COWLES FOUNDATION FOR RESEARCH IN ECONOMICS

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COWLES FOUNDATION DISCUSSION PAPER NO. 442

CAN THE GOVERNMENT AFFECT REAL OUTPUT?: A CRITIQUE OF MODELS WITH RATIONAL EXPECTATIONS

By

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January 4, 1977

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I. Introduction

A number of macroeconomic models have been constructed recently in which government actions affect real output only if they are unanticipated. Models in this category include those of Lucas [5], Sargent [9], Sargent and Wallace [11], Barro [1], and Sargent [10].[1] Three important characteristics of these 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] Because information is

*The research described in this paper was undertaken by grants from the National Science Foundation and from the Ford Foundation.

[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. Lucas' most recent model [6], while differing in a number of important ways from the other models, also has the property that anticipated government actions do not affect real output.

[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.

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 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 countercylical policy actions in these models. Regarding, for example, the recent oil and agricultural shocks to the U.S. economy, Barro [1] concludes that "the approach in this paper argues that there is no role for monetary policy in offsetting these real shifts." (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. The present paper is a response to this challenge. It is first argued, in Section II, that the theoretical structure of the above models is weak. (In the rest of this paper these models will be referred to as "RE models.") In the RE models economic agents are assumed to be rational in the sense that they use all of the available information in the system, but they are at the same time irrational in the sense that their decisions are not derived from the assumption of maximizing behavior. A model is then presented, in Section III, in which agents are rational both in their use of information and in their decision making processes. This model has the property that anticipated government actions

can affect real output. The omission of maximizing agents from the RE models thus has important consequences: with maximizing agents the conclusion about the ineffectiveness of anticipated government actions no longer holds. 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. The model discussed in Section III is a special case of the theoretical model developed in Fair [3]. The basic model in [3] is a model in which there are maximizing agents without rational expectations.

An important empirical question is whether the assumptions of rational expectations and maximizing agents lead to the specification of more accurate empirical macroeconomic relationships than have been estimated in the past. There are four basic theoretical models that one can consider using to guide the specification of empirical relationships: (1) the RE models, with rational expectations but not maximizing agents, (2) a model as in [3], with maximizing agents but not rational expectations, (3) a model as in Section III of this paper, with both rational expectations and maximizing agents, and (4) models with neither rational expectations nor maximizing agents, such as the standard Keynesian models. In Section IV of this paper some empirical evidence is adduced in favor of the assumption of maximizing agents and against the assumption of rational expectations; that is, in support of models of type (2).

Given that models of type (2) allow for effective government countercyclical policy actions, the two basic conclusions of this paper are: (1) Theoretically, anticipated government actions can affect real output except in the case in which agents have rational expectations but do not otherwise maximize. This latter case does not seem plausible, since it

seems odd for agents to have all of the information needed to form rational expectations and yet not also to maximize utility or profits. (2) Empirically, there is some evidence in favor of models in which anticipated government actions can affect real output.[3]

II. A Theoretical Weakness 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 [8]. 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

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[3] This paper is also in part a response to Lucas' review [7] of my book, Fair [3]. In this review Lucas correctly pointed out that in the basic model in [3] economic agents do not have rational expectations. While Lucas meant this to be a criticism of the model, it is not a criticism if, as the evidence discussed in Section IV of this paper seems to indicate, the assumption of rational expectations is not a good empirical approximation. Also, Lucas was apparently unaware, as is discussed in Section III of this paper, that the "static-equilibrium" version of the basic model in [3] is a model with rational expectations.

and expected price level has a positive effect on aggregate supply. A higher actual-than-expected price level in the RE models, for example, 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 [1], 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." (p. 4)

It is clear that the link between the LR model and the aggregate supply equation in the RE models is a loose one. An important theoretical weakness of the RE models is the exclusion of the interest rate from the supply equation. 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 on pages 730 and 750 in [8].) This is clearly, however, no reason to exclude the two variables from the theoretical specification of the

supply equation in the RE models.[4]

Another theoretical weakness, 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, completely unaware of this. Sargent and Wallace [11], 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." (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 very rational with respect to their expectations but not rational with respect to their overall behavior.[5] 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

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[4] There is also some empirical evidence that indicates that the aggregate supply of labor in the U.S. may be responsive to interest rates and assets. This evidence is discussed in Section IV of this paper.

[5] Lucas' most recent model [6] is also not based on the assumption of maximizing agents. Household labor supply, for example, is not derived from utility maximizing assumptions.

to the RE models reverses the key property of the models regarding the ineffectiveness of anticipated government actions on real output.

III. A Model with Both Rational Expectations and Maximizing Agents

In [3] a theoretical macroeconomic model is developed in which the decisions of the individual agents in the economy are based on the solutions of multiperiod 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.

