

The CBO's Policy Analysis:
An Unquestionable Misuse of a
Questionable Theory

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The analyses of fiscal and monetary policies that the Congressional Budget Office (CBO) provides Congress tend to be biased, encouraging the use of activist stabilization policies. The CBO's virtual neglect of economic uncertainties and its emphasis on very short time horizons make active policies appear much more attractive than its own model implies. Moreover, the CBO's adoption of the macroeconomic approach fundamentally biases its analyses. Macroeconomic models do not remain invariant to changes in policy rules and are mute on the implications of alternative policies for efficiency and income distribution. The rational expectations equilibrium approach overcomes these difficulties and implies that less activist and less inflationary policies are desirable.

The views expressed herein are solely those of the authors and do not necessarily represent the views of the Federal Reserve Bank of Minneapolis or the Federal Reserve System.

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The CBO's Policy Analysis:
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by P. Miller and A. Rolnick

The Congressional Budget Office (CBO) is in an unenviable position. It is called upon with short notice to produce objective, quantitative studies of the economic effects of alternative government policies. This is a most difficult task under the best of conditions. It then is not too surprising, given the time and political constraints within which the CBO staff must work, that one can find many faults with its procedure.

Our main criticism of the CBO's analysis, though, is that many of its faults are not neutral: they tend to have a bias which encourages active stabilization policies. The CBO's virtual neglect of economic uncertainties and its emphasis on very short time horizons make active policies appear much more attractive than even its own macroeconomic model would suggest.

It would not be enough, however, for the CBO to make better use of its existing model. That is because the CBO's model, like all existing macroeconomic models, is useless for policy analysis: it allows neither reliable prediction of the economic effects of alternative policies nor proper evaluation of alternative economic outcomes. We argue that the CBO should adopt a rational expectations, equilibrium approach in order to overcome these difficulties.

Our paper is organized as follows: In Part I we describe the control-theoretic framework that's been adopted by most macro analysts and examine its implications for policy analysis. We next describe the CBO's approach and indicate how it misuses this framework. In Part II we criticize the traditional macroeconomic approach to policy analysis and conclude by recommending the rational expectations, equilibrium approach.

I.

To help us evaluate the CBO's analysis, we first describe the control-theoretic framework that many macroeconometric analysts have adopted for policy evaluation. [See, for example, Chow (1973, 1975, 1976), Craine and Havenner (1973, 1977), Kareken, Muench, and Wallace (1973), Kendrick (1977), Poole (1970), and Theil (1965).] This framework imposes important criteria that must be met for an analysis to be valid. We argue that the CBO falls considerably short of meeting these criteria.

A. The Macroeconometric Approach

The control-theoretic framework consists of the following three elements:

1. a model which describes the effects of changes in the variables the decision makers control (instruments) on the rest of the variables in the system,
2. an objective function which assigns values to alternative paths of the variables important to decision makers (goals),
3. a technique for finding the settings of the instruments which maximize the objective function.

This framework is quite general and has been readily adapted to macro policy analysis. The typical macroeconometric model, objective function, and techniques used to compute the best values of the instruments are described below.

The typical macroeconometric model is a large system of equations describing the dynamic interactions of many economic variables. The variables involved consist of those determined within the model (the endogenous variables), and those that affect the endogenous variables but are determined outside the model (the exogenous variables) such as weather and policy instruments.

Because of its mathematical tractability, macro analysts usually use a linear model or a linear approximation to a nonlinear model in their analysis. It will be useful for our discussion to represent a linear macroeconomic system by

$$(1) \quad A_0 y_t + \dots + A_m y_{t-m} = B_0 x_t + \dots + B_n x_{t-n} + \epsilon_t$$

$$(2) \quad x_t = C_1 x_{t-1} + \dots + C_p x_{t-p} + u_t.$$

Here y_t is an $(L \times 1)$ vector of endogenous variables, x_t is a $(K \times 1)$ vector of exogenous variables, and ϵ_t is an $(L \times 1)$ and u_t is a $(K \times 1)$ vector of random disturbances. The A_j 's are $(L \times L)$ matrices, and the B_j 's are $(L \times K)$ matrices of system coefficients. The C_j 's are $(K \times K)$ matrices of coefficients which define the exogenous processes. Equation (1) represents the structural relationships in the economy, including both behavioral equations and accounting and balance sheet identities. Equation (2) contains, among other exogenous relationships, the rule followed by policymakers.^{1/} For simplicity, we assume that equation (2) contains only the policy rule.

Also because of its mathematical tractability, economists usually have employed a quadratic objective function. Chow (1976a), for example, postulates for a T-horizon control problem, the function

$$(3) \quad W = \sum_{t=1}^T (z_t - \hat{z}_t)' J_t (z_t - \hat{z}_t)$$

where the z_t 's are $(Q \times 1)$ vectors of exogenous and endogenous variables ($Q \leq K+L$), the \hat{z}_t 's are $(Q \times 1)$ vectors of given targets, and J_t 's are known symmetric, positive, semidefinite $(Q \times Q)$ matrices. The quadratic functional form is one of the simplest mathematical forms which satisfies the assumption of decreasing marginal rates of substitution and is commonly used in many fields of applied econometrics.^{2/}

Given a macroeconometric model and an explicit objective function, the problem of finding the optimal rule is technical and, because of coefficient uncertainty, usually quite difficult. One has to find the settings of the policy instruments over the planning horizon ($t=1, \dots, T$) that maximizes W subject to equation (1). The solution is a rule which describes how to set policy instruments in each period based on available information. Assuming that current information includes last period's realizations, the optimal rule will be of the form $x_t = D_1 \begin{bmatrix} x_{t-1} \\ y_{t-1} \end{bmatrix} + \dots + D_h \begin{bmatrix} x_{t-h} \\ y_{t-h} \end{bmatrix}$, which in general is different from equation (2). (The D_j 's are $K \times (K \times L)$ matrices.) In the case of linear models as represented in equation (1), with known coefficients, the method of dynamic programming has been successfully used to find the optimal rule. Even in the case of linear models, with unknown coefficients, but where the distributions of coefficients are known, optimal rules have been found. [For examples of both cases, see Chow (1975, Chapters 8 and 10).] Little progress, however, has been made in the case where the uncertainty about coefficients is due to estimation. [Suggested approximations to this problem can be found in Chow (1975, Chapter 11), Kendrick and Kang (1975), MacRae (1972), Prescott (1972), Tse and Bar Shalom (1973), and Zellner (1971, Chapter 11).]

At least in theory, though, the control-theoretic approach can produce--for a given model and objective function--a policy rule that yields the highest level of welfare over the policy horizon. Nevertheless, because in practice policy analysts are not policymakers, they cannot compute this rule. Seldom, if ever, are they given enough information about the objective function. They are usually told which variables are important, but they do not know how to evaluate alternative outcomes for these variables or how far to extend the analysis. So policy analysts, in practice, have never been able to calculate the optimal rule.

