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In This Issue . . .

In Memoriam

Leonall C. Andersen
1924–1985

This issue of the *Review* is dedicated to the memory of Leonall C. Andersen, who died on October 27, 1985. Andy's involvement with and contribution to economics spanned a period of three decades, divided almost equally between academia and the Federal Reserve Bank of St. Louis. He began his career in 1955 as an assistant professor of economics at St. Olaf College in Northfield, Minnesota; at the time of his death, he was Professor of Economics at Gustavus Adolphus College in St. Peter, Minnesota. For 16 years, however, from August 1962 to August 1978, he was a member of the Research Department at this Bank, where he contributed significantly to research in monetary issues.

Andy's best-known contributions, both to the economics profession at large and to the reputation of the Federal Reserve Bank of St. Louis in monetary policy matters, appeared in two articles in this *Review*. "Monetary and Fiscal Actions: A Test of Their Relative Importance in Economic Stabilization," co-authored with Jerry L. Jordan, was published in November 1968; it gave rise both to the well-known Andersen-Jordan (or St. Louis) equation and to the unending controversy about its methodology and results. "A Monetarist Model for Economic Stabilization," co-authored with Keith M. Carlson, was published in April 1970; it developed a small monetarist macroeconomic model that has been used for policy purposes at this Bank and elsewhere. To honor Andy, we are reprinting these original articles, along with evaluations by his co-authors and others, of their continuing importance and relevance. These will be followed by a brief biographical sketch and a selected bibliography of Andy's important contribution to economics.

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In the first article in this *Review*, "The Andersen-Jordan Approach after Nearly 20 Years," Jerry L. Jordan describes the theoretical and policy-related issues of the late 1960s that led he and Andy to develop what is now called the Andersen-Jordan approach. First, they viewed their research as a sequel to work by Friedman-Meiselman, Brunner-Meltzer and others who had demonstrated the general potence of monetary policy actions. In addition, their research attempted to answer a policy issue of vital concern in 1968: whether the expansive monetary stimulus or the restrictive fiscal policy actions then in place would have the predominant impact on spending. Jordan then discusses why, in his opinion, the Andersen-Jordan method and results were considered so controversial. Finally, after reviewing some reasons often cited for the alleged demise of monetarism in recent years, Jordan concludes that the Andersen-Jordan approach endures;

specifically, the single-equation, reduced-form methodology employed to assess the effects of different policy actions on the economy remains useful today.

In the second article in this issue, Dallas S. Batten and Daniel L. Thornton examine the controversy that emerged following the publication of the 1968 Andersen-Jordan article (see reprint of the original article beginning on p. 29). Andersen and Jordan's basic finding — that monetary actions have a lasting impact on economic activity while fiscal actions do not — generated immediate criticism, most of it econometric in nature, the authors note. Using the same data set as Andersen and Jordan did, Batten and Thornton investigate the validity of the major criticisms of the St. Louis equation. In particular, they test for bias due to misspecification, the presence of endogenous variables on the right-hand side of the equation, and the omission of certain right-hand-side variables. Moreover, they report findings published elsewhere about the dynamic specification of the St. Louis equation and the imposition of polynomial restrictions. In no instance could the authors find statistical support for the alleged, but previously untested, improprieties involving the estimation of the St. Louis equation.

In the third article, Keith M. Carlson reviews the development of the monetarist econometric model that he and Andy published in the April 1970 *Review* article (reprinted beginning on p. 45) and presents an updated version, comparing it with the original model. The general form of the model, the author reports, remains unchanged; it has been simplified to a rate-of-change form, however, and some supply-side variables have been added.

Carlson examines the properties of the updated model and summarizes its simulation performance. The properties of the model are little changed from the original Andersen-Carlson article: monetary actions have substantial short-run effects on total spending, output and unemployment, but over the long run, the effect on total spending is reflected almost entirely in the price level. Although the model's simulation performance appears satisfactory, a more accurate evaluation awaits comparison with similar results from other models.

The Andersen-Jordan Approach after Nearly 20 Years

Jerry L. Jordan

TO my knowledge, the label "monetarist" and its essential propositions were first put forth in an article in the July 1968 *Review* of the Federal Reserve Bank of St. Louis entitled "The Role of Money in Monetary Policy" by Karl Brunner. In it, Brunner states that,

> The critique of established policy procedures, which evolved from this research into questions concerning the monetary mechanism, is derived from a body of monetary theory referred to . . . as the *Monetarist position* [emphasis added]. Three major conclusions have emerged from the hypotheses put forth. First, monetary impulses are a major factor accounting for variations in output, employment and prices. Second, movements in the money stock are the most reliable measure of the thrust of monetary impulses. Third, the behavior of the monetary authority dominates movements of the money stock over business cycles.

The process of defining and refining what we now mean by monetarism grew out of a controversy that emerged in the 1960s regarding the relative importance of monetary and fiscal impulses. The dominant economic policy framework of the day was an outgrowth of the thinking of the 1930s, which became known as Keynesianism. The rapid growth of government spending associated with the Vietnam War, the Great Society programs and relatively large deficits in the federal government's budget were associated with conditions of rapid economic growth, rising inflation and a low unemployment rate. The political prescription for the problem of inflation was a surtax on personal and corporate incomes to restrain aggregate demand and reduce inflation.

Adherents to the propositions that became known as monetarism questioned whether such fiscal actions would, in fact, restrain aggregate demand and reduce inflation if monetary growth remained as rapid as it had been previously. Since the dominant position of the time was known as the Keynesian revolution, the critics of that view were said to have mounted a monetarist counterrevolution. At times, the quality of the discussion was silly, including such insights as "you can pull on a string, but you can't push on a string" and "you can lead a horse to water, but you can't make him drink." At other and more useful times, state-of-the-art econometric techniques were used to test rival conjectures about monetary and fiscal impulses.

The skirmishes of the period included the Friedman-Heller debate, the "Battle of the Radio Stations" — which referred to the research done by Ando-Modigliani (AM) and Friedman-Meiselman (FM) — and the associated contributions by DePrano, Hester and Mayer and by Brunner and Meltzer. The role of what became known as the gadfly or maverick research department of the Federal Reserve Bank of St. Louis is now well-known in economics circles; although it had started a few years earlier, it was given greatly heightened visibility with the publication of the Andersen-Jordan (AJ) article in 1968.

The 1966 credit crunch and subsequent "mini-recession" had demonstrated the potential for a restrictive monetary policy, measured in terms of a deceleration of monetary growth, to dominate an expansive fiscal impulse. In 1968, the issue was whether monetary stimulus — as indicated by continued rapid growth of money — could dominate a restrictive fiscal impulse as measured by a tax increase, reduction in the high employment deficit or

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some other summary variable. The research underlying the AJ article was motivated by two events: the Johnson administration's anti-inflation surcharge on personal and corporate income tax and the FOMC's decision to ease monetary policy to cushion the presumed highly restrictive effects of the tax surcharge.

We considered the AJ article to be a sequel to the FM article. Our purpose was to rigorously formulate potentially falsifiable hypotheses about various macroeconomic policy actions. The article also was an exercise in applying what was then state-of-the-art computerized regression programs using the Almon distributed lag for testing hypotheses.

I believe that the vehemence of the attacks on the AJ article arose from two sources. First, the results of the study sharply contradicted the inherited wisdom of the times and raised serious doubts about our ability to use activist/discretionary fiscal policy to influence the economy in predictable ways.

A second reason for the attacks was simply that the reduced-form approach used in the AJ study represented a threat to econometric model builders; it provided a low-cost alternative to the expensive efforts at the time to build large-scale structural models of the U.S. economy. For example, around that time, the Federal Reserve Board had entered into a contract to spend about $1 million to build what became known as the FRB-MIT econometric model. In my judgment, the structural model-builders of the times simply could not afford to leave unchallenged the competition that this relatively cheap approach presented in evaluating policy effects on the economy. In any event, those threatened by its challenge both to economic orthodoxy and to the usefulness of large-scale models had great incentive to seek to discredit the AJ methodology.

Thus, as the decade of the 1960s ended, the lines had been drawn for a prolonged intellectual battle. The Keynesian revolution was still dominant, but the challenge of the monetarist counterrevolution had been initiated. The 1970s was a decade of formulation, reformulation and empirical testing of the alternative views of the major macroeconomic influences on the economy. By the end of the 1970s and into the early 1980s, further testing of monetarist propositions by actual implementation was attempted, at least in name, if not in fact.

Recently, there have been numerous claims that monetarism has failed. Certainly the case against monetarism has been tried in the press with journalists acting as both prosecutors and jury. Economists, however, have yet to complete their deliberations. Because the "breakdown" of the AJ results is often cited as evidence against monetarism, I would like to comment briefly on the current controversy.

ON THE RECENT 'FAILURE' OF MONETARISM: IS 'ANDERSEN-JORDAN' PASSE?

The failure of monetarism has been asserted and reasserted often during the past few years. This failure is based on the contention that the relationship between money growth and GNP, or money growth and inflation, has broken down. In particular, the behavior of the income velocity of money over the last few years, especially in 1985, has raised questions about one of the central propositions of the quantity theory of money, or monetarism — namely, the stability of the demand function for money. The sharp decreases and increases in conventionally measured velocity have led to assertions that the demand for money is unstable and, therefore, the money supply (M1) is no longer a reliable indicator of the thrust of monetary policy impulses.

Growth rates of M1 over short intervals during the last few years have been highly volatile, and the contemporaneously measured ratio of GNP/M1 also has fluctuated over a wide range. Unfortunately, both monetarists and their critics seem to accept the view that the public policy relevance of monetarism depends on the short-run stability of the functional relationship between domestic income and/or output and growth of the money supply. The short-run volatility of a data series such as the ratio GNP/M1, however, does not yield any definitive information about the stability of the underlying functional relationship between money and economic activity.

There are three important aspects of velocity behavior in the recent past that must be examined: the role of institutional changes, the implications of lags and the appropriateness of the numerator in computing the velocity ratio.

Institutional Changes

Some analysts assert that deregulation of the financial system, starting with the Depository Institutions Deregulation and Monetary Control Act of 1980 and continued with the Garn-St. Germain legislation in 1982, has altered the behavior of M1 and, in turn, has caused the volatile behavior of velocity in the last two years. The empirical issue, on which there is no consensus at this time, is the degree to which the "demand for money balances" has shifted upward relative to income or wealth and, consequently, a downward shift in at least the level, and possibly the trend growth rate, of M1 velocity.

It has been argued that the removal of Regulation Q interest ceilings on bank deposits and the innovation of new types of deposit instruments has resulted in M1 containing a large savings component. Therefore, faster growth of the money supply, such as what occurred in 1985–86, should not be taken as an indicator of as much stimulus as before since the demand for money balances is also rising. Without an excess supply condition, it is argued, there is no reason to expect nominal income growth to accelerate.

Monetarists generally accept the view that deregulation and financial innovation have most likely resulted in a reduction in the trend rate of growth of M1 velocity. There is no reason, however, to believe that the level of velocity would be expected to decline. The trend rate of increase of historic M2 velocity has been between 0 and 1 percent. M2 has always contained a relatively large savings component. Deregulation and innovation may have resulted in M1 taking on the characteristics of historic M2. At this point, however, we do not have sufficient evidence to draw firm conclusions.

Even if M1 is now like old M2, the trend rate of increase of M1 velocity would have declined from the 3 percent rate of the post-war period to something more similar to historic M2 velocity growth. There is no theoretical reason and no evidence to suggest that the trend of M1 velocity would be negative as a result of deregulation and innovation.

The Role of Lags

The existence of lags in an environment of highly volatile short-run money growth *must* produce a highly volatile data series for velocity. Volatility of the data series, however, does not yield useful information about the stability of the underlying functional relationship.

This point can be illustrated with a simple example. Suppose it were known with certainty that the lag between changes in money and changes in nominal income was exactly 180 days. Suppose further that the growth of M1 accelerated and decelerated sharply over intervals lasting exactly six months. Starting from any initial condition, a sharp acceleration in M1 growth for six months would not be matched by an acceleration in the growth of the numerator of the velocity ratio. Consequently, contemporaneously measured velocity (V) would decline during the interval.

At the end of six months, the numerator would begin to rise more rapidly, while the denominator decelerated, causing a sharp increase in the V-ratio. Six months later, once again the denominator would accelerate while the numerator decelerated, causing a plunge in the V-ratio. Observing the behavior of the V-ratio over several such cycles could easily lead an undergraduate money-and-banking student to conclude that velocity, or the demand for money, was not stable. It was a perfectly stable and predictable functional relationship, however, that produced the volatility of the data series.

The relevance of the point is that, over the last several years, we have observed increasingly sharp accelerations and decelerations of M1 growth, with each movement in the rate of change tending to last two to three quarters followed by a sharp reversal. Since the real-world lag is not discrete, but rather is distributed and variable, the challenge to empirical research is to develop techniques to identify the actual lag structure.

Appropriate Numerator

It is common practice to compute the velocity of money as the ratio of GNP divided by M1 or a broader money measure. The original quantity theory equation, however, was $MV = PT$, where T is transactions. Changes in GNP reflect primarily changes in domestic output at prevailing prices, not total transactions at prevailing prices. The use of GNP in the velocity ratio implies both a closed economy and the stability of such components as business inventories. Since those assumptions are not a good representation of the real world, the use of GNP for computing velocity causes several problems.

In casual conversation, it is common to refer to GNP as a measure of aggregate demand or total spending in the economy. It is not. A rigorous formulation of the quantity theory of money, or monetarism, involves a statement about the demand for money balances relative to wealth or permanent income. Since quarterly fluctuations in GNP as compiled by the Commerce Department are not a good proxy for changes in wealth or permanent income, the use of GNP to compute the inverse of the demand for money — velocity — causes significant measurement problems.

The theory implies that an acceleration in monetary growth results in increased spending growth. In a closed economy, a short-run manifestation of the increased spending would be an involuntary and unanticipated reduction in business inventories, increased ordering and increased production. The longer-term effect is a reduction in the purchasing power of nominal money units — inflation.

In an open economy, an increase in money growth may be accompanied by an increase in demand for imported goods as well as domestically produced output. A sharp and sustained acceleration of money growth that is accompanied by a large increase in imports suggests a decline in the GNP/M1 ratio, at least for a while. Other adjustments, however, gradually do take place — such as in the foreign exchange value of the domestic currency which changes the relative prices of internationally traded output; eventually more costly imports and more competitive exports will reverse the situation. Those lags can be very long and are difficult to predict, introducing further uncertainty into the relation between money and GNP growth. This phenomenon limits the usefulness of monetarism in conducting short-run-oriented discretionary policies since the usefulness of money growth as an indicator of the thrust of monetary policy is usually gauged in terms of its reliability in forecasting GNP growth.

WHAT REMAINS OF THE ANDERSEN-JORDAN APPROACH?

One central monetarist proposition has always been that activist, discretionary policies are neither necessary nor desirable. Therefore, it is ironic that the "St. Louis equation" unintentionally strengthened the views of the public policymakers who wanted to "manage" monetary policy to achieve different economic results. The empirical relation between money growth and nominal income was used as a rationalization for an activist, discretionary policy under which faster or slower target growth rates for money were adopted to achieve faster or slower growth rates of nominal GNP and, in turn, more or less inflation, output and employment.

The use of the St. Louis equation to engage in "fine-tuning" was neither intended nor anticipated by us. As I noted earlier, our intent was to demonstrate that expansive monetary fine-tuning, intended to offset a presumed contractionary fiscal impact, was neither necessary nor desirable. Much to our surprise and chagrin, our results were used by some to demonstrate the efficacy of monetary fine-tuning.

The basic problem with activist policies is that numerous factors affect economic performance; in the past two decades, there have been ample opportunities to accumulate data about the effects of both policy and non-policy developments on economic activity. Yet, very little, if anything, has been learned from all this accumulated experience. The lags in the effects of policy actions are just as variable and just as uncertain, and policy actions still account for less than half the variability of economic variables.

The appendix to the Andersen-Jordan article emphasizes the importance of the "Z-factor," a variable summarizing all the other forces that influence total spending in the economy. While the text of the article concluded that monetary policy actions were relatively more important than fiscal actions, the analysis in the appendix suggests that a more complete conclusion would have been "and non-policy factors are even more important." The article's impact on economic policymaking would have been more favorable had it not led to an increased reliance on monetary over fiscal policy, but had it instead contributed to a general de-emphasis of fine-tuning attempts by policymakers. Some of the frustration and disappointment expressed by monetary policymakers in recent years may have resulted from the unsatisfactory results they observed from this misuse of the theory.

In my judgment, the enduring contribution of the AJ approach is the methodology employed to assess the differential impacts of policy actions on the economy, not the specific results offered at the time. While institutional and technological changes over time may alter empirical results, students of public policy debates can still usefully apply today the single-equation, reduced-form approach used by the AJ study 18 years ago.

The Monetary-Fiscal Policy Debate and the Andersen-Jordan Equation

Dallas S. Batten and Daniel L. Thornton

PERHAPS Andy's most important and lasting contribution to the economics profession was his research with Jerry Jordan that resulted in the publication of the Andersen-Jordan (A-J) equation or, as it is more widely known, the St. Louis equation. Almost immediately, the two found their work the subject of intense criticism and controversy — much of which continues, though in tones that are significantly muted.[1]

While the criticisms of Andersen-Jordan were focused on various technical and applied econometric aspects of their work, they were motivated, in large part, by A-J's conclusion that monetary policy has a significant and lasting effect on nominal GNP and that fiscal policy has no lasting effect. These results conflicted sharply not only with the conventional wisdom about the relative effects of monetary and fiscal policy actions but with the results of large-scale econometric models of the time.

The purpose of this paper is to review the criticisms that emerged following the publication of the A-J equation.[2] We note that many, if not all, of the criticisms of the A-J paper apply equally well to the vast majority of published research, then and now. More importantly, using the original A-J data, we find no evidence to support these criticisms.

THE ST. LOUIS EQUATION AND ITS CRITICS

Recently, Cooley and LeRoy (1981) have argued that a close correspondence tends to exist between the advocacy of a theory and the results of scientific investigation. It is not surprising, therefore, that when two known and vocal proponents of monetarism reported empirical results that strongly supported monetarist propositions, the results were received with skepticism, which was intensified by their use of a single, "reduced-form" equation. Critics were suspicious that A-J inadvertently had either misspecified the model or used faulty econometric techniques to obtain their results.[3]

Three major criticisms emerged following the publication of the A-J equation. First, it was argued that the equation was misspecified because important exogenous, right-hand-side variables had been excluded. Second, critics claimed that A-J's use of ordinary least squares (OLS) had resulted in simultaneous equation bias. Finally, it was asserted that A-J had failed to identify the relevant exogenous indicators of monetary and fiscal policy actions. In addition, critics were concerned that the A-J results were sample-specific or not robust to various econometric modifications, including their use of Almon's (1965) polynomial distributed lag estimation technique. The perception that A-J had somehow erred was enhanced when de Leeuw and Kalchbrenner (1969), Silber (1971) and Schmidt and Waud (1973) tried unsuccessfully to replicate the

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[1]The monetary-fiscal policy debate was actually initiated prior to Andersen-Jordan (1968) by Friedman and Meiselman (1963). Just as the ensuing debate surrounding Friedman and Meiselman's results was waning, however, Andersen and Jordan appeared, rekindling and intensifying the disagreement over the relative efficacy of monetary and fiscal policies.

[2]While our review differs from recent ones by McCallum (1986) and Meyer and Rasche (1980), it is necessary to traverse some of the ground they covered.

[3]A number of critiques appeared very shortly after the publication of the A-J paper, e.g., de Leeuw and Kalchbrenner (1969), Davis (1969), Corrigan (1970), and Goldfeld and Blinder (1972).

A-J results.[4] The following sections examine these criticisms.

MISSPECIFICATION

The charge that A-J had misspecified their equation by omitting important variables, other than monetary and fiscal policy variables, was leveled by numerous commentators. To understand this argument, consider the original A-J equation:

$$(1)\quad \Delta Y_t = \alpha + \sum_{i=0}^{3} \beta_i \Delta M_{t-i} + \sum_{i=0}^{3} \gamma_i \Delta E_{t-i} + u_t ,$$

where Y, M and E denote nominal GNP, the money stock (M1) and nominal high-employment government expenditures, respectively, and u_t denotes the usual random disturbance term.[5] This equation can be written more compactly as:

$$(2)\quad \Delta Y_t = \alpha + \beta(L)\Delta M_t + \gamma(L)\Delta E_t + u_t ,$$

where $\beta(L)$ and $\gamma(L)$ are polynomials in the lag operator L, such that $L^n x_t = Lx_{t-n}$ and where $\beta(L)\Delta x_t$ are distributed lags of a finite order k.[6] A-J chose k = 3.

If a relevant exogenous policy variable, Z_t, is omitted, the true specification is not equation 2, but

$$(3)\quad \Delta Y_t = \alpha + \beta(L)\Delta M_t + \gamma(L)\Delta E_t + \delta(L)\Delta Z_t + \varepsilon_t ,$$

in which case the error term in equation 2 is $u_t = \delta(L)\Delta Z_t + \varepsilon_t$. Furthermore, estimates of the monetary and fiscal policy responses from equation 2 will be biased if ΔZ_t is correlated with ΔM_t or ΔE_t.

This criticism of the A-J equation, while potentially damaging if valid, applies equally well to virtually all applied econometric research, including most large-scale, simultaneous-equation econometric models of the A-J vintage.[7] Moreover, although it was commonly argued that the A-J equation was potentially misspecified, econometric theory does not suggest that it is more susceptible to the resulting bias than other estimated equations. Indeed, there was no evidence that their results were biased since no tests for misspecification were performed.

While their results provided no evidence that the A-J equation is misspecified, Modigliani and Ando (1976) presented evidence from a Monte Carlo-style experiment that led some to doubt the validity of the A-J results.[8] Using artificial data generated by the MPS econometric model, they used a St. Louis-style equation to estimate the reduced-form parameters. The results indicated that the St. Louis-style equation produced poor estimates of the "true" monetary and fiscal multipliers, seriously overstating the size of the monetary influence and underestimating the magnitude of the fiscal policy effect. They concluded that the A-J reduced-form estimation technique yielded unreliable estimates.

This conclusion, however, is unwarranted.[9] If a

[4]It now appears that these differences resulted from differences in programming or in the imposition of polynomial restrictions. Batten and Thornton (1985) have replicated the A-J results to the second or third decimal place. Even though other researchers may have been unable to replicate the A-J results exactly, their studies generally supported the qualitative findings of A-J.

[5]The original A-J paper also contained specifications with the adjusted monetary base as the indicator of monetary policy actions and a distributed lag of high-employment government revenues as an additional right-hand-side variable. Equation 1 is the most commonly estimated form of the equation, however.

Furthermore, following an exchange between Friedman (1977) and Carlson (1978), the equation was specified in growth rates of the variables. It is interesting to note that A-J also estimated a growth-rate specification, but only reported the first-difference results. For the most part, the issues discussed below are independent of the specification.

[6]The notation used here is the same as employed by McCallum (1986).

[7]For example, Duesenberry et al. (1965).

[8]See McCallum (1986), p. 17 and footnote 16.

[9]McCallum (1986) criticized the Modigliani-Ando results by arguing that they failed to distinguish between reduced-form and "final-form" multipliers. He considers the case where $\Delta Z_t = a_0 + a_1 \Delta Y_{t-1} + a_2\Delta M_{t-1} + a_3\Delta E_{t-1} + \varepsilon_t$. Substituting this expression into equation 3 yields the following: $\Delta Y_t = \alpha + \beta'(L)\Delta M_t + \gamma'(L)\Delta E_t + \varepsilon_t'$ where the coefficients are defined to conform, e.g., $\beta'(L) = [1 - La_1\delta(L)]^{-1} [\beta(L) + La_2\delta(L)]$. In contrast to the finite order distributed lags of the A-J equation 2, the distributed lags on this final-form equation are of an infinite order. Also, the error term of the A-J equation, u_t, is hypothesized to be white noise, while that of the above equation, ε_t', is an infinite order AR process under the assumption about u_t. The distinction between reduced- and final-form equations may not be important, however, because if the lags of the final-form equation are truncated to match those of equation 2, these equations are indistinguishable save the error structure. While this difference will allow one to distinguish between the two equations, it will only do so if one is willing to make strong claims about the underlying distribution of u_t. (McCallum notes this; see p. 24, footnote 8).

It is interesting to note, however, that our results obtained by adding a distributed lag of ΔY to the A-J equation support McCallum's idea that the A-J results reflect all of the direct and indirect effects via lagged values of nominal GNP. A-J and Darby (1976) argued that the equation captured direct and indirect effects via other contemporaneous endogenous variables.

McCallum also argues correctly that "it is hard to imagine any important macroeconomic variable that is truly exogenous . . ." (p. 13). If there are really no exogenous variables, however, then the true reduced form would be a Sims-type VAR model where the only exogenous variables would be the policy and, perhaps, other innovations.

structural model is well defined with additive, normally distributed errors, consistent estimates of the reduced-form parameters can be obtained by the use of indirect least squares, a la A-J.[10] Because the MPS model does not necessarily reflect the true structure of the U.S. economy (for example, it ignores potentially important sources of crowding out through wealth effects and Ricardian equivalence), the Modigliani-Ando experiment cannot be a criticism of the A-J results or of the A-J methodology.[11] Consequently, the Modigliani-Ando evidence is predominantly a statement about Keynesian vs. monetarist views of the world.[12] Furthermore, they provide no general information concerning the usefulness of the reduced-form estimation. By design, the A-J equation did not conform to the reduced form of the MPS model; so it is not surprising that the parameter estimates were poor. The experiment merely reminds us that, if one estimates a reduced form that is known to be misspecified, the results may be biased.

Gordon's Evidence

Except for the usual checks for serial correlation and heteroskedasticity, the A-J equation was not subjected to formal tests of model specification. Gordon (1976) came closest to testing the A-J equation for misspecification. He added a set of "omitted variables," Z, to the St. Louis equation. Claiming that these variables were nonstochastic, he tested for their statistical significance and measured the impact of these variables on the A-J equation simply by observing whether they affected the size and statistical significance of the estimated long-run monetary and fiscal multipliers. Unfortunately, the Z-variable he constructed — the sum of net exports, consumer expenditures on new automobiles and nonresidential fixed investment — was arguably more endogenous than the money and expenditure variables that A-J had used. Hence, Gordon's results, while by and large favorable to A-J, say little about whether A-J's results were affected by specification error.[13]

RESET Test Results

Ideally, one should test the specification of a model by comparing it with a well-specified alternative. Since the reduced form of the MPS model (or any other large-scale Keynesian model) is well specified, it could, in principle, be used as the alternative in a test of the A-J equation. Unfortunately, most large-scale models have too many exogenous variables for the reduced form to be estimated directly. Even if it could be estimated directly, however, it would be difficult to obtain a data set that is comparably dated with the original A-J data.

This has prompted us to use a general test of misspecification, the RESET test of Ramsey and Schmidt (1976), which requires no additional data. The RESET test is a general diagnostic test for various types of misspecifications, including omitted variables, where the alternative hypothesis is not well specified.[14] Applied to equation 2, the F-statistic calculated according to the Ramsey-Schmidt version of the RESET test is .52, which is not significant at the 5 percent level.[15] Hence, the RESET test provides no support for claims that the original A-J equation was misspecified because A-J had omitted significant exogenous variables from their analysis.

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[10]Unique estimates of the structural parameters cannot be obtained, however, unless the system is exactly identified.

[11]Klein (1976), p. 50, noted in his discussion of the Modigliani-Ando paper, "If the world were constructed along lines portrayed by the MPS model, St. Louis conclusions could have been innocently obtained by one who did not bother to estimate the structure. This is the strongest statement that can be made."

[12]Gordon (1976) chides Schwartz (1976) for missing the point of the Modigliani-Ando critique because she criticizes the specification of the MPS model. But this is exactly the point. Gordon later states incorrectly that "the major contribution of the paper is its demonstration that the correlation between included policy variables and other excluded variables severely biases the estimated St. Louis multipliers and renders useless the reduced form technique" (p. 60).

