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Market Response to Economic Policies:
A Stumbling Block for Policymakers

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Two new themes—(1) optimal control and (2) rational expectations — have arisen recently in the economic-policy literature, and each of them promises to have a dramatic impact upon future analyses of appropriate policy-making. First, the literature on optimal control deals basically with the use of imperfect econometric models in forming policy decisions. The literature emphasizes the development of efficient rules for responding to the errors that would otherwise lead policymakers away from their economic goals. Optimal-control research seems to suggest that with a reasonably careful utilization of an econometric model and the use of mathematically derived rules for policy adjustment, the policymaker can improve upon alternative policies such as the constant money-growth rule proposed by Nobel laureate Milton Friedman. Some research even suggests that the adjustment process derived from optimal-control techniques is so efficient that the policymaker who uses the wrong model (i.e., one that doesn't describe the economy's behavior as well as other available models) may still improve upon Friedmanesque inactive policy by responding quickly to his mistakes.[1] Optimal-control results thus seem to provide arguments for activist economic policies.

In contrast, the rational-expectations literature tends to discredit activist policies because of a different interpretation of one of the fundamental issues in policy-making—the nature of the public response to economic-policy decisions. Since the time of Keynes, economists have made the reasonable assumption that economic agents — households and firms — cope with an uncertain future by making forecasts, and that these forecasts play a key role in determining eventual future levels of economic activity. Yet the rational-expectations literature suggests that households and firms do not form their expectations of future events the way that most economists presume they do. Furthermore, if economic agents form expectations in a way that is "rational" (i.e. using all the available information rather than just part of it), the latitude of policy-makers to exert a beneficial impact upon economic welfare is reduced or even eliminated. Policy-makers in such a world may not improve the expected future *levels* of economic activity, but they may, by informing consumers ahead-of-time about future policy, reduce consumer uncertainty about future *variations* in economic activity. Therefore, rules such as Friedman's constant money-growth rule, having the twin advantages of simplicity and clarity, are good policy prescriptions. The rational-expectations assumption thus tends to nullify the implications of optimal-control analysis and leads to the conclusion that passive policies are the most appropriate ones.

Consequently, a policy-maker's choice between active policies of "leaning against" the economic winds or passive policies such as Friedman's constant money-growth rule comes down to this: Can the policy responses that are generated by optimal-control rules overcome the uncertainties regarding future economic behavior that are created by rational expectations? To provide some insight into this issue, we describe two alternative methods used by economists to analyze the formulation of house-

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hold expectations. By considering the particular example of the consumption decision, we show how the outcome of a particular policy can be adversely affected through a misinterpretation of the means by which the consumer forms his expectations.

When the policy-maker writes his decisions in stone, a mistaken notion of the method of formulating consumer expectations can be disastrous. But the more interesting case is one where the policy-maker is more flexible, using the method of optimal control to adjust his policies to his initial errors. In this instance, we show that the policy-maker can improve his policy results by using optimal-control techniques, but that his misjudgment of the means by which consumers forecast future income nonetheless adds instability to the economy.

Formation of Expectations: Adaptive

The current standard approach to the modeling of expectation formulation assumes that economic agents form expectations adaptively. The adaptive expectations hypothesis is developed by induction. In the case of consumer forecasting of future income, for example, the consumer is presumed to begin with a forecast of levels of personal disposable income (PDI) in each future period. The consumer knows that he will commit forecasting errors, and he believes that these errors are related, in the sense that a low forecast in one year indicates that all his predictions may be too low. He reflects this knowledge by revising his future estimates upward when his current forecast is too low. We might suppose that a $10-billion under-estimation of PDI this quarter will cause the consumer to revise his next year's forecast upward by 20 percent of the $10-billion error. If so, this year's forecast will differ from last year's attempt by $2 billion, 20 percent of $10 billion.

But by the same token, last year's estimate was the result of a revision of the forecast of two years ago, which was increased or lowered depending upon whether it had been an under-estimate or an over-estimate. So we may think of this year's expectation of 1977 PDI as a forecast made in 1974 that has been subsequently revised in light of the errors in 1975 and 1976 income—or proceeding backward, may even think of it as a forecast originally made (say) in 1970 and adjusted for the errors made in PDI in each subsequent year. We might thus expect that the original estimate itself would become less and less important, and that the actual levels of PDI in periods after the original estimate would become more and more important. If so, we could safely state that the forecast of PDI for 1977 (or 1978, or any subsequent year) depends upon actual past levels of PDI. We might write this hypothesis in the form of an equation

$$(1)\quad E_{1976}(PDI_{1977}) = k_1 PDI_{1976} + k_2 PDI_{1975} + k_3 PDI_{1974} + \ldots$$

Where the symbol

$E_{1976}(PDI_{1977})$ represents the estimate (E) in 1976, of personal disposable income (PDI) in 1977,

and $k_1, k_2, k_3, \ldots$ the weights used to project past levels of PDI into 1977.

