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An Analytical and Empirical Examination of Monetary Multipliers in Single Equation Macroeconomic Models.

William Byron Green

Louisiana State University and Agricultural & Mechanical College

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IN SINGLE EQUATION MACROECONOMIC
MODELS

A Dissertation
Submitted to the Graduate Faculty of the
Louisiana State University and
Agricultural and Mechanical College
in partial fulfillment of the
requirements for the degree of
Doctor of Philosophy
in
The Department of Economics

by
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ABSTRACT

Interest in the role of money in the economy has been high in recent years, no doubt due to the exuberant behavior of the economy following the tax surcharge in 1968. When conventional forecasting methods consistently underestimated economic activity, many researchers began new efforts to measure the empirical relationship between money and economic activity. One avenue of these research efforts has been the development of "reduced-form" single-equation models. This study examines analytically and empirically monetary multipliers calculated using single-equation models.

Single-equation models, although simple in nature, often report widely different monetary multipliers as evidenced by the multipliers calculated with the Friedman-Meiselman, Andersen-Jordan, Laffer-Ranson, and Meiselman-Simpson models. The multipliers exhibited by these models often indicate extremely different implications as to the importance of money in the economy.

Using the Andersen-Jordan model as the standard of comparison, each dissimilar feature of the remaining three models were compared to determine the factors responsible for the different multipliers. The different-sized multipliers were attributable to: (1) the time period used for the analysis; (2) the inclusion of a fiscal variable in the regressions; (3) the choice of the monetary and dependent
variable; and (4) the technique used for estimating lagged coefficients. The different distributed impact of the total multiplier was attributable to: (1) the technique used to estimate lagged coefficients; (2) the deseasonalization method; and (3) the choice of the monetary variable.

To extend the analysis of single-equation models, a general model was formulated using various monetary variables and alternative lag structures to determine their abilities to predict changes in gross national product. Two procedures for deseasonalizing data and the high employment budget surplus were included in the model to determine the effects of each on the monetary multipliers.

Regressions using data deseasonalized by the ratio-to-moving-average method showed that among the monetary variables, \( M_2 \) and the monetary base were the best predictors of changes in gross national product, while \( M_1 \) and R.P.D.'s were the worst. No one particular lag structure was consistently best fitting.

Regressions using dummy variables to deseasonalize data caused: (1) the total multiplier for each monetary variable to increase; (2) a Koyck type lag structure to be best fitting for each monetary variable; (3) the percentage of the total effect occurring in the initial quarter to increase for monetary aggregate, while reducing the percentage for reserve aggregates; and (4) substantial increases in the \( R^2 \)'s and standard deviations of regression.

Inclusion of the high employment budget surplus had no uniform effects on the regressions, but generally caused: (1) the total
monetary multipliers to increase; (2) a reduction in the standard
deviation of regression; (3) the best fitting lag structure to re-
main the same for monetary aggregates, but not reserve aggregates;
and (4) the time response of most monetary variables to change—often
substantially.

An appropriate measure of monetary actions should be theoret-
ically sound, controlled by the Federal Reserve, and statistically
exogenous. By the criterion of a financially constrained economy,
the monetary base is an ideal measure of monetary actions since it
reflects any action altering this constraint (M₁ and M₂ can also be
justified since they are systematically related to the "base"). A
review of the literature indicates general agreement that movements
in monetary variables are dominated by Federal Reserve actions, but
some endogeneity may exist.

The results of this study warrant several tentative conclusions
regarding the use of single-equation models. (1) Bias may exist in
the multipliers due to endogeneity, but the problem is not sufficient
to recommend abandonment of the single-equation approach; (2) the
money-income relationship may be unstable since the time period was
such an important determinate of the size of the monetary multipliers;
(3) the ratio-to-moving-average approach to deseasonalizing data is
preferred since this procedure is more reliable for prediction as
evidenced by the lower standard deviations; (4) there is no one
"best" method of measuring distributed lags; (5) for theoretical and
empirical reasons the monetary base and M₂ are the most appropriate
measures of monetary actions; (6) the Federal Reserve should abandon R.P.D.'s as a target variable since it cannot be justified theoretically or empirically.
CHAPTER I

INTRODUCTION

"Monetary theory is often ridiculed for lagging a decade behind the problem actually faced by the economy. While theory grapples with the problems of one decade and gradually influences public policy in one direction, conditions change and the policy forged for one problem muddles up another. Yet despite the swings in policy views, work in monetary theory has pursued the same objective: to discover how and to what extent monetary factors affect prices and output. Nor has the nature of problems of policy changed basically, if one looks back more than a decade or two. It is just the answers that change."¹

The current intense interest in the problems of monetary policy, and more generally, the role of money in the economy, reverses a rather long period of what seemingly has been widespread indifference. In the late 1930's, following the publication of Keynes' General Theory,² and into the early 1940's there was a general feeling among most economists and policy makers that money was unimportant - a position that may have been derived from a misreading of Keynes.³


³For arguments that Keynes' view of the importance of money was misinterpreted see Axel Leijonhufvud, On Keynesian Economics and the Economics of Keynes, (New York: Oxford University Press, 1968).
In the late 1940's and early 1950's there was a resurgence in the belief that money after all was important, but the degree of this importance was, and still is, in dispute.

Because of this revived interest in, but lack of knowledge of, the role money plays in the economy, "the basic framework used for years . . . in analyzing such matters has come under serious challenge."⁴ Until recently, there was rather general agreement that a wide variety of factors produce changes in the level of business activity. Monetary changes were only one element in the list, and in the minds of many not an important inclusion. Money was thought to operate almost exclusively through financial markets (interest rates) and through changes in the degree of credit rationing which impinged on borrowers operating in imperfect capital markets.

The view that "only money matters" or, perhaps more accurately, that "mainly money matters" was held only by a few economists, primarily Milton Friedman and his followers.⁵ Generally, economists


regarded this group as an amusing collection of eccentrics. Only recently has there been an analytical attempt to grapple with the Friedman view on the role of money. A paper by J. M. Culbertson in 1960, Kareken and Solow's criticism of Friedman's method of measuring monetary lags, and the controversy surrounding the Friedman-Meiselman work nearly exhausts the pre-1968 literature. The role of money as the major single determinant of economic activity has not been given serious attention by most economists until recent years.


This situation changed rather abruptly in the late 1960's, primarily, no doubt, because of the rather surprisingly exuberant behavior of the economy following the enactment of the tax surcharge in June, 1968. Most forecasters consistently and to a substantial extent underestimated the strength of the economy in the succeeding period. These forecasting mistakes may not have been due to an overestimate of the power of fiscal policy or an underestimate of the potency of the monetary growth rate, of course, for other explanations are plausible. "Nevertheless" as one forecaster has stated,

"... it has been distinctly unsettling to see the projected slow-down recede further and further into the future month after month and quarter after quarter. It is the sort of experience to make one re-examine one's 'maintained hypothesis'--and perhaps such a reexamination is really in order." ⁹

This failure of conventional forecasting techniques would not have directed forecasters to the money supply for an explanation were it not for a large body of evidence establishing a very close association between the money supply and the level of economic activity. The most impressive evidence was derived from the Friedman-Schwartz measurement and comparison of specific cycles in the monetary growth rate with the National Bureau of Economic Research

⁹Davis, op. cit., p. 120.
reference cycles. These data consistently found that cycles in
the monetary growth rate leading NBER references cycles so that it
seemed impossible that the implied relationship between money and
economic activity could be due to chance alone. Friedman and
Schwartz interpreted these timing leads to mean a dominant causal
role for money, while the length and variability of the leads were
said to be the corresponding length and variability in the lags
between changes in the money supply and its effect on the level of
economic activity.

Although the Friedman-Schwartz publication may have been a
call to discipleship, new converts were few. One of the main
detractions was the possibility of reverse influence of business
activity on the money supply. This position, associated with the
"Banking School" view, argued that the quantity of money supplied
responds passively to the demand for it (a view which still remains
fairly strong in popular thinking on monetary policy). However,
this criticism was partly quelled by the monumental work of Phillip
Cagan on the money supply in the United States which demonstrated

10 Milton Friedman and Anna J. Schwartz, *A Monetary History of
Press for the National Bureau of Economic Research, 1965). The
major results of their study are summarized in Milton Friedman and
Anna Schwartz, "Money and Business Cycles," *Review of Economics and

11 Harry G. Johnson, "Recent Developments in Monetary Theory---A
Commentary" in *Money in Britain 1959-1969*, (ed.) D. R. Croome and
to most observers that the money supply is determined independently of the level of income.\textsuperscript{12,13}

Additional evidence to support the position that "mainly money matters" was the regression equations produced in the famous Friedman-Meiselman paper.\textsuperscript{14} Friedman and Meiselman regressed the money supply and what they called "autonomous" expenditures against consumption to determine which of the independent variables was most important and stable. Their results were "strikingly one-sided" in support of the money multiplier over what they called the Keynesian multiplier.\textsuperscript{15}

Again, it is doubtful that these results were instrumental in converting many economists to the Friedman position. Writers challenging the Friedman-Meiselman paper showed very readily that the


\textsuperscript{13}However, this demonstration is not universally accepted. For example, Richard Davis in "How Much Does Money Matter?" op. cit., p. 120, states, "while Cagan's book appears to be very much in the Friedman tradition, it seems to me that its results in fact tend to undercut the tradition. Cagan's work suggests rather clearly that the characteristic cyclical timing relationships between monetary rates of change and the business cycles are very importantly determined by the influence of business on money."


\textsuperscript{15}Ibid., p. 166.
results of their regression depended heavily on their definition of "autonomous" spending and on the years included in the computations. Another complicating factor was once again the inability of correlation techniques to distinguish the direction of influence between money and the level of economic activity.

Thus, those economists and public officials who began to review the evidence for the monetarist position in the wake of their forecasting errors following the 1968 surcharge enactment found a rather mixed bag. Although Friedman and his colleagues had definitely established that there was a gross association between money and the level of economic activity, they had not convinced the majority of their professional colleagues that money was as important as they claimed it to be.

Obviously, it is important for stabilization strategy to resolve the question of how important money is in affecting the level of economic activity. If, for example, money and monetary policy is all-important, as the extreme monetarists claim, then the central bank should probably be more cautious, or gradual, in its use of monetary instruments. If money is not very important in affecting

16 See in particular articles by Ando and Modigliani, and dePrano and Mayer cited in footnote 8 on page 3.

economic activity, then possibly the central bank should take a passive role and issue money to meet the needs of trade.

Two separate empirical questions underlie the debate over the importance of money. The first of these is the well known question of the "strength" of money and monetary policy. The second empirical issue concerns the timing lags of monetary policy. Timing questions usually take a back seat to the problem of strength, but time lags are crucial in shaping stabilization strategies and their importance should not be neglected.

In an effort to answer these two empirical questions, research has been primarily directed along two avenues: first, the establishment of large-scale econometric models; and second, the development of reduced-form single-equation models. A structural model of the economy attempts to set forth in equation form what are considered to be the underlying economic relationships in the economy. A "reduced-form" single equation model, on the other hand, is simply an equation in which key economic variables, such as GNP, are expressed as direct functions of policy variables and other forces exogenous to the economy. Although these two approaches are different in many ways, a large scale econometric model can, in principle, be "reduced" (solved), so that,

". . . the difference between a structural model and a reduced-form model is largely mathematical and does
not necessarily involve different assumptions about the workings of the economy . . . "18

Even though the difference between the two methods may be largely mathematical, a lively methodological debate has developed over the appropriateness of structural models versus the reduced-form approach to estimating the effects of stabilization policy on the economy.

Since direct estimation techniques and large econometric models are often designed to do different things, it is at best difficult to compare the merits of each approach in measuring the strength of monetary policy variables on final demand. The presumptions are even ambivalent. One presumption is that the economy is very complicated so one cannot study its structure without a very complicated model. The competing presumption is that since the economy is complicated one cannot study its structure even with an extremely large and complex model and should therefore test only broad hypotheses through reduced forms.

Specifically, monetarists who express a preference for the reduced-form approach argue that it is inherently difficult to measure the channels through which monetary policy operates with an econometric model. The influences of monetary variables may work through channels yet undiscovered or ones that we are not yet able to estimate, or they might work on nonquantifiable terms comprising

the relevant cost-of-capital but not measured by published interest rate data. Another possibility is that monetary influences may work on some components of final demand sometimes and on other components at other times. For these reasons, it is argued, a direct estimation of the effects of monetary policy on final demand may be more reliable than a large scale model. Those that prefer the single-equation approach contend that if we are interested in the behavior of key economic variables - such as Gross National Product, prices, unemployment, etc. - it is not necessary to estimate all the parameters of a large-scale model.

Friedman, in arguing for the reduced-form approach has used an analogy of a lake to justify his ideas. He states:

"information about the inflow/outflow relationship could be obtained by observing what went on in the lake and measuring changes in the water level, but the best way to obtain the required information was to observe the inflow and outflow and to ignore what went on in the lake."20

---


A. A. Walters has also expressed a preference for the reduced form approach. He states:

"The best way to treat the existence of a monetary multiplier is to measure the parameters directly in some version of the reduced (or final) form."\textsuperscript{21}

Those who favor the use of econometric models have two primary lines of argument. The first is the fact that in the process of regressing final output against monetary, fiscal, and other such variables, it is apparently crucial what is assumed to be exogenous. Much of the controversy surrounding the results of reduced-form studies has used the exogenity problem as a central argument.\textsuperscript{22}

A second weakness of the technique of estimating reduced-forms is that reduced-forms, by definition, reject structural information which econometric models may possibly use to great advantage. Estimates of reduced-form equations do not build in a \textit{a priori} restrictions on the coefficients - restrictions that an econometric model can include through nonlinearities, lags, identities, omitting variables, etc. Since reduced-forms ignore these restrictions they may not be


internally consistent. Also, the exogenous monetary and fiscal variables "... necessarily represent aggregation of many items which probably have quite diverse effects."24

The virtues of using prior information are not completely one-sided. If the prior information is incorrect, then estimating coefficients using wrong information would likely take one further from the truth than being agnostic about structural constraints. If an econometric model by construction does not allow for all of the existing channels of monetary policy, then the model probably will not tell us much about the strength of monetary policy.25

Since the two methods of estimating multipliers give somewhat different results, the resolution of this debate would be an important contribution toward establishing the importance of money in the economy, but such an effort is beyond the scope of this research. The aim of this study is much more modest. This work will look only at monetary multipliers calculated using single equation models and attempt to answer questions regarding their results. Specifically, the study will:


24 Gramlich, Ibid.

25 Ibid.
1. compare and reconcile the results of four single-equation models that are often mentioned and discussed in the economic literature;

2. formulate a single-equation model to be used:
   (a) to compare the reliability of changes in various monetary and reserve aggregates in predicting changes in economic activity;
   (b) to determine what type of lag structure is empirically consistent with the observed relationship between various monetary and reserve aggregates and changes in economic activity;
   (c) to determine what effect the seasonal adjustment procedure has on (i) the predictive ability of the various monetary and reserve aggregates, (ii) the choice of the best fitting lag structure, and (iii) the size of the monetary multipliers;
   (d) to determine what effect the inclusion of a fiscal variable has on (i) the predictive ability of various monetary and reserve aggregates, (ii) the choice of the best fitting lag structure, and (iii) the size of the monetary multipliers; and

3. examine the theoretical and statistical problems of selecting a variable to represent monetary actions in a single equation model.

To this end the study will proceed in the following manner. Chapter II compares the multiplier results of the Andersen-Jordan, Meiselman-Simpson, Laffer-Ranson, and the Friedman-Meiselman single-
equation models and illustrates problems that arise in an attempt
to compare the size and time response of the multipliers. Chapter
III empirically reconciles in a pair-wise method the four models
discussed and compared in Chapter II. Using the Andersen-Jordan
model as the standard of comparison, the monetary multipliers of
each model are reconciled by analyzing each aspect that is different
and determining what effect each difference has on the size and
time response of the monetary multipliers. Chapter IV extends the
analysis of the single-equation model. A general model is formu-
lated using various monetary and reserve aggregates as exogenous
variables to compare their relative abilities to predict changes in
gross national product. The model allows for alternative lag struc-
tures to be used to determine which is best fitting. Two procedures
for seasonally adjusting the data and a fiscal variable are included
in the model to determine the effect of each on the size of the
multipliers, the predictive ability of the equation, and the choice
of the best fitting lag structure—for the monetary and reserved
aggregates. Chapter V examines the theoretical and statistical
problems of selecting a monetary variable for single-equation models.
Chapter VI will simply summarize the previous chapters and draw
conclusions resulting from the analysis therein.
CHAPTER II

A DESCRIPTION AND COMPARISON OF FOUR SINGLE-EQUATION MODELS

Comparing single-equation monetary multipliers can be an arduous task due to differences in variables, time periods, types of data, and lag structures among models. This chapter will briefly describe four of the more well known single-equation models: the Friedman-Meiselman,\(^1\) Andersen-Jordan,\(^2\) Laffer-Ranson,\(^3\) and the Meiselman-Simpson.\(^4\) A comparison of these models and their multiplier results will indicate the difficulties that arise, however, when a meaningful comparison of multipliers is attempted.


A Description of the Models

Friedman-Meiselman Model

An early attempt to show the systematic relationship between the money supply and economic activity using a single-equation model was the study done for the Commission on Money and Credit by Milton Friedman and David Meiselman. Their investigation was designed primarily to compare the relative stability of monetary velocity and the "Keynesian" multiplier for the period 1897-1958. The major technique of the Friedman-Meiselman analysis was to correlate money and income (or consumption) and autonomous expenditures and income (or consumption). The results of these correlations were strikingly one-sided. Using absolute values and year-to-year or quarter-to-quarter changes, it was found that except for the early years of the Great Depression, money was more closely related to both normal and real values of income (or consumption) than was autonomous expenditures.5

While not mentioned in the text, the appendix to their paper presented a multiple regression equation with money multipliers that fits into the Friedman-Meiselman theoretical framework.6 The model regressed quarterly first differences in consumption on both quarterly first differences in the money supply broadly defined (currency

5Milton Friedman and David Meiselman, op. cit., p. 166.
6Ibid., p. 240.
and demand deposits plus time deposits in commercial banks) and quarterly first differences in autonomous expenditures (sum of net investment, net exports, and the government deficit). Consumption was used as a proxy for GNP since part of the autonomous expenditure variable is a component of GNP and therefore not exogenous in the statistical sense.

The single equation regression that they computed was

$$
\Delta C_t = \alpha + \sum_{i=0}^{4} b_i \Delta M_{t-i} + \sum_{i=0}^{5} b_{5+i} \Delta A_{t-i} + \mu
$$

where:

$\Delta C = \text{Seasonally adjusted quarterly first differences of consumption}$

$\Delta M = \text{Seasonally adjusted quarterly first differences of money (currency and demand deposits and time deposits in commercial banks)}$

$\Delta A = \text{Seasonally adjusted quarterly first differences of autonomous expenditures (sum of net investment, net exports, and the government deficit)}$

The monetary and autonomous expenditure multipliers they computed are shown in Table 1.

Shortly after publication by the Commission on Money and Credit of the Friedman-Meiselman investigation, there was a deluge of studies challenging the results of the published work. The combatants were mainly concerned with three weaknesses in the Friedman-Meiselman methodology: the years chosen for the computations; the definition of "autonomous" expenditures; and the inability of
Table 1

Multipliers Calculated on Changes in Consumption Using the Friedman-Meiselman Model for 1945III-1958IV

<table>
<thead>
<tr>
<th></th>
<th>ΔM</th>
<th>ΔA</th>
</tr>
</thead>
<tbody>
<tr>
<td>t</td>
<td>-.142</td>
<td>-.336</td>
</tr>
<tr>
<td>t-1</td>
<td>.830</td>
<td>.058</td>
</tr>
<tr>
<td>t-2</td>
<td>-.215</td>
<td>-.125</td>
</tr>
<tr>
<td>t-3</td>
<td>-.315</td>
<td>-.246</td>
</tr>
<tr>
<td>t-4</td>
<td>-.101</td>
<td>-.009</td>
</tr>
<tr>
<td>Σt-i</td>
<td>.057</td>
<td>-.658</td>
</tr>
<tr>
<td>Constant</td>
<td>26.245</td>
<td></td>
</tr>
<tr>
<td>R²</td>
<td>.523</td>
<td></td>
</tr>
</tbody>
</table>

ΔM = Quarterly first differences in the money supply (broadly defined)
ΔA = Quarterly changes in autonomous expenditures

Note: Regression coefficients are the top figures and their t-values appear below each coefficient enclosed by parenthesis.
correlation techniques to distinguish an influence of money on
business activity from an influence of business activity on money.⁷

**Andersen-Jordan Model**

In 1968, Leonall Andersen and Jerry Jordan at the Federal
Reserve Bank of St. Louis, using techniques similar to those used
by Friedman and Meiselman, published the results of their research
designed to measure the impact and lagged response of changes in
the money supply and the high employment budget surplus on gross
national product.⁸

The regression equation that Andersen and Jordan calculated
was

\[ ΔGNP = α + \sum_{i=0}^{3} b_i ΔM_{t-1} + \sum_{i=0}^{3} b_{4+i} Δ(R-E)_{t-1} + μ \]

⁷See, for example, Albert Ando and Franco Modigliani, "The
Relative Stability of Monetary Velocity and the Investment Multi-
Michael DePrano and Thomas Mayer, "Tests of the Relative Importance
(September, 1965), pp. 729-52; Milton Friedman and David Meiselman,
"Reply to Ando and Modigliani and to dePrano and Mayer," *American
Economic Review*, (September, 1965), pp. 753-85; A. Ando and F.
Modigliani, "Rejoinder," *American Economic Review*, (September, 1965),
pp. 786-90; Michael dePrano and Thomas Mayer, "Rejoinder," *American
Economic Review*, (September, 1965), pp. 791-93; Donald D. Hester,
"Keynes and the Quantity Theory: A Comment on the Friedman-Meiselman
pp. 364-8; Milton Friedman and David Meiselman, "Reply to Donald
369-76; Donald D. Hester, "Rejoinder," *Review of Economics and Sta-

⁸Leonall C. Andersen and Jerry Jordan, *op. cit.*
where:

\[ \Delta \text{GNP} = \text{Quarterly first differences in gross national product seasonally adjusted} \]

\[ \Delta M = \text{Quarterly first differences of money conventionally defined (currency and demand deposits)} \]

\[ \Delta (R-E) = \text{Quarterly first differences in the high employment budget surplus} \]

The structure of lags presented in the regression was estimated with the use of the Almon lag technique. This procedure for estimating lag distributions has become popular recently since it imposes very few a priori restrictions on the shape of the lag structure; the only requirement being that it can be approximated by a polynomial. Their regression coefficients are shown in Table 2.

The "St. Louis" study stimulated considerable interest and discussion partially because the calculated money multipliers were larger than most economists predicted. An equally surprising result of the "St. Louis" model was the speed with which money acted on the economy. The ensuing debate centered on several key issues, similar to the controversy surrounding the Friedman-Meiselman model. The main points of contention were how much of the relationship found

---

9 See Shirley Almon, "The Distributed Lag Between Capital Appropriations and Expenditures," Econometrica, (January, 1965), pp. 178-96. The lag structure chosen was selected on the basis of minimum standard error of the coefficient attached to the monetary variable.
Table 2

Multipliers Calculated on Changes in Gross National Product Using the Andersen-Jordan Model for 1952I-1968II

<table>
<thead>
<tr>
<th></th>
<th>$\Delta M$</th>
<th>$\Delta (R-E)$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$t$</td>
<td>1.57</td>
<td>-.15</td>
</tr>
<tr>
<td></td>
<td>(2.17)</td>
<td>(.65)</td>
</tr>
<tr>
<td>$t-1$</td>
<td>1.94</td>
<td>-.20</td>
</tr>
<tr>
<td></td>
<td>(3.60)</td>
<td>(1.08)</td>
</tr>
<tr>
<td>$t-2$</td>
<td>1.80</td>
<td>.10</td>
</tr>
<tr>
<td></td>
<td>(3.37)</td>
<td>(.55)</td>
</tr>
<tr>
<td>$t-3$</td>
<td>1.28</td>
<td>.47</td>
</tr>
<tr>
<td></td>
<td>(1.88)</td>
<td>(1.95)</td>
</tr>
<tr>
<td>$\Sigma_{t-1}$</td>
<td>6.59</td>
<td>.22</td>
</tr>
<tr>
<td></td>
<td>(7.73)</td>
<td>(.45)</td>
</tr>
<tr>
<td>Constant</td>
<td>1.99</td>
<td></td>
</tr>
<tr>
<td>$R^2$</td>
<td>.56</td>
<td></td>
</tr>
</tbody>
</table>

$\Delta M$ = Quarterly first differences in the money supply (narrowly defined)

$\Delta (R-E)$ = Quarterly first differences in the high employment budget surplus

Note: Regression coefficients are the top figures, and their t-values appear below each coefficient enclosed by parenthesis.
was due to reverse causation, the time period covered, and the use of the high employment budget surplus.  

**Laffer-Ranson Model**

A recent effort made to express the essential characteristics of the United States economy in a single-equation model is the Office of Management and Budget (OMB) model developed by Arthur B. Laffer and R. David Ranson. Their model reflected a composite of the Keynesian, quantity theory, and efficient-markets approaches to macro-economic theory. The Keynesian view of income determination is said to be included in the model by using Federal Government


11Arthur B. Laffer and R. David Ranson, op. cit.

12The first two schools of thought are fairly well known, but the third may need some explanation. Laffer and Ranson interpret the efficient-markets hypothesis to mean that market prices accurately reflect future economic events. For example, stock prices are assumed to provide the best (unbiased and minimum variance) forecast of future real income, and interest rates are assumed to offer the best forecast of future rates of inflation.
purchases of goods and services as a fiscal policy variable; the quantity theory, by the inclusion of the narrowly defined money stock (demand deposits plus currency); the efficient-markets hypothesis, by inclusion of the Standard and Poor's composite index of common stock prices.