Much of the modeling effort in [3] is concerned with tracing through the consequences of expectation errors. Banks, for example, know that they may make mistakes, and so they announce to firms and households both the loan rate and the maximum amount of money that they will lend in the period. Similarly, firms know that they may make mistakes, and so they announce to households both the wage rate and the maximum amount of labor that they will employ in the period. Firms take into account the loan constraint from banks when solving their maximization problems, and households take into account the loan constraint from banks and the labor

constraint from firms when solving their maximization problems. Binding constraints are a form of disequilibrium in the system. The difference, for example, between the number of hours that households would like to work if they were unconstrained and the number of hours that they choose to work given the constraints is a measure of unemployment. There are a number of different "regimes" in the model corresponding to different combinations of binding and nonbinding constraints.

It should be fairly obvious that the government can affect real output in this model because of the possibility of expectation errors.[6] 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. Since there are no random elements in the model, the assumption of rational expectations means that each agent knows all of the other agents' decision making processes and also knows how each decision affects all of the other decisions in the economy. Each agent, in other words, knows the entire model exactly. There can be no binding constraints in this situation (and thus no unemployment) since such constraints arise only from errors of expectations. A solution of the model for each period corresponds to each agent's decisions being equal to what all of the other agents expect those decisions to be. One of the decisions of a firm, for example, is the path of its price (the current and future values of its price), and in the case in which expectations are rational this path must be the same as the path that banks, households, and other firms expect the firm to choose.

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[6] The effect of government actions on the economy is analyzed in detail in Chapter Six in [3].

Consider now whether the government can affect real output in this rational expectations version of the model. The decision or control variables of the government in the model are five tax parameters, the reserve requirement ratio, the number of goods to purchase, the amount of labor to employ, and the amount of government securities outstanding. The government budget constraint is accounted for in the model, so that any nonzero level of savings of the government in a period that is not absorbed by a change in government securities outstanding corresponds to a change in bank reserves (high powered money). Assume that a set of values (both current and future) of the government variables have been chosen for which the model with rational expectations has a solution. (This set may or may not have to correspond to a zero level of savings of the government each period, depending, among other things, on what one assumes about terminal conditions for each agent's multiperiod maximization problem.) Consider now a change in at least one value in this set. A change will be said to be "feasible" if it leads to a solution of the model. (All feasible changes may require a change in more than one value in the set, if, for example, a zero level of savings of the government is required each period.)

The key question is whether all feasible changes leave the real output path unaffected. Real output changes in the model if the labor supply changes. The labor supply of each household is a function of the current and future values of: its wage rate, the price it pays for goods, the interest rate it faces, the marginal personal income tax rate, the level of transfer payments or nonlabor income it receives, and the value of its assets or liabilities.[7] Given the number of variables that affect

labor supply, it seems unlikely that all feasible changes in government values would leave labor supply unchanged. This conjecture is not, of course, a proof that there exists a feasible change that affects the real output path, but this can in fact be shown to be true by means of the following particular example.

A special case of the model with rational expectations is the "static equilibrium" (SE) version presented in Chapter Seven in [3]. The SE version was derived as follows. 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. 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.

The SE version consists of 33 independent equations. There are seven government control variables in the model: three tax parameters,[8] the reserve requirement ratio, the number of goods purchased, the amount

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[7]Except for the inclusion of tax rates and the generalization to more than two periods, this model of labor supply is very similar to the Lucas and Rapping model discussed in Section II.

[8]The SE version has two fewer tax parameters than does the basic model, but this difference has no direct bearing on the present discussion.

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. In other words, one of the seven variables of the government must be taken to be endogenous in order for the model to be solved (i.e., in order for changes in the other government values to be "feasible"). A number of experiments of the following kind were performed in [3]. 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 Table 7-5 in [3] 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 Table 7-6 in [3] 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:[9] (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

[9]These two examples are the first experiment reported, respectively, in Tables 7-5 and 7-6 in [3].

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 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 Chapter Seven in [3] 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. It should also be noted that the conclusion regarding the effectiveness of antici-

pated government actions in the SE version does not depend on whether or not the demand for money is a function of the rate of interest. Experiments were performed both with and without the demand for money being a function of the rate of interest, and, as discussed on page 176 in [3], the results in both cases are similar. In the SE version the interest rate is, in a loose sense, more influenced by the equations in the "real" block than by the equations in the "financial" block, and so whether or not the demand for money is a function of the rate of interest has only a slight effect on the overall properties of the model.

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 the more general (dynamic) model of maximizing agents with rational expectations discussed in this section would not also have the property that anticipated government actions affect real output. It is just that it is unnecessary for sake of the present argument to consider any other examples, given that the particular example used has this property.

IV. Empirical Issues

As mentioned in Section I, there are four basic theoretical models that one can consider using to guide the specification of empirical relationships: models with and without rational expectations and with and without maximizing agents. This section contains a brief discussion of some empirical evidence in favor of the model with maximizing agents and without rational expectations. A few remarks are also presented regarding possible future tests of the models.