We might further suppose that the estimate is a weighted average of the past values of PDI, so that $k_1 + k_2 + k_3 + \ldots = 1$.

The hypothesis that expectations of future values of an economic variable are weighted averages of past values of this variable is known as the hypothesis of adaptive expectations. Macroeconomists utilize adaptive expectations to help explain the sluggishness of the economy's response to external shocks. If the adaptive expectations hypothesis is correct, consumption (for example) would be set by the consumer at a level proportional to his estimate of the value of his own future income. But because the consumer forms his expecta-

tions adaptively, he is sluggish in revising his estimates and therefore sluggish in revising his consumption. Last year's PDI might lead him to expect an increase in his future PDI, but the lower PDI of earlier years also would have an effect on his forecast. Thus, he raises his estimate of expected future income more slowly than the rate of increase in present earnings.

Formation of Expectations: Rational

Some economists have challenged the adaptive-expectations assumption because the consumer under this approach tends to ignore some important information about the future path of key economic variables. The consumer may well have some notions of the intentions of public policy-makers, which it would be "rational" for him to include in his forecast of the growth of future disposable income.[2]

How would a consumer forecast the effect of government expenditures upon PDI? He might estimate the present value (PV) to him of the stream of future government expenditures:

$$(2) \quad PV = G_{1976} + \frac{1}{1+p} G_{1977} + \frac{1}{(1+p)^2} G_{1978} + \cdots$$

Where G_{1976}, G_{1977} . . . are the intended levels of government expenditure in the future, and p is the consumer's internal rate of discount of future disposable income, added to reflect the fact that a dollar received now is of greater value to the consumer than the same amount received later.

Or if the consumer were more sophisticated, he might analyze the full impact of government spending by estimating the value of the added disposable income accruing from the intended government expenditure.

$$(3) \quad PV = PDI_{1976} + \frac{1}{1+p} PDI_{1977} + \frac{1}{(1+p)^2} PDI_{1978} + \cdots$$

where PDI_{1976}, PDI_{1977}, . . . are the added disposable income in future years resulting from the intended government expenditure program.

The Consumption Function

According to the widely accepted life-cycle hypothesis, consumption expenditures during any particular period of time depend upon the current value the consumer places upon the income he expects to earn throughout his lifetime. Suppose, for example, the consumer were certain that he would earn $10,000 in personal disposable income for each coming year in perpetuity. To determine his life cycle income, he uses the relationship

$$(4) \quad A = k(PDI_{1977} + \frac{PDI_{1978}}{1+p} + \frac{PDI_{1979}}{(1+p)^2} + \cdots$$

Here "k" is a constant chosen so that the sum of the weights of each of the yearly forecasts of PDI is one, and A is a weighted average of the PDI's. For example, the weight of PDI_{1977} is k; the weight of PDI_{1978} is $k/1+p$; for PDI_{1979}, $k/(1+p)^2$ and $k + k/1+p + k/(1+p)^2 + \ldots = 1$. Since in this case $PDI_{1977} = PDI_{1978} = \ldots = \$10{,}000$ and the weights on the PDI's sum to one, $A = \$10{,}000$. The consumer is interested in the behavior of income over his lifetime because he prefers to minimize the year-to-year variation in his rate of consumption. The consumer's income may fluctuate as time goes on, but he attempts to mitigate the effects of his fluctuating income upon the level of consumption, and pays attention primarily to the average level of income he expects to receive over the long haul.

Aggregating consumption over the population of consumers, we may characterize the life-cycle hypothesis in two equations

$$(5) \quad a) \qquad C_{1977} = aA$$

$$(5 \quad b) \quad A = \frac{p}{(1+p)} \left[PDI_{1977} + \frac{PDI_{1978}}{1+p} + \frac{PDI_{1979}}{(1+p)^2} + \ldots \right]$$

where C_{1977} = consumption in 1977
a = proportion of life-cycle income consumed in each period.

These equations describe how consumption is related to expected life-cycle income when A, the value of life-cycle income, is known to the consumer.