The regression equation estimated was

$$\Delta Y = \alpha + b_1 D_1 + b_2 D_2 + b_3 D_3 + b_4 \Delta M_t + \sum_{i=0}^{3} b_{5+i} \Delta G_{t-i} + b_6 \Delta SH + b_{10} \Delta SP_{t-1} + \mu$$

where:

- $\Delta Y$ = Quarterly change in the log of gross national product
- $D_1$ = Dummy seasonal variable for the first quarter
- $D_2$ = Dummy seasonal variable for the second quarter
- $D_3$ = Dummy seasonal variable for the third quarter
- $\Delta M$ = Quarterly change in the log of money supply (currency plus demand deposits)
- $\Delta G$ = Quarterly change in the log of federal government purchases of goods and services
- $\Delta SH$ = Quarterly change in the proportion of industrial manhours lost due to strikes
- $\Delta SP$ = Quarterly change in the log of Standard and Poor's Composite Index of Common Stock Prices (the "S&P 500")

The coefficients for the OMB model were determined using ordinary least squares on seasonally unadjusted data. The results obtained are shown in Table 3.

Perhaps due to the relatively recent publication of the OMB model there have been few published critical evaluations of it. However, since the Office of Management and Budget used this model to make economic projections of the U.S. economy for the Nixon administration, Senator Proxmire asked the Board of Governors of
Table 3

Multipliers Calculated on Changes
In the Log of Gross National Product Using
The Laffer-Ranson Model for 1948I-1969IV

<table>
<thead>
<tr>
<th></th>
<th>$\Delta M$</th>
<th>$\Delta G$</th>
<th>$\Delta SH$</th>
<th>$\Delta SP$</th>
<th>$D_1$</th>
<th>$D_2$</th>
<th>$D_3$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$t$</td>
<td>1.10</td>
<td>0.136</td>
<td>-0.045</td>
<td></td>
<td>0.088</td>
<td>0.025</td>
<td>0.029</td>
</tr>
<tr>
<td></td>
<td>(5.5)</td>
<td>(6.9)</td>
<td>(3.7)</td>
<td></td>
<td>(12.1)</td>
<td>(2.6)</td>
<td>(4.0)</td>
</tr>
<tr>
<td>$t-1$</td>
<td>---</td>
<td>-0.068</td>
<td>---</td>
<td>0.068</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(3.3)</td>
<td></td>
<td>(2.2)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$t-2$</td>
<td>---</td>
<td>-0.039</td>
<td>---</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(1.9)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$t-3$</td>
<td>---</td>
<td>-0.024</td>
<td>---</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(1.2)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\Sigma t-1$</td>
<td>1.10</td>
<td>.005</td>
<td>-0.045</td>
<td>.068</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Constant</td>
<td>.032</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>R²</td>
<td>.958</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

$\Delta M$ = Quarterly change in the log of the money supply (narrowly defined)

$\Delta G$ = Quarterly change in the log of federal government purchases of goods and services

$\Delta SH$ = Quarterly change in the proportion of industrial manhours lost due to strikes

$\Delta SP$ = Quarterly change in the log of Standard and Poor's Composite Index of Common Stock Prices (the "S&P 500")

$D_1$, $D_2$, $D_3$ = Dummy seasonal variables for the first, second, and third quarters

Note: Regression coefficients are the top figures and their t-values appear below each coefficient enclosed by parentheses.
the Federal Reserve System to present a critique to the Joint Economic Committee of Congress. James L. Pierce of the Federal Reserve Board staff made such an evaluation and challenged the model on several issues. First, the statistical properties of the model (possibly reverse influence from business activity to money and using seasonally unadjusted data) would lead to biased coefficients. Second, there are strong a priori reasons to believe that it takes longer than the results of the model indicated for monetary changes to work out their total effects. Third, the model was not very accurate because its standard error of estimate was high.

**Meiselman-Simpson Model**

The Federal Reserve Bank of Boston recently published the proceedings of a monetary conference which contained a research effort by David Meiselman and Thomas D. Simpson using a single-equation model. In some ways this is an extension of the earlier work of

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15 David Meiselman and Thomas D. Simpson, op. cit.
Friedman and Meiselman with modifications. The two most notable changes were the assumptions made regarding the lag structure (Meiselman-Simpson used the Almon technique) and dropping the autonomous expenditure variable. A third change in the paper was a move toward disaggregation. Meiselman-Simpson showed money multipliers for income and consumption with consumption broken into six categories of expenditure. The basic model was

\[ \Delta GNP = \alpha + \sum_{i=0}^{5} b_i \Delta M_{t-i} + \mu \]

where:

\( \Delta GNP \) = Quarterly changes in seasonally adjusted gross national product

\( \Delta M \) = Quarterly changes in seasonally adjusted money supply narrowly defined (currency and demand deposits)

The regression coefficients computed using the Meiselman-Simpson model are shown in Table 4.

Although there has been little mention in the economic literature of this study, the disaggregated form of the model provides some insight into the channels of monetary impulses. As more work is done on the relationship between monetary changes and consumption, there is good reason to believe that more attention will be devoted to this important study.

The only criticisms and discussion of this work are found in Ronald J. Daly, "Discussion," in Consumer Spending and Monetary Policy: The Linkages, op. cit., pp. 280-8; and Franco Modigliani, "Epilogue--Some Evidence of the FMP Model's Ability to Capture Monetary Effect on Consumption and on the Reliability of the Reduced Form Approach," ibid., pp. 59-74.
Table 4

Multipliers Calculated on Changes In Gross National Product Using the Meiselman-Simpson Model for 1952I-1969IV

<table>
<thead>
<tr>
<th></th>
<th>( \Delta M )</th>
</tr>
</thead>
<tbody>
<tr>
<td>( t )</td>
<td>1.388</td>
</tr>
<tr>
<td>( t-1 )</td>
<td>1.681</td>
</tr>
<tr>
<td>( t-2 )</td>
<td>1.315</td>
</tr>
<tr>
<td>( t-3 )</td>
<td>0.669</td>
</tr>
<tr>
<td>( t-4 )</td>
<td>0.066</td>
</tr>
<tr>
<td>( t-5 )</td>
<td>-0.227</td>
</tr>
<tr>
<td>( \sum \Delta M_{t-i} )</td>
<td>4.892</td>
</tr>
<tr>
<td>Constant</td>
<td>3.032</td>
</tr>
<tr>
<td>( R^2 )</td>
<td>0.53</td>
</tr>
</tbody>
</table>

\( \Delta M \) = Quarterly changes in the money supply (narrowly defined)

Note: Regression coefficients are the top figures, and their t-values appear below each coefficient enclosed by parenthesis.
A Comparison of Results

A simple comparison of the monetary multipliers of these four models indicates significant differences in the results (see Table 5). The Friedman-Meiselman study presented multiplier results for five quarters with the total effect being rather small (.057). Although the total effect was positive, four of the five quarterly multipliers were negative. This is a rather surprising result in light of the Friedman view that money is all important in determining the level of money income. Friedman has indicated elsewhere, however, that the full impact of changes in the money supply is achieved only after a long lag. Therefore, five quarters may not be sufficient to capture the total effect. The only positive multiplier that Friedman-Meiselman presented, however, was money lagged one quarter.

Andersen-Jordan reported multipliers for the current and three lagged quarters. Each quarter reported had a positive multiplier and the total effect was the largest of the four studies compared (6.59). Not only were the quarterly multipliers large, but the response of the economy to monetary changes was very rapid. Over 50 percent of the total effect occurred within one quarter after the change in the money supply and the total effect was completed within a year (see Figure 1). Therefore, according to the "St.

### Table 5

Monetary Multiplier Results for Four Single Equation Models

<table>
<thead>
<tr>
<th>t</th>
<th>Friedman-Meiselman</th>
<th>Andersen-Jordan</th>
<th>Laffer-Ranson</th>
<th>Meiselman-Simpson</th>
</tr>
</thead>
<tbody>
<tr>
<td>t</td>
<td>-.142</td>
<td>1.57</td>
<td>1.10%</td>
<td>1.388</td>
</tr>
<tr>
<td>t-1</td>
<td>.830</td>
<td>1.94</td>
<td>--</td>
<td>1.681</td>
</tr>
<tr>
<td>t-2</td>
<td>-.215</td>
<td>1.80</td>
<td>--</td>
<td>1.315</td>
</tr>
<tr>
<td>t-3</td>
<td>-.315</td>
<td>1.28</td>
<td>--</td>
<td>.669</td>
</tr>
<tr>
<td>t-4</td>
<td>-.101</td>
<td>--</td>
<td>--</td>
<td>.066</td>
</tr>
<tr>
<td>t-5</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>-.227</td>
</tr>
<tr>
<td>(\Sigma M_{t-i})</td>
<td>.057</td>
<td>6.59</td>
<td>1.10%</td>
<td>4.892</td>
</tr>
<tr>
<td>Constant</td>
<td>26.245</td>
<td>1.99</td>
<td>.032</td>
<td>3.032</td>
</tr>
<tr>
<td>(R^2)</td>
<td>.523</td>
<td>.56</td>
<td>.958</td>
<td>.53</td>
</tr>
</tbody>
</table>
Figure 1
Cumulative Percentage Effects of Changes in Monetary Variables on GNP (Consumption for F-M) of Four Single Equation Models

Source: Computed from information given in Table 5.
Louis" equation, if the level of the money supply underwent a $1 billion once-and-for-all rise in a given quarter, it would raise GNP by $1.6 billion in that quarter and by $6.6 billion at the end of four quarters.

Possibly the most interesting results of the models discussed is the money multiplier of the OMB model reported by Laffer and Ranson. Laffer and Ranson showed a multiplier of 1.10, but their results were expressed in natural logs (i.e., every 1 percent change in the money supply was associated with a 1.1 percent change in GNP). Laffer-Ranson contended that converting the percentage multiplier to ordinary first differences would give a money multiplier of between four and five, which was roughly of the same magnitude as the Meiselman-Simpson model and slightly smaller than the Andersen-Jordan results. The surprising feature of this OMB result was not the size of the multiplier, but rather that the entire effect occurred in the same quarter as the change in the money supply. Essentially these results indicated that monetary policy was both a very powerful weapon and had an immediate and permanent impact on GNP.

Meiselman-Simpson showed monetary multipliers for six quarters. For comparable quarters the multipliers were smaller than those obtained by Andersen-Jordan, but the time pattern was almost identical (see Table 5 and Figure 1). The total effect (4.89) was closer, however, to the total effect reported by Laffer and Ranson.
Problems of Comparing Monetary Multipliers

The results of the models compared are similar in some respects, yet in other ways, very different. Isolating the factors that cause these variations is not easy because of the many differences among the models. A comparison of the basic features of the four models will help to expose the difficulty in trying to pinpoint the reasons for variations in the size and time response of monetary multipliers. Table 6 shows the major differences.

One difference is the time periods used in computing the regression coefficients (see Column 2). Second, there are variations in the type of data used. One study (Laffer-Ranson) used seasonally unadjusted quarterly first differences of natural logs, while the other three used seasonally adjusted quarterly first differences (see Column 3). A third difference is the dependent variable used in the regression. The Friedman-Meiselman study used consumption (as a proxy for GNP) as the dependent variable, while the others used gross national product (see Column 5). A fifth difference is variation in the fiscal variable. The Friedman-Meiselman study used an "autonomous expenditure variable". Their definition of "autonomous expenditures" was the sum of the government deficit on product account, net private domestic investment, and net exports. The Meiselman-Simpson study used no fiscal variable, while Andersen-Jordan used the high employment budget surplus, and Laffer-Ranson used Federal Government purchases of goods and services (see Column
### Table 6

A Comparison of Four Reduced-Form Models on Several Important Issues

<table>
<thead>
<tr>
<th>MODEL</th>
<th>TIME PERIOD</th>
<th>TYPE OF DATA</th>
<th>DEPENDENT VARIABLE</th>
<th>MONETARY VARIABLE</th>
<th>FISCAL VARIABLE</th>
<th>OTHER VARIABLES</th>
<th>LAG STRUCTURE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Friedman-Helselman</td>
<td>1945III-1958IV</td>
<td>Seasonally adjusted quarterly 1st differences</td>
<td>Consumption</td>
<td>$M_2$ (Money - broadly defined)</td>
<td>Autonomous Expenditures Variable = Net Investment + Govt. Deficit + Net Exports</td>
<td>none</td>
<td>Unconstrained</td>
</tr>
<tr>
<td>Andersen-Jordan</td>
<td>1952I-1968IV</td>
<td>Seasonally adjusted quarterly 1st differences</td>
<td>Gross National Product</td>
<td>$M_1$ (Money - narrowly defined)</td>
<td>High Employment Budget Surplus</td>
<td>none</td>
<td>Almon 4th degree polynomial</td>
</tr>
<tr>
<td>Laffer-Ranson</td>
<td>1948I-1969IV</td>
<td>Seasonally unadjusted quarterly 1st differences of natural logs</td>
<td>Gross National Product</td>
<td>$M_1$ (Money - narrowly defined)</td>
<td>Federal Government Purchases of Goods and Services</td>
<td>(1) Stock Prices (2) Manhours Lost Due to Strikes (3) Dummy Seasonal Variables</td>
<td>Unconstrained</td>
</tr>
<tr>
<td>Meiselman-Simpson</td>
<td>1952I-1969IV</td>
<td>Seasonally adjusted quarterly 1st differences</td>
<td>Gross National Product</td>
<td>$M_1$ (Money - narrowly defined)</td>
<td>none</td>
<td>none</td>
<td>Almon 4th degree polynomial</td>
</tr>
</tbody>
</table>
6). A sixth difference is that the Laffer-Ranson study included additional variables not found in the other studies. The Laffer-Ranson model had a stock price variable, a variable representing manhours lost due to strikes, and three dummy seasonal variables. Finally, the seventh difference involves the assumed lag structures. Meiselman-Simpson and Andersen-Jordan used the Almon lag technique (both assumed 4th degree polynomials) while Friedman-Meiselman and Laffer-Ranson made no explicit assumption about the lag structure and by not doing so allowed the variables to be "free" to take on any value.

Because of these numerous differences among the four models, a meaningful comparison of the monetary multipliers is difficult, if not impossible. It will therefore be the task of the following chapter to isolate each difference and to determine what effect it has on the size and time response of the monetary multipliers.
 CHAPTER III

A PAIRWISE RECONCILIATION OF THE MONETARY MULTIPLIERS IN FOUR SINGLE EQUATION MODELS

The preceding chapter suggested that comparing monetary multipliers is more complex than it might first appear. The four models presented and compared in Chapter II reported different monetary multipliers with respect to their total effect and the distribution of these effects. The fact that such differences exist, however, is not necessarily a cause for great concern, as some variations in the results are expected when regression periods and variables differ. What is astonishing, though, is the degree of difference that exists among the models. The monetary multipliers exhibited in Table 5 of Chapter II have, in some cases, extremely different implications as to the importance of money in its total multiplier effect and the speed of these effects on the economy. The determination of what factors are responsible for the different multipliers will be the objective of this chapter.

To isolate those factors accounting for the variation of the monetary multipliers, each model was initially calculated in its original form and for its original time period. To determine whether the time period itself is a significant factor influencing the regression results, a common time period - 1952I-1968II - was chosen
to compare the models. Using this period, the same used in the Andersen-Jordan study, allowed the Andersen-Jordan model to be the standard of comparison.

Reconciliation of the Meiselman-Simpson and the Andersen-Jordan Models

An examination of the characteristics of the Andersen-Jordan (A-J) and the Meiselman-Simpson (M-S) models disclosed several resemblances and differences that were helpful in the reconciliation of the monetary multipliers. Each model uses:

1. gross national product as the dependent variable and the narrowly defined money stock \( M_1 \) as the monetary variable;
2. first differences of seasonally adjusted quarterly data measured at annual rates;
3. the Almon lag technique to constrain the lags.\(^1\)

The basic differences noted in the models are as follows:

1. the M-S model uses the time period 1952I-1969IV for estimating the regression coefficients, while A-J uses 1952I-1968II;
2. the M-S model uses only a monetary variable \( M_1 \), whereas the A-J model uses both a monetary variable \( M_1 \) and the high employment budget surplus;

\(^1\)In each case the Almon lags were 4th degree polynomials constrained to zero at \( t+1 \) and \( t-n \) where \( n \) is the length of the lag.
3. the M-S model uses the 1970 money stock series while the A-J model uses the 1967;

4. the M-S model has five lagged periods - the A-J model has three.

The problem, therefore, was to ascertain how each of these differences contributed to the different monetary multipliers.

Shown in columns (1) and (2) of Table 7 are the monetary multipliers calculated using the A-J and M-S models for the time periods used in the original studies. The total multiplier calculated for the A-J model was 6.45; for the M-S model, 4.88. To measure the magnitude of this difference attributable to the different regression periods used, the M-S model was recalculated for the 1952I-1968II period. As shown in column (3) of Table 7 the recalculation increased the size of the multipliers of the M-S model for each quarter, so that the total multiplier increased from 4.88 to 5.83 - over 19 percent. Using a common time period thus eliminated over one-half of the difference (from 1.57 to .62) in the total

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The multipliers shown in columns (1) and (2) of Table 7 are slightly different from the published multipliers reproduced for discussion and comparison in Chapter II. To reconcile the models it was necessary that each model be calculated for its original regression period. However, two types of data problems made exact duplication impossible: first, the exact data used for the original calculations is often unavailable because of data revisions; and second, the original data may have had minor modifications made by researchers who did not report such changes when the results of the original studies were published. These problems coupled with slight computer rounding differences do not ordinarily cause drastic differences in the results, but make exact duplication extremely difficult and usually impossible.
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>t</td>
<td>1.72* (2.29)</td>
<td>1.51* (3.45)</td>
<td>1.41* (3.34)</td>
<td>1.68* (3.29)</td>
</tr>
<tr>
<td>t-1</td>
<td>1.94* (3.52)</td>
<td>1.77* (6.65)</td>
<td>1.87* (7.43)</td>
<td>2.18* (7.02)</td>
</tr>
<tr>
<td>t-2</td>
<td>1.65* (3.06)</td>
<td>1.39* (4.18)</td>
<td>1.59* (4.68)</td>
<td>1.89* (5.10)</td>
</tr>
<tr>
<td>t-3</td>
<td>1.15 (1.61)</td>
<td>0.80* (2.35)</td>
<td>0.85* (2.51)</td>
<td>1.19* (3.09)</td>
</tr>
<tr>
<td>t-4</td>
<td>.14 (.56)</td>
<td>.31 (.99)</td>
<td>.025 (.097)</td>
<td>.43 (1.30)</td>
</tr>
<tr>
<td>t-5</td>
<td>-.18 (.42)</td>
<td>-.049 (.10)</td>
<td>-.44 (.22)</td>
<td>-.067 (.133)</td>
</tr>
<tr>
<td>Σt</td>
<td>6.45</td>
<td>4.88</td>
<td>5.83</td>
<td>7.30</td>
</tr>
<tr>
<td>Constant</td>
<td>1.92 (1.94)</td>
<td>2.19* (2.02)</td>
<td>2.61* (2.90)</td>
<td>1.14</td>
</tr>
<tr>
<td>R²</td>
<td>.54</td>
<td>.52</td>
<td>.48</td>
<td>.58</td>
</tr>
<tr>
<td>S.E.E.</td>
<td>4.61</td>
<td>4.70</td>
<td>4.81</td>
<td>4.51</td>
</tr>
<tr>
<td>D.W.</td>
<td>1.41</td>
<td>1.27</td>
<td>1.25</td>
<td>1.47</td>
</tr>
</tbody>
</table>

Note: Numbers in parentheses represent t-values for the corresponding coefficient. Those marked with an * are significant at the .05 level.

1The following symbols are used to abbreviate variations in the Meiselman-Simpson Model: O.D. = original data; HERS = High Employment Budget Surplus.
multipliers. This difference can be reduced further by using the 1967 money stock revision as used in the A-J model instead of the 1970 series as used in the M-S model [see column (4) of Table 7].

The second difference of the two models examined was the use of high employment budget surplus as a fiscal variable in the A-J model. To measure the variation in the monetary multiplier attributable to the high employment budget surplus, the M-S model was recomputed for the 1952I-1969IV and 1952I-1968II periods with the fiscal variable included. The recalculated monetary multipliers are shown in columns (5) and (6) of Table 7. Comparing columns (2) and (5) shows that, with the exception of t-4, the monetary multipliers for each quarter of the 1952I-1969IV period increased. The total multiplier increased from 4.88 to 5.31. For the 1952I-1968II period the multipliers increased by an even larger amount [compare columns (3) and (6) of Table 7] using the high employment budget surplus. Each quarterly multiplier, except for t-5, was

3With each revision in the money stock since 1960 (about every three years) the figures on the average have been revised upward. This causes the monetary multipliers for any given period to be smaller ceteris paribus when computed with later revisions of the money stock.

4There may be some question as to whether the M-S model can still be called the M-S model when the high employment budget surplus is included in the regression as a variable. The unique characteristic of the M-S model is that it used only a monetary variable. The purpose of this analysis, however, is to identify the factors tending to make the A-J monetary multipliers larger than those computed by M-S. Since the inclusion of the high employment budget surplus by A-J may be a major factor in causing this difference, the variable should be included in the original M-S model to examine the effect on the monetary multipliers.
substantially larger for comparative quarters than the original M-S model. The multiplier for t-5 was smaller, but was a smaller negative multiplier, so that the total multiplier increased by 1.47, from 5.83 to 7.30.

The final difference of the two models is the number of lagged periods used. The results of recomputing the M-S model for the 1952I-1969IV and 1952I-1968II periods using only three lagged monetary variables are shown in columns (7) and (8) of Table 7. The resulting change in the M-S multipliers after eliminating two lagged periods from the M-S model was not uniform. Comparing the multipliers in columns (2) and (7) indicates that for the 1952I-1969IV period the t and t-3 multipliers increased, while the t-1 and t-2 multipliers decreased. The total multiplier increased from 4.88 to 5.07, primarily it appears, because the negative multiplier for t-5 was eliminated. For the 1952I-1968II period [see columns (3) and (8) of Table 7], the multipliers for t and t-3 also increased; while for t-1 and t-2, decreased. The total multiplier decreased slightly - from 5.83 to 5.80 - when including only three lagged periods in the M-S model.

To emphasize the distributed impact of the monetary multipliers in the M-S and A-J models, cumulative percentage multipliers were calculated. The results (shown in Figures 2, 3, and 4) indicate that neither the time period used, the high employment budget surplus, or the number of lagged periods included in the two models appreciably affected the measured time response of gross national
Figure 2
Cumulative Percentage Effects of Changes in the Money Supply ($M_1$) on GNP Using the Andersen-Jordan Model and Variations of the Meiselman-Simpson Model

Source: Calculated from Table 7

Note: Identifying numbers correspond to column numbers of Table 7
(1) Andersen-Jordan Model for Period 1952II-1968II
(2) Meiselman-Simpson Model for Period 1952I-1969IV
(3) Meiselman-Simpson Model for Period 1952I-1968II
(4) Meiselman-Simpson Model for Period 1952I-1968II using the 1967 Money Stock Series
Figure 3
Cumulative Percentage Effects of Changes in the Money Supply (M₁) on GNP Using the Andersen-Jordan Model and Variations of the Meiselman-Simpson Model

Source: Calculated from Table 7
Quarters after Changing the Money Supply

Note: Identifying numbers correspond to column numbers of Table 7
(1) Andersen-Jordan Model for Period 1952I-1968II
(2) Meiselman-Simpson Model for Period 1952I-1969IV
(3) Meiselman-Simpson Model for Period 1952I-1969IV with the full employment budget surplus
(6) Meiselman-Simpson Model for Period 1952I-1968II with the full employment budget surplus
Figure 4
Cumulative Percentage Effects of Changes in the Money Supply (M₁) on GNP Using the Andersen-Jordan Model and Variations of the Heiselman-Simpson Model

<table>
<thead>
<tr>
<th>Source: Calculated from Table 7</th>
<th>Note: Identifying numbers correspond to column numbers of Table 7</th>
</tr>
</thead>
<tbody>
<tr>
<td>(2) Heiselman-Simpson Model for Period 1952I-1968IV</td>
<td>(2) Heiselman-Simpson Model for Period 1952I-1968IV</td>
</tr>
<tr>
<td>(7) Heiselman-Simpson Model for Period 1952I-1968IV with only three lagged variables</td>
<td>(7) Heiselman-Simpson Model for Period 1952I-1968IV with only three lagged variables</td>
</tr>
<tr>
<td>(8) Heiselman-Simpson Model for Period 1952I-1968II with only three lagged variables</td>
<td>(8) Heiselman-Simpson Model for Period 1952I-1968II with only three lagged variables</td>
</tr>
</tbody>
</table>
product to changes in the money supply. Although there were slight variations, 25-30% of the total effect of a change in the money supply occurred within one quarter; 50-60%, within six months; and over 90%, within a year of the initial change in the money supply.

In summary, it appears that two factors - the time period used and the inclusion or omission of the high employment budget surplus - account for the major difference between the A-J and M-S monetary multipliers. The M-S model contains six quarters not included in the A-J regression period - the last two quarters of 1968 and all four quarters of 1969. The lower total multiplier of the M-S model would therefore indicate that the money supply was not as an important determinate of changes in nominal gross national product for those six quarters as for the 1952I-1968II period. This implies that the money-gross national product relationship measured in both the A-J and M-S models may not be stable over time.

When the high employment budget surplus was added to the M-S model, the effect was an increase in the monetary multipliers, especially for the 1952I-1968II period. This increased size might indicate that much of the deficit of the high employment budget of the 1960's was financed by monetary expansion.

The elimination of two lagged monetary variables in the M-S model had very little effect on the total monetary multiplier since most of the total effect occurred within one year. None of the monetary variables lagged had statistically significant coefficients and most of these coefficients were small in absolute size. None
of the differences in the M-S and A-J models materially affected the time response of the monetary multipliers.

Reconciliation of the Laffer-Ranson and the Andersen-Jordan Models

The many dissimilarities in the Andersen-Jordan (A-J) and the Laffer-Ranson (L-R) models presented reconciliation difficulties not encountered in that of the A-J and M-S. The basic differences in the models are as follows:

1. the multipliers of the L-R model are calculated using first differences of logs of quarterly data, whereas A-J uses ordinary first differences;

2. the L-R model is computed for the period 1948I-1969IV - the A-J model, for the 1952I-1968II period;

3. the L-R model uses seasonally unadjusted data, whereas A-J uses seasonally adjusted data;

4. the L-R model has no lagged money supply variables, while A-J has three;

5. the L-R model imposes no constraint on any lagged variables, while A-J uses the Almon lag technique with two zero constraints;

6. the L-R model uses the Federal Government's Purchases of Goods and Services to represent fiscal action, whereas the A-J model uses the high employment budget surplus;
7. the L-R model uses two variables that have no counterpart in the A-J model, "Manhours Lost Due to Strikes" and the "Standard and Poors Composite Index of Stock Prices".

