is not needed. The use of three periods is enough to capture the multiperiod nature of the maximization problems, so nothing is really lost by lessening the length of the horizon. (6) Because of the foregoing changes, the values used for the parameters and variables in the simulation work are generally different between the two models. This is not very important, however, because the only things of interest from the simulation experiments are the qualitative results.

The discussion of the class of rational expectations models in Section 3.1.7 is similar to that in Fair (1978c). The discussion in this paper relied on a "static-equilibrium" version of the basic model in Fair (1974d). I have not used this version in the present case. The main points about the class of rational expectations models can be made without reference to this version, of which I have never been particularly fond. It is an attempt to collapse the basic version, which is dynamic and has disequilibrium features, to one with no dynamics and no disequilibrium. So much of the basic version is lost in this process, however, that the resulting model is not very useful for comparison purposes.

The two-country model in Section 3.2 is similar to the theoretical model in Fair (1979a). In this paper a "quasi-empirical" two-country model was also presented, which consisted of my US econometric model linked to a model exactly like it. This model, which was called Model A, has not been used here. I look on Model A as a help in the transition from the theory to the multicountry econometric model in Chapter 4, but it is now no longer of much interest.

Although this note has concentrated on the differences between the models in Sections 3.1 and 3.2 and those in Fair (1974d) and (1979a), the general premises and main features are the same. In particular, the discussion of the models in Sections 3.1.1 and 3.2.1 pertains to both the earlier work and the present work.

4. An Econometric Model

The US model in Section 4.1 is similar to the model in Fair (1976), with the addition of the interest rate reaction function in Fair (1978b). The idea that firms may at times be off their production functions and hold excess labor, which is part of both the theoretical and econometric models, was first explored in Fair (1969). The employment and hours equations in Section 4.1.5 are similar to those in this earlier work. The specification of the production equation has been in part influenced by the results in Fair (1971a).

The US model has been updated and changed slightly over the years, but the basic structure and features have remained the same. One of the more important minor changes that has been made is the imposition of the real wage constraint in Section 4.1.5. A change that expanded the size of the model, but otherwise had little effect, was the disaggregation of the government sector into federal and state & local.

The US model is not a revised or extended version of my original forecasting model (Fair 1971b). The only stochastic equation that is similar between the two models is the employment equation, which, as just noted, is derived from the work in Fair (1969). The forecasting model was intended to be used for very short run forecasting purposes, which meant that a number of expectations variables, such as a variable measuring plant and equipment investment expectations, were taken to be exogenous. In this sense the forecasting model is not structural, whereas the US model is.

The MC model in Section 4.2, aside from the trade share equations, is presented in an unpublished working paper (Fair 1981a). The model in this paper took trade shares to be exogenous. The endogenous treatment of trade shares in Section 4.2.6 is new. This treatment is different from an earlier one presented in another unpublished working paper (Fair 1981b), where constraints were imposed on the coefficients across equations.

5. Other Econometric Models

The discussion of Sargent's model in Section 5.4 is similar to the discussion in section II in Fair (1979c). An iterative 2SLS procedure was used in this paper to estimate Sargent's model, but this has not been done here. A much better technique for rational expectations models is full information maximum likelihood (FIML), and it is now possible to estimate Sargent's model by FIML. This is discussed in Chapter 11.

6. Estimation

The method discussed in Section 6.3.2 for the linear-in-coefficients case with serial correlation is presented in Fair (1970). The formulas in (6.20)–(6.23) for the 2SLS covariance matrix are presented in Fair and Parke (1980). The 3SLS estimator that is based on the minimization of (6.26) is also presented in this paper. The 2SLAD estimator in Section 6.3.6 for $q = 1.0$ is suggested in Fair (1974c).

The FIML cost savings with respect to the Jacobians that are considered in Section 6.5.2 are discussed in Fair (1976, chap. 3). The estimation of subsets of coefficients by FIML is also discussed in this chapter. The DFP algorithm was used for this earlier FIML work, and it turned out that the "FIML" estimates that are reported in Fair (1976) are not the true FIML estimates. Parke later found using his algorithm a larger value of the likelihood function.

