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A Theoretical and Empirical Analysis of the Relationship Between Fiscal Policy and the Money Supply.

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TO MY PARENTS

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ABSTRACT

The fiscal policy-money supply relationship is examined within the context of a small structural model of the economy. The Federal Reserve is assumed to act as though it minimizes a static quadratic loss function subject to its perception of the structure of the economy. The loss function contains as arguments the weighted squared deviations of actual from desired values for real GNP, the inflation rate, a balance-of-trade measure, and a short-term interest rate. The first three arguments represent macroeconomic concerns of the Federal Reserve and the last argument is employed as a proxy for Federal Reserve concern with financial market stability. The macroeconomic model employed as a proxy for the Federal Reserve's perception of the structure of the economy is a linear variant of the IS-LM model that incorporates endogenous net taxes, an endogenous wealth measure, inflationary expectations, and budget constraints for both the fiscal and monetary authorities.

The solution to this constrained optimization problem yields a policy reaction function that relates the Federal Reserve's policy variable - unborrowed reserves adjusted for reserve requirement changes - to desired values of the arguments in the loss function and to lagged endogenous and exogenous variables of the model, which include two fiscal variables. The coefficients on the exogenous

fiscal variables in this equation are analyzed to determine the expected effect of these variables on the Federal Reserve's policy variable. These coefficients are complex mixtures of the structural parameters and weights in the loss function. Given widely held expectations about the signs of the structural parameters, the expected signs on the fiscal variables depend upon the relative weights in the loss function. It is shown that if the weight on the financial market stability proxy exceeds a weighted sum of the weights on the macroeconomic variables in the loss function, then the expected signs on federal expenditures and exogenous federal net taxes are positive and negative respectively. Coefficients of these signs thus indicate accommodation of fiscal policy by the Federal Reserve.

To determine the anticipated effect of the fiscal policy variables upon the money supply, the reaction function is added to structural model and the reduced form money supply equation is derived. It is shown that accommodation of fiscal policy by the Federal Reserve is a sufficient but not necessary condition for the reduced form coefficients on expenditures and net taxes to be positive and negative, respectively.

To empirically test the direction of effect of fiscal policy upon the monetary policy variable and the money supply, the IS-LM model, with and without the reaction function, is estimated over the period 1953-1976 utilizing three-stage least squares. The estimated coefficients on federal expenditures and exogenous federal

net taxes in the reaction function are positive and negative, respectively, thereby suggesting that within the same quarter the Federal Reserve accommodates expansionary fiscal policy. The signs of these coefficients thus imply that the Federal Reserve weights financial market stability more heavily than the macroeconomic stabilization goals. However, it should be noted that while within the same quarter financial market stability seems to dominate other goods, Federal Reserve behavior is significantly influenced by these other goods.

Solution of the models for the reduced form money supply equations reveals that the coefficients on the fiscal variables in these equations are positive for federal expenditures and negative for net taxes. However, the coefficients for the model without the reaction function are substantially smaller than for the model with the reaction function. These results suggest that failure to consider the response of the Federal Reserve to fiscal policy leads to underestimates of the effects of fiscal variables upon the money supply.

CHAPTER I

INTRODUCTION

A recent development in theoretical and empirical macroeconomics - the rise of monetarism - has stimulated interest in the role of money in the economy. Monetarists have asserted the primacy of the causal role of money in determining the level of output and prices. In describing the emphasis of the monetarist approach to macroeconomics, one prominent monetarist, Milton Friedman, has declared: "I regard the description of our position as 'money is all that matters for changes in nominal income and for short-run changes in real income' as an exaggeration but one that gives the right flavor of our conclusions."[1] The primacy of the causal role of money has been much debated in recent years,[2] and while many mainstream non-monetarists have not denied a significant role to money, one leading non-monetarist, Franco Modigliani, has suggested that "we are all monetarists now" in the sense that most

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[1]M. Friedman, "A Theoretical Framework for Monetary Analysis," in R. J. Gordon, ed., Milton Friedman's Monetary Framework: A Debate with His Critics (Chicago: University of Chicago Press, 1974), p. 27.

[2]This debate has theoretical and empirical elements. For a good summary of both of these elements, see A. S. Blinder and R. M. Solow, "Analytical Foundations of Fiscal Policy," in A. S. Blinder and R. M. Solow, et al., The Economics of Public Finance (Washington D.C.: The Brookings Institution, 1974), pp. 57-78.

economists now believe that the money stock has an important effect upon the level of output and prices.[3]

Although a great deal of research effort has been invested in studies of the effect of money on the economy, relatively little effort has been invested in examining the underlying determinants of changes in the money stock. Typically the level or rate of change in the money stock has been taken as exogenous in studies which address the economic effects of changes in the money stock. As noted by R. J. Gordon:

> In addition to their lack of investment of research effort in the short-run dynamics of wage and price adjustment, monetarist authors have been slow to shift their attention from the role of money as the basic determinant of income and price changes to the more fundamental underlying determinants of changes in money.[4]

The debate over the role of money in the economy has been accompanied by a debate over the efficacy of fiscal policy in altering the level of output and prices. Some monetarists have denied any significant fiscal policy effects upon real output unless the fiscal policy actions are accompanied by changes in the money stock. For example, one monetarist, David Fand, has written:

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[3]F. Modigliani, "The Monetarist Controversy or, Should We Forsake Stabilization Policies?," American Economic Review, 67, 2 (March 1977), p. 1.

[4]R. J. Gordon, "Recent Developments in the Theory of Inflation and Unemployment," Journal of Monetary Economies, 2, 2(April, 1976), p. 198.

> To the monetarist, the impact of fiscal actions will depend curcially on _how the government deficit is financed_: expenditures financed either by taxing or borrowing involve a transfer of resources (from the public to the government), with both interest rates and wealth effects on private portfolios, but the net effect of a temporary change in fiscal policy on spending may be ambiguous... . On the other hand, if the deficit is financed through money creation by the banking system -- if the deficit is monetized -- the effect is unambiguously expansionary.[5]

While many non-monetarists would agree that fiscal actions financed through money creation are more expansionary than fiscal actions financed through taxation or issuance of bonds, few would assert no significant effects from tax or bon financed actions.[6] The simulation of large scale models of the economy has provided empirical support for significant fiscal policy effects upon real output, although the magnitude of the effects varies with the mode of financing the fiscal action. In terms of total effects, money financed

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[5]D. I. Fand, "Some Issues in Monetary Economics: Fiscal Policy Assumptions and Related Multipliers," in T. M. Havrilesky and J. T. Boorman, eds., _Current Issues in Monetary Theory and Policy_ (Arlington Heights, Illinois: AHM Publishing Corporation, 1976), p. 233.

[6]See for example, W. H. Branson, _Macroeconomic Theory and Policy_ (New York: Harper and Row, 1972), pp. 278-96. It should be noted that in a long-run theoretical context, Blinder and Solow have demonstrated that under some conditions, the long-run multiplier for bond financed fiscal actions is greater than for money financed fiscal actions. See A. S. Blinder and R. M. Solow, "Does Fiscal Policy Matter?," _Journal of Public Economies_, 2, 4 (November 1973), pp. 319-37.

fiscal actions ranks first, followed respectively by bond financed and tax financed fiscal actions.[7]

While much research effort has been invested in separate studies of monetary and fiscal policies, relatively little effort has been devoted to the study of the relationship between monetary and fiscal policies. Macroeconomic models have been constructed that include a budget constraint for the government, an innovation that does link monetary and fiscal policies.[8] The budget constraint reflects the necessity for a fiscal policy action to be financed in some manner - through taxation, the sale of securities to the public,

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[7]See for example, N. N. Choudhry, "Integration of Fiscal and Monetary Sectors in Econometric Models: A Survey of Theoretical Issues and Empirical Findings," International Monetary Fund Staff Papers, 23, 2 (July 1976), pp. 424-33 and F. Modigliani and A. Ando, "Impacts of Fiscal Actions on Aggregate Income and the Monetarist Controversy: Theory and Evidence," in J. L. Stein, ed., Monetarism (Amsterdam: North-Holland Publishing Co.), pp. 17-42.

[8]Models with a budget constraint are described in: C. F. Christ, "A Simple Macroeconomic Model with a Government Budget Restraint," Journal of Political Economy, 76, 1 (January/February 1968) pp. 53-67; Blinder and Solow, "Does Fiscal Policy Matter?," pp. 112-27; E. F. Infante and J. L. Stein, "Does Fiscal Policy Matter?," Journal of Monetary Economics, 4, 2(November 1976), pp. 473-500; A. S. Blinder and R. M. Solow, "Does Fiscal Policy Still Matter?," Journal of Monetary Economies, 4, 2(November 1976), pp. 501-10; C. F. Christ, "Some Dynamic Theory of Macroeconomic Policy Effects on Income and Prices Under the Government Budget Restraint," Journal of Monetary Economics, 4, 1(January, 1978), pp. 45-70; and B. Hansen, "On the Effects of Fiscal and Monetary Policy: A Taxonomic Discussion," American Economic Review, 63, 4(September 1973), pp. 546-71.

With the exception of Hansen, these studies assume the authority for both monetary and fiscal policymaking resides in one political unit - the government. As noted by Hansen this assumption does not fit the institutional reality of U.S. policymaking in the post-Accord period.

or through an increase in the monetary base. These models thus allow the analysis of fiscal policy actions under different assumptions about the financing of the policy change. For example, these models permit the analysis of the output and price effects of, say, an expansionary fiscal action under the assumption that the policy move is financed by an increase in the monetary base.

While the budget constraint models allow the study of the relationship between fiscal and monetary policies under alternative assumptions about the financing of a fiscal policy change, these models do not provide any insight into the reaction of the monetary authorities to a particular fiscal policy action when the authority for fiscal and monetary policies resides in different decision making entities. This institutional arrangement, of course, characterizes the formulation of monetary and fiscal policies in the United States. In this institutional setting fiscal policymakers have only two direct means of financing a deficit - taxation or sale of securities to the public. Neither of these two modes of finance has any significant direct effects upon the monetary base or the money stock.[9] A relationship between fiscal and monetary policies is often asserted, but is seldom systematically analyzed. For example, Fand asserts: "Fiscal deficits are obviously often associated with, <u>if not directly</u>

[9]For a detailed discussion of this point see Chapter III of this study.

<u>responsible</u> <u>for</u>, substantial increases in the monetary aggregates."[10] (My emphasis added.) Fand does not, however, explain how the deficit leads directly to the increase in the monetary aggregates.

In the case of the United States, some analysts contend that because of an over-riding concern by the Federal Reserve to stabilize interest rates in the short-run an expansionary fiscal policy leads more or less mechanically to an increase in the money supply. In this view an expansionary fiscal policy action results in a budget deficit which must be financed through issuance of government securities. The sale of these securities to the private sector puts upward pressure upon market interest rates. This upward pressure is countered by Federal Reserve purchases of outstanding government securities thereby monetizing, at least in part, the debt issued to finance the deficit. Thus because of the effect of fiscal policy and its financing upon interest rates, the Federal Reserve, according to this view, accommodates expansionary fiscal policy by engaging in open market operations that expand the money supply.[11]

The suggestion that the primary goal of the Federal Reserve is interest rate stabilization is extreme. Certainly the Federal Reserve proclaims a wider range of goals than just interest rate stabilization. Examination of the minutes of the Federal Open Market

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[10] Fand, "Some Issues," p. 234.

[11] For an example of this approach see D. R. Francis, "How and Why Fiscal Actions Matter to a Monetarist," Federal Reserve Bank of St. Louis <u>Review</u>, 56, 5 (May 1974), pp. 4-7.

Committee meetings and the annual reports of the Board of Governors of the Federal Reserve System reveals stated concerns with the growth of real output, the rate of unemployment, the price of inflation, the repercussions of international economic events upon the U.S. economy, and financial market stability (often concern with fluctuations in interest rates is taken as a proxy for concern for financial market stability).[12] In addition, studies which have estimated policy reaction functions for the Federal Reserve have concluded that Federal Reserve policy actions reflect a significant concern for macroeconomic stabilization goals as well as the financial market stability goal.[13]

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[12]See any issue of the Federal Reserve Bulletin (Washington, D.C.: Board of Governors of the Federal Reserve System) or any recent issue of the Annual Report of the Board of Governors of the Federal Reserve System (Washington, D.C.: Board of Governors of the Federal Reserve System).

[13]See for example, J. H. Wood, "A Model of Federal Reserve Behavior," in G. Horwich, ed., Monetary Process and Policy (Homewood, Illinois: Richard D. Irwin, 1967), pp. 135-66. T. Havrilesky, "A Test of Monetary Policy Action," Journal of Political Economy, 75, 3 (June 1967), pp. 299-304; M. W. Keran and C. T. Babb, "An Explanation of Federal Reserve Actions (1933-68)," Federal Reserve Bank of St. Louis Review, 51, 7 (July 1969), pp. 7-20; A. F. Friedlaender, "Macro Policy Goals in the Postwar Period: A Study in Revealed Preference," Quarterly Journal of Economics, 87, 1 (February 1973), pp. 25-43; R. T. Froyen, "A Test of the Endogeniety of Monetary Policy," Journal of Econometrics, 2, 2 (July 1974), pp. 175-88; and T. M. Havrilesky, R. H. Sapp, and R. L. Schweitzer, "Tests of the Federal Reserve's Reaction to the State of the Economy 1964-74," Social Science Quarterly, 55, 4 (March 1975), pp. 835-52.

Theoretical analyses of the fiscal-monetary policy relationship which begin from the premise that the dominant goal of the Federal Reserve is interest rate stabilization bias the conclusion of the analysis toward acceptance of monetary accommodation of fiscal policy. This bias will be examined in more detail in a later chapter, but a simple example will illustrate the source of this bias. Suppose the Federal Reserve has two concerns - one is interest rate stabilization and the other is the inflation rate. Suppose now that the fiscal authorities initiate an expansionary policy action which is successful in stimulating aggregate demand. This fiscal policy move will tend to raise both the inflation rate and the interest rate. If Federal Reserve concern with inflation is sufficiently greater than its concern with interest rate stabilization, the Federal Reserve will take policy actions which will lower the money supply, a policy course that will reinforce the initial upward pressure on interest rates. On the other hand, if interest rate stabilization dominates over the concern for inflation, the Federal Reserve will take actions that will expand the money supply and thereby reinforce the pressure on the inflation rate.

In one set of circumstances the Federal Reserve acted to blunt the stimulative effects of the fiscal action, but in the other case the Federal Reserve acted to reinforce (accommodate) the fiscal action. Thus it is seen that concern with inflation relative to concern with interest rate stabilization determines Federal Reserve

response to fiscal policy. The theoretical analysis of the fiscal-monetary policy relationship is thus complicated by consideration of multiple goals for the Federal Reserve. This simple example is intended only to illustrate the complications introduced when multiple goals for the Federal Reserve are considered. The multiple goal case will be analyzed rigorously in Chapter IV of this study.

This study analyses the theoretical and empirical relationship between fiscal policy and the money supply when the Federal Reserve is assumed to pursue both macroeconomic stabilization goals and the goal of financial market stabilization. A linear variant of the IS-LM macromodel with endogenous taxes, inflationary expectations, and a government budget constraint is specified and estimated.[14] The effect of fiscal policy upon the money supply is examined initially under the presumption that the behavior of the Federal Reserve is exogenous to the model. While this assumption is often made, it is tantamount to suggesting that the Federal Reserve responds only randomly or not at all to economic events.

The effect of fiscal policy upon the money supply when the Federal Reserve is assumed to respond systematically to economic events is next analyzed. The Federal Reserve is hypothesized to minimize a quadratic loss function which contains as arguments the

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[14]While the budget constraint is explicit in the theoretical model, it is implicit in the estimated model. For a discussion of this point see Chapter V of this study.

weighted squared deviations of actual from desired values of real GNP, an inflation rate, a balance of trade measure, and a short-term interest rate subject to its perception of the structure of the economy. The IS-LM model described earlier is employed as a proxy for the Federal Reserve's perception of the structure of the economy. The solution to this constrained optimization problem yields a policy reaction function that relates the Federal Reserve's policy instrument to desired values of the arguments in the loss function and to exogenous and lagged endogenous variables in the structural model - which include the fiscal variables. Analysis of the coefficients on the fiscal variables in the reaction function permits specification of the conditions under which the Federal Reserve can be expected to accommodate fiscal policy in the sense that an expansionary fiscal policy will be accompanied by an expansion in the monetary policy variable.

The model, with the policy reaction function appended, is estimated by iterative three-stage least squares for the period 1953-76. Quarterly data are employed in the estimation. The estimated model is then employed to derive numerical estimates of the impact of fiscal policy upon the money supply. Analysis of the model also provides evidence on the Federal Reserve's pursuit of macroeconomic stabilization goals over this period. Finally, analysis of the model provides evidence on the Goldfeld-Blinder argument that model multipliers will be biased if policymakers reacted systematically to the

state of the economy over the period of estimation and this systematic reaction is not explicitly accounted for in the model.[15]

The remainder of this study will now be outlined. Chapter II contains a review of the literature dealing with the fiscal-monetary policy relationship. The IS-LM model is specified and the effects of fiscal policy upon the money supply when Federal Reserve behavior is exogenous are analyzed in Chapter III. The Federal Reserve loss function is specified and the fiscal policy effects upon the money supply when Federal Reserve behavior is endogenous are analyzed in Chapter IV. Chapter V presents the estimated model and estimates of the impact multipliers of the fiscal variables upon the money supply. Chapter VI summarizes the theoretical and empirical results derived in the previous chapters.

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[15]S. M. Goldfeld and A. S. Blinder, "Some Implications of Endogenous Stabilization Policy," Brookings Papers on Economic Activity, 3 (1972), pp. 585-644.

CHAPTER II

REVIEW OF THE LITERATURE

While little systematic research has been directed toward analyzing the relationship between fiscal policy and the money supply, several studies provide some direct or indirect evidence on this relationship, although with one exception examination of this relationship was not the principal aim of these studies. The studies that will be reviewed in this chapter are those of J. H. Wood, A. F. Friedlaender, R. T. Froyen, J. A. Cacy, R. J. Gordon, and R. J. Barro.

I. Wood

The analytic framework utilized in this study is similar to the framework employed by Wood in a study of Federal Reserve behavior. Wood assumes that the Federal Reserve attempts to optimize a preference function which contains as arguments the weighted squared deviations of actual from desired values for the changes in real GNP, the rate of unemployment, the current surplus in the balance of payments, and the price level subject to its perception of the structure of the economy. The solution to this optimization problem yields an equation - the policy reaction function - that relates

the Federal Reserve's policy instrument to the exogenous and lagged endogenous variables of the structural model.[1]

The structural model employed by Wood is a five equation model with equations for the changes in real output, the unemployment rate, the current surplus in the balance of payments, the price level, and the short-term interest rate. A summary measure of fiscal policy - the change in the annual cash surplus deflated by the wholesale price index - appears as an exogenous explanatory variable in all equations except the interest rate equation. A measure of the value of U.S. government securities held by the public appears as an explanatory variable in the interest rate equation, but there is no formal link between this variable and the fiscal policy variable. The Federal Reserve's policy variable - assumed here to be free reserves adjusted for changes in reserve requirements - appears in each equation.[2]

The final preference function used by Wood differs from the one described earlier. The function used in the empirical work contains two additional terms - the weighted squared short-term interest rate and the weighted squared volume of Federal Reserve purchases and sales of government securities adjusted for reserve

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[1] J. H. Wood, "A Model of Federal Reserve Behavior," in G. Horwick, ed., Monetary Process and Policy (Homewood, Illinois: Richard D. Irwin, 1967), pp. 135-66.

[2] Wood, "A Model," p. 141.

requirement changes. In addition, the empirical function contains the weighted unemployment rate and the weighted squared price level, not the weighted squared differences between actual and desired values for these variables. Wood thus assumes in his empirical work that the desired values for the changes in the price level, the interest rate, and the volume of securities bought and sold by the Federal Reserve are zero. In addition, Wood assumes that the Federal Reserve attempts to minimize the unemployment rate.[3]

From the preference function and structural model described above, Wood derives a reaction function which relates the change in the volume of purchases and sales of government securities by the Federal Reserve to the exogenous and lagged endogenous variables in the structural model. Wood then estimates the reaction function by ordinary least squares utilizing quarterly data (with the exception of the fiscal policy measure which is on an annual basis) for the period 1952-63.[4]

Analysis of the coefficients in the estimated reaction function leads Wood to conclude that the Federal Reserve responds systematically to changes in real GNP, price level changes, changes in the volume of government securities held by the public, and changes in the balance of payments. The coefficient on the fiscal policy measure is positive,

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[3]Wood, "A Model," p. 149.

[4]Wood, "A Model," p. 145-9.

thereby implying that an expansionary fiscal policy change induces open market sales which should, ceteris paribus, reduce the money stock. However, the coefficient is not statistically significant.[5] The use of annual data rather than quarterly data, by suppressing information about quarter to quarter movements in this variable, may result in a biased and inconsistent estimate of this coefficient. Furthermore, it would seem that the change in the volume of government securities held by the public and the current stance of fiscal policy would be correlated in any period of time since the financing of a deficit or surplus affects the volume of securities outstanding. If this correlation exists, inclusion of both variables in the reaction function may introduce multicollinearity into the estimation process. Finally, the fiscal variable employed in this study may not be a good measure of the thrust of fiscal policy since it does not distinguish between policy-induced shifts in expenditures and tax receipts and changes in these variables resulting from changes in the level of economic activity. If the Federal Reserve responds to the economic effects of fiscal policy, then employment of a fiscal variable such as the annual cash surplus that does not accurately measure these economic effects is inappropriate.[6] For

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[5] Wood, "A Model," p. 153.

[6] A. S. Blinder and R. M. Solow, "Analytical Foundations of Fiscal Policy," in A. S. Blinder and R. M. Solow, et al., The Economics of Public Finance (Washington, D.C.: The Brookings Institution, 1974), pp. 3-33.

these reasons, it is hazardous to infer a positive relationship between fiscal policy and the monetary policy variable on the basis of the positive coefficient on the fiscal variable in the reaction function.