[13]Gordon performed no formal tests. He noted merely that, when his Z-variable was included, the sum of coefficients on ΔM became smaller and, during one short period, was insignificant. (This period is the one for which the correlation between ΔM_t and ΔM_{t-1} and his composite variable is the highest.) There was no discussion, however, of the problem of multicollinearity or possible bias induced by including variables that are clearly endogenous. (If these extraneous variables do not belong in the model, the estimates are consistent but may be biased in small samples.)

[14]In general, if an equation is misspecified, the residuals will have a non-zero mean. The RESET test is designed to detect a non-zero mean of the residuals. The test is performed by adding $\Delta\hat{Y}^2$, $\Delta\hat{Y}^3$, ..., $\Delta\hat{Y}^h$ as additional regressors to equation 2 and testing the hypotheses that these regressors have no joint effect on the dependent variable. The test here was performed for h = 2, 3, 4; the result with the lowest significance level (in this case, h = 3) is reported. See Fomby, Hill and Johnson (1984), pp. 411–12, for a discussion of the RESET test.

[15]When A-J originally estimated equation 2, they used restricted least squares in the form of Almon's (1965) polynomial distributed lag estimation technique. We have recently shown, however, that none of the important conclusions of A-J depend on these restrictions [Batten and Thornton (1985)]. Consequently, all of the empirical results reported here are obtained with OLS.

SIMULTANEOUS EQUATION BIAS

A number of critics argued that the A-J results were unreliable because their policy variables were not strictly exogenous. Because of their knowledge of the issues surrounding targets and indicators of monetary policy, A-J were acutely aware of the need to select exogenous indicators of policy. Indeed, they considered a broad range of measures of monetary and fiscal actions that had been cited frequently in the literature.[16] In their analysis, they assumed that all excluded variables either were independent of monetary and fiscal actions or were influenced by them, so that monetary and fiscal policies exerted an indirect effect on the economy through these factors.[17] A-J reasoned that if monetary and fiscal influences were not independent of other factors, the constant term, which they argued summarized the impact of these factors, would have changed as these variables changed. Using a Chow test to test whether the parameters of their equation were temporally stable, they found no evidence of instability.

Given the attention that A-J gave to this issue, it is odd that their work was singled out as subject to simultaneous equation bias, when a number of works of applied economics of this vintage were not criticized for applying OLS to equations with right-hand-side variables that were more clearly endogenous.[18]

Wu Test Results

Again, despite claims that the A-J results were questionable on grounds of simultaneity, systematic testing for simultaneous equation bias has been sparse. McCallum (1986) compared OLS and instrumental variables (IV) estimates of the A-J equation, but performed no formal tests. Extending McCallum's analysis, we perform a Wu (1973) test using the original A-J data. Like McCallum, we used three lags of ΔM, ΔE and the three-month Treasury bill rate as instruments for ΔM_t and ΔE_t. The results are reported in table 1.

Table 1

OLS and IV Estimates of the Andersen-Jordan Equation

Variable	OLS	IV
Constant	2.311*	2.548*
	(2.82)	(2.45)
ΔM_t	2.121*	0.676
	(2.87)	(0.33)
ΔM_{t-1}	0.312	1.652
	(0.32)	(0.84)
ΔM_{t-2}	2.696*	2.005
	(2.69)	(1.56)
ΔM_{t-3}	0.671	0.452
	(0.87)	(0.51)
$\Sigma\Delta M_t$	5.800*	4.785*
	(7.34)	(3.68)
ΔE_t	0.379	1.300
	(1.40)	(1.46)
ΔE_{t-1}	0.523	0.315
	(1.88)	(0.81)
ΔE_{t-2}	0.022	−0.217
	(0.08)	(0.54)
ΔE_{t-3}	−0.763*	−0.832*
	(2.95)	(2.81)
$\Sigma\Delta E_t$	0.161	0.566
	(0.52)	(1.17)
Joint F-test, ΔM	15.84*	8.65*
Joint F-test, ΔE	3.17*	2.75*
$\bar{R}^2$	0.61	0.54
DW	1.747	2.010
SE	3.96	4.42

*Indicates statistical significance at the 5 percent level.
Absolute value of t-ratio in parentheses

A comparison of OLS and IV estimates shows some large differences, particularly for the coefficients on ΔM_t and ΔE_t. The IV estimates show a smaller initial effect of money and a larger initial effect of government expenditures relative to the OLS estimates. Nevertheless, the Wu test chi-square statistic is .20, not statistically significant at the 5 percent level.

It is not too surprising that the IV estimates are relatively imprecise. The first-stage $\bar{R}^2$'s were .54 and .38 for ΔM_t and ΔE_t, respectively. Moreover, the fact that three lags of ΔM_t and ΔE_t are used as instruments means that $\Delta\hat{M}_t$ and $\Delta\hat{E}_t$ are likely to be highly correlated with the other regressors of the A-J equation. While the test could be carried out with alternative instruments, there is no obvious guide to their selection. In any event, it is unlikely that the results will be

[16]Both Andersen and Jordan participated in a Conference on Indicators and Targets of Monetary Policy held at UCLA in 1966. Andersen contributed to the conference proceedings; see Andersen (1969).

[17]This possibility was also considered by McCallum (1986) and Darby (1976), though McCallum included a lagged dependent variable to obtain his distinction between the reduced form and the final form; see footnote 9 above.

[18]One of the most important of these was Chow's (1966) pathbreaking work on money demand, in which current values of real GNP and a nominal interest rate appeared on the right-hand side of the equation.

Table 2

Estimates of an Autoregressive Version of the Andersen-Jordan Equation

Variable	Coefficient	t-ratio[1]
Constant	2.464*	(2.58)
ΔM_t	2.049*	(2.84)
ΔM_{t-1}	−0.206	(0.21)
ΔM_{t-2}	2.971*	(2.98)
ΔM_{t-3}	0.399	(0.45)
$\Sigma\Delta M_t$	5.213*	(5.11)
ΔE_t	0.277	(0.97)
ΔE_{t-1}	0.638*	(2.27)
ΔE_{t-2}	0.025	(0.09)
ΔE_{t-3}	−0.709*	(2.80)
$\Sigma\Delta E_t$	0.231	(0.66)
ΔY_{t-1}	0.250	(1.86)
ΔY_{t-2}	−0.194	(1.52)
ΔY_{t-3}	−0.030	(0.26)
$\Sigma\Delta Y_t$	0.026	(0.15)

Joint F-test, ΔY = 1.91
Joint F-test, ΔM = 9.59*
Joint F-test, ΔE = 3.00*
$\bar{R}^2$ = 0.628
DW = 2.146
SE = 3.87

[1]Absolute value of t-ratio
*Indicates significance at the 5 percent level

convincing unless they are robust over a broad choice of instruments. It can only be said that, based on the instruments used, there is no evidence of simultaneous equation bias in the A-J equation.

Granger Causality Results

There is additional evidence that the A-J results were not affected by simultaneous equation bias. Simultaneity requires temporal feedback between money and income. Thus, the lack of Granger (1969) causality from income to money is a necessary, though not sufficient, condition for statistical exogeneity.[19] When Elliott (1975) performed tests of Granger causality between money, income and government expenditures, he found unidirectional causality running from money to income and bidirectional causality between expenditures and income.[20] More recently, using the original A-J data, Batten and Thornton (1985) found unidirectional causality running from money to income and no causal ordering between income and expenditures.

The fact that income does not Granger-cause money implies that the coefficients on the distributed lag of ΔM_t do not reflect the feedback of income on itself via money; instead, these coefficients measure the direct, and possibly indirect, effects of money on the economy. To verify this interpretation, a three-quarter distributed lag of ΔY was included in the A-J equation as separate regressors and the significance of these coefficients was tested. The results are reported in table 2. The coefficients on the lags of the dependent variable are not significantly different from zero — individually or jointly. Furthermore, the coefficients on the money and expenditure variables differ little from the OLS results of table 1.

The Sims Evidence

Although his criticism was not directed explicitly at the A-J equation, Sims (1980, 1982) has argued recently that the impact of monetary policy actions is very small if interest rates are included in the same equation.[21] To investigate Sims' conjecture, we added a contemporaneous and three-quarter distributed lag of the change in the three-month Treasury bill rate (ΔTB) to the A-J equation.[22] The results, reported in table 3, show that only the contemporaneous coefficient on ΔTB is significant. Moreover, the coefficients on the money and expenditure variables are little changed from those in table 1, and none of the qualitative conclusions about the effectiveness of monetary or fiscal policy actions is altered.

Thus, as was the case for allegations of misspecification, there is considerable disparity between the conventional wisdom and the empirical results concerning the issue of simultaneity. Nevertheless, the claim that simultaneity is a serious problem for the A-J equation is a deeply entrenched and widely accepted

[19]See Wu (1983) for a discussion of these issues.

[20]Elliott used Sims' (1972) procedure which requires that the data be filtered, a process that can affect the test results. See Feige and Pearce (1979).

[21]McCallum (1983, 1986) has critiqued Sims' results on theoretical grounds.

[22]The equation was also estimated with the level of the Treasury bill rate; however, none of the qualitative conclusions were changed.

criticism of their work.[23] The evidence examined in this section, however, suggests that estimation of the original A-J equation was not affected by simultaneity.

INAPPROPRIATE INDICATORS OF POLICY ACTIONS

A third major criticism of the St. Louis equation was that A-J's indicators of policy actions may be inappropriate. Failure to use appropriate indicators could bias the estimated parameters, perhaps by distorting the relative importance of monetary and fiscal actions.[24]

In a sense, this argument is an extension of the policy endogeneity argument since its proponents contended that the appropriate indicator of monetary policy should not respond endogenously to forces outside of the Fed's control. For example, in the first published criticism of A-J, de Leeuw and Kalchbrenner (1969) criticized the use of the monetary base (and implicitly M1) as an indicator of monetary policy actions on the grounds that some of its components (particularly, currency and borrowed reserves) were endogenous and not controlled by the Fed directly.[25] Instead, de Leeuw and Kalchbrenner offered an alternative exogenous policy measure that they obtained by subtracting currency and borrowings from the adjusted monetary base. When they estimated an A-J type equation using their measure of monetary policy actions, they found the cumulative monetary policy multiplier was much smaller than that of the A-J equation and not significantly different from zero. On the other hand, their estimated cumulative government spending multiplier was substantially larger and was statistically significant.[26]

In their reply, A-J (1969) pointed out that de Leeuw and Kalchbrenner's focus on the *uses* of the monetary base was inappropriate. Although the banks and the public determine the uses of the base, the Fed controls the size of the monetary base through its influence over the *sources* of the base, the largest component of which is the Fed's holdings of U.S. government securities. Thus, the Fed determines the size of the monetary base through its sales or purchases of government securities.

Furthermore, A-J noted that changes in the M1 money stock during their estimation period were dominated by changes in the monetary base. Hence, the Fed exercised control over M1 through its control of the sources of the monetary base. Since this exchange, the disagreement over the measurement of monetary policy actions has subsided, and the monetary base and M1 (and, at times, broader monetary aggregates) are generally accepted, and commonly used, as indicators of policy actions.

A-J's measurement of fiscal policy actions was criticized more than their measure of monetary policy actions. Recognizing that certain components of both federal government expenditures and revenues respond endogenously to the level of economic activity, A-J utilized high-employment measures, which were adjusted for these influences. De Leeuw and Kalch-

Table 3

Estimates of the Andersen-Jordan Equation with a Distributed Lag of Interest Rates

Lags	ΔM	ΔTB	ΔE
0	2.409*	4.216*	0.313
	(3.07)	(2.37)	(1.17)
1	−0.633	0.122	0.639*
	(0.61)	(0.06)	(2.32)
2	2.124	0.199	0.002
	(2.00)	(0.10)	(0.01)
3	0.737	−0.122	−0.666*
	(0.79)	(0.07)	(2.47)
Sum	4.637*	4.415	0.228
	(4.95)	(1.39)	(0.94)
Constant	2.910*		
	(3.47)		

Joint F-test, ΔM = 7.65*
Joint F-test, ΔTB = 1.96
Joint F-test, ΔE = 3.10*
$\bar{R}^2$ = .635
DW = 1.78
SE = 3.83

*Indicates statistical significance at the 5 percent level
Absolute value of the t-ratio in parentheses

[23]While Andersen and Jordan acknowledged that money *could* be endogenously related to income and expenditure variables via a "Fed reaction function," they considered this to be of little practical significance. See Andersen and Jordan (1969), p. 16.

[24]For some, the concern was that some of the effect of fiscal policy might be incorrectly attributed to monetary policy. See Blinder and Solow (1974).

[25]This line of argument was also taken by Gramlich (1971).

[26]Government receipts were also included; the estimated cumulative multiplier of government receipts also increased but was statistically significant only with longer lags.

brenner contended that this adjustment was incomplete because it failed to eliminate the influence of inflation. The substitution of inflation-adjusted, high-employment government expenditures and revenues, however, had little impact on the estimated parameters of the equation.

Gramlich (1971) felt that the non-monetary "exogenous" influences were too narrowly defined. Consequently, he constructed two broader composite measures. His expenditure measure was government purchases plus exports, grants-in-aid and an inventory adjustment for defense purchases. His revenue measure included high-employment personal taxes plus interest payments and social security contributions less exogenous transfers (that is, all transfers except unemployment compensation). While these changes did result in larger (and more nearly statistically significant) sums of estimated coefficients for the non-monetary influences, the general results of A-J remained intact.

Corrigan (1970) offered what appeared to be the most damaging criticism of the high-employment measures of fiscal policy actions. He argued that they did not represent appropriate indicators of discretionary fiscal policy actions, since high-employment measures (especially revenues) would change with high-employment income. In their place, he offered his initial stimulus (IS) measure of discretionary changes in fiscal policy. The IS measure of government expenditures did not differ significantly from the high-employment measure. The IS measure of revenues, on the other hand, differed considerably from its high employment counterpart. In particular, the IS measure of a change in government revenues was *nonzero* only in quarters in which a tax was introduced, modified, suspended or eliminated.

When IS measures were substituted for high-employment measures in an A-J type equation, the results were startling: the estimated cumulative impact of changes in M1 declined, while those of both changes in government expenditures and of changes in government revenues rose significantly and, more importantly, were apparently statistically significant.[27] Thus, Corrigan concluded that fiscal policy actions had a meaningful impact on nominal economic activity.

[27]Corrigan did not report t-statistics or standard errors for the summed coefficients. Assuming that the estimated coefficients are uncorrelated, one obtains a t-statistic of 3.01 for testing the hypothesis that the $\Sigma E = 0$ and a t-statistic of 9.46 for testing that $\Sigma T = 0$. Both of those are statistically significant at the 5 percent level.

Subsequently, however, Schmidt and Waud (1973) found that Corrigan's results depended critically on the polynomial restrictions he imposed.[28] When these restrictions, which appeared to be rejected by the data, were relaxed, Schmidt and Waud obtained results with the IS measures that were similar to A-J's.

The evidence suggests that A-J's results concerning the effect of fiscal policy were not critically dependent on their measurement of monetary or fiscal policy actions. Meyer and Rasche (1980) summarized their investigation of this issue by noting that, "the modifications suggested ... have not generally resulted in dramatic changes in the estimated multipliers in simple reduced-form equations."[29]

INAPPROPRIATE RESTRICTIONS

To estimate their dynamic specification, A-J used Almon's (1965) polynomial distributed lag estimation technique that was designed to improve the precision of the estimated parameters of a distributed-lag model. The technique constrains the parameters of each distributed lag to lie on a polynomial of a given degree. Perhaps because relatively little was known about the procedure when A-J published their paper, critics contended that the A-J results might be dependent upon, or at least sensitive to, their choice of lag length or polynomial degree.[30]

There have been relatively few investigations of this aspect of the A-J equation. The best-known study by Schmidt and Waud (1973), as well as others by Corrigan, de Leeuw and Kalchbrenner, and Silber, focused primarily on the selection of the lag length. Because these studies held the polynomial degree fixed, how-

[28]The restrictions forced the estimated parameters of each distributed lag to lie on a *second* degree polynomial.

[29]Meyer and Rasche (1980), p. 59. McCallum (1986), p. 14, simply notes that "if there is a fiscal policy measure that carries a strongly significant sum of coefficients in an equation of the St. Louis form, its existence has not been well publicized."

[30]Specifically, if the lag length is too long or the polynomial degree too high, estimated parameters are unbiased but inefficient. Alternatively, if the lag length is too short or the polynomial degree is too low, the estimates are biased. Therefore, it is important that the appropriate lag length and polynomial degree be determined. The parameters will also be biased if the chosen lag is too long and exceeds the true lag by more than the true polynomial degree and may be biased even if it exceeds the true lag by an amount less than or equal to the true polynomial degree. See Batten and Thornton (1983) for a discussion of this and other issues, and for other references.

ever, they did not analyze completely the restrictions imposed by the A-J specification.[31]

When Elliot (1975) examined the lag structure and the polynomial restrictions separately, he concluded that A-J results were not particularly sensitive to lag structure or to the polynomial restrictions. His conclusion, however, was not based on statistical tests. He merely compared parameter estimates for different lag structures and polynomial degrees. More recently, Batten and Thornton (1983) performed a systematic examination of the specification of the A-J equation using recent data, and Batten and Thornton (1985) performed a similar analysis using the original A-J data. They concluded that the policy-relevant results of A-J do not depend on their choice of lag length or polynomial degree.

SUMMARY AND CONCLUSIONS

Leonall C. Andersen's best known and most significant contribution to economics is his collaborative research with Jerry L. Jordan, which resulted in publication of the A-J equation. For a period of nearly 20 years, it has been the subject of much interest and considerable criticism.[32] Few other pieces of applied economics, if any, have been so thoroughly discussed, analyzed and investigated.

Our review of the original Andersen-Jordan study and the criticism that emerged following its publication points out the obvious, but seldom articulated, fact that all of the criticisms of Andersen and Jordan's work apply equally well to much of the applied economic research of that time, and even today. We also note that Andersen and Jordan were aware of many of the caveats of their work and took precautions against them. Most importantly, using their original data, we tested the Andersen-Jordan equation for misspecification and simultaneous-equation bias. We find that none of the oft-cited criticisms of their equation is (or could have been) substantiated by these statistical tests. Granted, some of the techniques used were unknown or unavailable when Andersen and Jordan's critics were most vocal. Furthermore, some of the criticisms are valid when applied to sample periods beyond that examined by Andersen and Jordan.[33] These facts notwithstanding, this review vindicates Andersen and Jordan of any serious breach of the standards of econometric practice and suggests that, in reality, it was not their application of econometric methods that was controversial, but their results.[34]

Andersen and Jordan should be congratulated for providing one of the most stable, lasting and robust equations in applied economics. In our opinion, however, their most important contribution is that they shook the foundations of conventional economic thought and subjected the results of standard applied economics to closer scrutiny. This forced economists and policymakers to take a closer look at the issue of the efficacy of monetary and fiscal policy.

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[31]After the polynomial degree has been chosen, alternative lag specifications amount to imposing polynomial restrictions on different parameter spaces. Consequently, the restrictions implied by different lag specifications are not nested within each other when the polynomial degree is fixed.

[32]One of the most recent additions to this literature, Raj and Siklos (1986), applies spectral analysis to the Andersen-Jordan equation for the period I/1947 to IV/1984. Again the results are consistent with those of A-J.

[33]For example, Thornton and Batten (1985) find bidirectional Granger causality between money and income over the period from II/1962 to III/1982.

[34]It is interesting to note the similarities between the A-J equation and Granger's (1969) and Sims' (1972) examination of causal ordering. Furthermore, except for the exclusion of the own distributed lag of the dependent variable, the A-J equation closely resembles the now frequently used and commonly accepted vector autoregression model.

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A Monetarist Model for Economic Stabilization: Review and Update

Keith M. Carlson

IN APRIL 1970, Leonall Andersen and I published an article, "A Monetarist Model for Economic Stabilization," in this *Review*.[1] In this article, we developed a small model of the U.S. economy purporting to explain the movements of certain key economic aggregates, namely, nominal GNP, output (real GNP), prices, unemployment and short- and long-term interest rates. The model's focus was on the role of monetary aggregates, in particular, M1, in the determination of these economic variables.

The purpose of the present article is to review this model in light of developments since 1970. This review begins with a discussion of the development of the original model and is followed by an explanation of the key differences between it and the current version of the model. This current version is analyzed by demonstrating its response to shocks and its ability to simulate, *ex post*, movements of nominal GNP, output, prices, unemployment and interest rates.

OUR EARLY ATTEMPT AT MODELING

In 1970, macroeconomic model-building was a popular exercise. The Michigan and Wharton models, which had existed for a number of years, were continually being modified and updated.[2] The FRB-MIT model, first published in 1968, was still being refined.[3] The Data Resources model was in the development stage.[4] Each of these models contained a large number of equations and focused on a sectoral breakdown of GNP derived from the Keynesian approach to GNP determination.

Andy and I felt that these models did not place proper emphasis on the role of monetary actions. Furthermore, they focused primarily on the short run — a projection horizon of, at most, several quarters. We wanted a model that moved from the short-run to a long-run dynamic equilibrium with appropriate recognition being given to initial conditions in this process. In addition, we wanted a model that was small enough that the interrelationships among the variables could be understood easily. Moreover, we sought to build on existing research at this Bank, combining various results to shed light on the issue of economic stabilization in a way that would overcome some of the shortcomings of large-scale Keynesian-style models.

Our concerns about the state of model-building strongly influenced our efforts to develop an alternative macroeconomic model of the U.S. economy. We were not concerned about respecifying behavioral equations (for example, consumption, investment, etc.); rather, we wanted to capture empirical relationships between a relatively few key macroeconomic variables that were implicitly grounded in economic theory.

The fundamental building block of our model was the Andersen-Jordan (A-J) equation, which focused on

[1]Andersen and Carlson (1970).

[2]See Klein and Burmeister (1976), pp. 188–210 and pp. 248–70.

[3]de Leeuw and Gramlich (1968 and 1969).

[4]Klein and Burmeister (1976), pp. 211–31.

the two chief arms of policymaking, monetary and fiscal actions.[5] Although this equation did not provide a model of GNP determination, it was useful in forecasting and in policy simulations. In the A-J equation, GNP was "determined" solely by current and past monetary and fiscal policy actions; other influences on GNP were found to be random during the sample period investigated by Andersen-Jordan.

Another important building block in the construction of the Andersen-Carlson (A-C) model was the interest rate equation, developed by Yohe and Karnosky in 1969, in which interest rates were systematically related to past inflation.[6] Their results were consistent with the Fisherian theory of interest in that they showed that inflation premia are incorporated into nominal interest rates.

To complete the model, we needed equations for the unemployment rate and the price level. The most famous and generally accepted unemployment rate equation, developed by Arthur Okun, was easily modified for our purposes.[7] This equation combines a given potential GNP with actual GNP to provide an estimate of the unemployment rate.

Finding an appropriate price equation was a more challenging task. Most large models used a wage-markup equation and, in some cases, some type of Phillips curve equation. These equations did not fulfill our requirements. Instead, we developed a price equation that combined the Phillips curve results with price expectations.[8] We used the coefficients on the inflation terms in the long-term interest rate equation as our measure of price expectations. We thought our approach was novel, and it seemed to work quite satisfactorily at the time. In retrospect, it seems rudimentary and has not worked as well in recent years.

THE ORIGINAL SPECIFICATION AND SUBSEQUENT CHANGES

The original model was recursive, with the particular form of each equation determined, for the most part, by the data. Since 1970, several changes have been made in the model in terms of the form of the equations and the exogenous variables that are included.

The original and current versions of the A-C model are summarized in table 1. The model still has the same number of key endogenous variables; however, the three GNP variables — total spending, output and prices — are now specified in rates of change instead of first differences. This change was made in the 1970s, when the first-difference form began to exhibit heteroskedasticity.[9] In any event, the rate-of-change form is easier to interpret, and the fundamental properties of the model are unchanged. Monetary actions have a short-run effect on output and a long-run effect on prices; fiscal actions have little effect on output or prices in either the short- or long-run.

Another change was the addition of two more exogenous variables — energy prices and exports. This change, necessitated by developments in the 1970s, was a crude way to incorporate such complex factors.[10] Nevertheless, it enabled us to keep the model small. Furthermore, changes in energy prices also enter the current model through their influence on potential GNP.

Another change, not shown explicitly in table 1, is the redefinition of two exogenous variables — potential GNP and federal expenditures. Potential GNP is now estimated using production-function methods developed by Rasche and Tatom.[11] Federal expenditures are now cyclically adjusted rather than high-employment.[12] The rationale underlying the fiscal measure remains the same — to construct a measure of federal spending that excludes the cyclical effect of the economy on the budget.

Finally, in the current version, the price, long-term interest rate and unemployment equations are adjusted for autocorrelation to avoid biasing the estimated standard errors of the coefficients.

Although these changes make it impossible to compare meaningfully the summary statistics for the two versions, the two versions show similar estimates of the impact of monetary and fiscal actions. An equation-by-equation comparison is summarized in the shaded insert on page 21.

[5]Andersen and Jordan (1968).

[6]Yohe and Karnosky (1969).

[7]Okun (1962).

[8]See Considine (1969).

[9]Carlson (1978).

[10]Rasche and Tatom (1977b).

[11]Rasche and Tatom (1977a).

[12]de Leeuw and Holloway (1983).

Table 1
St. Louis Model: Original vs. Current Version

Original version
Sample period: I/1953-IV/1969

(1) Total spending equation

$$\Delta Y_t = 2.67 + \sum_{i=0}^{4} m_i \Delta M_{t-i} + \sum_{i=0}^{4} e_i \Delta E_{t-i}$$

$\Sigma m_i = 5.57 \quad \Sigma e_i = .05$

$\bar{R}^2 = .66 \quad SE = 3.84 \quad DW = 1.75$

(2) Price equation

$$\Delta P_t = 2.70 + \sum_{i=0}^{5} d_i D_{t-i} + .86\,\Delta PA_t$$

$\Sigma d_i = .09$

$\bar{R}^2 = .87 \quad SE = 1.07 \quad DW = 1.41$

(3) Demand pressure identity

$$D_t = \Delta Y_t - (XF_t - X_{t-1})$$

(4) Total spending identity

$$\Delta Y_t = \Delta P_t + \Delta X_t$$

(5) Long-term interest rate equation

$$RL_t = 1.28 - .06\dot{M}_t + 1.42Z_t + \sum_{i=0}^{16} x_i \dot{X}_{t-i} + \sum_{i=0}^{16} p_i \left(\frac{\dot{P}_{t-i}}{U_{t-i}/4}\right)$$

$\Sigma x_i = .20 \quad \Sigma p_i = .96$

$\bar{R}^2 = .92 \quad SE = .28 \quad DW = .69$

(6) Anticipated price definition

$$\Delta PA_t = Y_{t-2}\left(\left[\left(\sum_{i=1}^{17} p_i \frac{\dot{P}_{t-i}}{U_{t-i}/4}\right).01 + 1\right]^{1/4} - 1\right)$$

$\Sigma p_i = .96$

(7) Unemployment rate equation

$$U_t = 3.90 + .04G_t + .28G_{t-1}$$

$\bar{R}^2 = .92 \quad SE = .30 \quad DW = .60$

(8) GNP gap identity

$$G_t = \frac{XF_t - X_t}{XF_t}.100$$

Current version
Sample period: I/1960-IV/1984

(1) Total spending equation

$$\dot{Y}_t = 3.08 - 4.28Z1_t + \sum_{i=0}^{3} m_i \dot{M}_{t-i} + \sum_{i=0}^{4} e_i \dot{E}_{t-i} + \sum_{i=0}^{3} ex_i \dot{EX}_{t-i}$$

$\Sigma m_i = .96 \quad \Sigma e_i = .07 \quad \Sigma ex_i = .00$

$\bar{R}^2 = .32 \quad SE = 3.91 \quad DW = 2.22$

(2) Price equation

$$\dot{P}_t = .96 + \sum_{i=0}^{3} pe_i \dot{PE}_{t-i} + \sum_{i=0}^{5} d_i D_{t-i} + 1.68\dot{PA}_t - .96Z2_t + .80Z3_t$$

$\Sigma pe_i = .09 \quad \Sigma d_i = .08 \quad \hat{\rho} = -.01$

$\bar{R}^2 = .77 \quad SE = 1.48 \quad DW = 1.98$

(3) Demand pressure identity

$$D_t = \dot{X}_t - ([(XF_t/X_{t-1})^4 - 1]100)$$

(4) Total spending identity

$$\dot{Y}_t = \dot{P}_t + \dot{X}_t$$

(5) Long-term interest rate equation

$$RL_t = 5.66 + \sum_{i=0}^{20} p_i \dot{P}_{t-i}$$

$\Sigma p_i = .55 \quad \hat{\rho}_1 = 1.15 \quad \hat{\rho}_2 = -.16$

$\bar{R}^2 = .07 \quad SE = .42 \quad DW = 1.96$

(6) Anticipated price definition

$$\dot{PA}_t = \sum_{i=1}^{21} p_i \dot{P}_{t-i}$$

$\Sigma p_i = .55$

(7) Unemployment rate equation

$$U_t - UF_t = .29G_t + .16G_{t-1}$$

$\hat{\rho}_1 = 1.20 \quad \hat{\rho}_2 = -0.33$

$\bar{R}^2 = .71 \quad SE = .21 \quad DW = 1.95$

(8) GNP gap identity

$$G_t = \frac{XF_t - X_t}{XF_t}.100$$

The St. Louis Model: Original vs. Current Versions

The total spending equation has been changed from a first-difference to a rate-of-change form, and the rate of change of exports and a dummy variable, designed to capture in a crude way the velocity shift after 1981, have been added. The lag on money was also shortened by one quarter.