Consumption Function with Adaptive Expectations

When we cease to assume that the consumer's life-cycle income, A, is known beforehand, we must replace it with an estimate, denoted by E(A). If expectations of future PDI are adaptive, expectations take on a form

$$(6) \quad E_{1976}(A) = k_0 PDI_{1976} + k_1 PDI_{1975} + \cdots$$

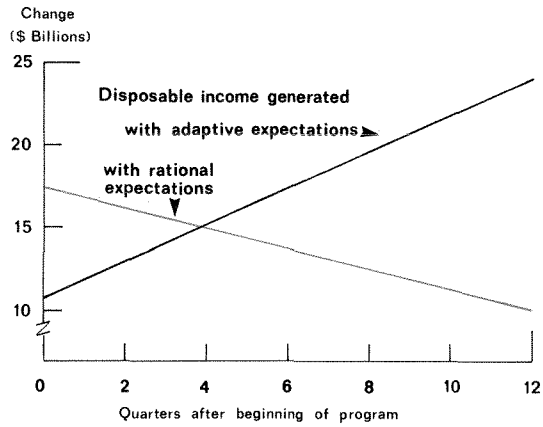
In other words, the current (1976) estimate of life-cycle income depends upon past disposable income. To illustrate the effect of adaptive expectations upon the consumption decision, we use a variant of the expression for the consumption function used by Modigliani.[3]

Since we assume that consumers form estimates of future income on the basis of knowledge of the past levels of income, we may conclude that they respond to a change in public policy as they would to any other economic shock, revising their expectations of future income only slowly as income increases. As a result of this sluggish response, a change in government expenditure increases the level of consumer expenditures quite slowly. To demonstate this point, we use the consumption function from Modigliani to display the effect of adaptive expectations upon a critical variable, $\frac{\Delta PDI}{\Delta G}$, the income multiplier of an increase in government expenditures at any point in time.

Consider the case of a $10-billion increase in real government expenditures sustained over a three-year horizon. We assume at first that the policy-maker believes that consumers form expectations adaptively, and then contrast the expected policy outcome with the actual outcome

Chart 1

Income Generated under Adaptive Expectations and Rational Expectations



when expectations are rational. Although the new government expenditures increase income from the very outset at a rate in excess of $10 billion per year, the consumer initially has only a single quarter of higher income to offset his past experience of income at a lower level. He is thus slow to revise his estimate of life-cycle income upward, so that consumption at first rises by only a relatively small amount. However, as time goes on and the Government continues to spend at the higher rate, the consumer becomes increasingly convinced of the permanence of the additions to income. This increasing certainty leads to higher levels of consumption and therefore to steadily increasing levels of income, over and above the $10 billion per year in added income produced directly by the government expenditures.[4] If in general we define ΔPDI_t as the difference between PDI with and without the added government expenditures in period t, then the government-spending multiplier becomes $\frac{\Delta PDI_t}{\Delta G}$. Chart 1 indicates the path that income takes when the estimation of permanent income is based upon adaptive expectations.

The increase in the multiplier $\frac{\Delta PDI_t}{\Delta G}$ through time is due to the increased consumer estimate

Modigliani Equation

$$C = .663\left[\sum_{i=0}^{11} b_i(PDI)_{-i}\right] + 54.43\left[\sum_{i=0}^{7} c_i (W)_{-1}\right] + .74\, e_{-1}$$

$$\sum_i b_i = 1 \qquad \sum_i c_i = 1$$

C = per capita consumption
PDI = per capita personal disposable income
W = per capita net financial wealth
e = C actual (−1) − C estimate (−1)

The coefficients b_i in the adaptive expectations estimate of per capita PDI, the first term on the right of the above equation, are given in the table.

Percentage of life-cycle income	No. of quarters in the past
b_0 = .1564	0
.1427	1
.1291	2
.1157	3
.1024	4
.0891	5
.0762	6
.0632	7
.0502	8
.0376	9
.0249	10
b_{11} = .0124	11

In the equation above, wealth enters the consumption function by increasing the growth of the income multiplier more rapidly through time. We ignore this wealth aspect, since we are less interested in the size of the multiplier than in its time path. (Unlike Modigliani, we consider only the first term of the equation.)

of life-cycle income, which in turn results from expectations of future increases in government expenditures and higher estimates of consumption due to multiplier effects. In Table (II), the second column represents the consumer estimate of additional life-cycle income resulting from the three-year government expenditure program and its multiplier effects upon consumption. Similarly, the third column shows the portion of the higher life-cycle income due directly to government expenditures, i.e., without multiplier effects upon consumption.

