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A Criticism of One Class of Macroeconomic Models with Rational Expectations

I. INTRODUCTION

THE PURPOSE OF THIS PAPER is to make a criticism of one class of macroeconomic models that have recently been developed [1, 6, 8, 9, 10].[1] Three characteristics of these models (henceforth called "RE models") are (1) the assumption that expectations are rational, given the available information; (2) the assumption that information is imperfect regarding the current state of the economy; and (3) the postulation of an aggregate supply equation in which aggregate supply is a function of exogenous terms plus the difference between the actual and expected price level.[2]

The RE models have the important property that government actions affect real output only if they are unanticipated. Because information is imperfect, unanticipated government actions can affect the difference between the actual and expected price level, and so they can affect, for at least one period, aggregate supply. Anticipated government actions, on the other hand, do not affect the

[1] The models in these five papers are not identical, but they are similar enough to be able to be grouped together for purposes of the discussion in this paper.

[2] The aggregate supply functions in the five papers are not identical, but again they are quite similar. Barro [1] adds to his supply function a wealth variable, but this has little effect on the properties of his model because he also assumes (except for a brief discussion in Appendix 2) that long-term money growth is zero. Barro's supply function also differs from the others by using for the expected price level the expected *future* price level rather than the expected *current* price level. This difference is also not important for purposes of the discussion in this paper.

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difference between the actual and expected price level (because, since expectations are rational, all the information regarding anticipated government actions has already been incorporated into the actual and expected price levels), and so they cannot affect aggregate supply. There is thus little room, if any, for effective government countercyclical policy actions in these models. Regarding, for example, the recent oil and agricultural shocks to the U.S. economy, Barro concludes that "the approach in this paper argues that there is no role for monetary policy in offsetting these real shifts" [1, p. 26].

The studies just cited clearly pose an important challenge to those whose models do allow for effective government countercyclical policy actions. If countercyclical actions are, in fact, not effective, an important discovery has been made and an important flaw in previous models has been uncovered. Although in the final analysis empirical tests must decide which class of models is the best representation of the economy, the RE models are, as discussed in section 2, subject to an important theoretical criticism. This criticism is briefly as follows. In the RE models economic agents are assumed to be rational in the sense that they know the model and use all the available information in the system in forming their expectations, but they are at the same time irrational in the sense that their decisions are not derived from the assumption of maximizing behavior. The models thus do not seem plausible, since it seems odd for agents to be rational in their expectation formation and not rational otherwise.

This weakness of the RE models might not be important if it had little effect on the properties of the models, but, as is discussed in section 3, adding maximizing agents to a model with rational expectations reverses the key property of the RE models regarding the ineffectiveness of anticipated government actions on real output. As will be seen, the main reason for this reversal is that the government can affect the labor-leisure choice of households in a model in which households maximize utility.[3]

Before proceeding to the criticism of the RE models, it should be stressed that this paper is not meant to be a review of the literature on rational expectations models. Only one class of models is considered here, and the criticism of the models in this class does not necessarily apply to rational expectations models that are not in this class.[4]

2. A CRITICISM OF THE RE MODELS

To the extent that the aggregate supply equation in the RE models has any microeconomic justification, it is based on the Lucas and Rapping (LR) model

[3] The model discussed in section 3 is a special case of the theoretical model developed in [2]. The basic model in [2] is a model in which there are maximizing agents without rational expectations.

[4] Lucas's recent model [4] differs in a number of important ways from the class of models considered in this paper. It does, however, also have the property that anticipated government actions do not affect real output, and it is also not based on the assumption of maximizing agents. (Household labor supply, for example, is not derived from utility maximizing assumptions.) The basic criticism in this paper thus also applies to this model.

[7]. In this model a household is assumed to maximize a two-period utility function in consumption and leisure subject to a two-period budget constraint. Current labor supply is seen to be a function of the current wage rate and price level, the discounted future wage rate and price level, and the initial value of assets. The discount rate is the nominal interest rate. The signs of the derivatives of this function are ambiguous for the usual reasons. If it is assumed, however, as LR do, that current and future consumption and future leisure are substitutes for current leisure and that income and asset effects are small, then current labor supply is a positive function of the current wage rate and a negative function of the current and future price level and the future wage rate. This model is used to justify, in at least a loose sense, the assumption in the RE models that the difference between the actual and expected price level has a positive effect on aggregate supply. In the RE models, for example, an actual price level higher than that expected is analogous to an increase in the current wage rate relative to the current and future price level and the future wage rate in the LR model. Barro, for example, states that "A positive response of supply to [the difference between the actual and expected price level] can be viewed as an effect of speculation over time associated with the intertemporal substitutability of leisure" [1, p. 4].