In the current version, the price equation has three additional variables and is now in rate-of-change form. Energy prices are now included as an independent variable, and dummy variables representing price control and decontrol in the early 1970s are also included. The demand pressure variable (equation 3) has been redefined to avoid mixing nominal and real variables. Demand pressure is defined now as actual output growth relative to its potential to expand. The coefficient on anticipated prices, 1.68, now appears out of line with both theoretical and past empirical estimates. However, when the sum for $\dot{P}$ in the long-term interest equation, .55, is taken into account, the product of the two coefficients, (1.68 × .55), is more in line with theoretical expectation.

Unlike the rest of the equations, the long-term interest rate equation is essentially unchanged. Since its sole function is to generate the weights on past prices to use in the measure of anticipated prices, the results for the early version had considerable appeal because Σp_i was close to one. This result is not observed in the current version. Although the form of the equation is now much simpler, the fit of the equation, which includes an autocorrelation adjustment, is very poor. The good fit of the original result was misleading because the residuals were highly correlated.

The seemingly major change in the form of equation 6, which defines anticipated inflation, results from the change from first-difference to rate-of-change form. The current version is much easier to interpret, being simply a weighted sum of past rates of price changes.

Finally, the unemployment equation has changed only slightly. Essentially, the constant in the original version has been replaced by the full-employment unemployment rate. This rate is intended to be consistent with the estimate of potential GNP.

Table 1 Continued . . .

Symbols:

- Δ = change in dollar values (note: $\Delta P_t = X_{t-1}(P_t - P_{t-1})$ and $\Delta X_t = P_{t-1}(X_t - X_{t-1})$)
- $\cdot$ = annual rate of change in variable
- Y_t = total spending (GNP in current prices)
- M_t = money stock (M1)
- E_t = federal expenditures (high-employment in original model and cyclically adjusted in current model)
- EX_t = Exports of goods and services (in current prices)
- P_t = GNP deflator (1958 = 1.00 in original model and 1982 = 1.00 in current model)
- D_t = demand pressure
- PA_t = anticipated price level
- XF_t = potential output (Council of Economic Advisers' estimate in 1958 prices in original model and Rasche-Tatom estimate in 1982 prices in current model)
- X_t = output (GNP in 1958 prices in original model and GNP in 1982 prices in current model)
- PE_t = relative price of energy
- RL_t = corporate Aaa bond rate
- U_t = civilian unemployment rate
- G_t = GNP gap as a percent of potential output
- Z_t = dummy variable (I/1955-IV/1960 = 0; I/1961-IV/1969 = 1)
- $Z1_t$ = dummy variable (I/1960-IV/1981 = 0; I/1982-IV/1984 = 1)
- $Z2_t$ = price control dummy (I/1960-II/1971, II/1973-IV/1984 = 0; III/1971-I/1973 = 1)
- $Z3_t$ = post-price control dummy (I/1960-I/1973, II/1975-IV/1984 = 0; II/1973-I/1975 = 1)

Table 2

The Current Model's Response to a Fiscal Shock (shocked values denoted by prime)

Quarters elapsed	Exogenous variable E'/E	Endogenous variables Y'/Y	X'/X	P'/P	U'–U	RL'–RL
1	1.0454	1.0025	1.0022	1.0001	–.061	.001
2	1.0440	1.0035	1.0027	1.0002	–.107	.004
3	1.0444	1.0032	1.0035	1.0005	–.137	.009
4	1.0445	1.0030	1.0017	1.0008	–.099	.015
5	1.0457	1.0036	1.0028	1.0011	–.105	.020
6	1.0461	1.0036	1.0029	1.0014	–.125	.026
7	1.0454	1.0036	1.0025	1.0018	–.116	.033
8	1.0455	1.0035	1.0020	1.0022	–.095	.038
12	1.0458	1.0036	1.0000	1.0033	–.004	.053
16	1.0479	1.0037	.9998	1.0041	.020	.056
20	1.0467	1.0036	.9983	1.0047	.067	.053
24	1.0436	1.0034	.9988	1.0050	.049	.040
28	1.0424	1.0033	.9977	1.0051	.082	.025
32	1.0391	1.0031	.9984	1.0046	.067	.003
36	1.0422	1.0032	.9990	1.0039	.046	–.015
40	1.0412	1.0032	1.0002	1.0033	–.008	–.026

NOTE: To calculate percent change for E, Y, X and P, subtract 1 and multiply by 100. U'–U and RL'–R are differences of percents.

PROPERTIES OF THE CURRENT MODEL

To demonstrate the properties of the current model, it was subjected to three different "shocks." In each case, the shock began in I/1975, and the simulated response was calculated through IV/1984. The three shocks are:[13]

1. **Fiscal shock.** An increase in cyclically adjusted expenditures equal to 1 percent of GNP.

2. **Monetary shock.** A gradual increase in M1 over a year to 3 percent above the base path.

3. **Supply-side shock.** A lowering of the world oil price by 20 percent.

The results of simulating the model with each shock are shown in tables 2–4. These results are summarized in table 5.

[13]These are the shocks simulated for Professor Klein's model comparison seminar, which was reorganized in 1985. For results of the earlier seminar in the 1970s, see Klein and Burmeister (1976).

Fiscal Shock Results

The increase in cyclically adjusted expenditures quickly influences total spending. The total effect, however, is at most a .37 percent increase or a measured elasticity of .08. The fiscal multiplier, $\Delta Y/\Delta E$, using average values for 1978–79 (the middle of the sample period), is .38. This is much lower than other econometric models.[14]

The dynamics of the model indicate that the initial increase in total spending is transmitted first and temporarily to real GNP, then fully to the price level. In fact, it appears that the price level overshoots its final equilibrium, implying an undershooting of real GNP. Output and the price level continue to oscillate after 40 quarters, but the fiscal shock has essentially no effect on output in the long run. Consequently, the effect on the unemployment rate is small, with the oscillation of the unemployment rate synchronous with output. Similarly, the effect on the long-term interest rate is negligible even four or five years after the shock, as interest rates rise with inflation and fall when the rate of inflation declines.

[14]See Klein and Burmeister (1976), p. 338.

Table 3

The Current Model's Response to a Monetary Shock (shocked values denoted by prime)

Quarters elapsed	Exogenous variable M'/M	Endogenous variables Y'/Y	X'/X	P'/P	U'–U	RL'–RL
1	1.0014	1.0004	1.0003	1.0000	–.007	.000
2	1.0073	1.0026	1.0019	1.0001	–.057	.002
3	1.0188	1.0081	1.0084	1.0004	–.262	.008
4	1.0280	1.0163	1.0145	1.0012	–.532	.024
5	1.0300	1.0231	1.0208	1.0026	–.810	.051
6	1.0300	1.0265	1.0226	1.0045	–.961	.086
7	1.0300	1.0272	1.0212	1.0067	–.946	.125
8	1.0300	1.0272	1.0186	1.0090	–.851	.167
12	1.0300	1.0272	1.0087	1.0181	–.421	.308
16	1.0300	1.0272	1.0016	1.0258	–.087	.390
20	1.0300	1.0272	.9948	1.0319	.202	.414
24	1.0300	1.0272	.9919	1.0361	.339	.371
28	1.0300	1.0272	.9891	1.0380	.450	.272
32	1.0300	1.0272	.9904	1.0370	.402	.140
36	1.0300	1.0272	.9930	1.0341	.311	.014
40	1.0300	1.0272	.9965	1.0311	.164	–.076

NOTE: To calculate percent change for M, Y, X and P, subtract 1 and multiply by 100. U'–U and RL'–R are differences of percents.

Monetary Shock Results

A monetary shock works through the model in the same way the fiscal shock does — via total spending. The difference is that the effect is much faster and larger. Normally, a monetary shock is fully reflected in total spending after four quarters (see equation 1 in table 1). With the experiment reported here, M1 builds up over a year's time to 3 percent above the base path. Consequently, the full effect on total spending is not registered until the seventh quarter.

The dynamics of the model take over quite quickly with respect to output and the price level. Output initially rises, but after four years returns close to its base path level; it then falls below the base level as the inflation rate continues to increase. In fact, the elasticity of the price level peaks at 1.27 after seven years. The 40-quarter simulation is not long enough to determine the nature of the long-run equilibrium.

The monetary shock produces a strong oscillatory movement in the unemployment rate. Initially, this rate drops quickly, falling to almost one percentage point below its base path after only six quarters. After four years, U moves back to its base path and then increases above it, staying there for the remainder of the simulation period.

The effect of the monetary shock on interest depends directly on the price level response. Inflation and interest rates respond slowly to the shock. As long as inflation increases, interest rates rise above their base path. When inflation slows after about seven years, interest rates move back toward their base path. As with several other variables, the simulation period is not long enough to determine the nature of the final equilibrium.

Supply-Side Shock Results

To simulate the effect of a supply shock, the price of oil per barrel was assumed to drop 20 percent, which reduces the relative price of energy by 8 percent. This variable directly affects the price equation and indirectly affects the price level because the drop in the price of oil is assumed to instantaneously increase potential output by .4 percent.[15] By assumption, total spending is not affected by the supply shock, that is, the relative price of energy is not included in the total spending equation. This assumption is in dispute, however, as Tatom argues that total spending is temporarily affected by such a shock.[16]

[15]Rasche and Tatom (June 1977).

[16]Tatom (1981). His argument rests on the significance of only one of the lagged values of PE. For this reason, this variation has not been introduced into the version of the model summarized in table 1.

Table 4

The Current Model's Response to a Supply-Side Shock (shocked values denoted by prime)

Quarters elapsed	Exogenous variables		Endogenous variables				
	PE'/PE	XF'/XF	Y'/Y	X'/X	P'/P	U'–U	RL'–RL
1	.9200	1.0040	1.0000	1.0000	.9998	.109	–.003
2	.9200	1.0040	1.0000	.9999	.9996	.172	–.009
3	.9200	1.0040	1.0000	1.0015	.9992	.130	–.016
4	.9200	1.0040	1.0000	1.0006	.9988	.132	–.023
5	.9200	1.0040	1.0000	1.0019	.9984	.110	–.030
6	.9200	1.0040	1.0000	1.0026	.9981	.071	–.035
7	.9200	1.0040	1.0000	1.0030	.9978	.049	–.040
8	.9200	1.0040	1.0000	1.0031	.9975	.040	–.044
12	.9200	1.0040	1.0000	1.0035	.9963	.030	–.058
16	.9200	1.0040	1.0000	1.0049	.9953	–.025	–.064
20	.9200	1.0040	1.0000	1.0048	.9946	–.039	–.059
24	.9200	1.0040	1.0000	1.0061	.9944	–.093	–.043
28	.9200	1.0040	1.0000	1.0050	.9946	–.057	–.022
32	.9200	1.0040	1.0000	1.0050	.9948	–.044	–.004
36	.9200	1.0040	1.0000	1.0044	.9953	–.018	.011
40	.9200	1.0040	1.0000	1.0046	.9957	–.029	.019

NOTE: To calculate percent change for PE, XF, Y, X and P, subtract 1 and multiply by 100. U'–U and RL'–R are differences of percents.

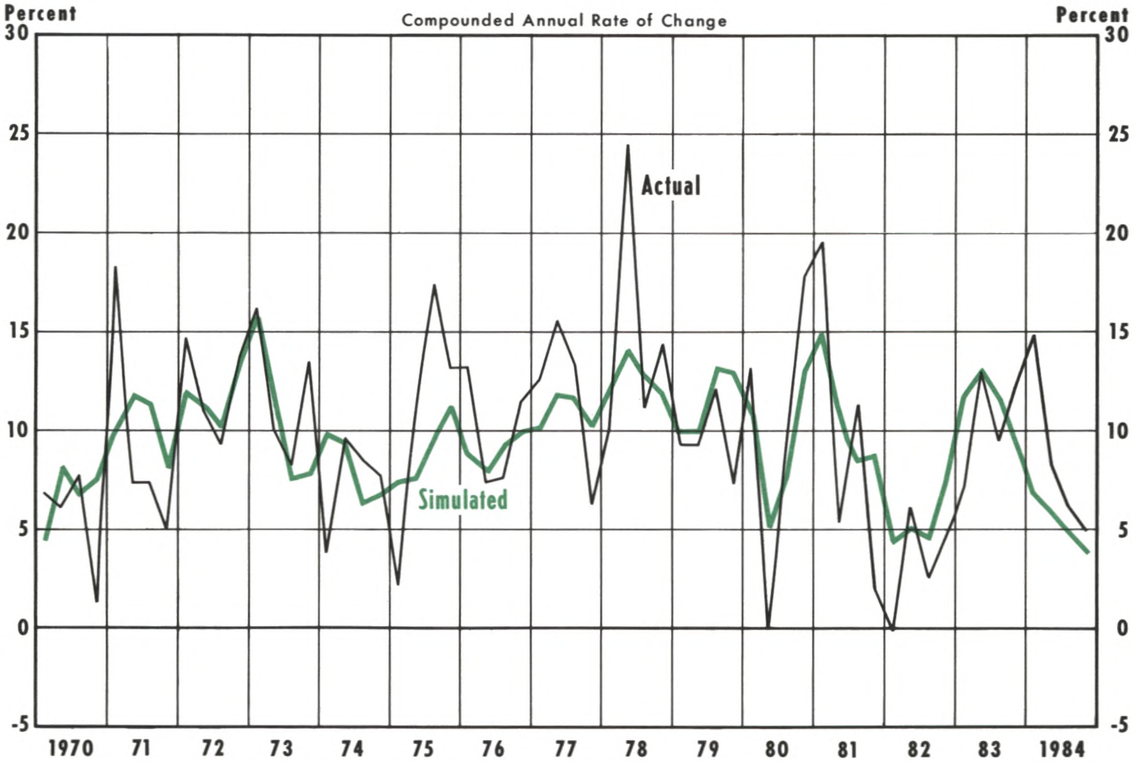
Table 5

Estimated Elasticities for the Current Model

Quarters elapsed	With respect to fiscal shock (E)			With respect to monetary shock (M)			With respect to supply shock (PE)		
	Y	X	P	Y	X	P	Y	X	P
1	.06	.05	.00	.29	.21	.00	.00	–.00	.00
2	.08	.06	.00	.36	.26	.01	.00	.00	.01
3	.07	.08	.01	.43	.45	.02	.00	–.02	.01
4	.07	.04	.02	.58	.52	.04	.00	–.01	.02
8	.08	.04	.05	.91	.62	.30	.00	–.04	.03
12	.08	.00	.07	.91	.29	.60	.00	–.04	.05
16	.08	–.00	.09	.91	.05	.86	.00	–.06	.06
20	.08	–.04	.10	.91	–.17	1.06	.00	–.06	.07
24	.08	–.03	.11	.91	–.27	1.20	.00	–.08	.07
28	.08	–.05	.12	.91	–.36	1.27	.00	–.06	.07
32	.08	–.04	.12	.91	–.32	1.23	.00	–.06	.07
36	.08	–.02	.09	.91	–.23	1.14	.00	–.06	.06
40	.08	.00	.08	.91	–.12	1.04	.00	–.06	.05

Tables 4 and 5 show that output and prices respond quite slowly to this shock. Moreover, the maximum effect, which occurs after about six years, is relatively small. In fact, the elasticities (calculated with respect to the relative price of energy) are similar in magnitude to those for federal expenditures.

Chart 1
Nominal GNP



ASSESSING THE CURRENT MODEL'S PERFORMANCE

To provide some indication of model performance, the model was simulated *ex post* during several periods after 1969. Denoting such simulations as *ex post* means that all simulations were within the sample period and the exogenous variables took on their actual values. All simulations were dynamic; that is, once the simulation was started, the model generated its own lagged values.

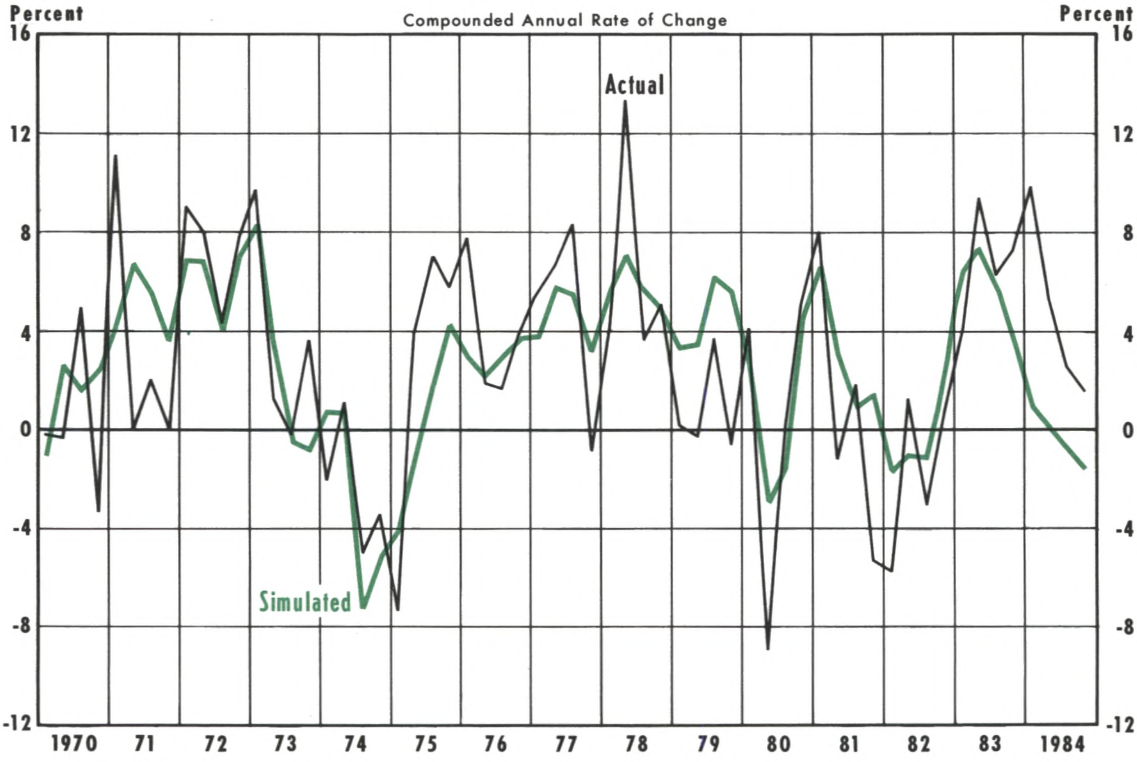
These simulations are summarized in charts 1–3 and table 6. Unfortunately, these results mean little by themselves because there is no basis for comparison. Results for similar simulation exercises with other models have been published for the 1960s and early 1970s, but are not readily available for more recent periods. Consequently, any conclusions about the model's performance are impressionistic.

Total Spending Growth

Charts 1–3 show the results of simulating $\dot{Y}$, $\dot{X}$ and $\dot{P}$ for the full simulation period from 1970 through 1984. Since the total spending equation contains no endogenous variables, the model simulation shown in chart 1 simply shows the fit of that equation. That fit obviously does quite poorly on a quarter-to-quarter basis but seems to follow the contours over several quarters, almost as if a moving average had been applied to the actual observations. A desirable feature of this equation is that the quarter-to-quarter errors do not tend to cumulate over time. The errors in the estimated equation are not correlated.

Table 6 shows that the RMSE of Y increases over

Chart 2
Real GNP



time and, even when standardized by the level of GNP (SRMSE), it continues to grow as the simulation period moves toward the present. This suggests that the relationship between $\dot{Y}$ and $\dot{M}$ has become looser recently.

Output Growth

The relative degree of success in simulating total spending is carried over to the simulation of output. The model simulated $\dot{X}$ well over the periods, although it underestimated economic strength during the expansion from the 1973–75 recession. The other period of substantial difference has occurred since the third quarter of 1983. The model indicated a recession, which did not occur.

When the model is simulated over different periods, no consistent pattern emerges for the SRMSE for X. In the 1970–84 period, the SRMSE for X exceeded that for Y. In the 1975–84 and 1979–84 periods, however, the SRMSE for X was less than for Y, apparently reflecting the emerging importance of aggregate demand shocks relative to supply-side shocks during these periods.

Inflation

The results of simulating the inflation rate over the 1970–84 period are shown in chart 3. Generally speaking, the movements were approximated during the 1970–77 period, but the acceleration starting in the second quarter of 1978 was not picked up until a year or so later. The essence of the general deceleration from mid-1980 was captured, but since mid-1982, the model has overestimated inflation by about 2 percentage points.

These visual impressions are borne out in the calculation of RMSE for the GNP deflator. The shortest and latest period was best with a standardized RMSE of 2.62 percent. The 1975–84 period was the worst with an SRMSE of 4.15 percent. The simulation for the

Chart 3

GNP Deflator

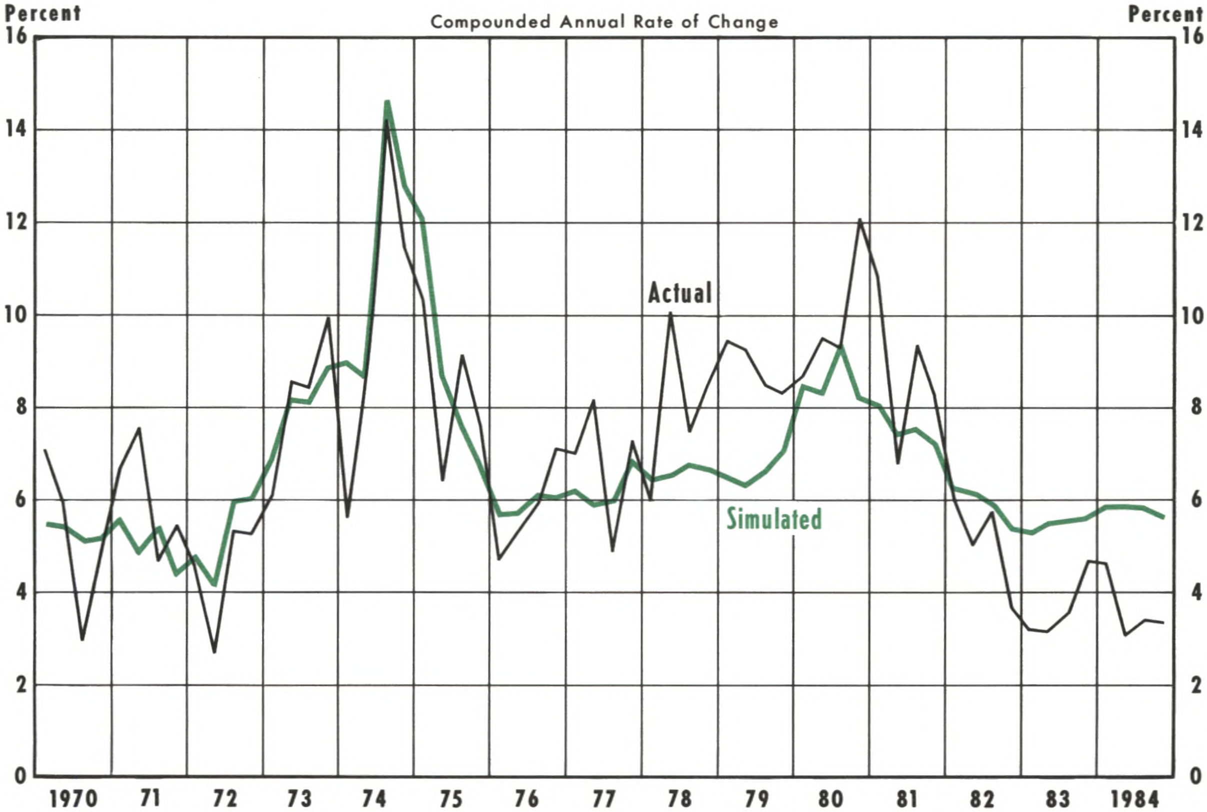


Table 6

Ex Post Simulation Results

	I/70–IV/84		I/75–IV/84		I/79–IV/84	
	RMSE	SRMSE	RMSE	SRMSE	RMSE	SRMSE
GNP (current dollars)	46.42	2.15%	78.24	2.98%	107.31	3.46%
Real GNP (1982 dollars)	75.31	2.56	85.55	2.75	72.03	2.21
GNP deflator (1982 = 100)	1.99	2.80	3.45	4.15	2.49	2.62
Unemployment rate (percent)	1.31	18.91	1.48	19.25	1.31	16.60
Corporate Aaa bond rate (percent)	2.35	23.95	2.89	26.69	3.23	26.13

NOTE: RMSE is root mean squared error; SRMSE is standardized RMSE, that is, RMSE divided by the level of the variable and multiplied by 100.

overall period was in between, with an SRMSE of 2.79 percent.

Unemployment and Interest Rates

Table 6 shows that the RMSE for simulations of the civilian unemployment rate and the Aaa bond rate do not vary by much over different simulation periods. The RMSE is more meaningful for these comparisons than SRMSE because the RMSE is already expressed in percentage points.

Simulations of the movements of the Aaa bond rate were generally unimpressive. Although the RMSE was little different for the alternative simulation periods, it increased as the simulation was brought closer to the present.

SUMMARY

The St. Louis model, as originally published in April 1970, was designed to focus on the importance of monetary actions in the determination of spending, output and prices. Its structure differed substantially from other econometric models at that time. It consisted of the Andersen-Jordan GNP equation and several other empirical relationships; it was recursive in form. It estimated GNP directly using monetary and fiscal variables, in sharp contrast to the conventional approach of estimating the components of GNP and then summing them to obtain a GNP estimate.

Since 1970, the general form of the model has been maintained, but several changes in its specification and estimation have been made. One notable change has been simplification — using rates of change instead of first differences. Another is the addition of supply-side variables — the relative prices of energy and price control and decontrol dummies and, most recently, a dummy in the GNP equation to capture the shift in the relationship since 1981. Other changes included alternative estimates of potential output and federal expenditures, and adjustments for autocorrelation in several of the equations.

Despite these changes, the properties of the model remain essentially unchanged. Monetary actions have a large short-run effect on total spending, output and unemployment; over the long run, however, the effect on total spending is almost entirely reflected in the price level, with very little effect on output and unemployment. Fiscal actions have small short-run effects that disappear (in terms of output) quite quickly. While the supply-side effects are not strong according to conventional elasticities, these effects can be important if energy prices move dramatically.