Thus the evidence on the fiscal-monetary policy link provided by the Wood study must be interpreted cautiously. The major contribution of the Wood study to this study is the suggestion of a general framework within which the relationship between fiscal policy and the money supply can be analyzed.

II. Friedlaender

Friedlaender's study of macro policy goals also provides some evidence on the empirical relationship between fiscal policy and the money supply. Friedlaender's approach to this study is similar to Wood's study of Federal Reserve behavior. She assumes that a unified fiscal and monetary policy authority conducts monetary and fiscal policy so as to maximize a quadratic preference function subject to the structure of the economy. The preference function contains as arguments the weighted squared deviations of actual from desired values for the level of real GNP, the unemployment rate, the price level, the balance of trade, the short-term interest rate, and the government budget surplus or deficit. The FRB-MIT econometric model serves as the structure of the economy. From this optimization problem Friedlaender derives and estimates reaction functions for both monetary and fiscal policy on a quarterly basis for the period

1954-1964, a period which coincides almost exactly with the period of Wood's study.[7]

The difference between actual and desired net free reserves is employed as the dependent variable in the monetary policy reaction function. The coefficient on the fiscal policy variable (the actual surplus or deficit in the administrative budget) is positive but not statistically significant, thereby indicating that an increase in the surplus is associated with an expansion in the gap between actual and desired net free reserves.[8] The interpretation of this positive sign is ambiguous for the determination of the effect of fiscal policy upon the money supply. The increase in the gap associated with the rise in the surplus (or a fall in the deficit) could result from either a reduction in desired net free reserves with actual reserves constant or falling less than desired net free reserves or it could result from an expansion in actual net free reserves with desired reserves constant or rising less than actual net free reserves. If the rise in the surplus leads to an increase in desired net free reserves, monetary policy could be said to be accommodative, in the sense that the movement in the desired level of net free reserves is expected to generate economic effects of the same type as the fiscal action. On the other hand if the rise in the surplus leads to a

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[7]A. F. Friedlaender, "Macro Policy Goals in the Postwar Period: A Study in Revealed Preference," Quarterly Journal of Economics, 87, 1 (February, 1973), pp. 25-43.

[8]Friedlaender, "Macro Policy Goals," p. 36.

reduction in desired net free reserves, then monetary policy would be said to be nonaccommodative in the same sense as before.

Thus, the implications of the positive coefficient on the fiscal variable for the relationship between fiscal policy and the money supply is ambiguous. Furthermore, it should be noted that as in the Wood study, the fiscal variable employed does not distinguish between discretionary budget changes and budget changes induced by changes in the level of economic activity.

Finally, it should be noted that Friedlaender assumes that one authority conducts both monetary and fiscal policy so as to maximize one preference function. Given the separate nature of monetary and fiscal policymaking in the United States after the Treasury-Federal Reserve Accord of 1951, the assumption of a unified policy authority does not seem appropriate. The assumption of one preference function for both authorities is also inappropriate given the nature of United States macro policymaking. There is no reason that the preference function for both authorities should be identical, particularly in light of Federal Reserve concern for financial market stability. Even if the preference functions contained the same variables, there is no inherent reason for the weights on these variables to be identical for the two authorities. Thus it might be argued that the Friedlaender framework does not represent the institutional reality of moentary and fiscal policymaking in the period under study.

Thus because of the particular measures for fiscal and monetary policy that are employed in this study, and because of the assumptions made about the nature of monetary and fiscal policymaking, the empirical results of this study should be interpreted cautiously.

III. Froyen

A study of the endogeniety of monetary policy by Froyen also provides some evidence on the relationship between fiscal and monetary policy. Froyen estimates reaction functions for the Federal Reserve using monthly data over three separate periods of time demarked by changes in presidental administrations. The periods for estimation are February 1953 - January 1961, February 1961 - January 1969, and February 1969 - December 1972. Froyen uses two monetary policy variables as the dependent variables in the reaction functions - the monetary base and the monetary base minus borrowed reserves (hereafter referred to as the unborrowed monetary base). The gaps between the actual and desired unemployment rate, the actual and desired inflation rate, the actual and desired balance of payments surplus, lagged values of actual manufacturing and trade sales, the volume of privately held federal debt lagged one month, the change in the long-term corporate bond rate, and the full-employment surplus lagged one month are employed as explanatory variables. Almon lags are used for the lags on the gaps between the actual and desired unemployment rate, the

inflation rate, the balance of payments surplus, and on the sales variable.[9]

Froyen suggests that one would expect a negative sign on the full-employment surplus since monetary policy has tended to accommodate fiscal policy in the postwar period. Furthermore, Froyen suggests that the coefficient on the volume of outstanding federal debt held by the private sector should be positive because of Federal Reserve concern for stability in the government securities market.[10]

The empirical evidence on the effect of fiscal policy upon the monetary policy variable is mixed. The coefficient on the full-employment surplus is negative and statistically significant only over the period February 1961-January 1969. These results hold for both monetary policy variables. In the other two periods, the coefficients on the fiscal variable are positive but not statistically significant. The coefficient on the volume of privately held federal debt is positive in every period but is statistically significant for both monetary variables only for the period February 1969-December 1972. The coefficient is significant for the period February 1961-January 1969 only when the monetary base is the dependent variable.[11]

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[9] R. T. Froyen, "A Test of the Endogeniety of Monetary Policy," Journal of Econometrics, 2, 2 (July 1974), pp. 175-88.

[10] Froyen, "A Test," p. 178.

[11] Froyen, "A Test," p. 182.

Froyen concludes his study with the observation that macroeconomic stabilization goals have significantly influenced Federal Reserve behavior in the past. The fiscal variable employed in this study is superior to the variables used in the Wood and Friedlaender studies. The evidence for the effect of fiscal policy upon the monetary policy variable is, however, mixed. The evidence suggests that in the period February 1961-January 1969 the Federal Reserve accommodated fiscal policy. In other periods the evidence is less suggestive since the coefficients on the fiscal variables are positive but not statistically significant.

IV. Cacy

The studies discussed up to this point have not focused directly upon the relationship between fiscal policy and the money supply. The evidence these studies have shed on this relationship has been a by-product of the pursuit of their primary research interests which varied from study to study. A study by Cacy has, however, focused directly upon the fiscal policy-money supply relationship. Cacy hypothesizes that the levels of certain monetary variables (M_1, M_2, the monetary base, member bank reserves, and the volume of U.S. securities held by the Federal Reserve) are affected by the current and previous federal budget deficits. Because of Federal Reserve concern for the effect of financing a deficit upon

the level of interest rates, Cacy anticipates a positive relationship between the monetary variables and the deficit.[12]

Cacy tests his hypotehsis by regressing the levels of the monetary variables on a proxy for the deficit, the level of net liabilities of the Treasury, over the period 1970-74. Each variable is seasonally adjusted and detrended, and lags of 18 and 24 months are employed in the regressions. Cacy reports a significant regression relation for M_1 with an 18-month lag (adjusted R^2 = .28), M_2 with both the 18 and 24 month lags (adjusted R^2s are .40 and .46 respectively), and the monetary base with a 24-month lag (adjusted R^2 = .58). However, the sums of the coefficients on net liabilities in the regressions for M_1, M_2 with the 18 month lag, and the monetary base are negative. The sum of the coefficients on net liabilities for M_2 with the 24-month lag is positive. No significant regression relation is found for member bank reserves (adjusted R^2 = .00).[13]

Cacy concludes that the Federal Reserve did not try to offset the interest rate effects of the budget deficit. He suggests that the negative relationships found are due to private sector response to the deficit. This conclusion points out the hazards of estimating and interpreting "reduced form" equations. In

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[12]J. A. Cacy, "Budget Deficits and the Money Supply," Federal Reserve Bank of Kansas City Monthly Review, June 1975, pp. 3-9.

[13]Cacy, "Budget Deficits," p. 7.

another regression Cacy finds a positive relationship between a short-term interest rate (the commercial paper rate) and the budget deficit.[14] Most studies of the money supply relation have found a positive relation between the level of the money stock and interest rates.[15] If deficits do lead to interest rate increases and the response of the public and commercial banks to this increase results in an expansion of the money supply, then Cacy's interpretation of the regression results is inappropriate. As in many other "reduced form" studies, the interpretation of the results is made difficult by the lack of specification of a model of the economy.[16]

As noted in Chapter IV of this study, a negative relationship between fiscal policy and the money supply is expected when Federal Reserve concern for macroeconomic stabilization goals dominates its concern for financial market stability. If this situation is found, then one would expect a negative relation between the fiscal measure and the Federal Reserve's policy variables. Two possible policy variables are included in the regressions run by Cacy. In the regression of the volume of

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[14]Cacy, "Budget Deficits," p. 8.

[15]See for example, R. L. Tiegen, "The Demand for and Supply of Money," in R. L. Tiegen, ed., Readings in Money, National Income, and Stabilization Policy, 4th ed. (Homewood, Illinois: Richard D. Irwin, Inc., 1978), pp. 69-81.

[16]For a discussion of other problems with the "reduced form" approach, see Blinder and Solow, "Analytical Foundations," pp. 63-78 and the references cited therein.

member bank reserves on the net liabilities measure, a significant regression relation is not found. In the regression of the monetary base on net liabilities, a significant negative relation is found for the 24-month lag. However, as Cacy notes, the existence of autocorrelation makes the interpretation of the regression relation difficult.[17] The evidence thus does not provide support for the supposition that the negative money supply-deficit relation is due to Federal Reserve response to the effects of the deficit.

Thus, the evidence provided by Cacy on the relationship between fiscal policy and the money supply is ambiguous. Some regressions provide weak support for a negative relationship, but a conclusion in favor of a negative relation does not receive support from the interest rate and monetary base regressions.

V. Gordon

An analysis of world inflation by Gordon yields some evidence on the fiscal policy - money supply relationship. Gordon suggests that a concern for stabilizing interest rates may lead the monetary authority to expand the money supply when a demand shock, such as an expansionary fiscal policy, hits the economy. Gordon tests the hypothesis of monetary accommodation of demand shocks by regressing

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[17] Cacy, "Budget Deficits," p. 8.

the growth rate of the money supply upon a fiscal policy variable, the money growth rate lagged one period, a wage rate variable, an output measure, an internationally traded-goods price index, and an international reserves measure. The equation is estimated using quarterly data over the period from the third quarter 1958 to the first quarter 1973 and over the period from the third quarter 1958 to the fourth quarter 1976. The fiscal measure employed is the residual from a regression of the actual federal deficit on the current and lagged values of real GNP. This measure is thus an improvement over the actual deficit since it eliminates, at least in part, changes in the deficit related to changes in the level of economic activity.[18]

For both estimation periods Gordon finds a negative relation between the fiscal variable and the growth rate of the money supply. However, the size of the coefficient varys significantly, changing from -1.012 from 1958-1973 to -.169 from 1958-1976. The results here suggest an offsetting rather than an accommodating relationship, but the relationship seems to be unstable.[19] Gordon's results should be interpreted cautiously, however, since the equation he is estimating is in effect a reaction function for the monetary authority. This equation is not derived from an explicit structural

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[18]R. J. Gordon, "World Inflation and Monetary Accommodation in Eight Countries," Brookings Papers on Economic Activity, 2 (1977), pp. 409-77.

[19]Gordon, "World Inflation," pp. 450-1.

model assumed to represent the structure perceived by these authorities. The equation estimated may thus be misspecified and if it is misspecified the coefficients may be biased and inconsistent.[20]

VI. Barro

A final study reviewed here that contributes some information about the relationship between fiscal policy and the money supply is Barro's study of the relationship between "unanticipated" money growth and unemployment. Barro assumes that government expenditures are financed through taxes and issuance of money. The financing mix is arranged so as to minimize the costs of raising the revenue to cover the expenditures. Barro asserts that with a given quantity of tax-raising capital any increase in government expenditures is financed through both tax increases and an increase in the growth rate of the money supply.[21]

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[20]For a discussion of specification errors and the effects of these errors on the estimated coefficients, see J. Kmenta, Elements of Econometrics (New York: The Macmillan Company, 1971), pp. 392-4.

[21]R. J. Barro, "Unanticipated Money Growth and Unemployment in the United States," American Economic Review, 67, 2 (March 1977), pp. 101-15.

Barro estimates a money growth equation using annual data for the period 1941-73. The dependent variable is the growth rate of M_1 and the explanatory variables include the money growth rate lagged one and two periods, an unemployment rate variable lagged one period, and a federal government expenditure variable. The government expenditure variable is the difference between the log of real federal expenditures and the log of "normal" real federal expenditures. "Normal" real expenditures are generated from an adaptive mechanism which specifies that "normal" expenditures are an exponentially decaying distributed lag of the log of actual real federal expenditures. The fiscal variable employed is thus a measure of the deviation of actual from expected real federal expenditures. Barro finds a positive relationship between the fiscal measure and the growth rate of the money supply, thereby implying monetary accommodation of deviations of actual from normal growth in federal expenditures. Barro also enters both the log of current real expenditures and the fiscal variable described above as separate arguments but finds that the coefficient on the log of actual expenditures is not significantly different from zero. He thus concludes that only deviations of actual from "normal" expenditures influence money supply growth.[22]

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[22]Barro, "Unanticipated Money Growth," pp. 103-5.

The theoretical basis for the inclusion of the fiscal variable in the money supply growth equation, which presumably is the reduced form of some structural model, apparently rests upon the argument that an increase in federal expenditures will be financed in part through an expansion of the money supply. Barro thus implicitly assumes either that fiscal and monetary policy are conducted by a single authority, "the" government, or else that the monetary authority is dominated by the fiscal authority. The latter assumption may be tenable over part of the sample period (1941-1950), but does not conform to the institutional reality of macroeconomic stabilization policies in the post-Accord period. While it is argued in Chapter III of this study that fiscal variables should appear in a monetary policy reaction function, justification of the inclusion of fiscal variables in such a function on deficit financing grounds is inappropriate for the United States in the post-Accord period. Once this institutional feature of policy-making is recognized, the interpretation of the positive coefficient on the fiscal variable in Barro's money growth equation is difficult without further knowledge of the structural model which implicitly lies behind this equation.

VII. Conclusion

With one exception (Cacy) the studies reviewed in this chapter have not focused primarily upon the relationship between fiscal policy and the money supply. In most cases this question

is subsidiary to the primary interest of the study and this primary interest varies from study to study. It is thus not surprising that the evidence on the fiscal policy-money supply relation provided by these studies is ambiguous and in some cases contradictory. Several studies - Wood, Cacy, Gordon, and Friedlaender - find a negative relationship between fiscal policy and either the money supply or a monetary policy variable, thereby implying that monetary policy actions tend to offset expansionary fiscal policy actions. Other studies - Froyen and Barro - find a positive relation between fiscal policy and either the money supply or a monetary policy variable, thereby implying that monetary policy actions tend to accommodate expansionary fiscal policy moves. However, it should be noted that the appropriateness of the fiscal variable may be questioned since many of the variables employed do not distinguish between discretionary fiscal policy changes and changes in the fiscal variable induced by a change in economic activity.

In the following chapters we wish to analyze and estimate empirically the effect of fiscal policy upon monetary policy and ultimately the money supply. A basic premise of this study is that the money supply effects of fiscal policy can be properly analyzed only within a framework which recognizes the concern of the monetary authority for both macroeconomic stabilization goals and financial market stability goals and which specifies a structural model that allows analysis of the effects of fiscal policy upon the achievement

of these goals. Our attention is now directed toward this analysis and estimation in the chapters that follow.

CHAPTER III

MONETARY EFFECTS OF FISCAL POLICY WHEN FEDERAL RESERVE BEHAVIOR IS EXOGENOUS

I. Introduction

The purpose of this chapter is to explore the theoretical links between fiscal policy and changes in the money supply. These links might be separated into two categories - direct and indirect. The direct links refer to the effects upon the money supply of the mode of financing the federal government's budget as distinct from the effects of the budget and its financing upon economic variables that lead to changes in economic behavior that in turn affect the money supply. These modes of financing include (1) drawing down Treasury balances built up from past budget surpluses or from past borrowing in excess of previous deficits, (2) selling government securities to the Federal Reserve, (3) selling government securities to the non-bank public and/or to commercial banks, and (4) selling government securities to the non-bank public and/or to commercial banks accompanied by an equivalent open-market purchase by the Federal Reserve.

The indirect links refer to changes in the money supply induced by adjustments in the spending and portfolio decisions of the non-bank public, commercial banks, and the Federal Reserve as a

response to changes in market interest rates, income, wealth, and other economic variables induced by the current state of the federal budget and its financing. Federal Reserve "even-keeling" would thus be classified as an indirect link within this classificatory scheme. The indirect links will be analyzed in the context of a linear variant of an IS-LM model which incorporates endogenous tax receipts, inflationary expectations, and a government budget constraint. The indirect links with Federal Reserve behavior exogenous are examined in this chapter; the indirect links when Federal Reserve behavior is endogenous to the model are examined in the next chapter.

Direct links are examined first, and it is shown that these effects are of a trivial magnitude and can hereafter be ignored in this analysis. After the model is specified, expressions are derived for the change in the money supply induced by changes in government expenditures and the exogenous portion of tax receipts. We show that a rise in government expenditures unambiguously leads to an expansion in the money supply and that an exogenous increase in tax receipts unambiguously lowers the money supply.

II. Direct Links Between Fiscal Policy and the Money Supply

The direct links between fiscal policy and changes in the money supply can be treated briefly since, in general, these direct effects will be of a trivial magnitude. In analyzing these direct links, we assume that the federal budget is in deficit and that

marginal reserve requirements at all commercial banks are the same. This latter assumption allows us to ignore changes in the money supply due to changes in the distribution of deposits and reserves within the banking system that result from the mode of financing the deficit. Our primary analytic concern is whether the mode of financing as distinct from its effects upon economic variables such as interest rates significantly changes the volume of deposits and reserves within the banking system and hence changes the money supply.

A. Financing Through Drawdown of Treasury Balances at the Federal Reserve

If the Treasury draws down its balances at the Federal Reserve, then, ceteris paribus, the money supply will expand as deposits are transferred from the Treasury, whose deposits are not included in the money supply, to the public, whose deposits are, of course, included in the money supply. Furthermore, the monetary base will expand as Treasury balances at the Federal Reserve fall. If, however, Treasury balances are rebuilt through the sale of securities to the public or through tax collections, the money supply and monetary base will contract as deposits are shifted from the public to the Treasury in payment for the securities or in payment of taxes. The initial change in the money supply and monetary base may also be offset (partially or fully) through Federal Reserve open-market sales. Typically, changes in Treasury

balances at the Federal Reserve are taken as a technical factor which the Federal Reserve acts to offset.

If Treasury balances are quickly rebuilt and if the Federal Reserve "defends" against changes in the money supply and the monetary base due to this mode of finance, the effects upon the money supply and reserves in the system will be short-lived and will be of a trivial magnitude. Empirical evidence on Federal Reserve response to the drawdown of Treasury balances has been provided by Lombra and Torto.[1] They found that changes in the monetary base induced by a reduction in Treasury balances are at least partially offset by open-market sales. Thus we might conclude that typically the effects upon the money supply and monetary base are partially offset by Federal Reserve actions. Empirical evidence on the rebuilding of Treasury balances and the statistical relationship between changes in Treasury balances and changes in M_1 has been provided by Hamblin.[2] Hamblin found that Treasury balances fluctuate widely from week to week, with declines being followed by rebuilding of these balances.[3] Furthermore, in

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[1]R. E. Lombra and R. G. Torto, "Federal Reserve 'Defensive Behavior' and the Reverse Causation Argument," Southern Economic Journal, 40, 1 (July 1973), p. 51.

[2]M. Hamblin, "Treasury Deposits and the Money Supply," Federal Reserve Bank of Kansas City Monthly Review, February 1977, pp. 14-20.

[3]Hamblin, "Treasury Deposits," Chart 1, p. 16.

regressions of the change in M_1 on changes in Treasury deposits at the Federal Reserve, Hamblin found weak statistical relationships for weekly data (R^2 = .17), monthly data (R^2 = .13), and for quarterly data (R^2 = .10).[4] This short-lived money supply effect of changes in Treasury balances has also been noted by Hansen.[5]

The evidence cited above is consistent with the conclusion that any effects of financing a deficit through the drawdown of Treasury balances upon the money supply are short-lived and are therefore of negligible interest for this study since we focus upon quarterly periods as the basic period of analysis.

B. Financing Through the Sale of Government Securities to the Federal Reserve

The sale of securities directly to the Federal Reserve by the Treasury, which would increase the money supply and reserves in the banking system as Treasury balances created in the sale are spent, also has negligible effects upon the money supply. At any given time, the Treasury is allowed by U.S. statute to borrow a maximum of $5 billion directly from the Federal Reserve. However, in the few occasions in which this has occurred in the past, direct borrowing has typically been limited to special Treasury certificates

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[4]Hamblin, "Treasury Deposits," Table 1, p. 17.

[5]B. Hansen, "On the Effects of Fiscal and Monetary Policy: A Taxonomic Discussion," American Economic Review, 63, 4 (September 1973), p. 551.

which were to be repaid within a few days of issue.[6] Thus this mode of finance can be ruled out as having any significant direct effects upon the money supply.

C. Financing Through the Sale of Government Securities to the Non-Bank Public and/or to Commercial Banks

The sale of securities to the non-bank public and/or to commercial banks generally has negligible effects upon the money supply and the monetary base. Sale of securities to the non-bank public reduces the balances of the non-bank public but results in an increase in Treasury balances at commercial banks; the money supply is thus reduced at this point. When the Treasury balances are transferred to the Federal Reserve, reserves in the system fall, but these reserves are restored and the original decline in the non-bank public's balances is reversed when these balances are spent by the Treasury.[7]

The sale of securities to commercial banks would likewise have no money supply effects if the purchase by the banks were financed through a sale of an equivalent amount of other assets held by the banks. In this case, the reduction in the deposits of

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[6] The Federal Reserve System: Purposes and Functions, 6th ed. (Washington, D.C.: Board of Governors of the Federal Reserve, September 1974), p. 66.