Although the LR model is used in part as a justification for the aggregate supply equation in the RE models, there are some important features of the LR model that are not incorporated into the supply equation. One important variable that is omitted from the supply equation is the interest rate. As just discussed, the interest rate has an effect on the current supply of labor in the LR model, and so it should be included in the supply equation in the RE models. The interest rate clearly belongs in an equation whose justification in part is based on an appeal to intertemporal substitution effects. The RE models, with the exception of Barro's [1], also exclude from the supply equation any asset variables, even though the initial value of assets has an effect on the current supply of labor in the LR model.

The omission of the interest rate and initial value of assets from the supply equation in the RE models may be due in part to the fact that LR themselves dropped these two variables from the basic model estimated in their paper. Although LR are not very specific as to why the variables were dropped, the main reason appears to be that no satisfactory empirical "proxies" were available for the two variables. (See the discussion in [7, pp. 730, 750].) This is clearly, however, no reason to exclude the two variables from the theoretical specification of the supply equation in the RE models.

Another omission, of both the LR and RE models, is the exclusion of personal tax rates from the analysis. It is well known that personal tax rates have an effect on the labor supply of a utility-maximizing household, and so if the aggregate supply equation in the RE models is to be justified on microeconomic grounds, it should not exclude the possible effects of the tax rates on aggregate supply.

Although the discussion so far has concerned the aggregate supply equation in the RE models, it is likewise true that many of the other equations in the models are not based on the assumption of maximizing behavior. The authors of these models are not, of course, unaware of this. Sargent and Wallace, for example, note that their model is *ad hoc*, where "by *ad hoc* we mean that the model is not derived from a consistent set of assumptions about individuals' and firms' objective functions and the information available to them" [10, p. 241]. They do argue (p. 254) that the aggregate supply equation has some microeconomic foundations, but, as just seen, even this is open to question.

The RE models thus have the odd characteristic that the economic agents in the models are rational with respect to their expectations but not rational with respect to their overall behavior. As mentioned in section 1, this weakness might not be important if it had little effect on the properties of the models, but, as will be seen in the next section, adding maximizing agents to a model with rational expectations reverses the key property of the RE models regarding the ineffectiveness of anticipated government actions on real output.

3. A MODEL WITH BOTH RATIONAL EXPECTATIONS AND MAXIMIZING AGENTS

I have [2] developed a theoretical macroeconomic model in which the decisions of the individual agents in the economy are based on the solutions of multi-period maximization problems. Firms and banks maximize the present discounted value of expected future profits, and households maximize the present discounted value of expected future utility. At the beginning of each period each agent solves its maximization problem, knowing all past values, receiving in some cases information from others regarding certain current-period values, and forming expectations of future values. Expectations are generally assumed to be formed in simple ways in the model, although in a few cases the agents estimate some of the important parameters in the system before making their expectations. No agent knows the complete model, and so expectations can turn out to be wrong even though there are no random shocks in the model. Expectations are thus not rational.

It should be fairly obvious that the government can affect real output in this model because of the possibility of expectation errors, and in fact much of the modeling effort in [2] is concerned with tracing through the consequences of expectation errors.[5] This point needs no further elaboration here, since the important question for purposes of this paper is what happens in the model if expectations are assumed to be rational. Fortunately, a special case of the model was analyzed in [2, chap. 7] in which all expectations are rational. This special case is the "static equilibrium" (SE) version, which was derived as follows.

[5] The effect of government actions on the economy in this model is analyzed in detail in chapter 6 in [2].

First, a "self-repeating" version of the basic (dynamic) model was constructed by appropriate choice of initial values, parameters, and terminal conditions. For a particular set of government values (unchanging over time), the solution of this version is the same for each period. (Remember that there are no random shocks in the model.) The decision values of each agent for each period are the same as the other agents' expectations of them, for if they were not, the solution would not be the same each period. Errors of expectations in a given period cause agents to change their decisions in the next period. This self-repeating version is thus also a rational expectations version. Since the version also corresponds to no change over time, it can be collapsed into a one-period ("static") model, and this is what the SE version is.[6]

The SE version consists of thirty-three independent equations. There are seven government control variables in the model: three tax parameters, the reserve requirement ratio, the number of goods purchased, the amount of labor employed, and the amount of government securities outstanding. Because of the requirement in the SE version that the government budget be balanced, the government is free to choose only six of the seven values. A number of experiments of the following kind were performed in [2]. One of the seven government variables was chosen to be endogenous, and given values of the other six variables, the model was solved. One of the six variables was then changed, and the model was resolved. The new solution was then compared to the old solution to see how the economy was affected by the change in the government variable. The results of ten experiments are reported in [2, Table 7–5] for the case in which the amount of government securities outstanding is taken to be endogenous, and the results of four experiments are reported in [2, Table 7–6] for the case in which the marginal personal income tax rate is taken to be endogenous.