The performance of the model is difficult to gauge, but, for the most part, the simulation results were deemed successful. *Ex post* simulations are the conventional method of assessing a model's performance, but they are more meaningful when compared with those from other models. There have been no published studies of how other models are performing in the 1980s. A more accurate evaluation awaits comparison with similar results from other current models.

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Monetary and Fiscal Actions: A Test of Their Relative Importance in Economic Stabilization

Leonall C. Andersen and Jerry L. Jordan

HIGH employment, rising output of goods and services, and relatively stable prices are three widely accepted national economic goals. Responsibility for economic stabilization actions to meet these goals has been assigned to monetary and fiscal authorities. The Federal Reserve System has the major responsibility for monetary management. Fiscal actions involve federal government spending plans and taxing provisions. Governmental units involved in fiscal actions are the Congress and the Administration, including the Treasury, the Bureau of the Budget, and the Council of Economic Advisers.

This article reports the results of recent research which tested three commonly held propositions concerning the relative importance of monetary and fiscal actions in implementing economic stabilization policy. These propositions are: the response of economic activity to fiscal actions relative to that of monetary actions is (1) greater, (2) more predictable, and (3) faster. Specific meanings, for the purposes of this article, of the broad terms used in these propositions are presented later.

This article does not attempt to test rival economic theories of the mechanism by which monetary and fiscal actions influence economic activity. Neither is it intended to develop evidence bearing directly on any causal relationships implied by such theories. More elaborate procedures than those used here would be required in order to test any theories underlying the familiar statements regarding results expected from monetary and fiscal actions. However, empirical relationships are developed between frequently used measures of stabilization actions and economic activity. These relationships are consistent with the implications of some theories of stabilization policy and are inconsistent with others, as will be pointed out.

A brief discussion of the forces influencing economic activity is presented first. Next, with this theory as a background, specific measures of economic activity, fiscal actions, and monetary actions are selected. The results of testing the three propositions noted above, together with other statements concerning the response of economic activity to monetary and fiscal forces, are then presented. Finally, some implications for the conduct of stabilization policy are drawn from the results of these tests.

A THEORETICAL VIEW OF ECONOMIC ACTIVITY

Our economic system consists of many markets. Every commodity, service and financial asset is viewed as constituting an individual market in which a

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particular item is traded and a price is determined. All of these markets are linked together in varying degrees, since prices in one market influence decisions made in other markets.

About a century ago, Leon Walras outlined a framework for analyzing a complex market economy. Such an analysis includes a demand and a supply relationship for every commodity and for each factor of production. Trading in the markets results in prices being established which clear all markets, i.e., the amount offered in a market equals the amount taken from the market. According to this analysis, outside occurrences reflected in shifts in demand and supply relationships cause changes in market prices and in quantities traded. These outside events include changes in preferences of market participants, in resource endowments, and in technology. Financial assets were not viewed as providing utility or satisfaction to their holders and were therefore excluded from the analysis.

Later developments in economic theory have viewed financial assets as providing flows of services which also provide utility or satisfaction to holders. For example, a holder of a commercial bank time deposit receives liquidity service (ease of conversion into the medium of exchange), store of value service (ability to make a future purchase), risk avoidance service (little risk of loss), and a financial yield. According to this later view, economic entities incorporate choices among goods, services, *and* financial assets into their decision-making processes.

The fact that economic entities make choices in both markets for goods and services and markets for financial assets requires the addition of demand and supply relationships for every financial asset. Market interest rates (prices of financial assets) and changes in the stocks outstanding of most financial assets are determined by the market process along with prices and quantities of goods and services.

These theoretical developments have enlarged the number of independent forces which are regarded as influencing market-determined prices, interest rates, quantities produced of commodities and stocks outstanding of financial assets. Government and monetary authorities are viewed as exerting independent influences in the market system. These influences are called fiscal and monetary policies or actions. Random events, such as the outbreak of war, strikes in key industries and prolonged drought, exert other market influences. Growth in world trade and changes in foreign prices and interest rates, relative to our own, influence exports and therefore are largely an outside influence on domestic markets.

Market expectations have also been assigned a significant factor in markets, but these are not viewed as a distinctly independent force. Expectations result from market participants basing their decisions on movements in market-determined variables, or they are derived from market responses to the expected results of random events, such as the outbreak of a war or the anticipation of changes in fiscal or monetary policy.

These dependent and independent market variables are summarized in exhibit 1. The dependent variables are determined by the interplay of market forces which results from changes in the independent variables. Market-determined variables include prices and quantities of goods and services, prices and quantities of factors of production, prices (interest rates) and quantities of financial assets, and expectations. Independent variables consist of slowly changing factors, forces from outside our economy, random events and forces subject to control by fiscal and monetary authorities. A change in an independent

Exhibit 1

Classification of Market Variables

Dependent Variables

- Prices and quantities of goods and services.
- Prices and quantities of factors of production.
- Prices (interest rates) and quantities of financial assets.
- Expectations based on:
  - a. movements in dependent variables.
  - b. expected results of random events.
  - c. expected changes in fiscal and monetary policy.

Independent Variables

- Slowly changing factors:
  - a. preferences.
  - b. technology.
  - c. resources.
  - d. institutional and legal framework.
- Events outside the domestic economy:
  - a. change in total world trade.
  - b. movements in foreign prices and interest rates.
- Random events:
  - a. outbreak of war.
  - b. major strikes.
  - c. weather.
- Forces subject to control by:
  - a. fiscal actions.
  - b. monetary actions.

variable (for example, a fiscal or a monetary action) causes changes in many of the market-determined (dependent) variables.

MEASURES OF ECONOMIC ACTIVITY AND OF MONETARY AND FISCAL ACTIONS

Three theoretical approaches have been advanced by economists for analyzing the influence of monetary and fiscal actions on economic activity. These approaches are the textbook Keynesian analysis derived from economic thought of the late 1930s to the early 1950s, the portfolio approach developed over the last two decades, and the modern quantity theory of money. Each of these theories has led to popular and familiar statements regarding the direction, amount, and timing of fiscal and monetary influences on economic activity. As noted earlier, these theories and their linkages will not be tested directly, but the validity of some of the statements which purport to represent the implications of these theories will be examined. For this purpose, frequently used measures of economic activity, monetary actions, and fiscal actions are selected.

Economic Activity

Total spending for goods and services (gross national product at current prices) is used in this article as the measure of economic activity. It consists of total spending on final goods and services by households, businesses and governments plus net foreign investment. Real output of goods and services is limited by resource endowments and technology, with the actual level of output, within this constraint, determined by the level of total spending and other factors.

Monetary Actions

Monetary actions involve primarily decisions of the Treasury and the Federal Reserve System. Treasury monetary actions consist of variations in its cash holdings, deposits at Federal Reserve banks and at commercial banks, and issuance of Treasury currency. Federal Reserve monetary actions include changes in its portfolio of Government securities, variations in member bank reserve requirements, and changes in the Federal Reserve discount rate. Banks and the public also engage in a form of monetary actions. Commercial bank decisions to hold excess reserves constitute a monetary action. Also, because of differential reserve requirements, the public's decisions to hold varying amounts of time deposits at commercial banks or currency relative to demand deposits are a form of monetary action, but are not viewed as stabilization actions. However, they are taken into consideration by stabilization authorities in forming their own actions. Exhibit 2 summarizes the various sources of monetary actions related to economic stabilization.

The monetary base[1] is considered by both the portfolio and the modern quantity theory schools to be a strategic monetary variable. The monetary base is under direct control of the monetary authorities, with major control exerted by the Federal Reserve System. Both of these schools consider an increase in the monetary base, other forces constant, to be an expansionary influence on economic activity and a decrease to be a restrictive influence.

The portfolio school holds that a change in the monetary base affects investment spending, and thereby aggregate spending, through changes in market interest rates relative to the supply price of capital (real rate of return on capital). The modern quantity theory holds that the influence of the monetary base works through changes in the money stock which in turn affect prices, interest rates and spending on goods and services. Increases in the base are reflected in increases in the money stock which in turn result directly and indirectly in increased expenditures on a whole spectrum of capital and consumer goods. Both prices of goods and interest rates form the transmission mechanism in the modern quantity theory.

The money stock is also used as a strategic monetary variable in each of the approaches to stabilization policies, as the above discussion has implied. The simple Keynesian approach postulates that a change in the stock of money relative to its demand results in a change in interest rates. It also postulates that investment spending decisions depend on interest rates, and that growth in aggregate spending depends in turn on these investment decisions. Similarly, in the portfolio school of thought, changes in the money stock lead to changes in interest rates, which are followed by substitutions in asset portfolios; then

[1]The monetary base is derived from a consolidated monetary balance sheet of the Federal Reserve and the Treasury. See Leonall C. Andersen and Jerry L. Jordan, "The Monetary Base: Explanation and Analytical Use," in the August 1968 issue of this *Review*. Since the uses of the base are bank reserves plus currency held by the public, it is often called "demand debt of the Government." See James Tobin, "An Essay on Principles of Debt Management," in *Fiscal and Debt Management Policies*, The Commission on Money and Credit, Prentice-Hall, Inc., Englewood Cliffs, N.J., 1963. In some analyses, Tobin includes short-term government debt outstanding in the monetary base.

Exhibit 2

Stabilization Actions and Their Measurement

Stabilization actions	Frequently used measurements of actions
1. Monetary Actions	**1. Monetary Actions**
Federal Reserve System a. open market transactions. b. discount rate changes. c. reserve requirement changes. Treasury a. changes in cash holdings. b. changes in deposits at Reserve banks. c. changes in deposits at commercial banks. d. changes in Treasury currency outstanding.	Monetary base.[1] Money stock, narrowly defined.[1] Money plus time deposits. Commercial bank credit. Private demand deposits.
2. Fiscal Actions	**2. Fiscal Actions**
Government spending programs. Government taxing provisions.	High-employment expenditures.[1] High-employment receipts.[1] High-employment surplus.[1] Weighted high-employment expenditures. Weighted high-employment receipts. Weighted high-employment surplus. National income account expenditures. National income account receipts. Autonomous changes in government tax rates. Net government debt outside of agencies and trust funds.

[1]Tests based on these measures are reported in this article. The remaining measures were used in additional tests. These results are available on request.

finally, total spending is affected. Interest rates, according to this latter school, are the key part of the transmission mechanism, influencing decisions to hold money versus alternative financial assets as well as decisions to invest in real assets. The influence of changes in the money stock on economic activity, within the modern quantity theory framework, has already been discussed in the previous paragraph.[2]

The monetary base, as noted, plays an important role in both the portfolio and the modern quantity theory approaches to monetary theory. However, there remains considerable controversy regarding the role of money in determining economic activity, ranging from "money does not matter" to "money is the dominant factor." In recent years there has been a general acceptance that money, among many other influences, is important. Thomas Mayer, in a recent book, summarizes this controversy. He concludes:

> All in all, much recent evidence supports the view that the stock of money and, therefore, monetary policy, has a substantial effect. Note, however, that this reading of the evidence is by no means acceptable to all economists. Some, professor Friedman and Dr. Warburton for example, argue that changes in the stock of money do have a dominant effect on income, at least in the long run, while others such as Professor Hansen believe that changes in the stock of money are largely offset by opposite changes in velocity.[3]

The theories aside, changes in the monetary base and changes in the money stock are frequently used as measures of monetary actions. This article, in part, tests the use of these variables for this purpose. Money is narrowly defined as the nonbank public's holdings of demand deposits plus currency. Changes in the money stock mainly reflect movements in the monetary base; however, they also reflect decisions of commercial banks to hold excess reserves, of the nonbank public to hold currency and time deposits, and of the Treasury to hold demand deposits at commercial banks. The monetary base reflects monetary actions of

[2]Also see Leonall C. Andersen and Jerry L. Jordan, "Money in a Modern Quantity Theory Framework" in the December 1967 issue of this *Review*. For an excellent analysis of these three monetary views see David I. Fand, "Keynesian Monetary Theories, Stabilization Policy and the Recent Inflation," a paper presented to the Conference of University Professors, Ditchley Park, Oxfordshire, England, Sept. 13, 1968.

[3]Thomas Mayer, *Monetary Policy in the United States*, Random House, NY, 1968, pp. 148–49.

the Federal Reserve, and to a lesser extent, those of the Treasury and gold flows. But changes in the base have been found to be dominated by actions of the Federal Reserve.[4]

Other aggregate measures, such as money plus time deposits, bank credit and private demand deposits, are frequently used as monetary indicators (exhibit 2). Tests using these indicators were also made. The results of these tests did not change the conclusions reached in this article; these results are available on request. Market interest rates are not used in this article as strategic monetary variables since they reflect, to a great extent, fiscal actions, expectations, and other factors which cannot properly be called monetary actions.

Fiscal Actions

The influence of fiscal actions on economic activity is frequently measured by federal government spending, changes in federal tax rates, or federal budget deficits and surpluses. The textbook Keynesian view has been reflected in many popular discussions of fiscal influence. The portfolio approach and the modern quantity theory suggest alternative analyses of fiscal influence.

The elementary textbook Keynesian view concentrates almost exclusively on the direct influence of fiscal actions on total spending. Government spending is a direct demand for goods and services. Tax rates affect disposable income, a major determinant of consumer spending, and profits of businesses, a major determinant of investment spending. Budget surpluses and deficits are used as a measure of the net direct influence of spending and taxing on economic activity. More advanced textbooks also include an indirect influence of fiscal actions on economic activity through changes in market interest rates. In either case, little consideration is generally given to the method of financing expenditures.

The portfolio approach as developed by Tobin attributes to fiscal actions both a direct influence on economic activity and an indirect influence. Both influences take into consideration the financing of government expenditures.[5] Financing of expenditures by issuance of demand debt of monetary authorities (the monetary base) results in the full Keynesian multiplier effect. Financing by either taxes or borrowing from the public has a smaller multiplier effect on spending. Tobin views this direct influence as temporary.

The indirect influence of fiscal actions, according to Tobin, results from the manner of financing the government debt, that is, variations in the relative amounts of demand debt, short-term debt, and long-term debt. For example, an expansionary move would be a shift from long-term to short-term debt or a shift from short-term to demand debt. A restrictive action would result from a shift in the opposite direction. As in the case of monetary actions, market interest rates on financial assets and their influence on investment spending make up the transmission mechanism.

The modern quantity theory also suggests that the influence of fiscal actions depends on the method of financing government expenditures. This approach maintains that financing expenditures by either taxing or borrowing from the public involves a transfer of command over resources from the public to the government. However, the net influence on total spending resulting from interest rate and wealth changes is ambiguous. Only a deficit financed by the monetary system is necessarily expansionary.[6]

High-employment budget concepts have been developed as measures of the influence of fiscal actions on economic activity.[7] In these budget concepts, expenditures include both those for goods and services and those for transfer payments, adjusted for the influence of economic activity. Receipts, similarly adjusted, primarily reflect legislated changes in federal government tax rates, including Social Security taxes.

[4]For a discussion of these points, see: Karl Brunner, "The Role of Money and Monetary Policy," in the July 1968 issue of this *Review*.

[5]Tobin, pp. 143–213.

[6]The importance of not overlooking the financial aspects of fiscal policy is emphasized by Carl F. Christ in "A Simple Macroeconomic Model with a Government Budget Restraint," *Journal of Political Economy*, Vol. 76, No. 1, January/February 1968, pp. 53–67. Christ summarizes (pages 53 and 54) that "the multiplier effect of a change in government purchases cannot be defined until it is decided how to finance the purchases, and the value of the multiplier given by the generally accepted analysis [which ignores the government budget restraint] is in general incorrect . . . (the) multiplier effect of government purchases may be greater or less than the value obtained by ignoring the budget restraint, depending on whether the method of financing is mainly by printing money or mainly by taxation."

[7]See Keith M. Carlson, "Estimates of the High-Employment Budget: 1947–1967," in the June 1967 issue of this *Review*. The high-employment budget concept was used in the *Annual Report of the Council of Economic Advisers* from 1962 to 1966. For a recent analysis using the high-employment budget, see "Federal Fiscal Policy in the 1960s," *Federal Reserve Bulletin*, September 1968, pp. 701–18. According to this article, "the concept does provide a more meaningful measure of the Federal budgetary impact than the published measures of actual Federal surplus or deficit taken by themselves."

The net of receipts and expenditures is used as a net measure of changes in expenditure provisions and in tax rates. These high-employment concepts are used in this article as measures of fiscal actions (exhibit 2). Tests were also made alternatively using national income account government expenditures and receipts, a series measuring autonomous changes in government tax rates, a weighted high-employment expenditure and receipt series, and a series of U. S. government debt held by the public plus Federal Reserve holdings of U. S. government securities. These tests did not change the conclusions reached in this article. Results of these tests are available on request.

Other Influences

Measures of other independent forces which influence economic activity are not used in this article. Yet this should not be construed to imply that these forces are not important. It is accepted by all economists that the non-monetary and non-fiscal forces listed in exhibit 1 have an important influence on economic activity. However, recognition of the existence of these "other forces" does not preclude the testing of propositions relating to the relative importance of monetary and fiscal forces. The analysis presented in this study provides indirect evidence bearing on these "other forces." The interested reader is encouraged to read the technical note presented in the appendix to this article before proceeding.

TESTING THE PROPOSITIONS

This section reports the results of testing the three propositions under consideration. First, the concept of testing a hypothesis is briefly discussed. Next, the results of regression analyses which relate the measures of fiscal and monetary actions to total spending are reported. Finally, statistics developed from the regression analyses are used to test the specific propositions.

The Concept of Testing a Hypothesis

In scientific methodology, testing a hypothesis consists of the statement of the hypothesis, deriving by means of logic testable consequences expected from it, and then taking observations from past experience which show the presence or absence of the expected consequences. If the expected consequences do not occur, then the hypothesis is said to be "not confirmed" by the evidence. If, on the other hand, the expected consequences occur, the hypothesis is said to be "confirmed."

It is important to keep the following point in mind. In scientific testing, a hypothesis (or conjecture) may be found "not confirmed" and therefore refuted as the explanation of the relationship under examination. However, if it is found to be "confirmed," the hypothesis cannot be said to have been proven true. In the latter case, however, the hypothesis remains an acceptable proposition of a real world relationship as long as it is found to be "confirmed" in future tests.[8]

The results presented in this study all bear on what is commonly called a "reduced form" in economics. A reduced-form equation is a derivable consequence of a system of equations which may be hypothesized to represent the structure of the economy (i.e., a so-called structural model). In other words, all of the factors and causal relations which determine total spending (GNP) are "summarized" in one equation. This reduced-form equation postulates a certain relationship over time between the independent variables and the dependent variable — total spending. Using appropriate statistical procedures and selected measures of variables, it is possible to test whether or not the implications of the reduced-form equation have occurred in the past. If the implied relationships are not confirmed, then the relationship asserted by the reduced-form equation is said to have been refuted. However, not confirming the reduced form does not necessarily mean that the whole "model," and all of the factors and causal relations contained in it, are denied. It may be only that one or more of the structural linkages of the model is incorrect, or that the empirical surrogates chosen as measures of monetary or fiscal influence are not appropriate.[9]

Frequently one encounters statements or conjectures regarding factors which are asserted to influence economic activity in a specific way. These statements take the form of reduced-form equations, and are sometimes attributed to various theories of the determination of economic activity. As stated previously, this study does not attempt to test the causal linkages by which fiscal and monetary actions influence total spending, but is concerned only with the confirma-

[8]For a detailed discussion of testing hypotheses in reference to monetary actions, see Albert E. Burger and Leonall C. Andersen, "The Development of Testable Hypotheses for Monetary Management," a paper presented at the annual meeting of the Southern Finance Association, November 8, 1968. It will appear in a forthcoming issue of the *Southern Journal of Business*, University of Georgia, Athens, Georgia.

[9]A more specific statement relating to these considerations is presented in the appendix.

tion or refutation of rival conjectures regarding the strength and reliability of fiscal and monetary actions based on frequently used indicators of such actions.

Measuring the Empirical Relationships

As a step toward analyzing the three propositions put forth earlier, empirical relationships between the measures of fiscal and monetary actions and total spending are established. These relationships are developed by regressing quarter-to-quarter changes in GNP on quarter-to-quarter changes in the money stock (M) and in the various measures of fiscal actions: high-employment budget surplus (R-E), high-employment expenditures (E), and high-employment receipts (R). Similar equations were estimated where changes in the monetary base (B) were used in place of the money stock.

Changes in all variables were computed by two methods. Conventional first differences were calculated by subtracting the value for the preceding quarter from the value for the present quarter.[10] The other method used is an averaging procedure used by Kareken and Solow called central differences.[11] The structure of lags present in the regressions was estimated with use of the Almon lag technique.[12] The data are seasonally adjusted quarterly averages for the period from the first quarter of 1952 to the second quarter of 1968.[13]

As discussed previously, statements are frequently made from which certain relationships are expected to exist between measures of economic activity on the one hand and measures of monetary and fiscal actions on the other hand. Such relationships consist of a direct influence of an action on GNP and of an indirect influence which reflects interactions among the many markets for real and financial assets. These interactions work through the market mechanism determining the dependent variables listed in exhibit 1. The postulated relationships are the total of these direct and indirect influences. Thus, the empirical relationship embodied in each regression coefficient is the *total* response (including both direct and indirect responses) of GNP to changes in each measure of a stabilization action, assuming all other forces remain constant.

The results presented here do not provide a basis for separating the direct and indirect influences of monetary and fiscal forces on total spending, but this division is irrelevant for the purposes of this article. The interested reader is referred to the appendix for further elaboration of these points.

Using the total response concept, changes in GNP are expected to be positively related to changes in the money stock (M) or changes in the monetary base (B). With regard to the high-employment surplus (receipts minus expenditures), a larger surplus or a smaller deficit is expected to have a negative influence on GNP, and conversely. Changes in high-employment expenditures (E) are expected to have a positive influence and changes in receipts (R) are expected to have a negative influence when these variables are included separately.

Considering that the primary purpose of this study is to measure the influence of a few major forces on changes in GNP, rather than to identify and measure the influences of all independent forces, the results obtained are quite good (table 1). The R^2 statistic, a measure of the percent of the variance in changes in GNP explained by the regression equation, ranges from .53 to .73; these values are usually considered to be quite good when first differences are used rather than levels of the data. All of the estimated regression coefficients for changes in the money stock or the monetary base have the signs implied in the above discussion (equations 1.1 to 2.4 in table 1) and have a high statistical significance in most cases. The estimated coefficients for the high-employment measures of fiscal influence do not have the expected signs in all cases and generally are of low statistical significance.

[10]Changes in GNP, R, and E are quarterly changes in billions of dollars measured at annual rates, while changes in M and B are quarterly changes in billions of dollars. Changes in GNP, R, and E are changes in flows, whereas changes in M and B are changes in a stock. Since all of the time series have strong trends, first differences tend to increase in size over time. Statistical considerations indicate that percent first differences would be more appropriate. On the other hand, regular first differences provide estimates of multipliers which are more useful for the purposes of this study. Test regressions of relative changes were run and they did not alter the conclusions of this article.

[11]John Kareken and Robert M. Solow, "Lags in Monetary Policy" in *Stabilization Policies* of the research studies prepared for the Commission on Money and Credit, Prentice-Hall, Inc., 1962, pp. 18–21.

[12]Shirley Almon, "The Distributed Lag Between Capital Appropriations and Expenditures," *Econometrica*, Vol. 33, No. 1, January 1965, pp. 178–96.

[13]As a test for structural shifts, the test period was divided into two equal parts and the regressions reported here were run for each sub-period and for the whole period. The Chow test for structural changes accepted the hypothesis that the sets of parameters estimated for each of the sub-periods were not different from each other or from those estimated for the whole period, at the five percent level of significance. As a result, there is no evidence of a structural shift; consequently, the whole period was used.

Table 1

Regression of Changes in GNP on Changes in Monetary and Fiscal Actions

First Differences	(Equation 1.1)		(Equation 1.2)			(Equation 1.3)		(Equation 1.4)		
	ΔM	Δ(R-E)	ΔM	ΔE	ΔR	ΔM	ΔE	ΔB	ΔE	ΔR
t	1.57*	−.15	1.51*	.36	.16	1.54*	.40	1.02	.23	.52
	(2.17)	(.65)	(2.03)	(1.15)	(.53)	(2.47)	(1.48)	(.49)	(.67)	(1.68)
t-1	1.94*	−.20	1.59*	.53*	−.01	1.56*	.54*	5.46*	.37	.02
	(3.60)	(1.08)	(2.85)	(2.15)	(.03)	(3.43)	(2.68)	(3.37)	(1.36)	(.07)
t-2	1.80*	.10	1.47*	−.05	−.03	1.44*	−.03	6.48*	−.21	−.17
	(3.37)	(.55)	(2.69)	(.19)	(.10)	(3.18)	(.13)	(4.10)	(.84)	(.64)
t-3	1.28	.47*	1.27	−.78*	.11	1.29*	−.74*	3.05	−.93*	.14
	(1.88)	(1.95)	(1.82)	(2.82)	(.32)	(2.00)	(2.85)	(1.54)	(3.10)	(.39)
Sum	6.59*	.22	5.84*	.07	.23	5.83*	.17	16.01*	−.54	.51
	(7.73)	(.45)	(6.57)	(.13)	(.32)	(7.25)	(.54)	(5.67)	(.89)	(.67)
Constant	1.99*		2.10			2.28*		1.55		
	(2.16)		(1.88)			(2.76)		(1.22)		
R^2	.56		.58			.60		.53		
SE	4.24		4.11			4.01		4.35		
DW	1.54		1.80			1.78		1.71		

Central Differences	(Equation 2.1)		(Equation 2.2)			(Equation 2.3)		(Equation 2.4)		
	ΔM	Δ(R-E)	ΔM	ΔE	ΔR	ΔM	ΔE	ΔB	ΔE	ΔR
t	1.50	−.24	1.58*	.53	.32	1.54*	.63*	.61	.28	.87*
	(1.84)	(.91)	(2.01)	(1.52)	(1.05)	(2.45)	(2.21)	(.28)	(.73)	(2.55)
t-1	2.11*	−.23	1.57*	.60*	−.04	1.63*	.59*	5.42*	.50	−.07
	(3.61)	(1.16)	(2.78)	(2.44)	(.17)	(3.57)	(2.61)	(3.16)	(1.87)	(.27)
t-2	1.89*	.15	1.41*	−.15	−.11	1.43*	−.16	6.87*	−.27	−.33
	(3.18)	(.81)	(2.45)	(.60)	(.47)	(3.16)	(.71)	(3.92)	(1.04)	(1.31)
t-3	1.06	.52	1.26	−.96*	.18	1.13	−.86*	3.51	−1.26*	.35
	(1.36)	(1.90)	(1.72)	(3.15)	(.48)	(1.71)	(3.07)	(1.71)	(3.65)	(.87)
Sum	6.56*	.21	5.80*	.02	.34	5.74*	.19	16.41*	−.75	.82
	(8.16)	(.47)	(7.57)	(.04)	(.54)	(8.45)	(.77)	(6.95)	(1.37)	(1.16)
Constant	2.02*		2.00*			2.30*		1.24		
	(2.48)		(2.14)			(3.55)		(1.14)		
R^2	.66		.72			.73		.67		
SE	3.35		3.03			2.97		3.26		
DW	.88		1.14			1.13		1.05		

Note: Regression coefficients are the top figures, and their "t" values appear below each coefficient enclosed by parentheses. The regression coefficients marked by an asterisk (*) are statistically significant at the 5 percent level. R^2 are adjusted for degrees of freedom. SE is the standard error of the estimate, and DW is the Durbin-Watson statistic.

These regression results are discussed in greater detail below.

Money and the monetary base — The total response of GNP to changes in money or the monetary base distributed over four quarters is consistent with the postulated relationship (i.e., a positive relationship), and the coefficients are all statistically significant. The coefficients of each measure of monetary action may be summed to provide an indication of the overall response of GNP to changes in monetary actions. These summed coefficients are also statistically significant and consistent with the postulated relationships. The results obtained for measures of monetary actions were not affected significantly when measures of fiscal actions other than those reported here were used in the regressions.

