Stabilization Policy:  A Framework for Analysis

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The Employment Act of 1946 mandated that the federal government take an active role in promoting "maximum employment, production and purchasing power." Yet it failed to establish specific goals and a specific modus operandi. It was left to Congress and the administration to set the goals and to the economics profession, and the Council of Economic Advisors in particular, to derive the policy strategy. Over the years this has resulted in a vast amount of research concerned with macroeconomic stabilization policy. Topics studied include the relative strength of fiscal and monetary policy, the effect of lags on optimal policy, the use of discretion or judgment versus explicit rules, the use of feedback rules versus nonfeedback rules, the optimal banking structure, and the role of intermediate targets.

It is not my purpose here to review this research nor to prescribe a way of conducting policy. Rather, it is to describe and defend a meaningful framework for studying these and other questions concerning stabilization policy.

The accepted framework for thinking about most decision problems has three elements: (a) the goals or objectives, or, more precisely, the objective function; (b) the constraints, or, in several different words, the opportunity set, the set of attainable outcomes, or the model; and (c) the best course of action or optimum policy, which is the solution to the problem: maximize the objective function subject to the constraint or model. To familiarize you with this framework as it might be applied to issues in stabilization policy, in Part 1 we consider some theoretical examples. To persuade you that this framework provides a rich mode of analysis and that it directs attention toward sensible questions, in Part 2 we assess some current policy issues.

## 1. The Policy Framework

The examples we consider center around a relatively simple objective function and an aggregate macro model. The examples differ mainly with respect to the degree of uncertainty embedded in the model.

For purposes of illustration, assume the policy maker's goal is to control income (Y). In particular, the policy maker has a desired level of income (Y*) he would like to maintain over some fixed horizon (t=1, N). An example of an objective function which expresses such a concern is given below.

$$(1) \qquad U = - \sum_{t=1}^{N} (Y_t - Y^*)^2$$

The problem is to find the time path of the policy instrument-- assumed here to be the interest rate (r)--which maximizes the objective function U. To do this we must have some notion, i.e., some model, which embodies the economic process of income determination and, just as importantly, links this process to the policy instrument. Again for purposes of illustration, we use a model which is a version of the one that appears in introductory macroeconomic texts. It consists of the following equations:

$$(2) \qquad C_t = \alpha_1 + \alpha_2 Y_{t-1} \qquad\qquad \alpha_1, \ \alpha_2 \geq 0 \text{ and } \alpha_2 \leq 1$$

$$(3) \qquad I_t = \beta_1 + \beta_2 r_t \qquad\qquad \beta_2 \leq 0, \ \beta_1 \geq 0, \ \beta_1 \equiv \beta_0 r_{t+1}^e$$
$$\text{and } r_{t+1}^e \text{ is fixed}$$

$$(4) \qquad Y_t = C_t + I_t$$

where $Y_t$ stands for income, $C_t$ for consumption, $I_t$ for investment and $r_t$, $r_{t+1}^e$ the current rate and the expected future rate of interest,

respectively. Equation (2) is a simple linear version of a consumption equation which says that current consumption is equal to a constant $(\alpha_1)$ plus a fraction $(\alpha_2)$ of last period's income. Equation (3) is a linear version of an investment equation which says that current investment is equal to a positive function of the expected future rate of interest $(\beta_1 = \beta_0 r^e_{t+1})$ plus a negative function of the current rate $(\beta_2)$. We initially assume expectations are fixed and treat $\beta_1$ as a constant; later we relax this assumption and examine the policy implications. Equation (4) defines income as the sum of consumption plus investment.

A model, in effect, is a description of an opportunity set or a set of attainable outcomes. The implied opportunity set of the model set forth in equations (2)-(4) is readily found by substituting (2) and (3) into (4) which yields

(5) $\qquad Y_t = \delta_2 + \alpha_2 Y_{t-1} + \beta_2 r_t$

where $\delta_2 \equiv \alpha_1 + \beta_1$.

Using the objective function (1) and various versions of the opportunity set (5) we are now ready to derive optimal rules, i.e., the settings of the policy instrument $(r_t^*$ for t=1, N) that maximize (1) subject to the constraints imposed by the model. More specifically, the plan is to consider five different versions of Equation (5). In the first, we assume all parameters are known and specify that $\alpha_2$ is zero so that (5) reduces to a static deterministic model. In the second, we let $\alpha_2$ take on a nonzero value so that (5) is dynamic, but still deterministic. In the third and fourth versions we add parameter uncertainty, the third being the static case, the fourth being dynamic. In the last version, we relax the assumption of fixed expectations.