Many macro analysts, however, have adopted an alternative procedure that, under certain conditions, is equivalent to following the best policy. Roughly stated, the procedure is as follows: In the initial decision period the model's residuals are set to zero; the model is then used to estimate the impact over the whole horizon of alternative sequences of policy instrument values; policymakers choose the most preferred outcome, and policy instruments in the first period are set at the values in the sequence associated with that outcome; when new information becomes available, forecasts, conditional on alternative sequences of policy instrument values, are again generated over the entire forecast horizon; and again the policymakers' choice of the most preferred outcome determines the settings of policy instruments, until new information is available. Theil (1965, pp. 423, 424) has shown that this procedure is equivalent to following the best rule if the world (and hence the model) is linear and the coefficients are known. This is the well-known certainty-equivalence theorem. The period-by-period approach it implies is well suited to the actual problems faced by policy analysts since no explicit objective function is required.

The period-by-period approach only yields an approximation to the best rule. Coefficients, as well as residuals, have to be treated as stochastic; most are unknown and must be estimated from a fairly limited data set. It immediately follows that the certainty-equivalence approximation to the best rule will only be as good as the precision of the estimates of the model's coefficients; the less known about the coefficients of the model, the further the approximation is from the best policy. The approximation, moreover, will probably not deviate in a neutral way; it will likely be biased towards policy activism. When there is coefficient uncertainty, the certainty-equivalence rule generally will call for a larger response to current information (that is, a larger change in the policy instruments) than the optimal rule response.^{3/}

Macroeconometric practitioners, therefore, should be cautious in their policy analysis. They are clearly handicapped by the lack of a well-defined objective function. To compensate they must estimate the consequences of alternative policies over a reasonably long period so it covers the likely policy horizon. To avoid seriously biasing their analysis toward activism, they must present not only their mean forecast of the impact of alternative policies, but the rest of the distribution as well.

B. The CBO's Approach

Even though the CBO works directly for policymakers, it faces the same handicaps as other macroeconometric analysts. Congress does not provide it with an objective function, yet it is required to analyze alternative Congressional policies. So like many other practitioners, it has adopted the period-by-period approach and presents Congress with forecasts of the impact of alternative policies.

To generate these forecasts the CBO uses a hybrid macroeconometric model. It forecasts macro goal variables, such as the rate of inflation and the unemployment rate, typically over one to two years. Each forecast is conditioned on a sequence of policy actions. The Social Security Tax Reform Act of 1977 and the fiscal 1979 congressional budget are two recent policies examined by the CBO in this way [CBO (1978b, 1978a)].

1. The CBO's Analysis of Two Recent Congressional Policies

The 1977 social security amendments were an attempt to make the social security system solvent for at least the next four decades. They imposed a substantial increase in payroll taxes beginning with \$6.6 billion in 1979 and increasing to \$24.9 billion by 1982. The tax increase included both an increase in the taxable income level and an increase in tax rates. (The amendments call for some benefit cuts, but they were relatively minor.)

This change in the tax structure of the system appears to be a significant step towards keeping the system solvent on a cash flow basis, but it could also have significant side effects on employment, output, and inflation. The CBO focused mainly on the policy's short-run impact on these macro variables. It compared a no tax increase policy to the 1979 tax increase. The CBO's analysis indicated that the reduction in aggregate demand caused by higher taxes immediately would translate into lower real GNP. In ensuing periods, inflation would increase. Specifically, CBO found that by 1982 this tax increase would reduce real GNP by almost 1 percent and employment by .5 million, while increasing the GNP deflator around 1/2 percentage point. These effects were expected to build up gradually prior to 1982 [CBO (1978b, p. 30)].

Another issue the CBO recently examined with the macroeconomic approach was the inflation-unemployment trade-off facing policymakers in the summer of 1978. What would be the likely outcome for the economy under the proposed 1979 fiscal budget? Would inflation continue at a high rate? And if so, what would be the cost of reducing inflation in terms of lost output and employment?

CBO's analysis of the economy indicated the policymakers were in a dilemma. While inflation was to continue at high rates, at least through 1979, the economy was to experience only a very moderate rate of growth. Any tightening of monetary or fiscal policy to fight inflation, therefore, could easily push the economy into a recession. Specifically, under the fiscal 1979 budget, which included a \$15 billion tax cut, and under an assumed moderate course for monetary policy (the Treasury bill rate not rising much above 7 percent), real GNP was expected to grow in the 3.5 to 4.5 percent range in 1978, slowing to 2.7 to 4.2 in 1979; the unemployment rate was expected to be within a 5.2 to 6 percent range by the fourth quarter of 1979. Inflation, meanwhile, could go as high as 7.8 percent in 1978 and slow very little in 1979 [CBO (1978a, p. 26)].

CBO estimated that to lower inflation even modestly would cause a recession. Under the same fiscal budget assumptions but assuming a significantly tighter monetary policy (the Treasury bill rate rising to 8.5 percent by early 1979), it estimated that real output would begin to decline by early 1979, leading eventually to a recession and 7 percent unemployment by the end of 1979. CBO found that this significant loss in output and jobs would lead only to a 1/2 percentage point reduction in the 1979 inflation rate.

CBO concluded that traditional fiscal and monetary policies, at least in the short run, would be a very expensive way to fight inflation. It instead suggested the use of a different mix of monetary and fiscal policies and new structural programs that eventually would improve the inflation-unemployment trade-off. The CBO recommended that the government should take a closer look at its own actions and regulations that raise the private sector's costs, that it intervene directly into the wage-price determination process with some form of incomes policy, and that it promote measures to increase the supply of goods and services [CBO (1978b, pp. 60-65)].

2. The CBO's Macroeconometric Model

The CBO's analysis follows the standard macroeconometrics approach. The model it employs to generate estimates of the impact of alternative policies, however, is a departure from the usual macroeconometric model.^{4/}

Several prominent econometric models exist which are specifically designed to address macroeconomic policy issues, but here the CBO has a problem. While generally appealing to the same Keynesian theory, these models differ considerably in detail and structure.^{5/} As a result, they produce a wide range of policy impacts. Experimenting with five such models--Data Resources, Inc., (DRI), Wharton, Chase, MIT-Penn-SSRC (MPS), and Fair--the CBO found, for example, that a \$10 billion annual increase in government expenditures caused

some increase in prices in one model, while causing virtually no change in another. Which model should it believe?

The CBO decided to believe partly in them all. To "make sense out of the diverse estimates,"^{6/} the CBO constructed its own model by averaging over the five macroeconomic models cited above. The averaging procedure is reported in CBO's Multipliers Project [CBO (1977)]. The procedure is to take a weighted average of certain so-called key ratios of endogenous variables (the consumption-to-income and investment-to-income ratios, for example) across models. The CBO averaged this way, instead of, say, averaging reduced-form policy multipliers, because it claimed to have some prior information about such ratios and virtually none about policy multipliers. It was this information that determined the weights the CBO used in its averaging scheme.