High-employment budget surplus — As pointed out previously, the high-employment surplus or deficit is often used as a measure of the direction and strength of fiscal actions. Equation 1.1 summarizes the total response of GNP to changes in money and changes in the high-employment surplus. The coefficients of the high-employment surplus estimated for the contemporaneous and first lagged quarter have the expected sign, but the coefficients are of very low statistical significance and do not differ significantly from zero. The signs of the coefficients estimated for the second and third lagged quarters are opposite to the expected signs. The sum of the coefficients (total response distributed over four quarters) is estimated to have a positive sign (opposite the postulated sign) but is not statistically significant. These results provide no empirical support for the view that fiscal actions measured by the high-employment surplus have a significant influence on GNP. In principle, these results may have occurred either because the high-employment surplus was not a good measure of fiscal influence, or because fiscal influence was not important during the sample period.[14]

Expenditures and receipts — Simple textbook Keynesian models of income determination usually demonstrate, theoretically, that changes in tax rates exert a negative influence on economic activity, while changes in government expenditures exert a positive influence. Equations 1.2 and 1.3 provide tests of these propositions. The signs of the coefficients estimated for tax receipts are the same as the hypothesized signs for only the first and second lagged quarters. However, since these coefficients (individually and the sums) are of low statistical significance, no importance can be attached to this variable. Inclusion of changes in receipts (ΔR) in equation 1.2 does not improve the overall results, in terms of R^2 and the standard error of estimate, compared with equation 1.3 from which receipts are excluded.

These results provide no support for theories which indicate that changes in tax receipts due to changes in tax rates exert an overall negative (or any) influence on economic activity. The results are consistent with theories which indicate that if the alternative to tax revenue is borrowing from the public in order to finance government spending, then the influence of spending will not necessarily be greater if the funds are borrowed rather than obtained through taxation. They are also consistent with the theory that consumers will maintain consumption levels at the expense of saving when there is a temporary reduction in disposable income.

The signs of the coefficients estimated for high-employment expenditures in equations 1.2 and 1.3 indicate that an increase in government expenditures is mildly stimulative in the quarter in which spending is increased and in the following quarter. However, in the subsequent two quarters this increase in expenditures causes offsetting negative influences. The overall effect of a change in expenditures distributed over four quarters, indicated by the sum, is relatively small and not statistically significant. These results are consistent with modern quantity theories which hold that government spending, taxing, and borrowing policies would have, through interest rate and wealth effects, different impacts on economic activity under varying circumstances.[15]

Three Propositions Tested

The empirical relationships developed relating changes in GNP to changes in the money stock and changes in high-employment expenditures and receipts are used to test the three propositions under consideration. The results of testing the propositions using changes in the money stock are discussed in detail in this section. Similar results are reported in the accompanying tables using changes in the monetary base instead of the money stock. Conclusions drawn using either measure of monetary actions are similar.

Proposition I states that fiscal actions exert a larger influence on economic activity than do monetary actions. A test of this proposition involves an examination of the size of the regression coefficients for high-employment expenditures relative to those for money and the monetary base.[16] Proposition I implies that the

[14]It was suggested to the authors that a weighted high-employment budget surplus might be a better measure of fiscal influence than the usual unweighted series. For an elaboration of such a weighted series, see Edward M. Gramlich, "Measures of the Aggregate Demand Impact of the Federal Budget," in *Staff Papers of the President's Commission on Budget Concepts*, U.S. Government Printing Office, Washington, D.C., October 1967. Gramlich provided weights from the FRB-MIT model of the economy for constructing a weighted series. It was further suggested that the level of the high-employment budget surplus was a more appropriate measure of fiscal actions. Coefficients of fiscal influence were estimated using both changes in the weighted series, and levels of the high-employment surplus. The results did not change any of the conclusions of this article.

[15]John Culbertson points out that in a financially constrained economy (i.e., no monetary expansion to finance government expenditures), expenditures by the government financed in debt markets in competition with private expenditures can very possibly "crowd out of the market an equal (or conceivably even greater) volume that would have financed private expenditures." He asserts that it is possible to have a short-lived effect of government spending on total spending if the financial offsets lag behind its positive effects. The results obtained for ΔE in this article are consistent with his analysis. See John M. Culbertson, *Macroeconomic Theory and Stabilization Policy*, McGraw-Hill, Inc., New York, 1968, pp. 462–63.

[16]Since little response of GNP to ΔR was found, further discussions consider only ΔE.

Table 2

Measurements of the Relative Importance of Monetary and Fiscal Actions

	Beta Coefficients						Partial Coefficients of Determination					
Quarter	ΔM	ΔE	ΔR	ΔB	ΔE	ΔR	ΔM	ΔE	ΔR	ΔB	ΔE	ΔR
First Differences (equations 1.2 and 1.4)												
t	.24	.14	.05	.06	.09	.16	.07	.02	.01	*	.01	.05
t-1	.26	.20	*	.31	.14	.01	.14	.08	*	.18	.03	*
t-2	.24	−.02	−.01	.37	−.08	−.05	.12	*	*	.24	.01	.01
t-3	.20	−.30	.03	.17	−.36	.04	.06	.13	*	.04	.16	*
Sum	.94	.02	.07	.91	−.21	.16	.45	*	*	.38	.02	.01
Central Differences (equations 2.2 and 2.4)												
t	.26	.20	.09	.04	.11	.25	.07	.04	.02	*	.01	.11
t-1	.26	.23	−.01	.31	.19	−.02	.13	.10	*	.16	.06	*
t-2	.23	−.06	−.03	.40	−.10	−.09	.11	.01	*	.23	.02	.03
t-3	.20	−.36	.05	.20	−.47	.10	.05	.16	*	.05	.21	.01
Sum	.95	.01	.10	.95	−.27	.24	.53	*	.01	.49	.04	.03

*Less than .005.

coefficients for ΔE would be larger, without regard to sign, than those for ΔM and ΔB.

The coefficients presented in table 1 are not appropriate for this test because the variables have different time dimensions and are a mixture of stocks and flows. An appropriate measure is developed by changing these regression coefficients to "beta coefficients" which eliminate these difficulties (table 2). These coefficients take into consideration the past variation of changes in each independent variable relative to the past variation of changes in GNP.[17] The size of beta coefficients may be, therefore, directly compared as a measure of the relative contribution of each variable to variations in GNP in the test period.

According to table 2, the beta coefficients for changes in money are greater than those for changes in high-employment expenditures for the quarter in which a change occurs and during the two following quarters. The coefficients for changes in the monetary base are greater for the two quarters immediately following a change in the base. In the lagged quarters in which the beta coefficients for ΔE are largest, a negative sign is associated with the regression coefficient, indicating a lagged contractionary effect of increased expenditures. As a measure of the total contribution over the four quarters, the sum of the beta coefficients for changes in money and the monetary base are much greater than those for changes in expenditures.

Proposition I may also be tested by the use of partial coefficients of determination. These statistics are measures of the percent of variation of the dependent variable remaining after the variation accounted for by all other variables in the regression has been subtracted from the total variation. Proposition I implies that larger coefficients should be observed for fiscal actions than for monetary actions. Table 2 presents the partial coefficients of determination for the variables under consideration. For the quarter of a change and the subsequent two quarters, these coefficients for ΔM are much greater than those for ΔE. With regard to ΔB, the coefficients are about equal to those for ΔE in the first quarter and are much greater in the two subsequent quarters. The partial coefficients of determination for the total contribution of each policy variable to changes in GNP over four quarters may be developed. Table 2 shows that the partial coefficients of determination for the overall response of ΔGNP to ΔM and ΔB range from .38 to .53, while those for ΔE are virtually zero.

Other implications of the results presented in table 1 may be used to test further the relative strength of the response of GNP to alternative government actions

[17]Arthur S. Goldberger, *Econometric Theory*. John Wiley & Sons, Inc., December 1966, New York, pp. 197–200.

Table 3

Simulated Response of an Increase in Government Expenditures Financed by Monetary Expansion (millions of dollars)

	Increase in Government Expenditures			Required Increase in Money			Total Response in GNP	
Quarter	Change in Expenditures	Impact Effect on GNP	Cumulative Effect on GNP	Change in Money Stock	Impact Effect on GNP	Cumulative Effect on GNP	Impact Effect on GNP	Cumulative Effect on GNP
1	$1000	$400	$400	$250	$ 385	$ 385	$ 785	$ 785
2	0	540	940	250	775	1160	1315	2100
3	0	− 30	910	250	1135	2295	1105	3205
4	0	− 740	170	250	1458	3753	718	3923
5	− 1000	− 400	− 230	0	1072	4825	672	4595
6	0	− 540	− 770	0	682	5507	142	4737
7	0	30	− 740	0	323	5830	353	5090
8	0	740	0	0	0	5830	740	5830

under conditions where "other things" are held constant. Three alternative actions are assumed taken by stabilization authorities: (1) the rate of government spending is increased by $1 billion and is financed by either borrowing from the public or increasing taxes; (2) the money stock is increased by $1 billion with no change in the budget position; and (3) the rate of government spending is increased by $1 billion for a year and is financed by increasing the money stock by an equal amount.

The impact on total spending of the first two actions may be measured by using the sums of the regression coefficients presented for equation 1.3. A $1 billion increase in the rate of government spending would, after four quarters, result in a permanent increase of $170 million in GNP. By comparison, an increase of the same magnitude in money would result in GNP being $5.8 billion permanently higher after four quarters.

The results of the last action are presented in table 3.[18] The annual rate of government spending is assumed to be increased by $1 billion in the first quarter and held at that rate for the following three quarters. This would require an increase in money of $250 million during each of the four quarters to finance the higher level of expenditures. Since we are interested only in the result of financing the original increase in expenditures by monetary expansion, expenditures must be reduced by $1 billion in the fifth quarter. If expenditures were held at the higher rate, money would have to continue to grow at $250 million per quarter. According to table 3, GNP would rise to a permanent level $5.8 billion higher than at the beginning. This increase in GNP results entirely from monetary expansion.

According to these three tests, the regression results implied by Proposition I did not occur. Therefore, the proposition that the response of total demand to fiscal actions is greater than that of monetary actions is not confirmed by the evidence.

Proposition II holds that the response of economic activity to fiscal actions is more predictable than the response to monetary influence. This implies that the regression coefficients relative to their standard errors (this ratio is called the "t-value"), relating changes in E to changes in GNP, should be greater than the corresponding measures for changes in M and in B. The greater the t-value, the more confidence there is in the estimated regression coefficient, and hence, the greater is the reliability of the estimated change in GNP resulting from a change in the variable. These t-values are presented in table 4.

An examination of this table indicates greater t-values for the regression coefficients of the two monetary variables than for the fiscal variable, except for the third quarter after a change. Also, the t-values for the

[18]The authors wish to give special thanks to Milton Friedman for suggesting this illustration and table 3. However, the formulation presented here is the sole responsibility of the authors.

Table 4

Measurement of Reliability of the Response of GNP to Monetary and Fiscal Actions ("t-values" of regression coefficients[1])

Quarter	ΔM	ΔE	ΔR	ΔB	ΔE	ΔR
First Differences						
t	2.03	1.15	0.53	0.49	0.67	1.68
t-1	2.85	2.15	0.03	3.37	1.36	0.07
t-2	2.69	0.19	0.10	4.10	0.84	0.64
t-3	1.82	2.82	0.32	1.54	3.10	0.39
Sum	6.57	0.13	0.32	5.67	0.89	0.67
Central Differences						
t	2.01	1.52	1.05	0.28	0.73	2.55
t-1	2.78	2.44	0.17	3.16	1.87	0.27
t-2	2.45	0.60	0.46	3.92	1.04	1.31
t-3	1.72	3.15	0.48	1.71	3.65	0.87
Sum	7.57	0.04	0.54	6.95	1.37	1.16

[1]t-values associated with equations 1.2, 1.4, 2.2 and 2.4 in table 1.

sum of the regression coefficients for ΔM and ΔB are large, while those for ΔE are not statistically significant from zero. Since the regression results implied by Proposition II did not appear, the proposition is not confirmed.

Proposition III states that the influence of fiscal actions on economic activity occurs faster than that of monetary actions. It is tested by examining the characteristics of the lag structure in the regressions. Proposition III implies that beta coefficients for ΔE should be greater than those for ΔM in the quarter of a change and in those immediately following. It also implies that the main response of GNP to fiscal actions occurs within fewer quarters than its response to monetary actions.

The beta coefficients are plotted in the charts.[19] A change in the money stock induces a large and almost equal response in each of the four quarters. The largest response of GNP to changes in the monetary base occurs in the first and second quarters after a change. The beta coefficients for changes in M are greater than those for changes in E for the quarter of a change and the following quarter, indicating comparatively smaller response of GNP to fiscal actions in these first two quarters. Moreover, the largest coefficient for ΔE occurs for the third quarter after a change.

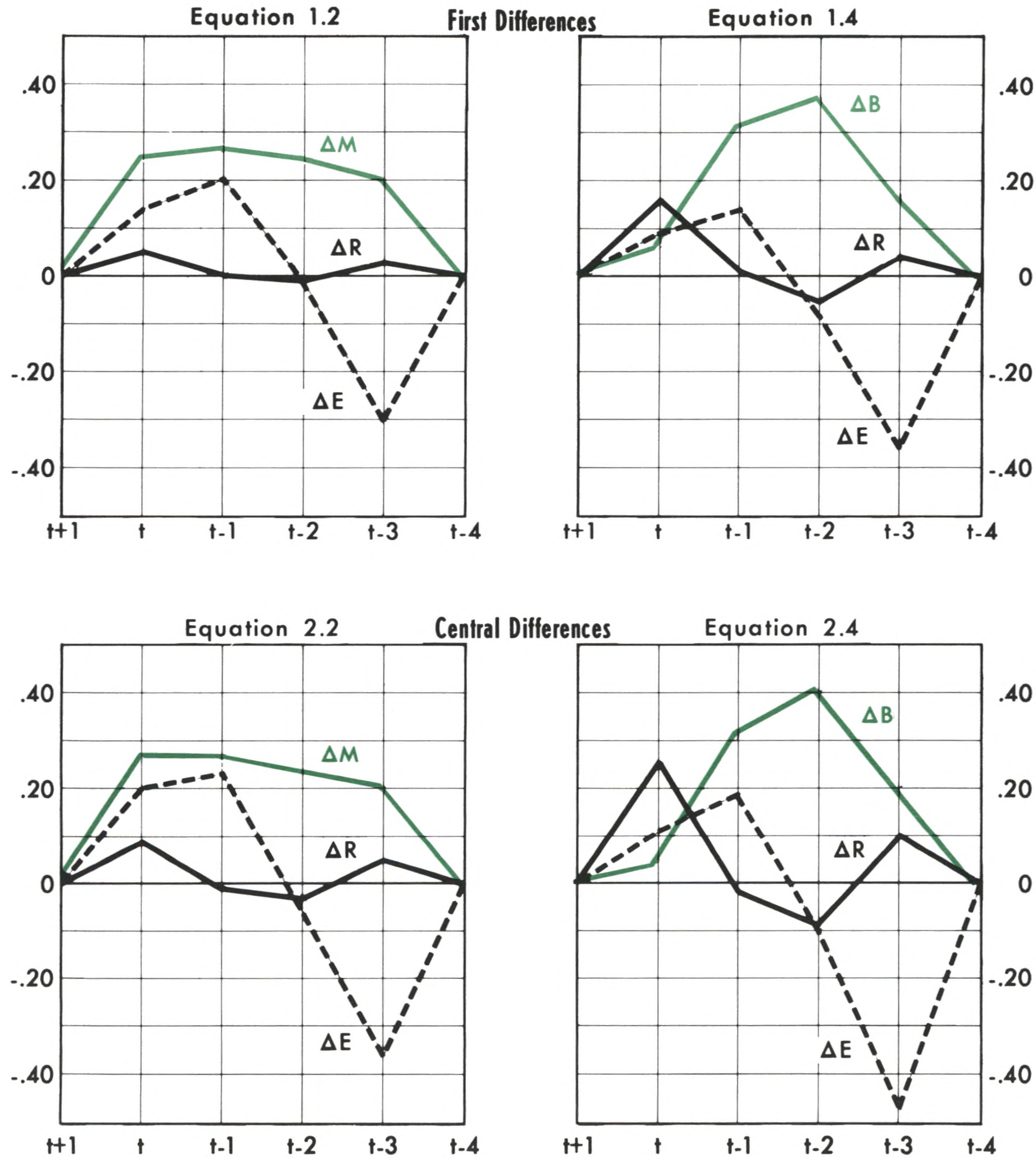
The expected regression results implied by Proposition III were not found. Therefore, the proposition that the major impact of fiscal influence on economic activity occurs within a shorter time interval than monetary influence is not confirmed.

Summary — This section tested the propositions that the response of economic activity to fiscal actions relative to monetary actions is (I) larger, (II) more predictable and (III) faster. The results of the tests were not consistent with any of these propositions. Consequently, either the commonly used measures of fiscal influence do not correctly indicate the degree and direction of such influence, or there was no measurable net fiscal influence on total spending in the test period.

The test results are consistent with an alternative set of propositions. The response of economic activity to monetary actions compared with that of fiscal actions is (I′) larger, (II′) more predictable, and (III′) faster. It should be remembered that these alternative

[19]The Almon lag structure was developed by using a fourth degree polynomial and constraining the coefficients for t-4 to zero. The regressions indicate that four quarters constitute an appropriate response period for both fiscal and monetary actions. Equations using up to seven lagged quarters were also estimated, but there was little response in GNP to fiscal and monetary actions beyond the three quarter lags reported.

Measures of Lag Response



Beta coefficients are for changes in the money stock (ΔM), the monetary base (ΔB), high-employment expenditures (ΔE), and high-employment receipts (ΔR). These beta coefficients are calculated as the products of the regression coefficient for the respective variables times the ratio of the standard deviation of the variable to the standard deviation of GNP.

propositions have not been proven true, but this is always the case in scientific testing of hypothesized relationships. Nevertheless, it is asserted here that these alternative propositions are appropriate for the conduct of stabilization policy until evidence is presented proving one or more of them false.

There is a major qualification to these statements. Since the propositions were tested using the period first quarter 1952 to second quarter 1968, it is implicitly assumed in making these statements that the general environment prevailing in the test period holds for the immediate future.

Implications for Economic Stabilization Policy

Rejection of the three propositions under examination and acceptance of the alternatives offered carry important implications for the conduct of economic stabilization policy. All of these implications point to the advisability of greater reliance being placed on monetary actions than on fiscal actions. Such a reliance would represent a marked departure from most present procedures.

The finding that statements which assert that changes in tax rates have a significant influence on total spending are not supported by this empirical investigation suggests that past efforts in this regard have been overly optimistic. Furthermore, the finding that the response of total spending to changes in government expenditures is small compared with the response of spending to monetary actions strongly suggests that it would be more appropriate to place greater reliance on the latter form of stabilization action.

Finding of a strong empirical relationship between economic activity and either of the measures of monetary actions points to the conclusion that monetary actions can and should play a more prominent role in economic stabilization than they have up to now. Furthermore, failure to recognize these relationships can lead to undesired changes in economic activity because of the relatively short lags and strong effects attributable to monetary actions.

Evidence was found which is consistent with the proposition that the influence of monetary actions on economic activity is more certain than that of fiscal actions. Since monetary influence was also found to be stronger and to operate more quickly than fiscal influence, it would appear to be inappropriate, for stabilization purposes, for monetary authorities to wait very long for a desired fiscal action to be adopted and implemented.

Evidence found in this study suggests that the money stock is an important indicator of the total thrust of stabilization actions, both monetary and fiscal. This point is argued on two grounds. First, changes in the money stock reflect mainly what may be called discretionary actions of the Federal Reserve System as it uses its major instruments of monetary management — open market transactions, discount rate changes, and reserve requirement changes. Second, the money stock reflects the joint actions of the Treasury and the Federal Reserve System in financing newly created government debt. Such actions are based on decisions regarding the monetization of new debt by Federal Reserve actions, and Treasury decisions regarding changes in its balances at Reserve banks and commercial banks. According to this second point, changes in government spending financed by monetary expansion are reflected in changes in the monetary base and in the money stock.

A number of economists maintain that the major influence of fiscal actions results only if expenditures are financed by monetary expansion. In practice, the Federal Reserve does not buy securities from the Government. Instead, its open market operations and other actions provide funds in the markets in which both the government and private sectors borrow.

The relationships expressed in table 1 may be used to project the expected course of GNP, given alternative assumptions about monetary and fiscal actions. Such projections necessarily assume that the environment in the period used for estimation and the average relationships of the recent past hold in the future. The projections are not able to take into consideration the influences of other independent forces; therefore, they are not suitable for exact forecasting purposes. However, they do provide a useful measure of monetary and fiscal influences on economic activity.

An example of such projections using equation 1.3 is presented in table 5. Equation 1.3 related quarter-to-quarter changes in GNP to changes in the money stock and changes in high-employment expenditures, both distributed over four quarters.

Assumptions used in computing the projections of quarterly changes in GNP reported in table 5 include: (a) high-employment expenditures were projected through the second quarter of 1969 under the assumption that federal spending in fiscal 1969 will be about 5 percent (or $10 billion) greater than fiscal 1968;

Table 5

Projected Change in GNP with Alternative Rates of Change in Money Stock[1]

Quarter	Assumed Rates of Change in Money Stock[2] 2%	4%	6%	8%
1968/III[3]	17.9	17.9	17.9	17.9
IV	14.6	16.0	17.5	19.0
1969/I	12.0	15.0	18.0	20.7
II	11.0	15.2	19.4	23.7
III	6.8	12.3	18.0	23.4
IV	8.0	13.7	19.4	25.2

[1]First differences of quarterly data. All variables are in billions of dollars. Projections are based on coefficients of equation 1.3 in table 1.

[2]Assumed alternative rates of change in the money stock from III/68 to IV/69.

[3]Preliminary estimate by the Department of Commerce.

(b) federal spending was assumed to continue increasing at a 5 to 6 percent rate in the first two quarters of fiscal 1970; and (c) quarter-to-quarter changes in the money stock were projected from III/68 to IV/69 for four alternative constant annual growth rates for money: 2 percent, 4 percent, 6 percent, and 8 percent.

The highest growth rate of the money stock (8 percent) indicates continued rapid rates of expansion in GNP during the next five quarters. The slowest growth rate of money (2 percent) indicates some slowing of GNP growth in the fourth quarter of this year and further gradual slowing throughout most of next year.

The projections indicate that if the recent decelerated growth in the money stock (less than 4 percent from July to October) is continued, and growth of government spending is at about the rate indicated above, the economy would probably reach a noninflationary growth rate of GNP in about the third quarter of 1969 and would then accelerate slightly. These projections, of course, make no assumptions regarding the Vietnam War, strikes, agricultural situations, civil disorders or any of the many other noncontrollable exogenous forces.

Appendix[1]

The specific hypothesis underlying the analysis in this study is expressed by the following relation:

(1) $Y = f(E, R, M, Z)$,

where: Y = total spending;
E = a variable summarizing government expenditure actions;
R = a variable summarizing government taxing actions;
M = a variable summarizing monetary actions;
Z = a variable summarizing all other forces that influence total spending.[2]

Expressing this relation in terms of the changes of each variable yields:

(2) $\Delta Y = f(\Delta E, \Delta R, \Delta M, \Delta Z)$.

If this relation (2) were empirically estimated, the following would be obtained:[3]

(3) $\Delta Y = \alpha_1 \Delta E + \alpha_2 \Delta R + \alpha_3 \Delta M + \alpha_4 \Delta Z$,

where the values for α_1, α_2, α_3, and α_4 are estimated by regression of the observed values of ΔY on the observed values of ΔE, ΔR, ΔM, and ΔZ. In (3) the value of the coefficients (α's) are the total response of ΔY to changes in each of the four independent variables.

As discussed in the text, time series for E, R, and M have been selected on the basis of frequently used indicators or measures of fiscal and monetary actions. The purpose of this study was to test some frequently encountered rival conjectures regarding the influence of fiscal and monetary forces on economic activity, not to quantify all forces influencing our economy. Therefore, attention here has been directed toward estimating the magnitude and statistical

[1]The authors would like to give special thanks to Karl Brunner for useful discussion regarding the points made in this note.

[2]See exhibit 1 for a listing of "other forces" which influence total spending.

[3]For purposes of this note the lags of the independent variables are ignored.

reliability of the response of ΔY to ΔE, ΔR, and ΔM. However, ΔZ cannot be simply ignored.

The reader will note that there is no constant term in equation (3) since the effect of "all other forces" influencing spending are summarized by $\alpha_4 \Delta Z$. However, in the results reported in table 1 of this study, a constant term is reported for each equation. These constant terms are an estimate of α_4 times the average autonomous non-monetary and non-fiscal forces summarized in Z.

In a complex market economy, it is possible for monetary and fiscal actions to exert an indirect as well as a direct influence on ΔY. This indirect influence would operate through ΔZ. One form of the relation between ΔZ and monetary and fiscal forces is shown by:

(4) $\Delta Z = b_0 + b_1 \Delta E + b_2 \Delta R + b_3 \Delta M$.

The empirical values of α_1, α_2 and α_3, which were estimated by regression analysis and reported in this study, embody both the direct and the indirect responses of total spending to monetary and fiscal actions. Using ΔE as an example, the expression $(a_1 + b_1 a_4)$ is an estimate of α_1, the total response of ΔY to ΔE. The direct response is a_1, and the indirect response is $b_1 a_4$. Consequently, the equation estimated and reported in this study (for example, equation 1.2 in table 1) is:

(5) $\Delta Y = b_0 a_4 + (a_1 + b_1 a_4) \Delta E + (a_2 + b_2 a_4) \Delta R + (a_3 + b_3 a_4) \Delta M$;

where $b_0 a_4$ is the "constant" reported in table 1. If it were known that b_1, b_2 and b_3 are zero, it could be concluded that there are no indirect effects of monetary and fiscal forces operating through Z on Y, only direct effects which are measured by a_1, a_2 and a_3. Since this cannot be established conclusively, it cannot be ruled out that ΔZ may include some indirect monetary and fiscal forces influencing economic activity.

The constant term is estimated to be quite large and statistically significant. This provides indirect evidence that ΔZ is explained to some extent by factors other than ΔE, ΔR, and ΔM. The value of $b_0 a_4$ is a measure of the average effect of "other forces" on ΔY, which operate through ΔZ.

As another test of the independence of ΔZ from monetary and fiscal forces, the total time period was divided into two sub-samples and the equations were estimated for these sub-samples. The Chow test (see text) was applied to the sets of regression coefficients estimated from the sub-samples compared to the whole sample; the hypothesis that there were no structural shifts in the time period could not be rejected, implying no change in the size of $b_0 a_4$. If there were a significant indirect influence of ΔE, ΔR, and ΔM operating through ΔZ, $b_0 a_4$ would change along with changes in these independent variables. Since this intercept was found to be stable over the test period, this provides further evidence that ΔZ is influenced by factors other than monetary and fiscal forces.

The results from the sub-samples indicate that there were differences in the relative variability of the independent variables between the two sub-samples. This tends to strengthen the conclusions of this article since the response of ΔGNP to ΔM or ΔB was greater even in the first sub-sample (I/53 to I/60) in which the variability of ΔM and ΔB was smaller than the variability of ΔE and ΔR.

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A Monetarist Model for Economic Stabilization

Leonall C. Andersen and Keith M. Carlson

THE monetarist view that changes in the money stock are a primary determinant of changes in total spending, and should thereby be given major emphasis in economic stabilization programs, has been of growing interest in recent years. From the mid-1930s to the mid-1960s, monetary policy received little emphasis in economic stabilization policy. Presumed failure of monetary policy during the early years of the Great Depression, along with the development and general acceptance of Keynesian economics, resulted in a main emphasis on fiscal actions — federal government spending and taxing programs — in economic stabilization plans. Monetary policy, insofar as it received any attention, was generally expressed in terms of market rates of interest.