A reconciliation of these differences will show how each contributes to the variation in the total multiplier and the distribution of its impact.

Since the monetary multipliers of the two models are expressed in different units, they are not directly comparable. The L-R monetary multiplier is stated in terms of percentage change, while the A-J multipliers are stated in terms of a one unit (dollar) change. The "percentage change" multiplier cannot, however, be converted into the "dollar change" multiplier without reference to a particular point in time. This is necessarily true because over the regression period the money supply on the average increased in size, so that a one dollar change in 1948 and a one dollar change in 1969 do not represent the same percentage change, even though the absolute change in gross national product caused by a one dollar change in the money supply may be identical in each case. Therefore, to put the two models in equivalent terms for purposes of comparison, the L-R model

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\[ L-R \text{ have stated that their percentage multiplier of } 1.1\% \text{ is equivalent to a first difference multiplier of between 4.0 and 5.0. How they arrived at this estimate is not known, but in any case it seems arbitrary. If they had used the last quarter of their regression period as a base for converting, the percentage multiplier would convert to 5.2. } \]
was recomputed for the original regression period (1948I-1969IV) using ordinary first differences.\(^6\)

The monetary multiplier calculated as a result of these changes is shown in column (5) of Table 8. This multiplier can now be directly compared to the A-J multipliers in column (1). The total multipliers for the two models are not much different, 5.8 for the L-R model versus 6.45 for the A-J model. The distribution of the total multiplier effect, however, is very different. The L-R model shows the entire multiplier effect occurs in the quarter that the money supply change takes place. It takes an entire year for the money supply change to have its total impact in the A-J model.

It might be surmised that the only reason the entire effect of a money supply change occurs so quickly in the L-R model is because no lagged money supply variables were included in the regression. This turns out, however, not to be the case. Columns (3) and (6) of Table 8 show the monetary multipliers computed using the L-R model when three lagged monetary variables were included. The multipliers in column (3) were computed using first differences of logs and those in column (6), using ordinary first differences. In each case the total multiplier remained nearly the same, whether

\(^6\)In the process of recomputing the L-R regression, one other change was made. The original L-R model was computed with quarterly data, while the A-J model used quarterly data stated at annual rates. Thus, to facilitate the comparison, the L-R data were converted to annual rates.
## Table 8

Monetary Multipliers Calculated Using the Andersen-Jordan Model and the Laffer-Ranson Model

<table>
<thead>
<tr>
<th></th>
<th>Andersen-Jordan Model</th>
<th></th>
<th></th>
<th>Laffer-Ranson Model Calculated Using</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1952T-1968II</td>
<td>First differences of Logs</td>
<td>Ordinary First Differences</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>t</strong></td>
<td>1.72* (2.29)</td>
<td>1.11* (5.46)</td>
<td>1.18* (5.34)</td>
<td>.86* (3.61)</td>
<td>5.80* (6.15)</td>
<td>6.04* (7.02)</td>
<td>6.84* (6.67)</td>
</tr>
<tr>
<td><strong>t-1</strong></td>
<td>1.96* (3.52)</td>
<td>-.51* (2.12)</td>
<td>-.28* (.96)</td>
<td>-4.70* (4.69)</td>
<td>-4.53* (3.79)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>t-2</strong></td>
<td>1.65* (3.06)</td>
<td>.52* (2.26)</td>
<td>.84* (3.13)</td>
<td>6.65* (6.98)</td>
<td>6.37* (5.75)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>t-3</strong></td>
<td>1.15* (1.61)</td>
<td>-.18* (.81)</td>
<td>-.06* (2.65)</td>
<td>-2.24* (2.47)</td>
<td>-2.27* (2.07)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>LdM</strong></td>
<td>6.45</td>
<td>1.1</td>
<td>1.01</td>
<td>1.36</td>
<td>5.80</td>
<td>5.75</td>
<td>6.41</td>
</tr>
<tr>
<td><strong>Constant</strong></td>
<td>1.92 (1.90)</td>
<td>.032* (4.85)</td>
<td>.038* (5.20)</td>
<td>.048* (6.11)</td>
<td>4.05</td>
<td>20.42*</td>
<td>18.16*</td>
</tr>
<tr>
<td><strong>R²</strong></td>
<td>.54</td>
<td>.96</td>
<td>.97</td>
<td>.98</td>
<td>.93</td>
<td>.96</td>
<td>.97</td>
</tr>
<tr>
<td><strong>S.E.</strong></td>
<td>4.61</td>
<td>.013</td>
<td>.013</td>
<td>.011</td>
<td>9.4</td>
<td>7.25</td>
<td>7.03</td>
</tr>
<tr>
<td><strong>D.W.</strong></td>
<td>1.41</td>
<td>2.16</td>
<td>1.99</td>
<td>2.09</td>
<td>2.88</td>
<td>2.54</td>
<td>2.50</td>
</tr>
</tbody>
</table>

**Note:** Numbers in parentheses represent t-values for the corresponding coefficient. Those marked with an * are significant at the .05 level.
or not the lagged money supply variables were included. Inclusions of the lagged variables changed the total multiplier from 1.1 to 1.01 when the regression was calculated in terms of first differences of logs, and from 5.8 to 5.75 when ordinary first differences were used.

Since the total multipliers of the A-J and L-R models seem not to be extremely different, the major reconciliation problem involved the distribution of the impact of changes in the money supply on gross national product. Figure 5 indicates how different the distribution of the total effect of a money supply change is between the two models. In the A-J model only about 26% of the total effect occurred in the quarter that the monetary change took place. In contrast, the entire long-run effect occurred in the quarter that the money supply change took place in the L-R model. This is true even when lagged money supply variables were included in the L-R model. Therefore, in the process of reconciling the two models, lagged money supply variables were included in the L-R model so the distributional impact of money supply changes on gross national product would be apparent.

To measure what portion of the difference in the size and time distribution of the total multiplier in the two models was due to the regression period, the L-R model was recalculated for 1952I-1968II. The result is shown in columns (4) and (6) of Table 8. Changing the regression period increased the total monetary multiplier from 1.01 to 1.36 using logarithmic first differences, while
Figure 5
Cumulative Percentage Effects of Changes in the Money Supply ($M_1$) on GNP Using the Andersen-Jordan Model and Variations of the Laffer-Ranson Model

Source: Calculated from Table 8 Quarters after Changing the Money Supply

Note: Identifying numbers correspond to column numbers of Table 8
(1) Andersen-Jordan Model for Period 1952I-1968II
(2) or (5) Laffer-Ranson Model for the Period 1948I-1969IV
(6) Laffer-Ranson Model using ordinary first differences and three lagged monetary variables for Period 1948I-1969IV
(7) Laffer-Ranson Model using ordinary first differences and three lagged monetary variables for Period 1952I-1968II
using ordinary first differences, the increase was from 5.75 to 6.41, which is almost exactly the total multiplier of 6.46 reported by A-J. However, Figure 5 indicates, changing the time period had almost no effect on changing the distribution of the impact of a money supply change. Slightly over 100% of the long-run effect still occurred in the quarter concurrent with the change in the money supply.\(^7\)

The second feature of the L-R model explored was the variable "Proportion of Manhours Lost Due to Strikes and Lockouts." The exclusion of this variable had conflicting results. For the period 1948I-1969IV the effect was to increase both the initial and total monetary multiplier; while for the 1952I-1968II period, the initial and long-run multiplier was reduced [compare columns (2) and (3) with (4) and (5) of Table 9]. Omitting the "Manhours" variable had almost no perceptible impact on the distribution of the total monetary impact; for the 1948I-1969IV period, the percent of the total impact occurring in the current quarter decreased from 105% to 96%, while for the 1952I-1968II period, it increased from 107% to 110%.

\(^7\)During the course of this study it was found that neither the \(R^2\), the significance of the variables, or the distribution of the impact of the monetary variables changed significantly when ordinary first differences were used in the regression analysis instead of first differences of logs. Since the model is stated in terms of ordinary first differences it facilitates comparison to compare the two models on the same basis. Therefore the remaining discussion and reconciliation of L-R and A-J models will be on the basis of ordinary first differences.
<table>
<thead>
<tr>
<th></th>
<th>Andersen-Jordan Model</th>
<th>Laffer-Ranson Model</th>
<th>Omitting SHF</th>
<th>Omitting SPICSP</th>
<th>Using Almon Lags</th>
<th>Using S.A. Data</th>
<th>Using MBHS and S.A.</th>
</tr>
</thead>
<tbody>
<tr>
<td>( t )</td>
<td>1.72*</td>
<td>6.04*</td>
<td>6.84*</td>
<td>6.05*</td>
<td>6.46*</td>
<td>5.97*</td>
<td>6.72*</td>
</tr>
<tr>
<td>( t-1 )</td>
<td>1.94*</td>
<td>-4.70*</td>
<td>-4.54*</td>
<td>-4.93*</td>
<td>-4.42*</td>
<td>-4.82*</td>
<td>-4.75*</td>
</tr>
<tr>
<td>( t-2 )</td>
<td>1.65*</td>
<td>6.65*</td>
<td>6.37*</td>
<td>6.67*</td>
<td>6.13*</td>
<td>6.65*</td>
<td>6.38*</td>
</tr>
<tr>
<td>( t-3 )</td>
<td>1.15</td>
<td>-2.26*</td>
<td>-2.27*</td>
<td>-1.51</td>
<td>-1.77</td>
<td>-2.12*</td>
<td>-2.12*</td>
</tr>
<tr>
<td>( \text{LM}_{t-1} )</td>
<td>6.45</td>
<td>5.75</td>
<td>6.41</td>
<td>6.28</td>
<td>5.90</td>
<td>5.68</td>
<td>6.23</td>
</tr>
<tr>
<td>Constant</td>
<td>1.92</td>
<td>20.42*</td>
<td>18.16*</td>
<td>19.81*</td>
<td>19.17*</td>
<td>20.69*</td>
<td>18.45*</td>
</tr>
<tr>
<td>( R^2 )</td>
<td>.54</td>
<td>.96</td>
<td>.97</td>
<td>.96</td>
<td>.97</td>
<td>.96</td>
<td>.97</td>
</tr>
<tr>
<td>S.E.E.</td>
<td>4.61</td>
<td>7.25</td>
<td>7.03</td>
<td>7.50</td>
<td>7.24</td>
<td>7.21</td>
<td>6.98</td>
</tr>
<tr>
<td>D.W.</td>
<td>1.41</td>
<td>2.54</td>
<td>2.50</td>
<td>2.58</td>
<td>2.57</td>
<td>2.54</td>
<td>2.52</td>
</tr>
</tbody>
</table>

Note: Numbers in parentheses represent t-values for the corresponding coefficient. Those marked with an * are significant at the .05 level.

The following symbols are used to abbreviate variations in the Laffer-Ranson Model: SHF = Manhours Lost Due to Strikes and Lockouts; SPICSP = Standard and Poors Composite Index of Stock Prices; S.A. = Seasonally Adjusted Data; MBHS = High Employment Budget Surplus.
The third feature of the L-R model examined was the "Standard and Poor's Composite Index of Stock Prices". When the "Standard and Poor's" variable was omitted from the L-R model the effect on the money multipliers was quite small and very uniform for both the 1948I-1969IV and 1952I-1968II periods [compare columns (6) and (7) with (2) and (3) in Table 9]. In both cases the initial and total multipliers were slightly reduced. However, in neither period was the percentage of the monetary effect occurring in the current quarter changed - it remained 105% and 107% respectively.

A difference in the A-J and L-R models that had a very noticeable effect on the size of the multiplier and on the distributed impact of money supply changes was the use of the Almon lag technique. In columns (8) and (9) of Table 9 are the calculated coefficients when the Almon technique was applied to the monetary and fiscal variables in the L-R model. It will be observed that the total multiplier increased rather substantially, from 5.75 to 6.67 for the 1948I-1969IV period and from 6.41 to 7.63 for the 1952I-1968II period, when the "Almon lags" were used. The imposition of the Almon constraints also had the effect of changing the distribution of the impact of money on gross national product. Although as

---

8 One rather surprising discovery was made while experimenting with the Almon lag procedure in the L-R model. For the Almon technique to change the magnitudes or distribution of the coefficients, the constraints must be placed on both ends. In other words a constraint on the far end only will give results identical to those calculated using ordinary least squares with no constraints placed on any of the lagged variables.
Figure 6 indicates, 60 and 64 percent of the total effect still occurred in the first quarter for the 1948I-1969IV and 1952I-1968II periods, respectively, the cumulative pattern looked much more like the A-J model. The extent of the differences in the coefficients obtained for individual lagged variables, with or without the use of the Almon technique, was not very reassuring since the explanatory power of the equations (the $R^2$s) remained virtually the same in each case.

The most important factor determining the distributed impact of monetary changes in the L-R model was the use of seasonally unadjusted data. Columns (10) and (11) of Table 9 show the coefficients calculated for the monetary variable when seasonally adjusted data are used. The change that occurs in the total multiplier effect was rather negligible however. As Figure 7 indicates, the cumulative pattern of the total multiplier was much more like the A-J model when seasonally adjusted data were used. The percentage of total effects that took place in the L-R model in period $t$ was reduced from 106 to 40 percent when seasonally adjusted data were used.

Since the measured impact of money supply changes was so drastically altered by the use of seasonally adjusted data, there arose an important question as to which data were most appropriate. L-R

9When the Laffer-Ranson model was calculated in its original form of first differences of logs the cumulative percentage effects were patterned even closer to the Andersen-Jordan model. For the 1952I-1968II period 43% of the total multiplier effect took place in period $t$, 74% in period $t+1$, 86% in $t+2$, and 100% in $t+3$. 
Figure 6
Cumulative Percentage Effects of Changes in the Money Supply on GNP
Using the Andersen-Jordan Model and Variations of the Laffer-Ranson Model

Source: Calculated from Table 9

Note: Identifying numbers correspond to column numbers of Table 9
(1) Andersen-Jordan Model for Period 1952I-1968II
(2) Laffer-Ranson Model calculated using ordinary first differences and three lagged monetary variables for Period 1948I-1968IV
(3) Laffer-Ranson Model calculated using ordinary first differences and three lagged monetary variables for Period 1952I-1968II
(8) Same as number (2) but Almon Lag Technique is used on the monetary and fiscal variables
(9) Same as number (3) but Almon Lag Technique is used on the monetary and fiscal variables
Figure 7
Cumulative Percentage Effects of
Changes in the Money Supply on GNP
Using the Andersen-Jordan Model and Variations of the Laffer-Ranson Model

Source: Calculated from Table 9

Note: Identifying numbers correspond to column numbers of Table 9
(1) Andersen-Jordan Model for Period 1952I-1968II
(2) Laffer-Ranson Model calculated using ordinary first differences and three lagged monetary variables for the Period 1948I-1969IV
(10) Laffer-Ranson Model calculated using ordinary first differences, seasonally adjusted data and three lagged monetary variables for the Period 1948I-1969IV
(11) Same as number (2) but for Period 1952I-1968II
contended that for purposes of conditional forecasting and for hypothesis testing seasonally adjusted data were not appropriate for several reasons:

"First seasonal adjustments which are arrived at in part through smoothing the original data tend to remove some of the behavioral covariance in the guise of seasonality. Second, seasonal adjustments, because of their averaging aspects, may tend to introduce autocorrelation into the data. Thus averaging can also obfuscate the timing of statistical relationships. Third, hypothesis tests which use seasonally adjusted data do not take account of the inevitable loss of degrees of freedom."10

Michael Hamburger in partial support of the L-R position stated that: "In principle, joint estimation of the seasonal factors and the economic parameters of a model is preferable to the use of data generated by the standard type of seasonal adjustment procedure."11 However, Hamburger further contended that by L-R having only three dummy variables they "... assume that the seasonal pattern in income is constant over the entire sample period. If this assumption is not correct, it becomes a purely empirical question as to whether their procedure is any better or worse than the use of seasonally adjusted data."12


12 Ibid., pp. 294-5.
The last difference in the A-J and L-R models explored was the fiscal variables used. The L-R model used federal government purchases of goods and services, while the A-J model used the high employment budget surplus. Because of data problems no *ceteris paribus* test could be made to determine exactly what the effect would have been in the L-R model had the high employment budget surplus been used.\(^{13}\) As an alternative measure, coefficients were calculated in the L-R model using the high employment budget surplus and *seasonally adjusted data*. These coefficients were then compared to coefficients calculated using federal government purchases of goods and services and seasonally adjusted data. The results of the former are shown in columns (12) and (13) of Table 9. For the 1948I-1969IV period the total multiplier was slightly decreased [compare columns (10) and (12)], while for the 1952I-1968II period the size of the coefficients were slightly increased so that the total multiplier was very close to the A-J [compare columns (11) and (13)]. However, the percentage of total effect occurring in each quarter was scarcely affected by the change in fiscal variables.\(^{14}\)

\(^{13}\)Two things prevented the *ceteris paribus* test: one is that the high employment budget surplus is not available except in a seasonally adjusted form; and second, some of the quarterly observations of the high employment budget are negative and therefore it is not possible to put them in log form. For these reasons it is not possible to completely isolate the effect of the full employment budget surplus in the Laffer-Ranson model.

\(^{14}\)One other difference in the two models that was not investigated is the money supply series being used. A-J used the 1967 money stock revision whereas L-R used the 1970 revision. The reconciliation of the M-S and A-J models showed however that the difference in those two money supply series was of relatively minor importance.
Because there were so many individual factors influencing the monetary multipliers in the L-R model, it is difficult to isolate any one or two factors that caused the monetary multipliers to differ from those of the A-J model. Several conclusions, however, were reached. First, the size of the total multiplier effect seemed to be influenced primarily by the time period used for the regressions and the use of the Almon lag technique to constrain the lag distribution. Both of these factors tended to increase the size of the monetary multipliers. Second, other changes made in the model had a rather negligible effect on the size of the total multiplier. Third, the distribution of the total effect was influenced primarily by the use or nonuse of seasonally adjusted data and the Almon lag technique. Fourth, seasonally adjusted data tended to smooth out the total effect as did the Almon technique. Fifth, other factors tended not to have much effect on the distribution of the multiplier effect.

Reconciliation of the Friedman-Meiselman and the Andersen-Jordan Models

Reconciling the monetary multipliers of the Friedman-Meiselman model (F-M) and the Andersen-Jordan model (A-J) was rather involved due to the many differences in the models as enumerated below:

1. the F-M multipliers are calculated using data stated in quarterly totals for the 1945III-1958IV period, while the A-J model
uses quarterly totals stated at annual rates for the 1952I-1968II period;

2. the F-M model uses consumption as the dependent variable, while the A-J model uses gross national product;

3. the F-M model uses money broadly defined ($M_2$) as the monetary variable, while the A-J model uses the narrowly defined money stock ($M_1$);

4. the lagged variables in the F-M are allowed to remain free, while the Almon technique is used to constrain the lagged variables in the A-J model;

5. the F-M model contains four lagged monetary variables, while the A-J model contains only three;

6. the F-M model uses an "autonomous expenditure" variable (net investment + net exports + National Income and Accounts Budget Surplus) to represent fiscal actions, while the A-J model uses the high employment budget surplus.

The reconciliation of the F-M and A-J models therefore involved the determination of how each of these differences contributes to differences in the total multiplier calculated with the two models. The F-M model was calculated for the 1945III-1958IV period using currently available data for $M_2$, consumer expenditures and "autonomous expenditures." To eliminate one difference in the models the calculations were made using quarterly data stated at annual
rates. The results are shown in column (2) of Table 10.\textsuperscript{15,16} A comparison of the A-J multiplier of 6.45, shown in column (1) of Table 10, with the F-M multiplier of .54 indicates a significant discrepancy. Recalculating the F-M model for the 1952I-1968II period, shown in column (3), eliminated part of this difference by increasing the total multiplier to 1.05, yet still a substantial portion remained unexplained.

Much of the difference in the A-J and F-M multipliers may be illusory since the models use different dependent and monetary variables. The essential characteristic of the A-J model is that changes in gross national product are a function of changes in M\(_1\). That is,

\[ \Delta \text{GNP} = \beta_0 \Delta M_1 \]  

\textsuperscript{15}The newly estimated F-M multipliers, shown in column (2) of Table 10, and the published multipliers, shown in Table 1 of Chapter II, are very different. Part of this difference can be attributed to using quarterly data stated at annual rates, rather than quarterly totals. Using data stated at annual rates increased the size of the multipliers by a multiple of four. To illustrate, the total multiplier of .54 shown in column (2) of Table 10 would have been .13 if the multipliers had been calculated with data stated in quarter totals. While a total multiplier of .13 is substantially higher in percentage terms than the published multiplier of .06, the absolute difference does not appear to be significant. Data revisions, however, changed the distribution of the total impact significantly. Four of the five original multipliers reported by F-M were negative, while only one of the newly estimated coefficients had a negative sign. The present findings actually appear more consistent with the F-M position that the money supply exerts a powerful and positive influence upon the economy.

\textsuperscript{16}All subsequent variations of the F-M model are calculated using data stated in annual rates.
Table 10
Monetary Multipliers Calculated Using the Andersen-Jordan Model and Variations of the Friedman-Meiselman Model

<table>
<thead>
<tr>
<th></th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
<th>(5)</th>
<th>(6)</th>
<th>(7)</th>
<th>(8)</th>
<th>(9)</th>
<th>(10)</th>
<th>(11)</th>
<th>(12)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Andersen-Jordan Model</td>
<td>Friedman-Meiselman Model</td>
<td>Using GNP Using M₁ Using Almon Lags Using 3 Lags</td>
<td>Using HEBS</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>t</td>
<td>1.72* (.29)</td>
<td>-1.6 (.73)</td>
<td>.065 (.45)</td>
<td>-20 (.41)</td>
<td>.11 (.49)</td>
<td>.37 (.74)</td>
<td>1.49* (.35)</td>
<td>.075 (.48)</td>
<td>.12 (.108)</td>
<td>-.12 (.55)</td>
<td>.11 (.74)</td>
<td>-.02 (.13)</td>
</tr>
<tr>
<td>t-1</td>
<td>1.94* (.32)</td>
<td>.46* (2.15)</td>
<td>.25 (1.59)</td>
<td>.12 (1.62)</td>
<td>.38 (1.62)</td>
<td>.88 (1.47)</td>
<td>.14 (1.13)</td>
<td>.11 (1.52)</td>
<td>.46* (2.19)</td>
<td>.28 (1.78)</td>
<td>.31 (1.88)</td>
<td></td>
</tr>
<tr>
<td>t-2</td>
<td>1.65* (.06)</td>
<td>.10 (3.71)</td>
<td>.017 (1.42)</td>
<td>1.23* (.103)</td>
<td>.34 (.103)</td>
<td>.27 (1.28)</td>
<td>.70 (1.42)</td>
<td>.17 (1.65)</td>
<td>.04 (1.38)</td>
<td>.06 (1.35)</td>
<td>.10 (1.62)</td>
<td></td>
</tr>
<tr>
<td>t-3</td>
<td>1.15 (1.61)</td>
<td>.10 (.91)</td>
<td>.42* (2.69)</td>
<td>.75* (1.38)</td>
<td>.68* (2.88)</td>
<td>.18 (1.36)</td>
<td>.57 (1.03)</td>
<td>.14 (1.32)</td>
<td>.30* (3.84)</td>
<td>.04 (3.62)</td>
<td>.54* (2.96)</td>
<td></td>
</tr>
<tr>
<td>t-4</td>
<td>.04 (1.67)</td>
<td>.30 (1.90)</td>
<td>.30 (2.04)</td>
<td>.43 (1.00)</td>
<td>.48* (1.00)</td>
<td>.26 (1.51)</td>
<td>.064 (1.05)</td>
<td>.35* (2.83)</td>
<td>.25 (1.59)</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>ΣDXt-1</td>
<td>6.45 (.64)</td>
<td>.54 (1.91)</td>
<td>1.05 (2.04)</td>
<td>2.05 (1.90)</td>
<td>.90 (2.04)</td>
<td>.73 (1.51)</td>
<td>.27 (1.05)</td>
<td>.59 (1.05)</td>
<td>.42 (1.59)</td>
<td>.99 (2.31)</td>
<td>1.13 (2.32)</td>
<td></td>
</tr>
<tr>
<td>Constant</td>
<td>1.92 (1.94)</td>
<td>2.32* (3.68)</td>
<td>1.60* (3.30)</td>
<td>1.95 (1.40)</td>
<td>1.67* (2.27)</td>
<td>2.59* (4.55)</td>
<td>2.14* (3.97)</td>
<td>2.26* (3.48)</td>
<td>1.58* (3.23)</td>
<td>2.44* (4.17)</td>
<td>1.73* (3.52)</td>
<td>1.40* (2.46)</td>
</tr>
<tr>
<td>R²</td>
<td>.54 (.37)</td>
<td>.37 (.36)</td>
<td>.62 (.78)</td>
<td>.36 (.52)</td>
<td>.78 (.27)</td>
<td>.36 (.27)</td>
<td>.52 (.58)</td>
<td>.36 (.57)</td>
<td>.57 (.57)</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>S.E.</td>
<td>4.61 (2.56)</td>
<td>2.56 (2.19)</td>
<td>2.19 (2.58)</td>
<td>5.64 (2.45)</td>
<td>3.31 (2.65)</td>
<td>2.84 (2.21)</td>
<td>2.65 (2.53)</td>
<td>2.27 (2.31)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>D.W.</td>
<td>1.41 (2.83)</td>
<td>2.83 (2.29)</td>
<td>2.29 (1.97)</td>
<td>1.29 (2.94)</td>
<td>2.18 (3.08)</td>
<td>2.46 (2.77)</td>
<td>2.35 (2.32)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: Numbers in parentheses represent t-values for the corresponding coefficient. Those marked with an * are significant at the .05 level.