These examples are used not only to illustrate the framework, but also to establish the following policy implications of this approach:

(A) Given an objective function and a model, finding the rule is a technical problem, although possibly one that is difficult to solve.

(B) The degree of difficulty is directly related to the degree of uncertainty about the economic process.

(C) The more uncertainty, the less the optimal setting of the policy instrument deviates from its historical mean.

(D) If expectations are functions of the policy rule, using models with fixed expectations may seriously misrepresent the impact of policy.

## A Static Deterministic Model

Here we assume that we know the coefficients of our model and specifically that $\alpha_2 = 0$. Equation (5) then reduces to

$$(5') \qquad Y_t = \delta_2 + \beta_2 r_t$$

Since the model is deterministic and static, the problem reduces to finding the value of $r_t$, for any arbitrary period, which produces the desired level of income. This model is static because the current setting of the instrument only affects current income. It is deterministic because we have assumed the coefficients $\delta_2$, $\alpha_2$ and $\beta_2$ are known. The optimal setting for $r_t$ ($r_t^*$) is found by substituting $Y^*$ for $Y_t$ in (5') and solving for $r_t$. This yields

$$(6) \qquad r_t^* = (Y^* - \delta_2)/\beta_2$$

for all t.

Notice that in every period we achieve Y* exactly and that $r_t$* is the same.

## A Dynamic Deterministic Model

Again assume we know the coefficients, but now assume $\alpha_2$ is not equal to zero. Equation (5), reproduced below, represents the opportunity set.

(5) $\qquad Y_t = \delta_2 + \alpha_2 Y_{t-1} + \beta_2 r_t$

Since the parameters $\delta_2$, $\alpha_2$, and $\beta_2$ are known, the model is deterministic, but it is dynamic in the sense that past income affects current and thus future income. From the policy point of view, however, it is only dynamic in a trivial way. As in the static model, we are always able to exactly hit the target income, and the optimal value of the instrument is unchanged over time. This is readily seen by looking at the first period decision,

$$Y_1 = \delta_2 + \alpha_2 Y_0 + \beta_2 r_1$$

where $Y_0$ is some initial value of income. The optimal value of $r_1$ is

(7) $\qquad r_1$* $= (Y* - \delta_2 - \alpha_2 Y_0)/\beta_2$

which produces $Y_1 = Y*$. Now for t=2, N, the optimal value for $r_t$ is

(8) $\qquad r_t$* $= [Y*(1 - \alpha_2) - \delta_2]/\beta_2$

which produces $Y_t = Y*$.

## A Static Stochastic Model

In the previous examples we assumed the policy maker knew the coefficients. In general, since economic structures must be estimated

from finite data sets, we are not so lucky. Instead, we must deal with stochastic models where the policy maker finds that he is in the position of choosing among alternative actions whose consequences are uncertain. There is a well-developed theory of choice in such circumstances, which says that under highly plausible axioms the decision maker should rank actions on the basis of their expected utilities. (An exposition of this theory is given by Arrow in Chapter 2 of Essays in the Theory of Risk Bearing.) The problem of finding the optimal policy is then one of finding the policy rule which maximizes the expected value of the preference function subject to a stochastic model of the economic process.

In particular our problem becomes maximize expected utility

$$(1') \qquad E[U] = -E[\sum_{t=1}^{N} (Y_t - Y*)^2] = - \sum_{t=1}^{N} [(Y_t* - \overline{Y}_t) + \sigma_{Y_t}^2]$$

where

$$Y_t = \delta_2 + \alpha_2 Y_{t-1} + \beta_2 r_t + \varepsilon_t$$

$$\overline{Y}_t = E[Y_t]$$

$$\sigma_{Y_t}^2 = E(Y_t - \overline{Y}_t)^2$$

and $\varepsilon_t$ is a random disturbance with finite variance and mean zero. We maximize (1') subject to the opportunity set

$$\overline{Y}_t = \hat{\delta}_2 + \hat{\alpha}_2 Y_{t-1} + \hat{\beta}_2 r_t$$

where $\hat{\delta}_2$, $\hat{\alpha}_2$, and $\hat{\beta}_2$ are unbiased estimates of $\delta_2$, $\alpha_2$, and $\beta_2$ having standard errors $\sigma_\delta$, $\sigma_\alpha$, and $\sigma_\beta$, respectively.