[7] It should be noted that the primary purpose of the Treasury's holding deposits at the Federal Reserve and at commercial banks (tax and loan accounts) is to reduce the effect of government financing actions upon bank reserves and interest rates. See P. Brockschmidt, "Treasury Cash Balances," Federal Reserve Bank of Kansas City Monthly Review, July-August 1975, pp. 12-13.

the non-bank public stemming from the banks' sale of assets would offset the money supply effects of the Treasury expenditures and the money supply would not change.

If the bank's purchase of the securities were financed through a drawdown of excess reserves or through increased borrowing at the Federal Reserve, Treasury expenditure of the proceeds of the security sale would change the money supply. If commercial banks rebuilt excess reserves or repaid the borrowing at the Federal Reserve through a sale of other assets, then the initial money supply effects would be reversed and the money supply would have risen only temporarily. However, if the security sales alter economic variables such as market interest rates that affect banks willingness to hold excess reserves or to borrow from the Federal Reserve, then commercial banks may not fully rebuild excess reserves and may extend their borrowing from the Federal Reserve. In this instance, the money supply will not return to its initial level. The money supply effect in this case results from a change in banks' portfolio behavior as a result of the change in market interest rates and, under the classificatory scheme outlined in the introduction, is properly classified as an indirect link between fiscal policy and the money supply.

Thus we can conclude that the third mode of financing the deficit will not have any direct effects upon the money supply but may, through effects upon market variables that affect private

behavior, have an indirect effect upon the money supply. This indirect effect is examined later in this chapter.

D. Financing Through the Sale of Government Securities to the Non-Bank Public and/or Commercial Banks Accompanied by Federal Reserve Open-Market Purchases

The sale of securities by the Treasury accompanied by an equivalent open-market purchase by the Federal Reserve was effectively eliminated as a viable mode of finance by the Treasury - Federal Reserve Accord of 1951. In the period 1942-1951, Federal Reserve pegging of interest rates led to Federal Reserve purchase of all securities offered to it by private holders; in effect the Federal Reserve monetized any Treasury sales of securities in order to prevent interest rates from rising.[8] The automatic response of the Federal Reserve to movements in interest rates was eliminated by the Accord of 1951. This Accord has been widely interpreted to mean that the Federal Reserve was freed to conduct monetary policy so as to achieve the goals specified in the Employment Act of 1946. For example, Chandler and Goldfeld suggest that the Accord's ". . . longer-run purpose was to work toward a situation in which its open-market policies would be shaped almost exclusively by economic stabilization objectives, and its purchases and sales would again be directed exclusively toward regulating the

[8] L. V. Chandler and S. M. Goldfeld, The Economics of Money and Banking, 7th ed. (New York: Harper and Row, 1977), pp. 555-564.

reserve position of the banking system . . . ."[9] As a result of this change in the orientation of monetary policy, the monetization of Treasury securities sales was eliminated as an acceptable method of financing a deficit.

We may, however, observe a federal government budget deficit and a simultaneous open market purchase by the Federal Reserve.[10] In the post-Accord period, this simultaneity is presumably the outcome of a Federal Reserve decision that fiscal policy has not been expansive enough or that a rise in market intrest rates generated by the sale of securities by the Treasury is unacceptable. This change in security holdings by the Federal Reserve is properly classified as an indirect link between fiscal policy and changes in the money supply. Federal Reserve response to the deficit will be analyzed in Chapter IV when the Federal Reserve is treated as endogenous.

The central argument of the discussion presented above is that the financing of the deficit - whether through temporary drawdown of Treasury balances or through sale of securities - has no significant money supply effects other than the effects resulting from changes in market variables that lead to changes in private sector or Federal Reserve behavior that in turn affect the money

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[9] Chandler and Goldfeld, The Economics of Money and Banking, p. 567.

[10] T. D. Simpson, Money, Banking, and Economic Analysis (Englewood Cliffs, N.J.: Prentice-Hall, Inc., 1976), p. 248.

supply. Thus the remaining analysis will concentrate upon the indirect effects of the deficit upon the money supply and the direct links will hereafter be ignored.

III. Specification of the IS-LM Model

As noted in the introduction to this chapter, the indirect effects of fiscal policy upon the money supply are examined within the context of a model of the macroeconomy. This model is also employed in the next chapter as representative of the Federal Reserve's perception of the structure of the economy.

The equations of the model are:

Product Market

(3.1) $C_t = a_0 + a_1(Y_t - T_t) + a_2\, WE_t,$ (consumption function)

(3.2) $WE_t = (\frac{\bar{K}_t}{i^{\ell}_t}) + (\frac{G^s_t}{i^{\ell}_t}) + B_t,$ (wealth definition)

(3.3) $I_t = b_0 + b_1 i^{\ell}_{t-2} + b_2 dY_{t-1} + b_3 Y_t + b_4 I_{t-1},$ (investment function)

(3.4) $E_t = \bar{E}_t,$ (export function)

(3.5) $IM_t = c_0 + c_1 Y_t,$ (import function)

(3.6) $G_t = \bar{G}_t,$ (government expenditure function)

(3.7) $T_t = r_0 + r_1 Y_t,$ (net tax function)

(3.8) $Y_t = C_t + I_t + \bar{G}_t + \bar{E}_t - IM_t$, (equilibrium condition)

Money Market

(3.9) $M_t^D = f_0 + f_1 i_t^m + f_2 Y_t + f_3 \dot{P}_t^E$, (money demand function)

(3.10) $M_t^S = g_0 + g_1 i_t^m + g_2 i_t^{DS} + g_3 UBR_t$, (money supply function)

(3.11) $i_t^{DS} = \bar{i}_t^{DS}$, (discount rate function)

(3.12) $UBR_t = \overline{UBR}_t$, (unborrowed reserves function)

(3.13) $i_t^{\ell} = h_0 + h_1 i_t^m + h_2 Y_t$, (term structure of interest rates function)

(3.14) $M_t^D = M_t^S$, (equilibrium condition)

Phillips Curve Relation

(3.15) $\dot{P}_t = j_0 + j_1 (\frac{1}{U_t}) + j_2 (\frac{Y_t}{Y_t^{POT}}) + j_3 \dot{P}^E$, (Phillips Curve function)

(3.16) $\dot{P}_t^E = (1-\ell) \sum_{n=1}^{\infty} \ell^{n-1} \dot{P}_{t-n}$, (price expectations function)

Aggregate Price Level

(3.17) $P_t = P_{t-1}(1 + \dot{P}_t)$, (price level definition)

where:

Y_t = nominal income,

dY_{t-1} = change in Y from period t-2 to t-1,

Y_t^{POT} = nominal potential income,

C_t = nominal consumption expenditures,

I_t = nominal investment expenditures,

$\bar{G}_t$ = nominal government expenditures on goods and services,

T_t = nominal net tax receipts (total tax receipts - transfer payments),

$\bar{E}_t$ = nominal exports,

IM_t = nominal imports,

i_t^m = a representative nominal short-term market interest rate,

i_t^ℓ = a representative nominal long-term market interest rate,

WE_t = nominal net wealth,

$\bar{K}_t$ = nominal value of net dividend payments to the public by domestic corporations,

$(\frac{\bar{K}_t}{i_t^\ell})$ = nominal value of the economy's capital stock,

B_t = nominal monetary base,

G_t^S = volume of perpetual government securities with an interest payment of \$1/year held by the public,

$(\frac{G_t^S}{i_t^\ell})$ = nominal value of government securities held by the public,

M_t^D = nominal demand for money (M_1),

M_t^S = nominal supply of money (M_1),

$\bar{i}_T^{DS}$ = Federal Reserve discount rate,

$\overline{UBR}_t$ = nominal volume of unborrowed reserves adjusted for reserve requirement changes,

P_t = aggregate price level,

$\dot{P}_t$ = inflation rate,

$\dot{P}^E_t$ = expected inflation rate, and

U_t = total unemployment rate.

The subscript t refers to the time period under consideration. A bar over a variable (for example, $\overline{UBR}_t$) indicates that the variable is exogenous. In the present formulation of the model the endogenous variables are Y_t, C_t, I_t, IM_t, T_t, WE_t, M^D_t, M^S_t, i^{ℓ}_t, $\dot{P}_t$, P_t, and $\dot{P}^E_t$. The exogenous and lagged endogenous variables in this formulation of the model are K_t, G^S_t, B_t, i^{ℓ}_{t-2}, dY_{t-1}, I_{t-1}, E_t, G_t, i^{DS}_t, UBR_t, U_t, Y^{POT}_t, and $\dot{P}_{t-n}$ $(n = 1, \ldots, \infty)$.

Before examining the consumption equation, it is necessary to consider the definition of net wealth employed in the model. Nominal net wealth is defined as the sum of the value of the capital stock, the nominal value of the monetary base, and the nominal value of government securities held by the public. The nominal value of the capital stock might be measured by the nominal value of the ownership claims to this stock of capital. The value of these equities then depends upon expected earnings and the discount rate applied to the earnings. Assuming for simplicity that capital is a perpetuity and that the expected returns in the current and all future periods are equal, we can write the value of the capital stock in the current period as $(\bar{K}_t/i^{\ell}_t)$ where $\bar{K}_t$ is a measure of

the expected earnings from the stock of capital. The value of the capital stock can thus change because of a change in expected returns (assumed to be exogenous) or because of a change in the long-term interest rate.[11] The nominal value of the monetary base and the stock of government securities held by the public represents the liabilities of the Federal Reserve and the Treasury to the public and are hence counted as private sector wealth.

The inclusion of the monetary base is uncontroversial;[12] however, it has been argued that the value of demand deposits should be added to the monetary base and included in net wealth.[13] The case for inclusion of demand deposits in net wealth rests upon the argument that since banks are prevented from paying explicit interest on demand deposits, and since banks in competitive markets would pay interest on demand deposits, banks earn monopoly profits. However, these monopoly profits should be reflected in the value of the bank's stock. Furthermore, banks pay implicit interest on demand deposits; thus even if banks were not required to hold reserves against demand deposits, the value of the bank to its owners would not increase on a one-for-one basis with increases

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[11] L. A. Meyer, "Wealth Effects and the Effectiveness of Monetary and Fiscal Policy," Journal of Money, Credit, and Banking, 6, 4 (November 1974), p. 488.

[12] See for example, D. Patinkin, Money, Interest, and Prices, 2nd ed. (New York: Harper and Row, 1965), p. 289.

[13] See for example, B. Pesek and T. Saving, Money, Wealth, and Economic Theory (New York: Macmillan, 1967), pp. 79-102.

in demand deposits because of the implicit interest payments made by the bank.[14] Therefore, demand deposits will not be included as net wealth for the purposes of this analysis and will be considered as representing an asset of the non-bank public which is fully offset by an equivalent liability of banks.

Furthermore, it is often argued that the value of government securities should not be included as net wealth because individuals anticipate higher tax payments in the future to pay interest on the bonds, and the discounted value of these tax payments is thought to exactly offset the current value of the government securities. It has also been suggested that while some discounting takes place the public does not fully discount the anticipated future taxes and hence some fraction of the value of government securities outstanding should be included as net wealth.[15] However, the usual assumption that the public does not anticipate higher tax rates to pay bond interest will be followed in this paper and the entire value of government securities in the hands of the public will be included as net wealth. Thus net wealth can be written as:

$$WE_t = \left(\frac{\bar{K}_t}{i_t^\ell}\right) + \left(\frac{G_t^S}{i_t^\ell}\right) + B_t.$$

The consumption function relates the level of nominal consumption expenditures to the key determinants of these expenditures,

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[14] D. Patinkin, "Money and Wealth," in D. Patinkin, Studies in Monetary Economics, (New York: Harper and Row, 1972), pp. 168-94.

[15] Patinkin, Money, Interest, and Prices, p. 289.

and the function employed in this model is in the spirit of the Ando-Modigliani life-cycle consumption function. Ando-Modigliani begin from the assumption that individuals maximize their lifetime consumption stream subject to the constraint that the present value of consumption equals the present value of the individual's human and non-human earnings. From this starting point and based upon a number of other assumptions, Ando-Modigliani develop an aggregate consumption function that contains current labor income and net wealth lagged one period as arguments in the function.[16] For simplicity, current income will be substituted for current labor income and current net wealth will be substituted for net wealth lagged one period in the consumption function employed in this model. The coefficient of current labor income, a_1, is greater than zero but less than one, as is the coefficient for net wealth, a_2. The Ando-Modigliani model implies that the coefficient for net wealth will be small since an increase in net wealth is an addition to a stock and consumption from this change in net wealth will be spread over the lifetime of an individual. Thus the model suggests that a_2 is less than a_1; empirical research bears out this theoretical expectation.[17]

The investment function relates the level of investment expenditures to the hypothesized key determinants of these

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[16] A. Ando and F. Modigliani, "The 'Life-Cycle' Hypothesis of Saving: Aggregate Implications and Tests," American Economic Review, 53, 1 (March 1963), pp. 56-9.

[17] Ando and Modigliani, "The 'Life-Cycle' Hypothesis," pp. 60 and 64.

expenditures, and the investment function employed in this model draws from several different theories of investment behavior. The Jorgenson model of aggregate investment behavior suggests that the rental rate per unit of capital adjusted for the price level is an important determinant of the firm's desired capital stock; through its effect upon the level of the desired capital stock, the rental rate exerts an influence upon net investment by the firm. The rental rate is affected by the long-term rate of interest, the depreciation rate, the tax rate appropriate to the firm, the proportion of depreciation expense deductible from the firm's tax bill, and the proportion of interest cost deductible from the tax bill.[18] If all elements of the rental rate other than the long-term rate of interest change slowly or are constant, then most of the changes in the real rental rate can be attributed to changes in the long-term interest rate, and the long-term interest rate, which is readily observable, can be used as a proxy for changes in the rental rate. It is assumed in this study that the long-term interest rate is a proxy for the rental rate. The Jorgenson investment model as modified here implies that the interest rate affects investment expenditures with a lag; the form and length of this lag is, however, an empirical question.[19] The expected sign of the coefficient on the long-term interest rate, b_1, is negative.

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[18] D. W. Jorgenson, "Capital Theory and Investment Behavior," American Economic Review, 53, 2(May 1963), pp. 248-9.

[19] The long-term interest rate lagged two periods gave the best fit for the investment equation (see Chapter V of this study). For this reason the long-term rate lagged two periods is employed

One can also argue that the level of investment is determined in part by the firm's expectations about future levels of sales and that these expectations are in part related to past changes in sales. The change in sales from period t-2 to t-1 affects the firm's expectations of the change in sales from t-1 to t; this latter expected change affects the firm's desired level of the capital stock, and hence investment, in period t. If the firm forms its expectations in this manner, then an accelerator variable should be included in the investment equation.[20] The change in output from t-2 to t-1 is employed as the accelerator variable in this model. Furthermore, the level of investment is in part influenced by the level of current output,[21] and this explanatory variable is also included in the investment equation in this model. The expected

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in the IS-LM model. This finding is in accord with previous studies. See for example, J. R. Moroney and J. M. Mason, "The Dynamic Impacts of Autonomous Expenditures and the Monetary Base on Aggregate Income," Journal of Money, Credit, and Banking, 3, 4 (November 1971), p. 798 and the studies referenced therein.

[20]See for example, D. J. Ott, A. F. Ott, and J. H. Yoo, Macroeconomic Theory (New York: McGraw-Hill, 1975), pp. 93-110. The inclusion of an accelerator variable is consistent with the Jorgenson investment model. See Jorgenson, "Capital Theory," pp. 248-51.

[21]In the Jorgenson approach to investment behavior, the level of output affects the level of the desired capital stock and hence investment. See Jorgenson, "Capital Theory," p. 249. Furthermore, as noted by Ackley, the accelerator model can be formulated in terms of the level of output. See G. Ackley, Macroeconomics: Theory and Policy (New York: Macmillan, 1978), pp. 644-7.

sign on the accelerator coefficient, b_2, is positive as is the expected sign of the output coefficient, b_3.

Finally, many studies have shown that the adjustment of actual investment to the desired rate of investment takes more than one quarter.[22] The gradual adjustment of actual to desired investment may be due to technological constraints in implementing the investment plans. The effect of gradual adjustment upon the investment equation is now demonstrated. The discussion of investment expenditures up to this point can be summarized in an equation of the following sort

$$I_t^D = b_0^* + b_1^* \, i_{t-2}^{\ell} + b_2^* dY_{t-1} + b_3^* Y_t \text{ where}$$

I_t^D = desired investment in period t, i_{t-2}^{ℓ}, dY_{t-1}, and Y_t are as defined previously, and the b_i^*, i = 1, 2, 3, are the coefficients on the explanatory variables. The relationship between actual investment, I_t, and desired investment, I_t^D, can be written as $I_t - I_{t-1} = v(I_t^D - I_{t-1})$. That is, the difference between actual investment in the current and previous periods is proportional to the gap between desired investment in the current period and actual investment in the previous period. v is the adjustment coefficient and indicates the rate of adjustment of actual to desired investment.

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[22] C. W. Bischoff, "Business Investment in the 1970's: A Comparison of Models," Brookings Papers on Economic Activity, 1 (1971), pp. 13-58.

Rearranging this equation we obtain $I_t^D = \frac{1}{v} I_t - (\frac{1-v}{v}) I_{t-1}$. Substituting from the equation for desired investment we obtain $I_t = vb_0^* + vb_1^* i_{t-2}^{\ell} + vb_2^* dY_{t-1} + vb_3^* Y_t + (1-v) I_{t-1}$. Letting $vb_0^* = b_0$, $vb_1^* = b_1$, $vb_2^* = b_2$, $vb_3^* = b_3$, and $(1-v) = b_4$, we obtain the investment equation described earlier in this chapter

$$I_t = b_0 + b_1 i_{t-2}^{\ell} + b_2 dY_{t-1} + b_3 Y_t + b_4 I_{t-1}.$$

The expected sign of the coefficient on the level of investment in the previous quarter is positive.

Exports are taken as exogenous in the model employed in this study since exports are only a small part of total output of the U.S. economy and are influenced in the short-run by the rate of economic activity in foreign countries and by negotiated trade agreements.[23] Imports are taken as endogenous to the model with current income as the chief determinant of the level of imports. The expected sign of the coefficient on current income, c_1, is positive.

Government expenditures are assumed to be exogenous. Since the inside lag in the implementation of changes in government expenditures has been estimated as greater than three months,[24] the

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[23]Moroney and Mason, "The Dynamic Impacts," p. 799.

[24]R. Fels, "The Recognition Lag and Semi-Automatic Stabilizers," Review of Economics and Statistics, 45, 3 (August 1963) pp. 280-5.

assumption of exogenous government expenditure is thought to be reasonable in the context of a quarterly model. The same assumption cannot be made for net tax receipts since, with a given tax rate structure and given structure of transfer payments, changes in income will produce variations in net tax receipts. Net taxes are assumed to be related to the level of income, and the coefficient on income, r_1, is assumed to be positive. It should be noted that changes in either the tax rate structure or in the structure of transfer payments will change the value of this coefficient.

The equilibrium condition for the product market merely states that the current level of nominal income depends upon the current levels of nominal consumption expenditures, nominal investment expenditures, nominal government expenditures, and nominal net exports $(\bar{E}_t - IM_t)$. It should be noted, however, that because of the specific formulation of the investment function, lagged values of investment expenditure and nominal income affect the current level of nominal income.

The money demand function employed here can be written in general form as: $M_t^D = \ell(i_t^m, Y_t, \dot{P}_t^E)$. This general form is broadly consistent with a number of different theoretical and empirical approaches to the demand for money,[25] although in many instances

[25]See for example, S. M. Goldfeld, "The Demand for Money Revisited," Brookings Papers on Economic Activity, 3 (1973), pp. 576-638; A. Meltzer, "The Demand for Money: The Evidence from the Time Series," Journal of Political Economy, 71, 3 (June 1963), pp. 219-46; M. Friedman, "The Quantity Theory of Money - A Restatement," in

the scale variable employed is either permanent income or net wealth. The scale variable employed here will be current nominal income. The specific form of the money demand function utilized in this study is linear in i_t^m, Y_t, and $\dot{P}_t^E$. The money demand function can thus be written as $M_t^D = f_0 + f_1 i_t^m + f_2 Y_t + f_3 \dot{P}^E$. The expected sign of the coefficient on i_t^m is negative (economic units economize on money balances as the opportunity cost of holding these balances rises), the expected sign of the coefficient on Y_t is positive (as the scale variable expands economic units expand their holdings of all normal goods, to include money balances), and the expected sign of the coefficient on $\dot{P}_t^E$ is negative (the expected rate of inflation can be viewed as the rate of return on physical goods so that as the expected rate of inflation rises economic units retrench their holdings of money balances).

One might object to the inclusion of both the nominal short-term rate and the expected rate of inflation as explanatory variables in the money demand function as redundant. Economic theory suggests that nominal market interest rates reflect (at least partially) anticipated inflation. However, many empirical studies of the relationship between anticipated inflation and nominal interest rates have found that anticipated inflation affects these interest rates

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M. Friedman, ed., Studies in the Quantity Theory of Money (Chicago: The University of Chicago Press, 1956), pp. 3-21; and D. E. W. Laidler, The Demand for Money. 2nd ed. (New York: Dun-Donnelley Publishing Corp., 1977), pp. 49-98.

with a coefficient of less than unity.[26] Thus nominal market rates may not fully reflect anticipated inflation rates. If this is the case, a direct effect of anticipated inflation on the demand for money is possible even though anticipated inflation indirectly affects this demand through its effects upon nominal market interest rates. Recent empirical tests of a money demand function that includes both nominal interest rates and expected inflation as explanatory variables have found both variables to be significant.[27] Based upon these empirical results, both nominal interest rates and expected inflation will be included as explanatory variables in the money demand function.

For convenience, the money demand function will be written in inverse form and rearranged so that i_t^m is the dependent variable. Performing the necessary manipulations, we obtain the following equation which will be utilized in the remainder of this paper

$$(3.18) \qquad i_t^m = f_0' + f_1' M_t^D + f_2' Y_t + f_3' \dot{P}_t^E$$

where

$$f_0' = -(f_0/f_1),\ f_1' = (1/f_1),\ f_2' = -(f_2/f_1),\ \text{and}\ f_3' = -(f_3/f_1).$$

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[26]See for example, D. Laidler and M. Parkin, "Inflation: A Survey," <u>The Economic Journal</u>, 85, 34 (December 1975), pp. 771-2 and the articles cited therein.