The CBO constructed the first version of its model to answer the question, What happens to GNP, consumption, fixed investment, other GNP components, transfer payments, tax revenues, and wages when there is a change in federal expenditures? Monetary policy and corporate tax versions were also constructed. The following simplified version of the CBO's fiscal expenditure model will help explain its procedure:

$$\Delta Y_{t+i} = \Delta C_{t+i} + \Delta I_{t+i} + \Delta G_{t+i}$$

$$\Delta C_{t+i} = a_i \Delta Y_{t+i}$$

$$\Delta I_{t+i} = b_i \Delta Y_{t+i}$$

$$\Delta G_{t+i} = \Delta \bar{G} \quad i=1, \dots, 10$$

where ΔY , ΔC , and ΔI denote the change in income, consumption, and investment, respectively, in period $t+i$ due to exogenous changes in government spending, $\Delta \bar{G}$, initiated at $t+1$. The ten values of a_i and b_i are the parameters the CBO derives.

The a_i 's and b_i 's are constructed by simulation for given G's. The CBO first simulates each model for some given level of government expenditures and other exogenous variables. The models are then simulated again with the same exogenous variables but with new levels of G that reflect a once-and-for-all jump of $\Delta\bar{G}$ vis-a-vis the original path. For each model, ten quarters of key ratios are computed. The CBO would compute the ten quarters of a_i 's and b_i 's for our illustrative model by averaging these ratios across models and incorporating (in some unspecified way) its prior information about the a_i 's and b_i 's. The table below contains the consumption-income ratios (a_i 's) the CBO computed for the five models cited above, and the averaged coefficients it used in its fiscal expenditure model [CBO (1977, p. 6)]. These coefficients were based on a sustained \$10 billion increase in government expenditures.

TABLE 1
QUARTERLY VALUES OF a_i

Quarter	Models					Basic Multipliers Model
	DRI	Wharton	Chase	MPS	Fair	
1	.41	.26	.55	.25	.68	.35
2	.63	.26	.47	.37	.80	.45
3	.68	.28	.56	.44	.95	.51
4	.71	.30	.65	.51	.97	.55
5	.73	.39	.68	.58	1.02	.60
6	.73	.49	.67	.62	.96	.62
7	.73	.69	.69	.65	.97	.67
8	.71	.83	.70	.70	.98	.70
9	.71	.75	.70	.72	.95	.71
10	.71	.67	.70	.76	.90	.71

The Multipliers Project is the CBO's attempt to construct a consensus model to forecast the impact of a particular change in policy. It clearly can't be used to study policy changes in general. Except for policy changes that are simply multiples of the one the CBO used to generate its key ratios, different policies generally yield different ratios [CBO (1977, p. 18)]. Since any

specific CBO model has limited use, the CBO produced different versions of its model for different policies. Thus, there is a monetary policy version and a corporate tax rate version [CBO (1977, pp. 15, 20)].

While limited to particular policies only, a CBO model can be used to forecast policy effects on all the endogenous variables in the system. Yet, the CBO uses the model only to predict nominal income. The impact on real GNP, inflation, and unemployment are derived from other equations the CBO estimates directly. The specific equations are reported in an unpublished study [CBO, 1975] and described in the following way:

"... employment and unemployment changes resulting from a policy change are derived from an Okun's law type of relationship between unemployment and the real GNP gap, lagged one quarter. . . . A two-equation, wage-price model and a CPI-GNP deflator relationship are then used to derive a GNP deflator consistent with the unemployment rate. The deflator, together with the level of nominal GNP, determines real GNP. The new GNP gap determines the next period's unemployment."7/

The logic of this model implies that the inflationary effects of aggregate demand policies stem entirely from changes in the unemployment rate acting through the Phillips curve. In the current period unemployment is predetermined, so that a change in aggregate demand policies affects real GNP but not prices. (Thus, if the Fed announced it intended to double or triple the money supply and then actually carried out its plan, the CBO model would predict that initially output would increase but prices would not be affected.) In subsequent periods the changes in real GNP alter the real GNP gap, thereby causing changes in unemployment which work through the Phillips curve to changes in prices.

C. The CBO's Analysis Is Flawed and Biased Towards Activism

How seriously should Congress take the CBO's model and its policy forecasts? Should it abandon fiscal and monetary policy restraint because it is an expensive way to fight inflation and instead adopt wage and price controls?

Should it also reconsider the social security tax increase because it will permanently lower real GNP? We think not. Even if we thought macroeconomic models were useful for policy analysis (and there are good reasons to think they are not, as we discuss in Part II), the CBO's analysis is seriously flawed.

The most obvious problems with CBO's approach stem from its model. To construct an average forecast it chose five of the dozen or so existing macroeconomic models, but it never provides a rationale for its selections. Did it pick models based on ex post or ex ante forecasting properties or some other criteria? The CBO also never describes the prior information it used to weight coefficients across models. One must wonder how good this information is and whether or not it was ignored by all other model builders. Without it being reported, we can neither assess its quality, nor reproduce the CBO's analysis. Another criticism is the model's potential lack of consistency. One of the major advantages of a macroeconomic model is that it can impose balance sheet and income constraints. One never has to worry about agents spending more than they receive because the model automatically enforces this constraint. It is not obvious that this holds for the CBO's model because it goes outside the averaged model to predict unemployment and inflation. Furthermore, we are again not provided with a rationale for its procedure. Although the CBO reports real GNP and inflation forecasts from its averaged model [CBO (1977, p. 24)], no explanation is given as to why the CBO replaces these forecasts with those generated by its own forecasting equations.

These shortcomings of the CBO's model raise serious doubts about its results, but do not bias them in any obvious way. However, when the CBO forecasts policy effects for only one to two years and when it virtually ignores the uncertainty implicit in its model, it does bias its results.

1. The CBO's Analysis Is Biased Because Its Horizon Is Too Short

Earlier in this paper we suggested that a careful analysis of alternative economic policies must include outcomes over the entire policy horizon. If policy analysts instead forecast the impact of alternative policies for only one or two years and then repeat the analysis two years later (because policy-makers really do care about more than just the immediate future), they in effect are solving for the optimal rule over the wrong policy horizon. It can readily be shown that a better policy would result by extending the initial analysis over a longer period.

Cutting the horizon short in this case also is not neutral. Most standard macroeconomic models--and the CBO's does not appear to be an exception--predict that a move to an expansionary policy will stimulate output and have little effect on inflation over a period of one to two years. Subsequently, the real output effect will die out, while the inflationary effect will grow. By truncating the forecasts at less than two years, therefore, the CBO gives the misleading picture that changes in policy will have major effects on real output and negligible effects on inflation. The chart on page 14 demonstrates these effects using an older version of the MPS model described in de Leeuw and Gramlich (1969).

2. The CBO's Analysis Is Biased Because It Ignores Uncertainty

Earlier in this paper we argued that a careful policy analysis must incorporate uncertainty. Yet here again CBO fails, and again it biases its results towards activism. The theory of decision making generally suggests that the less we know, the less we should do.^{8/} For economic policy this means that the more uncertainty about the impact of economic policies, the less responsive policy actions should be to current conditions. Thus, ignoring or just understating uncertainty will generally imply a more activist policy than is warranted.