Table I

Multiplier Effects Under Adaptive Expectations

Quarter	Increase in life-cycle PDI Total	Due to G
0	1.74	1.56
1	3.16	2.99
2	4.76	4.28
3	6.38	5.44
4	7.98	6.46
5	9.55	7.35
6	11.09	8.12
7	12.56	8.75
8	13.95	9.25
9	16.40	9.63
10	16.40	9.88
11	17.41	10.00

Thus, consumers' forecasts of the future government-spending contribution rise throughout the period, until at the end of three years the consumer expects to receive $10 billion per year in perpetuity.

There is a disturbing aspect to this adaptive-expectations approach. At the end of the three-year period, when it is public knowledge that the $10-billion government-expenditure program will be curtailed, the adaptively forecasting consumer is expecting the government to continue spending the $10 billion in perpetuity. It takes three more years without the $10 billion to disabuse him of this notion.

Consumer Knowledge of Policy-maker's Intentions

How would the consumer value the same 3-year, $10-billion per year program of increased government expenditures if, contrary to the policy-maker's belief, he were to perform according to a rational rather than adaptive scheme of expectations? This question can be answered by reference to equation (5b). As this equation suggests, the rational consumer is concerned about future income, not past income, so that past policies only matter to him if they affect future income. He will thus react to the government-expenditure program by evaluating its future effects. As the three-year period approaches its end, the program will have very little further impact on his consumption decision, because it will only affect his income for a few remaining quarters.

The policy's impact on life-cycle income instead will be maximized at the outset, because government expenditures are expected to continue for twelve quarters into the future. Consequently, consumption out of life-cycle income —and the income multiplier—also will be greatest in the beginning of the program.

Chart I displays the difference between the income generated by a government program based on adaptive expectations and the income generated based upon rational expectations. In the latter case, the fiscal stimulus is greater at the beginning of the period and thereafter declines—just the opposite of what would be expected by a policy-maker using an adaptive-expectations forecast, who would be increasingly disappointed throughout the three-year period.

Table II

Multiplier Effects With Rational Expectations

Quarter	Increase in life-cycle PDI	
	Total	Due to G
0	6.50	5.27
1	5.90	4.86
2	5.31	4.44
3	4.86	4.02
4	4.15	3.60
5	3.60	3.17
6	3.06	2.73
7	2.52	2.29
8	2.00	1.84
9	1.48	1.40
10	0.98	0.93
11	0.48	0.47

Since the rational consumer expects future consumption to be increased as a result of the higher government expenditures, the value to him of the government-spending program exceeds the value of the expenditures themselves, including the value of the added consumption induced by those expenditures. In either case, the value of the income multiplier of the spending program declines as time goes on, whereas the multiplier associated with an adaptive-expectations approach increases as time goes on.

Policy-maker's Mistaken Assumption of Adaptive Expectations

As Chart 1 shows, the policy-maker who mistakenly assumes that the consumer forms expectations adaptively would find his policy multipliers becoming increasingly incorrect over the three-year period. This is not an unusual turn of events for the macroeconomist. Indeed, substantial empirical evidence suggests that policy multipliers are subject to massive uncertainty. Carl Christ has pointed out that estimated values of policy multipliers differ widely among the major econometric models, and has suggested that this divergence of opinion seriously damages economists' ability to give policy advice.[5]

The lack of certainty about the effect of public policies would clearly be of serious concern if the policy-maker were required to write his decisions in stone. Arguing against the Christ conclusion, Gregory Chow has shown that a more flexible policy, which is revised when short-run errors occur, can under some circum-