[27]See for example, Goldfeld, "The Demand for Money Revisited," pp. 577-638; A. A. Shapiro, "Inflation, Lags, and the Demand for Money," <u>International Economic Review</u>, 14, 1 (February 1973), pp. 81-96; and J. Melitz, "Inflationary Expectations and the French Demand for Money, 1959-70," <u>Manchester School</u>, 44, 1 (March 1976), pp. 17-41.

The linear money supply function utilized in this model can be derived from the following model which relates the level of M_1 (currency plus demand deposits) to the level of unborrowed reserves and the multiplier for unborrowed reserves. Since the ultimate concern of this paper is focused upon the effects of fiscal policy upon the money supply, the money supply function is developed in greater detail than any of the other functions in this model. A model which has as a special case a linear money supply function is now developed.

The behavioral relationships of the model are

(3.19) $$C_t/DD_t = k(i_t^m, i_t^{TD}, Y_t),$$

(3.20) $$TD_t/DD_t = td(i_t^m, i_t^{TD}, Y_t),$$

(3.21) $$GD_t/DD_t = \bar{g},$$

(3.22) $$XR_t/DD_t = e(i_t^m), \text{ and}$$

(3.23) $$BR_t/DD_t = b(i_t^m, i_t^{DS}).$$

The identities of the model are

(3.24) $$B_t = UBR_t + BR_t + C_t,$$

(3.25) $$B_t = UBB_t + BR_t, \text{ and}$$

(3.26) $$B_t = RR_{DD,t} + RR_{TD,t} + RR_{GD,t} + XR_t + C_t,$$

where

C_t = currency holdings of the non-bank in period t,

DD_t = volume of demand deposits in period t,

TD_t = volume of time deposits in period t,

GD_t = volume of Federal government deposits in period t,

XR_t = volume of excess reserves in period t,

BR_t = volume of borrowed reserves in period t,

B_t = monetary base in period t,

UBR_t = volume of unborrowed reserves in period t,

UBB_t = volume of the unborrowed monetary base in period t,

$RR_{DD,t}$ = volume of required reserves on demand deposits in period t $= r_{DDt}DD_t$,

$RR_{TD,t}$ = volume of required reserves on time deposits in period t $= r_{TDt}TD_t$,

$RR_{GD,t}$ = volume of required reserves on government deposits in period t $= r_{GD,t}GD_t$,

$r_{DD,t}$ = weighted fractional-reserve requirement on DD_t,

$r_{TD,t}$ = weighted fractional-reserve requirement on TD_t,

$r_{GD,t}$ = weighted fractional-reserve requirement on $GD_t = r_{DD,t}$,

i_t^m = a representative short-term market interest rate in period t,

i_t^{TD} = interest rate on TD_t,

i_t^{DS} = Federal Reserve discount rate in period t, and

Y_t = nominal income in period t.

The behavioral relationships explain the movement of the C_t/DD_t, TD_t/DD_t, GD_t/DD_t, XR_t/DD_t, and BR_t/DD_t ratios. As will be seen later, changes in these ratios affect the unborrowed reserve multiplier and hence affect the level of M_1. The following assumptions are made with respect to the signs of the partial derivatives of the ratios listed in (3.19) - (3.23) [28]

$\partial k/\partial i^m < 0$, $\partial k/\partial i^{TD} < 0$, $\partial k/\partial Y > 0$,

$\partial td/\partial i^m < 0$, $\partial td/\partial i^{TD} > 0$, $\partial td/\partial Y > 0$,

$\partial e/\partial i^m < 0$, $\partial b/\partial i^m > 0$, and $\partial b/\partial i^{DS} < 0$.

The GD_t/DD_t ratio is assumed to be exogenous since movements in this ratio depend mainly upon the timing of receipts and expenditures by the Treasury and less upon movements in market variables.

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[28]The assumptions made are consistent with theory and generally consistent with the available empirical evidence. See for example, W. R. Hosek and F. Zahn, Monetary Theory, Policy, and Financial Markets (New York: McGraw-Hill, 1977), pp. 82-104. The empirical evidence for the sign of $\partial k/\partial i^m$ is mixed. For empirical studies that support the contention that $\partial k/\partial i^m < 0$, see for example W. R. Hosek, "Determinants of the Money Multiplier," Quarterly Review of Economics and Business, 10, 2 (Summer 1970), pp. 37-46, and A. Hess, "An Explanation of Short-Run Fluctuations in the Ratio of Currency to Demand Deposits," Journal of Money, Credit, and Banking, 3, 3 (August 1971), pp. 666-79. For an empirical study that finds $\partial k/\partial i^m > 0$ see W. E. Becker, Jr., "Determinants of the United States Currency-Demand Deposit Ratio," Journal of Finance, 30, 1 (March 1975), pp. 57-74. However, since most studies find $\partial k/\partial i^m < 0$, this assumption will be maintained.

Utilizing identities (3.25) and (3.26) and suppressing for convenience the time subscript we can write

$$UBB = RR_{DD} + RR_{TD} + RR_{GD} + XR + C - BR.$$

Dividing by DD and substituting from (3.19) - (3.23) into this equation we obtain

$$\frac{UBB}{DD} = [r_{DD} + r_{TD}td(i^m, i^{TD}, Y) + r_{DD}g + e(i^m) + k(i^m, i^{TD}, Y) - b(i^m, i^{DS})].$$

Rearranging, we obtain

$$UBB = [r_{DD} + r_{TD}td(i^m, i^{TD}, Y) + r_{DD}g + e(i^m) + k(i^m, i^{TD}, Y) - b(i^m, i^{DS})]DD.$$

Solving for DD, we obtain:

$$DD = \left[\frac{1}{r_{DD}+r_{DD}g+r_{TD}td(i^m,i^{TD},Y)+e(i^m)+k(i^m,i^{TD},Y)-b(i^m,i^{DS})}\right](UBB)$$

An expression for M_1 can now be derived by utilizing the definition $M_1 = DD + C$. Thus we have

$$M_1 = [1 + k(i^m,i^{TD},Y)]DD.$$

Substituting the expression for DD derived earlier we obtain

$$M_1 = \left[\frac{1 + k(i^m, i^{TD}, Y)}{(r_{DD}+r_{DD}g+r_{TD}td(i^m,i^{TD},Y)+e(i^m)+k(i^m,i^{TD},Y)-b(i^m,i^{DS})}\right](UBB).$$

The responsiveness of M_1 to a changes in i^m, i^{DS}, UBB, and UBR can now be derived. The remaining analysis will focus upon these variables. For notational convenience let $[r_{DD} + r_{DD}g + r_{TD}td(i^m, i^{TD}, Y) + e(i^m) + k(i^m, i^{TD}, Y) - b(i^m, i^{DS})] = A$ and $[1 + k(i^m, i^{TD}, Y)] = E$. The expression for M_1 can now be written as

$$M_1 = msUBB \text{ where } ms = EA^{-1}.$$

The partial derivative of M_1 with respect to i^m is given by

$$\frac{\partial M_1}{\partial i^m} = [\{\frac{\partial k}{\partial i^m}(1-ms) - (r_{TD}\frac{\partial td}{\partial i^m} + \frac{\partial e}{\partial i^m} - \frac{\partial b}{\partial i^m})\, ms]\, A^{-1}UBB.$$

Based upon *a priori* expectations and the results of most empirical models of the money supply, the sign of the derivative can be determined in the following manner. In evaluating the expression in brackets [ ] we find that $\partial k/\partial i^m(1-ms)$ is > 0 since $\partial k/\partial i^m < 0$ and $[1-ms] < 0$ since $E > 1$ and $A^{-1} > 1$, and that $(r_{TD}\frac{\partial td}{\partial i^m} + \frac{\partial e}{\partial i^m} - \frac{\partial b}{\partial i^m}) < 0$ since $\frac{\partial td}{\partial i^m} < 0$, $\frac{\partial e}{\partial i^m} < 0$, and $\frac{\partial b}{\partial i^m} > 0$.[29] ms is > 0 so that the

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[29] In evaluating the expression EA^{-1}, we find the proposition $E > 1$ to be uncontroversial since the C/DD ratio is positive and $E = 1 + C/DD$. The assertion that $A^{-1} > 1$ is subject to empirical refutation since one might conceive of a situation where the expectation is that $A^{-1} < 1$. However, the available empirical evidence supports the original assertion that $A^{-1} > 1$. See for example, D. Fand, "Some Implications of Money Supply Analysis," *American Economic Review*, 57, 2 (May 1967), pp. 380-400; K. Brunner and A. Meltzer, "Some Further Investigations of Demand and Supply Functions for Money," *Journal of Finance*, 19, 2 (May 1964), pp. 240-83; R. L. Tiegen, "Demand and Supply Functions for Money in the United States: Some Structural Estimates," *Econometrica*, 32, 4 (October 1964),

expression in brackets [ ] is > 0. Thus $\frac{\partial M_1}{\partial i^m} > 0$ so that forces which cause short-term interest rates to rise - such as expansionary fiscal policy - lead to an induced expansion in the money supply.

The responsiveness of M_1 to changes in the Federal Reserve's policy instruments can also be determined within this model. The volume of unborrowed reserves (UBR), a component of UBB, was selected as the chief instrument of monetary control. It was felt that changes in unborrowed reserves were dominated more by Federal Reserve actions than were other possible measures (the unborrowed monetary base or the monetary base), and, in fact, this is the variable used in most large-scale econometric models of the economy.[30] Another

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pp. 476-509; W. E. Gibson, "Demand and Supply Functions for Money in the United States: Theory and Measurement," Econometrica, 40, 2 (March 1972), pp. 361-70; R. L. Tiegen, "Demand and Supply Functions for Money: Another Look at Theory and Measurement," Econometrica, 44, 2 (March 1976), pp. 377-85; and R. Rasche, "A Review of Empirical Studies of the Money Supply Mechanism," Federal Reserve Bank of St. Louis Review, 54, 7 (July 1972), pp. 11-19.

[30]The theoretical arguments for this assertion have not, however, been accepted uncritically. See for example, F. deLeeuw and J. Kalchbrenner, "Monetary and Fiscal Actions: A Test of Their Relative Importance in Economic Stabilization - Comment," Federal Reserve Bank of St. Louis Review, 51, 4 (April 1969), pp. 6-11, and L. C. Andersen and J. C. Jordan, "Monetary and Fiscal Actions: A Test of Their Relative Importance in Economic Stabilization - Reply," Federal Reserve Bank of St. Louis Review, 51, 4 (April 1969), pp. 12-16.

For a detailed analysis of various monetary and reserve variables that the Federal Reserve could use in giving instructions to the Open Market Committee see R. G. Davis, "Short-Run Targets for Open Market Operations," in Open Market Policies and Operating Procedures - Staff Studies (Washington, D.C.: Board of Governors of the Federal Reserve System, July 1971), pp. 37-69.

policy instrument, the discount rate, is assumed to be exogenous. It is felt that this assumption is justified by the fact that borrowed reserves are a small portion of total reserves, by the fact that the Federal Reserve does not generally use the discount rate as an active tool for achieving its major objectives, and by the fact that changes in the discount rate tend to follow changes in short-term market interest rates.[31] Finally, reserve requirements are assumed to be exogenous since this is an infrequently applied policy tool.

The partial derivative of M_1 with respect to UBR is given by the following expression

$$\frac{\partial M_1}{\partial UBR} = ms + \frac{\partial ms}{\partial i^m} \frac{\partial i^m}{\partial UBR} \cdot UBR.$$

Since a change in UBR will, in general, affect market rates of interest and since a change in market interest rates will affect ms, we must include the term $(\frac{\partial ms}{\partial i^m})(\frac{\partial i^m}{\partial UBR})$ in the expression for $\frac{\partial M_1}{\partial UBR}$. An increase in UBR will reduce i^m. A reduction in i^m will reduce ms; hence, $\frac{\partial ms}{\partial UBR} < 0$. Thus if $\frac{\partial ms}{\partial i^m} \frac{\partial i^m}{\partial UBR}$ UBR > ms, $\frac{\partial M_1}{\partial UBR}$ may be < 0.

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[31]For an empirical study of discount rate changes, see R. T. Froyen, "The Determinants of Federal Reserve Discount Rate Policy," Southern Economic Journal, 42, 2 (October 1975), pp. 193-200. Froyen found a positive relationship between the discount rate and other short-term market interest rates. He interpreted this relationship as resulting from Federal Reserve attempts to keep the discount rate in line with the costs of other ways of adjusting the short-term reserve positions of banks. He also found that the balance of payments deficit had a significant effect upon discount rate policy.

However, the available empirical evidence supports $\frac{\partial M_1}{\partial UBR} > 0$.[32] Decisions by the Federal Reserve to increase UBR, whether exogenous as in this chapter or endogenous as in the next chapter (perhaps induced by an expansionary fiscal policy) would thus result in an expansion in M_1.

The partial derivative of M_1 with respect to i^{DS} is given by

$$\frac{\partial M_1}{\partial i^{DS}} = -[-(\frac{\partial b}{\partial i^{DS}})A^{-2} \cdot E \cdot UBR].$$

Since $\frac{\partial b}{\partial i^{DS}} < 0$ and the expression in brackets [ ] is > 0. Thus $\frac{\partial M_1}{\partial i^{DS}} < 0$.[33] Federal Reserve increases in the discount rate result in reductions in M_1.

Thus far we have discussed the effects of changes in i^m and Federal Reserve policy tools upon M_1 within the context of a specific money supply model. The money supply model just developed and analyzed is nonlinear. Since the IS-LM model used in this study is linear, the money supply model is linearized for compatibility with the other equations in the model. In general terms, we can write the money supply model developed above as $M_1 = ms(i^m, i^{DS})$ UBR where

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[32] See the references cited in footnote 29 for this empirical evidence.

[33] See the references cited in footnote 29 for empirical studies that support $\partial M_1/\partial i^{DS} < 0$.

ms( ) is the monetary policy variable multiplier. In principle, all of the variables listed in equation (3.19) through (3.23) should be included in the money supply equation. However, precedents in the money supply literature (see footnote 29) will be followed, and the independent variables employed in the money supply function will be limited to i^m, i^{DS}, and UBR. In linear form the money supply function can be written as $M_t^s = g_0 + g_1 i_t^m + g_2 i_t^{DS} + g_3 UBR_t$ with g_1, $g_3 > 0$ and $g_2 < 0$. The coefficient signs are based upon the discussion above.

The model employed in this analysis has two different interest rates in the structural equations of the model. The short-term interest rate is determined in the money market, but the long-term interest rate is hypothesized to affect nominal spending. A simplistic term structure equation (3.13) is added to the model in order to tie these rates together. The long-term rate is seen as being influenced by the current short-term rate (a crude representation of the expectations hypothesis of the term structure) and also by the current level of nominal income (nominal income is taken as a crude proxy for the demand for loanable funds and is seen as influencing the long-term rate directly as well as through its influence on the short-term rate).[34]

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[34]For an explanation of the expectations and market segmentation of the term structure, see for example, F. Modigliani and R. Sutch, "Innovations in Interest Rate Policy," American Economic Review, 56, 2 (May 1966), pp. 178-197, and B. G. Malkiel, The Term Structure of Interest Rates: Theory, Empirical Evidence, and Applications (Morristown, N.J.: General Learning Press, 1970).

Equation (3.14) closes the money market equations by stipulating that in every time period, the nominal demand for money equals the nominal supply of money.

The relationship between the rate of inflation and the rate of unemployment - the Phillips Curve relation - is developed in equation (3.15). The rate of inflation is hypothesized to be a function of the inverse of the rate of unemployment, the ratio of nominal income to potential income, and the expected rate of inflation. The expected sign of the coefficient on the inverse of the unemployment rate, j_1, is positive. The unemployment rate can be viewed as a proxy for demand pressure in labor markets so that as the unemployment rate falls, demand pressure in labor markets builds up, thereby tending to increase the rate of change in wages. Assuming a constant mark-up type of pricing in product markets, a rise in the rate of change in wages is translated into an increase in the rate of inflation.[35]

The expected sign of the coefficient on the ratio of nominal income to nominal potential income, j_2, is positive. The ratio of nominal income to nominal potential income is taken as a proxy for excess demand in product markets; thus an increase in this ratio tends

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[35]For general surveys of the inflation-unemployment relation see Laidler and Parkin, "Inflation," pp. 741-809; R. J. Gordon, "Recent Developments in the Theory of Inflation and Unemployment," Journal of Monetary Economics, 2, 2 (April 1976), pp. 185-219; and H. Frisch, "Inflation Theory 1963-1975: A 'Second Generation' Survey," Journal of Economic Literature, 15, 4 (December 1977), pp. 1289-1317.

to raise the rate of inflation directly through its effect upon the final demand for goods and services and indirectly through its effect upon demand pressure in labor markets.[36]

The expected sign of the coefficient on the expected rate of inflation, j_3, is also positive. As the expected rate of inflation rises, economic units will modify their behavior in light of this expectation and the change in the behavior of these units will affect the rate of inflation. For example, as workers anticipate higher rates of inflation, their wage demands will reflect this expectation. Higher rates of wage increase coupled with constant mark-up pricing in product markets thus imply higher rates of inflation.[37]

Price expectations, equation (3.16), are assumed to be formed through an adaptive expectations mechanism. Thus the expected rate of inflation in the current period is a weighted average of all previous rates of inflation where the weights are greatest for the most recent rates of inflation. In this model we assume $0 \leq \ell < 1$. This assumption insures that the expression has a finite limit and that the expected inflation rate is more strongly influenced by the more recent actual rates of inflation.[38]

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[36]For further development see the references listed in footnote 35.

[37]For further development see the references listed in footnote 35.

[38]The references cited in footnote 35 develop the expectations formation mechanism in more detail.

Equation (3.17) merely defines the price level in period t as fixed by the price level in the previous period and the current rate of inflation. Although the previous price level is exogenous, the incorporation of the current rate of inflation (which is endogenous) in the determination of the current price level means that the current price level is endogenous.

Since the ultimate concern of this study is to analyze the effects of fiscal policy upon changes in the money supply, the model described in previous paragraphs will be written in the form of first differences, a form which will allow direct analysis of changes in the money supply related to the stance of fiscal policy. In first difference form, the equations of the model are

Product Market

(3.1') $dC_t = a_1(dY_t - dT_t) + a_2\, d\, WE_t,$ (consumption function)

(3.2') $d\, WE_t = d(\frac{\bar{K}_t}{i^\ell_t}) + d(\frac{G^S_t}{i^\ell_t}) + dB_t,$ (wealth definition)

(3.3') $dI_t = b_1 di^\ell_{t-2} + b_2 d^2Y_{t-1} + b_3 dY_t + b_4 dI_{t-1},$ (investment function)

(3.4') $dE_t = d\bar{E}_t,$ (export function)

(3.5') $dIM_t = c_1 dY_t,$ (import function)

(3.6') $dG_t = d\bar{G}_t,$ (government expenditure function)

$$(3.7') \quad dT_t = r_{1,t-1}dY_t + Y_{t-1}dr_{1,t},$$ (net tax function)

$$(3.8') \quad dY_t = dC_t + dI_t + d\bar{G}_t + d\bar{E}_t - dIM_t$$ (equilibrium condition)

Money Market

$$(3.9') \quad di_t^m = f_1'dM_t^D + f_2'dY_t + f_3'd\dot{P}_t^E,$$ (inverse money demand function)

$$(3.10') \quad dM_t^S = g_1di_t^m + g_2di_t^{DS} + g_3dUBR_t,$$ (money supply function)

$$(3.11') \quad di_t^{DS} = d\bar{i}_t^{DS},$$ (discount rate function)

$$(3.12') \quad dUBR_t = \overline{dUBR}_t,$$ (unborrowed reserves function)

$$(3.13') \quad di_t^{\ell} = h_1di_t^m + h_2dY_t,$$ (term structure of interest rates function)

$$(3.14') \quad dM_t^D = dM_t^S,$$ (equilibrium condition)

Phillips Curve Relation

$$(3.15') \quad d\dot{P}_t = j_1d\left(\frac{1}{U_t}\right) + j_2d\left(\frac{Y_t}{Y_t^{POT}}\right) + j_3d\dot{P}_t^E,$$ (Phillips Curve function function)

$$(3.16') \quad d\dot{P}_t^E = (1-\ell)\sum_{n=1}^{\infty} \ell^{n-1}d\dot{P}_{t-n}, \text{ and}$$ (price expectations function)

Aggregate Price Level

$$(3.17') \quad dP_t = (1+\dot{P}_t)dP_{t-1} + (P_{t-1})d\dot{P}_t.$$ (price level definition)

IV. Government Budget Constraint

The model as specified above has one important omission - the federal government's budget constraint. This budget constraint merely stipulates that government expenditures on goods and services

plus interest payments on outstanding debt must be financed in the current period in some manner, either by tax receipts, sales of bonds to the private sector, an increase in the monetary base, or some combination of these methods of finance. As was pointed out by Bent Hansen, the particular form of the budget constraint appropriate to a model depends upon the institutional nature of the system the model is purported to represent.[39] Hansen separates budget constraints into two general types - pre-Accord (European type) and post-Accord (United States type) budget constraints. Each type of constraint is now briefly examined and the constraint appropriate to the model specified above is developed.

The pre-Accord constraint has explicitly been employed in several macromodels[40] and can be written in the following manner

$$(3.27) \qquad \left(\frac{1}{i_t^{\ell}}\right) dG_t^S + dB_t = \bar{G}_t - T_t + D_{t-1}$$

where

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[39] Hansen, "On the Effects of Fiscal and Monetary Policy," p. 549.