The CBO has done exactly that by virtually ignoring the forecasting differences among macroeconomic models as well as ignoring the stochastic properties of the models themselves.

The CBO obviously recognizes that there is some uncertainty about policy forecasts. In fact, incorporating this uncertainty into its model was the purpose of the CBO's Multipliers Project. Nevertheless, simply averaging forecasts across models does not accomplish this purpose. The extent of this diversity, moreover, appears to be substantial. Consider for example its estimates of the consumption-to-income ratio. The range of this coefficient across models in the first quarter is .25 to .68. The range decreases in later quarters and is .71 to .90 in the tenth quarter (Table 1). The investment-to-income ratio varies from .02 to .08 in the first quarter and increases in range to .01 to .24 by the tenth [CBO (1977, p. 10)].

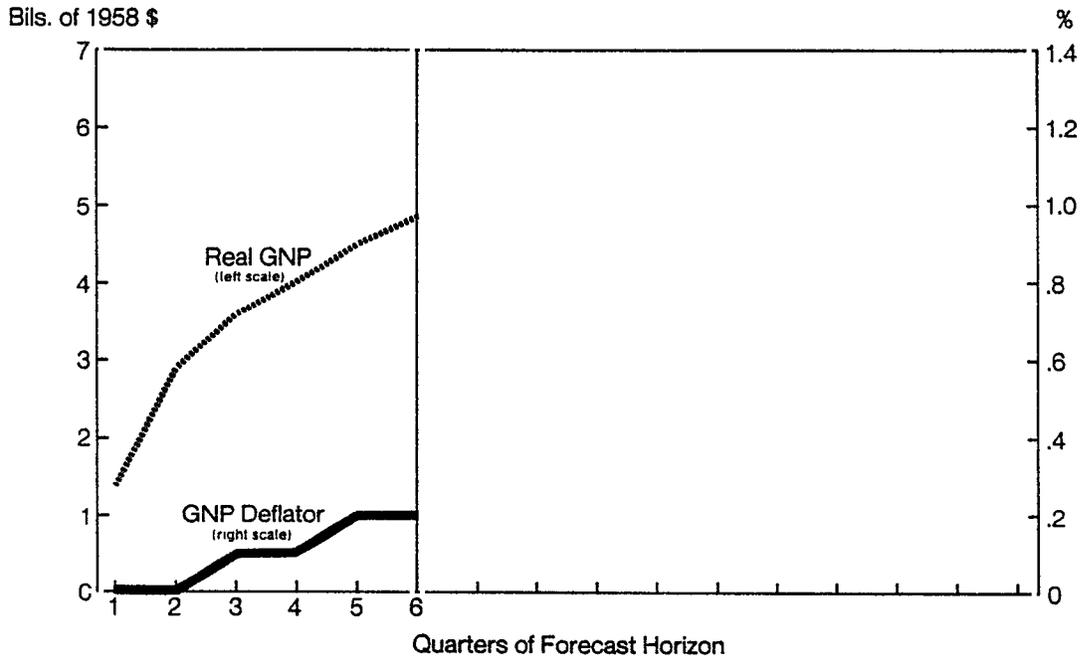
The stochastic properties of the individual models are another major source of uncertainty that is not incorporated into the CBO's analysis. The available evidence suggests that these models generate fairly large forecasting errors and are not stable over time. Yet no reference to this problem is found in any of the CBO studies.

There are two substantive ways to describe the accuracy of an economic model. The first is a model's implied forecasting properties, i.e., the distribution of forecasting errors implied by the estimation procedure and the sample period data and commonly summarized by the standard error of forecast statistic. The second is the actual forecasting record of the model outside the sample period, which is usually summarized by the average of actual forecasting errors.

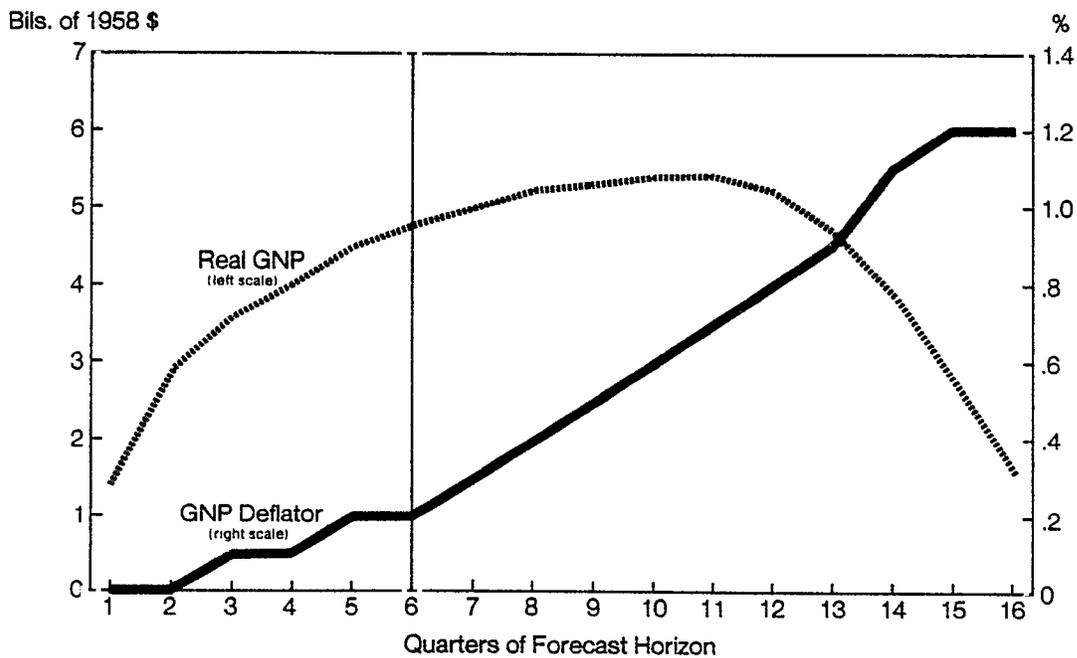
Both statistics are needed to judge the accuracy and usefulness of a model. The standard error of forecast measures the expected accuracy of a model, the degree of accuracy we can expect a model to produce over a long period of time

The Outcome From a Tax Cut*

Short Term: What Congress Sees



Longer Term: What the MPS Model Implies



* Effects of a .02 decrease in the personal income tax rate, initial conditions of 1964, Q1 [deLeeuw and Gramlich (1969, p. 489)].

if the model is correct. The actual forecast errors then provide a test of a model. If they are, say, two or more times greater than the standard error of forecast, we can reject the model at a high level of confidence. Either it never captured the true coefficients, or the true coefficients have changed. In either case, the model is not a reliable forecasting tool. A minimum forecasting criterion for a credible model, therefore, is that it pass a test of stability. That is, the model (the estimated parameters) must be stable over time.^{9/}

Clearly, this is a necessary but not a sufficient criterion. We can always build a model with large enough standard errors of forecast so that it easily passes a test of stability. For sufficiency, then, we would like models to have relatively small standard errors of forecast so that they provide some information to policymakers.