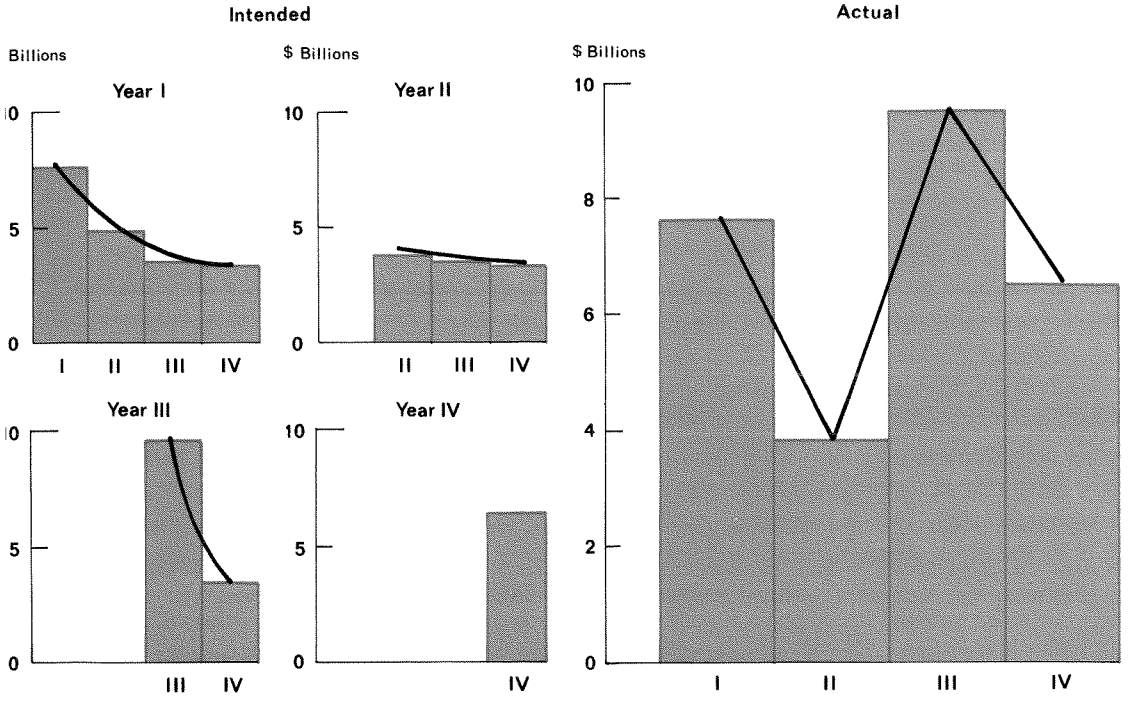
stances be quite effective in offsetting multiplier errors.[6] Chow analyzes the policy-maker's behavior and his impact upon the economy when he receives conflicting signals from two major econometric models and erroneously follows the incorrect one. To evaluate his argument and obtain a realistic picture of the impact of public-expenditure decisions when based upon a mistaken understanding of consumer expectations, we must allow the policy-maker the latitude to adjust his decisions.

We will imagine a world in which the policy-maker believes that the consumer is an adaptive forecaster, but the consumer is actually "rational" in the sense that he bases his forecasts of disposable income upon his knowledge of the announced path of government policy. When the policy-maker discovers that he has made a forecasting error, he will adapt his policy to this mistake, revising his planned expenditures and announcing his revised intentions to consumers.[7] Such a policy-maker would begin by looking at his income goal for the first quarter. In the present example, suppose that the policy-maker wishes to raise the level of GNP by $10 billion above the level it would otherwise attain in each of the next four years,[8] and then reduce government expenditures to their old levels. At the beginning of the four-year program, the policy-maker might well announce—utilizing his adaptive expectations assumption—the desirable levels of increased government expenditures throughout the entire period.

We will assume that policy is revised once each year over the four-year period. We will also assume that the policy-maker does not "forgive" himself for policy mistakes, i.e., he intends to add the same $40 billion to the level of GNP throughout the period as a whole regardless of his year-to-year performance.[9] We can then determine the outcome at the end of each year, and, show how the policy-maker

Chart 2

Intended and Actual Expenditures



would revise his subsequent policy whenever he errs in hitting his GNP target.

Chart 2 pictures each of the strategies that the policy-maker constructs in this case. After a false start in the first year, he realizes that his policy did not incorporate sufficient stimulus in the last half of the four-year period. This turn of events results inevitably from his belief that the stimulus provided by *past* policies is the dominant concern of the consumer, when in fact the consumer is quite rationally concerned with the future stimulus the policy-maker *intends* to provide.

The policy-maker then makes three revisions in his forecast:

1.) Reduces the planned additions to income in the remainder of the period by the amount of the initial overshoot.

2.) Revises upward the consumption multiplier. The policy-maker mistakenly assumes that part of the added income was due to a shift in consumer's preference to a higher rate of consumption out of life-cycle income.

3.) Increases the estimate of life-cycle income. The policy-maker correctly detects that the consumer's estimate of life-cycle income was higher in the current period than he had expected, but he incorrectly concludes that the estimate of the next period's life-cycle income will also be higher. These revisions in the policy-maker's forecast result in a change in the planned policy over the following three years.