The following symbols are used to abbreviate variations of the Friedman-Meiselman Model: GNP = gross national product as the dependent variable; M₁ = money narrowly defined as the monetary variable; HEBS = High Employment Budget Surplus.
The F-M model indicates, however, that changes in consumption are a function of changes in $M_2$. That is,

$$\Delta C = \beta_1 \Delta M_2$$  \hspace{1cm} (2)

Since changes in gross national product are larger than changes in consumption and changes in $M_1$ are smaller than changes in $M_2$, $\beta_0$ calculated in equation (1) would be larger *ceteris paribus* than $\beta_1$ calculated in equation (2). That is, differences in both the dependent and independent variables work together to make the multipliers calculated in the A-J model larger than those of the M-S model, and this would be the case even if both models indicated the *same* thing about the impact of monetary changes upon the economy.

To examine the possibility that the multipliers of the two models convey similar information as to the impact of monetary changes on economic activity, the *average* relationship between changes in consumption and changes in gross national product was computed, as well as the *average* relationship between changes in $M_1$ and changes in $M_2$. These relationships can be expressed as follows:

$$\frac{\Delta C}{\Delta GNP} = a_1 \text{ or}$$

$$\Delta C = a_1 \cdot \Delta GNP$$  \hspace{1cm} (3)

and
\[ \frac{\Delta N_2}{\Delta N_1} = a_2 \quad \text{or} \]
\[ \Delta M_2 = a_2 \cdot \Delta M_1 \]

Therefore, \( \Delta C = \beta_1 \Delta M_2 \) can be stated as

\[ a_1 \cdot \Delta GNP = \beta_1 \cdot a_2 \cdot \Delta M_1 \quad \text{or} \]
\[ \Delta GNP = \beta_1 \cdot \frac{a_2}{a_1} \cdot \Delta M_1 \quad (5) \]

Calculating \( a_1 \) and \( a_2 \) for the regression period yields two values to substitute in equation (5) to convert the F-M multipliers to dimensions comparable to the A-J multipliers.\(^{17}\) For the 1945III-1958IV period the values for \( a_1 \) and \( a_2 \) were .81 and 2.17 respectively.

Substituting those values in equation (5) and multiplying by the \( \beta \)'s calculated using the F-M model [shown in column (2) of Table 10] gave a total multiplier of 1.41. Although this conversion did very little to eliminate the differences in the F-M and A-J total multipliers, the conversion for the 1952I-1968II period [using the multipliers shown in column (3) of Table 10] yielded a F-M total multiplier of 6.09 which was close to the 6.45 calculated by A-J.

This suggests that for the 1952I-1968II period, much of the

\(^{17}\)The relationships expressed in equations (3) and (4) should not be construed as behavioral relationships. A behavioral relationship between the two sets of variables may exist, but that particular problem is not part of the present study. Rather, the equations simply represent an algebraic expression useful for comparative purposes.
difference in the total multipliers is due to different magnitudes of the dependent and monetary variables used.

Although using monetary and dependent variables of different magnitudes "explained" much of the variation in the total multipliers of the two models, especially for the 1952I-1968II period, the "average relationship" method described is at best a questionable procedure and gives no indication of which of the two variables involved in the conversion was most responsible for narrowing the difference in total multipliers. The conversion also provided no insight as to how the time response of the total multipliers was affected by using different dependent and monetary variables. It was therefore necessary to examine the dependent and monetary variables as well as all other differences of the two models separately to isolate the effects of each on the size and time response of the monetary multipliers. To do this, the F-M model was recalculated several times with each recalculation isolating one facet of the F-M model that differed from the A-J model.

The first modification made was to substitute gross national product for consumption as the dependent variable. Columns (4) and (5) of Table 10 show the results for the 1945III-1958IV and 1952I-1968II periods respectively. Comparing the original multipliers, shown in columns (2) and (3), with the coefficients shown in column (4) and (5) indicates that the total multiplier increased by an approximate multiple of four (.54 to 2.05) for the 1945III-1958IV period and almost doubled (1.05 to 1.99) for the latter period.
However, the total multiplier was still much different from the A-J total multiplier of 6.45. The modified version of the F-M model offered little explanation as to the different distributed impact recorded by the A-J and F-M models. As Figure 8 shows, except for the initial period, the time response of the original F-M model was closer to the A-J model than was the recalculated F-M model.

Another alteration made in the F-M model was to substitute $M_1$ for $M_2$ [see Table 10, columns (6) and (7)]. With this variation, the total multiplier increased approximately 50% (.54 to .73) for the 1945III-1958IV period. Each quarterly multiplier, however, increased more than 50%, but the change of signs in three quarters cancelled much of the effect. For the 1952I-1968II period, the total multiplier increased from 1.05 to 2.76, with only one multiplier changing signs. This modified version of the F-M model drastically altered the distributed impact of monetary actions for the 1945III-1958IV period. Figure 9 indicates, however, that changing the monetary variable for this period only increased the differences in the distributed multiplier impact. In contrast, for the 1952I-1968II period, the time response of the two models was very similar after the initial quarter.

The third transposition made in the F-M model was to use the Almon technique to estimate coefficients for the monetary variables [see Table 10, columns (8) and (9)]. Comparing these coefficients with the original multipliers, shown in columns (2) and (3), indicates that the individual coefficients often changed substantially
Figure 8
Cumulative Percentage Effects
of Changes in the Monetary Variable on
Consumption and GNP Using the Andersen-Jordan
Model and Variations of the Friedman-Neiselman Model

Source: Calculated from Table 10 the Monetary Variables

Note: Identifying numbers correspond to column numbers
of Table 10
(1) Andersen-Jordan for Period 1952I-1968II
(2) Friedman-Neiselman for Period 1945III-1958IV
(3) Friedman-Neiselman for Period 1952I-1968II
(4) Friedman-Neiselman using GNP as the dependent
variable for Period 1945III-1958IV
(5) Same as number (4) b.i.c. for Period 1952I-1968II
Figure 9
Cumulative Percentage Effects
of Changes in the Monetary Variable on
Consumption and GNP Using the Andersen-Jordan
Model and Variations of the Friedman-Heiselman Model

Source: Calculated from Table 10

Note: Identifying numbers correspond to column numbers
of Table 10
(1) Andersen-Jordan for Period 1952I-1968II
(2) Friedman-Heiselman for Period 1945III-1958IV
(3) Friedman-Heiselman for Period 1952I-1968II
(6) Friedman-Heiselman using $M_1$ (money narrowly
defined) as the monetary variable for Period
1945III-1958IV
(7) Same as number (6) but for Period 1952I-1968II
(in percentage terms) while the total multiplier change was little or nonexistent for both the 1945III-1958IV and 1952I-1968II periods. Although the Almon technique did not substantially influence the total impact of monetary changes, it did alter the measured distribution of these effects. As Figure 10 indicates, the Almon technique caused a smoothing process which made the distributed impact of the F-M model much closer to that of the A-J. Interestingly, for both periods considered, the explanatory power of the equation was reduced using the Almon constraint.

Altering the F-M model by reducing the number of lagged periods from four to three did not explain any of the existing differences of the F-M and A-J models. In fact, as a comparison of columns (2) and (10) of Table 10 shows, each of the coefficients for the 1945III-1958IV period, with the exception of t-1, was reduced when one lagged variable was eliminated. For the 1952I-1968II period each coefficient was increased, but the total multiplier decreased when fewer variables were included because the increase in the four remaining variables was not sufficient to cover the loss of the coefficient for t-4. The time impact of monetary actions was altered somewhat, simply because the total effect was now distributed over fewer periods. However, reducing the number of lagged periods was not helpful in reconciling the differences in the distributed impact recorded in the two models for either period.
Figure 10
Cumulative Percentage Effects
of Changes in the Monetary Variable
on Consumption and GNP Using the
Andersen-Jordan Model and Variations of the Friedman-Meiselman Model

Source: Calculated from Table 10

Note: Identifying numbers correspond to column numbers of Table 10
(1) Andersen-Jordan for Period 1952I-1968II
(2) Friedman-Meiselman for Period 1945III-1958IV
(3) Friedman-Meiselman for Period 1952I-1968II
(8) Friedman-Meiselman using the Almon Lag Technique
    on lagged variables for Period 1945III-1958IV
(9) Same as number (8) but for Period 1952I-1968II
The last mutation of the F-M model concerned the fiscal variable. As indicated earlier, the F-M model did not have a fiscal variable as such, but rather an "autonomous" expenditure variable which included a fiscal component. Substituting the high employment budget surplus into the F-M model did little, however, to reconcile the two models. A comparison of columns (3) and (12) indicates the total multiplier increased from 1.05 to 1.13, a change that does not appear to be significant, while the explanatory power of the equation decreased from .62 to .57. In addition, the measured distribution of monetary effects was not significantly altered by changing the "fiscal" variable.

In summary, three factors were important in explaining the difference in the size of the monetary multipliers of the F-M and A-J models: (1) the choice of the dependent variable; (2) the choice of the monetary variable; and (3) the time period used. The distribution of the monetary effects appeared to be influenced primarily by two factors - the choice of the monetary variable and the use of the Almon lag technique. Substituting $M_1$ for $M_2$ drastically altered the distributed impact of monetary actions but did not help to reconcile the A-J and F-M models. The Almon technique, however, tended to smooth the lag pattern of the monetary variable and in so

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For this part of the reconciliation only the 1952I-1968II period was used because the high employment budget surplus data are unavailable prior to 1947.
doing made the distribution of monetary effects similar in the A-J and F-M models.

Summary and Conclusions

The objective of this chapter was to identify those factors responsible for the different monetary multipliers calculated using the A-J, M-S, L-R, and F-M models. Using the A-J model as the standard of comparison, each feature of the remaining three models which differed from the "standard" was isolated to determine its effect on the monetary multipliers. Four factors were found to be important in resolving differences in the size of the total monetary multiplier: (1) the time period used for the analysis; (2) the inclusion of a fiscal variable in the regressions; (3) the choice of dependent and monetary variables; and (4) the technique used for estimating lagged coefficients.

The single most important element accountable for the size differential in the monetary multipliers was the time period selected. This finding implied that the money-income relationship may be unstable. If, however, the relationship changed gradually, single-equation models would still be useful for predictions as long as the parameters were estimated from relatively short regression periods.

The inclusion or omission of a fiscal variable also influenced the size of the monetary multipliers. The addition of the high
employment budget surplus to the M-S model increased the total multiplier. However, substituting the high employment budget surplus for federal government purchases of goods and services in the L-R model or "autonomous" expenditures in the F-M model had little effect on the total multiplier. Three conclusions can be drawn from these findings: first, the size of the monetary multiplier is influenced by the inclusion of a fiscal variable in the regression model; second, alternative variables selected to represent fiscal actions appear to increase the monetary multipliers in a similar way; and third, since the monetary multipliers increased in size when a fiscal variable is included in the models, this suggests that some part of government expenditures are financed by monetary expansion.

A third factor that influences the size of the monetary multiplier is the choice of dependent and monetary variables used in the regression. Different multipliers are inevitable when a variable of one magnitude is substituted for one with a different magnitude even if the new variable is a linear transformation of the former. The technique used for estimating lagged coefficients was the fourth factor affecting the size of the monetary multiplier. The Almon technique tended to smooth the lag distribution. If the smoothing process changed the signs of lagged variables, it usually changed the total multiplier.

The time distributed impact of the total multiplier was primarily affected by three factors: the technique used for estimating lagged coefficients; the seasonal adjustment procedures; and the
choice of the monetary variable. The models examined in this chapter used one of two procedures for calculating lagged coefficients - the Almon technique (A-J and M-S) or an unconstrained lag structure which allowed the variable to remain "free" to assume any value dictated by the data (L-R and F-M). Coefficients calculated using the latter procedure had a very uneven pattern, often fluctuating from positive to negative. The Almon technique tended to smooth the lag pattern and changed the measured time response of the total monetary multiplier.

When dummy variables were used to deseasonalize data (L-R), the total multiplier effect was achieved very quickly (even when the Almon technique was used). Coefficients for the lagged variables fluctuated between positive and negative, cancelling the lagged effects. When previously adjusted data were used (i.e. by the collecting agency) the distributed impact of the total multiplier was significantly altered, allowing the total multiplier to be spread rather evenly over several quarters.

The choice of monetary variables used in the regressions also affected the distributed impact of the total multipliers. This, of course, would be expected, since it is unlikely that two variables will move in exact parallel fashion. It would be expected that movements in one monetary variable might precede or lag behind another, even though their trend rates are similar.

The reconciliation of the models discussed in this chapter indicates several aspects of single-equation models that need further
research. The following chapter, therefore, will develop a single-equation model to examine the reliability of various monetary variables in predicting changes in economic activity. Alternative lag structures, seasonal adjustment procedures, and the inclusion of a fiscal variable will also be examined.
CHAPTER IV

AN EXAMINATION OF THE ABILITY OF VARIOUS
MONETARY VARIABLES TO PREDICT ECONOMIC ACTIVITY

Controversy over the usefulness of single equation models (such as those discussed in the previous two chapters) is scattered throughout the economic literature of recent years. Some of the participants in this on-going debate contend that single-equation models are useful devices for testing economic hypotheses, as illustrated by the Friedman-Meiselman model. This model was developed to test whether the "quantity theory" approach to income determination was

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empirically more meaningful than the Keynesian "autonomous expenditure" approach. However, the use of single-equation models for such purposes is not generally accepted. The only generally acceptable use of single-equation models is to "establish empirical regularities" which can then be used in forecasting and policy decisions. This approach, illustrated by the Andersen-Jordan, Laffer-Ranson, and Meiselman-Simpson studies, provides general indications about the strength and predictability of relationships between variables. The purpose of these models was not to test some underlying theory or hypothesis about economic behavior per se. Rather, they simply showed the relationships existing between key economic variables.

Chapter III showed that the evidence from these models indicates a very important association between money ($M_1$) and gross national product. These models do not prove causation, but this evidence, coupled with recent evidence from large scale econometric models\(^2\) and the Friedman-Schwartz National Bureau studies\(^3\) (among others) tend to substantiate an increasingly prominent view that


changes in the money supply have important influences on broad measures of economic activity such as total spending, employment, and prices. \(^4\) Likewise, agreement is rather uniform that the actions of the monetary authorities through open market operations influence changes in the money supply and other monetary aggregates.

Recognizing that money and monetary aggregates may influence economic activity, Federal Reserve operations in recent years have concentrated on controlling one or more monetary aggregates while downgrading the more traditional operating targets of interest rates and money market conditions. This change in emphasis was first apparent in 1966 when the "proviso" clause was introduced into the policy directive drafted by the Federal Open Market Committee. The clause "... was designed to permit the manager to modify day-to-day operations if cumulative evidence of an undesirably rapid expansion of credit developed during the interval between committee meetings."\(^5\)

In early 1970, monetary aggregates were given additional emphasis culminating with the directive adopted March 10, which placed money

\(^4\)This statement is not intended to imply that there is general agreement as to the "degree" of importance placed on the creation of money and its influence on economic activity. For a recent summary of this on-going debate see Leonall C. Andersen, "The State of the Monetarist Debate," Review, Federal Reserve Bank of St. Louis, (September, 1973), pp. 2-8.

market conditions subservient to monetary aggregates and established
growth objectives for certain monetary and credit aggregates.  

This increased concern with monetary aggregates was not without
opposition within the Federal Reserve System. A number of officials
within the System have long proclaimed the inability of the Federal
Reserve to control monetary aggregates sufficiently to warrant their
use as operating targets, even if the Federal Reserve desired to
use measures in that way. Because of controversy within the Fed-
eral Reserve, the difficulty in trying to control monetary aggregates
and the efforts to gauge more precisely the influence of open market

6 "Monetary Aggregates and Money Market Conditions in Open
79-104; Board of Governors of the Federal Reserve System, Annual
description of the significance of this change, see Arthur F.
Burns, "Statement to Congress," Federal Reserve Bulletin, (August,

7 Statements to this effect are abundant in Federal Reserve
literature, speeches of Federal Reserve officials, and Congres-
sional testimony. Examples of such statements can be found in
Alan Holmes, "Operational Constraints on the Stabilization of
Money Supply Growth," and Sherman J. Maisel, "Controlling Monetary
Aggregates," in Controlling Monetary Aggregates, (Boston: Federal
Reserve Bank of Boston, 1969), pp. 65-77 and pp. 152-74; Alan R.
Holmes, "Open Market Operations and Monetary and Credit Aggregates,"
Monthly Review, Federal Reserve Bank of New York, (April, 1972),
pp. 79-94. A discussion of the desirability of operating on moneto-
tary aggregates appears in Open Market Policies and Operating Pro-
cedures - Staff Studies, (Washington, D.C.: Board of Governors
operations, attention has centered on a group of monetary variables, often labeled reserve aggregates.\(^8\)

Two reasons are often given for distinguishing between reserve and monetary aggregates. The first reason pertains to the reliability and availability of data. Relatively reliable estimates on the reserve aggregates can be developed with a lag of only one day. However, data on the money stock and other monetary aggregates are not available for at least a week - making it difficult if not impossible for use in daily operations. Also when data on monetary aggregates becomes available, it is not as precise as data for reserve aggregates because part of the data must be estimated. Thus the reliability of the data decreases because of errors in the estimates of data components, changing seasonal factors, and short-term irregular movements.\(^9\)

The second reason for distinguishing the two aggregates is the relative degree of influence of open market operations on the monetary and reserve aggregates. Although both types of variables

\(^8\)Monetary aggregates are usually some definition of money, such as \(M_1\), \(M_2\), or \(M_3\). The Bank Credit Proxy and Bank Credit are technically credit aggregates but are often grouped with the monetary aggregates for analysis. Reserve aggregates include such variables as the monetary base, unborrowed reserves, total bank reserves, and R.P.D.s (reserves available to support private nonbank deposits). Throughout this chapter the term monetary aggregates will be used to include credit aggregates and the term monetary variables will refer to the broad category of variables that includes monetary and reserve aggregates.

reflect actions taken by the Federal Reserve, Treasury, commercial banks, and the public, the reserve aggregates can be more closely controlled by the Federal Reserve.10

From a theoretical point of view most economists concerned with the problem of monetary policy believe that money (using various definitions) is a key variable in determining economic activity. However, since the Federal Reserve finds it easier to control reserve aggregates a number of studies have been undertaken to describe and measure the relationship between various reserve aggregates and monetary aggregates.11


This study will use an alternate approach and examine the relationship between reserve aggregates and economic activity and between monetary aggregates and economic activity. Since the intention is to measure relationships, rather than to test a theory, the single-equation approach is an appropriate procedure. Specifically, the objective of this chapter is to use single-equation models to determine:

1. how reliable are changes in various monetary aggregates and reserve aggregates in predicting changes in economic activity;
2. what type of lag structure (among several alternatives) is empirically more consistent with the observed relationship between various monetary variables and changes in economic activity;
3. what effect the seasonal adjustment procedure has on:
   (a) the predictive ability of the various monetary variables, (b) the choice of lag structure which best fits the relationship between the monetary variable and economic activity, and (c) the size of monetary multipliers; and
4. what effect the inclusion of a fiscal variable has on
   (a) the predictive ability of various monetary variables, (b) the choice of the best lag structure, and (c) the size of the monetary multipliers.
To achieve the objective of this chapter, frequently used measures of economic activity, monetary variables, and fiscal actions were used. All data were quarterly figures with the flow variables stated at annual rates for the period 1962I-1972IV.

**Economic Activity**

Total spending for final goods and services (gross national product) at current prices was used as the measure of economic activity since it appears to be the most comprehensive measure. The source of the data was the "National Income and Product Accounts" published by the Department of Commerce in the *Survey of Current Business*.

**Monetary Variables**

Nine different monetary variables were regressed against gross national product. The following is a list and a definition of the monetary variables used:

\[ M_1 = \text{Average of daily figures for (a) demand deposits of commercial banks other than domestic interbank and U.S. government deposits, less cash items in the process of collection and Federal Reserve float; (b) foreign demand balances at Federal Reserve Banks; and (c) currency outside the Treasury, Federal Reserve Banks, and vaults of commercial banks;} \]
\[ M_2 = \text{Average of daily figures for } M_1 \text{ plus commercial bank savings deposits, time deposits open account, and time certificates other than negotiable certificates of deposit of } \$100,000 \text{ of large weekly reporting banks;} \]

\[ M_3 = M_2 \text{ plus the average of the beginning and end-of-the month figures for deposits of mutual savings banks and for savings capital of savings and loan associations;} \]

Bank Credit = Total loans and investments at all commercial banks adjusted to exclude domestic commercial interbank loans;

Bank Credit Proxy = Total deposits in member banks subject to reserve requirements, plus Euro-dollar borrowings, bank-related commercial paper, and certain other nondependent items;

Monetary Base = Member bank deposits at the Federal Reserve plus currency held by banks plus currency held by the public;

Member Bank Reserves = Member bank deposits at the Federal Reserve plus currency held by member banks;

Non-Borrowed Reserves = Member bank reserves minus reserves borrowed from the Federal Reserve;

R.P.D.'s = "Reserves available to support private nonbank deposits" defined as (1) required reserves for (a) private demand deposits, (b) total time and savings deposits, and (c) nondeposit sources subject to reserve requirements, and (2) excess reserves. Excluded are required reserves for net interbank and U.S. government demand deposits.
The sources of the data for the monetary variables were the *Federal Reserve Bulletin* and the Research Department of the Federal Reserve Bank of St. Louis.\(^{12}\)

**Fiscal Indicators**

The fiscal measure used in the study was the "high-employment budget surplus." This measure is an estimate of the national income accounts budget at some arbitrarily defined high-employment level of economic activity.\(^{13}\) The high-employment budget surplus data were obtained from the Research Department of the Federal Reserve Bank of St. Louis.

\(^{12}\)Absent from this list of monetary variables are free reserves. From the middle 1950's to 1968 free reserves were possibly the single most closely controlled target of Federal Reserve policy actions. However, due to the work of Brunner and Meltzer, Dewald, and Meigs, free reserves have been thoroughly discredited as a gauge or indicator of monetary actions. In the course of this study regressions were estimated using free reserves as the monetary variable. The results were so consistently poor that it was decided to ignore this variable in reporting the results. For a critical analysis of using free reserves as a target variable see K. Brunner and A. H. Meltzer, *The Federal Reserve's Attachment to the Free Reserve Concept: A Staff Analysis*, Report of the Subcommittee on Domestic Finance, Committee on Banking and Currency, House of Representatives, 88th Congress, 2nd session, (Washington D.C.: U.S. Government printing Office, 1964); W. G. Dewald, "Free Reserves, Total Reserves, and Monetary Control," Journal of Political Economy, (April, 1963) pp. 141-53; A. J. Meigs, *Free Reserves and the Money Supply*, (Chicago: University of Chicago Press, 1962).

\(^{13}\)Alternative fiscal measures were not examined since the major concern of this study is monetary multipliers. The reconciliation in Chapter III showed, however, that alternative fiscal indicators had little effect on the monetary multipliers. For a comprehensive discussion of the theoretical and statistical aspects of the high-employment budget see Michael E. Levy, *Fiscal Policy, Cycles and Growth*, National Industrial Conference Board, Studies in Business Economics, Number 81, (New York: The Conference Board, 1963). Two articles that stress the use and interpretation of the high-employment
Relationships Among Monetary Variables

Monetary Base

The monetary base, a widely mentioned reserve aggregate, is often referred to as "high-powered money." It is derived from the consolidated balance sheet of the Federal Reserve Banks and Treasury. Since the "base" is constructed from double-entry accounts, it has an asset (source) side and a liability (use) side. The source side, often called the source base, is the sum of total Federal Reserve Credit, the nation's gold stock, Special Drawing Rights, and Treasury currency outstanding less Treasury deposits at the Federal Reserve banks, Treasury cash holdings, and certain other deposits and accounts at the Federal Reserve banks.

The only item among this list over which the Federal Reserve has complete control is "U.S. Government securities and agency holdings," listed under Federal Reserve Credit. This account, representing the largest single source in the base equation, is essentially under the control of the Federal Reserve System, since

changes in Federal Reserve Credit dominate changes in other items.  

Although Federal Reserve float, changes in the gold stock, and other items are largely beyond the control of the monetary authorities, control over just one item in the monetary base, especially an item as important and flexible as the security holdings of the System, may be equivalent to control over all accounts since movements in noncontrolled items can be offset.  

Member Bank Reserves

One potential problem in using the "base" as a reserve target is that the "use base" contains currency, the demand for which is influenced by seasonal factors and income. Unless these cyclical and seasonal factors are offset, fluctuations in currency will affect the level of bank reserves, thus providing expansionary or contractionary movements in deposits. This problem is overcome by subtracting currency held by the public and nonmember banks from the base. The result is a measure called member bank reserves — deposits at the Federal Reserve of member banks plus currency held in member bank vaults.

14 Several studies have found that movements in Federal Reserve Credit dominate movements in other sources of the source base, and therefore determine most of the movements of the monetary base. For a discussion of these studies, see Karl Brunner, "The Role of Money and Monetary Policy," Review, Federal Reserve Bank of St. Louis, (July, 1968), pp. 9-24.

15 To make the base comparable over time it must be adjusted for reserve requirement changes and the proportion of deposits subject to each reserve requirement. These adjustments, expressed in dollars, increase when average reserve requirements fall and vice versa.
Member bank reserves are favored by some economists as a reserve target for two reasons. First, it is contended that the growth in member bank reserves is not affected by swings in currency, and second, member bank reserves measure the entire reserve base available for deposit expansion.  

Nonborrowed Reserves

Frequently borrowings from the discount window are subtracted from member bank reserves. The resulting measure is called nonborrowed reserves. Two reasons are usually cited for excluding borrowed reserves: first, borrowing from the discount window responds quickly to business conditions and interest rate changes and, second, member bank reserves do not allow for the possible difference in impact of borrowed and nonborrowed reserves on deposit growth. To illustrate the former, when loan demand increases, borrowing ordinarily increases. Since the Federal Reserve cannot control business conditions directly, member bank reserves, which includes borrowings at the discount window, may not measure the intended impact of monetary policy. As to the latter, the contention is often made that banks are less likely to expand deposits on borrowed reserves. If so, an increase in borrowed reserves would tend to be less expansionary than reserves gained through open market operations. Consequently, unborrowed reserves are thought by some

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authorities to be a better measure of the banking system's ability to expand since it records that portion of reserves obtained through the net effects of Federal Reserve open market operations.

Others argue that unborrowed reserves do not reflect the capacity of the banking system to expand money and credit as the banking system can elect to use either borrowed or unborrowed reserves to expand credit.