Although we do not have forecasting statistics for the specific models the CBO used in its Multipliers Project, the evidence we do have suggests these models are suspect. Macro models have generally done poorly on both forecasting criteria. Standard errors of forecast are usually quite large, well outside the range policymakers would find useful; and actual forecast errors are even larger, raising doubts about the reliability of these models.

The frequent use of intercept adjustments provides some casual evidence that macroeconomic models do not hold up over time. In practice macroeconomic models are hardly ever used with their originally estimated coefficients. Intercept adjustments might be justified as an efficient technique for reestimating a model as current information becomes available. Yet, no systematic or testable procedure has been used. Instead, we observe ad hoc adjustments that are rarely explained or defended. Either macro analysts have simply not done a careful job of describing their reestimation techniques, or their models really don't capture fixed economic relationships.

Formal testing of macroeconomic models, while limited, strongly confirms the latter proposition. Since the structure of most macro models is rather complex, the only practical way to calculate their forecasting properties is by simulation. The one study of which we are aware that simulated the distribution of forecasting errors for several macroeconomic models and tested for stability [Muench, et al., (1974)] raises serious doubts about the credibility of such models. The standard errors of forecast (estimated with pre-1970 data) were quite large for several key goal variables, and the models dramatically failed stability tests.

The distribution of forecasting errors for real GNP growth estimated in the Muench, et al., study illustrates the questionable value of macroeconomic models. The standard error of forecast for real growth was estimated at 2.5 percentage points for a four-quarter prediction and 3 percentage points for a six-quarter prediction. Since CBO's model is based on models similar to the ones analyzed in this study, the forecasting properties are likely to be about the same. If this is true, it would imply that CBO's 3 percent real GNP forecast for 1979 has a one-standard-error confidence band of 0.5 to 5.5 percent and a two-standard-error confidence band of -2.0 to 8.0 percent. It is likely that this margin of error would be considered large by most policymakers and would give them little confidence in the CBO's ability to forecast the future course of the economy.

Consumption, residential construction, business inventories, and short-term interest rates were other variables the Muench, et al., study found to have rather large standard errors of forecast. Yet, this was not true of all variables: the price level, for example, had a very small confidence band. Nevertheless, it's here where the models broke down the most. Actual forecast errors for the GNP deflator were quite large, significantly greater than three

times the standard error of forecast and probably caused these models to fail on the multivariate test [Muench, et al., (1974, pp. 502, 511)].

The evidence we have suggests that the macroeconometric models used by the CBO have generally large forecasting errors and are not stable over time. But what about the averaged model? Could it be stable and have relatively small forecast errors even though the underlying models lack these properties? We doubt it. Although we have no formal statistics, it is likely that an ad hoc average of unstable models will also be unstable; and besides the within-model errors, the diversity the CBO found across models suggest rather large standard errors of forecast.

The Phillips curve in CBO's model, which is not an average constructed from other models, also is unlikely to meet the minimum forecasting criteria. Both casual observations and formal tests suggest the Phillips curve has not been stable. As late as the early 1970s, the estimated relationship between inflation and unemployment suggested that the economy would experience as little as 4 percent inflation with an unemployment rate of 4 percent [Lucas (1977, p. 13)]. In recent years there have been a number of tests on the stability of Phillips curve relationships as posed by the CBO, and they have uniformly rejected the hypothesis that the relationships remained invariant over the 1970s. [For examples of such tests see McNees (1978, pp. 37-40).] So this crucial equation in the CBO model is also suspect.

There is obviously much evidence to at least question the stability and accuracy of macroeconometric models, yet the CBO hardly mentions the problem. It sometimes reports ranges for real GNP growth and inflation, but it does not tell us what these ranges represent. Based on the available evidence, the inflation range may be a one-standard-error confidence band; however, the real growth range is significantly smaller than that. Its words also suggest much more certainty than is warranted.

"The first concurrent resolution provided for a \$15 billion cut in taxes in fiscal year 1979 as compared with revenues from current policies. According to CBO estimates, if the entire tax cut were dropped, real growth from the fourth quarter of 1978 to the fourth quarter of 1979 would be about 0.5 percentage point lower and the unemployment rate would be 0.2 percentage point higher than the baseline forecast. . . . The price level, as measured by the Consumer Price Index, would be only around 0.2 percent lower by the end of 1980."10/

Thus, by ignoring the uncertainty implicit in its own model and by overstating the accuracy of its forecasts in this way, the CBO misleads policy-makers into having too much confidence in macro analysts' ability to predict the impact of a change in policy. It therefore encourages more policy change than is warranted.

II.

We have argued that the CBO has not made good use of the macroeconomic approach to policymaking. In particular, it has neglected uncertainty and long-run effects of policies--omissions which tend to encourage activist policies. Even if these misuses of the macroeconomic approach were corrected, however, the CBO's analysis would still be objectionable. That is because the macroeconomic approach is, itself, deficient.

The macroeconomic approach to policymaking suffers two fundamental deficiencies:

1. The behavioral relationships in macroeconomic models do not remain invariant to changes in monetary or fiscal policy rules. Those relationships are estimated under the assumption of fixed policy rules over the sample period. The models logically cannot be manipulated to analyze the effects of alternative policies, because deviations in policy from the historical rules cause the decision rules of individuals to change. Since the macroeconomic behavioral relationships are aggregations of individual decision rules, they too must change when policy rules change.
2. Macroeconomic models are mute on the implications of alternative policies for efficiency and income distribution. Without the capability to relate policy outcomes to economic welfare, macroeconomic policy evaluation has been carried out in terms of proxy variables, such as the level of real GNP, the unemployment rate, and the inflation rate. These proxy variables can give very misleading signals, however, about the desirability of alternative policies.

In this section we discuss in more detail these fundamental deficiencies of the macroeconomic approach and argue that they have important

policy implications. The rational expectations, equilibrium approach, the alternative to the macroeconomic policy approach, overcomes these deficiencies and implies that less activist and less inflationary policies are desirable. The CBO's choice of the macroeconomic approach to policymaking and its failure to acknowledge the alternative rational expectations approach is thus another source of bias in its advice. We describe a rational expectations theory of the business cycle and then indicate how such a theory is incorporated into the policymaking framework.

A. Instability of Macroeconomic Models

In discussing the uncertainty about macroeconomic model forecasts, we cited evidence that these models do not remain invariant over time. This empirical finding of model instability over time prompted economists to search for theoretical explanations. The most plausible explanation was advanced by Lucas (1976), and his explanation serves as a severe criticism of the macroeconomic approach to policymaking.

Lucas' explanation for the instability of macroeconomic models rests on the dependence of individual decisions to the government's policy rules. His point can be made simply using game theory. Suppose we consider policymaking to be an economic game between the government on one hand and private agents on the other. The question then arises, Which player makes the last move? Lucas points out in macroeconomic policy analysis it is assumed that the government makes the last move. Individual decision rules, implicit in macroeconomic models, are estimated over an historical period, and in predicting the effects of alternative policies it is assumed that these decision rules are fixed. Thus, the search for optimal policies in macroeconomic models consists of allowing government policy rules to vary while holding individual decision rules fixed.