The policy-maker then revises his intended expenditures downward in an attempt to bring his projection of more rapid income growth back to desired levels.

Chart 3 pictures the effect of the four-year policy upon income, and contrasts this with the policy-maker's intended levels of income. In the end, the increased government expenditures produce $4.58 billion less PDI than intended, as Table III demonstrates.

The fundamental factor preventing the policy-maker from making the necessary adjustments to target income more closely is the temporary nature of government policy. Even though the policy-maker boosts expenditure levels by hefty amounts, the temporary nature of the program tends to offset these increases as the end of the program moves closer in time. If the policy-maker intended a permanent increase in annual income, the optimal-control procedure would provide him with much greater success.

Chart 3

Actual and Intended Changes in Disposable Income

Assumption of Adaptive Expectations

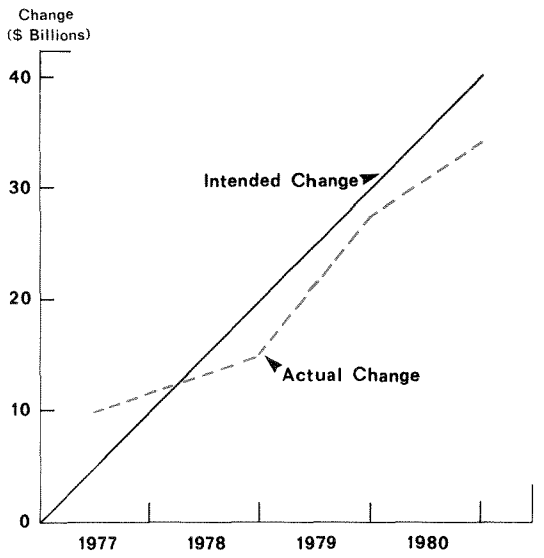


Table III

Income-Expenditure Patterns with Given Expenditure Information

Year	Expenditures	Income
1	7.63	10.68
2	3.85	5.52
3	10.34	12.34
4	6.03	6.88
Total	27.85	35.42

Ratio of income to expenditures—35.42/27.85 = 1.27

Conclusion

While consumer behavior is an important concern of the policy-maker, policy decisions are an equally important concern of the consumer. Since policy is announced ahead of time while other events affecting economic growth are not, it is reasonable to suppose that households and firms will be affected by policy decisions in a qualitatively different way than they are by other economic shocks.

This possibility serves to emphasize the importance of the distinction between the response of an economy to an unforeseen turn of events and the same economy's response to a predictable change in policy. While the existence of prolonged changes in economic growth is indisputable, the policy-maker's ability to offset these divergences in the short run is still open to question.

What we have shown is that announcing economic policies ahead of time may create serious difficulties for the policy-maker. This announcement can affect consumer expectations in ways that are difficult to forecast. But the government can take two measures that would reduce the extent of this problem.

(1). If the policy-maker did not announce his policies ahead of time, the consumer would have no information about future policies and would therefore form his expectations adaptively.

(2). If government-spending programs brought about permanent, rather than temporary, increases in future disposable income, the government-expenditure multiplier under rational expectations would not decline so rapidly through time, and control of income would become easier.

However, these options are, to our good fortune, not available to elected policy-makers. The benefits of a government elected by the people are, like most benefits, not without economic costs.

FOOTNOTES

1. Gregory C. Chow, "Usefulness of Imperfect Models for the Formulation of Stabilization Policies." Princeton University: Econometric Research Program, Memorandum #199 (1976).

2. Critics of the rational-expectations argument note that the conclusion that policy is impotent is based upon the very special assumption that economic agents forecast **prices** only. R. J. Gordon, "Recent Developments in the Theory of Inflation and Unemployment." **Journal of Monetary Economics,** (April 1976), pp. 185-219. If economic agents forecast quantities—e.g. consumers' forecast of future income in the commonly accepted life-cycle consumption hypothesis—then policymakers may still have a beneficial impact upon such goals as income, employment and price stability. Advocates of rational expectations disagree, as in R. E. Lucas, "Econometric Policy Evaluation, A Critique," **Journal of Monetary Economics,** (January 1976 supplement), pp. 19-46. Despite the possibility of a beneficial short-run impact on employment and income, if expectations are rational, policy-makers will still misjudge the long run impact of their decisions.

3. Franco Modigliani, "Monetary Policy and Consumption: Linkages via Interest Rates and Wealth Effects in the MPS Models." **Consumer Spending and Monetary Policy.** Conference Series No. 5 (Boston: Federal Reserve Bank of Boston, 1971).