The evidence in favor of the assumption of maximizing agents is

as follows. The basic theoretical model in [3] (not the SE version) is, as discussed in Section III, one in which there are maximizing agents but not rational expectations. An econometric version of this model is developed in [4]. In Chapter Eight in [4] the prediction accuracy of the econometric model is compared to the prediction accuracy of other models. The other models are Keynesian in spirit and, it seems safe to say, are not based in any significant way on either the assumption of maximizing agents or the assumption of rational expectations. The evidence in Chapter Eight, although clearly tentative, does seem to indicate that this econometric model is more accurate than the others. There thus seems to be some evidence in favor of the assumption of maximizing agents, although more tests are needed before anything very definitive about this issue can be said.

Other evidence is also contained in [4] in favor of the assumption of maximizing agents. The seven consumption and labor-supply equations of the household sector (equations (1)-(7) in Table 2-3 in [4]) include as explanatory variables a price variable, the wage rate, a short-term interest rate, a long-term interest rate, the marginal personal income tax rate, nonlabor income, and the value of assets of the previous period. These are all variables that one expects on microeconomic grounds to affect the consumption and labor-supply decisions of households. While these variables are not all significant in all seven equations, there are enough significant variables in the equations to lend some support to the view that the assumption of maximizing agents is a useful guide for the specification of empirical macroeconomic relationships. Again, of course, more evidence is needed before anything very definitive can be said about this.

One of the labor-supply equations in [4] (equation (6) in Table 2-3) explains the labor force participation of all persons 16 and over except males 25-54. A variable measuring the real value of assets of the previous period appears in this equation with a t-statistic of -2.23, and an interest rate variable (the mortgage rate, which is taken to be a proxy for long-term interest rates facing the household sector) appears in the equation with a t-statistic of 1.42. There is thus some slight evidence that assets and interest rates affect the aggregate supply of labor in the U.S. At the least, this evidence indicates that assets and interest rates should not be excluded a priori from the supply equation in the RE models. A variable defined to be one minus the marginal personal income tax rate appears in the equation explaining the labor force participation rate of males 25-54 (equation (5) in Table 2-3) with a t-statistic of 2.71, evidence which again indicates at the least that tax rates should not be excluded a priori from the supply equation in the RE models.

The evidence against the assumption of rational expectations is also contained in [4], but it is more indirect. This evidence is as follows. Disequilibrium situations in the theoretical model are due to errors of expectations. An attempt is made to account for disequilibrium effects in the econometric version by the inclusion of certain variables in the estimated equations. The most important variable in this regard is a variable ZJ, which is designed to measure the labor constraint from firms to households. In principle this variable is equal to one when the labor constraint is not binding on households, and is less than one when the constraint is binding.[10] The variable turns out to be an impor-

[10] A discussion of the construction of ZJ can be found in Section 4.3 in Chapter Four in [4].

tant explanatory variable in the consumption and labor-supply equations of the household sector. It seems quite unlikely that this variable would be as important as it is were there never any disequilibrium effects in practice. To the extent, therefore, that these effects can be attributed to expectation errors, the importance of the ZJ variable in the model is a piece of evidence against the assumption of rational expectations.

Since the evidence just cited is far from definitive, more tests of the assumption of rational expectations would clearly be desirable. Sargent [10] has estimated an econometric model based on the assumption of rational expectations, and so one test would be to compare the prediction accuracy of this model to that of others. Sargent does not, unfortunately, present any results of solving the model, and so it is not possible to judge its prediction accuracy from the results in his paper. In future work, however, it should be possible to make such comparisons. One potential problem with this test is, of course, the fact that Sargent's model is not also based on the assumption of maximizing agents. If, for example, his model turns out to be less accurate than the model in [4], it may be difficult to tell whether this is due to the assumption of rational expectations or to the assumption that agents do not maximize (or to both). An alternative procedure would be to specify an econometric model based on the assumption of both rational expectations and maximizing agents, and then test the prediction accuracy of this model against that of others.

One final point about possible tests of the assumption of rational expectations should be made. In most empirical work based on this assumption, lagged values have been used to estimate or account for expectations.[11]

[11] This is true, for example, of the empirical work in Sargent [9] and [10]

This procedure is, of course, no different from that used in empirical work not based on the assumption.[12] This similarity of procedures means that it is generally not possible to distinguish empirically between models with and without rational expectations on the basis of estimated expectations. One must look elsewhere for possible tests of the assumption, such as the above test regarding the ZJ variable or tests of the relative prediction accuracy of alternative models.

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and Barro [2]. The question of whether this procedure is appropriate in models based on the assumption of rational expectations is an interesting one, but it is beyond the scope of the present paper. One might think that if expectations are truely rational, they would not be very well captured in empirical work by the use of a few lagged values.

[12] In the specification of the econometric model in [4], for example, lagged values were used freely to try to capture expectational effects.

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