Chapter Eight

Conclusion

8.1 SUMMARY

The purpose of this study has been to develop a theoretical model of macroeconomic activity with the characteristics outlined at the beginning of Chapter One. The model should be general, should be based on solid microeconomic foundations, should not be based on the assumption of perfect foresight, and should not be based on the postulation of tâtonnement processes that clear markets every period.

The model is general in the sense that the goods market, the labor market, and the financial markets are all treated endogenously. The model also accounts for wealth effects, capital gains effects, all flow-of-funds constraints, and the government budget constraint. The model is based on solid microeconomic foundations in the sense that the decisions of the main behavioral units in the model—banks, firms, and households—are assumed to be based on the solutions of optimal control problems. Before the behavioral units solve these problems, they are assumed to form expectations of future values, and these expectations are used in the solutions of the problems. Much of the specification of the model is concerned with how these expectations are formed. None of the behavioral units in the model is assumed to have perfect foresight. The model is recursive in the sense that information flows in one direction, and no tâtonnement processes, in which information flows back and forth between behavioral units before transactions take place, are postulated.

In a nontâtonnement model, where the quantity demanded of something may not always equal the quantity supplied, one must specify carefully how the actual quantities traded are determined. In the present model

the actual quantities traded are the quantities determined from the *constrained* maximization processes of the firms and households. Firms solve their optimal control problems knowing the loan constraints, and households solve their optimal control problems knowing the loan, hours, and goods constraints. Because of this, the aggregate demand for loans that results from the solutions of the constrained problems of the firms and households is always less than the aggregate amount that the bank sector is willing to supply, and the aggregate supply of labor that results from the solutions of the constrained problems of the households is always less than the aggregate amount that the firm sector and the government are willing to hire. Also, the demand for goods that results from the solutions of the constrained problems of the households is always less than the amount the firm sector is willing to sell to the households after meeting the demand from the government and from itself.

There is thus an important distinction in the model between unconstrained and constrained quantities. While the unconstrained demand for loans, supply of labor, and demand for goods can be greater than the supply of loans, demand for labor, and supply of goods, respectively, the constrained quantities are guaranteed from the way they are determined to be less. The bond dealer also serves a useful purpose in the model in determining the actual quantities of bills and bonds traded. The bond dealer absorbs each period the difference between the supply of bills and bonds from the government and the demand for bills and bonds from the bank sector.

In a nontâtonnement model some mechanism must also be postulated as to how prices, wages, and interest rates are determined, since these can no longer be assumed to be set by an auctioneer. In the present model each firm is assumed to set its own price and wage rate and each bank is assumed to set its own loan rate. The bond dealer is assumed to set the bill and bond rates and the stock price. The rates set by the firms and banks result, of course, along with the values of the other decision variables, from the solutions of the optimal control problems. Market share considerations play an important role in influencing the rates set by the firms and banks. A firm is assumed to expect, for example, that its market share of goods sold is a function of its price relative to the expected prices of the other firms. This assumption is common to a number of recent studies, in particular, Mortensen [39], Phelps [40], Phelps and Winter [47], and Maccini [36]. In the present case, however, the firm is also assumed to expect that the prices of other firms are in part a function of its own past prices.

The main factors that influence the decisions of the behavioral units have been discussed in a summary fashion at the beginning of Chapter Six, and this discussion will not be repeated here. The behavioral model for firms is clearly the most complicated of the behavioral models because of the treatment of the price, production, investment, and employment decisions as joint decision variables of a firm. (The employment decision corresponds to a firm's wage rate

decision and its decision on the maximum amount of labor to hire.) In previous studies no more than two of these decisions have been considered simultaneously. Two important characteristics of the present behavioral model of a firm are the postulation of a putty-clay technology and the assumption that there are costs of adjustment in changing the size of the work force and the size of the capital stock. Because of these characteristics, it may at times be optimal for a firm to hold excess labor and/or excess capital.

The way in which the complete model is put together is presented in Tables 6-2 and A-2 and discussed in Section 6.1, and this discussion will also not be repeated here. Once all the decisions have been made at the beginning of the period, the determination of the transactions that take place throughout the rest of the period is quite straightforward. Although for the non-condensed model time paths of the decision variables are computed each period, only the values for the current period are used in computing the transactions that take place. Each period the behavioral units reoptimize, and so the optimal values of the decision variables for periods other than the current one never get used in computing the transactions that take place.