The computational method for the LAD and 2SLAD estimators in Section 6.5.4 is discussed in Fair (1974c).

The possible use of the Hausman test in Section 6.6 to compare the 2SLS, 3SLS, and FIML estimates is discussed in Fair and Parke (1980). The discussion in this paper is misleading in one respect: we failed to point out that the alternative hypothesis that is tested when the 3SLS and FIML estimates are compared for a nonlinear model is that the distribution of the error terms is such as to lead to inconsistent FIML estimates. It was implicitly assumed that any nonnormal distribution meets this requirement, which, as Phillips (1982) has pointed out, is not the case. The Hausman test was used in this paper to compare the 2SLS and 3SLS estimates even though, as we pointed out, the comparison is not valid because of the different sets of first-stage regressors used by 2SLS and 3SLS. The test was applied, where possible, to try to get a feeling for the results, but very little weight was placed on them. For purposes of this book, no attempts have been made to use the Hausman test.

7. Solution

Part of the discussion in this chapter is taken from Fair (forthcoming).

8. Evaluating Predictive Accuracy

The discussion in Sections 8.2 and 8.3 is taken from Fair (forthcoming). The original discussion of the method in Section 8.4 is contained in Fair (1980a). Further discussion of the method and its use can be found in Fair (1979c) and (1982b). The discussion of the d_{itk} values in Section 8.5.2 is similar to that in Fair (1982b), and the comparison of the models in Section 8.5.4 is similar to that in Fair (1979c). The comparison of the MC and ARMC models in Section 8.6 is similar to that in Fair (1981a).

9. *Evaluating Static and Dynamic Properties*

The original discussion of the stochastic simulation method in Section 9.3 for estimating the uncertainty of policy effects is contained in Fair (1980b). The empirical analysis in Section 9.4.2 is similar to that in Fair (1980b); the analysis in Section 9.4.4 is similar to that in Fair (1978b); and the analysis in Section 9.4.5 is similar to that in Fair and Parke (1980). The empirical results in these sections are not exactly the same as those in the original papers because the US model has been updated for the purposes of this book.

The discussion of the properties of the MC model in Section 9.5 is similar to that in Fair (1982a). The results in this section are not exactly the same as those in the paper because the US and MC models have been updated and because a different set of trade share equations has been used. For the results in the paper the trade share equations in Fair (1981b) were used, whereas for the results in this book the trade share equations in Section 4.2.6 have been used.

10. Optimal Control Analysis

The original discussion of the method in Section 10.2 is in Fair (1974a). The measure of performance in Section 10.3 was first proposed in Fair (1978a). Chow's (1978) comment on this measure contains an error. Chow asserts that because the measure is based on the open-loop approach it assumes that "decisions . . . [are] made once for all four years at the beginning of each administration" (p. 314). This statement is incorrect because the measure is based on the open-loop approach *with* reoptimization each period. Furthermore, Chow is not explicit in pointing out that his measure also requires that a new optimization problem be solved each period for a nonlinear model because the linearization changes with each new realization. An attempt was made in Fair (1978a) to approximate the measure of performance by solving fewer control problems than are actually needed in the complete case. These approximations were then used to compare past U.S. presidential administrations. No attempt has been made to do this here, since it is not clear how good the approximation is.

11. Models with Rational Expectations

The discussion in Sections 11.2, 11.3, 11.4, and 11.6 is based on Fair and Taylor (1983). The analysis in Section 11.7 is similar to that in Fair (1979d). The results in Section 11.7 do not match exactly the results in this paper because the US model has been updated for present purposes and because the experiments are not exactly the same. The experiments differ in the prediction periods used, in the choice of a value of T in (11.20), in the treatment of the initial value of stock prices, and in the treatment of the variable values beyond the end of the data. The discussion of the solution of optimal control problems in Section 11.5 and the estimation of Sargent's model by FIML in Section 11.8 are new.

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