12 Conclusions

Because of the "wait and see" theme of this book, no strong conclusions are drawn here. The following is a summary of some of the main results in the book and a discussion of problems that I think are in particular need of future research.

12.1 Methodology

One of the three main goals of this book has been to argue for a particular methodology. The methodology centers around the testing of econometric models using the method in Section 8.4. An example of the use of the method is presented in Section 8.5. I am under no illusions that the method can be easily used to decide which model best approximates the structure of the economy. The problem is not that the method is expensive to use, since, as seen in Section 8.5, the method is not prohibitively expensive now and it will be considerably less expensive in the future with cheaper and faster computers. Rather, the problem is that it is in general difficult to use macroeconomic data to distinguish among alternative hypotheses or models. Given the smoothness of much of the data, the size of the sample that one is dealing with is to some extent small. Many more observations are needed before much can be said. I am also aware of the possibility, as discussed in Section 2.4, that the structure of the economy is not stable enough for any model in the future to be very good. If this is the case, any attempt to find the "best" model is futile. Whether the methodology emphasized here will in fact help to advance our knowledge of the structure of the economy is clearly an open question. Since the method presented here can be easily used within the context of the Fair-Parke program, the hope is that this book will stimulate more comparisons and testing of models as well as more work on the method itself.

12.2 Specification

Another goal of this book has been to present my theoretical and econometric macro models. This modeling exercise is my attempt at approximating the

structure of the economy, and it provides an example of the transition from theoretical to econometric models.

12.2.1 The US Model

The theoretical model on which the US econometric model is based is one in which disequilibrium can occur because of expectation errors. Contrary to the work of Barro and Grossman (1976) and the related work on fixed price equilibria, the model provides an explanation of market failures. Firms determine prices and wages (along with other variables) within the context of their multiperiod maximization problems, and because of expectation errors, these prices and wages are not always market clearing. Whether the key assumption in the model regarding expectations, namely that expectations are not rational, is the best approximation to the truth is one of the most important current issues in macroeconomics. If expectations are in fact rational, many of the features of the theoretical model are not likely to be good approximations, and thus the econometric model that is based on this model should not, other things being equal, perform well in tests against models in which expectations are rational.

Another important feature of the theory is the idea that firms may spend time "off" their production functions. Because of adjustment costs, it may be optimal for firms to hold excess labor, excess capital, or both during periods of slack demand. If this is true, it has important implications for empirical work: it means that attempts to estimate the degree of substitution between capital and labor that are based on the assumption that the observed inputs are the utilized inputs are not trustworthy. The same holds for attempts to estimate the effects of the cost of capital on investment behavior.

Another characteristic of both the theoretical and econometric models is the accounting for all flow-of-funds and balance-sheet constraints. This implies that the government budget constraint is accounted for, and it makes clear the various assumptions about monetary policy that are possible. These issues are discussed in Sections 4.1.10 and 9.4.4.

The results that have been obtained for the econometric model so far are encouraging. With respect to the disequilibrium issue, the key disequilibrium variable in the model (the Z variable) appears in the three consumption equations and in three of the four labor supply equations. It is significant in the three labor supply equations and in two of the three consumption equations (Section 4.1.4). Regarding the question of whether firms spend time off their production functions, the excess labor variable is significant in

the employment and hours equations and the excess capital variable is significant in the investment equation (Section 4.1.5). The tests of the overall model in Section 8.5 show that it is more accurate than the ARUS, VAR1US, VAR2US, and LINUS models for a number of the key variables, and the results of the comparisons in Section 11.8 show that it is more accurate than Sargent's model.

Some of the open questions or problems about the US model as I see them are the following.

1. The method in Chapter 8 has not been used to compare the model to other large-scale structural models. Also, the results in Section 8.5 show that the model is less accurate than at least one of the other models for some variables, and therefore more work is needed regarding the explanation of these variables.

2. Interest rates have a very large effect on consumption and housing investment (and thus on GNP). This can be seen best in Tables 9-4 and 9-5, especially the latter. It may be that these effects are too large. Trying both the short-term and the long-term rates, current and lagged, in each equation and then choosing the one that was most significant may have resulted in an upward bias in the estimated effects.

3. The interest rate reaction function appears to have changed when Volcker became chairman of the Fed, although not enough observations are available to know whether the way in which this change has been modeled is a good approximation. It may be that the entire equation will have to be replaced by a reaction function with a different LHS variable.

4. Some of the minor equations of the model, such as the equation explaining the interest payments of the firm sector, have fairly poor statistical properties and are thus in need of further work.

5. No evidence could be found for the effects of real as opposed to nominal interest rates in the household expenditure equations, which could be because of poor estimates of expected future inflation rates. More work is needed here.

Within the next ten years or so these problems should be worked out one way or another. One should also have by this time a good idea of how the model compares to other structural models. If the problems have not been adequately dealt with or if other features of the model are poor approximations, the comparisons should reveal this. In particular, if the Lucas point is a serious quantitative problem for the model, this should be revealed in poor performances. Likewise, if the Brainard-Tobin pitfalls criticism regarding the treatment of financial securities in models like the US model is important quantitatively, this should show up.