The properties of the complete model have been discussed in Chapter Six. The loan constraints are an important channel through which government actions that take money out of the system affect the behavior of the private sector. The hours constraints are an important channel through which a decrease in the sales of the firm sector affects the household sector. The goods constraints are not an important part of the model because of the fact that the firm sector holds inventories of goods.

In an economy characterized by binding loan constraints, an argument can be made for the use of monetary policy rather than fiscal policy to stimulate the economy. Monetary policy is defined as a change in the value of bills and bonds with no change in government purchases of goods and labor, and fiscal policy is defined as a change in government purchases of goods and labor with no change in bills and bonds. Both policies have about the same effect in the model in increasing bank reserves, an increase in bank reserves being what is needed in a situation of binding loan constraints, but an expansionary fiscal policy also increases sales of goods directly. As discussed in Chapter Six, one does not want to increase the sales of firms before the firms realize that they can borrow more money to increase investment and output.

In an economy characterized by binding hours constraints, an argument can be made for the use of fiscal policy rather than monetary policy, unless the interest rate responses of the firm and household sectors are large and quick. Fiscal policy, by increasing the sales of the firm sector directly, leads the firm sector in general to want to increase output and employment and thus to make the hours constraints less restrictive. Monetary policy, by not increasing the sales of the firm sector directly, must rely on increasing sales by stimulating the investment and consumption demand of the firm and household sectors

through the lower interest rates that an expansionary monetary policy produces.

When trying to expand the economy in any way, consideration must be given to the work effort of the household sector. If, for example, the hours constraints are not binding (no unemployment) and the firm sector is not holding any excess labor, then output can be increased only if the household sector can be induced to work more (or the firm sector induced to purchase less labor-intensive machines). In the model the work effort of the household sector is a positive function of the wage rate and the interest rates, and a negative function of the price level, the value of assets, the proportional tax parameter, and the minimum guaranteed level of income (transfer payments). The response of the household sector to the tax parameters is important. If taxes are raised by increasing the proportional tax parameter, this has a negative effect on work effort. If there was unemployment before the increase, there will be less unemployment after the increase, other things being equal, because of the decrease in the unconstrained supply of labor. If taxes are raised by lowering the minimum guaranteed level of income (decreasing transfer payments), this has a positive effect on work effort. This change will cause more unemployment, other things being equal, because of the increase in the unconstrained supply of labor. Also, a contractionary monetary policy that increases interest rates will cause more unemployment, other things being equal, because of the increase in the unconstrained supply of labor due to the higher interest rates.

Unemployment arises in the model because of errors of expectations on the part of the firms. Firms choose the values of their decision variables with the expectation that there will be no unemployment in the current period and in the future. Therefore, any unemployment that arises in the model is due to errors in the firms' expectations of the behavioral responses of the households. As discussed in Section 6.4, it is not possible for there to exist unemployment in equilibrium if firms observe the unconstrained supply of labor as well as the constrained supply.

Equilibrium is defined to be a situation in which the value of each variable in the model is the same from period to period—a self-repeating run. If firms are assumed *not* to observe the unconstrained supply of labor, then it is possible, as discussed in Section 6.4, to concoct a self-repeating run in which there does exist unemployment. There is no frictional unemployment in the model because search is not treated as a decision variable of the households. "Full employment" corresponds to a zero unemployment rate.

Errors of expectations are also an important factor in causing the model not to return to a self-repeating position once a one-period shock has been inflicted in it—i.e., in causing the model not to be stable. The lack of stability of the model does not appear to be an unreasonable property of the model. The decision processes of the banks, firms, and households are complicated enough that it would seem to be unrealistic to assume that the bond dealer learns over time exactly what the responses of the banks are, that the

banks learn over time exactly what the responses of the firms and households are, and that the firms learn over time exactly what the responses of the households are. This is especially true in a market share context, where banks and firms are likely to put more resources into finding out what their competitors are going to do than in finding out what the aggregate quantities are going to be. There is, in short, too much room in the model for errors of expectations to be made in the model to expect that the model will settle back down to the self-repeating position once it is shocked.