[40] See for example, A Blinder and R. Solow, "Does Fiscal Policy Matter?," Journal of Public Economics, 2, 4 (November 1973), pp. 319-37; A. Blinder and R. Solow, "Analytical Foundations of Fiscal Policy," in A. Blinder and others, The Economics of Public Finance (Washington, D.C.: The Brookings Institution, 1974), pp. 3-115; C. Christ, "A Short-Run Aggregate Demand Model of the Interdependence and Effects of Monetary and Fiscal Policies with Keynesian and Classical Interest Elasticities," American Economic Review, 57, 2 (May 1967), pp. 434-43; and C.F.Christ, "A Simple Macroeconomic Model with A Government Budget Restraint," Journal of Political Economy, 76, 1 (January/February 1968), pp. 53-67.

$(\frac{1}{i^{\ell}_t})dG^S_t$ = the change in the nominal value of government bonds held by the public in period t resulting from Treasury and Federal Reserve actions, evaluated at the current market price,[41]

dB_t = the change in the nominal monetary base in period t,

G_t = nominal government purchases of goods and services in period t,

T_t = nominal net tax receipts in period t, to include subtraction of interest payments on securities issued to the public in period t from net taxes,

and

D_{t-1} = the nominal interest payments on outstanding government securities in the hands of the public at the end of period t-1.[42]

This constraint specifies that the deficit $(\bar{G}_t - T_t)$ plus interest payments on outstanding debt from the previous period must be

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[41]Note that this differs from the change in the market value of outstanding bonds which is given by $d(G^S/i^{\ell})_t$.

[42]This formulation of the pre-Accord constraint implicity assumes that Treasury balances are constant during this period. As was noted in a previous section of this chapter (Direct Links Between Fiscal Policy and the Money Supply), changes in Treasury balances have a trivial effect upon reserves and the monetary base (see pp. 33-35). For this reason, changes in Treasury balances will not be incorporated into this constraint. The particular form of the constraint also abstracts from foreign transactions and their effects upon the monetary base. Changes in foreign balances at the Federal Reserve are typically thought of as a transaction that the Federal Reserve offsets (at least partly) in its open-market operations. (See Lombra and Torto, "Federal Reserve," pp. 47-55.) For this reason, foreign transactions are excluded from the budget constraint.

financed by issuance of new securities and/or an increase in the monetary base.

Although this constraint has been utilized in some macro-models of the United States economy, the appropriateness of this constraint for the United States economy given the current institutional division between fiscal and monetary policymaking authorities is questionable. A budget constraint of the pre-Accord type implies an institutional structure where fiscal and monetary policymaking are centered in one authority (as is found in some European countries) or a structure with separate policy authorities where one authority is under the thumb of the other (the United States in the pre-Treasury-Federal Reserve Accord period). The coordination of monetary and fiscal policy and hence the division of the total required financing between security issues to the public and changes in the monetary base is facilitated by either of these institutional settings.

However, the institutional nature of macro policymaking in the United States changed after the Treasury-Federal Reserve Accord of 1951. As was noted in an earlier section of this chapter, the Accord has been interpreted as freeing the Federal Reserve to conduct monetary policy ao as to achieve the goals specified in the Employment Act of 1946.[43] An important implication of the Accord is that any change in the monetary base is ultimately at the discretion

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[43] See pp. 38-39 of this chapter.

of the Federal Reserve. The implied single authority coordination of both fiscal and monetary policy found in the pre-Accord constraint is inappropriate in a period of time in which the authority to conduct monetary and fiscal policy is vested in independent decision making units. It would thus seem that a constraint that recognizes the institutional realities of the post-Accord period would be appropriate for a macro-model of the United States after 1951. Because of this institutional change, Hansen's post-Accord constraint is employed in the remainder of the analysis in this paper.

The post-Accord budget constraint can be written as

$$(3.28) \qquad \left(\frac{1}{i_t^{\ell}}\right) dG_t^{S,F} = \bar{G}_t - T_t + D_{t-1}$$

where

$\left(\frac{1}{i_t^{\ell}}\right) dG_t^{S,F}$ = the nominal value of securities issued in period t by the fiscal authority, evaluated at the current market price,

and the other elements in the constraint are as previously defined. This constraint specifies that a change in the deficit plus the interest payments on outstanding debt at the end of the previous period is financed entirely by an issue of new securities to the public.[44] As noted earlier, we may observe a concurrent increase in the monetary base, but presumably, this increase in the monetary base is undertaken at the discretion of the Federal Reserve and is not an

[44]The assumptions made in footnote 41 also apply to this budget constraint.

automatic response to the financing requirements of the fiscal authority.

Since the post-Accord constraint differs from the pre-Accord constraint by the elimination of the automatic response of the monetary authority, a constraint for the monetary authority must be added to a model which adopts a post-Accord constraint for the fiscal authority. The constraint for the monetary authority can be derived from the sources and uses of the monetary base statement for the Federal Reserve. The sources side of this statement can be summarized by $B_t = (\frac{1}{i_t^{\ell}})G_t^{S,M} + A_t + X_t$

where

B_t = nominal monetary base,

$(\frac{1}{i_t^{\ell}})G_t^{S,M}$ = nominal value of Federal Reserve holdings of government securities,

A_t = discounts and advances, and

X_t = summary variable which includes positive values for float, the gold stock, SDRs, and Treasury currency outstanding and negative values for Treasury deposits at the Federal Reserve, foreign deposits at the Federal Reserve, Treasury cash holdings, and other liabilities and capital accounts.

From the sources side, the change in B can be written as

$$dB_t = (\frac{1}{i_t^{\ell}})dG_t^{S,M} + dA_t + dX_t.$$

The uses side of the statement can be written as

$$B_t = UBR_t + BR_t + C_t$$

where

BR_t = borrowed reserves (= A_t) and all other variables are as previously defined.

From the uses side the change in B is given by

$$dB_t = dUBR_t + dC_t + dA_t. \tag{3.29}$$

Utilizing the necessary equality between a change in the sources and the uses of the monetary base, we can write

$$\left(\frac{1}{i_t^{\ell}}\right) dG_t^{S,M} + dA_t + dX_t = dUBR_t + dC_t + dA_t.$$

Rearranging, we obtain

$$\left(\frac{1}{i_t^{\ell}}\right) dG_t^{S,M} = dUBR_t + dC_t - dX_t. \tag{3.30}$$

This equation can thus be interpreted as the constraint for the monetary authority.

The first difference form of the model can be completed by the addition of the following equations

$$\left(\frac{1}{i_t^{\ell}}\right) dG_t^{S,F} = \bar{G}_t - T_t + D_{t-1}, \tag{3.28}$$

$$dB_t = dUBR_t + dC_t + dA_t, \tag{3.29}$$

$$(3.30) \quad (\frac{1}{i_t^{\ell}})dG_t^{S,M} = dUBR_t + dC_t - dX_t, \text{ and}$$

$$(3.31) \quad (\frac{1}{i_t^{\ell}})dG_t^{S} = (\frac{1}{i_t^{\ell}})dG_t^{S,F} - (\frac{1}{i_t^{\ell}})dG_t^{S,M}.$$

where $(\frac{1}{i_t^{\ell}})dG_t^{S}$ = the change in the nominal value of government securities evaluated at current market prices in the hands of the public and all other variables are as previously defined.

Equation (3.28) is the budget constraint of the fiscal authority, and equation (3.30) is the budget constraint of the Federal Reserve. Equation (3.29) is merely a definition derived from the sources and uses statement for the monetary base. Equation (3.31) specifies that the change in the nominal value of government seucrities in the hands of the public evaluated at current market prices is the difference between the nominal value of the change in securities issued by the fiscal authority and the change in the nominal value of government securities held by the Federal Reserve, again evaluated at current market prices.

The budget constraints just developed are linked to the rest of the model through the wealth equation. The wealth equation in first difference form was written as

$$(3.2') \qquad dWE_t = d(\frac{\bar{K}t}{i_t^{\ell}}) + d(\frac{G_t^S}{i_t^{\ell}}) + dB_t.$$

Expanding the differential of this equation, we obtain

$$dWE_t = (\frac{1}{i^{\ell}_t})d\bar{K}_t - (\frac{\bar{K}_t}{i^{\ell 2}_t})di^{\ell}_t + (\frac{1}{i^{\ell}_t})dG^S_t - (\frac{G^S_t}{i^{\ell 2}_t})di^{\ell}_t + dB_t.$$

Substituting the relationships specified in equations (3.28), (3.29), (3.30) and (3.31) into equation (3.2') we obtain

$$dWE_t = (\frac{1}{i^{\ell}_t})d\bar{K}_t - (\frac{\bar{K}_t}{i^{\ell 2}_t})di^{\ell}_t - (\frac{G^S_t}{i^{\ell 2}_t})di^{\ell}_t + [\bar{G}_t - T_t + D_{t-1} - dUBR - dC_t + dX_t] + [dUBR_t + dC_t + dA_t].$$

Rearranging this equation, we obtain a final expression for the change in net wealth which is substituted for equation (3.2') in the model

(3.2") $$dWE_t = \bar{G}_t - T_t + D_{t-1} + dX_t + dA_t + (\frac{1}{i^{\ell}_{t-1}})d\bar{K}_t - [(\frac{\bar{K}_{t-1}}{i^{\ell 2}_{t-1}}) + (\frac{G^S_{t-1}}{i^{\ell 2}_{t-1}})]di^{\ell}_t.$$ [45]

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[45] In order to preserve the linearity of the model, the terms $(\frac{1}{i^{\ell}_t})d\bar{K}_t$ and $[(\bar{K}_t/i^{\ell 2}_t) + (G^S_t/i^{\ell 2}_t)]di^{\ell}_t$ will be approximated by $(\frac{1}{i^{\ell}_{t-1}})$ $(\frac{1}{i^{\ell}_{t-1}})d\bar{K}_t$ and $[(\bar{K}_{t-1}/i^{\ell 2}_{t-1}) + (G^S_{t-1}/i^{\ell 2}_{t-1})]di^{\ell}_t$. This approximation does not alter the basic conclusions of the model and is merely a discrete approximation to a continuous process. Futhermore, the expressions $\bar{G}_{t-1} + d\bar{G}_t$ and $T_{t-1} + r_{1,t-1}dY_t + Y_{t-1}dr_{1,t}$ will be substituted for $\bar{G}_t$ and T_t, respectively, in equation (3.2") since the policy variables of interest are $d\bar{G}_t$ and $Y_{t-1}dr_{1,t}$.

V. Solution of the Complete Model

The IS-LM model can now be solved to obtain reduced form equations for dY_t and di_t^m. The reduced form equation for di_t^m is employed in the next section to obtain a reduced form equation for the money supply.

Combining and rearranging equations (3.1'), (3.2"), (3.3'), (3.4'), (3.5'), (3.6'), (3.7'), (3.8'), and (3.13'), we obtain the following IS equation

$$(3.32)\quad dY_t = \frac{1}{A_0}\{(1+a_2)d\bar{G}_t - (a_1 + a_2)Y_{t-1}dr_{1,t} + a_2[\bar{G}_{t-1} - T_{t-1} + D_{t-1} + dX_t + dA_t + (\frac{1}{i^{\ell}_{t-1}})d\bar{K}_t] - a_2h_1[(\frac{\bar{K}_{t-1}}{i^{\ell 2}_{t-1}}) + (\frac{G^S_{t-1}}{i^{\ell 2}_{t-1}})]di_t^m - b_1di^{\ell}_{t-2} + b_2dY_{t-1} + b_4dI_{t-1} + d\bar{E}_t\},$$

where

$$A_0 = (1-a_1+a_1r_{1,t-1}+a_2r_{1,t-1}+a_2h_2[(\frac{\bar{K}_{t-1}}{i^{\ell 2}_{t-1}})+(\frac{G^S_{t-1}}{i^{\ell 2}_{t-1}})]-b_3+c_1).$$

Combining and rearranging equations (3.9"), (3.10'), (3.11'), (3.12'), and (3.14'), we obtain the following LM equation

$$(3.33)\quad di_t^m = \frac{1}{A_1}\{f_1'g_2d\overline{\bar{i}_t^{DS}} - f_1'g_3\overline{dUBR}_t + f_2'dY_t + f_3'd\dot{P}_t^E\},$$

where

$$A_1 = (1 + f_1'g_1).$$

Solving equations (3.32) and (3.33) simultaneously, we obtain the following reduced form equations for dY_t and di_t^m

$$(3.34)\quad dY_t = \frac{1}{A_2}\{A_3 d\bar{G}_t - A_4 Y_{t-1} dr_{1,t} + A_5[\bar{G}_{t-1} - T_{t-1} + D_{t-1} + dX_t + dA_t + (\frac{1}{i^{\ell}_{t-1}})d\bar{K}_t] - A_6 di^{\ell}_{t-2} + A_7 dY_{t-1} + A_8 dI_{t-1} + A_9 d\bar{E}_t - A_{10} d\bar{i}_t^{\overline{DS}} + A_{11} d\overline{UBR}_t - A_{12} d\dot{P}^E_t\}$$

and

$$(3.35)\quad di_t^m = \frac{1}{A_2}\{A_{13} d\bar{G}_t - A_{14} Y_{t-1} dr_{1,t} + A_{15}[\bar{G}_{t-1} - T_t + D_{t-1} + dX_t + dA_t + (\frac{1}{i^{\ell}_{t-1}})d\bar{K}_t] - A_{16} di^{\ell}_{t-2} + A_{17} dY_{t-1} + A_{18} dI_{t-1} + A_{19} d\bar{E}_t + A_{20} d\bar{i}_t^{\overline{DS}} - A_{21} d\overline{UBR}_t + A_{22} d\dot{P}^E_t\},$$

where

$$A_2 = \{1 - a_1 + a_1 r_{1,t-1} + a_2 r_{1,t-1} + a_2 h_2[(\frac{\bar{K}_{t-1}}{i^{\ell 2}_{t-1}}) + (\frac{G^S_{t-1}}{i^{\ell 2}_{t-1}})] - b_3 + c_1)(1 + f_1' g_1) + f_2'(a_2 h_1[(\frac{\bar{K}_{t-1}}{i^{\ell 2}_{t-1}}) + (\frac{G^S_{t-1}}{i^{\ell 2}_{t-1}})])\},$$

$$A_3 = (1 + a_2)(1 + f_1' g_1),$$

$$A_4 = (a_1 + a_2)(1 + f_1' g_1),$$

$$A_5 = a_2(1 + f_1' g_1),$$

$A_6 = b_1(1+f_1'g_1)$,

$A_7 = b_2(1+f_1'g_1)$,

$A_8 = b_4(1+f_1'g_1)$,

$A_9 = (1+f_1'g_1)$,

$$A_{10} = a_2h_1[(\frac{\bar{K}_{t-1}}{i^{\ell 2}_{t-1}}) + (\frac{G^S_{t-1}}{i^{\ell 2}_{t-1}})]f_1'g_2,$$

$$A_{11} = a_2h_1[(\frac{\bar{K}_{t-1}}{i^{\ell 2}_{t-1}}) + (\frac{G^S_{t-1}}{i^{\ell 2}_{t-1}})]f_1'g_3,$$

$$A_{12} = a_2h_1[(\frac{\bar{K}_{t-1}}{i^{\ell 2}_{t-1}}) + (\frac{G^S_{t-1}}{i^{\ell 2}_{t-1}})]f_3',$$

$A_{13} = (1+a_2)f_2'$,

$A_{14} = (a_1+a_2)f_2'$,

$A_{15} = a_2f_2'$,

$A_{16} = b_1f_2'$,

$A_{17} = b_2f_2'$,

$A_{18} = b_4f_2'$,

$A_{19} = f_2'$,

$A_{20} = A_0(f_1'g_2)$,

$A_{21} = A_0(f_1'g_3)$, and

$A_{22} = A_0(f_3')$.

VI. Derivation of the Reduced Form Money Supply Equation and Analysis of the Effects of Fiscal Policy Upon the Money Supply

The results obtained in the preceding section can be combined with the money supply equation to obtain a reduced form equation for the money supply. Combining and rearranging equations (3.10') and (3.35), we obtain the following reduced form money supply equation

$$(3.36)\quad dM_t^S = g_1(\frac{A_{13}}{A_2})d\bar{G}_t - g_1(\frac{A_{14}}{A_2})Y_{t-1}dr_{1,t} + g_1(\frac{A_{15}}{A_2})[\bar{G}_{t-1}-T_{t-1} + D_{t-1} + dX_t + dA_t + (\frac{1}{i_{t-1}^{\ell}})d\bar{K}_t] - g_1(\frac{A_{16}}{A_2})di_{t-2}^{\ell} + g_1(\frac{A_{17}}{A_2})dY_{t-1} + g_1(\frac{A_{18}}{A_2})dI_{t-1} + g_1(\frac{A_{19}}{A_2})d\bar{E}_t + [g_1(\frac{A_{20}}{A_2}) - g_2]d\bar{i}_t^{DS} + [g_3 - g_1(\frac{A_{21}}{A_2})]d\overline{UBR}_t + g_1(\frac{A_{22}}{A_2})d\dot{P}_t^E.$$

All variables and coefficients are as previously defined.

The effects of fiscal policy upon changes in the money supply can now be determined by examining the partial derivatives of dM_t^S with respect to an exogenous change in government expenditures ($d\bar{G}_t$) and an exogenous change in tax receipts ($Y_{t-1}dr_{1,t}$). These partial derivatives are given by

$$(3.37)\quad \frac{\partial dM_t^S}{\partial d\bar{G}_t} = g_1\ A_{13}/A_2 \quad \text{and}$$

$$(3.38)\quad \frac{\partial dM_t^S}{\partial Y_{t-1}dr_{1,t}} = -g_1\ A_{14}/A_2.$$

To determine the signs of these drivatives we need to examine the elements in each expression. Let us first examine the term $A_2 = \{(1-a_1+a_1r_{1,t-1}+a_2r_{1,t-1}-a_2h_2[(\frac{\bar{K}_{t-1}}{i^{\ell 2}_{t-1}})+(\frac{G^S_{t-1}}{i^{\ell 2}_{t-1}})]-b_3+c_1)(1+f'_1g_1)$

$$+ f'_2(a\ h\ [(\frac{\bar{K}_{t-1}}{i^{\ell 2}_{t-1}})+(\frac{G^S_{t-1}}{i^{\ell 2}_{t-1}})])\}.$$

Based upon the previous discussion of the individual equations of the model, the elements of A_2 are assumed to have the following signs and magnitudes

$0 < a_1 < 1$, $0 < a_2 < 1$, $0 < r_1 < 1$, $h_2 > 0$, $b_3 > 0$, $c_1 > 0$, $(\frac{\bar{K}_{t-1}}{i^{\ell 2}_{t-1}}) > 0$, $(\frac{G^S_{t-1}}{i^{\ell 2}_{t-1}}) > 0$, $f'_1 > 0$, $g_1 > 0$, $f'_2 > 0$, and $h_1 > 0$. The term $(1-a_1+a_1r_{1,t-1}+a_2r_{1,t-1}-a_2h_2[(\frac{\bar{K}_{t-1}}{i^{\ell 2}_{t-1}})+(\frac{G^S_{t-1}}{i^{\ell 2}_{t-1}})]-b_3+c_1)$ is > 0 if $(1+a_1r_{1,t-1}+a_2r_{1,t-1}+c_1) > (a_1+a_2h_2[(\frac{\bar{K}_{t-1}}{i^{\ell 2}_{t-1}})+(\frac{G^S_{t-1}}{i^{\ell 2}_{t-1}})]+b_3)$. Theoretical and empirical evidence tends to support the direction of this inequality;[45] hence, we will assume that the term $(1-a_1+a_1r_{1,t-1} + a_2r_{1,t-1}-a_2h_2[(\frac{\bar{K}_{t-1}}{i^{\ell 2}_{t-1}})+(\frac{G^S_{t-1}}{i^{\ell 2}_{t-1}})]-b_3+c_1) > 0$. Since f'_1 and g_1 are > 0,

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[46]See for example, Branson, <u>Macroeconomic Theory and Policy</u>, pp. 169-226, 267-318, and E. Kuh and R. L. Schmalensee, <u>An Introduction to Applied Macroeconomics</u> (Amsterdam: North-Holland Publishing Co., 1973), pp. 31-101, 175-83.

the term $(1+f_1'g_1)$ is also > 0. The product of this term and the previously discussed term is thus > 0. Since $f_2'(a_2h_1[(\frac{\bar{K}_{t-1}}{i^{\ell 2}_{t-1}})+(\frac{G^S_{t-1}}{i^{\ell 2}_{t-1}})])$ > 0 we can conclude that $A_2 > 0$.[47]

The sign of $\frac{\partial dM^S_t}{\partial d\bar{G}_t}$ can now be determined. Since $A_{13} = (1+a_2)f_2'$ and since a_2, f_2', g_1, and A_2 are all positive, we see that $\frac{\partial dM^S_t}{\partial d\bar{G}_t} = g_1 \frac{A_{13}}{A_2} > 0$. This result can be explained in the following manner: An increase in $d\bar{G}_t$, ceteris paribus, directly stimulates aggregate demand and necessitates issuance of more bonds by the fiscal authority. The bond financing increases net wealth and further stimulates aggregate demand. The mode of financing and the increase in aggeegate demand put upward pressure upon the interest rate. The interest rate increase leads to adjustments in the non-bank public's holdings of currency, demand and time deposits and in commercial banks holdings of excess reserves and borrowings from the Federal Reserve. As a result of these adjustments, the policy variable multiplier rises and, with a given level of the policy variable, the money supply rises. The rise in interest rates also tends to mitigate or even to offset the increase in net wealth and thus tends to reduce the initial increase in aggregate demand and hence interest rates. Whether this effect

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[47]We should note that this conclusion is based upon theoretical and empirical studies such as those cited in footnote 46.

offsets the stimulatory effect of the initial change in G and bonds outstanding is an empirical question; however, evidence from macroeconometric models of the United States economy suggests that the initial stimulatory effect of $d\bar{G} > 0$ is not offset by the interest rate effect upon net wealth.[48]

Thus $\frac{\partial dM_t^S}{\partial d\bar{G}_t} = g_1A_{13}/A_2$ represents the change in the money supply induced by private sector response to higher interest rates brought about by the increase in income and net wealth attributable to the increase in government purchases of goods and services. The meaning of the term A_{13}/A_2 or $(1+a_2)f_2'/A_2$ can be explained in the following manner: $(1+a_2)/A_2$ represents the change in income associated with a one unit change in government expenditures and the term $(1+a_2)f_2'/A_2$ represents the change in the short-term market interest rate as a result of the change in income. Since g_1 is the coefficient on di_t^m in the money supply equation, the entire expression represents the change in the money supply as a result of the change in government expenditures.