4. In the first quarter of the expenditure program, for example, the increment provided by increased government spending to consumers' life-cycle income is 0.1564(10) = $1.56 billion. Since the change in consumption and income associated with the government-spending increase is found from the joint solution of

$$\Delta C_0 = .663\ [.1564 \Delta PDI)$$

and $$\Delta PDI_0 = \Delta C_0 + 10.$$

we have ΔPDI_0 = the change in income resulting from the first quarter of increased government expenditures

$$= \Delta C_0 + \Delta G_0$$

$$= 1.16 + 10 = \$11.16 \text{ billion, measured at an annual rate.}$$

5. Carl F. Christ, "Judging the Performance of Econometric Models of the U.S. Economy." **International Economic Review,** (February 1975), pp. 54-74.

6. Chow, op. cit., p. 23-24.

7. The policy-maker assumes the error to be partially carried forward through the lagged adjustment term, ϵ_{-1} in the consumption function, and through the effect of the unexpected level of income upon the adaptive-expectations estimate of life-cycle disposable income.

8. The four-year period is chosen because it is the length of the political cycle determined by presidential elections.

9. This presumption is consistent, for instance, with the wording of the Humphrey-Hawkins bill.

APPENDIX I

Derivation of government expenditures and their impact on DPI

In an adaptation of the Modigliani model, the policy-maker's model of income generation in the period i quarters ahead of the present period, τ, under his four-year policy of generating $10 billion per year of added PDI, can be expressed as

$$\Delta C_i = .663 \left[\sum_{j=0}^{\tau} b_j \Delta PDI_j + 10 \sum_{j=\tau+1}^{i} b_j \right] + (.74)^{i-\tau} e_{-1}$$

$$\Delta C_i + \Delta G_i = \begin{cases} 10 - e_{-1} & j = \tau + 1, \ldots \tau + 4 \\ 10 & j = \tau + 5, \ldots, i \end{cases}$$

The consumer's model of income generation i years in the future is

$$\Delta C_i = .663 \left[\Delta PDI_i + \sum_{j=i}^{4} \Delta PDI_{j+i} (1+p)^{-i} \right] \frac{p}{1+p}$$

$$\Delta C_i + \Delta \bar{E}_i = \Delta PDI_i.$$

The consumer treats this problem as a dynamic programming problem with $\bar{E}_i$ given.

These two sets of relationships highlight the difference between consumer and policy-maker. The consumer is choosing present consumption based upon his estimate of future income, but the policy-maker is forecasting consumption from information contained in past levels of personal consumption.

Suppose that instead of announcing his planned expenditures the policy-maker announced planned levels of income. While this may seem more devious than announcing planned expenditures, in the light of the earlier example it may be more informative to the consumer to release income goals, since the policy-maker's planned expenditures will not be realized anyway. In this case, the government would simply announce its intention to increase income by $10 billion in each of the next four years, stating that expenditures would be at whatever level is required to produce this outcome. This change in announced intentions would have no effect upon the policy-maker's procedures for forecasting future consumption and determining future expenditure intentions, but it would affect the consumer's valuation of future government policy and hence the final outcome both in terms of income and expenditures. For example, in the first year the policy-maker would proceed as before, choosing expenditure levels that produce $10 billion in income under the assumption that consumers forecast by means of an adaptive-expectations scheme. The consumer would use a different method for forming his expectations, however. Instead of using announced government expenditures to estimate future income, the consumer simply makes his own valuation of an added $10 billion per year in PDI for the second through the fourth years:

$$I_t = \frac{p}{1+p} \left(10 + \frac{10}{1+p} + \frac{10}{(1+p)^2} \right)$$

and adds this to income generated in the current year. By this method, the consumer considers himself wealthier in the first year than he did in the earlier example, primarily because he is unaware of the low level of intended government expenditures in years 2 through 4. The result is a relatively high level of consumption, $12.58 billion, somewhat above the $10.58 billion in added income shown in the earlier example in the text.

Planned Government Expenditures—Alternative Strategy

To spend in year	Planned in year 1	2	3	4
1	7.63			
2	4.91	.97		
3	3.58	3.45	9.67	
4	3.37	3.55	3.79	5.10

The table below shows the income resulting from the policy-maker's two alternative approaches to providing information to the consumer. The results are quite similar, but by revealing income intentions rather than expenditure intentions the policy-maker gains a marginal increase in the four-year ratio of income generated to expenditures—1.48 with the income policy and 1.27 with the expenditure policy. At the same time, he loses some control over income generated—$5.48 billion away from the $40-billion target with income policy, and $4.58 billion away from target with the expenditures policy.