Because of the lack of perfect foresight in the model, and because of the way the constraints operate, it was seen in Chapter Six that it is easy to generate multiplier reactions in the model. If, for example, firms make the hours constraints more restrictive, this causes the households to consume less, which in turn causes the sales of the firms to be less. Lower sales, other things being equal, will cause the firms to plan to produce less and make the hours constraints even more restrictive, which causes the households to consume even less, and so on. In an expansion the opposite can happen. Firms make the hours constraints less restrictive, households consume more, sales of firms rise, firms make the hours constraints even less restrictive, households consume even more, and so on.

Three of the most important variables in the model that prevent the model from accelerating or decelerating indefinitely are the three interest rates. Holding the variables under the control of the government constant, as the system contracts, interest rates fall, and falling interest rates have a positive effect on investment and consumption demand. Conversely, as the system expands, interest rates rise, and rising interest rates have a negative effect on investment and consumption demand. Falling interest rates also cause capital gains on stocks, and capital gains have a positive effect on consumption demand. Conversely, rising interest rates cause capital losses on stocks, which have a negative effect on consumption demand. There is no natural tendency for the price level and wage rate to bring the economy out of, for example, a contracting situation. Whether the price level and the wage rate help in this regard depends on how the firm sector changes the two relative to one another and how the household sector responds to such changes.

The price decision of a firm is heavily influenced by what it expects other firms' prices to be. The specification of how these expectations are formed has been kept fairly simple in this study, but it would be easy to incorporate more complicated assumptions into the model. Because these expectations are so important in influencing a firm's price decision and since these expectations need not be tied to aggregate demand factors, it is quite possible within this basic theoretical framework for there to be rising prices during periods of falling aggregate demand and vice versa. There is also no reason to expect within the general structure of the model for there to be any simple or stable relationship between the unemployment rate and changes in prices and wages.

Demand deposits serve two main purposes in the model. They are needed for transactions purposes, and they serve as a buffer for firms and the bond dealer to meet unexpected changes in cash flow. Because of the residual nature of part of demand deposits, there is no reason to expect in the model a close short run relationship between the aggregate level of demand deposits and the aggregate level of output. It also makes little difference in the model, as discussed in Section 6.6, whether or not demand deposits are assumed to be an explicit function of interest rates. Relaxing the assumption that they are not an explicit function of interest rates would have little effect on the final properties of the model.

The static-equilibrium version of the model in Chapter Seven is meant to show how much is lost in going from a dynamic model to a static model and to provide something to compare to the standard, textbook model. Some of the main characteristics lost in going from the dynamic model to the static model are the treatment of prices and wages as decision variables of the firms, the treatment of loan rates as decision variables of the banks, the treatment of the bill and bond rates as decision variables of the bond dealer, any treatment of loan, hours, and goods constraints, any treatment of excess labor and excess capital, and any treatment of errors of expectations. Regarding the comparison to the textbook model, the static model appeared to be an improvement over the textbook model in its joint treatment of the consumption and labor supply decisions of the household sector, in its joint treatment of the investment and labor demand decisions of the firm sector, and in its accounting for all flows of funds in the system and for the zero savings constraints. It was also seen in the static model that it makes little difference to the properties of the model whether or not demand deposits are made a function of the rate of interest.

8.2 POSSIBLE EXTENSIONS OF THE MODEL

There are a number of ways in which the model developed in this study might be extended or changed. One obvious change is that different expectational assumptions could be made. The model is structured in such a way that it would be quite easy to replace the particular expectational assumptions made in this study with other assumptions. The expectational assumptions have for the most part been kept relatively simple in this study, so that the properties of the model could be more easily examined, but there is no reason why more complicated assumptions could not be used. One might want, for example, to postulate that a behavioral unit's expectations of the future values of a particular variable are a function of more than just the immediate past value of the variable. In practice, these expectations are likely to be a function of other past values of the variable and of past values of other variables.