Growing recognition of the importance of money and other monetary aggregates in the determination of spending, output, and prices has been fostered by the apparent failure of stabilization policy to curb the inflation of the last half of the 1960s. Sharply rising market interest rates were interpreted to indicate significant monetary restraint, while the Revenue and Expenditure Control Act of 1968 was considered a major move toward fiscal restraint.

Despite these policy developments, total spending continued to rise rapidly until late 1969, and the rate of inflation accelerated. Those holding to the monetarist view were not surprised by this lack of success in curbing excessive growth in total spending, largely because the money stock grew at a historically rapid rate during the four years ending in late 1968. Economic developments from 1965 through 1969 were in general agreement with the expectations of the monetarist view.

This article develops a model designed to analyze economic stabilization issues within a framework which focuses on the influence of monetary expansion on total spending. Most of the major econometric models have not assigned an important role to the money stock or to any other monetary aggregate.[1] Furthermore, most econometric models contain a large number of behavioral hypotheses to be empiri-

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[1]Frank de Leeuw and Edward M. Gramlich, "The Federal Reserve-MIT Econometric Model," *Federal Reserve Bulletin* (January 1968), pp. 11–40, and "The Channels of Monetary Policy: A Further Report on the Federal Reserve MIT Econometric Model," *Federal Reserve Bulletin* (June 1969), pp. 472–91; James S. Duesenberry, Gary Fromm, Lawrence R. Klein, and Edwin Kuh (ed.), *The Brookings Quarterly Econometric Model of the United States* (Chicago: Rand McNally, 1965), and *The Brookings Model: Some Further Results* (Chicago: Rand McNally, 1969); Michael K. Evans and Lawrence R. Klein, *The Wharton Econometric Forecasting Model,* 2nd Enlarged Edition (Philadelphia: University of Pennsylvania, 1968); Maurice Liebenberg, Albert A. Hirsch, and Joel Popkin, "A Quarterly Econometric Model of the United States: A Progress Report," *Survey of Current Business* (May 1966), pp. 423–56; Daniel M. Suits, "The Economic Outlook for 1969," in *The Economic Outlook for 1969,* papers presented to the Sixteenth Annual Conference on the Economic Outlook at The University of Michigan (Ann Arbor: University of Michigan, 1969), pp. 1–26. For a discussion of the role of money in these models, see David I. Fand, "The Monetary Theory of Nine Recent Quarterly Econometric Models of the United States," forthcoming in the *Journal of Money, Credit, and Banking.*

cally estimated and integrated with each other, because they are designed to aid in understanding the determination of many economic magnitudes. By comparison, the model presented in this article is quite small. It is designed to provide information on the most likely course of movement of certain strategic economic variables in response to monetary and fiscal actions.

The model presented here is the authors' own version of how monetary and fiscal actions influence the economy. Other economists (including those of a monetarist persuasion) may prefer to develop certain aspects of the model in a different way. Two such modifications are presented in appendix C. The model is considered open to revision, but is presented at this time with a view to stimulating others to join in quantifying relationships that are generally associated with the monetarist view.

This article is divided into five major sections. A general monetarist view of the response of spending, output, and prices to monetary and fiscal actions is summarized first. Next, the specific features of the model are discussed within a formal framework of analysis. Statistical estimates of the model's parameters are presented in the third section. The fourth section tests the performance of the model with several dynamic simulation experiments. Finally, by simulating the response of the economy to alternative rates of monetary expansion, an illustration is provided of how the model can be used for current stabilization analysis.

GENERAL MONETARIST VIEW

The general monetarist view is that the rate of monetary expansion is the main determinant of total spending, commonly measured by gross national product (GNP).[2] Changes in total spending, in turn, influence movements in output, employment and the general price level. A basic premise of this analysis is that the economy is basically stable and not necessarily subject to recurring periods of severe recession and inflation. Major business cycle movements that have occurred in the past are attributed primarily to large swings in the rate of growth in the money stock.

This view regarding aggregate economic relationships differs from prevailing views which consider aggressive policy actions necessary to promote stability. Monetarists generally hold that fiscal actions, in the absence of accommodative monetary actions, exert little net influence on total spending and therefore have little influence on output and the price level. Government spending unaccompanied by accommodative monetary expansion, that is, financed by taxes or borrowing from the public, results in a crowding-out of private expenditures with little, if any, net increase in total spending. A change in the money stock, on the other hand, exerts a strong independent influence on total spending. Monetarists conclude that actions of monetary authorities which result in changes in the money stock should be the main tool of economic stabilization. Since the economy is considered to be basically stable, and since most major business cycle movements in the past have resulted from inappropriate movements in the money stock, control of the rate of monetary expansion is the means by which economic instability can be minimized.

The theoretical heritage of the monetarist position is the quantity theory of money.[3] This theory dates back to the classical economists (particularly David Ricardo) in the early 1800s. The quantity theory in its simplest form is characterized as a relationship between the stock of money and the price level. Classical economists concentrated on the long-run aspects of the quantity theory in which changes in the money stock result in changes only in nominal magnitudes, like the price level, but have no influence on real magnitudes like output and employment.

The quantity theory of money in its modern form recognizes the important influence that changes in the money stock can have on real magnitudes in the short run, while influencing only the price level in the long run. The modern quantity theory postulates that in the short run a change in the rate of growth in money is followed with a moderate lag by changes in total spending and output, while changes in the price level follow with a somewhat longer lag.[4] These

[2]General references on the monetarist view are Karl Brunner, "The Role of Money and Monetary Policy," this *Review* (July 1968), pp. 9–24; David I. Fand, "Some Issues in Monetary Economics," this *Review* (January 1970), pp. 10–27, and "A Monetarist Model of the Monetary Process," forthcoming in the *Journal of Finance.*

[3]The classic work on the quantity theory is Irving Fisher, *The Purchasing Power of Money* (New York: Macmillan, 1911). For an extensive review of the quantity theory literature, see Arthur W. Marget, *The Theory of Prices: A Re-examination of the Central Problems of Monetary Theory* (New York: Prentice-Hall, 1938), volume II, pp. 3–133.

[4]Many of the ideas prevalent in current monetarist doctrine can be found in the writings of Clark Warburton in the 1940s and early 1950s. Many of his important articles have been reprinted in his *Depression, Inflation, and Monetary Policy, Selected Papers, 1945–1953* (Baltimore: The Johns Hopkins Press, 1966). See also Milton Friedman (ed.), *Studies in the Quantity Theory of Money* (Chicago: University of Chicago Press, 1958), and Lloyd W. Mints, *Monetary Policy in a Competitive Society* (New York: McGraw-Hill, 1951).

Exhibit 1

Model in Algebraic Form

(1) Total Spending Equation
$$\Delta Y_t = f_1 (\Delta M_t \ldots \Delta M_{t-n}, \Delta E_t \ldots \Delta E_{t-n})$$

(2) Price Equation
$$\Delta P_t = f_2 (D_t \ldots D_{t-n}, \Delta P^A_t)$$

(3) Demand Pressure Identity
$$D_t = \Delta Y_t - (X^F_t - X_{t-1})$$

(4) Total Spending Identity
$$\Delta Y_t = \Delta P_t + \Delta X_t$$

(5) Interest Rate Equation
$$R_t = f_3 (\Delta M_t, \Delta X_t \ldots \Delta X_{t-n}, \Delta P_t, \Delta P^A_t)$$

(6) Anticipated Price Equation
$$\Delta P^A_t = f_4 (\Delta P_{t-1} \ldots \Delta P_{t-n})$$

(7) Unemployment Rate Equation
$$U_t = f_5 (G_t, G_{t-1})$$

(8) GNP Gap Identity
$$G_t = \frac{X^F_t - X_t}{X^F_t}$$

Endogenous Variables

ΔY_t = change in total spending (nominal GNP)
ΔP_t = change in price level (GNP price deflator)
D_t = demand pressure
ΔX_t = change in output (real GNP)
R_t = market interest rate
ΔP^A_t = anticipated change in price level
U_t = unemployment rate
G_t = GNP gap

Exogenous Variables[1]

ΔM_t = change in money stock
ΔE_t = change in high-employment Federal expenditures
X^F_t = potential (full-employment) output

[1]Other than lagged variables.

changes in total spending, output and prices are in the same direction as the change in the rate of monetary expansion.

The modern quantity theory still accepts the long-run postulates of its older version. A change in the rate of monetary expansion influences only nominal magnitudes in the long run, namely, total spending (GNP) and the price level. Real magnitudes, notably output and employment, are unaffected.[5] Following the short-run responses to a change in the rate of monetary growth, total spending and the price level grow at rates determined by the rate of increase in money, while output moves toward and resumes a long-run growth path. Such growth in output is little influenced by the rate of monetary expansion. Instead, it is determined by growth in the economy's productive potential, which depends on growth of natural resources, capital stock, labor force and productivity.

GENERAL FORM OF THE MODEL

A summary of the model is presented in algebraic form in exhibit 1, along with a listing of variables classified as to whether they are endogenous or exogenous to the model (for a graphical illustration of the model, see appendix B). This general form of the model summarizes its essential features, ignoring problems of dimensionality and lag length.

[5]See Milton Friedman, "The Role of Monetary Policy," *American Economic Review* (March 1968), pp. 1–17.

Equations of the Model

Equation (1) is the total spending equation. The change in total spending (ΔY) is specified as a function of current and past changes in the money stock (ΔM) and current and past changes in high-employment federal expenditures (ΔE). This general specification represents the reduced form for that class of structures which has ΔM and ΔE as exogenous variables. In this form the total spending equation remains uncommitted as to structure; it is potentially consistent with both Keynesian and quantity theory models.[6] (The magnitude and significance of the estimated parameters determine whether the data conform more closely to a Keynesian or a quantity theory.)

Equation (2) specifies the change in the price level (ΔP) as a function of current and past demand pressures (D) and anticipated price changes (ΔP^A). Demand pressure is defined in equation (3) as the change in total spending minus the potential increase in output ($X^F - X$). The price equation is an alternative to the standard short-run Phillips curve relation generalized to include changes in total spending and anticipated prices.[7] (See appendix A for further development of this relationship.)

Equation (4) defines a change in total spending in terms of its components, the part associated with changes in the price level (ΔP) and the part associated with changes in output (ΔX).[8] With ΔY determined by equation (1), and ΔP by equation (2), ΔX can be derived from equation (4).

Equation (5) specifies the market rate of interest (R) as a function of current changes in the money stock (ΔM), current and past changes in output (ΔX), current price change (ΔP), and anticipated price change (ΔP^A). The price anticipations term is included to capture the Fisher effect.[9] The anticipated price function is defined in equation (6). Anticipated price change (ΔP^A) in the current period is assumed to depend on past price changes (ΔP).

Equation (7) is the unemployment rate equation and is a transformation of the GNP gap (G), as defined in equation (8), into a measure of unemployment relative to the labor force. This transformation is based on "Okun's Law."[10]

Workings of the Model

The workings of the model are summarized by a flow diagram (exhibit 2). Only variables in the current period are shown in the diagram; lagged variables, with the exception of past changes in prices, are omitted. The relationship that determines total spending is the fundamental one among those that determine the endogenous variables of the model. Total spending is determined by monetary actions and fiscal actions (federal spending financed by taxes or borrowing from the public), though no direct information is provided as to *how* such actions affect spending.

The change in total spending is combined with potential (full employment) output to provide a measure of demand pressure. Anticipated price change, which depends on past price changes, is combined with demand pressure to determine the change in the price level.

The total spending identity enables the change in output to be determined, given the change in total spending and the change in prices. This method of determining the change in total spending and its division between output change and price change differs from most econometric models. A standard practice in econometric model building is to determine output and prices separately, then combine them to determine total spending.

The change in output, the change in prices and in anticipated prices, along with the change in the money stock, determine market interest rates. The flow diagram shows that the market interest rate does

[6]For further discussion of the structural versus the reduced form of a model, see Michael Keran, "Monetary and Fiscal Influences on Economic Activity — The Historical Evidence," this *Review* (November 1969), pp. 5–24; Edward M. Gramlich, "The Usefulness of Monetary and Fiscal Policy as Discretionary Stabilization Tools," forthcoming in the *Journal of Money, Credit, and Banking;* and Richard G. Davis, "How Much Does Money Matter? A Look at Some Recent Evidence," Federal Reserve Bank of New York *Monthly Review* (June 1969), pp. 119–31.

[7]See Roger W. Spencer, "The Relation Between Prices and Employment: Two Views," this *Review* (March 1969), pp. 15–21.

[8]The change in the price level, ΔP, and the change in output, ΔX, are defined in dollar units so that their sum is equal to the change in total spending, ΔY.

[9]For a detailed study of interest rates and the Fisher effect, see William P. Yohe and Denis S. Karnosky, "Interest Rates and Price Level Changes, 1952–69," this *Review* (December 1969), pp. 18–38.

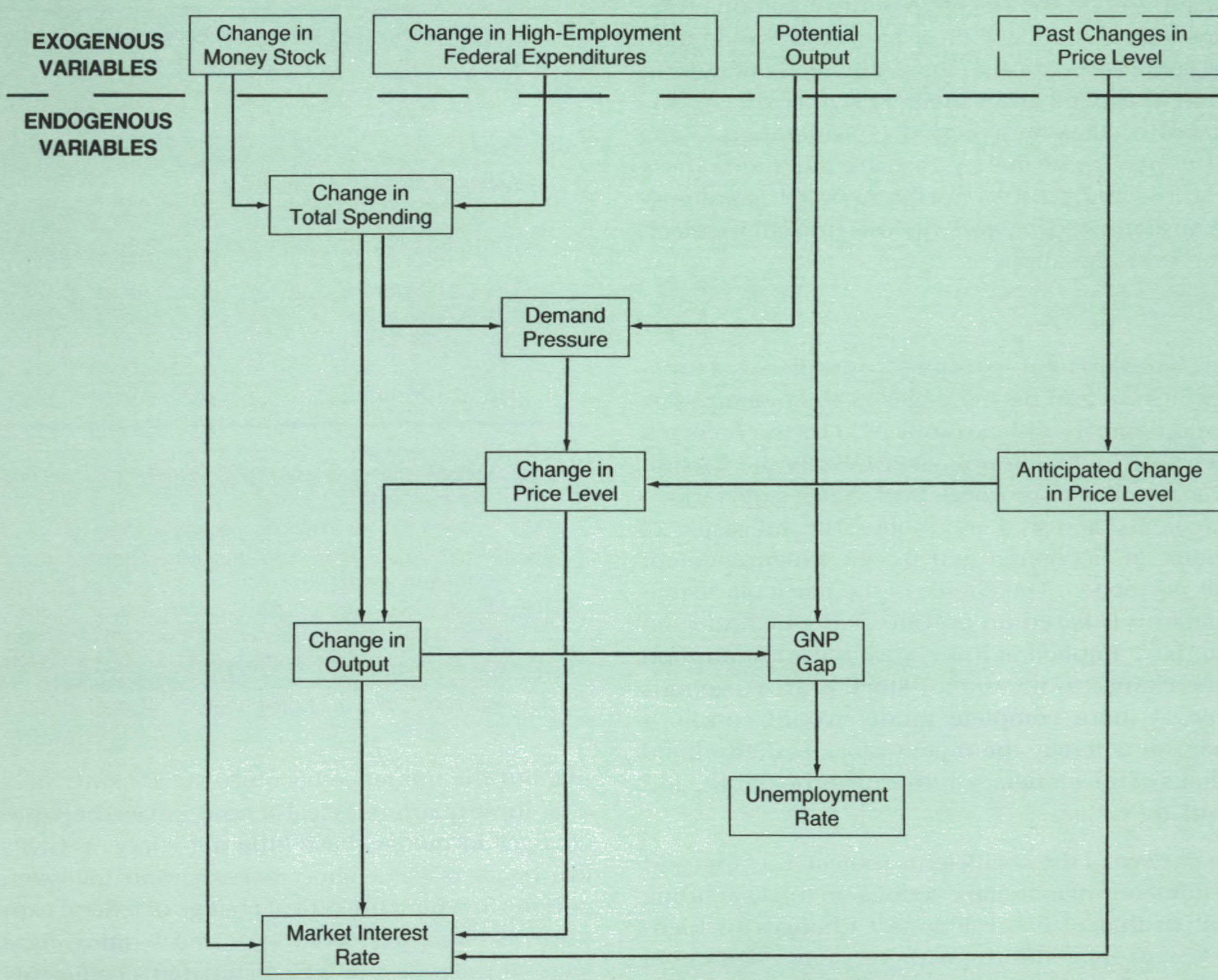
[10]Arthur M. Okun, "Potential GNP: Its Measurement and Significance," *1962 Proceedings of the Business and Economic Statistics Section of the American Statistical Association*, pp. 98–104. Okun's Law relates the GNP gap to the unemployment rate as follows:

$$X^F_t - X_t = .03(U_t - 4)X_t.$$

The number .03 is a productivity factor and 4 is defined as the unemployment rate consistent with full resource utilization.

Exhibit 2

Flow Diagram of Model



not exercise a direct role in the model in the determination of spending, output, and prices.

To determine the unemployment rate, the change in output is first combined with potential output to determine the GNP gap relative to potential output. The GNP gap is then transformed into the unemployment rate.

Summary

The model has been presented in general form to show the basic linkages postulated among money, federal expenditures, prices and output. The purpose of the following statistical section is to estimate the response of output and prices to monetary and fiscal actions, not to test a hypothesized structure. The focus is on the response in the short run — periods of two or three years — but the long-run properties of the model also are examined.

ESTIMATION OF THE MODEL

The general form of the model indicates those variables that are included in each equation. Estimation requires selection of the algebraic form of the equations and the techniques to be used in estimation.

Each of the equations of the model is estimated by ordinary least squares. Lag structures, with one exception, are estimated by the Almon lag technique. The reported relationships reflect considerable experimentation with the number of lags and the degree of the polynomial.[11] The sample period starts with 1953 for the spending equation and with 1955 for all the others. The data are quarterly and, with the exception of interest rates, are seasonally adjusted.

Criteria used in the selection of the equations were minimizing the standard error of estimate and eliminating serial correlation in the estimated residuals. In addition, the signs and statistical significance of the estimated coefficients received consideration, along with the pattern of the lag distribution. Since these criteria frequently could not be satisfied simultaneously, an element of subjectivity was present in selecting the "best" equation.

Total Spending

The change in total spending is specified as a function of current and past changes in the money stock (demand deposits and currency held by the nonbank public) and in high-employment Federal expenditures (expenditures on goods and services plus transfer payments adjusted to remove the influence of variations in economic activity on unemployment benefit payments). The choice of the particular equation (table 1) is based on previous work by Andersen and Jordan.[12] Implicit in this choice is the assumption that the change in the money stock is an exogenous variable. A more complete model would specify a mechanism whereby the money stock is determined by actions of the monetary authorities, the public, and the banking system.

The pattern of the coefficients indicates a large and rapid influence of monetary actions on total spending relative to that of fiscal actions.[13] Changes in high-employment expenditures, with the money stock held constant, first have a positive influence on total spending, but the influence becomes significantly negative after three quarters. Fiscal actions, unaccompanied by changes in money, have little net effect on GNP over five quarters.[14] For short periods, and for extended periods in which the rate of change of federal expenditures is either accelerating or decelerating, fiscal effects are significant. The estimated coefficients for changes in money and changes in federal expenditures are in general agreement with the monetarist view of the response of total spending to these two variables.

The specification of the total spending equation, as shown in table 1, has been criticized as being incomplete in that it allegedly ignores the effects of interest rates on velocity.[15] However, since the spending equa-

Table 1
Total Spending Equation
Sample Period: I/1953–IV/1969

Constraints: 4th Degree Polynomial

$(m_{-1} = e_{-1} = 0;\ m_5 = e_5 = 0)$

$$\Delta Y_t = \underset{(3.46)}{2.67} + \sum_{i=0}^{4} m_i \Delta M_{t-i} + \sum_{i=0}^{4} e_i \Delta E_{t-i}$$

$R^2 = .66$
SE = 3.84
DW = 1.75

$m_0 =$	1.22 (2.73)	$e_0 =$	.56 (2.57)
$m_1 =$	1.80 (7.34)	$e_1 =$	.45 (3.43)
$m_2 =$	1.62 (4.25)	$e_2 =$	.01 (.08)
$m_3 =$	.87 (3.65)	$e_3 =$	−.43 (−3.18)
$m_4 =$	.06 (.12)	$e_4 =$	−.54 (−2.47)
$\Sigma m_i =$	5.57 (8.06)	$\Sigma e_i =$	.05 (.17)

Symbols are defined as:
ΔY_t = dollar change in total spending (GNP in current prices) in quarter t
ΔM_{t-i} = dollar change in money stock in quarter t − i
ΔE_{t-i} = dollar change in high-employment federal expenditures in quarter t − i

NOTE: "t" statistics appear with each regression coefficient, enclosed by parentheses. R^2 is the percent of variation in the dependent variable which is explained by variations in the independent variables. SE is the standard error of the estimate. DW is the Durbin-Watson statistic.

[11]For discussion of the use and interpretation of the Almon lag technique, see Keran, p. 10.

[12]Leonall C. Andersen and Jerry L. Jordan, "Monetary and Fiscal Actions: A Test of Their Relative Importance in Economic Stabilization," this *Review* (November 1968), pp. 11–24. See also Keran, pp. 5–24.

[13]Andersen and Jordan tried several measures of fiscal actions in their basic equation. The best results were obtained by using only high-employment expenditures, rather than the high-employment surplus or both high-employment expenditures and receipts. They justify their choice by appealing to the notion that financing expenditures by borrowing from the public and taxes have essentially the same impact on total GNP. For some results that contradict those of Andersen and Jordan, see E. G. Corrigan, "The Measurement and Relative Importance of Fiscal Policy," forthcoming in Federal Reserve Bank of New York *Monthly Review*. It should be repeated that, *a priori*, specification of the total spending equation was sufficiently general as to be consistent with a number of theories of GNP determination.

[14]Andersen and Jordan, p. 18, indicate that these results are consistent with a "crowding-out" theory of effects of government spending.

[15]See Paul S. Anderson, "Monetary Velocity in Empirical Analysis," in *Controlling Monetary Aggregates*, Proceedings of the Monetary Conference held on Nantucket Island (June 1969), pp. 37–51, and the discussion of that paper by Leonall C. Andersen, pp. 52–55. See also Henry A. Latané, "A Note on Monetary Policy, Interest Rates and Income Velocity," *Southern Economic Journal* (January 1970), pp. 328–30.

tion is a reduced form, such effects are embodied in the coefficients of money.[16]

Total Spending Equation

The total spending equation is the cornerstone of the model, providing its monetarist character. The focus of this paper, however, is on determining the division of the change in total spending between price and output changes. Price changes are estimated as a function of (1) current and past demand pressure, and (2) anticipated price change.

Demand pressure — As a measure of demand pressure on prices, the change in total spending is related to the potential change in output (GNP in constant prices).[17] These two variables, when combined, provide a measure of the economy's demand for goods and services relative to its capacity to supply goods and services. The change in prices is specified as a positively related linear function of this measure of demand pressure (see appendix A).

Demand pressure, D_t, is defined as:

$$D_t = \Delta Y_t - (X^F_t - X_{t-1}),$$

where ΔY_t is the change in total spending in quarter t; X^F_t is potential (full employment) GNP in 1958 prices in quarter t; and X_{t-1} is real GNP in the previous quarter.[18] Given the GNP gap, defined as $X^F_t - X_{t-1}$, the larger is the change in total spending (ΔY_t), the greater is the spillover into higher prices. Given ΔY_t, the larger is $X^F_t - X_{t-1}$, the greater is the expansion of output and the less the spillover into higher prices.

In addition to current values, past values of the demand pressure variable are included in the price equation. The purpose of including past values is to allow for lags in the determination of prices in response to changing demand. Furthermore, the impact of changing demand through changing input prices and costs of production is given a chance to operate by including lagged values for the demand pressure variable.

Anticipated price change — The other independent variable included in the price equation is a measure of anticipated price change (ΔP^A_t). The purpose of including this variable as a factor influencing current changes in the price level is to allow anticipations of future price movements to influence the decisions of market participants. Since such a variable is not observable, it has to be constructed. This is accomplished by assuming that anticipations about future price changes are formed on the basis of past price experience.

The measure of price anticipations used in this study is a by-product of estimating long-term market interest rates.[19] Yohe and Karnosky showed that long-term market interest rates respond to price anticipations of borrowers and lenders, since commitments to borrow and lend funds require an assessment of anticipated changes in the price level for the period of the loan. The problem consists of isolating this price effect on market interest rates from factors influencing the real rate.

In the process of constructing a measure of anticipated price change, past changes in prices are adjusted by a summary measure of current economic conditions. Since price changes tend to lag changes in total spending, the degree of resource utilization as measured by the unemployment rate is used as a leading indicator of future price movements.[20] For example, if unemployment is rising relative to the labor force, decision-making economic units would tend to discount current inflation in forming anticipations about future price movements. Reflecting this consideration, the price change in each quarter is divided by an index of the unemployment rate applicable to that quarter. Thus the measure of price anticipations would be less for a given inflation rate accompanied by high or rising unemployment than when unemployment is low or falling.

The specific definition of price anticipations is shown in table 2. The weights and the length of the lag

[16]See A. A. Walters, "Monetary Multipliers in the U. K.: 1880–1962," *Oxford Economic Papers* (November 1966).

[17]This measure was apparently first used by Ray Fair of Princeton University. See his "The Determination of Aggregate Price Changes," forthcoming in the *Journal of Political Economy*. For a similar specification of a price equation, see Milton Friedman, "A Theoretical Framework for Monetary Analysis," also forthcoming in the *Journal of Political Economy*. See also a paper by William Considine of Stanford University, "Public Policy and the Current Inflation," prepared as a part of a summer intern program at the U.S. Treasury Department (September 5, 1969).

[18]The series on potential output is based on that used by the Council of Economic Advisers. Currently, potential output is estimated to be rising at a 4.3 percent annual rate. For alternative estimates of potential output, see Fair, "The Determination of Aggregate Price Changes."

[19]For other ways of handling expectations, see appendix C on alternative price equations.

[20]For purposes of exposition the unemployment rate was not included in the definition of anticipated price change in exhibits 1 and 2.

Table 2

Anticipated Price Definition

(p_i from Long-Term Interest Rate Equation)

$$\Delta P^A_t = Y_{t-2}\{[(\sum_{i=1}^{17} p_i \frac{\dot{P}_{t-i}}{U_{t-i}/4}).01 + 1]^{1/4} - 1\}$$

$p_1 = .02$	$p_7 = .08$	$p_{13} = .06$
$p_2 = .03$	$p_8 = .08$	$p_{14} = .06$
$p_3 = .04$	$p_9 = .08$	$p_{15} = .04$
$p_4 = .06$	$p_{10} = .08$	$p_{16} = .03$
$p_5 = .06$	$p_{11} = .08$	$p_{17} = .02$
$p_6 = .07$	$p_{12} = .07$	$\Sigma p_i = .96$

Symbols are defined as:

ΔP^A_t = anticipated price change (scaled in dollar units) in quarter t

$\dot{P}_{t-i}$ = annual rate of change in GNP deflator (1958 = 100) in quarter t − i

$U_{t-i}/4$ = index of unemployment as a percent of labor force (base = 4.0) in quarter t − i

Y_{t-2} = total spending (GNP in current prices) in quarter t − 2

Table 3

Price Equation
Sample Period: I/1955–IV/1969

Constraints: 2nd Degree Polynomial

$(d_{-1} \neq 0; d_6 = 0)$

$$\Delta P_t = \underset{(7.07)}{2.70} + \sum_{i=0}^{5} d_i D_{t-i} + \underset{(8.55)}{.86}\Delta P^A_t$$

$R^2 = .87$
SE = 1.07
DW = 1.41

$d_0 = .02$ (2.63)	$d_4 = .01$ (1.86)
$d_1 = .02$ (6.33)	$d_5 =$ * (1.38)
$d_2 = .02$ (6.63)	$\Sigma d_i = .09$ (9.18)
$d_3 = .01$ (2.93)	

Symbols are defined as:

ΔP_t = dollar change in total spending (GNP in current prices) due to price change in quarter t

$D_t = \Delta Y_t - (XF_t - X_{t-1})$

ΔY_t = dollar change in total spending (GNP in current prices) in quarter t

XF_t = potential output in quarter t

X_{t-1} = output (GNP in 1958 prices) in quarter t − 1

ΔP^A_t = anticipated price change (scaled in dollar units) in quarter t

NOTE: "t" statistics appear with each regression coefficient, enclosed by parentheses. R^2 is the percent of variation in the dependent variable which is explained by variations in the independent variables. SE is the standard error of the estimate. DW is the Durbin-Watson statistic.