12.2.2 The MC Model

The MC model is in a much more preliminary state than is the US model, and it will take more than ten years to decide if it has formed the basis for a model that provides a good approximation of the economic linkages among countries.

One of the key features of the theoretical model is that there is no stock-flow distinction with respect to the determination of the exchange rate. Because the model accounts for the flow-of-funds and balance-sheet constraints, the stock and flow effects are completely integrated. The other features of the theoretical model are essentially those of the single-country model, since the two-country model is conceived of as two single-country models put together.

For the econometric work, data limitations required that a special version of the theoretical model be considered. This is a version in which (1) the short-term interest rates are determined by interest rate reaction functions, (2) the exchange rate is determined by an exchange rate reaction function, (3) the forward rate is passive, and (4) the bonds of the two countries are perfect substitutes. In addition, the sectors are aggregated into just one sector per country. This version guided the econometric specifications.

The results of comparing the MC and ARMC models in Section 8.6 are encouraging regarding the MC model. In general, it does better than the ARMC model, and variables like the exchange rates seem to be explained fairly well so far. These results are, of course, very preliminary, and for variables like consumption and investment more work on the specification of the equations is needed.

The discussion and results in Section 9.5 give a good idea of the properties of the MC model. It is clear from these results that the effects of a given change vary considerably across countries and that the trade effects by no means dominate the price, interest rate, and exchange rate effects. Although sufficient observations in the flexible exchange rate regime are not yet available to allow much weight to be placed on these results, they do suggest that models that are primarily trade multiplier models are likely to be poor approximations.

12.3 Estimation and Analysis

The final main goal of this book has been to discuss the techniques needed to estimate and analyze large nonlinear macroeconometric models. The Fair-Parke program, which is discussed in Appendix C, provides a fairly easy way of implementing these techniques.

12.3.1 Estimation Techniques

The results in Chapter 6 show that it is becoming feasible to estimate large-scale models by full information techniques and by robust techniques like 2SLAD. If one takes the view that all models are at least slightly misspecified, and thus that the standard statistical properties of the estimators are not valid, the key question is which estimator yields a model that is the best approximation of the structure. The results in Chapter 6 and in Section 8.5.5 are inconclusive on this matter, but to some extent they show that the choice of estimator does not make much difference. An important question for future research is whether this conclusion holds for other models and for later versions of the US model.

12.3.2 Testing and Analysis

The results in Chapters 7, 8, and 9 show that stochastic simulation can now be a fairly routine matter in analyzing models. The use of stochastic simulation allows one to compare models by means of the method in Chapter 8 and to estimate standard errors of multipliers. The method in Chapter 8 requires that a model be estimated a number of times, which is clearly feasible for the limited information techniques. This is still not feasible for 3SLS and FIML, although in a few years even these techniques may be capable of being used routinely.

The method in Chapter 8 is based on the premise that all models are misspecified. It is not designed to test the null hypothesis of correct specification, since this hypothesis is already assumed to be false, but instead to *estimate* the degree to which a model is misspecified. An important conclusion from the results in Table 8-2 is that all the models tested appear to be misspecified by a fairly large amount. More precisely, the estimated contribution of misspecification to the total variance of the forecast error is fairly large for most variables. This conclusion has important implications for the estimation of the standard errors of multipliers in Chapter 9. The method in Chapter 9 that is used to estimate these standard errors does not account for misspecification effects, and thus the estimated standard errors are merely lower bounds. An important question for future research is how to account for misspecification effects in this context.

The results in Chapter 10 show that it is feasible to solve optimal control problems for large models. Until models become more accurate, it is unlikely that optimal control techniques will be used in a serious way for actual policy

purposes. The techniques can also be used, however, to help analyze the properties of the models, and in this respect they are of current interest. They are also of current interest in helping to evaluate past policies in the light of particular welfare functions.

12.4 Rational Expectations Models

The methods in Chapter 11 now allow nonlinear rational expectations models to be estimated and solved. The methods are expensive for large models, but not necessarily prohibitively so on fast and cheap computers. The estimation method is, as far as I know, the only method available for estimating a nonlinear rational expectations model by FIML. Given the widespread use of the rational expectations assumption and the important implications it has for policy, it is important in future research that the assumption be tested. The methods in Chapter 11 allow this to be done.

The solution method in Chapter 11 is used in Section 11.7 to analyze two versions of the US model, one with rational expectations in the bond market and one with rational expectations in the bond and stock markets. These versions are not realistic because they have not been estimated, but this exercise provides a good example of the way in which the solution method can be used. The exercise is also useful in determining how sensitive the properties of the US model are to alternative specifications. The estimation method is used in Section 11.8 to estimate Sargent's model.

It may be that it will become feasible to test econometric rational expectations models before these models are actually developed. Very little work has been done in this area since Sargent's model in 1976. Now that the methods in Chapter 11 are available, it may be that work will proceed more rapidly. One would hope that within the next ten years or so, well-developed rational expectations models will be available to compare to other models.