Another way in which the expectational assumptions might be modified has to do with the possible effects of "cost push" factors on the level of prices. Consider, for example, a case in which for some reason a firm observes that it has to pay a higher wage rate than before to attract the same amount of labor as before–i.e., that the firm observes a shift in the labor supply curve facing it. Given the present expectational assumptions in the model, this shift has no effect on the firm's expectations of other firms' prices. The shift will, of course, still affect the firm's price decision through its general effect on the optimal control problem of the firm.

One might want, however, to postulate that the shift affects directly the firm's expectations of other firms' prices. In other words, it may be reasonable to assume that the firm expects that other firms are observing similar shifts in the labor supply curves facing them and will respond to these shifts by raising their own prices. Certainly in the case in which an industry-wide union obtains a large settlement from all of the firms in the industry or in the case in which the cost of any common input to the industry rises, it seems reasonable to assume that this will affect firms' expectations of other firms' prices. While this type of an assumption has not been built into the model, it would be easy to do so. The more are a firm's expectations of other firms' prices influenced by "cost push" factors, the more will cost push factors influence the determination of the level of prices.

Another way in which the model might be changed is to postulate a different order of the flow of information. As mentioned in Chapter One, the particular order chosen here was designed to try to capture possible credit rationing effects from the financial sector to the real sector and possible employment constraints from the business sector to the household sector. Other orders could obviously be postulated. Another important assumption of the model in this regard is the assumption that the frequency with which decisions are modified is the same for all of the behavioral units, namely one period. Households, for example, are not allowed to modify their decisions or reoptimize more often than are the firms and banks.

It is also the case that no future commitments are allowed in the model. Although, for example, firms plan how much they are going to invest in the future, they are always free to change their plans in the next period as new information becomes available. There are also no delivery lags in the model and no lags between the time a firm buys a machine and the time the machine is ready for use. The properties of any nontâtonnement model may be sensitive to the assumptions regarding the order and frequency of the flow of information among the behavioral units and to the assumptions regarding the lags between the time decisions are made and the time that they are carried out. In the present case it would be interesting to see how the properties of the model change when different assumptions along these lines are made.

An important extension of the model might be to make search a decision variable of households and possibly firms. Treating search as a decision variable, however, would enormously complicate the model, since distributional issues could then no longer be ignored, and it is not clear whether the possible gains from such a project are worth the cost. It may be best in a macroeconomic context to continue to ignore distributional issues and not try to specify a model in which one needs to keep track of the trades between each pair of behavioral units in the model.

Another important assumption of the model, which is related to the ignoring of distributional issues, is the assumption that bills and bonds are perfect substitutes from the point of view of the banks, and that savings deposits and stocks are perfect substitutes from the point of view of the households. In order to justify these assumptions it had to be assumed that capital gains and losses were recorded each period and taxed as regular income. It also had to be assumed that banks and households were indifferent to the fact that the rate of return on bills and savings deposits is certain, while the rate of return on bonds and stocks is not. All the behavioral units in the model deal only with expected values and are not concerned with variances or other measures of risk. Another possible extension of the model thus might be to relax the assumptions that are necessary to insure that bills and bonds are perfect substitutes and that savings deposits and stocks are perfect substitutes.

This is again not a trivial extension, for relaxing such assumptions would greatly complicate the model. The model has essentially ignored the financial portfolio choices of the asset holders, and this has, of course, greatly simplified matters. What appeared to be most important to account for in the model were the aggregate flows of funds, and it seemed less important to consider the question of how asset holders divide their funds among alternative securities. Nevertheless, it might be of interest to consider more types of securities in the model and to treat the portfolio choices of asset holders in a more detailed way. If this were done, it would probably be desirable at the same time to bring risk considerations into the model.