If individual agents are rational, Lucas argues that they will attempt to make the last move. Under different government policy rules, individual decision rules will be different. Thus, when government changes policy, individual decision rules and macro relations, which are the sums of these rules, will change in response. Lucas attributes this failure to account for the response of individual decision rules to changes in policy--the failure to allow individuals the last move--as a major cause for the instability of macro-econometric models over time.

Lucas' point can be expressed in terms of our earlier notation (see page 3). In our representation of a macroeconomic model as

$$(1) \quad A_0 y_t + \dots + A_m y_{t-m} = B_0 x_t + \dots + B_n x_{t-n} + \epsilon_t$$

$$(2) \quad x_t = C_1 x_{t-1} + \dots + C_p x_{t-p} + u_t,$$

his point is that a change in the government's rule, represented by a change in the C's, is also going to change the A's and B's. A simple consumption example illustrates why.

Let disposable income be exogenously generated by the process

$$(i) \quad DI_t = c_1 DI_{t-1} + c_2 DI_{t-2}$$

where DI_t (an element of the x_t vectors) is period t disposable income and c_1 and c_2 are parameters that are directly affected by government tax policies.

For simplicity we assume all agents are identical, plan one period ahead, and consume CON_t (an element of the y_t vector) a constant portion (β) of their "permanent" disposable income (DI_t^P) at time t . Thus, we have

$$(ii) \quad CON_t = \beta DI_t^P$$

and

$$(iii) \quad DI_t^P = (1-\alpha)E_t(DI_t) + \alpha E_t(DI_{t+1}) \quad 0 \leq \alpha < 1$$

where $E_t(DI_t)$ and $E_t(DI_{t+1})$ are forecasts of current and future disposable income based on information available at time t , and where α reflects preferences between present and future consumption.

Now assuming agents know current and past income and use information efficiently, it follows that

$$(iv) \quad E_t(DI_t) = DI_t \text{ and } E_t(DI_{t+1}) = c_1 DI_t + c_2 DI_{t-1}.$$

Substituting (iv) into (iii) and then (iii) into (ii) yields

$$(v) \quad CON_t = \gamma_1 DI_t + \gamma_2 DI_{t-1}$$

where

$$\gamma_1 = \beta[(1-\alpha) + \alpha c_1] \text{ and } \gamma_2 = \beta \alpha c_2.$$

Equation (v) is the consumption-to-income decision rule that holds under the income-generating process (i). The parameters γ_1 and γ_2 are quite easy to estimate, and the equation will do a very good job predicting consumption, if tax policies don't change. But what if they do? Equation (v) cannot accurately predict the effect on consumption. Any change in policy, that is, any change in c_1 and/or c_2 , affects the coefficients γ_1 and/or γ_2 . Thus, if taxes were lowered in period $t+1$, equation (v) would predict no change in period t consumption, yet in fact consumption would change. Notice that this problem only disappears if agents don't care about their future ($\alpha=0$). Equation (v) then reduces to

$$(v') \quad CON_t = \gamma_1 DI_t$$

where $\gamma_1 = \beta$ and the impact of changes in either current or future taxes will not affect γ_1 .

Although we can construct more general examples by allowing for differences in utility functions, longer planning horizons, and some degree of uncertainty, the main point still holds: to predict accurately the impact of economic policies, a useful model must not only identify decision rules (the A's and B's in (1)), but it must also identify how they change under alternative policies (changes in the C's).^{11/}

This criticism of macroeconometric models is not just theoretical nitpicking; it has a major impact on policy analysis. Sargent and Wallace (1975), McCallum (1978), and McCallum and Whitaker (1979) have shown that the real impact of aggregate demand policies can in some standard macroeconometric models literally disappear once individuals are allowed to respond rationally to changes in government policies. In their simple models nonactive policies are optimal, and the inflation-unemployment trade-off proves to be illusory.

B. Macroeconometric Policy Evaluation

The unemployment rate and inflation rate are not, however, the ultimate concerns of policy. The ultimate concerns are the levels of welfare of the individuals in the society. Yet, macroeconometric models force the desirability of alternative policies to be judged in terms of macroeconomic variables, and they provide no clues on the link between these variables and economic welfare. As Sargent (1975, p. 2) states, "The models themselves can't be used to tell who is hurt by inflation (anticipated or unanticipated?), why inflation is bad, or why a larger variance in the unemployment rate is bad." Moreover, recent advances in economic theory clearly indicate that any link between macro variables and economic welfare is extremely tenuous.

Search theories of the labor market suggest that there are policies (such as elimination of unemployment insurance) which would lower the unemployment rate (at a given inflation rate) and yet could be welfare reducing. Such

policies can result in too much of individuals' time being allocated to labor and too little to leisure and, thus, can make them worse off.

The theory of optimal tax structure implies that some amount of taxation by inflation could be optimal.^{12/} In this case, policies which reduce inflation below its efficient rate (at a given unemployment rate) would be welfare reducing, since they result in too little government revenues being raised by the inflation tax.

Even policies which dampen the business cycle need not be desirable. Sargent (1979) devised a tax policy rule in a rational expectations model of the business cycle which effectively stabilizes output. That rule, however, is Pareto dominated by a purely passive rule for which policy actions do not respond at all to current conditions. In Sargent's model output fluctuations result from optimal adjustments in the private sector to unavoidable random shocks. Efforts by the government to smooth the output fluctuations, then, just interfere with the adjustments being made in the private sector and increase the total costs of adjustment.

C. The Macroeconometric Policy Approach Should Be Replaced by the Rational Expectations, Equilibrium Approach

Since the macroeconometric approach as used by the CBO does not allow us reliably to predict the outcomes associated with different policies nor to rank policy outcomes in terms of welfare, a different approach to policymaking is required. We argue that a rational expectations, equilibrium approach is what's needed. This approach is nothing more than classical economics applied in a dynamic, stochastic setting.

Keynesian theory, which underlies the macroeconometric approach, at one time filled a void. It was developed as a separate branch of economics because of classical theory's inability to explain certain business cycle phenomena. In particular, the classical neutrality propositions seemed to be

contradicted by observed positive correlations persisting from one business cycle to another between real variables, such as output and employment, and nominal variables, such as the price level and money supply.

Keynes correctly attributed these correlations to "sticky" wages. For in an economy where wages and prices adjust instantaneously to new market conditions, such correlations would not be observed. Shifts in nominal demand would result in fluctuating wages and prices, but they would leave the real wage, and hence, output and employment, unchanged. The question is, what makes nominal wages sticky?

Keynesian economists have explained sticky wages by assuming either nonoptimizing agents or nonclearing markets.^{13/} Either of these assumptions generally is enough to overturn the classical neutrality propositions.