Reserves Available to Support Private Nonbank Deposits (R.P.D.'s)

Since early 1972 the Federal Reserve has emphasized member bank reserves available to support private nonbank deposits (R.P.D.'s) as its short-run operating target. When reserves supporting government and interbank deposits are subtracted from total member bank reserves, the R.P.D. measure results. Consequently, R.P.D.'s are the reserves required to support private demand deposits, time and savings deposits, and nondeposit sources of funds subject to reserve requirements, plus excess reserves.

It is argued that R.P.D.'s is an appropriate target reserve measure because it excludes bank reserves supporting government deposits and deposits of other banks, since frequent, large fluctuations in these deposits make them - and the reserves that support them - hard to predict. Also erratic fluctuations are often reversed after a short period so that reserves supporting government

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and interbank deposits may have little effect on the Federal Reserve's ability to influence longer-term growth in monetary and credit aggregates.

A possible objection to the R.P.D. measure is that no distinction is made between required and excess reserves. Excess reserves tend to be rather erratic since they are influenced by, among other factors, interest rates and the general level of economic activity. Because of this unpredictable component, the ability of the Federal Reserve to predict and control R.P.D.'s is hampered. This objection is also true for the other reserve measures.18

Links Between Reserve Aggregates and Monetary Aggregates

The link between reserve aggregates and monetary aggregates is usually developed within the context of a "money supply model." Two types of supply functions for money (or deposits) appear in the literature. One type can be classified as a true offer function which identifies the quantity of deposits the banking system will supply at alternative interest rates subject to a reserve constraint.19

Most investigators rely on the second or the "equilibrium" supply function. These functions relate the stock of money (or


deposits) to reserves at alternative levels of reserve absorption by
the components of and substitutes for the money supply. That is,
the supply of money is determined by some aggregate reserve measure
(monetary base, member bank reserves, etc.) multiplied by a statist-
ic (the reserve multiplier), whose value depends on the mix of
financial assets absorbing reserves and on which financial assets
are included in the definition of money. 20 The following example
showing the relationship between the monetary base and M 1 will serve
to illustrate this procedure. 21

When the monetary base is increased, the banking system is able
to expand deposits, the extent of which depends on a number of fac-
tors including the following:

20 See, for example, Jerry L. Jordan, "Elements of Money Stock
Determination," op. cit.; Karl Brunner and Allan Meltzer, "Some Fur-
ther Investigations of Demand and Supply Functions for Money," Jour-
nal of Finance, (May, 1964), pp. 247-8; Ronald T. Teigen, "The Demand
for and Supply of Money," Readings in Money, National Income, and
Teigen, (Homewood: Richard D. Irwin, 1970), pp. 92-7; Lionel Kalish
III, "A Study of Money Supply Control," Journal of Finance, (Septem-
ber, 1970), pp. 761-6; Milton Friedman and Anna J. Schwartz, A
Monetary History of the United States, 1867-1960, (Princeton: Prince-
ton University Press, 1963), Appendix B; Phillip Cagan, Determinants
and Effects of Changes in the Stock of Money, 1875-1960, (Princeton:
Princeton University Press, 1965); Albert E. Burger, "Money Stock
Control," op. cit.; Albert E. Burger, Lionel Kalish and Christopher
T. Babb, "Money Stock Control and Its Implications for Monetary
Policy," Review, Federal Reserve Bank of St. Louis, (October, 1971),
pp. 6-22.

21 The following analysis draws heavily from Jerry L. Jordan,
"Elements of Money Stock Determination," op. cit.
1. how the deposits will be distributed between member and nonmember banks;
2. how the deposits will be distributed among banks subject to different average reserve requirements;
3. how the deposits will be distributed among private demand deposits, government demand deposits, and the sub-classes of time deposits;
4. how the change in deposits will affect banks' desired ratio of excess reserves to total deposits;
5. how a change in deposits will affect the public's desired ratio of currency to deposits.

Each factor affecting the relationship between the monetary base and $M_1$ might best be described as a behavioral relationship with the level of income, required reserve ratios, interest rates, and interest rate ceilings entering into the behavior functions. To simplify, these relationships can be expressed definitionally as follows:

1. $M_1 = D + C$
2. $B = R + C$
3. $R = r(D + T + G) + E$
4. $C = kD$
5. $T = tD$
6. $G = gD$
7. $E = sD$
where:

\[ M_1 = \text{money supply (narrowly defined)} \]
\[ D = \text{private demand deposits} \]
\[ C = \text{public's currency holdings} \]
\[ B = \text{monetary base} \]
\[ R = \text{bank reserves} \]
\[ G = \text{government demand deposits} \]
\[ T = \text{time deposits} \]
\[ E = \text{excess reserves} \]
\[ k = \text{fraction showing the proportional relationship between the public's holdings of currency and private demand deposits} \]
\[ t = \text{fraction showing the proportional relationship between time deposits and private demand deposits} \]
\[ g = \text{fraction showing the proportional relationship between government demand deposits and private demand deposits} \]
\[ s = \text{fraction showing proportional relationship between excess reserves and demand deposits} \]
\[ r = \text{average required reserve ratio against all deposits} \]

Substituting (7) into (3), and (3) and (4) into (2) gives:

\[ B = r(D + T + G) + sD + kD, \quad (8) \]

which expresses the monetary base completely in terms of deposits.

Substituting (5) and (6) into (8) gives:

\[ B = r(D + tD + gD) + sD + kD, \quad (9) \]
which expresses the base in terms of *private* demand deposits. Simplifying (9) produces:

\[
B = [r(1 + t + g) + s + k] \cdot D \tag{10}
\]

which can be rearranged to express deposits in terms of the base as follows:

\[
D = \frac{1}{r(1 + t + g) + s + k} \cdot B \tag{11}
\]

Since \( M_1 \) equals \( D \) plus \( C \), equation (4) and (11) can be used to redefine \( C \) in terms of the base.

\[
C = \frac{k}{r(1 + t + g) + s + k} \cdot B \tag{12}
\]

Substituting (11) and (12) into (1) gives

\[
M_1 = \frac{l+k}{r(1 + t + g) + s + k} \cdot B \tag{13}
\]

which expresses the relationship between \( M_1 \) and the monetary base.

A similar process can be developed to show the relationship between the "base" and other definitions of money and monetary aggregates. Likewise, relationships between other reserve and monetary aggregates can be developed using the above procedure.
Formulation of the Single-Equation Model(s)

The single-equation model(s) used in this analysis is not intended to test an economic theory or hypothesis per se. Nonetheless, the underlying theory of the model is that actions of the Federal Reserve dominate movements in monetary variables. These movements, in turn, influence the level of economic activity. Because the time series data used contain a strong trend element, ordinary first differences are used in the model(s). The relationship between economic activity and the monetary variable can thus be expressed in the regression equation:

\[ \Delta Y_t = \alpha + \beta \Delta X_t + \mu_t \]  

where:

\( \Delta Y \) = changes in economic activity  
\( \text{gross national product} \)  

\( \Delta X \) = changes in the monetary variable  
\( \text{however defined} \)  

\( \alpha \) = constant  

\( \mu \) = error term

22 The time series variables used in this analysis have strong trend factors so that first differences tended to increase in size over the regression period. This would indicate, from a statistical standpoint, that logarithmic first differences would be the most appropriate form of estimating the model(s). However, ordinary first differences provides estimates of multipliers which are more useful for purposes of this study, and allows the high employment budget surplus to be used as the fiscal indicator since it contains some zero and negative values which cannot be put in log form.
However, when formulating a model using time series data, it is more realistic to include lagged values of the explanatory variables on the right-hand side of the equation. Rather than the entire effect of $\Delta X$ occurring in period $t$ as equation (14) assumes, it is more reasonable to expect the effect to be distributed over several time periods.

A more general formulation of the regression model which allows for current and past values of $\Delta X_t$ can be written as:

$$
\Delta Y_t = \alpha + \beta_0 \Delta X_t + \beta_1 \Delta X_{t-1} + \beta_2 \Delta X_{t-2} + \ldots + \beta_n \Delta X_{t-n} + \mu_t \quad (15)
$$

Serious statistical problems arise in estimating a general model of the form specified in equation (15). These problems, however, can be largely overcome by placing a priori restrictions on the regression coefficients $\beta_0, \beta_1, \ldots, \beta_n$, so that the number of regression parameters to be estimated are substantially reduced. These restrictions mean that at least the form of the lag distribution is specified in advance.

23 The two main statistical difficulties that arise in estimating distributed lags in the form of equation (15) are: (a) lags may leave few degrees of freedom unless there is a very large number of observations; and (b) typically the lagged values of $X$ are highly correlated with each other, leading to imprecise estimates of the lagged coefficients. For a discussion of these problems see J. Johnston, *Econometric Methods*, 2nd Edition, (New York: McGraw-Hill, 1972), pp. 293-4; and Jan Kmenta, *Elements of Econometrics*, (New York: The Macmillian Co., 1971), p. 273.
Lag Structures

This study examines several methods of specifying the "lag structure" to determine which procedure best describes the relationship between changes in gross national product and changes in the various monetary variables. Four "lag structures" are used in this analysis - the rectangular, inverted V, Koyck, and Almon.

A. Rectangular Distribution

One way of placing a priori restrictions on the regression coefficients of a model is to specify the weights of the individual variables in advance and estimate the entire lag distribution as a single variable.

The rectangular distribution explicitly assumes that the effect of $\Delta X_{t-n}$ on $\Delta Y_t$ in each of the $n$ periods is equal, and zero thereafter. Using this assumption the model to be estimated is:

$$\Delta Y_t = \alpha + \beta_0 Z_t + \mu_t$$

(16)

where

$$Z_t = \frac{1}{n+1} (\Delta X_t + \Delta X_{t-1} + \Delta X_{t-2} + \Delta X_{t-3} + \ldots + \Delta X_{t-n})$$

(17)

The weighting scheme $\frac{1}{n+1}$ is ordinarily used in estimating an equation where a rectangular distribution is assumed so that the coefficients will sum to unity; otherwise, the estimated $\beta$ value will have to be scaled up or down ex post. When the general equation (15) has several separate variables (i.e., $\Delta X_{t-n}$, $\Delta F_{t-n}$, and
each with their own distributed lag, then each is estimated as a single variable with a weighting scheme as shown in equation (17).

B. Inverted V Distribution

In a study of capital investment, Frank de Leeuw found evidence which favors an "inverted V" weighting scheme. The basic assumption of this distribution is that the most important values of $\Delta X$ in determining the mean value of $\Delta Y_t$ are neither the most current nor the farthest in the past, but rather the lagged values some place in the middle. The weights assigned to the lagged values of $\Delta X$ can take many forms just so they build up for half of the lagged periods and then decline symmetrically. If for example, $n = 4$, one might specify a weighting scheme such as:

$$Z_t = \frac{1}{16} \Delta X_t + \frac{4}{16} \Delta X_{t-1} + \frac{6}{16} \Delta X_{t-2} + \frac{4}{16} \Delta X_{t-3} + \frac{1}{16} \Delta X_{t-4}$$

(18)

and the lag distribution is then estimated as the single variable, $Z_t$, as was done in equation (16). Other types of schemes are possible. For a total lag of $n$ periods de Leeuw used weights for the

---


first half of the n periods as proportional to the rising series 1, 2, 3, . . . n/2 (for even values of n) and the last half proportional to the declining series n/2, n/2-1, . . . 3, 2, 1. Since these weights do not sum to unity the estimated coefficient was multiplied by the proportionality factor 4/(n² + 2n) so the weights sum to unity. The "inverted V" can be attached to each lagged independent variable in the regression equation.

C. Koyck Distribution

A particular response pattern made popular first by Koyck and later by Nerlove is that the importance of lagged values of \( \Delta X \) decline geometrically with each successive lag, so the effect of distant values of \( \Delta X \) eventually become negligible. Such a relationship can be written as:

\[
\Delta Y_t = \alpha + \lambda^0 \beta_0 \Delta X_t + \lambda^1 \beta_1 \Delta X_{t-1} + \lambda^2 \beta_2 \Delta X_{t-2} + \ldots + \mu_t \quad (19)
\]

where \( 0 \leq \lambda < 1 \)

If equation (19) is lagged by one period and multiplied through by \( \lambda \), equation (20) is obtained.

\[26\text{L. M. Koyck, Distributed Lags and Investment Analysis, (Amsterdam: North Holland, 1954).}\]

\[27\text{Marc Nerlove, Distributed Lags and Demand Analysis for Agricultural and Other Commodities, (Washington: U.S. Department of Agriculture, 1958).}\]
\[ \lambda \Delta Y_{t-1} = \alpha \lambda + \lambda^1 \beta_1 \Delta X_{t-1} + \lambda^2 \beta_1 \Delta X_{t-2} + \lambda^3 \beta_2 \Delta X_{t-3} + \ldots + \lambda^\mu \mu_{t-1} \] (20)

Subtracting (20) from (19) and rewriting gives

\[ \Delta Y_t = \alpha^* + \beta \Delta X_t + \lambda \Delta Y_{t-1} + \mu^*_t \] (21)

where

\[ \alpha^* = \alpha(1-\lambda) \]
\[ \mu^* = \mu_t - \lambda \mu_{t-1} \]

Thus, using the "Koyck transformation" the distributed lag relationship can be simplified to (21). Instead of having to estimate a large number of \( \beta \) coefficients, only two parameters are estimated, \( \beta \) and \( \lambda \).

When using quarterly or monthly time series data, it may seem inappropriate to have the weights decline geometrically from the initial time period \( t \). In such cases the first few values of \( \Delta X \) are left "free" from the Koyck pattern and the geometrically declining weights begin only after say, three, four, or five periods. This allows the first few coefficients to be estimated separately from the Koyck assumption. For example, if the first three values of \( \Delta X \) were to be estimated free of the Koyck assumption the model would be written as

\[ \Delta Y_t = \alpha + \beta_0 \Delta X_t + \beta_1 \Delta X_{t-1} + \beta_2 \Delta X_{t-2} + \lambda^1 \beta_3 \Delta X_{t-3} + \lambda^2 \beta_4 \Delta X_{t-4} + \lambda^3 \beta_5 \Delta X_{t-5} + \ldots + \mu_t \] (22)
Using the Koyck transformation multiply equation (22) by \( \lambda \), lagging the variables by one period, and subtracting the result from the original equation yields equation (23).

\[
\Delta Y_t = \alpha^* \Delta Y_{t-1} + \beta^*_1 \Delta X_{t-1} + \beta^*_2 \Delta X_{t-2} + \beta^*_3 \Delta X_{t-3} + \lambda \Delta Y_{t-1} + \mu^*_t \tag{23}
\]

where:

\[
\begin{align*}
\alpha^* &= \alpha(1-\lambda) \\
\beta^*_1 &= \beta_1 - \lambda \beta_0 \\
\beta^*_2 &= \beta_2 - \lambda \beta_1 \\
\beta^*_3 &= \beta_3 - \lambda \beta_2 \\
\mu^* &= \mu_t - \lambda \mu_{t-1}
\end{align*}
\]

The Koyck method can also be used with two explanatory variables, say \( \Delta X \) and \( \Delta Z \), whose lagged values decline geometrically in importance. In this case, there are two methods of making the Koyck transformation, but the simplest method is to initially assume that both distributions have the same parameter \( \lambda \).\(^{28}\) This can be written as

\[
\Delta Y_t = \alpha + \lambda \beta_{01} \Delta X_t + \lambda \beta_{11} \Delta X_{t-1} + \lambda \beta_{21} \Delta X_{t-2} + \ldots + \lambda \beta_{02} \Delta Z_t + \\
\lambda \beta_{12} \Delta Z_{t-1} + \lambda \beta_{22} \Delta Z_{t-2} + \ldots \mu_t \tag{24}
\]

\(^{28}\)For another method of making the Koyck transformation with the separate independent variable see J. Johnston, op. cit., pp. 299-300.
Using the procedure of lagging (24) by one period, multiplying through by $\lambda$, and subtracting the resulting equation from (24) gives, after rearrangement,

$$\Delta Y_t = \alpha^* + \beta_{01}\Delta X_t + \beta_{02}\Delta Z_t + \lambda \Delta Y_{t-1} + \mu^*$$  \hspace{1cm} (25)

where:

$$\alpha^* = \alpha(1 - \lambda)$$

$$\mu^* = \mu_t - \lambda \mu_{t-1}$$

Variations of this procedure may also be used where the first few values of both $\Delta X$ and $\Delta Z$ are allowed to remain free of the Koyck assumption.

D. Almon Distribution

An approach to choosing a lag distribution considered more flexible than those previously discussed has been suggested by Shirley Almon.\footnote{Shirley Almon, "The Distributed Lag Between Capital Appropriations and Expenditures," \textit{Econometrica}, (January, 1965), pp. 178-96.} Consider once again, equation (15):

$$\Delta Y_t = \alpha + \beta_0 X_t + \beta_1 \Delta X_{t-1} + \beta_2 \Delta X_{t-2} + \beta_3 \Delta X_{t-3} + \ldots + \beta_n \Delta X_{t-n} + \mu_t$$  \hspace{1cm} (15)

where it was postulated that a lagged effect of $\Delta X_{t-n}$ on $\Delta Y_t$ occurs over $n$ periods. Instead of estimating $n$ different lag coefficients $\beta_0, \beta_1, \ldots, \beta_n$, each can be approximated by some function $\beta_n \sim f(z)$. \footnote{Shirley Almon, "The Distributed Lag Between Capital Appropriations and Expenditures," \textit{Econometrica}, (January, 1965), pp. 178-96.}
In the absence of any a priori assumptions about its form, the function \( f(Z) \) is unknown. The Almon method, however, is based on the Weierstrass theorem which states that "a function continuous in a closed interval can be approximated over the whole interval by a polynomial of suitable degree which differs from the function by less than any given positive quantity at every point of the interval."\(^{30}\) Using this theorem it is possible to represent \( f(Z) \) approximately by a polynomial in \( Z \); that is,

\[
f(Z) \approx a_0 + a_1Z + a_2Z^2 + a_3Z^3 + \ldots + a_nZ^n
\]  

(26)

There is a double approximation implied. The discrete values of \( \beta_n \) are approximated by values of a continuous function \( f(Z) \) which in turn is approximated by an nth degree polynomial. Weierstrass's theorem gives no indication of the degree of the polynomial, but the approximation can be made arbitrarily close by using higher and higher degrees.\(^{31}\) Ordinarily a fairly low degree (third or fourth) polynomial will yield accurate results.\(^{32}\)

To estimate the \( \beta \)s using the Almon procedure, values for \( n \) and \( r \) (the number of lagged periods and the degree of the polynomial

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\(^{30}\)J. Johnston, op. cit., p. 294.

\(^{31}\)James L. Murphy, op. cit., pp. 275-7.

\(^{32}\)Ibid., p. 276.
respectively) are initially postulated. If it is supposed, for example, that \( n = 5 \) and \( r = 3 \), then simply ignoring the fact that both the \( \beta \)'s and \( f(z) \) are approximations gives the following scheme for the \( \beta \)'s.

\[
\begin{align*}
\beta_0 &= f(0) = a_0 \\
\beta_1 &= f(1) = a_0 + a_1 + a_2 + a_3 \\
\beta_2 &= f(2) = a_0 + 2a_1 + 4a_2 + 8a_3 \\
\beta_3 &= f(3) = a_0 + 3a_1 + 9a_2 + 27a_3 \\
\beta_4 &= f(4) = a_0 + 4a_1 + 16a_2 + 64a_3 \\
\beta_5 &= f(5) = a_0 + 5a_1 + 25a_2 + 125a_3
\end{align*}
\]

This expresses the six unknown \( \beta \)'s in terms of four unknown \( a \)'s.

Substituting (27) into (15) gives

\[
\Delta Y_t = a_0(\Delta X_t + \Delta X_{t-1} + \Delta X_{t-2} + \Delta X_{t-3} + \Delta X_{t-4} + \Delta X_{t-5}) + \\
a_1(\Delta X_{t-1} + 2\Delta X_{t-2} + 3\Delta X_{t-3} + 4\Delta X_{t-4} + 5\Delta X_{t-5}) + \\
a_2(\Delta X_{t-1} + 4\Delta X_{t-2} + 9\Delta X_{t-3} + 16\Delta X_{t-4} + 25\Delta X_{t-5}) + \\
a_3(\Delta X_{t-1} + 8\Delta X_{t-2} + 27\Delta X_{t-3} + 64\Delta X_{t-4} + 125\Delta X_{t-5}) + \\
\mu_t
\]

\( \mu_t \)

33 Often a search is made over various alternative values of \( n \) and \( r \) to find the best fitting values for the regression equation.
By using ordinary least squares on equation (28) the a's can be estimated. The calculated a's, substituted into (27), gives the β coefficients.\(^3^4\)

In practice the Almon technique allows for postulating a different lag structure for each independent variable and for using statistical techniques to estimate the lag structure rather than impose an a priori weighting pattern. An added feature of the Almon procedure is that either or both of the coefficients for the extremes of the polynomial (i.e. t+1 or t-n+1) can be postulated to have a zero value. Zero values at both ends means that the current value of ΔY is influenced neither by values of ΔX more than n periods earlier nor by values of ΔX to be made in the future.

**The Seasonal Adjustment Problem**

One aspect of this study is to examine the implications of using alternative methods of seasonally adjusting data to determine the effect on the monetary multipliers, best fitting lag structures, and the time response of variables. Although the ratio-to-moving-average method and the "dummy" variable approach, the most common methods of deseasonalizing data, are often used in regression analysis, the assumptions and implications of the deseasonalization process are usually ignored.

\(^{34}\) The above procedure is explained in J. Johnston, *Econometric Methods*, op. cit., p. 295; and James L. Murphy, *Introductory Econometrics*, op. cit., p. 276.
Ordinarily a regression equation such as:

\[ Y_t = \alpha + \beta \bar{X}_t + \mu_t \]  \hspace{1cm} (29)

is formed where \( \bar{Y} \) and \( \bar{X} \) are the "deseasonalized" values of \( Y \) and \( X \).\(^{35}\)

If the deseasonalized data used in equation (29) have been deseasonalized by a ratio-to-moving-average method, the seasonal components are considered to be multiplicative and the implicit assumption of using such data is that \( \beta \) and the intercept in the model vary in a particular way. As to the multiplicative elements, the relationship between deseasonalized and unadjusted data can be expressed as:

\[ Y_t = \bar{Y}_t S_{ty} \quad \text{and} \quad X_t = \bar{X}_t S_{tx} \]  \hspace{1cm} (30)

where \( S_{ty} \) and \( S_{tx} \) represent seasonal indices pertaining to the respective series. So the regression equation (29) implies

\[ \frac{Y_t}{S_{ty}} = \alpha + \beta \frac{X_t}{S_{tx}} + \mu_t \]  \hspace{1cm} (31)

\(^{35}\)This discussion of "deseasonalization" assumes that the deseasonalization process has removed all the seasonal elements from the series. In practice, the deseasonalization process may: (1) eliminate components that are not seasonal; (2) introduce components that are not seasonal; and (3) distort temporal relations among the series. Marc Nerlove has used spectral analysis to quantitatively assess these three possibilities for the Bureau of Labor Statistics (BLS) method of seasonal adjustment of unemployment. He concludes that the BLS method eliminates far more than can be properly called seasonal, but does not appear to introduce non-seasonal components. See Marc Nerlove, "Spectral Analysis of Seasonal Adjustment Procedures," \textit{Econometrica}, (July, 1964), pp. 241-86.
or

\[ y_t = \alpha_{\text{ty}} + \beta_{\text{tyx}} s_{\text{tx}} + s_{\text{ty}} \mu_t \]  

Equation (32) indicates that using data seasonally adjusted by a multiplicative method changes the slopes and intercept of the model in a particular way. Although slopes and intercepts may vary seasonally, George Ladd contends that "... there is no reason they should vary in this certain way. If \([s_{\text{ty}}]\) or \([s_{\text{tx}}]\) vary secularly or cyclically (i.e. changing seasonals), the use of seasonally adjusted data then implies a certain pattern of secular cyclic change in the slopes and intercept."  

If these implicit assumptions of the model are not met, the calculated parameters will not be unbiased estimates.

An alternative method of deseasonalizing data - an approach suggested by Klein and others - is to let the model itself seasonally adjust through the use of dummy variables. When dummy

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37 Ibid., pp. 406-9; Dale Jorgenson has shown that if variables are deseasonalized through regression analysis rather than by a moving average approach the estimated parameters will be best linear unbiased estimators of the systematic and seasonal components. See Dale W. Jorgenson, "Minimum Variance, Linear, Unbiased Seasonal Adjustment of Economic Time Series," Journal of the American Statistical Association, (September, 1964), pp. 681-724.

variables are used, the implication is that seasonals are additive.
When this is true the relationship between unadjusted data and
deseasonalized data can be expressed as

\[ Y_t = \tilde{Y}_t + D_{ty} \quad \text{and} \quad X_t = \tilde{X}_t + D_{tx} \quad (33) \]

where \( D_{ty} \) and \( D_{tx} \) represent seasonal deviations contained in the
respective series. Therefore the regression equation

\[ \tilde{Y}_t = \alpha + \beta \tilde{X}_t + \mu_t \quad (34) \]

implies that

\[ (Y_t - D_{ty}) = \alpha + \beta (X_t - D_{tx}) + \mu_t \quad (35) \]
or

\[ Y_t = \alpha^* + \beta X_t + \mu_t \quad (36) \]

where

\[ \alpha^* = \alpha + D_{ty} - \beta D_{tx} \]

In this case the seasonal factors are assumed to operate by shifting
the intercept of the regression function.

Ladd has shown that if the multipliers of the model do not vary
seasonally, the dummy procedure for deseasonalization of data yields
unbiased estimates, but if slopes do vary seasonally, the dummy vari-
able procedure will bias the regression coefficients.\(^{39}\)

The data used in regression analysis may not satisfy the implicit assumptions of either deseasonalization method, let alone the assumptions of both methods simultaneously. Thus Ladd contends that coefficients calculated with a model using each of these methods may be expected to be different. 40 Other researchers have found that the different deseasonalization processes yield very similar results.41

Results of the Empirical Study

Each of the monetary and reserve aggregates were regressed against gross national product using the alternative lag structures previously discussed. The number of periods included in each distribution was varied to determine the "best" fit. For the rectangular and inverted V distributions, 4, 6, 8, 10, and 12 quarters were used, while for the Koyck distribution the number of periods allowed to remain free of the Koyck assumption was 2, 4, 6, 8, 10, and 12. Four combinations of the Almon lag procedure was estimated: two fourth degree polynomials - one constrained at both ends and the other at the far end only, and two second degree polynomials - one

40Ibid., p. 420.