No price, wage, or interest rate rigidities have been postulated in the model, but it would be easy to do so. For example, price and wage ceilings could easily be incorporated into the optimal control problem of the firm as just another constraint on the firm's behavior. The firm would solve its control problem subject not only to constraints like the loan constraint, but also to constraints that said that it could not set its price above a certain value and could not set its wage rate above a certain value. Likewise, a loan rate ceiling could be handled by having a bank solve its control problem subject to a constraint that said that it could not set its loan rate above a certain value. Costs of *changing* prices, wages, and interest rates could also be incorporated into the control problems in the same way that costs of changing employment,

investment, and sales were incorporated into the control problem of the firm. Each bank and firm would solve its control problem incorporating these costs as well.[a]

The way the model is currently specified, unemployment and other disequilibrium phenomena arise only because of errors of expectations. Incorporating various price, wage, and interest rate rigidities into the model would obviously mean that disequilibrium could arise even if there were no expectation errors. One reason for not incorporating these rigidities into the model in this study was to show that disequilibrium phenomena can easily arise without such rigidities. It might be of interest, however, to incorporate some of these rigidities into the model, since rigidities of various sorts obviously exist in practice.

Three other potentially important extensions of the model would be: (1) to consider consumer durables explicitly, (2) to add a foreign sector, and (3) to incorporate population growth and technical progress into the model. Adding consumer durables would require changing the utility function and the optimal control problem of the households to incorporate the fact that goods could be purchased that render utility over more than one period. Adding a foreign sector would require keeping track of the flows of funds between the domestic economy and the rest of the world and keeping track of the other transactions (in goods and labor) that occur between the two. Adding population growth and technical progress would require, among other things, changing the definition of an equilibrium run in Chapter Six from a self-repeating run to a run in which variables either self-repeat or grow at constant rates.

Consideration might also be given to examining the effects on the economy of changing depreciation laws and investment tax credits. In this study depreciation has been assumed to be straight line and there have been assumed to be no investment tax credits, but it would be easy to change these assumptions. One could examine the effects of changing these policy variables in the same way that the effects of changing other policy variables have already been examined. In future simulation work of this sort it would be desirable to consider more than just two types of machines to give the firms more flexibility in their investment decisions.

Making demand deposits a function of the rate of interest would not, as mentioned above, have much effect on the properties of the model, and it is probably not worth spending much time on this issue.

It might also be of interest to solve the optimal control problems of the banks, firms, and households using different parameter values and under different specifications of the equations to see how sensitive the results are to these changes. As mentioned in the Appendix, there are some aspects of the optimal control problem of the firm that might be desirable to change. There are

clearly other ways in which the control problems of the behavioral units could be specified, and one hope of this study is that it will stimulate further work in analyzing the decisions of economic agents by the numerical solutions of optimal control problems.

A final possible extension to consider is the treatment of the government decisions as endogenous. One could either postulate certain reaction functions of the government or, more formally, postulate that the government behaves by maximizing a welfare function. Consider the latter case, and assume that the horizon of the government is M periods, so that at any one time the welfare function is a function of the values of the relevant endogenous variables for the current period and for the next $M-1$ periods. The government, in solving its maximization problem, would have to compute optimal *time paths* of its decision variables. For any given set of time paths of the government values, a value of the welfare function could be computed. One computation of the welfare function would correspond to solving the model M times. Each of the M solutions requires, of course, that the optimal control problem of each behavioral unit in the model be solved. The solution of the maximization or optimal control problem of the government would require choosing in some way that set of time paths of the government values that maximizes the welfare function.

Although it would not be feasible to solve this problem for the non-condensed model, it would probably be feasible to do so for the condensed model using the method described in Fair [15]. As long as one can compute the value of the welfare function fairly cheaply, given a set of time paths of the government values, the method in [15] should be feasible to use.[b] For the non-condensed model, it is not cheap to compute the value of the welfare function because each computation requires the solution of M optimal control problems of each behavioral unit. For the condensed model, however, it is fairly cheap to compute the value of the welfare function because no optimal control problems need to be solved for the solution of the condensed model.

It is important to realize that in solving its optimal control problem the government would be maximizing its welfare function *subject to* the constraint that the behavioral units in the model are each maximizing their own objective functions. When one is solving the control problem of the government, one is also solving separate optimal control problems within the overall optimal control problem. This is, of course, the way things should be, since the government must take into account the responses of the private sector of the economy in determining the optimal values of its own decision variables.