Due to the pathbreaking work of Lucas (1972), there is no longer a void to be filled. Lucas succeeded in reconciling the observed business cycle correlations with the classical neutrality propositions. He was able to construct rational expectations models of the business cycle which do not violate the classical postulates of optimizing agents and clearing markets. We thus see the major contribution of Lucas' work as the return of business cycle analysis to the fold of classical economics.

If business cycle phenomena are subject to classical economic analysis, it then follows that government stabilization policies are subject to classical analysis and evaluation. That is, they can be analyzed and evaluated--as are all other government economic policies--in the traditional framework of public finance and welfare economics.

In the following sections we discuss the rational expectations theory of the business cycle and its incorporation into the policymaking framework. We conclude by suggesting that this approach will lead economists to ask better questions.

1. Foundations of Rational Expectations Theory of the Business Cycle

The rational expectations theory of the business cycle has its roots in Lucas (1972). Lucas extended classical macroeconomic theory by explicitly considering uncertainties faced by economic agents and costs incurred in gathering information. He was able to show that sticky wages, and thus output fluctuations, can occur as the result of actions of optimizing agents in markets that clear.

In order to illustrate the principles of Lucas' theory, we offer the following simple story.^{14/} Our story has agents entering into contracts which specify wages and prices over a number of periods into the future. The length of the contract is struck as a balance: the shorter the contract, the less agents are vulnerable to unanticipated inflation but the more they must pay in terms of information gathering and contracting costs.

Agents in this story are assumed to form forecasts of future prices rationally; that is, their forecasts are equal to the true mathematical expectations conditional on the set of information they have on hand. Rational forecasts of prices, thus, are unbiased, and rational agents cannot be systematically fooled by aggregate demand policies.^{15/}

All uncertainty is assumed to stem from two sources: random changes in government aggregate demand policies and random shifts in consumer preferences. When agents observe a price change for a single good, they cannot determine whether it is due to

1. a change in aggregate demand policies which can be expected to cause proportionate changes in prices of other goods,
2. a shift in preferences which can be expected to cause relative price changes, or
3. some combination of the two.

Thus, agents cannot infer with certainty the behavior of average prices from the behavior of any single price.

Prices are more flexible than wages in this story because firms only have to know parameters of the demand and cost curves for their own product to set prices, while workers must consider the prices of all goods when they enter contracts to determine wages. Thus, with smaller information costs, the contracting period for prices is shorter than that for wages. To simplify our story we assume prices adjust instantaneously.

According to our story, a government aggregate demand policy action which is essentially neutral--such as money transfers proportional to individuals' initial holdings and funded by money creation--has different effects depending on whether or not it is correctly anticipated. Anticipated policy actions will be incorporated into workers' price expectations and reflected in long-term contracts. They will affect wages as well as prices but leave the real wage and, hence, output unchanged.

Unanticipated policy actions, in contrast, will have real effects. An unanticipated increase in money holdings, for example, will act to raise prices more than agents had previously expected. Firms then have the incentive to hire more workers at fixed dollar wages and at lower real wages, while workers are bound to offer their services for wages which exchange for smaller quantities of consumption goods. Thus, in this case, output and employment will increase, and firms will benefit at the expense of workers.

The distinction between anticipated and unanticipated policy changes provides an explanation for observed correlations between aggregate demand variables and measures of real output, e.g., observed Phillips curves. Unanticipated policy changes, as we have seen, result in positively correlated movements in prices and output and, hence, can explain an observed negative Phillips

curve relationship between the rate of inflation and the unemployment rate. On the other hand, anticipated changes in an essentially neutral policy will affect prices but have no effect on real variables. Anticipated changes to more stimulative policies, then, might explain why the observed Phillips curve has shifted up since the early 1960s.

Our story not only produces an explanation for sticky wages and fluctuations in output, it also produces an explanation for regular cycles in output, that is, "persistence." The impulses which cause output to fluctuate in our story are the price expectational errors of the workers. Since workers enter into multiperiod contracts, price expectational errors in one period get carried over into future periods--such as in Taylor's (1979) model. In Taylor's model contract lengths are fixed exogenously, however, and that introduces a role for active government stabilization policy. In our story the lengths will depend on the government's policy rule, since the choice of policy rule will have an impact on the inflation process.^{16/} In our story there is no role for active stabilization policy.

2. The Rational Expectations Theory in the Policymaking Framework

The objective of policy is to maximize social welfare, and with rational expectations models this objective can be stated in terms of individual utilities. There then is no need to use aggregate proxy variables. Each individual in the economy is assumed to maximize the expected discounted flow of utility over time, where each period's utility depends on contemporaneous consumption and leisure. Policy evaluation in rational expectations models generally takes the determination of income distribution to be outside the scope of the analysis. The set of Pareto efficient policies, together with the implied income distributions, is described, and no attempt is made to select one policy from this set.

Explicit general equilibrium, microeconomic models are used for rational expectations policy analysis. These models specify the economic environment of their hypothesized agents: initial endowments, utility functions, production processes, information technologies, and sources of random disturbances. They then specify the rules of the game, which include the permissible strategies of agents and the trading technology. A solution, or equilibrium, exists when

1. each agent follows a maximizing strategy subject to
 - a. the economic environment,
 - b. the rules of the game, and
 - c. the strategies of other agents; and
2. aggregates add up, such as total sources equal total uses.

The solution describes how resources are allocated in equilibrium.

As an example, in a Debreu-type, nonstochastic, general equilibrium model the economic environment consists of many agents and firms--agents with given endowments of goods and concave utility functions, firms with nonincreasing returns to scale production functions, and information sets of all agents composed of prices of individual goods. The rules of the game are that agents maximize utility and firms maximize profits, all by determining how much goods to buy and sell on the market at prices called out by a Walrasian auctioneer. A solution is a set of prices such that each individual maximizes utility subject to his budget constraint, each firm maximizes profits, and demand equals supply in each market.

In rational expectations models it is necessary to specify the information which accrues over time to individuals as well as to the government. The solutions to the models depend crucially on assumptions about information costs and availability.

For each assumed government policy there is a corresponding solution to the rational expectations model which describes equilibrium allocations of goods, and hence utilities, across individuals. Policy analysis consists of determining the set of Pareto optimal policies and the properties of the policies in that set.

The rational expectations, equilibrium approach not only allows proper evaluation of alternative outcomes, it conceivably can overcome the invariance problem inherent in macro modeling. Because rational expectations models are based explicitly on theories of individual optimizing behavior, they offer some hope of discovering how individual decision functions will change when government policies change. Earlier we discussed how a change in tax policy can lead to a change in individual consumption functions. Later, in our simple rational expectations business cycle story, we saw that individuals' labor supply depends on predictions of future prices and that these predictions incorporate the systematic part of government policy. A change in the government policy rule changes expectations of future prices conditioned on a given set of data. This change in the way expectations are formed causes a change in the relationship of the amount of labor individuals supply to current and past conditioning variables. In general, only the economic environment (e.g., utility and production functions) can be expected to remain invariant to a change in the policy rule.

Because rational expectations models are based on explicit theories of individual optimizing behavior, they conceivably make it possible to identify parameters of individual objective functions. This knowledge allows us to solve agents' optimization problems anew each time there is a change in policy rules in order to determine how individual decision functions change.