Income-Expenditure Patterns with Given Information

Year	Expenditure Information: Expenditures	Expenditure Information: Income	Income Information: Expenditures	Income Information: Income
1	7.63	10.68	7.63	12.58
2	3.85	5.52	.97	3.75
3	10.34	12.34	9.67	12.40
4	6.03	6.88	5.10	5.83
Total	27.85	35.42	23.37	34.56
Income-expenditure ratio		1.27		1.48

APPENDIX II

Consumer forecasts—prices only

A second type of rational-expectations model may be developed where economic agents forecast price rather than quantity variables. In this model, economic decisions might depend upon the divergence of actual prices from price forecasts. Consumers might, for example, adjust planned expenditures in an attempt to hold them constant in real (price-adjusted) terms, but would treat an unanticipated deviation of price from expectation as a temporary change in the relative price of present goods vis-a-vis future goods—perhaps postponing current consumption outlays when prices are unexpectedly high.

The consumption decision in 1977 would therefore depend upon

$$P_{1977} - E_{1976}(P_{1977})$$

which is the deviation of 1977 prices from the level expected in the previous year. This forecast of 1977 prices might be based upon all available information, such as the expected path of future government expenditures and the impact of these expenditures upon personal disposable income.

In the standard version of the life-cycle consumption model, the level of current consumption is assumed to depend upon the consumer's valuation of his future lifetime income. The problem generally is viewed as one of judging the approximate value of an uncertain quantity, in other words a forecasting problem. But suppose that the consumer did not have to forecast the future level of income but instead had a large measure of choice in the matter, given some "natural" restrictions such as his current holdings of capital goods and the value of his labor services. Then he could determine the value of his future DPI at his own discretion—depending, for example, upon whether he greatly preferred leisure to added wages. One of the determinants of his decision to work would be the price level. If prices were high relative to expectations, he might decide to increase his present offering of labor services, hence increasing his life-cycle income. At the old level of life-cycle income, the same consumer-laborer might respond to price increases by reducing present consumption, waiting for future periods when prices would be closer to his expectations to "catch up." However, unexpectedly higher prices would increase his life-cycle income as well, since he offers more labor services at higher prices. Therefore, the decision to reduce or increase consumption would depend on the relative magnitude of income and substitution effects.

In this model, then, consumers may be assumed to forecast prices only, and to consume on the average at a fixed rate. They will revise their planned consumption only if presented with a surprise change in prices. If prices increase above expectations, the consumer will believe the increase to be temporary, and therefore will find it advantageous to defer some present consumption to the future if the substitution effect of high present prices is dominant.

By the same token, if prices fall below expectations, present consumption will be increased at the expense of lost future consumption. When consumption is subjected to a shock, however, time is required for the consumer to readjust his consumption to equilibrium levels. Thus we have

$$C_t = a_1 C_{t-1} + a_2 C_{t-2} + a_3 [P_t - E_{t-1}(P_t)]$$

$$E_{t-1}(P_t) = E(P_t | I_{t-1})\ a_1, a_2 > 0, a_3 < 0$$

The second of these two equations states the rule by which the consumer forecasts future prices. $E_{t-1}(P_t)$ is the price level that the consumer expects to find in period t from a perspective one period in the past. This forecast is conditioned on all the information, I_{t-1}, which is available to the consumer in the earlier period. The consumer may have some knowledge of the policymaker's plans, and he may have some knowledge of the behavior of the economy as well. These equations suggest that if the policy-maker informs the consumer in advance of his policy intentions, he cannot hope to influence the consumer's behavior. This is because the consumer is able to form price forecasts identical to those of the policy-maker when both possess equal levels of information. Consider, for example, the impact of an increase in government expenditures, G. In this case, the consumer revises his forecast of future prices:

$$E_{t-1}(P_t) = E(P_t | G)$$

The policy-maker may estimate the effect on consumption $E_{t-1}(C_t) = a_0 C_{t-1} + a_1 C_{t-2}$

$$+ E_{t-1}[P_t - E_{t-1}(P_t | G)]$$

but since $E_{t-1}(P_t) = E_{t-1}(P_t | G)$

i.e. consumer and policy-maker have the same information

$$E_{t-1}(C_t) = a_0 C_{t-1} + a_1 C_{t-2} + 0$$

and an announced increase in government expenditures has no effect upon consumption.