8.3 EMPIRICAL IMPLICATIONS OF THE MODEL

Since the purpose of Volume II of this study is to specify an econometric model that is based on the present theoretical model, only a brief discussion is

presented here of the empirical implications of the theoretical model. Consider first the behavior of the firm. Since a firm's price, production, investment, employment, and wage rate decisions all come out of the same maximization process, one should probably consider these decision variables together in empirical work. One should in particular be wary of including the current value of a decision variable on the right-hand side of an equation explaining the current value of another decision variable.

In some cases one may be able to consider the decisions of the firm as being made sequentially and specify, for example, that the current level of production is a function of the current level of sales and that the current levels of employment and investment are functions of the current level of production. In general, however, one should probably use only nondecision variables or lagged values of decision variables as explanatory variables. In particular, the common practice[c] of specifying a simultaneous equations model determining prices and wages, in which the current price variable appears in the wage equation and the current wage variable appears in the price equation, is questionable in the present context. If both these variables are decision variables of firms and thus affected by the same factors, their current values are likely to be highly correlated, but this does not mean that the current values ought to be explanatory variables of each other.

It is also the case, regarding the decision variables of a firm in the model, that inventory investment is not a direct decision variable, but a consequence of the other decisions. It is thus questionable whether one ought to treat inventory investment as a decision variable, as is done in most macroeconometric models.

The results in Chapter Three indicate that the reactions of the firm are not symmetrical to increases and decreases in particular variables. Although asymmetricies are difficult to deal with econometrically, more consideration should probably be given in econometric work to possible asymmetrical reactions. Since (as discussed in Chapter Three) the ability of firms to hold excess labor and excess capital during contractions may be an important cause of asymmetrical behavior, more consideration should probably be given to accounting for the existence of excess labor and excess capital than has been done previously.

Regarding the behavior of a household, a household's decision on the number of hours to work and its decision on the number of goods to purchase also both come out of the same maximization process. In empirical work these decisions should thus probably be considered together. Again, one should be wary of including the current value of one of these decision variables on the right hand side of an equation explaining the current value of the other. The Keynesian consumption function does, of course, by having current income as an explanatory variable, treat the current number of hours worked as an explanatory variable. This procedure can be justified if it is assumed that the

hours constraints are always binding on the households. If the constraints are always binding, then the number of hours worked is in effect not a decision variable of the households, and so there is no harm in including it as an explanatory variable in the consumption function. If the constraints are not binding all of the time, then one would presumably want to try to determine when they are and are not binding and specify the consumption function differently in the two cases. One would also presumably want to specify the equation determining the number of hours worked differently in the two cases. In the binding constraint case the number of hours worked is determined by the firms, and in the nonbinding case the number is determined by the households.

The situation in which constraints are binding at certain times and not at others is difficult to deal with econometrically. One must somehow decide or estimate when the constraints are binding and when they are not and then proceed accordingly. In estimating the behavior of the firm sector there is only one important constraint to consider, the loan constraint; but in estimating the behavior of the household sector there are two important constraints to consider, the loan constraint and the hours constraint.

Some recent work in econometric theory has been concerned with the problem of estimating supply and demand schedules in markets that are not always in equilibium.[d] It is usually postulated that the actual quantity observed in the market at any one time is the minimum of the quantity demanded and the quantity supplied. Two regimes then exist in this case, one in which the quantity demanded is observed and one in which the quantity supplied is observed. The basic idea of much of this work is to use information on price changes to help in the choice of which regime is in effect at any one time. Price changes are assumed to be a positive function of excess demand, so that when prices are rising, the quantity supplied is assumed to be observed, and when prices are falling, the quantity demanded is assumed to be observed. Rising prices, for example, correspond to positive excess demand (the quantity demanded being greater than the quantity supplied), so that if the minimum of the quantity demanded and the quantity supplied is what is observed, then rising prices correspond to the quantity supplied being observed.

This recent work in econometric theory is, unfortunately, of somewhat limited use in the present context. In the household case, for example, there are at least two constraints to be concerned about, so that more than two different regimes can exist. Also, if prices, wage rates, and interest rates are set in a market share context, in which expectations are not only important but may not always turn out to be correct, then one may not always be able to rely on changes in prices, wage rates, and interest rates to determine which regime is in effect at any one time. In other words, prices may be rising even if there is not excess demand, and vice versa, so that one may not, for example, be able to postulate that the quantity supplied is what is always observed when prices are rising.