3. Implications of the Rational Expectations Equilibrium Approach for Policymaking

The rational expectations approach emphasizes that policies must be considered as rules. Individuals' actions today in response to a tax cut, for example, will be different depending on whether they expect no future tax cuts, or whether they expect future tax cuts every time real GNP declines. In order to determine the impact of a policy action, it then is necessary to specify how individuals believe policy will respond in given situations in the future.

Not only are we restricted to evaluating policy rules, but only those rules which are well understood by the economic agents. We saw that anticipated and unanticipated policy actions can be expected to have different effects. Our theories explain individual behavior under a set of anticipated, or understood, policies. We do not know how to predict the effects of an unanticipated change to a new policy rule. Presumably, individuals initially expect the old policy to remain in place, and then they learn about the policy change over time. How fast do they learn, and what type of behavior do they display over this learning period? Existing theory does not supply answers to these questions.

Although we can only evaluate well-understood rules, the question remains whether these policy rules should be active in the sense that policy actions respond to current economic conditions, or passive rules. We argue that at the present time passive rules are preferable.

First, theoretical justification for active rules is not strong. In the simple rational expectations models of Sargent and Wallace (1975), McCallum (1978), and McCallum and Whitaker (1979), for instance, active policy rules do not outperform passive rules.

Second, the econometric requirements for adopting beneficial, quantitative active rules are staggering. In order to determine a good active policy rule, it is necessary to determine how different policy rules affect economic

outcomes. But as we have argued, this requires the identification of parameters in individual objective functions so that we can determine how agents' decision functions depend on the policy rule. This is no easy task. Moreover, a model where such identification is possible involves complicated cross-equation, cross-time restrictions which make estimation extremely difficult. Estimation subject to these constraints is at the frontier of current knowledge.^{17/}

Given the present limitations to knowledge, we make some modest proposals. First, we should aim for stable and neutral fiscal and monetary policies. We should avoid sharp changes in federal expenditures and tax rates, balance the federal budget on average over the business cycle, and keep the ratio of high-powered money to total government debt approximately fixed.^{18/} Second, we should concentrate on improving economic institutions. Rational expectations theory makes it clear that the economic structure matters. Automatic tax stabilizers and transfer program rules affect the way the economy adjusts following shocks.^{19/} The financial system, how it is set up and regulated, also can have important effects on how the economy adjusts.^{20/} Third, we should concentrate on some classical issues: How much public goods should the government provide? How should it finance these goods, by taxation or debt issue? How should a given amount of revenue be collected through different taxes? We believe that the payoff to applying sound economic analysis to these classical issues is currently greater than the payoff to searching for quantitative, active stabilization policy rules.

Conclusion

We have argued that a rational expectations, equilibrium approach to policymaking yields two basic advantages over a macroeconomic approach:

1. It allows us to determine, at least conceptually, how individual decision functions change when policy rules change.

2. It allows us to evaluate policies in terms of social welfare.

We also believe economists are led to ask better questions when working in a general equilibrium framework. We list a few examples below:

- . The CBO staff asked whether a tax cut is needed to spur employment. We think a more relevant question is, What is the efficient rate of inflation in the optimal tax structure of our monetary economy?
- . The CBO staff asked how changes in social security taxes will affect inflation. Again, we think more relevant questions are, What is the role of social security in an economy with fiat money, and what are minimally distorting tax and payment schedules?
- . The CBO staff asked whether high interest rates cause inflation. Once again, we think a more relevant question is, What is the optimal mix of fiat money and fiat bonds in an economy with a risky bank sector?

Some will protest that we have laid out too difficult a program for economists to follow. They will say we at least have some chance of getting answers to the types of questions asked by the CBO staff; we have no chance of coming to grips with the more difficult--albeit more relevant--questions we posed. They are wrong. Economists have made significant progress in answering them. We refer readers to Wallace (1979) on inflation as a tax, Diamond and Mirrlees (1978) on social security taxation, and Bryant and Wallace (1979) on the optimal mix of fiat money and fiat bonds. It is time that government economists apply the economics of the 1970s to contemporary policy problems.

Footnotes

^{1/}For simplicity, we assume that the rule only depends on exogenous variables. If the rule depends on both exogenous and lagged endogenous variables, it's contained in equation (1), though the arguments that follow are not affected.

^{2/}See Theil (1964, pp. 2-5) for a general discussion of the use of quadratic preferences.

^{3/}If variability in policy instruments is used to generate information about coefficients, the certainty-equivalence approach could imply a smaller response to current information than the optimal rule. For other conditions under which the responses could be smaller, see Chow (1975, pp. 249, 250).

^{4/}The CBO's model discussed here is presented in its Multipliers Project [CBO (1977)]. The model is explicitly referenced in the CBO's social security tax study [CBO (1978b, p. 26)]. No specific model is mentioned in the fiscal 1979 budget analysis [CBO (1978a)], but some version of such a model was presumably used.

^{5/}The consumption equations of two prominent models [see equations in MPS (1975) and McCarthy (1972)] help to illustrate how large these differences can be. To explain consumption expenditures, the MPS model builders estimated a single aggregate equation with essentially three explanatory variables--personal disposable income, wealth, and inflation. Wharton, on the other hand, estimated a disaggregated equation dividing consumption into autos, other durables, non-durables, and services. As in the MPS model, disposable personal income and wealth are explanatory variables, but Wharton also includes the unemployment rate and an interest rate differential. MPS explanatory variables enter as constrained distributed lags; Wharton's are mostly contemporaneous, with no distributed lags.

^{6/}CBO (1977, p. 1).

^{7/}CBO (1977, p. 25).

^{8/}This is not necessarily true if we allow policymakers to experiment with variability in policy instruments in order to learn more about the structure.

^{9/}This test corresponds to the single-equation test devised by Chow (1960).

^{10/}CBO (1978a, p. 56).

^{11/}For an elaboration of this view, see, for example, Marschak (1953), Lucas (1976), and Lucas and Sargent (1979).

^{12/}See, for example, Drazen (1979), Phelps (1973), and Siegel (1978).

^{13/}On nonoptimizing agents, see Tobin (1965); and on nonclearing markets, see Hall (1975) and Taylor (1979).

14/ Our story essentially extends the model in Lucas (1972) by incorporating a theory of endogenous contracting. An explicit model along the lines of our story, however, has not been fully worked out.

15/ This proposition holds as long as agents' information sets contain past prices. For a proof see Sargent (1973).

16/ Keynesian economists have objected to two basic assumptions in rational expectations models of the business cycle: that agents' expectations are rational and that markets clear. For a defense of the rational expectations assumption, see Sargent (1975) and Townsend (1978); and for a defense of the market-clearing assumption, see Barro (1979) and Lucas and Sargent (1979).

17/ See Hansen and Sargent (1979).

18/ See Lucas (1978) and Bryant and Wallace (1979) for defenses of these proposals.

19/ See McCallum and Whitaker (1979).

20/ See Bryant (1979).

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