*Less than .01

period were obtained from the estimated long-term interest rate equation.[21]

Estimated price equation — The estimated price equation is shown in table 3, where ΔP_t is defined as the dollar change in total spending due to price changes in quarter t. The influence on prices of the demand pressure variable, D_{t-i}, is significant and positive for five quarters but very small thereafter.[22] The pattern of influence is one of steady decay, with 70 percent of the total effect of demand pressure taking place in the first three quarters and 95 percent in the first five quarters.

Anticipated price change, represented by ΔP^A_t, is a significant determinant of current price change. Though significant, the measure of the impact of this variable should not be taken too literally, because its construction indicates that it cannot really be viewed independently of the demand pressure variable.[23] The influence of these two variables should perhaps be viewed in combination, rather than as independent and separate influences.[24]

Determination of output — Given ΔY_t as determined by the total spending equation, and ΔP_t from the price equation, the dollar change in total spending due to output changes, defined as ΔX_t, can be derived

[21]The price expectations variable as shown in table 2 is scaled in dollar units. This transformation is made because prices are estimated as the dollar change in total spending due to price changes.

[22]When the price equation is estimated with the components of D_{t-i} separated, the coefficients for the ΔY_t portion are not statistically significant at the five percent level, implying that the gap portion $(X^F_t - X_{t-1})$, explains most of the changes in ΔP_t. However, there may be collinearity problems which influence the estimated coefficients. Furthermore, the D_{t-i} form is used because, theoretically, it is a measure of excess demand (see appendix A).

[23]From the standpoint of the model as a unit, price anticipations are important only in determining the division of total spending between prices and output, not the level (or change) of spending itself. To allow for the possible direct influence of price expectations on total spending, the spending equation was estimated with the price anticipations variable. The coefficient of the price anticipations variable was not significant for this specification.

[24]There is, however, some evidence that the price anticipations variable may be interpreted as an independent and separate influence. When the price equation is estimated without ΔP^A_t, the sum of the coefficients on D_{t-i} is only slightly more than shown in table 3 and the standard error is increased considerably.

from the following identity:

$$\Delta Y_t = \Delta P_t + \Delta X_t + (P_t - P_{t-1})(X_t - X_{t-1}).$$

The cross-product term is assumed equal to zero.[25] Thus,

$$\Delta X_t = \Delta Y_t - \Delta P_t.$$

The unemployment rate plays a role in the model, representing the means by which past prices are adjusted to take into account varying economic conditions in the formation of anticipated price changes. To estimate the unemployment rate, the unemployment rate is regressed on current and lagged values of the GNP gap, expressed as a percent of potential GNP. This equation is estimated by unconstrained ordinary least squares and is shown in table 4.

Table 4

Unemployment Rate Equation
Sample Period: I/1955–IV/1969

$$U_t = 3.90 + .04G_t + .28G_{t-1}$$
(72.50) (1.10) (6.80)

$R^2 = .92$
$SE = .30$
$DW = .60$

Symbols are defined as:

U_t = unemployment as a percent of labor force in quarter t

$G_t = \frac{XF_t - X_t}{XF_t} \cdot 100$

XF_t = potential output in quarter t

X_t = output (GNP in 1958 prices) in quarter t

NOTE: "t" statistics appear with each regression coefficient, enclosed by parentheses. R^2 is the percent of variation in the dependent variable which is explained by variations in the independent variables. SE is the standard error of the estimate. DW is the Durbin-Watson statistic.

Interest Rates

Interest rates do not function explicitly in the model as a part of a transmission mechanism running from changes in the money stock to output and prices. The estimated long-term interest rate equation plays a vital role in the model, however, providing the information to calculate the measure of price anticipations.

Market interest rates are specified to depend on current and past *rates of change* of output ($\dot{X}$), the current rate of change in the money stock ($\dot{M}$), and current and past rates of change in prices ($\dot{P}$) adjusted by an index of the unemployment rate. This specification draws on Sargent's work, which was explored further by Yohe and Karnosky.[26]

Long-term interest rate — The long-term market rate (R^L_t) is measured by the rate on seasoned corporate Aaa bonds. Changes in output and prices (adjusted for unemployment) lagged for 17 quarters provide the most satisfactory results. The estimated equation for the long-term rate is shown in table 5.

The results reflect, in a general way, the view stressed by monetarists that a change in the rate of monetary expansion influences market interest rates in three stages.[27] First, the liquidity effect of an increase in the rate of change of the money stock on market interest rates is negative. Second, an increase in the rate of monetary expansion influences the rate of change in output, which in turn has a positive influence on market interest rates. Finally, an increase in money growth influences the rate of change in prices, which has a positive effect on market interest rates.

Short-term interest rate — The short-term interest rate (R^S_t) which is estimated is the four- to six-month commercial paper rate. The equation is shown in table 6. Price changes are found to enter significantly for a shorter lag period than in the long-term rate equation. Also, the short-term rate, as measured by the four- to six-month commercial paper rate, is much more sensitive to changes in output and the money stock than is the long-term rate as measured by the rate on seasoned corporate Aaa bonds.

Time Response to Monetary Actions: A Summary

The pattern of the coefficients in the equations provides information about the time response of total spending, output, and prices to monetary and fiscal actions. The equations indicate that monetary actions

[25]The value of this cross-product term was calculated from 1953 to the present and provides ample justification for the assumption that it be equated to zero for purposes of the model here. Also note that ΔP_t is defined in dollar units, that is, as $(P_t - P_{t-1})X_{t-1}$, *not* $(P_t - P_{t-1})$. ΔX_t is defined analogously.

[26]Thomas Sargent, "Commodity Price Expectations and the Interest Rate," *Quarterly Journal of Economics* (February 1969), pp. 127–40, and Yohe and Karnosky, pp. 31–34, 38. The estimated interest rate equations also contain a dummy variable (0 for 1955–60 and 1 for 1961–69). The significance of this dummy variable indicates a shift of structure within the sample period. Questions can be raised about this procedure, but it is felt that a price expectations variable should not be constructed on the basis of a sample period containing only an expansion like 1961–69. Including the dummy variable leaves unexplained that factor (or factors) which changed the relationship, but it does provide a way of estimating a set of coefficients on prices that is based on a sample period reflecting varying economic circumstances.

[27]See Friedman, "The Role of Monetary Policy," p. 6.

generally affect total spending with a two- to three-quarter lag. A change in the rate of growth of total spending is accompanied by a simultaneous change in the rate of growth of output, and it is not until three quarters later that the response of prices to a change in demand pressure builds to 70 percent of the total. The response of prices to a change in total spending is yet slower when there are anticipations of a high rate of inflation.

The spending equation (table 1) indicates that about half of the total response to a change in monetary growth occurs in the first two quarters, and about 80 percent in the first three quarters.

The pattern of coefficients in the price equation (table 3) indicates that the effect of a change in total spending is reflected first in output and later in prices. Operating through the demand pressure variable, about a fourth of the response of prices to a change in total spending is in the first quarter, which is about two quarters after the change in monetary actions. Over 70 percent of the price response is in the first three quarters, and 95 percent in the first five quarters. The response of the price level to changes in total spending is also influenced by anticipated prices. The greater the anticipated rise in prices, the longer delayed is the response of the price level to a decline in the rate of change in total spending.

Table 5

Long-Term Interest Rate Equation Sample Period: I/1955–IV/1969

Constraints: 2nd Degree Polynomial

$(x_{-1} \neq 0, p_{-1} \neq 0; x_{17} = p_{17} = 0)$

$$R^L_t = \underset{(5.20)}{1.28} - \underset{(-3.53)}{.06}\dot{M}_t + \underset{(11.01)}{1.42}Z_t + \sum_{i=0}^{16} x_i \dot{X}_{t-i} + \sum_{i=0}^{16} p_i \left(\frac{\dot{P}_{t-i}}{U_{t-i}/4}\right)$$

$R^2 = .92$
SE = .28
DW = .69

x_0 = .02 (3.85)	x_6 = .01 (2.61)	x_{12} = .01 (1.38)
x_1 = .02 (4.35)	x_7 = .01 (2.27)	x_{13} = .01 (1.28)
x_2 = .02 (4.44)	x_8 = .01 (2.01)	x_{14} = * (1.20)
x_3 = .02 (4.08)	x_9 = .01 (1.80)	x_{15} = * (1.13)
x_4 = .02 (3.54)	x_{10} = .01 (1.64)	x_{16} = * (1.07)
x_5 = .02 (3.03)	x_{11} = .01 (1.50)	Σx_i = .20 (2.88)

p_0 = .02 (1.23)	p_6 = .08 (17.13)	p_{12} = .06 (9.29)
p_1 = .03 (3.05)	p_7 = .08 (14.49)	p_{13} = .06 (8.89)
p_2 = .04 (5.96)	p_8 = .08 (12.64)	p_{14} = .04 (8.57)
p_3 = .06 (10.82)	p_9 = .08 (11.37)	p_{15} = .03 (8.30)
p_4 = .06 (17.34)	p_{10} = .08 (10.47)	p_{16} = .02 (8.07)
p_5 = .07 (19.66)	p_{11} = .07 (9.81)	Σp_i = .96 (19.04)

Symbols are defined as:

R^L_t = Moody's seasoned corporate Aaa bond rate in quarter t

$\dot{M}_t$ = annual rate of change in money stock in quarter t

Z_t = dummy variable in quarter t (0 for I/1955–IV/1960 and 1 for I/1961–IV/1969)

$\dot{X}_{t-i}$ = annual rate of change in output (GNP in 1958 prices) in quarter t − i

$\dot{P}_{t-i}$ = annual rate of change in GNP deflator (1958 = 100) in quarter t − i

$U_{t-i}/4$ = index of unemployment as a percent of labor force (base = 4.0) in quarter t − i

NOTE: "t" statistics appear with each regression coefficient, enclosed by parentheses. R^2 is the percent of variation in the dependent variable which is explained by variations in the independent variables. SE is the standard error of the estimate. DW is the Durbin-Watson statistic.

*Less than .01

TESTS OF THE MODEL'S PERFORMANCE

The equations of the model are to be viewed as a unit, and the specification of the model is such that given the change in money (ΔM), and the change in high-employment expenditures (ΔE), the model can be solved in the following sequence: for the change in total spending (ΔY), the change in the price level (ΔP), the change in real output (ΔX), the unemployment rate (U) and the long- and short-term interest rates (R^L and R^S).

The explanatory power of each of the equations shown in tables 1–6 may be acceptable by conventional standards, but this provides no guarantee that the model will perform satisfactorily as a unit. There are interdependencies in the model that have to be taken into account when evaluating the complete model. Of interest in evaluating the model as a unit is the implied pattern for the endogenous variables when only an initial set of lagged endogenous variables and the time paths of the exogenous policy variables (money stock and high-employment federal expenditures) are assumed known. To conduct such a test, several dynamic simulation experiments were performed. These simulations take the form of *ex post* dynamic simulations and an *ex ante* dynamic simulation.[28]

[28]For a discussion of the different ways of assessing the tracking ability of econometric models, see Carl F. Christ, "Econometric Models of the Financial Sector," forthcoming in the *Journal of Money, Credit, and Banking*. For a discussion of simulation procedures and results with an income-expenditure model, see Evans and Klein, pp. 50–69.

Table 6

Short-Term Interest Rate Equation
Sample Period: I/1955–IV/1969

Constraints: 2nd Degree Polynomial

$(x_{-1} \neq 0, p_{-1} \neq 0; x_{11} = p_{11} = 0)$

$$R^{S}_{t} = \underset{(-3.14)}{-1.13} - \underset{(-6.36)}{.17\dot{M}_{t}} + \underset{(5.03)}{.92Z_{t}} + \sum_{i=0}^{10} x_i \dot{X}_{t-i} + \sum_{i=0}^{10} p_i \left(\frac{\dot{P}_{t-i}}{U_{t-i}/4}\right)$$

$R^2 = .90$
SE = .47
DW = .69

x_0	= .08 (8.10)	p_0	= −.04 (−.91)
x_1	= .08 (8.99)	p_1	= .04 (1.53)
x_2	= .08 (8.97)	p_2	= .09 (8.26)
x_3	= .08 (8.45)	p_3	= .14 (18.52)
x_4	= .08 (7.83)	p_4	= .17 (13.17)
x_5	= .07 (7.25)	p_5	= .18 (10.29)
x_6	= .07 (6.76)	p_6	= .19 (8.92)
x_7	= .06 (6.36)	p_7	= .18 (8.14)
x_8	= .05 (6.02)	p_8	= .15 (7.64)
x_9	= .03 (5.75)	p_9	= .11 (7.30)
x_{10}	= .02 (5.52)	p_{10}	= .06 (7.04)
Σx_i	= .71 (8.24)	Σp_i	= 1.27 (16.89)

Symbols are defined as:

R^{S}_{t} = four- to six-month commercial paper rate in quarter t

$\dot{M}_t$ = annual rate of change in money stock in quarter t

Z_t = dummy variable in quarter t (0 for I/1955–IV/1960 and 1 for I/1961–IV/1969)

$\dot{X}_{t-i}$ = annual rate of change in output (GNP in 1958 prices) in quarter t − i

$\dot{P}_{t-i}$ = annual rate of change in GNP deflator (1958 = 100) in quarter t − i

$U_{t-i}/4$ = index of unemployment as a percent of labor force (base = 4.0) in quarter t − i

NOTE: "t" statistics appear with each regression coefficient, enclosed by parentheses. R^2 is the percent of variation in the dependent variable which is explained by variations in the independent variables. SE is the standard error of the estimate. DW is the Durbin-Watson statistic.

Ex Post Dynamic Simulations

An *ex post* dynamic simulation is confined to the sample period from which the estimated relationships are derived. Actual values for all current and lagged exogenous variables are used, but only initial actual values for the lagged endogenous variables are used. The model generates solution values for the endogenous variables in the first simulation period, which are then used to generate solution values for the second period, and so on for each succeeding period.[29] A comparison of these calculated time paths for the endogenous variables with their actual time paths enables one to formulate some judgment as to how well the model performs as an interdependent unit in tracking the movements of certain strategic economic variables.

Ex post dynamic simulations were conducted for several subperiods within the sample period (1955–69). The results for the entire sample period are summarized in chart 1 on the next page. When simulations are conducted for subperiods within the 1955–69 period, the pattern of movement as shown for the whole period simulation tends to hold, but the levels are closer to the actual values at the beginning of each subperiod.

Chart 1 indicates that the model tends to track the movement of the endogenous variables quite well during the 1955–69 period. Since criteria for judging the performance of the model in such a simulation have not been developed, any conclusions are necessarily subjective.[30] The tendency for the model to avoid diverging sharply from the actual path for extended periods is an especially important feature. Such a feature provides some basis for trusting the tracking ability of the model over several quarters, even if on a quarter-by-quarter basis it may appear to be off the mark.

To gain additional information about the predictive performance of the model, a comparison is made with an *ex post* simulation from another model. Results of an *ex post* simulation for 1963 and 1964 have been published for the Wharton model. The results for the model are compared with those of the Wharton model in table 7.

The period 1963–64 includes the 1964 tax cut, which, according to the Wharton model, is considered an important factor influencing economic developments in 1964. However, the St. Louis model, which does not emphasize such fiscal actions, did about as well, on average, for the years 1963 and 1964 (see table 7). The main difference to be remembered in evaluating these simulations is that the St. Louis model contains three primary exogenous variables, while the Wharton model contains 43.

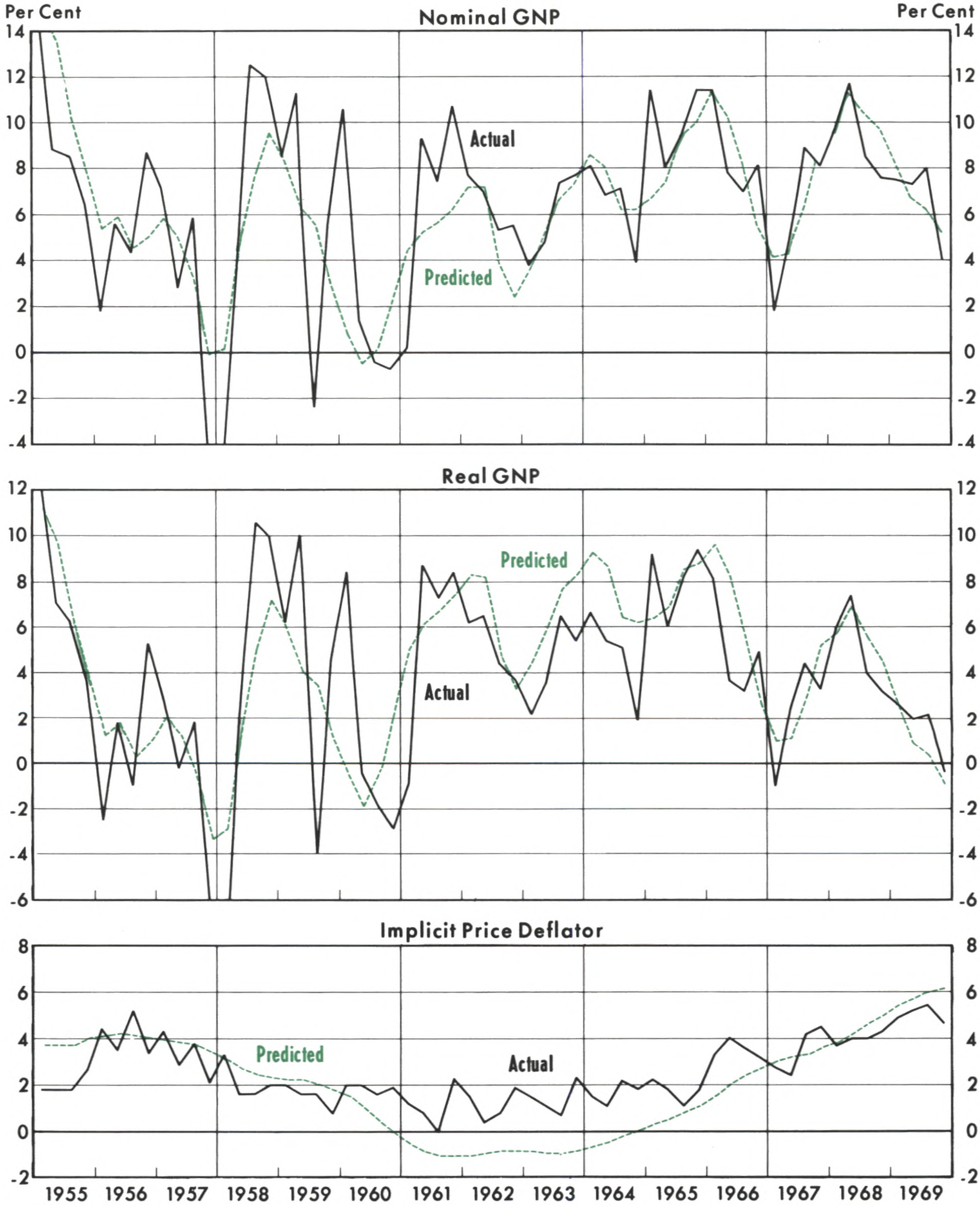
[29]See de Leeuw and Gramlich, "The Channels of Monetary Policy . . . ," p. 485.

[30]See Robert H. Rasche and Harold T. Shapiro, "The F.R.B.-M.I.T. Econometric Model: Its Special Features," *American Economic Review*, Papers and Proceedings (May 1968), p. 142.

Chart I

Results of Ex Post Dynamic Simulation

Annual Rates of Change



Note: Predicted values based on estimate of model for sample period ending IV/1969.

Table 7

Alternative Ex Post Simulations: Actual Minus Predicted[1]
Comparison of Wharton and St. Louis Models for 1963–64

	Nominal GNP[2]		Real GNP[2]		Price Level[3]		Unemployment Rate[4]	
	Wharton	St. Louis	Wharton	St. Louis	Wharton	St. Louis	Wharton	St. Louis
1963: I	−4.6	0.4	−3.9	−0.4	−0.1	0.2	0.9	0.3
II	−0.2	0.3	0.4	−0.7	−0.1	0.2	0.7	0.1
III	1.3	1.5	2.5	0.6	−0.3	0.1	0.9	−0.1
IV	0.9	2.1	2.2	−0.4	−0.2	0.5	1.2	0.2
1964: I	0.9	1.7	2.7	−1.4	−0.3	0.6	1.4	0.2
II	1.1	0.1	2.3	−3.2	−0.3	0.6	1.4	0.2
III	1.5	1.7	4.0	−2.7	−0.5	0.8	1.6	0.2
IV	0	−1.7	2.2	−6.8	−0.4	0.9	1.2	0.2
Average Error	0.11	0.76	1.55	−1.88	−0.28	0.49	1.16	0.16
Root Mean Squared Error	2.00	1.49	2.92	3.09	0.33	0.60	1.28	0.21

[1]Sample period:
Wharton: 1948–1964
St. Louis: 1955–1969

Exogenous variables:
Wharton: 43
St. Louis: 3

[2]Billions of dollars.

[3]Computed from the level of implicit price deflator.

[4]Percent.

Sources: M. K. Evans and L. R. Klein, *The Wharton Econometric Forecasting Model,* 2nd, Enlarged Edition (Philadelphia: University of Pennsylvania, 1968); and Federal Reserve Bank of St. Louis.

The comparison is not meant to imply that the St. Louis model is superior. Rather, the suggestion is offered that a small model constructed within a monetarist framework may yield as much information about the key aggregates as a large structural model. In summary, small monetarist models may be useful as a guide in the formulation of stabilization policy.

Ex Ante Dynamic Simulations

An *ex ante* dynamic simulation is like an *ex post* dynamic simulation, except that it extends beyond the sample period. To conduct such a simulation for this model, it was necessary to re-estimate the model for a subperiod within the full sample period. All equations of the model were re-estimated with data through 1967. The period of the *ex ante* dynamic simulation is 1968 and 1969. The results are summarized in chart 2 and in tables 8 and 9.

The success of the *ex ante* dynamic simulation can be assessed by comparing it with the tracking record of the *ex post* simulation for the same period. A comparison of the errors associated with the *ex ante* simulation with those of the *ex post* simulation (where the errors in both cases are computed with reference to actual values) suggests that any structural shifts that occurred in the 1968–69 period were not of such a magnitude that the *ex ante* tracking ability of the model was significantly different from that of *ex post* simulation.

Any conclusions about the tracking ability of the model are necessarily tentative, because they are based on only one *ex ante* dynamic simulation experiment. Nevertheless, these results provide a tentative basis for confidence in the tracking ability of the model in estimating the economic response to monetary and fiscal actions. Unfortunately, it is difficult to conduct additional tests of this type for other subperiods in the sample, because degrees of freedom are severely reduced when the sample period is shortened further.

USING THE MODEL FOR CURRENT ANALYSIS

The model is used in this section to simulate the effects of possible future rates of monetary expansion on spending, output, prices, unemployment and interest rates, given the economic circumstances of late 1969 and early 1970. Simulation of these alternative courses of monetary action suggests how the model may provide information which will be helpful to policymakers.

Simulations of the model are conducted only for alternative rates of monetary expansion. This is done because of the nature of the results for the spending equation. The net effect of a change in federal expenditures on total spending (GNP) over a five-quarter period is very small if unaccompanied by monetary expansion.

Short-Run Projections

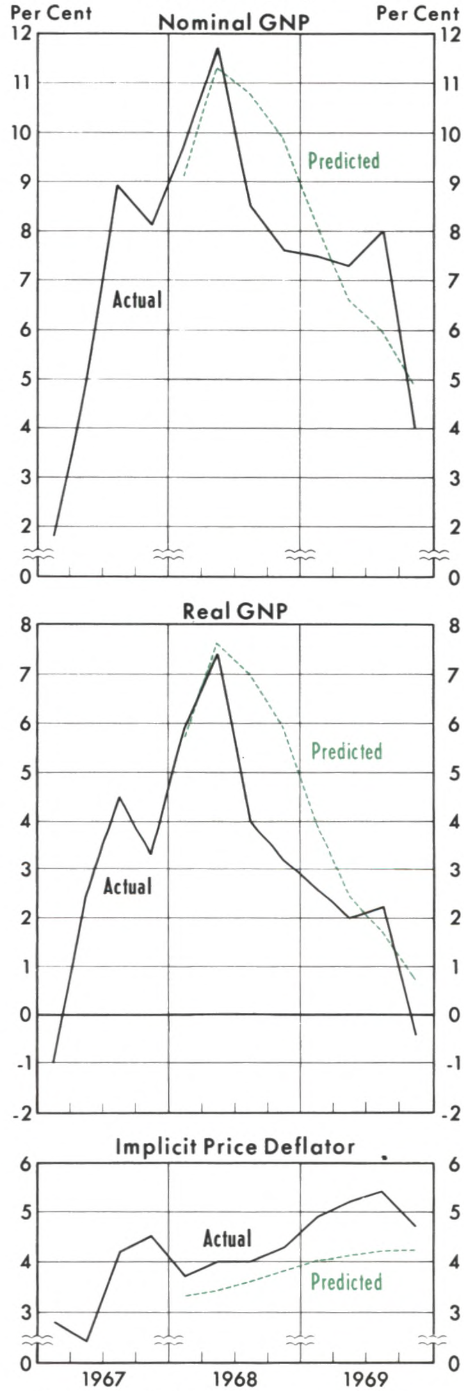
The results of simulating the model for alternative growth rates of money, and for the growth of federal expenditures as projected in the fiscal 1971 budget, are shown in table 10. These simulation results reflect the accelerating inflation of the past several years and the fiscal and monetary restraint in force throughout 1969 and early 1970. These projections assume that empirical relationships based on past experience will continue to hold in the near future.

Rates of change in the money stock were computed from the first quarter of 1970. Three alternative rates are shown in table 10. The "no-change case" corresponds to the course of monetary actions in the second half of 1969. The "three percent case" corresponds to the trend rate of increase in money from 1961 to 1965. Finally, the "six percent case" represents monetary actions similar to those of 1967 and 1968.

No-change case — A course of no change in the money stock from the first quarter of 1970 would lead to further reduction in the rate of increase of total spending in 1970 and 1971 (table 10). A slowing of total spending along with upward pressures on prices from the past inflation (anticipated price effect) would lead to continued declines in output through 1971. Such a restrictive course of monetary actions would slow the rate of price increase to a 4 percent rate by late 1970 and to a 2 percent rate by late 1971. The decline in output would be accompanied by a rise in the unemployment rate to over 7 percent by late 1971.

The effects of such restrictive monetary actions on

Chart II
Results of Ex Ante Dynamic Simulation
Annual Rates of Change



Note: Predicted values based on estimate of model for sample period ending IV/1967.