41Athena Georgopoulou and J. Johnston, "Seasonal Adjustment of Economic Time Series," unpublished manuscript. The principal findings of the above study were quoted by J. Johnston in Econometric Methods, op. cit., pp. 191-2.
constrained at both ends, and the other at the far end only. For each of the four equations, 4, 6, 8, 10, and 12 quarters were used in the lag structures to determine the best fit.

The regression results are divided into two sections - monetary aggregates and reserve aggregates. Each section discusses the "best" fitting regressions calculated using: (1) seasonally adjusted data (i.e. adjusted by the collecting agencies); (2) data seasonally adjusted within the context of the regression model using dummy variables; and (3) seasonally adjusted data and the high employment budget surplus as a fiscal variable.

Choosing the "best" equation involves two decisions. One is selecting the number of lag periods to be included within a given lag structure; and second, determining the best fit among various lag structures.

Because selectivity can become very subjective, an objective criterion - minimum "standard deviation of regression" (also called the standard error of estimate) - was established for purposes of this study. The standard deviation of regression is an absolute measure of goodness of fit which gives a measure of the typical size of the residuals from the estimation. Since the dependent variable in each of the regression equations is the same, the use of

42 Throughout the remainder of the chapter the "standard deviation of regression" will be referred to simply as the "standard deviation".
an absolute measure is well suited as an objective measure of the
ability of the exogenous variables to explain the endogenous
variable.\textsuperscript{43}

**Monetary Aggregates**

Table 11 shows the multipliers calculated for the best fitting
regressions for the monetary aggregates. Three columns of multi-
pliers and other relevant information appear with each variable.
Column (1) shows multipliers calculated using seasonally adjusted
data; Column (2) presents the multipliers calculated when dummy
variables are used to deseasonalize the data; and Column (3) denotes
the monetary multipliers calculated using seasonally adjusted data
and the high employment budget surplus as a fiscal variable.

A. **Seasonally Adjusted Data**\textsuperscript{44}

The regressions calculated using seasonally adjusted data indi-
cate that money defined in the Friedman tradition (\(M_2\)) is the most
reliable predictor (i.e. lowest standard deviation) of changes in

\textsuperscript{43}For an explanation and discussion of this and alternative
measures of goodness of fit see David S. Huang, *Regression and Eco-


\textsuperscript{44}In the remainder of this chapter the terms "seasonally ad-
justed data" and "preadjusted data" will be used interchangeably to
refer to data that has been deseasonalized by the collecting agencies.
### Table 11

Monetary Multipliers Calculated With Best Fitting Lag Structures and Using Two Methods of Deseasonalizing Data

<table>
<thead>
<tr>
<th>Structure</th>
<th>$M_1$</th>
<th>$M_2$</th>
<th>$M_3$</th>
<th>Bank Credit</th>
<th>Adjusted Bank Credit Proxy</th>
</tr>
</thead>
<tbody>
<tr>
<td>$t$</td>
<td>1.18</td>
<td>.56</td>
<td>.56</td>
<td>.56</td>
<td>.56</td>
</tr>
<tr>
<td></td>
<td>(3.95)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$t-1$</td>
<td>-2.01</td>
<td>.56</td>
<td>-07</td>
<td>-07</td>
<td>-07</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(.31)</td>
<td>(.27)</td>
<td>(.27)</td>
</tr>
<tr>
<td>$t-2$</td>
<td>1.18</td>
<td>.56</td>
<td>.01</td>
<td>.01</td>
<td>.01</td>
</tr>
<tr>
<td></td>
<td>(1.63)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$t-3$</td>
<td>-1.30</td>
<td>.56</td>
<td>1.08**</td>
<td>.005</td>
<td>1.03**</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(3.97)</td>
<td>(.005)</td>
<td>(3.35)</td>
</tr>
<tr>
<td>$t-4$</td>
<td>3.16</td>
<td>.56</td>
<td>.99</td>
<td>.81</td>
<td>.12</td>
</tr>
<tr>
<td></td>
<td>(1.98)</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
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<td>.56</td>
<td>.40</td>
<td>.97</td>
<td>-.23</td>
</tr>
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<td></td>
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<td>(.45)</td>
<td>(1.67)</td>
<td>(.29)</td>
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<tr>
<td>$t-6$</td>
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<td>.56</td>
<td>.39</td>
<td>-1.07</td>
<td>.40</td>
</tr>
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<td></td>
<td></td>
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<td>(.63)</td>
<td>(1.89)</td>
<td>(.45)</td>
</tr>
<tr>
<td>$t-7$</td>
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<td>.56</td>
<td>.76</td>
<td>.89*</td>
<td>-.18</td>
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<td>$t-8$</td>
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<td>.56</td>
<td>.208</td>
<td>2.64**</td>
<td>1.53**</td>
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<td>(1.97)</td>
<td>(2.49)</td>
<td>(3.42)</td>
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<tr>
<td>$t-9$</td>
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<td>.56</td>
<td>-2.63*</td>
<td>-2.94**</td>
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<td></td>
<td>(2.22)</td>
<td>(2.46)</td>
<td>(2.18)</td>
</tr>
<tr>
<td>$t-10$</td>
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<td>.56</td>
<td>3.2**</td>
<td>3.3**</td>
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<td>.56</td>
<td>.56</td>
<td>-2.33**</td>
<td>-1.79**</td>
<td>-3.6**</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(2.89)</td>
<td>(2.36)</td>
<td>(2.36)</td>
</tr>
</tbody>
</table>

**Note**: Numbers in parenthesis represent t-values for the corresponding coefficient. Those marked with an * are significant at the .05 level; those marked with ** are significant at the .01 level.

1SA = Seasonally Adjusted Data; S.A.-D.V. = Seasonally adjusted with dummy variables; H.E.B.S. = High Employment Budget Surplus

The following symbols are used to represent the various lag structures: R = rectangular; K = Koyck; V = Inverted V; A = Almon [the number represents the degree of the polynomial and the letters B and P represent the zero constraints - B for both ends, P for far only].
gross national product. "M₂'s" standard deviation of 4.73 is lower than those for the other monetary aggregates. "M₃", "Bank Credit" and the "Adjusted Bank Credit Proxy" have standard deviations of 4.85, 4.83 and 4.77 respectively, while M₁ has 5.35, the highest standard deviation.

The best fitting lag structures were somewhat surprising. In recent years the Almon procedure has become a popular method of estimating lags; yet, only the regression using M₂ as the monetary variable found the Almon polynomial to be the best fitting. This particular lag distribution was estimated using a 4th degree polynomial with zero restrictions placed on each end of the polynomial and from variables included in the structure - the current and three lagged changes in M₂. Two of the coefficients were statistically significant at the .01 level and three had the expected positive sign. The one variable that had a negative sign was small (-.07) and statistically insignificant. The best fitting lag structure for M₁ and Bank Credit was a rectangular distribution containing the current and three lagged variables. For each variable this estimated coefficient was positive and statistically significant at the .01 level. The coefficient for M₁ was 4.72, a multiplier very

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45For the rectangular distribution the four variables included in the lag structure are combined and estimated as a single variable so there is only one calculated coefficient. In Tables 11 and 12 the single calculated variables are shown as the ∑DMₜ₋₁.
similar to those calculated with the models examined in Chapter III. These estimated regressions show the effect on gross national product through time of changes in the monetary variables. Figure 11 compares the cumulative percentage of these effects.

Bank Credit and $M_1$ show 25 percent of their total impact occurring in each quarter, since the best fitting lag structure for each was rectangular. The total impact for $M_2$ and $M_3$ also occurs in four quarters, but the impact is less symmetrical than for Bank Credit and $M_1$, with 45 percent of the change being transmitted in period $t$. For the next two periods the net impact of a change in $M_2$ and $M_3$ on GNP is virtually zero, with the remaining 55 percent of the total impact occurring in the fourth quarter. Although the Koyck type lag structure, which was best fitting for $M_3$, contains four more quarters, the net impact of these additional variables is zero.

Of the five monetary aggregates used in this study the "proxy" showed the longest lagged relationship on gross national product through time of changes in the monetary variable. It takes two years before the total impact of a change in the "proxy" is reflected in GNP, even though over 70 percent of the impact occurs within the first year.

For $M_3$ and the Adjusted Bank Credit Proxy the best fitting lag structure was a form of the Koyck distribution. For both aggregates the current and seven lagged quarters were allowed to remain free of the Koyck assumption. This freedom means that the geometric decline did not begin until two years after the change in the monetary
Figure 11
Comparison of the Cumulative Percentage Effects of a One Dollar Change in Various Monetary Aggregates on Gross National Product Using Seasonally Adjusted Data and the Best Fitting Lag Structure for Each Regression

Source: Calculated from Table 11
variable. Some of the lag values for $M_3$ had unexpected negative signs, but none of the negative variables was statistically significant. Three of the four positive value multipliers were significant at the .05 level. For the "proxy", all but one of the coefficients had the expected positive signs and three were significant at the .01 level.

B. **Seasonally Adjusted with Dummy Variables**

When the regression calculated using dummy variables to deseasonalize the data are compared with those using preadjusted data, several uniform changes are apparent. First, as a comparison of adjacent columns for each variable in Table 11 indicates, the size of the total multiplier increased for each of the monetary variables. Second, the best fitting lag structure for each variable was a Koyck type model with several variables "free" of the Koyck assumption. These lagged free variables almost uniformly took on alternating signs, a characteristic that might indicate that the dummy variables are not able to capture all of the seasonality in the data. Third, the $R^2$'s for each regression rose significantly when the data were adjusted with dummy variables. The regressions deseasonalized with

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46 It is interesting to note that the Koyck type model was by far the best fitting lag structure. Also, all but the Koyck type lag structure showed negative serial correlation as is shown by the Durbin-Watson statistic.
dummy variables had $R^2(s) \geq .98$, whereas the highest $R^2$ for previously adjusted data was .68. Part of the reason for such high $R^2$'s may be that much of the quarterly variations in the unadjusted data results from seasonal patterns which are picked up in the regressions by the dummy variables thereby giving the equation high explanatory powers. Fourth, when dummy variables were used in the regressions, the standard deviations rose considerably. The lowest standard deviation using unadjusted data with dummy variables was 7.27 (for bank credit), while the highest, using previously adjusted data, was 5.35 (for $M_1$). This increase in the size of the standard deviation(s) indicates that the predictive accuracy of the equations are diminished when dummy variables are used to deseasonalize data (even though the explanatory power of the regression are increased - i.e. higher $R^2$'s).

A fifth change noted was that the best fitting lag structure contained more lagged variables (with the exception of the "proxy" which contained the same number) when dummy variables were used to deseasonalize data. Sixth, a comparison of Figures 11 and 12 shows ______

47The mean values of the dependent variables are not exactly the same because first differences are used and unadjusted data has a higher quarter-to-quarter variation than does preadjusted data. The mean value for preadjusted data is 14.94; for data deseasonalized with dummy variables, 15.41. The higher mean value of the dependent variable for unadjusted data partially explains the increase in the standard deviation. However, for preadjusted data the mean value of the dependent variable averages about three times the size of the standard deviation; while for data deseasonalized with dummy variables, it is less than twice the size.
Figure 12
Comparison of the Cumulative Percentage Effects of a One Dollar Change in Various Monetary Aggregates on Gross National Product Using Data Seasonally Adjusted by Dummy Variables And Best Fitting Lag Structure for Each Regression

Source: Calculated from Table II
that the percentage of the total effect of the monetary variables occurring in period \( t \) (i.e. the quarter in which the change took place) increased, with the exception of the "proxy," when dummy variables were used. Seventh, when data were seasonally adjusted by dummy variables it took longer for 100 percent of the monetary effects to be realized. However, for \( M_1 \), \( M_2 \), and \( M_3 \) a greater percentage of the effect was achieved within two quarters of the change, (compare Figures 11 and 12).

When dummy variables were used to deseasonalize the data the ability of the various monetary variables to predict changes in gross national product changed, but not uniformly. The "best" regression among the monetary aggregates is now bank credit, with a standard deviation of 7.27.

C. Seasonally Adjusted Data with the High Employment Budget Surplus

Generalizations about the effect of including the high employment budget surplus as an additional independent variable with its own separate lag structure in regressions using seasonally adjusted data are difficult to find. There did not appear to be one uniform impact on the regressions when the high employment budget was included. The closest thing to uniformity (\( M_3 \) was the exception) that occurred was that the best fitting type of lag structure remained the same regardless of whether the high employment budget surplus was included in the regressions. Another common tendency (with the exception of \( M_1 \)) was that the predictive accuracy of the equations
dropped, if they changed at all. In the case of \( M_1 \), however, the
standard deviation of regression fell from 5.35 to 4.93, thereby
increasing the reliability of the equation. The other standard
deviation either slightly increased or did not change.

Changes in the monetary multipliers did not appear to follow
any discernible pattern when the HEBS was included in the regress-
sions. For instance, when the lag structure contained the same
number of lagged monetary variables as the regressions without the
HEBS, such as for \( M_2 \) and Bank Credit, the size of the total multi-
pliers fell slightly. For \( M_2 \) the multiplier fell from 1.94 to 1.87;
for bank credit, from 1.60 to 1.56. When the lag structure con-
tained fewer lagged variables, such as for \( M_3 \), the monetary multi-
plier decreased significantly - from 1.37 to 1.07. Regressions con-
taining more lagged variables, such as for \( M_1 \) and the Adjusted Bank
Credit Proxy, had larger total multipliers. The total multiplier
increased from 4.72 to 5.60 and from 3.63 to 3.97 for \( M_1 \) and the
"proxy" respectively. These results suggest that the HEBS had much
less of an effect on the size of the monetary multipliers than did
the number of lagged monetary variables included in the regression.

A comparison of Figures 11 and 13 shows that with the exception
of \( M_1 \) the time response of the monetary variables was not appreciably
affected by the inclusion of the HEBS in the regression. When the
HEBS was included with \( M_1 \), the best fitting lag structure showed a
full two and one-half years before the full effect was embodied in
Table 12

Monetary Multipliers Calculated With Best Fitting Lag Structures and Using Two Methods of Deseasonalizing Data

<table>
<thead>
<tr>
<th></th>
<th>M.B.R.</th>
<th>N.B.R.</th>
<th>Monetary Base</th>
<th>E.P.D.E.</th>
</tr>
</thead>
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<tr>
<td></td>
<td>S.A.</td>
<td>S.A.</td>
<td>S.A.</td>
<td>S.A.</td>
</tr>
<tr>
<td></td>
<td>D.V.</td>
<td>H.E.B.S.</td>
<td>D.V.</td>
<td>H.E.B.S.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>S.A.</td>
<td>H.E.B.S.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>D.V.</td>
<td>H.E.B.S.</td>
</tr>
<tr>
<td>t</td>
<td>5.31</td>
<td>-4.65</td>
<td>9.58</td>
<td>.24</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(1.19)</td>
<td>(2.62)**</td>
<td>(.08)</td>
</tr>
<tr>
<td>t-1</td>
<td>7.97</td>
<td>15.60</td>
<td>.80</td>
<td>3.32</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(3.54)**</td>
<td>(.16)</td>
<td>(1.05)</td>
</tr>
<tr>
<td>t-2</td>
<td>7.97</td>
<td>15.13</td>
<td>13.17</td>
<td>6.36</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(2.92)**</td>
<td>(2.78)**</td>
<td>(1.97)</td>
</tr>
<tr>
<td>t-3</td>
<td>5.31</td>
<td>-10.68</td>
<td>.18</td>
<td>-8.50*</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(2.48)</td>
<td>(.03)</td>
<td>(2.65)</td>
</tr>
<tr>
<td>t-4</td>
<td></td>
<td>-7.27</td>
<td>-3.99</td>
<td>-4.82</td>
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<tr>
<td></td>
<td></td>
<td>(1.50)</td>
<td>(.97)</td>
<td>(.21)</td>
</tr>
<tr>
<td>t-5</td>
<td></td>
<td>10.63*</td>
<td>3.63</td>
<td>-1.24</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(2.17)</td>
<td>(.89)</td>
<td>(3.44)</td>
</tr>
<tr>
<td>t-6</td>
<td></td>
<td>5.26</td>
<td>.53</td>
<td>-4.65</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(1.21)</td>
<td>(.17)</td>
<td>(.17)</td>
</tr>
<tr>
<td>t-7</td>
<td></td>
<td>5.70</td>
<td>9.92**</td>
<td>12.77*</td>
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<td></td>
<td></td>
<td>(.82)</td>
<td>(2.50)</td>
<td>(2.69)</td>
</tr>
<tr>
<td>t-8</td>
<td></td>
<td>-4.26</td>
<td>-9.12</td>
<td>-1.67</td>
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<tr>
<td></td>
<td></td>
<td>(1.02)</td>
<td>(1.41)</td>
<td>(1.41)</td>
</tr>
<tr>
<td>t-9</td>
<td></td>
<td>-5.24</td>
<td>4.97</td>
<td>1.67</td>
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<tr>
<td></td>
<td></td>
<td>(1.34)</td>
<td>(.80)</td>
<td>(1.02)</td>
</tr>
<tr>
<td>t-10</td>
<td></td>
<td>8.42</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(2.13)**</td>
<td>(1.02)</td>
<td>(1.02)</td>
</tr>
<tr>
<td>t-11</td>
<td></td>
<td>-3.99</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(3.71)*</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**LM**         | 25.56  | 40.32  | 31.95         | 22.08    |
|                | (3.71)*|        |               |          |

*ANOVAR*       | -.47** | .11    | -.35          | .24      |
|                | (3.18) | (.60)  | (1.30)        | (1.99)   |

**Constant**   | 6.83   | 55.64  | 3.52          | 4.99     |
|                | (4.13) | (13.88)| (1.65)        | (2.26)   |

**D.F.**       | 1.81   | 1.57   | 1.95          | 1.88     |
|                | .84    | .98    | .70           | .66      |

**S.E.**       | 5.62   | 8.14   | 5.25          | 5.21     |
|                | 5.62   | 8.14   | 5.25          | 5.21     |

Lag**          |        |        |               |          |
|                |        |        |               |          |

Structure       | A-7-g  | K      | K             | A-4-8    |
|                |        |        |               | R       |

Note: Numbers in parentheses represent t-values for the corresponding coefficient. Those marked with an * are significant at the .05 level; those marked with ** are significant at the .01 level.

1SA = Seasonally Adjusted Data; S.A.-D.V. = Seasonally Adjusted With Dummy Variables; H.E.B.S. = High Employment Budget Surplus

2The following symbols are used to represent the various lag structures: K = rectangular; K = Knock; V = Inverted V; A = Almon [the number represents the degree of the polynomial and the letters B and F represent the zero constraints - B for both ends, F for far only].
GNP. For the other monetary aggregates, full effect occurred in the same time period as when the HEBS was excluded.

**Reserve Aggregates**

Table 12 shows the multipliers and other relevant information calculated for the best fitting lag structures using reserve aggregates as the monetary variables. Again, three columns of information appear with each variable: Column (1) shows multipliers calculated using seasonally adjusted data; Column (2) presents the multipliers calculated when dummy variables are used to deseasonalize the data; and Column (3) denotes the multipliers calculated using seasonally adjusted data and the high employment budget surplus as a fiscal variable.

**A. Seasonally Adjusted Data**

As can be seen in Table 12 when seasonally adjusted data are used the monetary base is the best predictor of changes in gross national product as reflected by the standard deviation of 5.00. This is the lowest among the reserve aggregates, including non-borrowed reserves, member bank reserves, and R.P.D.'s which had standard deviations of 5.21, 5.62 and 5.79, respectively. Interestingly, R.P.D.'s, the Federal Reserve target variable in recent years, is the poorest among the reserve aggregates as a predictor of changes in gross national product.

Among the lag structures examined there was no one distribution best fitting for more than one reserve aggregate. For the monetary
Figure 13
A Comparison of the Cumulative Percentage Effects
Of a One Dollar Change in Various Monetary Aggregates
On Gross National Product Using Seasonally Adjusted
Data With High Employment Budget Surplus and the
Best Fitting Lag Structure for Each Regression

Source: Calculated from Table 11
base the best lag structure was a rectangular distribution containing the current and five lagged quarters. The estimated coefficient of 16.08 was positive and significant at the .01 level. For member bank reserves an Almon second degree polynomial constrained to zero at both ends was the best fit. Using the Almon technique a second degree polynomial with two constraints was estimated by a single variable which was divided into a symmetrical pattern much like the inverted V. The estimated coefficient for member bank reserves was positive and significant at the .01 level.

A Koyck type distribution with twelve "free" variables was best fitting for nonborrowed reserves. Of the twelve "free" variables, eight had the expected positive sign; however, only three of the coefficients were significant at the .05 level. For R.P.D.'s a fourth degree polynomial with the far end constrained to zero was the best fitting. The distribution contained the current and seven lagged variables all of which had positive signs with two coefficients being significant.

The cumulative percentage effects on gross national product for changes in the reserve aggregates are shown in Figure 14. Member bank reserves showed the quickest total impact, as after four quarters 100 percent of the impact was reflected in changes in gross national product. The pattern of response was evenly distributed with 20 percent of the impact occurring in each of quarters one and four and 30 percent in the second and third.
Figure 14
Comparison of the Cumulative Percentage Effects of a One Dollar Change in Various Reserve Aggregates on Gross National Product Using Seasonally Adjusted Data and the Best Fitting Lag Structure for Each Regression

Source: Calculated From Table 12
The monetary base regressed with a rectangular lag structure showed 17 percent of its total impact occurring in each of its six quarters. For the nonborrowed reserves the impact pattern was smooth for the first four quarters in which 85 percent of the total impact occurred; yet four more quarters were utilized before the remaining 15 percent was reflected in GNP.

The time response for R.P.D.'s, the slowest among the reserve aggregates, followed an uninterrupted pattern with 10 to 20 percent of its total impact occurring in each of eight quarters.48

B. Seasonally Adjusted with Dummy Variables

Table 12 indicates that several changes occurred when the regressions using reserve aggregates were seasonally adjusted with dummy variables. First, the size of the total multipliers increased for each reserve aggregate - a finding that substantiates the similar finding for the monetary aggregates. For the monetary base the total multiplier increased from 16.08 to 24.95, even though the lag structure contained the same number of lagged periods. The best fitting lag structure for member bank reserves included two more lagged periods when dummy variables were used, and the total multiplier increased from 26.56 to 40.32. Even though nonborrowed reserves and R.P.D.'s each contained two less lagged variables when

48 The first and fifth quarters were exceptions to this generalization. Roughly four percent of the total impact occurred in each of these two quarters.
using the dummy variables, the total multipliers increased from 22.08 to 36.96 and 35.24 to 44.28 respectively.

Second, the Koyck type lag structure with several "free" variables was the best fitting lag distribution for each of the reserve aggregates. This finding corresponded with that for monetary aggregates, and similarly (except for the coefficient for t-2), each coefficient took alternating positive and negative signs.

Third, and again like the pattern established for monetary aggregates, the $R^2(s)$ increased substantially when dummy variables were used to deseasonalize the data. All of the reserve aggregates had $R^2(s) \geq .97$ when dummy variables were used as contrasted with the highest for preadjusted data of .66.

Fourth, the standard deviations of regression for each variable increased substantially when dummy variables were used. The lowest standard deviation using dummy variables was 8.14 (member bank reserves) as compared to the highest using preadjusted data of 5.79 (R.P.D.'s).

Fifth, as indicated by the standard deviations, the best predictor of changes in gross national product is member bank reserves, with a standard deviation of 8.14. Nonborrowed reserves with a standard deviation of 8.43 had a closer relationship to gross national product than the monetary base with a standard deviation of 9.75, while R.P.D.'s standard deviation of 9.92 remained last among the reserve aggregates in predictive reliability.
A comparison of Figures 14 and 15 indicates there is little change in the time response among the reserve aggregates when data deseasonalized with dummy variables were used in the regressions. However, when dummy variables were used to adjust the data, the time response was slightly more erratic. Although member bank reserves took two quarters longer to complete their total effect when dummy variables were used, 90 percent of this effect still occurred within one year. R.P.D.'s showed a slightly more rapid response with its total impact occurring in six quarters. For the monetary base and nonborrowed reserves, it took six and eight quarters, respectively, for 100 percent of the change to be realized in G.N.P. The response was also more erratic when the data was deseasonalized using dummy variables.

C. Seasonally Adjusted Data with the High Employment Budget Surplus

When the high employment budget surplus (HEBS) was included with the reserve aggregates in the regressions, the total multipliers for each variable increased, although not significantly (as shown in Table 12). For the "base" the total multiplier increased from 16.08 to 16.70, while for member bank reserves, nonborrowed reserves, and R.P.D.'s the increase was from 26.56 to 31.95, 22.08 to 23.03, and 35.24 to 36.16, respectively.

For the monetary aggregates the best fitting type of lag structure remained the same when the HEBS was included in the regressions. For the reserve aggregates, however, only the monetary base with a rectangular distribution had the same type of lag structure. As to
Figure 15
Comparison of the Cumulative Percentage Effects
of a One Dollar Change in Various Reserve Aggregates
on Gross National Product Using Data Seasonally Adjusted by
Dummy Variables and the Best Fitting Lag Structure for Each Regression

Source: Calculated from Table 12
member bank reserves the best fit changed from an Almon second degree polynomial to a Koyck with eight "free" periods. For non-borrowed reserves, the change was from a Koyck to an Almon fourth degree polynomial containing the current and three lagged periods. Changing from an Almon fourth degree polynomial to a rectangular distribution containing eight periods was the best fit for R.P.D.'s.

Except for nonborrowed reserves, the standard deviation of each regression decreased when the high employment budget was added to the equation. For nonborrowed reserves the standard deviation increased from 5.21 to 5.38 while for the monetary base, member bank reserves, and R.P.D.'s the decrease was from 5.00 to 4.93, 5.62 to 5.25 and 5.79 to 5.46, respectively.