Consider again the case where we know $\alpha_2 = 0$. The expected value of $Y_t$ then is given by

(9) $\qquad \overline{Y}_t = \hat{\delta}_2 + \hat{\beta}_2 r_t \qquad\qquad\qquad \hat{\beta}_2 < 0 .$

Assuming $r_t$ is exogenous over the estimation period, the variance of income is given by

(10) $\qquad \sigma_{Y_t}^2 = c_0 \sigma_\delta^2 + \sigma_\beta^2 (r_t - \overline{r})^2$

where

$$c_0 = \frac{\sum\limits_{j=1}^{m} (r_j - \overline{r})^2}{\sum\limits_{j=1}^{m} r_j^2} ,$$

$\overline{r}$ is the mean value of the interest rate over the estimation period, and m is the number of observations. If we set the interest rate $(r_t)$ lower than it was on average over the data period $(\overline{r})$, we get a higher expected value of income (Equation (9)) and a higher variance (Equation (10)); if we set the rate higher, we get a lower expected value of income and a higher variance. This tradeoff, or opportunity set, is represented below by the curve AB in the mean-variance plane.

The objective function is represented on the same diagram by a set of semicircles centered at Y* (the dotted curves). Points on a semicircle represent combinations of mean and variance yielding the same expected value of the objective function. The expected value decreases the further the points are from the origin (Y*). The tangency (point x) represents the "best" combination of mean and variance attainable. (This analysis is more fully developed in Brainard, "Uncertainty and the Effectiveness of Policy," American Economic Review, Vol. 57, No. 2, May 1967.)

One of the major conclusions resulting from this model is that the more uncertainty about the impact of policy, i.e., the greater $\sigma_\beta^2$, the closer the policy instrument, $r_t$, should be set to its mean level, $\bar{r}$, over the estimation period. (This conclusion does not follow, however, when a change in $r_t$ produces information about the structure that outweighs the cost of higher variance.)

## A Stochastic Dynamic Model

Finding the optimal policy begins to get more complicated when we incorporate both uncertainty and lags into the framework. In general, the solution to the problem exists, yet technically it is difficult to derive. The difficulties arise because not only is there a contemporaneous mean-variance tradeoff, but a more complex tradeoff over time.

To illustrate consider the opportunity set

$$(11) \qquad \bar{Y}_t = \hat{\delta}_2 + \alpha_2 Y_{t-1} + \hat{\beta}_2 r_t \qquad \hat{\beta}_2 < 0.$$

Here we again assume $\delta_2$ and $\beta_2$ have to be estimated, but now we let $\alpha_2$ be some positive known coefficient. Again, assuming $r_t$ is exogenous over the data period the variance of income is given by

$$(12) \qquad Y_t^2 = c_0 \sigma_\delta^2 + \sigma_\beta^2 (r_t - \bar{r})^2 \ .$$

We still have a contemporaneous mean-variance tradeoff since $r_t$ lower than $\bar{r}$ yields a higher $\bar{Y}_t$ and a higher $\sigma_{Y_t}^2$. But we also have a tradeoff over time since the mean-variance decision made today affects future opportunity sets. Consequently, the optimal rule must reflect the dynamic nature of the decision-making problem.

## An Endogenous Expectations Model

We began these examples by assuming that the expectation of the future rate of interest was fixed (recall $\beta_1 \equiv \beta_0 r_{t+1}^e$). We now relax this assumption and briefly discuss its policy implication. Suppose the expectation of future rates is a function of the current rate. This implies that when we solve for the optimal rule, we can no longer treat $\beta_1$ as fixed. It will change in some systematic way with different settings of the policy instrument. As a result, the optimization problem is somewhat more complicated. Essentially, it involves estimating the expectations function and solving the model with $\beta_1$ as an endogenous variable.

A major result of endogenizing expectations is that if expectations are correct on average, there exists a class of models in which the policy rule will have no "real" effects. (See Sargent and Wallace, "Rational Expectations, the Optimal Monetary Instrument, and the Optimal Money Supply Rule," Journal of Political Economy, April 1975.) In the real-income mean-variance plane, this implies a horizontal opportunity locus instead of a positively sloped curve.

Whether or not expectations are correct on average, however, if expectations are functions of the policy rules, using models with fixed expectations may seriously misrepresent the impact of policy. (See Lucas, "Econometric Policy Evaluation: A Critique," The Phillips Curve and Labor Markets, Ed. by Brunner and Meltzer. A supplement to the Journal of Monetary Economics, 1976.)

2.   Some Current Policy Issues

The proposed framework consists of an objective function, an opportunity set or model, and a rule which maximizes the objective function subject to the opportunity set.  Within this mode of analysis, many policy issues can be clarified and many, in principal at least, can be resolved.  We now examine some of these issues in an attempt to defend and to illustrate the usefulness of the framework.

## The Role of Judgment or Discretion in the Policy Process

This framework, many economists and policy makers contend, is fine in theory, but not in practice.  The real world, they argue, is too complicated to model.  Any rule resulting from such a model should be supplemented by whatever information and judgment is not part of the formal structure.