Table 8
Model Simulations

	1968				1969			
	I	II	III	IV	I	II	III	IV
GNP Level (billions of dollars)								
Actual	835.3	858.7	876.4	892.5	908.7	924.8	942.8	952.2
Ex Ante[1]	834.1	856.7	878.9	899.9	917.6	932.3	945.9	957.2
Ex Post[2]	834.6	856.7	877.7	897.8	914.9	929.4	943.4	955.1
Annual Rate of Change in Y								
Actual	9.7	11.7	8.5	7.6	7.5	7.3	8.0	4.0
Ex Ante	9.1	11.3	10.8	9.9	8.1	6.6	6.0	4.9
Ex Post	9.4	11.0	10.2	9.5	7.8	6.5	6.1	5.1
Annual Rate of Change in X								
Actual	5.9	7.4	4.0	3.2	2.6	2.0	2.2	−0.4
Ex Ante	5.7	7.6	7.0	5.9	4.0	2.4	1.7	0.7
Ex Post	5.4	6.7	5.7	4.8	3.0	1.6	1.1	0.0
Annual Rate of Change in P								
Actual	3.7	4.0	4.0	4.3	4.9	5.2	5.4	4.7
Ex Ante	3.3	3.4	3.6	3.8	4.0	4.1	4.2	4.2
Ex Post	3.8	4.0	4.3	4.5	4.7	4.9	5.0	5.0
Unemployment Rate (percent)								
Actual	3.7	3.6	3.6	3.4	3.4	3.5	3.6	3.6
Ex Ante	3.9	3.8	3.5	3.3	3.2	3.2	3.3	3.5
Ex Post	3.9	3.7	3.5	3.4	3.4	3.5	3.7	3.9
Corporate Aaa Rate (percent)								
Actual	6.1	6.3	6.1	6.2	6.7	6.9	7.1	7.5
Ex Ante	5.8	5.9	6.0	6.4	6.5	6.7	7.0	7.1
Ex Post	5.9	6.0	6.1	6.5	6.7	6.9	7.2	7.4
Commercial Paper Rate (percent)								
Actual	5.6	6.1	6.0	6.0	6.7	7.5	8.5	8.6
Ex Ante	5.1	5.1	5.1	5.6	5.7	6.0	6.6	6.7
Ex Post	5.8	5.8	5.8	6.5	6.6	7.0	7.8	8.0

Key to Abbreviations:
Y = Nominal GNP
X = Real GNP
P = GNP price deflator

[1]Simulation based on equations estimated through IV/1967.
[2]Simulation based on equations estimated through IV/1969.

interest rates would be to keep the long-term interest rate at recent levels through 1970, mainly because of the effects of past inflation. By early 1971, the slower advance of prices in 1970 and the slowing of output growth would lead to declines in the long-term rate. The short-term interest rate, on the other hand, would hold at recent levels only temporarily, partly because of continued restrictive monetary actions. Short-term rates would drop sharply by the second half of 1970, reflecting primarily the slowing of output growth. Since the price lags are shorter for the short-term rate, the effects of past inflation are not so pervasive as for the long-term rate.

Three percent case — Growth of the money stock at a three percent annual rate is presented to illustrate the effects of a moderate expansion of money. This rate corresponds to the trend rate of increase in money from 1961 to 1965. In the current economic situation, a three percent rate of expansion in money would represent a moderate easing of monetary policy from its restrictive influence of late 1969 and early 1970.

The effect of such expansion would be to maintain growth in total spending at a rate about the same as in the fourth quarter of 1969. Given the influence of past inflation on prices, output would decline slightly through 1970, but would resume its increase by 1971. The effect on prices in 1970 would be little different from the no-change case, but by late 1971 the difference would be marked. In the three percent case, prices would still be rising at a three percent rate by late 1971 compared with a two percent rate for the no-change case. Moderate expansion of the money stock leads to a rise in the unemployment rate through 1970 and 1971. In general, for this model, the unemployment rate rises as long as output grows at less than a four percent rate.

The long-term interest rate would remain at recent levels throughout 1970, and not until early 1971 would the effect of slower price increases and output growth be enough to offset the effects of past inflation. The short-term interest rate would fall more quickly than the long-term rate but would not fall as much by late 1971 as in the no-change case. Such a pattern for the short-term rate illustrates the short- and longer-run influence of quickened monetary expansion.

Six percent case — A six percent annual rate of increase in money is shown to illustrate the effects of a sudden shift to a very rapid rate of monetary expansion in the second quarter of 1970. Such increase in money would be about the same as during 1967 and 1968.

A major effect of shifting to rapid monetary expansion would be to advance the rate of total spending growth. By late 1971, total spending would be increasing at an 8 percent rate with such monetary actions. The rate of price increase would fall somewhat, however, because of past restrictive monetary actions. But the gain in price performance would be small, because by late 1971 prices would still be increasing at a 4 percent rate. The effects of past monetary and fiscal actions, along with past inflation, would lead to a decline in output through mid-1970. From then through 1971, output growth would increase.

Despite a shift to a very rapid rate of monetary growth, unemployment would rise until mid-1971. This increase in unemployment would follow because of the continued influence of past monetary and fiscal actions. By late 1971, the recovery in output growth would be pushing the unemployment rate back down.

A shift to rapid monetary expansion has a pronounced effect on market interest rates. The long-term rate would stay at recent levels through 1971, because the influence of past prices (anticipated price effect) would not be offset by a sustained reduction in output growth. The short-term rate would fall, in response to the temporary reduction in output growth, but the decline by late 1971 would be less than for either the no-change or three percent case.

Table 9

Ex Ante vs. Ex Post Simulation: Actual Minus Predicted — I/1968–IV/1969 (root mean squared errors)

	Ex Post	Ex Ante
GNP[1]	1.26	1.45
GNP in 1958 Prices[1]	0.99	1.58
GNP Deflator[1]	0.25	0.76
Unemployment Rate	0.14	0.20
Corporate Aaa Rate	0.17	0.26
Commercial Paper Rate	0.44	1.26

[1]Computed from actual minus predicted annual rates of change.

Implications of the Model for the Long Run

Short-run prospects for economic variables tend to dominate policymakers' decisions. However, the longer-run consequences of alternative monetary policies should also be given consideration. This model is incomplete for long-run analysis; nevertheless, it yields results that are of interest and may not be too far removed from results that might evolve from a more complete specification.[31]

When simulations are conducted for long periods into the future (30 years), the model demonstrates properties consistent with those expounded by the classical economists. Over the long run, monetary actions have no effect on real magnitudes; the rate of growth of output, the unemployment rate and the real rate of interest all tend to move toward some equilibrium rate, regardless of which rate of money

[31]The shortcomings of the model for the long-run analysis are quite evident. There are no assumptions specified as to labor force growth and productivity. Furthermore, there is no investment function and, therefore, the capital stock is not an endogenous variable. All long-run assumptions are embodied in assumptions about the growth rate of potential output. With these assumptions, policy actions cannot affect the economy's long-run growth rate.

Table 10

Simulation of Alternative Rates of Monetary Expansion

Projected Rate of Change in M[1]		Actual IV/1969	Projected I/1970	II/1970	III/1970	IV/1970	I/1971	II/1971	III/1971	IV/1971
0 Percent										
Annual Rate of change in	Y	4.0 (5.1)[2]	3.5	3.1	1.0	0.3	0.7	0.9	2.1	0.9
	X	−0.4 (0.1)	−1.3	−1.6	−3.3	−3.6	−2.7	−2.0	−0.4	−1.0
	P	4.7 (5.0)	4.9	4.7	4.4	4.0	3.5	3.0	2.5	1.9
Unemployment Rate		3.6 (4.0)	4.3	4.8	5.2	5.8	6.4	6.9	7.4	7.7
Corporate Aaa Rate		7.5 (7.4)	7.4	7.5	7.4	7.4	7.3	7.1	6.9	6.7
Commercial Paper Rate		8.6 (8.0)	7.6	7.6	7.1	6.5	5.7	5.0	4.4	3.6
3 Percent										
Annual Rate of change in	Y	4.0 (5.1)[2]	3.5	3.8	2.9	3.1	4.1	4.4	5.5	4.3
	X	−0.4 (0.1)	−1.3	−0.8	−1.5	−1.0	0.3	0.8	2.2	1.4
	P	4.7 (5.0)	4.9	4.7	4.5	4.2	3.8	3.5	3.2	2.9
Unemployment Rate		3.6 (4.0)	4.3	4.8	5.2	5.6	6.0	6.3	6.5	6.7
Corporate Aaa Rate		7.5 (7.4)	7.4	7.3	7.3	7.3	7.3	7.2	7.1	6.9
Commercial Paper Rate		8.6 (8.0)	7.6	7.2	6.8	6.4	5.9	5.5	5.0	4.5
6 Percent										
Annual Rate of change in	Y	4.0 (5.1)[2]	3.5	4.6	4.8	6.0	7.6	7.8	8.9	7.7
	X	−0.4 (0.1)	−1.3	−0.1	0.2	1.6	3.3	3.7	4.8	3.8
	P	4.7 (5.0)	4.9	4.7	4.5	4.3	4.2	4.0	3.9	3.8
Unemployment Rate		3.6 (4.0)	4.3	4.8	5.1	5.4	5.6	5.6	5.7	5.7
Corporate Aaa Rate		7.5 (7.4)	7.4	7.2	7.2	7.2	7.3	7.3	7.3	7.2
Commercial Paper Rate		8.6 (8.0)	7.6	6.7	6.5	6.3	6.1	5.9	5.7	5.5

Key to Abbreviations:
Y = Nominal GNP P = GNP Price Deflator
X = Real GNP M = Money Stock

[1]Rates of change in money projected from I/1970. High-employment Federal expenditures projected on basis of fiscal 1971 budget, as released in January 1970.

[2]Model estimates.

growth is maintained. The effects of alternative rates of monetary expansion are on nominal magnitudes, namely, total spending, prices, and market interest rates.

Based on the assumptions of the model, a six percent rate of growth in money along with a six percent growth rate in federal expenditures, for example, would lead ultimately to about a six percent rate of growth in total spending, a four percent rate of growth in output, a two percent rate of increase in prices and market interest rates about two percentage points in excess of the real rate. Alternatively, a two percent growth rate in money would result approximately in a two percent growth in total spending, a four percent rate of growth in output, a two percent rate of decline in prices and market interest rates about two percentage points below the real rate. Over the long run, the model indicates that high employment and price stability are compatible.

SUMMARY

The main purpose of this study has been to quantify the effects of monetary and fiscal actions within a small-model framework and thereby offer an alternative to existing large-scale econometric models. Such a model has been formulated and the effects of monetary and fiscal actions on spending, output, prices, employment and interest rates have been estimated.

The model developed in this article is primarily "monetarist" in character. The estimated equations indicate that monetary actions, as measured by changes in the money stock, play a strategic role. Fiscal actions, as measured by high-employment federal expenditures, have some short-run effects, but for periods of a year or more the net effect on spending, output and prices is near zero. Simulations of alternative rates of monetary expansion produce short-run and long-run responses which are consistent with the general monetarist view of the economy.

One of the chief advantages of this model is that it depends primarily on information about only two variables — the money stock and high-employment expenditures.[32] Considerable insight can be gained about the pattern of expected movements of certain strategic economic variables by considering alternative courses of monetary and fiscal actions. However, since the model is limited to only monetary and fiscal influences, to the exclusion of other independent forces, it is not suitable for exact forecasting.[33] Its primary purpose is to measure the general pattern of influence of monetary and fiscal actions on several strategic economic variables. Since the economy is viewed as being basically stable, other factors influencing total spending, output and prices are not considered to be of great importance in estimating the response to monetary and fiscal actions.

[32]This feature has led John Deaver to conjecture that the standard error of forecast in the Andersen-Jordan model may be far lower than that of the FRB-MIT model. See his "Monetary Model Building," *Business Economics* (September 1969), p. 30.

[33]See Andersen and Jordan, pp. 15, 23, 24, and Leonall C. Andersen, "Money in Economic Forecasting," *Business Economics* (September 1969), p. 17.

Appendix A
Explanation of the Price Equation

The price equation (omitting timescripts and lags) is

$$\Delta P = f(D, \Delta P^A),$$

where D, demand pressure, is defined as

$$D = \Delta Y - (X^F - X).$$

ΔY is the change in total spending, $(X^F - X)$ is the GNP gap, that is, the difference between potential and actual output, and ΔP^A is anticipated price change. This specification of the price equation is based on standard theory of macroeconomic equilibrium.

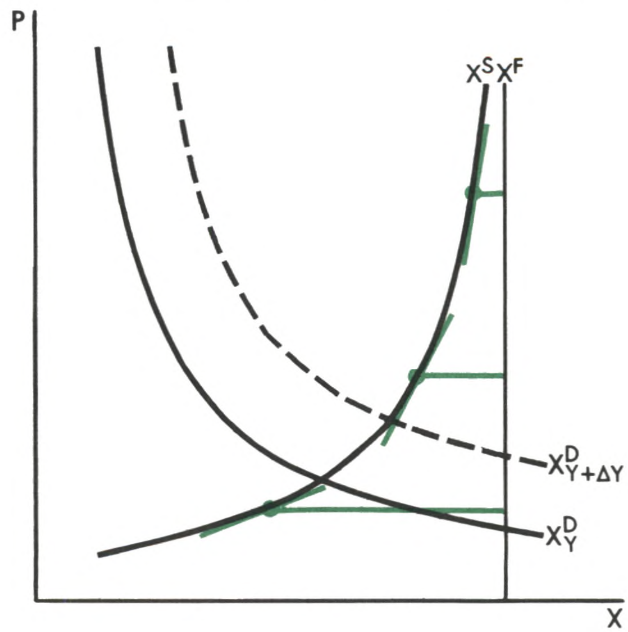
Macroeconomic equilibrium can be depicted graphically as in figure 1. The solid downward-sloping line, X^D_Y, is the total spending line, which represents the combinations of prices and output consistent with a particular level of total spending, Y. This total spending line can be interpreted as total demand for output.

The upward-sloping line, labeled X^S, is the total supply line. This line corresponds to that combination of prices and output which maximizes profits of firms, given the prices of factors of production, the degree of competition among firms and the stock of human and physical capital (defined to embody the state of technology).

The intersection of total supply and total demand determines the levels of output and prices. The equilibrium price level is that level which equates the amount of output supplied with the amount demanded.

The focus of the model is on the change in prices and the

Figure I
Macroeconomic Equilibrium
(Determination of Output and Prices)



change in output. In terms of figure 1, changes in prices and output are brought about by shifts in demand and/or supply. Since X_Y^D is drawn for a level of total spending, a shift **of that line upward and to the right to** $X_{Y+\Delta Y}^D$ represents an increase in total spending. If the total supply line remains fixed, the effect of ΔY on prices depends on (1) the magnitude of ΔY, and on (2) the slope of the total supply line, X^S.

The purpose of the model is to estimate the response of spending, output, and prices to monetary and fiscal actions, not to test a hypothesized structure. Consequently, rather than attempt to determine the shape of the total supply line empirically, its variable slope is proxied by the difference between potential output and actual output. As drawn in figure 1, there is a one-to-one relationship between $X^F - X^S$ and the slope of X^S. Assuming that this relationship is approximately linear within the range of experience since 1955, and that the observed values fall on the supply line, the effect of a variable slope for X^S can be approximated by $X^F - X$. In this way the term $[\Delta Y - (X^F - X)]$ brings together both the magnitude of demand shift and the slope of the supply line.

The other term in the price equation, anticipated price change, ΔP^A, is considered as a separate influence on prices. In terms of figure 1, the anticipated price term is a shift parameter for the total supply line (an increase in ΔP^A shifts X^S upward and to the left). Including it in this way allows for the influence of past prices on current pricing policies of firms and factors of production.

Appendix B
Graphical Illustration of the Model

The workings of the model can be demonstrated with graphical techniques. Figure 2 is a representation of the core of the model, showing the determination of changes in spending, output, and prices.

Panel A of figure 2 is a graphical representation of the total spending equation with ΔM on the horizontal axis and ΔY on the vertical axis. Changes in ΔE shift the total spending line.

Panel B shows prices (ΔP) as a function of ΔY. A short-run price line (ΔP_1) is drawn consistent with empirical results showing that ΔP is not very sensitive to ΔY in the short run. Important determinants of the position of the short-run price line are the size of the GNP gap and anticipated price changes. The long-run price line ($\Delta P(LR)$) is drawn to show the relationship between ΔP and ΔY when the GNP gap is zero and anticipated prices are equal to actual prices. Its slope (45 degrees from its origin on the ΔY axis) is based on the monetarist view that in the long run, ΔM influences only ΔP.

Panel C expresses the total spending identity in graphical terms. Total spending is divided between output and prices; to reflect this, the line in panel C is drawn as a 45 degree line with its position determined by the magnitude of total spending (ΔY). There is a family of 45 degree lines, one for each possible ΔY. Also included in panel C is a horizontal line representing the long-run growth rate of output. It is shown as a horizontal line to indicate that long-run output growth is exogenously determined by resource growth and technology.

In panel D, the ΔX_1 line shows the relationship between money (ΔM) and output (ΔX) as derived from the other three panels. The equation for this line is not shown in exhibit 1 in the text, but it can be derived from the other equations of the model.

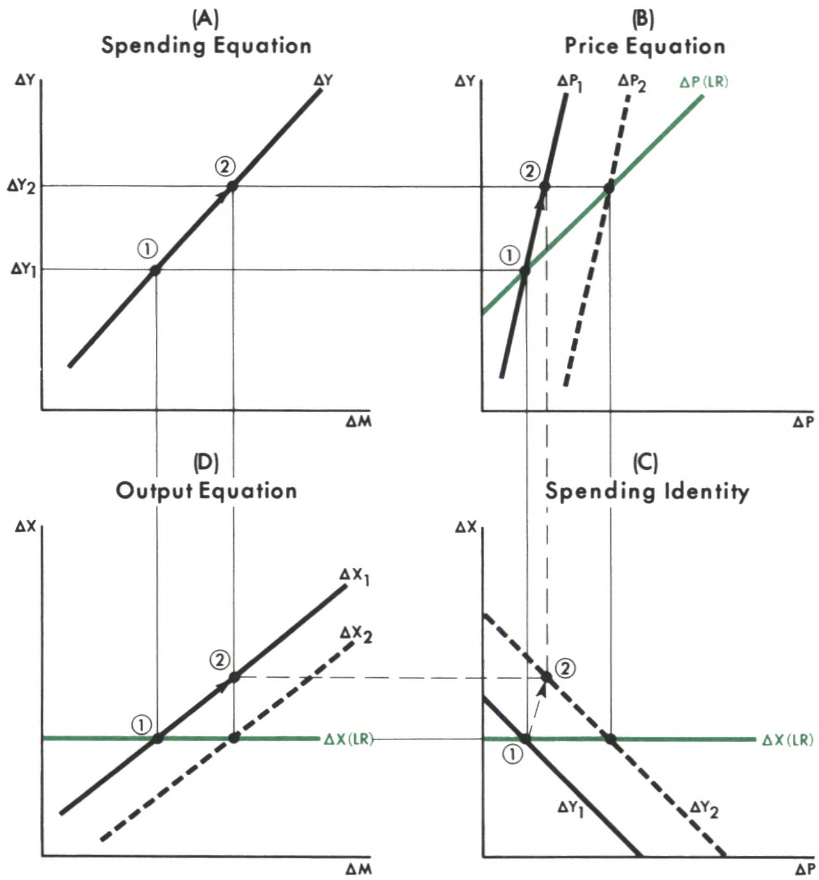
Figure 2 is drawn to represent an initial equilibrium for a given ΔM, which has associated with it the short-run price and output lines, ΔP_1 and ΔX_1. The effect of a change in ΔM, given ΔE, is shown as a movement along the spending line in panel A from ① to ②. Given the initial price line, ΔP_1, and the changed ΔY, the effect on prices and output is shown in panels B, C and D as a movement from ① to ②.

This case illustrates the impact of a change in ΔM in the short run. For longer periods, anticipated price changes and the GNP gap will also change; they become endogenous variables in a long-run model. To illustrate the effects for the long run, the long-run price line, $\Delta P(LR)$, in panel B, is relevant. The interpretation of the long-run price line is that changes in ΔM are reflected only in ΔP, with ΔX determined by considerations of resource growth and technology. The horizontal line in panels C and D is the long-run relation between prices and output.

In the short-run, the solution of the model need not lie on the long-run price line in panel B (or the long-run output line in panels C and D). However, a succession of short runs (shown as a shift of the ΔP and ΔX lines to ΔP_2 and ΔX_2) will tend to move equilibrium toward the long-run price and output lines, as anticipated prices adjust to actual prices and the GNP gap goes to zero.

Figure II

Model in Graphical Form



Appendix C Alternative Price Equations

The model consists, for the most part, of equations which have been estimated in previous studies. The purpose of this paper is to combine the equations in a way which represents the general monetarist view.

The primary distinguishing feature of this model, other than the reduced-form total spending equation, is the inclusion of a price anticipations variable in the price equation. Two alternative methods of introducing price anticipations were considered. One alternative bypasses the precise form of the price anticipations function and uses the long-term market interest rate (yield on corporate Aaa bonds) as an independent variable in the price equation. The other alternative bypasses both price expectations and interest rates, and introduces changes in money as an independent variable in the price equation. Such a specification allows monetary actions to serve as a proxy for anticipated prices.

A Market Interest Rate in the Price Equation

The first alternative replaces the price anticipations variable with the long-term market interest rate.[1] The rationale is that the process of price anticipations formation is so complex that it defies measurement. However, there seems to be agreement that the level of market interest rates reflects anticipated price changes, however formed. Thus the market interest rate can be used as a proxy for price anticipations.

[1]The suggestion for using the interest rate in the price equation came from the Money and Banking Workshop at the University of Chicago.

Table 11

Alternative Price Equations (Dependent Variable — ΔP_t)
Sample Period: I/1955–IV/1969

	Independent Variable							
	ΣD_{t-i}	ΔP^A_t	$(R^L_{t-1}X_{t-1}).01$	$\Sigma \Delta M_{t-i}$	Constant	R^2	SE	DW
Price Anticipations Specification[1]	.09	.86	*	*	2.70	.87	1.07	1.41
	(9.18)	(8.55)			(7.07)			
Interest Rate Specification[2]	.09	*	.11	*	1.93	.88	1.04	1.49
	(8.72)		(8.73)		(4.10)			
Money Stock Specification[3]	.06	*	*	2.61	2.11	.86	1.11	1.37
	(4.61)			(7.82)	(4.22)			

[1]Where i goes from 0 to 5.
[2]Where i goes from 0 to 10.
[3]Where i goes from 0 to 9.
*Not estimated for this equation.
NOTE: Regression coefficients are the top figures; their "t" statistics appear below each coefficient, enclosed by parentheses. R^2 is the percent of variation in the dependent variable which is explained by variations in the independent variable. SE is the standard error of the estimate. DW is the Durbin-Watson statistic.

Since interest rates reflect factors other than price anticipations, including the interest rate does not provide a clean measure of price anticipations. Using the market interest rate allows those factors influencing the real rate of interest to enter indirectly as an influence on prices. In general, however, it has been argued that the real rate of interest is very stable.

Following this reasoning, the price equation was estimated by including the long-term interest rate. The results are shown in table 11. The coefficient of the interest rate variable is significant at the five percent level for this specification, and the sum of the coefficients for the demand pressure variable is roughly the same as for the price anticipations version of the equation. However, the length of the lag structure is longer, indicating that the response of prices to changes in demand pressure may be slower than in the basic equation. But this need not imply that prices are slower to respond to monetary actions, since the magnitude of the interest rate contribution to price change is smaller than with the price anticipations specification.

Money in the Price Equation

Several observers have been critical of price equations that do not include monetary variables directly. As shown in the text, excluding monetary variables from the price equation does not necessarily imply a non-monetary theory of inflation.[2] Such a conclusion cannot be derived by examining the price equation alone, but requires an examination of the whole model, and the linkages between money and prices in particular.

The second alternative that is considered is based on the central proposition of the quantity theory — that changes in money are ultimately reflected in changes in the price level. Accordingly, current and past changes in money are used as a proxy to measure anticipated movements in prices.[3] Though this rationale for including money is somewhat narrower than that proposed by some monetary economists, the direct and indirect effects of money are being measured once it is included in the price equation.

The price equation incorporating current and lagged values of changes in money is shown in table 11. Except for the current quarter, the coefficients are significant for nine lagged quarters. The effect of including changes in money lowers the sum of the coefficients on the demand pressure variable, however. The overall explanatory power of the equation is about the same as for the price anticipations model.

Comparison of the Alternatives

To compare the price equation in the text with the two alternatives in this appendix, the model was simulated with each of the three different specifications from 1965 through 1969. The period starting in 1965 is used because the relative tracking ability of the models during a period of accelerating inflation is especially relevant in assessing the current

[2]See Fand, "Some Issues in Monetary Economics," pp. 20–23.

[3]This suggestion was made by Professors David Fand and Allan Meltzer.

Table 12

GNP Price Deflator Alternative Ex Post Simulations: Actual Minus Predicted (compounded annual rates of change)

	Price Anticipations Specification	Interest Rate Specification	Money Stock Specification
1965 I	0.6	0.3	−0.5
II	0.2	−0.2	−1.0
III	−0.7	−1.0	−1.7
IV	−0.2	−0.4	−1.0
1966 I	1.0	1.0	0.4
II	1.4	1.5	1.0
III	0.8	0.8	0.6
IV	0.2	0.1	0.3
1967 I	−0.3	−0.3	−0.2
II	−0.8	−0.8	−0.8
III	1.0	1.1	0.9
IV	1.3	1.4	1.1
1968 I	0.4	0.4	0.3
II	0.5	0.7	0.6
III	0.2	0.7	0.4
IV	0.2	0.9	0.3
1969 I	0.6	1.4	0.7
II	0.7	1.6	0.8
III	0.8	1.7	1.0
IV	0.1	0.9	0.5
Average Absolute Error			
1965–69	0.60	0.86	0.71
1965–67	0.71	0.74	0.79
1968–69	0.44	1.04	0.58
Root Mean Squared Error			
1965–69	0.50	0.96	0.63
1965–67	0.67	0.76	0.79
1968–69	0.25	1.27	0.39

economic situation. Since the price equation is the only part that varies from one model to the next, only the results for the rate of change of prices are reported (see table 12).

The price anticipations specification has the smallest average absolute error and the smallest root mean squared error for the period. During the last two years of the period, 1968 and 1969, each of the alternative specifications tends to underestimate price changes. However, for 1968 and 1969, the price anticipations specification again has both the smallest average absolute error and root mean squared error.

Conclusions

An examination of the model reflecting three different specifications for the price equation indicates that none of the specifications is clearly superior as judged by conventional criteria. A policymaker might well consider the results provided by each of the three.

When simulations are performed for 30-year periods beginning in 1970, the price anticipations version (as presented in the text) approaches closest a long-run classical solution. For the other two specifications the unemployment rate does not stabilize at the same level for alternative growth rates of money. These two alternatives yield the same equilibrium growth rates of output for alternative growth rates of money, but since this rate is approached asymptotically, unemployment stabilizes at a different rate for each alternative growth rate of money.[4]

[4]Supplementary materials relating primarily to the long-run simulations are available on request.

Leonall C. Andersen: A Biographical Sketch

Andy was born in Marshall, Minnesota, on November 4, 1924. He attended Gustavus Adolphus College, where he received a B.S. in business administration in 1949; three years later, he earned an M.S. in Economics from the University of Illinois.

He joined the faculty at St. Olaf College in Northfield, Minnesota, in 1955 as an assistant professor, while simultaneously pursuing graduate work at the University of Minnesota. In 1962, having been awarded his Ph.D., he joined the Research Department at the Federal Reserve Bank of St. Louis.

Except for a one-year leave in 1969 as a senior staff economist at the Council of Economic Advisers in Washington, D.C., Andy remained in St. Louis for 16 years. At the St. Louis Federal Reserve Bank, he rose from economist (1962–65) to senior economist (1965–66), to vice president (1966–71), to senior vice president (1971–74), to economic adviser to the president (1974–78).

In 1978, Andy retired from the Bank to accept an appointment as professor of banking in the College of Business Administration at the University of Florida. In 1981, he returned home to Minnesota to his alma mater, Gustavus Adolphus, as a professor of economics, a position he held until his death on October 27, 1985.

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