The expansionary effect of the increase in government expenditures upon the money supply can also be explained graphically in the context of the money market. The increase in government

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[48]See for example, G. V. L. Narasimham, "Policy Multipliers in a Quarterly Econometric Model of the U.S. Economy," Southern Economic Journal, 43, 4 (April 1977), pp. 1486-1504; and N. N. Choudhry, "Integration of Fiscal and Monetary Sectors in Econometric Models: A Survey of Theoretical Issues and Empirical Findings," International Monetary Fund Staff Papers, 23, 2 (July 1976), pp. 395-440.

expenditure, as noted before, leads to an increase in income. The rise in income stimulates the demand for money. This is illustrated in Figure I by the shift in the money demand curve from M_0^D to M_1^D. Private sector response to the initial disequilibrium in the money market leads to a movement along the M^S curve until equilibrium is restored at a higher interest rate (i_1^m) and an increased money supply (M_1).

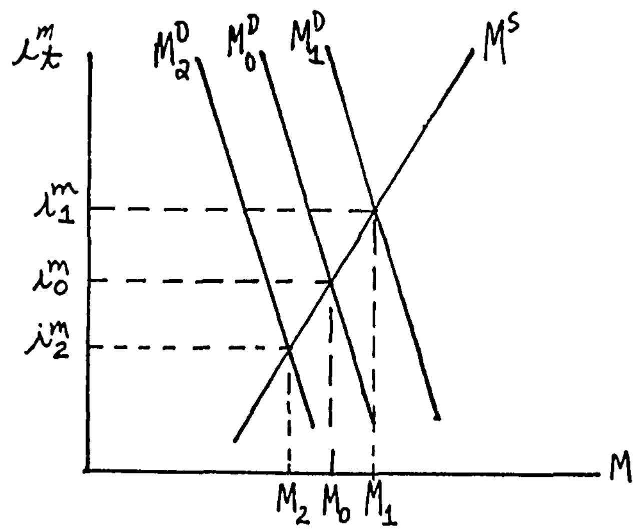

Figure I

Fiscal Policy Effects Upon the Money Supply

The sign of $\partial dM^S/\partial Y_{t-1}dr_{1,t}$ will now be analyzed. Since $g_1 > 0$, $A_{14} = (a_1+a_2)f_2' > 0$, and $A_2 > 0$, we are led to the conclusion that $\partial dM_t^S/\partial Y_{t-1}dr_{1,t} < 0$. This result can be explained in the following manner: An increase in $Y_{t-1}dr_{1,t}$, ceteris paribus, reduces disposable income and hence aggregate demand. This change also reduces the size of the deficit to be financed or perhaps generates a surplus. The reduction in aggregate demand, and the

potential debt retirement, puts downward pressure upon interest rates. The fall in interest rates induces adjustments by banks and the non-bank public that reduce the policy variable multiplier and hence the money supply. The fall in interest rates tends to raise net wealth and thus mitigates the decline in aggregate demand. However, evidence from econometric models again suggests that the effect upon income and interest rates is not reversed by this wealth effect.[49]

We can interpret $\frac{\partial M_t^S}{\partial Y_{t-1} dr_{1,t}} = -g_1 A_{14}/A_2$ as the change in the money supply induced by private sector response to lower interest rates brought about by the reduction in income induced by the contractionary tax changes. The term $\frac{(a_1+a_2)}{A_2}$ represents the change in income induced by a unit change in taxes and $\frac{(a_1+a_2)f_2'}{A_2}$ represents the change in interest rates as a result of the change in money demand stemming from the change in income. In Figure I, this conclusion is illustrated by the shift in money demand from M_0^D to M_2^D as income falls and the movement down the money supply curve to i_2^m and M_2.

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[49]See the references cited in footnote 48.

VII. Conclusion

We thus conclude that in the context of the macroeconomic model developed in this chapter, and given widely held perceptions about the signs and magnitudes of the structural coefficients in the model, a change in government expenditures leads to a change in the money supply in the same direction and a change in the exogenous component of tax receipts leads to a change in the money supply in the opposite direction. The changes in the money supply examined in this chapter stem solely from private sector response to changes in income and interest rates resulting from a change in fiscal policy. The Federal Reserve and its policy tools were assumed to be exogenous, that is, the Federal Reserve was presumed not to respond systematically to the movements in such variables as income and interest rates that evoked private sector response. The next chapter will examine the effects of fiscal policy upon changes in the money supply when Federal Reserve actions are endogenous to the model. The conclusions about the effects of fiscal policy upon the money supply when Federal Reserve behavior is endogenous are then contrasted with the money supply effects examined in this chapter.

CHAPTER IV

MONETARY EFFECTS OF FISCAL POLICY WHEN FEDERAL RESERVE BEHAVIOR IS ENDOGENOUS

I. Introduction

The previous chapter examined the fiscal policy effects upon the money supply under the presumption that monetary policy was exogenous. Federal Reserve policymakers were assumed not to systematically react to the current movement of economic variables and to the current stance of fiscal policy; thus, any change in the money supply related to fiscal policy resulted from portfolio and spending adjustments by commercial banks and the non-bank public. However, if Federal Reserve policymakers respond to current movements in macroeconomic variables, then treatment of monetary policy as exogenous is inappropriate, and monetary policy should be considered endogenous.

The appropriateness of treating the Federal Reserve as endogenous is supported by policy statements issued by Federal Reserve officials and by the empirical studies cited in Chapter II.[1]

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[1]For example, the FOMC policy directive to the System Open Market Account manager contains references to the current and expected future movements of macroeconomic variables and to the reserve, monetary aggregate, and money market conditions required to move the macroeconomic variables toward the positions desired by the Federal Reserve. The November 15, 1977 domestic policy directive contains the following evidence of Federal Reserve concern with macroeconomic variables: ". . . in light of the foregoing developments, it is the policy of the Federal Open Market Committee to foster bank

As was mentioned in previous chapters, monetary policy will be made endogenous in this study by postulating that the monetary authorities act as if they were minimizing a loss function which contains as arguments the weighted squared differences between actual and desired states of macroeconomic variables of expressed concern to Federal Reserve policymakers subject to the policymakers' perception of the structure of the economy. The remainder of this chapter is devoted to a discussion of the particular form of the Federal Reserve loss function and to the derivation of a policy reaction function for the Federal Reserve. This reaction function relates the Federal Reserve policy variable to exogenous and lagged endogenous variables from the macroeconomic model

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reserve and other financial conditions that will encourage continued economic expansion and help resist inflationary pressures, while contributing to a sustainable pattern of international transaction . . . ." This statement is taken from "Record of Policy Actions of the Federal Open Market Committee," Federal Reserve Bulletin, 64 (January 1978), p. 25. Similar statements can be found in other issues of the Federal Reserve Bulletin, or in any recent issue of the Annual Report of the Board of Governors of the Federal Reserve System.

For examples of empirical studies supporting the concept of an endogenous monetary policy, see J. H. Wood," A Model of Federal Reserve Behavior," in G. Horwich, ed., Monetary Process and Policy (Homewood, Illinois: Richard D. Irwin, 1967), pp. 135-66; A. F. Friedlaender, "Macro Policy Goals in the Postwar Period: A Study in Revealed Preference," Quarterly Journal of Economics, 87, 1 (February 1973), pp. 25-43; R.T. Froyen, "A Test of the Endogeniety of Monetary Policy." Journal of Econometrics, 2, 2(July 1974), pp. 175-88; T. Havrilesky, "A Test of Monetary Policy Action," Journal of Political Economy, 75, 3 (June 1967), pp. 299-304; T. Havilesky, R. M. Sapp, and R. L. Schweitzer, "Tests of the Federal Reserve's Reaction to the State of the Economy 1964-74," Social Science Quarterly 55, 4 (March 1975), pp. 835-52; and M. W. Keran and C. T. Babb, "An Explanation of Federal Reserve Actions (1933-68)," Federal Reserve Bank of St. Louis Review, 51, 7(July 1969), pp. 7-20.

formulated in the previous chapter and to desired values for the arguments in the loss function. The policy reaction function is then incorporated into the macroeconomic model and a reduced form equation for the money supply is derived. The reduced form money supply equation is then employed in the analysis of the effects of fiscal policy upon the money supply when monetary policy is endogenous.

II. The Federal Reserve Loss Function

The form of the loss function employed in this study is a static quadratic function without interaction terms. The loss function contains as arguments the weighted squared current period deviations of actual from desired values for real GNP, the rate of inflation, the balance of trade, and the short-term interest rate. The arguments included in the loss function are drawn from policy statements by Federal Reserve officials and are similar to the arguments in previous reaction function studies.[2] The quadratic loss function is employed here as in approximation to the "true" loss function of the Federal Reserve policymakers, although there are certain well known problems encountered with this particular form of the loss function.[3] Despite these problems, the quadratic

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[2]See the references cited in footnote 1 of this chapter.

[3]One problem with a quadratic loss function noted by Wood, "A Model of Federal Reserve Behavior," p. 139 is the implicit assumption that the same level of loss is associated with an actual value of an argument that exceeds a desired value by a certain

function is used in this study because of its widespread usage in estimating policy reaction functions, because this type of loss function produces linear policy reaction functions, and because the relative weights in the loss function can be readily determined.

The following quadratic loss function is postulated as representative of the Federal Reserve's preferences

$$(4.1) \quad \ell_t = w_1(d(\frac{Y_t}{P_t}) - dy_t^*)^2 + w_2(d\dot{P}_t - d\dot{P}_t^*)^2 + w_3(dBT_t - dBT_t^*)^2$$

$$+ w_4(di_t^m - di_t^{m*})^2,$$

where

ℓ_t = level of loss in period t,

Y_t = nominal output in period t,

P_t = price level in period t,

$d(\frac{Y_t}{P_t})$ = actual change in real output from t-1 to t,

dy_t^* = desired change in real output from t-1 to t,

$d\dot{P}_t$ = actual change in rate of inflation from t-1 to t,

$d\dot{P}_t^*$ = desired change in rate of inflation from t-1 to t,

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amount as is associated with the actual value <u>below</u> the desired value by the same amount.

Other problems with the quadratic approach have been enumerated by Friedlaender, "Macro Policy Goals," p. 26, and include the following observations: (1) the desired values of the arguments in the disutility function must be attainable, and (2) empirical estimates of the weights are sensitive to the deviations of actual from desired values.

dBT_t = actual change in balance of trade from t-1 to t,

dBT_t^* = desired change in balance of trade from t-1 to t,

di_t^m = actual change in short-term interest rate from t-1 to t, and

di_t^{m*} = desired change in short-term interest rate from t-1 to t.

The terms $(d(\dot{\frac{Y_t}{P_t}}) - dy_t^*)^2$, $(d\dot{P}_t - d\dot{P}_t^*)^2$, and $(dBT_t - dBT_t^*)^2$ are measures of the traditionally stated goals of monetary and fiscal policy. The balance of trade is utilized here as a proxy for Federal Reserve concern with the balance-of-payments since, unlike the balance of trade, the balance of payments is not endogenous to the model developed earlier. The term $(di_t^m - di_t^{m*})^2$ is included to capture Federal Reserve concern for orderly conditions in financial markets (taken here as the absence of large changes in market interest rates) and for the avoidance of the disruptive effects of disintermediation felt in some sectors of the economy, especially the housing sector.

It should be noted that all of the arguments in the loss function are in the form of current period changes. This formulation of the loss function thus implies that the Federal Reserve's time horizon is one period long. Since the basic period of interest in this study is a quarter and since the policy making process at the Federal Reserve begins with the development of four-quarter forecasts for output, inflation, unemployment, and other economic

variables by the staff,[4] the focus upon current period deviations in this chapter may be questioned. For example, if the Federal Reserve had a four-quarter horizon the loss function might be formulated in the following manner

$$(4.2) \quad \ell_t = \sum_{i=0}^{3} w_{1i}\left(d\left(\frac{Y_{t+i}}{P_{t+i}}\right) - dy^*_{t+i}\right)^2 + \sum_{i=0}^{3} w_{2i}(d\dot{P}_{t+i} - d\dot{P}^*_{t+i})^2$$

$$+ \sum_{i=0}^{3} w_{3i}(dBT_{t+i} - dBT^*_{t+i})^2 + w_4(di^m_t - di^m_t{}^*)^2.$$

In this formulation the Federal Reserve is concerned with current period deviations and with forecasted deviations for the next three quarters for real output, the inflation rate, and the balance of trade. Current period deviations are considered sufficient only for financial market stability.[5]

While the employment of a four-quarter loss function appears to be in line with stated policy procedures, the significance of utilizing this function depends upon the relative weights assigned by the Federal Reserve to future peiod deviations. If the future

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[4]For a description of the policy making process at the Federal Reserve, see R. L. Lombra and R. G. Torto, "The Strategy of Monetary Policy," Federal Reserve Bank of Richmond Monthly Review, September/October 1975, pp. 3-14; and J. L. Pierce, "Quantitative Analysis for Decisions at the Federal Reserve," Annals of Economic and Social Measurement, 3, 1 (1974), pp. 11-19.

[5]A formulation of this type is consistent with the policy-making process described in the references in footnote 4 of this chapter.

period weights are significant relative to the current period weights, then the multi-period loss function is appropriate. However, if the future period weights are insignificant relative to the current period weights, then the multi-period loss function is inappropriate. Some evidence on the relative significance of the weights in a multi-period function has been provided by Friedlaender.[6] Friedlaender found that in a two-quarter framework the second quarter weights were insignificant relative to the current quarter weights. These results are suggestive that a one-period disutility function is adequate to describe the preferences of the Federal Reserve.

Furthermore, even though the Federal Reserve employs forecasts of economic activity for the next four to six quarters in its policy making process, a reading of FOMC directives leaves one uncertain about how far into the future the Federal Reserve's concern extends. For example, in a discussion of the FOMC directive, Axilrod asserts:

> Generally, only the statement about over-all economic activity had a future cast to it. But the time horizon for this future was often rather indefinite. Sometimes the wording has been such that the reader would think it referred to no more than a quarter ahead, or to the quarter in process. An example of such wording would be "economic activity appears to be slowing." On the

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[6]Friedlaender, "Macro Policy Goals," p. 27.

> other hand, at times statements simply noted that economic activity is projected to slow. In such cases the time horizon appears more indefinite. (p. 3)[7]

It is thus often difficult to determine the exact length of the Federal Reserve's time horizon for policymaking. Furthermore, based upon the results obtained by Friedlaender, the widespread usage of the one-period approach in the reaction-function literature, and the difficulty of determining the exact length of the appropriate time horizon, a one-period function will be employed in this study as representative of the Federal Reserve's preferences.[8]

III. The Federal Reserve Policy Reaction Function

The derivation of the policy reaction function can be facilitated by employing matrix algebra. The loss function can be written in matrix form as

$$\ell = (Y_t - Y_t^*)'W(Y_t - Y_t^*)$$

where

Y = nx1 vector of actual values of the arguments in the loss function and n equals the number of arguments,

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[7] S. H. Axilrod, "The FOMC Directive As Structured in the Late 1960's: Theory and Appraisal," in _Open Market Policies and Operating Procedures - Staff Studies_ (Washington, D.C.: Board of Governors of the Federal Reserve System, July 1971), pp. 1-36.

[8] Statistical considerations may also influence the choice of the time horizon if the reaction function is to be empirically estimated. A multi-period horizon may, by reducing the available degrees of freedom, increase the degree of multicollinearity to such an extent that the estimated coefficients are unreliable.

Y^* = nx1 vector of desired values of the arguments in the loss function, and

W = nxn diagonal matrix of positive weights in the loss function.[9]

In the approach taken in this study, the Federal Reserve is assumed to minimize ℓ subject to its perception of the structure of the U.S. economy. In matrix form the structure of the economy can be written as

$$Y_t = JR_t + HZ_t \text{ where}$$

R_t = 1x1 vector of the Federal Reserve policy variable,

J = nx1 vector of coefficients on the policy variable,

Z_t = mx1 vector of exogenous and lagged endogenous variables, and

H = nxm matrix of coefficients on the variables in Z_t.[10]

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[9]For more detailed definitions of these matrices and the matrices defined in the next paragraph, see Appendix One: Matrix Derivation of the Federal Reserve Policy Reaction Function.

[10]This formulation of the Federal Reserve's constraint implies that the policymaker knows the structure of the economy with certainty. In actuality the structure is not known with certainty. However, Theil's certainty equivalence theorem states that as long as the policymaker optimizes with respect to the expected values of the stochastic variables (the elements of Y_t), the solution is the same as if all uncertainty had been disregarded, as has been done here. For a proof of this see H. Theil, Economic Forecasts and Policy, 2nd ed. (Amsterdam: North-Holland Publishing Co., 1961), pp. 414-7.

Furthermore, it is assumed that the policymaker acts as if the multipliers between the policy variable and the elements of Y_t are known with certainty. For a discussion of this assumption, see W. Brainard, "Uncertainty and the Effectiveness of Policy," American Economic Review, 57, 2 (May 1967), pp. 411-25.

The minimization problem can be solved by substituting $Y_t = JR_t + HZ_t$ into the loss function, expanding the resulting expression, taking the partial derivative of this expression with respect to R_t, and then solving the resulting first-order condition for R_t. Substituting $JR_t + HZ_t$ into $\ell = (Y_t - Y_t^*)'W(Y_t - Y_t^*)$, we obtain

$$\ell = (JR_t + HZ_t - Y_t^*)'W(JR_t + HZ_t - Y_t^*).$$

Expanding this expression we obtain

$$\ell = (JR_t)'W(JR_t)+2(JR_t)'W(HZ_t)-2(JR_t)'WY^*+(HZ_t)'W(HZ_t)-2(HZ_t)'WY^* + Y^{*\prime}WY^*.$$

Taking the partial derivative of ℓ with respect to R_t and setting it equal to zero, we obtain

$$\frac{\partial \ell}{\partial R_t} = 2J'WJR_t + 2J'WHZ_t - 2J'WY^* = 0 \text{ or}$$

$$\frac{\partial \ell}{\partial R_t} = J'WJR_t + J'WHZ_t - J'WY^* = 0$$

Solving this equation for R_t, we obtain

$$R_t = [J'WJ]^{-1}J'WY^* - [J'WJ]^{-1}J'WHZ_t.$$

The equation $R_t = [J'WJ]^{-1}J'WY* - [J'WJ]^{-1} J'WHZ_t$ relates the Federal Reserve's policy tool to desired values of the arguments in the loss function and to exogenous and lagged endogenous variables from the macro model. This equation can thus be interpreted as the Federal Reserve's policy reaction function. After performing the necessary matrix manipulations, the policy reaction function can be rewritten in the following form

$$(4.3)\quad dUBR_t = -V_0 - V_1 d\bar{G}_t + V_2 Y_{t-1} dr_{1,t} - V_3[\bar{G}_{t-1} - T_{t-1} + D_{t-1} + dX_t + dA_t + (\frac{1}{i^{\ell}_{t-1}})d\bar{K}_t] + V_4 di^{\ell}_{t-2} - V_5 dY_{t-1} - V_6 dI_{t-1} - V_7 d\bar{E}_t + V_8 d\bar{i}^{DS}_t + V_9 d\dot{P}^E_t + V_{10} d(\frac{1}{U_t}) - V_{11} dY^{POT}_t + V_{12} dy^*_t + V_{13} d\dot{P}^*_t - V_{14} dBT^*_t - V_{15} di^{m}_t{}^*,$$

where

$$V_0 = \frac{A_2 A_{11} A_{23}(\frac{1}{P_{t-1}} + A_{25})}{S_2},$$

$$V_1 = \frac{A_{11}A_3S_1 - w_4A_{21}A_{13}}{S_2},$$

$$V_2 = \frac{A_{11}A_4S_1 - w_4A_{21}A_{14}}{S_2},$$

$$V_3 = \frac{A_{11}A_5S_1 - w_4A_{21}A_{15}}{S_2},$$

$$V_4 = \frac{A_{11}A_6S_1 - w_4A_{21}A_{16}}{S_2}$$

$$V_5 = \frac{A_{11}A_7S_1 - w_4A_{21}A_{17}}{S_2},$$

$$V_6 = \frac{A_{11}A_8S_1 - w_4A_{21}A_{18}}{S_2},$$

$$V_7 = \frac{A_{11}A_9S_1 - w_4A_{21}A_{19} - w_3A_2A_9c_1}{S_2},$$

$$V_8 = \frac{A_{11}A_{10}S_1 - w_4A_{21}A_{20}}{S_2},$$

$$V_9 = \frac{A_{11}A_{12}S_1 + w_4A_{21}A_{22} - w_1A_2A_{11}A_{26}}{S_2},$$

$$V_{10} = \frac{A_2A_{11}S_3}{S_2},$$

$$V_{11} = \frac{A_2A_{11}A_4}{S_2},$$

$$V_{12} = \frac{w_1A_2A_{11}(\frac{1}{P_{t-1}} + A_{25})}{S_2}$$

$$V_{13} = \frac{w_2A_2A_{11}j_2(\frac{1}{Y^{POT}_{t-1}})}{S_2},$$

$$V_{14} = \frac{w_3A_2A_{11}c_1}{S_2},$$

$$V_{15} = \frac{w_4A_2A_{21}}{S_2},$$

$$S_1 = w_1(\frac{1}{P_{t-1}} + A_{25})^2 + w_2j_2^2(\frac{1}{Y^{POT}_{t-1}})^2 + w_3c_1^2$$

$$S_2 = A_{11}^2S_1 + w_4A_{21}^2,$$

$$S_3 = w_1 j_1 A_{24}\left(\frac{1}{P_{t-1}} + A_{25}\right) + w_2 j_1 j_2 \left(\frac{1}{Y^{POT}_{t-1}}\right),$$

$$S_4 = w_1 A_{24}\left(\frac{1}{P_{t-1}} + A_{25}\right)\left(\frac{Y_{t-1}}{Y^{POT}_{t-1}}\right) + w_2 j^2 \left(\frac{Y_{t-1}}{Y^{POT^2}_{t-1}}\right),$$

$$A_{23} = \left(\frac{Y_{t-1}}{P^2_{t-1}}\right)(1+\dot{P}_t)\,dP_{t-1},$$

$$A_{24} = \left(\frac{Y_{t-1}}{P^2_{t-1}}\right)P_{t-1},$$

$$A_{25} = \left(\frac{Y_{t-1}}{P^2_{t-1}}\right)P_{t-1} j_2,$$

$$A_{26} = A_{24} j_3,$$

and all other terms are as previously defined.