It is unnecessary for purposes of this paper to discuss these experiments in any detail. All that needs to be pointed out here is that *in every experiment real output was affected by the change in the government variable.* Two examples are the following:[7] (1) When the number of goods purchased by the government was increased in the endogenous government securities case, the supply of labor and real output increased. The price level, the money wage rate, and the interest rate also increased, and the real wage rate decreased. A higher interest rate has a positive effect on labor supply and a lower real wage rate has a negative effect, and in this case the positive interest-rate effect more than offset the negative real-wage effect. The demand for money also increased, as did the demand for and supply of government securities. (2) When the number of goods purchased by the government was increased in the endogenous personal tax rate case, the supply of labor and real output decreased. In this case the increase

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[6] Lucas [5] correctly pointed out that in the basic model in [2] economic agents do not have rational expectations. Lucas was, however, apparently unaware that the SE version of the basic model is a model with rational expectations.

[7] These two examples are the first experiment reported, respectively, in [2, Tables 7-5, 7-6].

in government spending was primarily financed by an increase in the personal tax rate, which, other things being equal, has a negative effect on labor supply. (In the endogenous government securities case the increase in government spending was primarily financed by an increase in the price level.)

The reader is referred to [2, chap. 7] for further discussion of these and other experiments. The experiments show that government actions affect real output by affecting the variables that influence labor supply, i.e., by affecting the labor-leisure choice of households. The property that anticipated government actions have no effect on real output is thus reversed when one considers a model with both rational expectations and maximizing agents.

Before concluding this section, it should be noted that anticipated government actions affect real output in the SE version of the model even when these actions do not involve tax-rate changes. In the first experiment discussed above, for example, the increase in the number of goods purchased by the government affected real output even though all three tax parameters of the government remained unchanged. The key variable that government actions do affect, which in turn affects the labor-leisure choice of households and thus real output, is the interest rate.

Finally, it should be stressed that the SE version was used here only as a convenient example, convenient in the sense that a number of relevant experiments had already been performed. This is not to say that a dynamic model of maximizing agents with rational expectations would not also have the property that anticipated government actions affect real output. It is just that it is unnecessary for the sake of the present argument to consider any other examples, given that the particular example used has this property.

4. SUMMARY AND CONCLUSION

The main argument of this paper is easy to summarize. The RE models postulate rationality with respect to the formation of expectations, but not with respect to overall behavior, and this does not seem plausible. When rationality with respect to overall behavior is introduced into a model with rational expectations, the key property of the RE models regarding the ineffectiveness of anticipated government actions on real output is reversed. In this "completely" rational model the government can affect real output by affecting the labor-leisure choice of households.

There is some attempt in the RE models to justify the aggregate supply equation by appealing to the Lucas-Rapping model, which is based on the assumption of maximizing behavior, but this justification is weak. The interest rate is excluded from the supply equation and, except for Barro's model [1], so also is the initial value of assets. Both of these variables are in the original LR model. Many of the other equations of the RE models are also *ad hoc*, as noted by Sargent and Wallace [10].

As a final remark, it should be noted that nothing has been said in this paper about possible empirical tests of alternative types of macroeconomic models. With respect to the assumptions of rational expectations and maximizing agents, there are four types of models that one can consider testing: models with and without rational expectations and with and without maximizing agents. The standard Keynesian model is an example of a model without rational expectations and without maximizing agents; the basic model in Fair [2, 3] is an example of a model without rational expectations but with maximizing agents; the model discussed in section 3 of this paper is an example of a model with rational expectations and with maximizing agents; and the RE models are examples of a model with rational expectations but without maximizing agents. As is well known, empirical tests of alternative types of models are difficult, and a discussion of this issue is beyond the scope of the present paper. It does seem, however, given the criticism of the RE models in this paper, that they should be modified to be consistent with the assumption of overall maximizing behavior before they are tested.

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