The greatest change that took place when the HEBS was included in the regressions was the measured response through time on GNP for changes in the reserve aggregates. A comparison of Figures 14 and 16 indicates that the time response for R.P.D.'s was the only reserve aggregate which remained virtually unchanged. With the HEBS in the regression it takes two full years before the full impact of changes in member bank reserves occurred, as contrasted to the previous one year. However, 75 percent of the total impact still took place within three quarters. Whereas the full impact of a change in nonborrowed reserves took a year excluding the HEBS, including the HEBS increased the time period to two years (although 85 percent of impact occurred within the first year). The monetary base showed the most drastic change; including the HEBS in the
Figure 16
A Comparison of the Cumulative Percentage Effects
Of a One Dollar Change in Various Reserve Aggregates
On Gross National Product Using Seasonally Adjusted
Data with the High Employment Budget Surplus and
The Best Fitting Lag Structure for Each Regression

Source: Calculated from Table 12
regression increased the total measured impact from one and one-half to two and one-half years.

Summary and Conclusions

The major intention of the preceding analysis was to determine the reliability of various monetary variables in predicting changes in gross national product. Regarding this objective, several conclusions are warranted based on the regressions calculated using preadjusted data. First, for the monetary aggregates, money broadly defined to include time deposits ($M_2$) was the most accurate predictor of changes in gross national product, while money narrowly defined ($M_1$) was the least reliable. The regressions themselves give no clue why $M_1$ performed so poorly relative to $M_2$, but one possible answer is that time deposits, which are included in $M_2$, are more stable than either demand deposits or the currency holdings of the public.

Second, among the reserve aggregates, the monetary base was the most reliable predictor while R.P.D.'s was the least reliable. Interestingly, two reserve aggregates, the monetary base and non-borrowed reserves, were more reliable predictors than $M_1$. This was an unexpected finding since the base and nonborrowed reserves are at least one step farther removed from gross national product than is $M_1$. The only reasonable explanation for such a finding seems to be the variability that may have existed in $M_1$ during the 1960s as interest rates changed. In a period of more stable interest
rates it is likely that $M_1$ would be a better predictor than the reserve aggregates.

Third, changes in all of the monetary aggregates examined showed a fairly rapid impact on gross national product, as of the five variables examined, four showed 100 percent of their impact occurring within one year. The regressions indicated that the reserve aggregates took longer to reach their full impact: of the four reserve aggregates analyzed only member bank reserves showed its full impact in one year while the others required one and one-half to two years. This result is in accordance with most economists' *a priori* expectations about the lag in monetary policy. It seems reasonable to expect at least the majority of the effects of a change in monetary aggregates to be reflected in gross national product within a year. Since the reserve aggregates are at least one step removed from the monetary aggregates, it should take longer for their impact to be reflected in gross national product.

Fourth, no one particular type of lag structure was consistently superior in fitting the relationship between the monetary variables and gross national product. This is somewhat surprising in view of the fact that the Almon procedure has been heralded in recent years as the best way to measure lags since the Almon technique estimates lags utilizing statistical procedures rather than *a priori* assumptions. The only lag structure examined that was not best fitting for at least one equation was the inverted V. However, a weighting scheme other than the one used in this study
might have produced a better fitting structure. Such a divergence of best fitting lag structures may indicate that much has yet to be learned about measuring lags.

A secondary aim of this chapter was to determine the effects of seasonal adjustments on various aspects of the regressions. Several changes were observed when the data were deseasonalized with dummy variables instead of the ratio-to-moving-average approach. First, the total multipliers for all of the variables increased using the dummy variable approach. Why this happened is not certain. However, if seasonality is not strictly additive and if there is co-seasonality between quarters, the monetary coefficients may pick up seasonality and bias them upward.49

Second, a Koyck type lag structure using several "free" variables was best fitting for all the variables. The calculated multipliers for these "free" variables almost uniformly had alternating signs, a finding which may confirm the speculation that the monetary coefficients contain seasonal factors.50


50 It was pointed out earlier that all regressions where the lag structures were clearly specified showed negative autocorrelation, an indication that the model may be misspecified.
Third, for the monetary aggregates, the percentage of the total impact occurring in the first quarter increased when dummy variables were used to deseasonalize data, while for the reserve aggregates, the percentage decreased. For the monetary aggregates this finding is consistent with the Laffer-Ranson results.\(^{51}\) However, there does not appear to be a logical explanation of why monetary and reserve aggregates would be affected differently.

Fourth, the R\(^2\)'s and the standard deviation of regression substantially increased when the data were deseasonalized with dummy variables. Adding variables to a regression is likely to increase the R\(^2\) (unless the R\(^2\) is already very high), even if the variable itself is insignificant statistically. Therefore, using seasonally unadjusted data with three seasonal dummies and a constant term (which also picks up seasonality) would be expected to increase the R\(^2\)(s). Also, if the dummy variables pick up more than seasonality, the explanatory power of the regressions would be increased. Several explanations for the increased size of the standard deviation of regression are feasible. With the mean value of the dependent variable increasing,\(^{52}\) the absolute value of deviations from this mean are likely to increase even if the percentage deviations do not. This would increase the size of the standard deviation.

\(^{51}\)For a summary of their results and an analysis of their model see Chapters II and III of this study.

\(^{52}\)As noted earlier (see footnote 43, p. 111), the mean value of the dependent variable increases from 14.94 to 15.41 when unadjusted data is used.
deviation. Also, when dummy variables are added to the regressions, the degrees of freedom are reduced which will increase the standard deviations noticeably if the sample size is not large. Likewise, the Koyck type regressions with several "free" variables, which were best fitting for all variables when dummy variables were used to deseasonalize the data, have fewer degrees of freedom than the regressions whose lag structures were estimated as a single variable.

Although the inclusion of the high employment budget surplus (HEBS) in the regressions using seasonally adjusted data did not have any uniform effect on the choice of lag structures, the predictive ability of the regressions, or the size of the monetary multipliers, several observations can be made. First, the total multipliers tended to increase for all the reserve aggregates and most of the monetary aggregates. The only logical explanation for this behavior is that the actual deficits of the 1960s were largely financed by monetary expansion, and that actual surpluses coincided with monetary contractions. However, exactly how monetary expansion and contraction relate to the HEBS is not certain because some of the quarter-to-quarter changes in the actual surplus or deficit had opposite signs to that of the quarter-to-quarter changes in the high employment budget surplus.

Second, the majority of the equations became more reliable predictors of gross national product when the HEBS was included, as evidence by the lower standard deviation. Inclusion of an additional variable in a regression would tend to increase the
predictive ability of an equation but the loss in degrees of freedom may offset this increase so that the standard deviation of regression may rise.

Third, when the HEBS was included in the regressions the best fitting type of lag structure tended to remain the same for the monetary aggregates (only \( M_3 \) changed), while for the reserve aggregates, only the lag structure for the "base" remained unchanged. What this finding means or why it occurred is not certain, but it appears to indicate once again that very little is known about the proper way to measure lags.

Fourth, inclusion of the high employment budget surplus changed the measured response (often substantially) over time on gross national product for many of the monetary variables. It would be easier to interpret this finding if changes in the time response were consistently in one direction; however, such is not the case. Among the monetary aggregates, only \( M_1 \) changed significantly, but the inclusion of the HEBS prolonged the time response from one year (without the HEBS) to two and one-half years. For nonborrowed reserves the time response was reduced from two years (when 100 percent of the effect occurred) to one year, while for the monetary base the time response was prolonged from one and one-half to two and one-half years. For member bank reserves, the time response was also lengthened when the HEBS was included, in this case from one to two years. This finding seems to further substantiate the problems inherent in trying to measure lags.
The results of this chapter indicate several tentative conclusions. From a strictly empirical standpoint these findings indicate that the Federal Reserve should be more concerned with controlling the monetary base or non-borrowed reserves than with R.P.D.'s, the reserve target most often cited by Federal Reserve officials in recent years. Likewise, more attention should be given to $M_2$ and the Adjusted Bank Credit Proxy than to $M_1$, a target advocated by many monetarists.

Regarding the seasonal adjustment procedure, the results of this study appear to favor the ratio-to-moving-average approach. The alternating signs of the coefficients in the Koyck type models and the negative autocorrelation shown in the regressions which clearly specified the lag structure, may indicate that the model is not specified correctly when dummy variables are used to deseasonalize time series data. If the seasonal factors are not strictly additive, then the coefficients may be picking up seasonality. Therefore, unless it is definitely established that seasonals are strictly additive, there is no reason for using the dummy variable method for seasonally adjusting data since the regressions are much less reliable predictors of gross national product as shown by their higher standard deviations.

The tendency for the monetary multipliers to increase when the high employment budget surplus is included in the regressions indicates that budgetary deficits and surpluses probably take place through monetary expansion and contraction; however, it is doubtful
that the influence of each of these variables can be correctly separated. From a predictive standpoint there is no reason to include the HEBS in the regressions unless doing so increases the ability of the equation to predict gross national product.
CHAPTER V

THEORETICAL AND STATISTICAL PROBLEMS OF SELECTING MONETARY VARIABLES FOR SINGLE-EQUATION MODELS

Whether a single-equation model is used to test some economic hypothesis or is simply used to show empirical regularities, several methodological, statistical, and theoretical problems must be considered if meaningful statements are to be made from the results.¹

These problems as they relate to the analysis of Chapter IV deal with the selection of appropriate indicators of monetary influences.

For a monetary variable to be appropriate it should be justified from several standpoints. First, a theoretical justification for using a particular variable is required. Such justification ordinarily evolves from various theories developed to explain the determination of income, such as the Quantity Theory. Second, evidence should exist to show that movements in the variable(s) selected are dominated by actions of the monetary authorities. This does not imply that policy makers have acted consciously to control the specific variable(s) used. Third, to interpret meaningfully the regression coefficients, the monetary variable must be statistically exogenous. The economic meaning of this requirement is

that the variable(s) selected to represent monetary actions should not itself be determined by economic activity. If the variable used is not statistically exogenous, the direction of causation will be uncertain, and a close statistical association with economic activity will not provide evidence of the magnitude of monetary influences.

The objective of this chapter is to explore the aforementioned problems to determine which variables examined in Chapter IV can be justified theoretically and statistically.

Theoretical Influence of Monetary Actions

Carl Christ contends that from a theoretical position an appropriate variable representing monetary actions in any econometric model must reflect the financial constraint of the economy.\(^2\) The


\(^4\)A financially constrained economy is defined for this analysis as one in which a decision to spend more than current income by one economic unit can only be achieved by the reduction in the level of spending out of income by some other economic unit.
basic idea underlying the analysis of a financially constrained economy is the familiar micro-analysis of consumer demand. Traditional microeconomic analysis assumes that households maximize utility subject to an income or wealth constraint. Ordinarily, current income is the constraint while other things such as prices, interest rates, etc. are held constant. A change then in the constraint alters the desired level of the households' outlay on goods and services and on savings.

This analysis can be extended to include two households, each with a financial constraint. Assume, for example, that an economy exists that has only two households, (A) and (B). (A) prefers current consumption to future consumption and can maintain a level of expenditures on goods and services (given income, wealth, prices, etc.) in excess of its current income only by borrowing from (B); that is, by selling its liability to (B). Given the income constraint, (A)'s desire to issue a liability (or sell a financial asset) will depend on the interest rate it must offer relative to the interest returns and prices of real assets. (B)'s desire to acquire (A)'s liability also depends on (A)'s offering rate relative to other interest rates and prices. Of course, if (B) has a preference for future consumption this would be facilitated by acquiring (A)'s financial liability.

In this example, total spending of the two households is not increased; (A)'s spending in excess of income must be matched by (B)'s reduction in spending out of current income. The interest
rate on the financial asset will move to the rate necessary to equate the supply of and demand for funds. This type of analysis can be further expanded to include all households as a single economic entity as well as all types of economic units including households, businesses, and government.

For the economy as a whole, total spending is equal to the current total production of final goods and services (G.N.P.) with the acquisition of real assets representing saving. The net acquisition of financial assets is a transfer of purchasing power from surplus to deficit economic units. Buying or selling existing financial assets has little effect on the level of total expenditures unless velocity changes, since there is merely a shift in purchasing power. Total spending is subject to a "financial constraint" because financing of a purchase by one economic unit requires a reduction in spending by another.  

Monetary Actions

If there exists an economic unit which can acquire either existing or newly issued financial assets without necessarily reducing its own spending, the financial constraint on total spending of the economy can be varied. For all practical purposes, the Federal Reserve System is such an economic unit. The Federal Reserve System's ability to acquire assets by issuing liabilities is

5Total spending might possibly increase if borrowing transactions increased interest rates to the extent that the rate of spending out of current income increases, i.e. velocity increases.
not constrained, and therefore, it can vary the financial constraint imposed on the economy. Because of this attribute, the Federal Reserve System in all likelihood exerts an important influence on total spending.

The actions of the Federal Reserve primarily affect the **monetary base**. The "base" therefore is an important aspect of a financially constrained economy. Although open market purchases and sales of government securities are the main source of variation in the monetary base, changes in other items (member bank borrowing, gold, currency holdings of public, etc.) can alter the base. These can, however, be offset by open market transactions.

When the monetary base increases as a result of open market purchases of government securities, the following sequence is likely. First, a government securities dealer receives demand deposits in exchange for the securities. Rather than holding this additional deposit idle in his account, the dealer probably would rebuild his securities inventory or repay debts, causing deposits to be transferred to other economic units. These transactions spread the new deposit balances throughout the country until prices on securities (interest yields) reach a new market equilibrium.

Second, as a result of the open market operation the checks received by the dealers from the Federal Reserve are deposited at commercial banks, giving the banks a credit to their reserve account
when the check is deposited at a Federal Reserve Bank. With a fractional reserve system the commercial bank receives an increase in its excess reserves, since the bank is required to hold only part of the additional deposits in reserves. Ordinarily a bank has a demand for excess reserves and for income earning assets and with given yields on various assets the bank will likely have more excess reserves than desired resulting from the increased deposit. This discrepancy between actual and desired excess reserves will be eliminated by the bank creating demand deposits to purchase financial assets (loans and investments). The expansion of deposits will continue until excess reserves are reduced to their desired level.

If the entire banking system is included in the analysis, then the initial effect of an increase in the monetary base from an open market purchase (or an increase resulting from some other source) is to increase the magnitude of the financial constraint on the commercial banking system. When the constraint is expanded the banking system responds by an increased willingness to make loans or investments to other sectors of the economy, and interest rates may be lowered to induce borrowing. The banks can acquire these assets without causing a reduction in spending to the nonbanking sectors of the economy.

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6 This analysis assumes all banks are members of the Federal Reserve System.
Economic units (households, businesses, and government) will be willing to sell securities to banks (borrow) as long as the expected yields from their borrowings are higher than the interest rate charged by banks. These borrowing units exchange their increased demand deposits for goods and services and real and financial assets. There has, therefore, been an increase in total spending as a direct result of an increase in the monetary base and this spending is likely to be distributed widely across the economy in the form of income receipts. This increased income does not end the expansion process.

As income is generated other economic units receive money balances greater than their desired holdings at prevailing interest rates and prices. Spending increases as these excess balances are eliminated. This process continues until equilibrium levels of income, output, prices, interest rates, etc. are reached so that the economic units are content to hold the existing stock of money.

**Fiscal Actions**

In a financially constrained economy, the impact of changes in government spending is little different than that of changes in

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7Fiscal actions are changes in programs for government expenditures and changes in taxing provisions. Although much attention in macroeconomic analysis is placed upon changes in the government's budget position in analyzing the effect of fiscal actions, little attention is ordinarily given to the alternative methods of financing government expenditure. These alternatives include taxing, borrowing from the public, and monetary expansion. Foreign exchange reserves and stockpiles of commodities are two other kinds of assets that sometimes adjust to offsetting unbalanced budgets; however, for simplicity these alternatives will be ignored.
private spending. Unless monetary actions alter the financial constraint, increased government expenditures must be financed by debt sold to the public or by increased taxes. As funds and resources are channeled from the private sector to the public sector, interest rates and prices would be expected to adjust. This rechanneling constitutes what has been called the "crowding-out effect". Since the adjustment process takes time there may be an initial increase in G.N.P. as interest rates and prices only partially adjust. As the adjusting process continues, there will be a crowding-out of private expenditures as prices and interest rates fully adjust to bring about a new equilibrium and G.N.P. will tend to decline toward its original level. The extent of the crowding-out depends on a large number of price and interest elasticities. However, with the exception of a case involving the liquidity trap, only when government deficit are financed by monetary expansion will there necessarily be a sustained expansion in G.N.P.

8John Culbertson has pointed out that in a financially constrained economy, expenditures by the government financed in debt markets in competition with private expenditures can very possibly "Crowd out of the market an equal volume that would have financed private expenditures." It is possible, however, to have a short-term effect of government spending on total spending if the financial offsets lag behind the initial positive effects. See John M. Culbertson, Macroeconomic Theory and Stabilization Policy, (New York: McGraw-Hill, 1968), pp. 462-3. Also see L. S. Ritter, "Some Monetary Aspects of Multiplier Theory and Fiscal Policy," Review of Economic Studies, (February, 1956), pp. 126-31.
Choosing a Monetary Variable to Fit the Financially Constrained Economy

The preceding analysis of monetary and fiscal actions in a financially constrained economy indicates that summary measure(s) used in the regressions to represent these actions must allow for the financial constraint.

One summary measure of monetary actions which encompasses the financial constraint of the economy is the monetary base. Changes in the monetary base reflect changes in the financial constraint instituted in Federal Reserve policy actions through open market operations. The base also shows the important connection between monetary and fiscal policy since the government deficit in any period must be equal to the combined increase in government securities and the monetary base in the hands of the private sector. Additionally the government surplus in any period must equal the combined reduction in government securities and the monetary base held by the private sector for the period. 9

Leonall Andersen has argued that the money stock is also an appropriate measure of monetary actions that reflect the financial


constraint of the economy. The major reason given for this contention is that the money supply ($M_1$) is systematically related to the monetary base, which reflects the financial constraint of the economy.

Aside from the monetary base, two of the remaining three reserve aggregates examined in Chapter IV (nonborrowed reserves and total member bank reserves) have been used as a summary measure of monetary actions in both large-scale econometric models and in single-equation models. The third reserve aggregate (R.P.D.'s)

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11 Leonall C. Andersen, "An Evaluation of the Impacts of Monetary and Fiscal Policy on Economic Activity," op. cit., pp. 236. His arguments are developed for $M_1$, but the same arguments can be made for the alternative measures of the money stock $M_2$ and $M_3$.

has not been used as a policy variables in any model but has become an important measure since the Federal Reserve adopted it as a target for monetary policy.

From a theoretical view of a financially constrained economy, it is difficult to justify any of these three reserve aggregates as summary measures of monetary actions. The main difficulty is that the nonbank private sector can exchange currency for deposits at their own discretion, thus affecting all reserve measures but the base since the sum of currency outside the banks plus reserves is not affected.  

With R.P.D.'s and nonborrowed reserves there is another difficulty. A transfer of deposits from the private sector to the public sector or vice versa will change R.P.D.'s without changing total bank reserves, and banks can increase their ability to expand by borrowing from a Federal Reserve bank - which is not reflected in the nonborrowed reserve measure.

The two credit aggregates - "bank credit" and the "adjusted bank credit proxy" - cannot be justified as summary measures of monetary actions because they also do not reflect the banking systems total reserve position or currency holdings of the nonbank public. These variables as well as all the reserve aggregates, except the "base", are not likely indicators of monetary influence because there is no underlying, well-specified economic theory (i.e. Quantity Theory, etc.) from which they are derived. So even if

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13 This is essentially the argument presented by Carl F. Christ, "Econometric Models of the Financial Sector," op. cit., p. 429.
statistical results indicate a close relationship between them and economic activity, it is difficult to interpret the results.

Control of the Variables and the Reverse-Causation Problem

A second criterion of a variable chosen to represent monetary actions in single-equation models is that evidence should indicate that movements in the variable chosen are dominated by actions of the monetary authorities. A third condition which is so closely related to the second that they are often treated as one is the so-called "exogenity" condition. That is, the monetary variable chosen must be statistically exogenous as well as controlled by the monetary authorities. This combined problem of "who or what" causes movements in the monetary variables has plagued proponents of the monetarist position and users of single equation models for some time.

Monetarists contend that movements in the money supply (or some reserve aggregate, usually the base) are dominated by actions of the monetary authorities. Thus, users of single-equation models either explicitly or implicitly assume that the direction of causation is from money to economic activity. Opponents of the monetarist position have long recognized that the money stock and current dollar measures of economic activity, such as G.N.P. are positively correlated. They further realize that there is evidence that movements in the money supply precede movements in economic activity or
income. However, as James Tobin and William Brainard have shown, chronological leads do not necessarily imply causal ordering.

Monetarists and non-monetarists agree that when the System's Open Market Manager buys or sells government securities the immediate effect is to change the monetary base. Recognizing however that Federal Reserve behavior causes movements in the monetary base is not sufficient evidence to indicate that these changes dominate movements in the base or other reserve and monetary aggregates since


15 Tobin has shown that it is possible to construct models of the economy in which money has no influence on economic activity but which generate a consistent lead of peaks and troughs in general business activity. See James Tobin, "Money and Income: Post Hoc Propter Hoc?" Quarterly Journal of Economics, (May, 1970), pp. 301-17. Brainard and Tobin have constructed more complicated models in which both GNP and money are endogenous. For endogenous money to appear exogenous in these models, however, money must be essentially identical to a truly exogenous variable. See William Brainard and James Tobin, "Pitfalls in Financial Model Building," American Economic Review, (May, 1968), pp. 99-122.

16 This does not imply that the Federal Reserve is consciously concerned with the size or growth rate of the monetary base. The Federal Reserve may in fact be concerned with such measures as the Treasury bill rate, free reserves, or the "tone and feel" of the money market.
some components of the base and the base multiplier are outside Federal Reserve control.¹⁷

Richard Davis has stated several ways that economic activity (business conditions) can and has affected the rate of growth of the money supply:

1. "the state of business influences decisions by the monetary authorities to supply reserves and to take actions likely to affect the money supply . . ."

2. "business conditions may influence the money stock through an influence on the volume of member bank borrowing at the Federal Reserve."

3. "... influence of business on money operates through the effects of business on the ratio of the public's holdings of coin and currency to its holdings of bank deposits."

4. "a final avenue of influence of business on money is through the influence of business conditions on the ratio of bank excess reserves to deposits."¹⁸

¹⁷Federal Reserve policy decisions are primarily implemented through changes in required reserve ratios and changes in the discount rate as well as open market operations. Of these tools, the most important, especially as it relates to movements in the monetary and reserve aggregates, is open market operations.

¹⁸Richard G. Davis, "The Role of the Money Supply in Business Cycles," Monthly Review, Federal Reserve Bank of New York, (April, 1968), pp. 63-73. Similar arguments have been raised over the exogeneity of the monetary base, although the base is usually considered "more exogenous" than the money stocks. For a discussion of how business conditions may affect the base see Frank de Leeuw and John Kalchbrenner, "Monetary and Fiscal Actions: A Test of their Relative Importance - Comment," op. cit.; Richard G. Davis, "How Much Does
The problem of whether the Federal Reserve controls movements in the money supply (or other monetary variables) or whether movements in the monetary variables result from changes in economic activity (the reverse- causation hypothesis) is a difficult empirical question. Empirical analysis attempting to measure the direction of causality is directed in either of two ways: one approach tries to analyze Federal Reserve behavior and its impact on monetary variables by using the concept of a "reaction function"; the other approach attempts to test directly the exogeneity of various monetary variables.

The general approach using "reaction function" analysis is to suppose the Federal Reserve possesses a utility function relating its conception of the public's welfare to such variables as income, employment, price levels, and the balance of payments. It is then assumed that the Federal Reserve manages its portfolio of government securities in such a way as to maximize utility subject to the constraints imposed by its view of the structure of the economy. One such study relating policy targets of the Federal Reserve to the monetary base was made by Keran and Babb. Their analysis made changes in the base a function of three Federal Reserve objectives: (1) stabilization with respect to income, employment, and prices,


reflected in the Federal Reserve Open Market Committee policy statements as proxied by the level of free reserves; (2) even-keel with respect to Government debt financing, measured by changes in the national debt; and (3) stabilization with respect to the financial system, measured by deviations of Corporate Aaa bond yields from "normal" yield levels. The Keran-Babb results indicate that a large portion of the movements in the monetary base can be explained by Federal Reserve Actions. For the 1953I-1968IV period 69 percent of the variations in the "base" are explained by actions of the monetary authorities.20 In contrast, where the actions of the public were assumed to operate (i.e., changes in the "base" were made a function of changes in gross national product), the best results explained 15 percent or less of the variations of the "base".21

20Ibid., p. 14. Keran and Babb also examined the periods 1929II-1939IV and 1940I-1952IV. For these periods Federal Reserve actions explained 59 and 46 percent of the variations in the monetary base, respectively.

Several studies taking an alternative approach to the problem of "who or what" causes movements in monetary variables have addressed themselves to the direction of causality in regression models.22 The major concern of this type of analysis is whether the money stock (or some other monetary variable) is statistically exogenous. This is a difficult problem as "an exogenous variable in a stochastic model is a variable whose value in each period is statistically independent of the values of all the random disturbances in the model in all periods."23 However, random disturbances cannot be observed, and hence the statistical relationship of the variable treated as exogenous cannot be observed either. Therefore, Christ contends that what variables are treated as exogenous "... must be decided on the basis of whatever presumptions seem plausible in the light of economic theory and experience."24

The most important study to test direction of causality between money and income was done by Christopher Sims25 using a criterion


24 Ibid., p. 158.  

25 Christopher A. Sims, "Money, Income, and Causality," American Economic Review, (September, 1972), pp. 540-52. Sims contends that his test of causality cannot be fooled by the linear structures with reversed causality as developed by Tobin (see footnote 15 of this chapter). The Sims test can be fooled by the bivariate system
developed by C. W. J. Granger. The basic theorem on which the Sims test rests is:

"If and only if causality runs one way from current and past values of some list of exogenous variables to a given endogenous variable, then in a regression of the endogenous variable on past, current, and future values of the exogenous variable, the future values of the exogenous variables should have zero coefficients."