The present case does have the advantage, however, that disequilibrium takes the form of one sector constraining another sector, so that one may be able to use information on one sector to help determine which regime is in effect in another sector. In other words, in the estimation of a multisector, macroeconometric model, there may be more information available on the status of any particular sector than there is when the estimation of only a single market is considered. Because of the links among the various sectors, there are likely to be a number of variables, other than changes in prices, wage rates, and interest rates, that one might attempt to use to help determine when the various regimes are in effect. In particular, the flow of funds data may be helpful in this regard. Otherwise, it is difficult to know in general what data will be useful without knowing the particular data base in question and the particular specification of the empirical model.

Since expectations play such an important role in the theoretical model, any empirical model that is based on it must be concerned with estimating or accounting for these expectations in some way. For example, any variable that is likely to influence a firm's expectations of other firms' prices is a possible candidate for inclusion as an explanatory variable in equations determining price behavior. The importance of expectations in the theoretical model also provides an explanation for why lagged endogenous variables are important explanatory variables in most macroeconometric models. When there is not perfect foresight and when decisions are made on the basis of expectations, it is likely that what has happened in the past will have an important effect on expectations of the future and thus on current decisions.

This is not the place to dwell on how each equation in an empirical model that is based on the theoretical model might be specified, but three specific points about the empirical implications of the model will be made. First, the model implies that excess labor should have a negative effect on employment and that excess capital should have a negative effect on investment. The negative effect of excess labor on employment is confirmed by the results in Fair [14]. Second, the model indicates that excess labor and capital should have a negative effect on prices and that the loan rate and the loan constraints should have a positive effect on prices. Finally, as mentioned in Chapter Three, the model indicates that the loan rate and other aspects of the cost of capital may have effects on investment that have nothing to do with capital-labor substitution in the sense of the firm purchasing different types of machines.

It would be of interest to test for the effects of excess labor and excess capital on prices and also for the effects of the loan rate and loan constraints on prices. It would also seem to be important in empirical work to be aware of the different ways in which the costs of labor and capital can affect employment and investment. One should not necessarily attribute all of the estimated cost effects to the existence of capital-labor substitution.

It should be clear by now that the theoretical model implies that econometric models ought to be specified differently than they now are. The model implies that the four or five main decisions of the firm sector should be considered together, that the two main decisions of the household sector should be considered together, and that the possibility of different regimes existing at different times should be considered. In addition, the model indicates that it is likely to be important to account for all of the flows of funds in the model. The model also, of course, implies that the specification of many individual equations should be different from currently existing specifications. The fact that the model does imply that econometric models ought to be specified differently means that it should be possible, according to the philosophy expounded in Chapter One, to determine if the model is more useful than currently existing theoretical models.

8.4 CONCLUDING REMARKS

It is hoped that this study will stimulate further work, both on extending the theoretical model and on developing empirical versions of it. It is also hoped that this study has demonstrated some of the advantages of using computer simulation techniques over standard analytic methods to analyze theoretical models. By the use of such techniques it appears feasible to consider a macroeconomic model that is dynamic, general, and based on solid micro-economic foundations. It appears feasible, in other words, to break away from the standard static-equilibrium model found in most macroeconomic textbooks to a more satisfactory model.

NOTES

[a]Barro [4] has considered a model of monopoly behavior in which there are lump-sum costs of adjusting the price that the monopolist sets.

[b]The method in Fair [15] converts an optimal control problem into an unconstrained maximization problem, and then uses standard algorithms for maximizing unconstrained functions of variables to solve the problem. This method could have been tried in this study to solve the optimal control problems of the banks, firms, and households. It seemed best in these three cases, however, to write separate algorithms for each problem in order to take more advantage of the structure of each individual problem. For the optimal control problem of the government, on the other hand, it may not be as important to take advantage of the structure of the problem, and one may be able to rely on the method in [15].

[c]For two recent empirical studies see Eckstein and Brinner [13] and Gordon [23].

[d]See, for example, Fair and Jaffee [16], Fair and Kelejian [17], Goldfeld and Quandt [21], Maddala and Nelson [37], Amemiya [2], and Quandt [48].