Although the phrases "too complicated" and "information and judgment not part of the formal structure" are commonly used in such criticisms, the meaning of these phrases often vary.  In responding to this criticism, therefore, we consider different interpretations.

"Too complicated" seems to imply too much uncertainty.  But, if it means that the economic process contains no systematic relationships, then judgment can fare no better than formal models.  Similarly, if it refers to unforeseen one-time economic shocks, an oil embargo for example, then while models estimated on past data have little to offer the policy maker, neither does the judgmental method.  (To illustrate, consider two of the judgmental policy prescriptions to the price increase which followed the 1973 oil embargo.  One was to have a once-and-for-all matching increase in the money supply so that monetary policy would not

become unduly restrictive. Another was no change in the money supply since any increase would only further increase the price level. Which policy should have been followed? Without previous experience and some kind of model, it's difficult to say.) On the other hand, if "too complicated" refers to uncertainty about systematic relationships that hold on average, then, as we demonstrated in Part 1, this type of randomness can be incorporated into the framework.

We have argued that if uncertainty cannot be modeled formally, we cannot judgmentally improve the policy process. But what about using "information and judgment not part of the formal structure" to improve policy? Again, we consider various interpretations. Using information not part of the model may mean that some key equations are missing. Or it could imply that because most models contain aggregate relationships, there exists more information than they can analyze. Both of these interpretations are criticisms of the current state of model building. In principal, however, these models can be expanded to include all known systematic relationships and can be estimated on a disaggregated level consistent with the data.

Another interpretation of using judgment, which we believe to be the more common meaning, is that of using the expertise of the experienced forecaster. This forecaster is supposed to have deep insights and intuitions into the workings of the economy enabling him to produce, on average, more accurate predictions than explicit models. But how can we choose an optimal strategy based on a single forecast? We need to know the implications of many different strategies. Moreover, if we cannot reproduce and test the "expert's" forecasting techniques, there is no possibility for learning and little for empirical verification.

Thus, we conclude that framework cannot be dismissed simply on grounds that the economy is too complicated or that intuition works better. If there is a role for discretionary policy or judgment, it must be made explicit and part of the formal structure.

If we can agree, at least in principal, that we can construct a model that can take account of all relevent information and that explains economic data, then with such a model a number of current issues can be resolved.

## The Fiscal Versus Monetary Policy Debate

Consider the fiscal versus monetary policy debate. Fiscal policy, monetarists argue, has much less effect on aggregate income than monetary policy. Advocates of fiscal policy reverse the ordering. But within the decision framework presented above, this controversy seems to be irrelevant. In general, if there is more than one policy instrument, then both will be used.

## Fixed Rules Versus Feedback Rules

Another issue that seems to lose its relevance is the argument that due to long and variable lags, the impact of policy is so uncertain that it is best to have a fixed rule. Long and variable lags, it can be shown, are neither necessary nor sufficient conditions for ruling out feedback rules. As long as the uncertainty about lag responses is not infinite, a feedback rule is optimal.

The controversy between fixed rules and feedback rules, however, is still a meaningful issue and one which conceptually can be addressed within this framework. The answer, it turns out, depends critically on the way expectations are modeled. In particular, if expectations of

future variables are formed "rationally," i.e., the forecasts of these variables are on average correct, then there exists a class of models in which a fixed rule is as good as any feedback rule. (See the Sargent and Wallace article referenced above.)

## The Optimal Monetary Framework

The optimal monetary instrument and the optimal banking structure are two other issues that can be addressed within this framework. Both, however, are only interesting in a stochastic model.

On determining the optimal instrument, the policy maker is assumed to have the choice of either setting the rate of interest or the money stock. Determining which instrument maximizes the expected value of the objective function resolves the issue. (See Poole, "Optimal Choice of Monetary Policy Instruments in a Simple Stochastic Macro Model," Quarterly Journal of Economics, May 1970.)

On determining the optimal banking structure, there are a host of issues. They include whether or not we should: (1) increase or decrease reserve requirements; (2) equalize reserve requirements between deposit types; (3) equalize reserve requirements between different classes of banks; and (4) tie the discount rate to a market rate. Again, given the appropriate stochastic model, these are sensible questions and, in principal, can be resolved. (See Rolnick, "The Effectiveness of Monetary Reforms," Journal of Monetary Economics, July 1976.)

## The Role of Intermediate Targets

Finally, a few words about the role of intermediate targets. The models we consider contain some variables which are directly controlled by the policy maker (instruments), some which appear in the policy makers' utility function (goal variables), and some that may be

influenced by policy but do not appear in the utility function

(intermediate variables).  The role of these latter variables, within

this framework, is one of the topics discussed in the Miller-Kareken

paper.