Applying this test to a two-variable system using quarterly observations of a monetary aggregate and G.N.P. in current dollars shows "... clearly that causality does not run one way from G.N.P. to money. The evidence agrees quite well with a null hypothesis that causality runs entirely from money to G.N.P. without feedback."

Sims used two variables to represent "money" in his analysis - $M_1$ and the monetary base. The evidence showed that "future values of G.N.P. were highly significant in explaining ... $[M_1$ and the monetary base], but ... future values of $[M_1$ and the base] were developed by Brainard and Tobin, but only when money is essentially identical to a truly exogenous variable. However, if there is substantial random error in the correspondence between the truly exogenous variable and money and that error has a pattern of serial correlation different from that of the exogenous variable itself, Sims contends his test will show bidirectional causality.


27Christopher A. Sims, *op. cit.*, p. 541.

28Ibid.
not significant in explaining the G.N.P. dependent variable."\(^{29}\)

Regressions were also tested using nonborrowed reserves as the money variable. Nonborrowed reserves regressed on G.N.P. were less significant statistically than either \(M_1\) or the base and G.N.P. regressed on nonborrowed reserves did not show one-way causation.\(^ {30}\)

Michael Keran using an approach somewhat different from Sims also attempted to measure the influence of economic activity on the money stock.\(^ {31}\) His analysis revolved around the Brunner-Meltzer money stock identity

\[ M = mB \]

in which the money stock \((M)\) was defined as the product of the money multiplier \((m)\) and the monetary base \((B)\). The influence of economic activity on money therefore must operate either through the monetary base \((B)\) or the money multiplier \((m)\). To test the proposition that economic activity influences the monetary base, regressions were run for the period 1919-1969 and several sub-periods. Regressing a proxy for nominal G.N.P.\(^ {32}\) on the monetary base for the

\(^{29}\)Ibid., p. 546.

\(^{30}\)Ibid., p. 548.


\(^{32}\)The proxy consists of the scaled product of the Industrial Production Index (IPI) and the Consumer Price Index (CPI) and multiplied by the value of nominal GNP in the base year of the value index (1957-59). The formula used to compute this measure of economic activity \((Y)\) is: \(Y = \left[ \frac{IPI-CPI}{10,000} \right] \cdot (457.4\ \text{billion}).\)
50 year period showed an $R^2$ of .04. The calculated coefficient of 
.008 was, however, statistically significant. Thus an increase of 
$1$ billion in economic activity is associated with an $8$ million 
increase in the base in the same quarter.

To test the proposition that economic activity influences the money stock through the monetary multiplier, Keran made changes in the money stock a function of changes in the monetary base and economic activity. Assuming that the monetary authorities determine changes in the base and the public operating through economic activity influences the money multiplier, the regression results indicated, after converting to beta coefficients, that monetary authorities have an impact on the money stock which is $3\frac{1}{2}$ times as large as the public's influence.\(^3\)

Richard Davis in an effort to measure the influence of "business conditions" on the money supply made changes in $M_1$ a function of the current and three lagged changes in G.N.P., the current and three lagged changes in the nonborrowed monetary base (i.e., the monetary base minus borrowed reserves), and changes in the discount rate.\(^4\) The results showed that the current and lagged changes in G.N.P.

\(^3\)Michael Keran, op. cit., p. 21.

alone explain about 32 percent of the variations in $M_1$ for the 1952 to 1968II period. However, 90 percent of the measured impact occurred in the current quarter when the direction of causation was ambiguous. The lagged changes in G.N.P. contributed only about 10 percent of the total G.N.P. multiplier and none of the lagged coefficients were statistically significant.\(^{35}\)

The inability of the test used by Davis to detect within quarter feedback is a problem also shared by Sims and Keran. If money and income are connected by two causal relations - one from money to income involving a distributed lag and the other from income to money with only the current value of income influencing money - then the tests used by Sims, Keran, and Davis would not detect feedback from income to money.\(^{36}\) Another problem of their analysis is that "business conditions" may influence the supply of money in a way not reflected by current dollar G.N.P. since it is a one-dimensional measure.\(^{37}\)

A completely different approach to the reverse causation argument has been suggested and tested by Raymond Lombia and Raymond

\(^{35}\text{Ibid., pp. 126-128.}\)

\(^{36}\text{For a discussion of this see Christopher Sims, op. cit., pp. 541-2.}\)

\(^{37}\text{Richard Davis, "How Much Does Money Matter?" op. cit., pp. 127-8.}\)
Torto. They propose that the monetary base and other monetary aggregates are not exogenous because they are basically controlled by the Federal Reserve System and argue that the monetary authorities have acted in a way which permitted the money stock \([M_1]\) or the monetary base] to respond to changes in demand for money. Therefore "... if the demand for money is, in part, a function of the level of economic activity and the supply of money has been at least partially demand determined, then the money stock is endogenous ...".

As support, Lombia-Torto estimated an equation to show that Federal Reserve behavior has been primarily defensive in nature. To show that the majority of open market operations can be explained by the systematic responses of the Federal Reserve to changes in economic activity, they regressed the change in the Federal Reserve holding of government securities \((\Delta G)\) on the sum of the sources of the monetary base \((\Delta A)\) and the change in member-bank borrowing \((\Delta B)\), which is treated separately from the monetary base. These variables were designed to test the offsetting behavior of the authorities.

\[\text{Lombia and Torto define "defensive open market operations" to include both offsetting and accommodating actions designed to achieve stable money market conditions.}\]
To measure the accommodating behavior of the Federal Reserve the change in required reserves (ΔRR) and the change in currency (ΔC) were included in the equation. Their results are shown in equation (1).

\[
\Delta G = -0.41\Delta A - 1.21\Delta B + 1.07\Delta RR + 0.81\Delta C \quad (1)
\]

\[t = 5.81 \quad t = 3.43 \quad t = 3.91 \quad t = 4.90\]

\[R^2 = 0.80\]

\[DW = 2.16\]

\[SE = 0.39\]

The results indicate that the Federal Reserve acts to partially offset changes in the base and member bank borrowing and accommodate changes in required reserves and currency drains.\(^{41}\) This accommodating action by the "... authorities to changes in required reserves and changes in currency will lead, ceteris paribus to changes in the monetary base."\(^{42}\) This makes the base endogenous since currency holdings of the public and required reserve holdings of commercial banks are determined endogenously. Extending the analysis Lombia-Torta attempt to show that changes in the monetary base can result from defensive open market operations. If it can be shown that this is true, they contend, "... then the level of economic activity does affect the monetary base and it is not an exogenous variable in the statistical sense of the term."\(^{43}\)

\(^{41}\)Ibid., pp. 7-10.

\(^{42}\)Ibid., pp. 9-10.

\(^{43}\)Ibid., p. 11.
To support the contention that changes in monetary base result
from defensive behavior of the monetary authorities Lombia-Torta
showed that changes in the base (ΔMB) must result from changes in
the Federal Reserve's holdings of securities (ΔG), plus changes in
member-bank borrowing (ΔB), plus changes in the gold stock, float,
and treasury currency outstanding minus treasury cash holdings,
treasury deposits, foreign deposits, and other accounts (ΔA). This
identity can be shown as

\[ ΔMB = ΔG + ΔB + ΔA \]  

(2)

Equation (1) explained part of the variation in ΔG via the "defensive" behavior of the monetary authorities by generating a set of
estimated values (\( \hat{ΔG} \)) which represented "defensive" open market opera-
tion. Substituting \( \hat{ΔG} \) into (2) gives an estimated value for the
monetary base (\( \hat{ΔMB} \)):

\[ \hat{ΔMB} = \hat{ΔG} + ΔB + ΔA \]  

(3)

Their next step was to regress \( ΔMB \) on \( \hat{ΔMB} \) to see if \( \hat{ΔMB} \) explained
any of the variations in \( ΔMB \). Their results, shown in equation (4),
indicated that 92 percent of the variation in (ΔMB) can be explained
by (\( \hat{ΔMB} \)).

\[ ΔMB = .98\hat{ΔMB} \]  

(4)

\[ R^2 = .92 \]

\[ DW = 2.19 \]

\[ SE = .40 \]
Since $\Delta MB$ is derived by assuming only "defensive" open market op-
eration, Lombia-Tort Mart contend the "... results enable us to infer
that the monetary base is a jointly determined variable and, there-
fore, should be treated endogenously."\textsuperscript{44}

The Lombia-Tort Mart study and others discussed seem to show that
the Federal Reserve System through open market operations dominate
movements in monetary variables although there is likely to be some
feedback from G.N.P. (or business conditions) to money or some re-
related monetary variable.\textsuperscript{45} The Lombia-Tort Mart study indicates, however,
that the source of the feedback may come from the ability of the
Federal Reserve to control monetary variables and react to business
conditions.

\textsuperscript{44}Tbid., p. 12.

\textsuperscript{45}The studies discussed in this section did not examine all the
monetary variables included in the analysis of Chapter IV. However,
empirical analysis has shown that trend movements in all the reserve
aggregates - member bank reserves, nonborrowed reserves, R.P.D.'s
and the monetary base - are almost identical. A study by Lacy Hunt
found correlation coefficients between each reserve aggregate and
each other reserve aggregate to be nearly 1.00 for the period Janu-
ary, 1961, to June, 1972, using monthly data. A comparison of rates
of changes show correlation coefficients of between .63 and .84.
Undoubtedly these coefficients would have been higher had quarterly
data been used. See Lacy A. Hunt, II, "Evaluating Movements in the
pp. 57-9. Other research efforts indicate that movements in the
monetary and credit aggregates conform closely to movements in the
reserve aggregates. See "Monetary Aggregates and Money Market Con-
ditions in Open Market Policy," \textit{Federal Reserve Bulletin}, (February,
1971), pp. 79-104; Paul Meek, "Open Market Operations and the Mon-
Bank of New York, (April, 1972), pp. 79-94. See also the studies
cited in footnote 19 of Chapter IV.
Relevant to the problem of exogenity or "reverse causation" is deciding at which point an explanatory variable should be considered endogenous and an additional equation be added to the model. On this issue, Carl Christ states:

"For there is no point in the enlargement of most models at which a convincing stand can be made against such arguments for the addition of another equation unless it is the point where all possible variables have already been included, and of course the model would then be unmanageable. What the economist should do in practice, therefore, in my opinion, is to stop adding equations and variables when he believes that the variables he chooses to call exogenous meet the definition close enough so that the errors incurred through the discrepancy are small in comparison with the degree of accuracy that he thinks is desirable for his purposes (or is attainable)." 46

If lagged values of the (endogenous) monetary variables appear in the G.N.P. equation where reverse-causation is considered to be a problem, there are various estimating procedures available including ordinary least squares (OLS), two stage least squares (TSLS), other forms of limited information methods, and full information models. 47 The latter two are not widely used in practice so the choice is restricted to OLS or TSLS. 48


48 Ibid.
Walters indicates selection between OLS and TSLS should be made pursuant to the purpose of the estimation. If predicting an endogenous variable is the purpose, OLS yields unbiased best estimators, while those using TSLS are biased and inefficient. If the purpose, however, is to estimate structural parameters, then the estimators using OSL are biased and inconsistent, while those using TSLS are consistent, although biased in small samples. 49

Fisk contends, however, that inconsistency with OLS is not always pertinent:

"It is not obvious that this lack of consistency (of single equation least-squares) should always cause concern, particularly when dealing with small samples for which the alternative consistent estimator may have grossly inflated variances compared with the biased estimator given by (least-squares). We must always balance the desirability of consistent estimators against the other criteria by which we judge estimators-principally: degree of precision of the estimator and ease of calculation."50

Bias, according to Fisk, is not the only undesirable property of an estimating procedure - a large variance of parameter estimates is also undesirable. Goldberger reiterates by stating:


"... for small samples the second moments of the classical least-squares estimators (about the true parameter values) may be less than those of the TSLS estimators - their variances may be sufficiently small to compensate for their bias."\(^{51}\)

Consequently, the researcher may have to trade-off bias against larger variances of parameters when switching from an OLS to a TSLS estimating procedure. Thus, estimates of regression coefficients and the determination of lag structures may never be measured with certainty. The fact that we have "... only small samples, while our statistical techniques refer chiefly to large sample properties with current values, only highlights the unsettled nature of measuring economic relationships."\(^{52}\)

In view of the unsettled nature of these issues, there appears to be no clear-cut case for asserting that there is an obviously large bias in the OLS parameters estimated in Chapter IV, or that the bias is of such a magnitude as to more than offset the gain from a smaller variance of parameter estimates.

Summary and Conclusions

The foregoing analysis and discussion indicate that a variable chosen to represent monetary actions in a single equation model


\(^{52}\)H. Albert Margolis, *op. cit.*, p. 83.
should be theoretically sound, controlled by the Federal Reserve, and statistically exogenous.

From the theoretical viewpoint of a financially constrained economy several conclusions are warranted. First, the monetary base is an ideal measure of monetary actions since it reflects the financial constraint of the economy. Any monetary or fiscal action altering the economy's financial constraint is reflected as changes in the monetary base. Second, since the monetary aggregates, $M_1$, $M_2$, and $M_3$, are systematically related to the monetary base, they reflect the financial constraint of the economy and justifiably represent monetary actions. Third, the reserve aggregates - non-borrowed reserves, member bank reserves, and R.P.D.'s - and the two credit aggregates - bank credit and the adjusted bank credit proxy - cannot be justified theoretically as a summary measure of monetary actions since they do not reflect the requirements of a financially constrained economy.

In addition to the theoretical considerations the summary measure representing monetary actions must also be controlled by the monetary authorities and statistically exogenous. The available evidence indicates that all of the monetary variables examined in Chapter IV are dominated by actions of the monetary authorities. As to the criterion of exogenity, however, the evidence is conflicting. The Sims study indicates that $M_1$ and the monetary base are exogenous, while for nonborrowed reserves there is two-way causation. The Keran and Davis studies may have indicated some within quarter
feedback from G.N.P. to $M_1$ and the monetary base, but the results were ambiguous. Lombia and Torta reasoned, however, that the monetary base is endogenous because the Federal Reserve acts endogenously. Since the Lacy Hunt study shows that trend movements and the rates of change in the various monetary variables are highly correlated, it is likely that if the "base" is endogenous the other measures are also. It is not clear, however, that endogenity is so problematical as to require a full scale econometric model to measure monetary actions. The trade off may be more consistency in the parameters for larger variances (using two-stage least squares), while for small samples, even using two-staged least squares, the results are biased. Therefore it does not appear that any definite conclusions can be drawn with respect to the statistical problems of single-equation models. The parameters may be biased, but alternative estimating procedures may not be any better.
CHAPTER VI

Summary and Conclusions

Interest in the role of money in the economy has been high for the last few years, no doubt due to the exuberant behavior of the economy following the enactment of the tax surcharge in 1968. When conventional forecasting methods consistently underestimated economic activity, many researchers looked more closely at the large body of evidence compiled by Friedman and others which showed a close association between the money supply and the level of economic activity.

New efforts to measure the empirical relationships between money and economic activity developed along two avenues - the establishment of large-scale econometric models and the development of "reduced-form" single-equation models. A "reduced-form" single-equation model is simply an equation in which the key economic variables, such as G.N.P., are expressed as direct functions of policy variables and other forces exogenous to the economy.

The purpose of this study was to examine analytically and empirically monetary multipliers calculated using single-equation macroeconomic models of the economy. Single-equation models, although simple in nature, often report widely different monetary
multipliers with respect to their total effect and the distribution of these effects.

In Chapter II, four models - the Friedman-Meiselman, Andersen-Jordan, Laffer-Ranson and Meiselman-Simon - were described and compared. Although variations are expected when regression periods and variables differ, the degree of difference exhibited by these four models was unexpected. In some instances the monetary multipliers bore extremely different implications as to the importance of money in its total effect and the speed of these effects on the economy.

In Chapter III, those factors responsible for the different monetary multipliers calculated using the four models were identified through a "reconciliation" process. The Andersen-Jordan model was used as the standard of comparison by which each dissimilar feature of the remaining three models was compared. The factors found to be important in explaining the different sized monetary multipliers were as follows: (1) the time period used for the analysis; (2) the inclusion of a fiscal variable in the regressions; (3) the choice of the dependent and monetary variables; and (4) the technique used for estimating lagged coefficients.

The factor most responsible for the size differential was the regression period selected. This finding, which is somewhat unsettling, implies that the money-income relationship may be unstable.

The inclusion of a fiscal variable in the regression equation also influenced the size of the monetary multiplier, although the
particular fiscal variable selected did not appear important. Adding the high employment budget surplus to the Meiselman-Simpson model increased the total multiplier; while substituting the high employment budget surplus for federal government purchases of goods and services in the Laffer-Ranson model or for "autonomous" expenditures in the Friedman-Meiselman model had little effect on the total money multiplier. This indicates some of the difficulty in separating the impact of monetary and fiscal actions. The increased size of the money multiplier further indicated that some part of government expenditures was likely financed by monetary expansion.

As expected, the dependent and monetary variables used in the regression affected the size of the monetary multiplier. Unless two variables are essentially identical, substituting one for the other in a regression equation would affect the size of the calculated multiplier. This is true for either endogenous or exogenous variables.

Using the Almon lag technique for estimating lagged coefficients rather than an unconstrained lag structure, tended to increase the size of the total multiplier. The apparent reason for this result is that the Almon lag technique tends to smooth the time pattern on lagged coefficients. This smoothing process often changed the signs of lagged coefficients from negative to positive, which, in turn, increased the total multiplier.

The factors found to be important in determining the distributed impact of the total multiplier in the four models were:
(1) the technique used to estimate lagged coefficients; (2) the method used to deseasonalize data; and (3) the choice of the monetary variable.

The four models examined used either the Almon technique for calculating lagged coefficients or had an unconstrained lag structure which allowed the variables to be "free". Coefficients calculated using the latter procedure had a very uneven pattern, while those calculated with the Almon technique tended to have a smooth lag pattern.

Data used in the four models examined were deseasonalized either by the collecting agencies or within the context of the regression model itself using dummy variables. When data was deseasonalized using dummy variables the total multiplier effect was quickly achieved. The signs on lagged variables tended to alternate from positive to negative and in the process cancel out the lagged effects. The distributed impact of the total multiplier calculated using data deseasonalized by the collecting agencies was spread more evenly over several quarters.

As expected, the variable selected to represent monetary actions also affected the distributed impact of the total monetary multiplier. This is unavoidable unless the various monetary variables move in exact parallel fashion.

In Chapter IV, the analysis of single-equation models was extended by formulating a general model using various monetary (M₁, M₂, M₃, bank credit, and the bank credit proxy) and reserve (monetary
base, member bank reserves, unborrowed reserves, and R.P.D.'s) aggregates as exogenous variables to determine their relative abilities to predict changes in gross national product. The model allowed for alternative lag structures (rectangular, inverted V, Koyck, and Almon) to be used to determine the best fit. Two procedures for seasonally adjusting the data as well as the high employment budget surplus were included in the model to determine the effects of each on the size of the multipliers, the predictive ability of the equation, and the choice of the best fitting lag structure for both monetary and reserve aggregates.

Regressions calculated using data deseasonalized by the collecting agencies revealed several findings. Among the monetary aggregates, $M_2$ was the best predictor of changes in gross national product, and $M_1$, the worst, while among the reserve aggregates, the monetary base was the best predictor of changes, and R.P.D.'s, the worst. Of the five monetary aggregates examined, four showed 100 percent of their total impact occurring within one year, while among the reserve aggregates, only member bank reserves showed its full impact within one year - the others required one and one-half to two years. Of the lag structures examined, no one particular type was found to be consistently best fitting - in fact, the only lag structure that was not best fitting for at least one equation was the inverted V.

Regressions calculated using dummy variables to deseasonalize the data provided the following findings. First, the total multipliers for each monetary and reserve aggregate increased. A possible
explanation of this result is that seasonality is not strictly additive and that co-seasonality exists between quarters so that the monetary coefficients pick up seasonality which bias them upward. Second, a Koyck type lag structure with several "free" variables was best fitting for all variables. The "free" variables for several of the regressions had alternating signs which may confirm the speculation that seasonality is not completely removed by the dummy variables. Third, for the monetary aggregates, the dummy variable approach to deseasonalization increased the percentage of the total impact occurring in the first quarter, while for the reserve aggregates, the percentage of impact occurring in the first quarter decreased. Fourth, the R²'s and the standard deviations substantially increased using data deseasonalized with dummy variables. An increase in the R²'s appears logical, since three dummy variables were added to the model which helped to explain that portion of the movements in gross national product attributable to seasonality. However, the consistently high R²'s (i.e., .92 and higher) indicate that possibly the dummy variables were "explaining" more than seasonal movements in gross national product. The higher standard deviations indicate that the absolute fit of the regressions is not as good using data deseasonalized with dummy variables. Part of the increased size of the standard deviations is attributable to the addition of three dummy variables to the model. These extra variables reduced the degrees of freedom in the regression which in turn increased the standard deviations.
Although including the high employment budget surplus in regressions using data deseasonalized by the collecting agencies did not have a uniform effect on the choice of the best fitting lag structures, the predictive ability of the regressions, or the size of the monetary multipliers, several generalizations can be made. First, the total multiplier increased for all of the reserve aggregates and most of the monetary aggregates. This finding reinforces the contention that some portion of government expenditures are financed by monetary expansion. Second, most of the regressions proved better predictors of changes in gross national product. Third, the best fitting type lag structure tended to remain the same for the monetary aggregates (only $M_3$ changed), while for the reserve aggregates, only the lag structure for the "base" remained unchanged. Fourth, the time response of the monetary variables on gross national product changed - often substantially.

In Chapter V, the theoretical and statistical problems of selecting monetary variables for single-equation models were examined. A single-equation model used to test some economic hypothesis, or to show empirical regularities, must consider several methodological, statistical, and theoretical problems if meaningful statements are to be made from the results. Although an empirically close relationship between a monetary variable and economic activity is desirable for predictive purposes, a close empirical relationship does not make a variable an ideal measure of monetary actions. For a monetary variable to be an appropriate measure of monetary actions
it should be theoretically sound, controlled by the Federal Reserve, and statistically exogenous.

It is argued that for a monetary variable to be theoretically sound it should reflect the financial constraint of the economy. By this criterion, the monetary base is an ideal measure of monetary actions since it reflects any monetary or fiscal action altering the financial constraint of the economy. Furthermore, since the monetary base is systematically related to $M_1$, $M_2$, and $M_3$, these latter variables also reflect the financial constraint of the economy and therefore can represent monetary actions from a theoretical standpoint. On the other hand, nonborrowed reserves, member bank reserves, R.F.D.'s, bank credit, and the bank credit proxy do not reflect the requirements of a financially constrained economy and therefore cannot be justified theoretically as summary measures of monetary actions.

Federal Reserve control and statistical exogenity, as they relate to the selection of a variable to represent monetary actions, were treated as the combined problem of "who or what" causes movements in the monetary variables. A review of the economic literature dealing with these problems indicates general agreement among researchers that movements in monetary variables are dominated by Federal Reserve actions, but divided opinion on the statistical exogenity requirement. The evidence, although divided, indicates that some endogeneity may exist; however, it is not clear that endogeneity is such a problem that a full scale econometric model is
required. Although a full-scale econometric model may produce more consistent parameters than a single-equation model, a trade-off is involved. When estimating a full-scale model using two-stage least squares, variances will be larger than for single-equation models and the coefficients will remain biased if the sample size is small.

The results of this study provide information to warrant several tentative conclusions regarding the general use of single-equation models and the selection of variables to represent monetary actions in those models.

Critics of the single-equation models often argue that the money-income relationship cannot be properly measured using such a procedure because the parameters are biased. Although the evidence presented in this study concurs that bias may exist, it is not sufficient to recommend abandonment of the single-equation approach, particularly since alternative estimating procedures may be no better.

The time period used in measuring the money-income relationship was found to be a significant factor in determining the size of the monetary multiplier. Since this indicates that the money-income relationship may be unstable, great care should be exercised in selecting time periods included in the analysis as well as making projections based on the parameters estimated.

The proper method of deseasonalizing data is a problem often overlooked in econometric research. The results of this study indicate, however, that the procedure selected greatly affects the
measured time distributed impact of monetary actions. Of the two most commonly used methods - the ratio-to-moving-average and the dummy variable approach - the ratio-to-moving-average approach is favored. The alternating signs of the coefficients in the Koyck type models and the negative autocorrelation shown in the regressions specifying the lag structure indicate the model may be misspecified when dummy variables are used. In addition, if seasonality is not strictly additive and co-seasonality exists between quarters, the monetary coefficients will likely pick up some seasonal factors. Therefore, unless it is ascertained that seasonals are strictly additive, data deseasonalized by some type of ratio-to-moving-average process is preferable since the regressions using this procedure are much more reliable predictors of changes in gross national product as evidenced by their lower standard deviations.

There seems to be no one "best" method to measure distributed lags with single-equation models. Of the many variations of the four different types of lag structures examined in this study, there was no one particular structure that was consistently "best fitting". This suggests that much is yet to be learned about measuring lags, and until then, the best procedure is trial and error.

For theoretical and empirical reasons the monetary base and \( M_2 \) are the most appropriate variables to represent monetary actions. Within the context of a financially constrained economy any monetary or fiscal action which alters the financial constraint of the economy is reflected as a change in the monetary base and in \( M_2 \). Of
all the variables examined, $M_2$ is the best predictor of changes in gross national product, and the "base" is the best predictor among the reserve aggregates.

The Federal Reserve should abandon R.P.D.'s as a target variable since it cannot be justified theoretically or empirically. It does not reflect the financial constraint of the economy and among the variables examined in this study is the worst predictor of changes in gross national product.

The results of this study showed that monetary actions during the 1962I-1972IV period were both powerful and speedy. Using seasonally adjusted data, the best fitting lag structure for the monetary base indicated that a one dollar increase in the "base" gave rise to a sixteen dollar increase in gross national product within six quarters. Also, using seasonally adjusted data and the best fitting lag structure, a one dollar change in $M_2$, which is at least one step removed from the monetary base, resulted in an approximate two dollar change in gross national product.

The above findings and conclusions are tentative pending development of better techniques to properly measure economic relationships. Certainly more research is needed regarding the measurement of distributed lags and the methods of deseasonalization of data. Also, additional work is needed to develop a technique to separate the impact of monetary and fiscal policy. The single-equation model approach provided much useful information, yet indicated areas
requiring more research and possibly more elaborate estimating procedures.
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VITA

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