Although the change in the monetary policy instrument is a linear function of exogenous and lagged endogenous variables and of the desired values of the arguments in the loss function, the coefficients of the independent variables are complex mixtures of structural parameters and weights in the policymakers' loss function. A shift in either the structural parameters or in the relative weights in the loss function will lead to a change in the implied magnitude or, perhaps, in the sign of the coefficients in the policy reaction function. For example, de-emphasis upon financial market stability and increased emphasis upon the deviation of the actual change in real output from the desired change in real output or upon the deviation of the actual inflation rate from the

desired rate will change the size and perhaps the sign of the coefficients on $d\bar{G}_t$ and $Y_{t-1}dr_{1,t}$ and will thereby change the implied response of the monetary policymakers to a change in government expenditures or tax receipts. The responsiveness of the money supply to a change in these variables will also be altered as a result of a shift in preferences by monetary policymakers.

IV. Derivation of the Reduced Form Money Supply Equation and Analysis of the Effects of Fiscal Policy Upon the Money Supply

The policy reaction function can now be combined with the structural model to derive a reduced form equation for the money supply. Substituting equation (4.3) and (3.35) (the reduced form equation of di_t^m) into equation (3.10') (the money supply equation), we obtain the following reduced form money supply equation

$$dM_t^S = H_0 + H_1 d\bar{G}_t - H_2 Y_{t-1} dr_{1,t} + H_3[\bar{G}_{t-1} - T_{t-1} + D_{t-1} + dX_t + dA_t + (\frac{1}{i^{\ell}_{t-1}}) d\bar{K}_t]$$

$$- H_4 di^{\ell}_{t-2} + H_5 dY_{t-1} + H_6 dI_{t-1} + H_7 d\bar{E}_t + H_8 d\bar{i}_t^{DS} + H_9 d\dot{P}_t^E$$

$$- H_{10} d(\frac{1}{U_t}) + H_{11} dY_t^{POT} + H_{12} dy_t^* + H_{13} d\dot{P}_t^* + H_{14} dBT_t^* - H_{15} di_t^{m*}$$

where

$$H_0 = -FV_0,$$

$$H_1 = g_1 \frac{A_{13}}{A_2} - FV_1,$$

$$H_2 = g_1 \frac{A_{14}}{A_2} - FV_2,$$

$$H_3 = g_1 \frac{A_{15}}{A_2} - FV_3,$$

$$H_4 = g_1 \frac{A_{16}}{A_2} - FV_4,$$

$$H_5 = g_1 \frac{A_{17}}{A_2} - FV_5,$$

$$H_6 = g_1 \frac{A_{18}}{A_2} - FV_6,$$

$$H_7 = g_1 \frac{A_{19}}{A_2} - FV_7,$$

$$H_8 = g_1 \frac{A_{20}}{A_2} - FV_8,$$

$$H_9 = g_1 \frac{A_{22}}{A_2} - FV_9,$$

$$H_{10} = FV_{10},$$

$$H_{11} = -FV_{11},$$

$$H_{12} = FV_{12},$$

$$H_{13} = FV_{13},$$

$$H_{14} = FV_{14},$$

$H_{15} = FV_{15}$,

$F = (g_3 - g_1 \frac{A_{21}}{A_2})$,

and the V's and the g's are as previously defined.

The partial derivatives of dM_t^S with respect to $d\bar{G}_t$ and $Y_{t-1}dr_{1,t}$ can now be determined. These partial derivatives are given by

$$\frac{\partial dM_t^S}{\partial d\bar{G}_t} = g_1 \frac{A_{13}}{A_2} - (g_3 - g_1 \frac{A_{21}}{A_2})V_1,$$

and

$$\frac{\partial dM_t^S}{\partial Y_{t-1}dr_{1,t}} = - [g_1 \frac{A_{14}}{A_2} - (g_3 - g_1 \frac{A_{21}}{A_2})V_2].$$

The signs of these derivatives depend in a complex way upon the structural parameters of the model and the relative weights on the arguments in the policymakers' loss function; evaluation of the signs requires as a starting point some assumptions about the relative weights in the loss function.

Let us evaluate $\partial dM_t^S/\partial d\bar{G}_t$ first. This partial derivative can be rewritten as

$$-g_3V_1 + g_1 \frac{A_{21}}{A_2} V_1 + g_1 \frac{A_{13}}{A_2} .$$

As a starting point in the evaluation of the sign of this derivative, the sign of $(-V_1)$, the coefficient on $d\bar{G}_t$ in the policy reaction function, will be analyzed. $(-V_1)$ can be written as

$$-[\frac{A_{11}A_3S_1-w_4A_{21}A_{13}}{S_2}].$$

S_2, in expanded form, equals $A_{11}^2S_1+w_4A_{21}^2$. S_1 is equal to $w_1[\frac{1}{P_{t-1}} + (\frac{Y_{t-1}}{P_{t-1}^2})P_{t-1}j_2]^2 + w_2j_2^2(\frac{1}{Y_{t-1}^{POT}})^2 + w_3c_1^2]$. Since $[\frac{1}{P_{t-1}} + (\frac{Y_{t-1}}{P_{t-1}^2})P_{t-1}j_2]^2$, $j_2^2(\frac{1}{Y_{t-1}^{POT}})^2$, and c_1^2 are > 0 and since w_1, w_2, and w_3 are > 0, S_1 is > 0. Since A_{11}^2 and A_{21}^2 are > 0 and S_1 and w_4 are > 0, $S_2 > 0$. Thus since S_2 is > 0, for $(-V_1)$ to be > 0 (thereby implying that the Federal Reserve increases any change in the level of its policy instrument in response to an increase in government expenditure) the term $-[A_{11}A_3S_1 - w_4A_{21}A_{13}]$ must be > 0. Stated alternatively, $[w_4A_{21}A_{13} - A_{11}A_3S_1]$ must be > 0. For this inequality to hold, $w_4A_{21}A_{13}$ must be > $A_{11}A_3S_1$ or $w_4 > \frac{A_{11}A_3}{A_{21}A_{13}} S_1$.

Thus if the weight assigned by the Federal Reserve to financial market stability exceeds the sum of the weights on all other arguments in the loss function where this sum is pre-multiplied by the ratios $(\frac{A_{11}}{A_{21}})(\frac{A_3}{A_{13}})$, $(-V_1)$ will be > 0. Since g_3 (the coefficient on $dUBR_t$ in the money supply function - see equation (3.10')) is > 0, if $(-V_1)$ is > 0, then the money supply

change will be positive as a result of $d\bar{G}_t > 0$. The term (A_{11}/A_{21}) is the ratio of the coefficient on $dUBR_t$ in the reduced form equation for dY_t (equation (3.34)) and the coefficient on $dUBR_t$ in the reduced form equation for di_t^m (equation (3.35)), respectively. The term (A_3/A_{13}) is the ratio of the coefficient on $d\bar{G}_t$ in the reduced form equation for dY_t and the coefficient on $d\bar{G}_t$ in the reduced form equation for di_t^m, respectively. The extent to which w_4 must exceed S_1 depends upon the values of these ratios. If the ratios are > 1 then w_4 must be greater in absolute terms than if the ratios are < 1. Evidence from a model of the U.S. economy similar to the one developed in this study suggests that these ratios are both > 1.[11]

The second term in the partial derivative is more complex to interpret. This term can be rewritten as

$$g_3V_1 \frac{A_0f_1'}{A_2} g_1$$

after substituting $A_0(f_1'g_3)$ for A_{21} and rearranging. As noted earlier g_3V_1 represents the policy induced change in the money supply. Since the model employed in this study requires that the quantity of money demanded equals the quantity of money supplied in every period, $g_3V_1 \frac{A_0f_1'}{A_2}$ represents the change in i_t^m required

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[11]Moroney and Mason, "The Dynamic Impacts," p. 803.

to equate the quantity demanded and supplied. Since g_1 is the coefficient on di_t^m in the equation for dM_t^S (equation (3.10')) $g_3V_1 \frac{A_0f_1'}{A_2} g_1$ represents the change in the quantity of money resulting from the equilibrium of the quantity of money demanded and supplied. We should note that the change in the quantity of money due to the equilibration process is in the opposite direction of the policy induced change at the initial level of the market interest rate.

The analysis of the third term in the partial derivative, $g_1 \frac{A_{13}}{A_2}$, can be facilitated by substituting the full expression for A_{13} in the term $g_1 \frac{A_{13}}{A_2}$. Since $A_{13} = (1+a_2)f_2'$, we can rewrite this term as

$g_1 \frac{(1+a_2)f_2'}{A_2}$ or as $g_1f_2' (\frac{1+a_2}{A_2})$. The term $(\frac{1+a_2}{A_2})$ represents the change in income resulting from the expansionary fiscal action financed by bond issuance (hence the inclusion of a_2 - the coefficient on net wealth in the consumption function - in the numerator). Since f_2' is the coefficient on dY_t in the equation for di_t^m (equation (3.9")) and since g_1 is the coefficient on di_t^m in the equation for dM_t^S, the expression $g_1f_2' (\frac{1+a_2}{A_2})$ is the change in the money supply induced by private sector response to higher interest rates brought about by the increase in income generated

by the expansionary fiscal policy action. We should note that this change in the quantity of money is in the same direction as the policy induced change at the initial level of market interest rates.

The three effects of $d\bar{G}_t > 0$ on dM_t^S can be illustrated in the context of the monetary sector of the macromodel. Let the money demand and supply curves be represented in the following manner

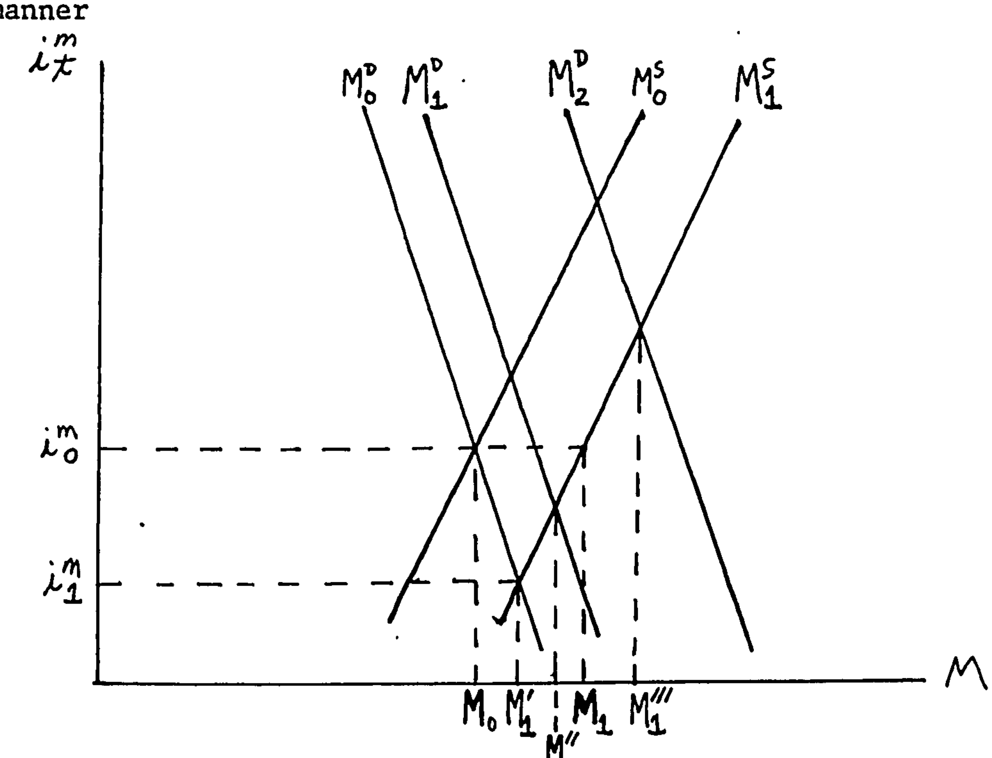

Figure I

Money Supply Effects of Increased Government Expenditures With Accommodative Federal Reserve Response

If $g_3(-V_1)$ is > 0, then $d\bar{G}_t > 0$ induces a rightward shift of M_0^S to M_1^S as the Federal Reserve responds to the fiscal policy action. The policy induced change in money is thus $M_1 - M_0$. Immediate

restoration of equilibrium requires a reduction in i_0^m to i_1^m; this reduction would induce private sector response that would reduce the expansion in the level of money from M_1 to M_1'. This is the effect represented by the second term of the partial derivative. However, as income begins to rise because of $d\bar{G} > 0$ and the initial fall in i_t^m, the money demand curve will shift to M_1^D. The interest rate will begin to rise and private sector response will induce an expansion in the money supply beyond M_1' to M_2''. If the money demand curve shifts out to M_2^D, then private sector response will induce an expansion in the money supply beyond M_1 to M_1'''. Whether the money supply ultimately rises beyond the policy induced change at the initial interest rate depends upon the magnitude of the change in income and the income elasticity of money demand.

Thus when $g_3(-V_1) > 0$, the ultimate response of the money supply to $d\bar{G}_t > 0$ is > 0. Private sector response may or may not expand the money supply beyond the policy induced change at the initial interest rate.

When $g_3(-V_1) < 0$, that is, when the Federal Reserve contracts the money supply in response to a fiscal action of $d\bar{G}_t > 0$, perhaps because of an overriding concern for possible inflationary consequences of this policy, the ultimate change in the money supply could be $\gtreqless 0$. While the policy response is unambiguous, the private sector response may result in a rise in the money supply.

The initial private sector response before income changes $(g_3 V_1 \frac{A_0 f_1'}{A_2} g_1)$ is > 0 since the policy induced reduction in the money supply drives up the market interest rate thereby inducing action in the private sector that partly offsets the policy induced contraction in the money supply.

Let us initially assume that the expansionary fiscal action has a stronger effect upon aggregate demand than does the contraction in the money supply so that income rises. When income begins to rise, the demand for money rises, and the market interest rate begins to rise. This rise results in further private sector response that mitigates or even offsets the initial reduction in the money supply.

These effects can again be illustrated graphically (see Figure II). The policy induced response shifts the money supply curve to M_1^S thereby reducing the money supply by $M_0 - M_1$ at i_0^m. However, the adjustment to equilibrium drives i_0^m to i_1^m and induces private sector response that partly offsets the initial fall. With unchanged income, the reduction in the money supply is $M_0 - M_1'$. As income rises, the money demand curve shifts out, say to M_1^D. The interest rate rises, and the money supply expands to M_1''. Thus the initial reduction is further blunted by the shift in money demand. Note also that if the shift in money demand is sufficiently large, say to M_2^D, then the final level of the money supply (M_1''') is

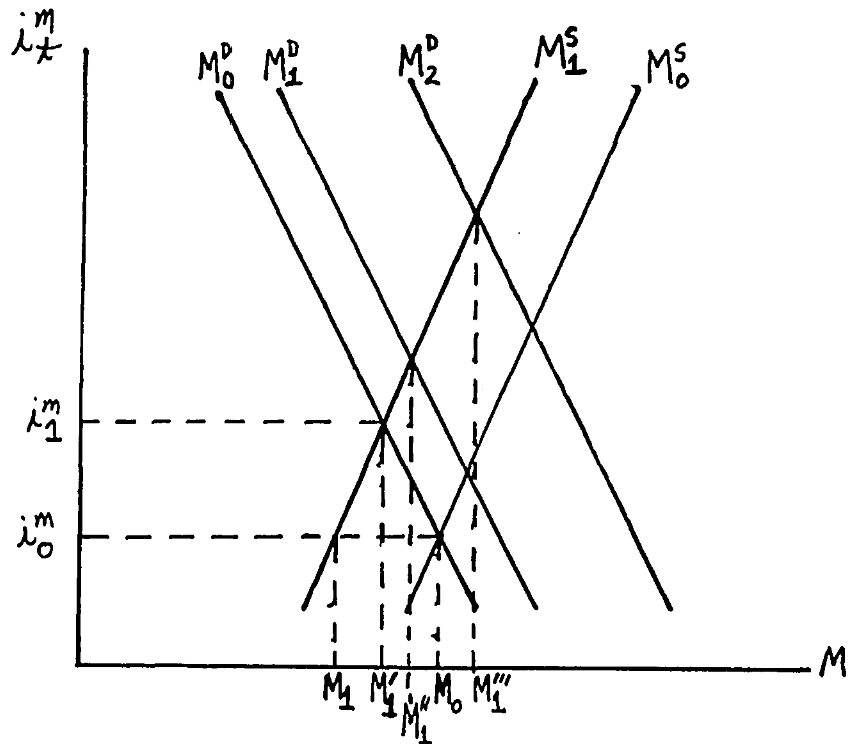

Figure II

Money Supply Effects of Increased Government Expenditures
With Non-Accommodative Federal Reserve Response

greater than the initial level, even though the policy reaction initially lowers the money supply.

We must also consider the possibility that the negative response of the Federal Reserve is so large that income falls. In this instance, private sector response may drive the money supply below the policy induced reduction. However, for this possibility to occur, $(-V_1)$ not only must be negative but must also be large in absolute size. A response of the size necessary to reduce income in the face of expansionary fiscal policy might be found if the economy were in an hyperinflationary period and the Federal Reserve heavily weighted a deviation of the actual inflation rate from the desired rate.

The sign of $\partial dM_t^S/\partial Y_{t-1}dr_{1,t}$ will now be evaluated. This partial derivative is given by

$$g_3V_2 - g_1 \frac{A_{21}}{A_2} V_2 - g_1\frac{A_{14}}{A_2}.$$

Again, as a starting point, the sign of V_2, the coefficient on $Y_{t-1}dr_{1,t}$ (the exogenous change in tax receipts) in the policy reaction function, will be evaluated. V_2 can be written as:

$$\frac{A_{11}A_4S_1-w_4A_{21}A_{14}}{S_2}$$

As noted earlier in this chapter, $S_2 > 0$. For V_2 to be < 0 (thereby implying that the Federal Reserve reduces any change in the level of its policy instrument in response to an increase in exogenous tax receipts), the term $[A_{11}A_4S_1-w_4A_{21}A_{14}]$ must also be < 0. This inequality will be met if

$$w_4 > (\frac{A_{11}}{A_{21}}\frac{A_4}{A_{14}})S_1.$$

Thus if $w_4 > (\frac{A_{11}}{A_{21}}\frac{A_4}{A_{14}})S_1$ (as was necessary for the level of the policy tool to expand when $d\bar{G}_t > 0$), V_2 would be < 0 and $Y_{t-1}dr_{1,t} > 0$ would lead to a reduction in the level of the policy tool. If $Y_{t-1}dr_{1,t} > 0$, any deficit is reduced and government bonds are retired. The retirement of the bonds reduces the market interest rate. The Federal Reserve would then reduce the level of

its policy variable to offset this presumably undesirable fluctuation in market interest rates. Thus when financial market stability is more heavily weighted than are other policy goals, the Federal Reserve changes its policy variable to offset the financial market effects of $Y_{t-1}dr_{1,t} > 0$. Note again that the extent to which w_4 must exceed S_1 depends upon the values of the ratios (A_{11}/A_{21}) and (A_4/A_{14}). If the ratios are > 1 then w_4 must be greater in absolute terms than if the ratios are < 1.

If $V_2 < 0$, then g_3V_2 is also < 0. That is, if $V_2 < 0$, an increase in exogenous tax receipts leads to a reduction in the money supply at the initial level of the market interest rate as a result of the Federal Reserve reaction to the fall in a deficit (or a rise in a surplus) brought about by the rise in exogenous tax receipts.

The second term in the partial derivative can be rewritten as $g_3V_2 \frac{A_0f_1'}{A_2} g_1$. Following the logic of the analysis of the similar term in $\partial dM_t^S/\partial d\bar{G}_t$, this term represents the change in the money supply resulting from the equilibration of the quantity of money demanded and supplied after the policy induced change in the money supply. In the case of $V_2 < 0$, this change due to the equilibration process is > 0.

The third term in the partial derivative can be rewritten as $g_1f_2'(\frac{a_1+a_2}{A_2})$ since $A_{14} = (a_1+a_2)f_2'$. The term $(\frac{a_1+a_2}{A_2})$ represents the change in income resulting from the exogenous increase in tax

receipts; the entire expression is the change in the money supply induced by private sector response to a change in the interest rate brought about by the change in income generated by contractionary fiscal policy action. Again, we should note that this change in the quantity of money is in the same direction as the policy induced change at the initial level of the market interest rate.

Graphically, the events described in the preceding paragraph can be represented in the following way

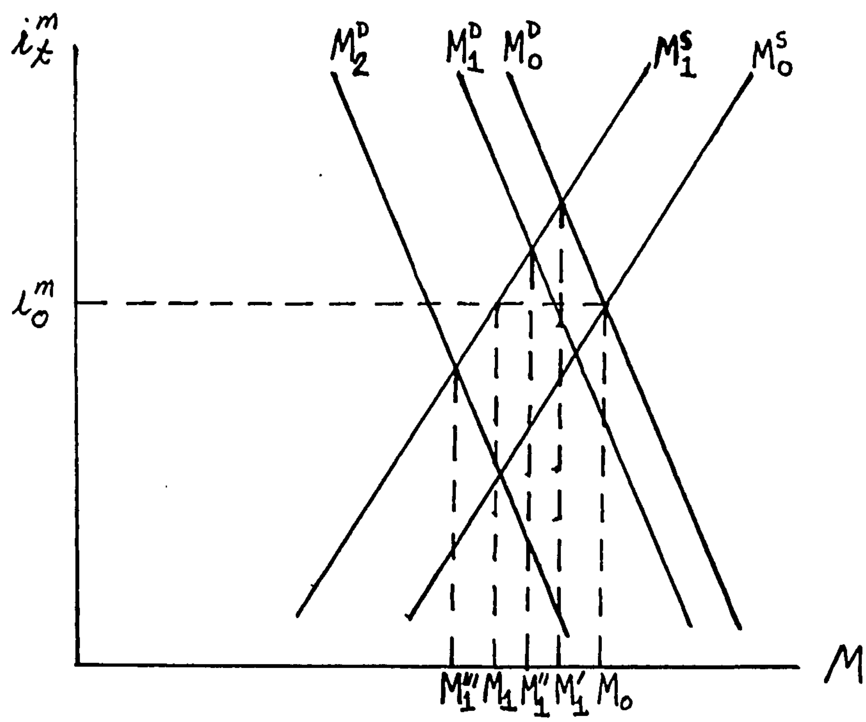

Figure III

Money Supply Effects of Increased Tax Receipts With Accommodative Federal Reserve Response

The policy response of the Federal Reserve results in the leftward shift of M_0^S to M_1^S; the money supply falls by $M_0 - M_1$ at the initial level of the interest rate. However, as the interest rate begins to rise, private sector response leads to an increase in the money supply to M_1'. As income begins to fall, money demand shifts down to M_1^D, and private sector actions result in a fall in the money supply to M_1''. The final level of the money supply can thus be less than or greater than the initial policy induced decline (the decline will be greater (to M_1''') if, for example, money demand falls to M_2^D).

If the Federal Reserve responds to $Y_{t-1}dr_{1,t} > 0$ by increasing its policy variable ($V_2 > 0$), then $g_3V_2 > 0$; that is, the money supply rises as a result of the Federal Reserve policy action. Furthermore, when $V_2 > 0$, the response of the private sector in restoring equilibrium in the money market at an initially unchanged level of income reduces the money supply below the initial policy induced expansion ($[-g_3V_2 \frac{A_0f_1'}{A_2} g_1] < 0$). If, as a result of $Y_{t-1}dr_{1,t} > 0$, income begins to fall, money demand begins to fall and private sector response further reduces the money supply, possibly below the initial level before the change in tax receipts ($[-g_1f_2' \frac{a_1+a_2}{A_2})] < 0$). However, one must also consider the possibility that the policy induced expansion in the money supply cancels or outweighs any contractionary effects of $Y_{t-1}dr_{1,t} > 0$. If the monetary expansion cancels the contractionary effect of the tax

increase, then the ultimate monetary response to $Y_{t-1}dr_{1,t} > 0$ is an increase beyond the initial level but less than the policy induced increase. If the monetary expansion outweighs the contractionary tax effects then income will rise, money demand will rise, and the money supply may expand beyond the initial policy induced increase.

The analysis thus far has examined the cases where $V_1 \gtrless 0$ and $V_2 \gtrless 0$. If either or both V_1 and V_2 equaled 0 (implying that the Federal Reserve doesn't respond to $d\bar{G}_t$ and/or $Y_{t-1}dr_{1,t}$ then the appropriate partial derivatives of dM_t^S with respect to $d\bar{G}_t$ or $Y_{t-1}dr_{1,t}$ would be the same as in the case of exogenous monetary policy.

The results of the analysis are summarized in the following Table I, p. 113.

V. Conclusion

Thus we see that in the case of exogenous monetary policy, given the traditionally expected signs of the structural coefficients in the equations of the macromodel, $d\bar{G}_t > 0$ unambiguously leads to an expansion in the money supply and $Y_{t-1}dr_{1,t} > 0$ unambiguously leads to a contraction in the money supply. However, when monetary policy is endogenous, $d\bar{G} > 0$ may lead to either an expansion or contraction in the money supply and $Y_{t-1}dr_{1,t} > 0$ may also lead to either an expansion or contraction in the money supply.

Table I
Fiscal Policy Effects Upon Changes in the Money Supply

	Exogenous Monetary Policy	Endogenous Monetary Policy		
$\frac{\partial dM_t^S}{\partial dG_t}$	$g_1 \frac{A_{13}}{A_2}$ (>0)*	$-g_3V_1+g_1 \frac{A_{21}}{A_2} V_1+g_1 \frac{A_{13}}{A_2}$ and	(a) $(-V_1)>0$	(>0)
			(b) $(-V_1)<0$	
			(1) income rises	$(\gtrless 0)$
			(2) income falls	(<0)
			(c) $(-V_1)=0$	(>0)
$\frac{\partial dM_t^S}{\partial Y_{t-1} dr_{1,t}}$	$-g_1 \frac{A_{14}}{A_2}$ (<0)	$g_3V_2-g_1 \frac{A_{21}}{A_2} V_2 - g_1 \frac{A_{14}}{A_2}$ and	(a) $V_2>0$	(<0)
			(b) $V_2<0$	
			(1) income rises	$(\gtrless 0)$
			(2) income falls	(<0)
			(c) $V_2=0$	(<0)

*( ) indicates direction of change in the money supply

The ambiguity in the case of endogenous monetary policy stems from the fact that the direction of change in the policy instrument depends upon the relative weights in the policymaker's loss function, the magnitude of the change in the policy instrument depends upon the relative weights and relevant structural parameters of the macromodel, and the ultimate change in the money supply depends upon the reactions of the Federal Reserve and the private sector (this reaction depends upon the structural parameters of the model) to the fiscal policy change.

The question of the effect of fiscal policy upon changes in the money supply cannot be finally answered by analysis of a theoretical macromodel that treats monetary policy as endogenous. Although manipulation of the macromodel allows one to examine the conditions under which the direction of change can be determined, the actual response of the monetary authorities to federal deficits can only be determined by empirical estimation of the macromodel and the monetary policy reaction function. The analysis in the next chapter will be directed to empirical estimation of the macromodel and the policy reaction function.

CHAPTER V

EMPIRICAL ANALYSIS OF THE FISCAL POLICY - MONEY SUPPLY RELATIONSHIP

I. Introduction

The previous chapter examined the effects of fiscal policy upon the money supply when Federal Reserve policymakers are presumed to systematically and predictably react to current and previous period movements in economic variables. It was shown that changes in government expenditures and taxes have an ambiguous impact upon the money supply. The direction of change of the money supply depends upon the reactions of Federal Reserve policymakers and the private sector of the economy to the change in fiscal policy, and these reactions in turn depend upon the relative weights in the Federal Reserve loss function and the structural parameters of the macromodel. Thus to determine the actual response of the Federal Reserve and the money supply to fiscal policy, the structural parameters of the macromodel and the coefficients in the Federal Reserve reaction function must be empirically estimated.

Presentation and analysis of these empirical estimates occupy the remainder of this chapter. Estimates of the structural parameters of the macromodel when the Federal Reserve is exogenous and when the Federal Reserve is endogenous are presented and analyzed in section II of this chapter. Estimates of the coefficients in the reaction function and the implicit relative weights in the loss function are

examined in section III. Reduced form money supply equations for both the macromodel with the Federal Reserve exogeneous and the model with the Federal Reserve endogenous are presented and analyzed in section IV.

II. Parameter Estimates for the Macromodels

Since an interdependent system of equations is to be estimated, a systems method is employed. Ordinary least squares estimation of the equations of a simultaneous system leads to inconsistent estimates of the structural parameters, but the problem of inconsistent estimates is overcome through the use of a systems method of estimation. An iterative three-stage least squares estimation technique is employed in this study since this technique produces consistent and asymptotically efficient estimates of the structural parameters. This technique utilizes information about the correlation between structural disturbances in the estimation of the equations of the system, information that is not utilized in the two-stage least squares estimation technique.[1]

The estimates of the structural parameters of the macromodels with the Federal Reserve exogenous and with the Federal Reserve endogenous are presented in Tables I and II, respectively. Definitions of the variables are provided in Table III. The equations of these models are discussed below. These models were estimated from

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[1]For a technical description of the three-stage least squares technique and other systems methods of estimation, see, for example, Jan Kmenta, Elements of Econometrics, (New York: The Macmillan Company, 1971), pp. 531-99.

Table I

Model I: Federal Reserve Exogenous*

Product Sector

(1) $Y_t = C_t + I_t + G_t^F + G_t^{SL} + E_t - IM_t$ (Equilibrium Condition)

(2) $C_t = -10.54 + .257\ YD_t + .018\ WE_t + .728\ C_{t-1}$ $\bar{R}^2 = .998$ (Consumption Function)

(-3.43) (4.25) (3.03) (10.48)

(3) $YD_t = Y_t - KCA_t - T_t^{SL} - T_t^{F,EN} - T_t^{F,EX}$ (Disposable Income Definition)

(4) $WE_t = 620.38 - 34.94\ i_t^m - 53.74\ i_t^{\ell} + .572\ Y_t$ $\bar{R}^2 = .923$ (Wealth Function)

(33.72) (-9.23) (-5.22) (18.13)

(5) $I_t = 9.82 - 3.31\ i_{t-2}^{\ell} + .166\ dY_{t-1} + .053\ Y_t + .685\ I_{t-1}$ $\bar{R}^2 = .986$ (Investment Function)

(3.28) (-2.25) (1.97) (5.85) (13.69)

(6) $IM_t = -2.77 + .008\ Y_t + .964\ IM_{t-1}$ $\bar{R}^2 = .991$ (Import Function)

(-2.05) (2.12) (26.74)

Monetary Sector

(7) $M_t^D = M_t^S$ (Equilibrium Condition)

(8) $i_t^m = 8.67 - .099\ M_t^D + .015\ Y_t + .596\ \dot{P}_t^E$ $\bar{R}^2 = .683$ (Inverse Money Demand Function)

(3.99) (-3.44) (3.84) (6.81)

Table I (Continued)

(9) $M^S_t = 32.53 + 3.88\,[i^m_t - i^{DS}_t] + 7.46\,UBR_t$ $\quad \bar{R}^2 = .991$ (Money Supply Function)

(20.54) (3.35) (103.25)

(10) $i^\ell_t = .351 + .069\,i^m_t + .0006\,Y_t + .780\,i^\ell_{t-1}$ $\quad \bar{R}^2 = .985$ (Term Structure Function)

(3.88) (3.64) (3.66) (16.33)

<u>Price Sector</u>

(11) $\dot{P}_t = .401 - .113\,RAD_t + .923\,\dot{P}^E_t - .016\,GP - .546\,WPC + 2.82\,WPCAF$ $\quad \bar{R}^2 = .706$ (Inflation Function)

(1.31) (-4.51) (10.88) (-.41) (-.97) (4.86)

*t-statistics are in parentheses below each coefficient. $\bar{R}^2 = R^2$ adjusted for degrees of freedom.

TABLE II

Model II: Federal Reserve Endogenous*

Product Sector

	Equation		Description
(1)	$Y_t = C_t + I_t + G_t^F + G_t^{SL} + E_t - IM_t$		(Equilibrium Condition)
(2)	$C_t = -10.88 + .304\ YD_t + .02\ WE_t + .673\ C_{t-1}$	$\bar{R}^2 = .999$	(Consumption Function)
	(-3.58) (5.20) (3.40) (9.99)		
(3)	$YD_t = Y_t - KCA_t - T_t^{SL} - T_t^{F,EN} - T_t^{F,EX}$		(Disposable Income Definition)
(4)	$WE_t = 617.61 - 35.29\ i_t^m - 51.58\ i_t^\ell + .565\ Y_t$	$\bar{R}^2 = .923$	(Wealth Function)
	(34.53) (-9.49) (-5.20) (18.44)		
(5)	$I_t = 9.13 - 2.88\ i_{t-2}^\ell + .197\ dY_{t-1} + .049\ Y_t + .697\ I_{t-1}$	$\bar{R}^2 = .986$	(Investment Function)
	(3.07) (-1.98) (2.41) (5.48) (14.06)		
(6)	$IM_t = -2.89 + .008\ Y_t + .960\ IM_{t-1}$	$\bar{R}^2 = .991$	(Import Function)
	(-2.14) (2.22) (26.70)		

Monetary Sector

	Equation		Description
(7)	$M_t^D = M_t^S$		(Equilibrium Condition)
(8)	$i_t^m = 8.08 - .091\ M_t^D + .014\ Y_t + .582\ \dot{P}_t^E$	$\bar{R}^2 = .683$	(Inverse Money Demand Fntion)
	(3.82) (-3.25) (3.67) (6.71)		
(9)	$M_t^S = 32.4 + 3.80\ [i_t^m - i_t^{DS}] + 7.47\ UBR_t$	$\bar{R}^2 = .991$	(Money Supply Function)
	(20.44) (3.31) (103.25)		

Table II (Continued)

(10) $$UBR_t = \underset{(6.55)}{4.57} + \underset{(2.98)}{.022}\, G^F_t - \underset{(-2.98)}{.034}\, T^{F,EX}_t + \underset{(19.26)}{.017}\, Y_{t-1} + \underset{(2.27)}{.003}\, RYH_t$$

$$+ \underset{(.894)}{.051}\, \dot{P}^D_t + \underset{(2.47)}{.172}\, IIDEMO + \underset{(2.04)}{.123} IIREP2 - \underset{(-11.41)}{.573}\, i^m_{t-1} + \underset{(.435)}{.048}\, GP$$

$$+ \underset{(2.08)}{.342}\, WPC + \underset{(3.56)}{.583}\, WPCAF$$

$\bar{R}^2 = .998$ (Federal Reserve Reaction Function)

(11) $$i^\ell_t = \underset{(4.25)}{.38} + \underset{(4.00)}{.074}\, i^m_t + \underset{(4.04)}{.0006}\, Y_t + \underset{(16.28)}{.762}\, i^\ell_{t-1}$$

$\bar{R}^2 = .985$ (Term Structure Function)

<u>Price Sector</u>

(12) $$\dot{P}_t = \underset{(1.79)}{.52} - \underset{(-3.56)}{.075}\, RAD_t + \underset{(11.05)}{.897}\, \dot{P}^E_t - \underset{(-.36)}{.135}\, GP - \underset{(-.93)}{.505}\, WPC + \underset{(4.93)}{2.74}\, WPCAF$$

$\bar{R}^2 = .727$ (Inflation Function)

*t-statistics are in parentheses below each coefficient. $\bar{R}^2 = R^2$ adjusted for degrees of freedom.

TABLE III

Definition of Variables

Y_t = nominal GNP, period t.

C_t = nominal consumption expenditures, period t.

C_{t-1} = nominal consumption expenditures, period t-1.

I_t = nominal investment expenditures, period t.

I_{t-1} = nominal investment expenditures, period t-1.

G_t^F = nominal federal government expenditures on goods and services period t.

G_t^{SL} = nominal state and local government expenditures on goods and services, period t.

E_t = nominal exports, period t.

IM_t = nominal imports, period t.

IM_{t-1} = nominal imports, period t-1.

YD_t = nominal disposable income, period t.

WE_t = nominal net wealth, period t.

KCA_t = nominal value of capital consumption allowance, period t.

T_t^{SL} = nominal state and local net tax receipts, period t.

$T_t^{F,EN}$ = nominal endogenous federal net tax receipts, period t.

$T_t^{F,EX}$ = nominal exogenous federal net tax receipts, period t.

i_t^m = short-term interest rate (3-month Treasury bill rate), period t.

i_{t-1}^m = short-term interest rate (3-month Treasury bill rate), period t-1.

i_t^ℓ = long-term interest rate (long-term federal government bond rate), period t.

i^{ℓ}_{t-1} = long-term interest rate (long-term federal government bond rate), period t-1.

i^{ℓ}_{t-2} = long-term interest rate (long-term federal government bond rate), period t-2.

dY_{t-1} = change in nominal income from period t-2 to t-1.

M^D_t = nominal money demand, period t.

M^S_t = nominal money supply, period t.

$\dot{P}^E_t$ = anticipated rate of inflation, period t.

$\bar{i}^{DS}_t$ = Federal Reserve discount rate, period t.

UBR_t = nominal unborrowed reserves adjusted for reserve requirement changes, period t.

RYH_t = real high-employment output, period t.

$\dot{P}^D_t$ = Federal Reserve desired rate of inflation, period t.

IIDEMO = interaction dummy variable for $\dot{P}^D_t$ and Kennedy-Johnson administration.

IIREP2 = interaction dummy variable for $\dot{P}^D_t$ and Nixon-Ford administration.

WPC = wage and price freeze dummy variable.

WPCAF = post-freeze wage and price control dummy variable.

GP = guidepost dummy variable.

$\dot{P}_t$ = actual rate of inflation, period t.

RAD_t = aggregate demand proxy, period t.

seasonally adjusted, quarterly data beginning in the first quarter of 1953 (1953:01) and ending in the last quarter of 1976 (1976:04).[2] This period was selected since it spans three political regimes of eight consecutive years each. Eisenhower was President from 1953:01-1960:04, Kennedy and Johnson from 1961:01-1968:04, and Nixon and Ford from 1969:01-1976:04. The sample period was chosen to facilitate the testing of the hypothesis that Federal Reserve policies reflect, in part, changes in political attitudes toward economic policy generated by changes in presidential administrations. The influence of the administration on Federal Reserve behavior could result from public discussion of Federal Reserve policies by fiscal policymakers or from joint discussion of policy problems by Federal Reserve and fiscal policymakers. The testing of this hypothesis is discussed in section III of this chapter. The model is estimated in level rather than first-difference form. Data sources are described in the appendix.

It should be noted that the consumption, import, and term-structure equations differ slightly from the specifications made in Chapter III. The difference in each case is the inclusion of the dependent variable lagged one period as an explanatory variable. The inclusion of such a term is consistent with an implicit Koyck lag structure. Since economic theory has little to say about the

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[2]The estimation package used is the LS123 program written by J. Tu of the Brookings Institution.

The Durbin-Watson statistics are not presented in Tables I and II since they are unreliable indicators of autocorrelation in the presence of lagged dependent variables.

appropriate time lags to be imposed in an equation, considerable experimentation with alternative lag schemes led to the adoption of the implicit Koyck lag structure for the consumption, import, term-structure, and investment equations. The investment equation was specified in Chapter III with an implicit Koyck lag structure due to the gradual adjustment of actual to desired investments.[3] Similar lag structures for the wealth, short-term interest rate, money supply, inflation, and reaction function equations were tested but did not improve the fit of these equations. Hence, these equations have no lagged terms as explanatory variables.

The individual equations of the models will now be discussed. Since t-tests revealed that only the coefficient on RAD_t differed significantly (at the 5 percent level) between Models I and II, and since Model II contains the reaction function for the monetary authority, the discussion of the individual equations will be limited to Model II.

All coefficients in the consumption function are of the expected sign and are significant at the 5 percent level.

Disposable income is a jointly dependent variable in the model and is derived by subtracting the aggregate capital consumption

[3]It should be noted that the lag patterns experimented with in the estimation of the system were restricted by the characteristics of the three-stage least squares estimation package utilized in this study. The package employed could not accommodate polynomial lag structures. Thus implicit Koyck lag structures were preferable to any other lag pattern tested, but a polynominal lag structure may or may not have been preferable to the implicit Koyck structures utilized in this study.

allowance and total net taxes (state, local, and federal) from GNP. The capital consumption allowance and net taxes for state and local governments are assumed to be exogenous to the model. Federal net taxes are split into an exogenous and an endogenous component. This division of net taxes is accomplished in the following manner. Beginning with a tax function of the form $T = rY$ where T = net federal tax receipts, r = average tax rate, and Y = GNP, we can write

$$T_t = T_{t-1} + dT_t \text{ where } dT_t = T_t - T_{t-1}.$$

Differentiating $T = rY$ we obtain

$$dT \approx rdY + Ydr.$$

$$\text{Thus, } dT_t \approx r_{t-1}dY_t + Y_{t-1}dr_t.$$

The term $r_{t-1}dY_t$ represents the change in net tax receipts when r_{t-1} is unchanged but Y changes. This term thus represents a component of the endogenous portion of tax receipts, that is, the change in receipts due only to changes in the level of economic activity.

The term $Y_{t-1}dr_t$ appears to combine two effects on tax receipts receipts - the effect of a change in the level of economic activity on the average tax rate and the effect of a discretionary change in tax rates on tax receipts. In a tax system with some progressive elements, one would expect r to fluctuate with changes in Y; as Y rises one expects r to rise and vice versa. However, because of exemptions

and deductions that become accessable as one's income rises, a system that is progressive in name may not in fact be progressive. Thus the proposition that r varies with changes in Y is an empirical question, and this proposition was tested by regressing dr_t on Y_t using ordinary least squares. r_t was calculated by dividing net federal tax receipts in period t by Y_t. The regression of dr_t on Y_t revealed no systematic variation of dr with changes in Y. The R^2 for the equation was very low and the coefficient on Y_t was not statistically significant. Based upon this result, all changes in r were taken as discretionary so that the term $Y_{t-1}dr_t$ represents the exogenous change in tax receipts, that is, the change in tax receipts due only to a change in tax rates.

Utilizing the equation $T_t = T_{t-1} + dT_t$ and substituting from the total differential we obtain

$$T_t \approx r_{t-1}Y_{t-1} + r_{t-1}dY_t + Y_{t-1}dr_t.$$

Rearranging we obtain $T_t \approx r_{t-1}(Y_{t-1} + dY_t) + Y_{t-1}dr_t$ or $T_t \approx r_{t-1}Y_t + Y_{t-1}dr_t$. The term $r_{t-1}Y_t$ is used to generate a time series for endogenous net tax receipts and the term $Y_{t-1}dr_t$ is used to generate a time series for exogenous net tax receipts. Examination of the time series so generated reveals that the change in exogenous receipts is generally in the same direction as announced changes in tax policy.

However, one problem that emerges in utilizing this technique stems from the effect of a temporary change in tax receipts in one quarter on the tax rate for subsequent quarters. Take for example the case of a temporary rebate that applies only to one quarter. Net tax receipts will fall in this quarter and hence the net tax rate will fall in this quarter. Net tax receipts will return to the normal pattern in the next quarter but the change in the "permanent" tax rate will be exaggerated because of the temporary decline in tax receipts in the previous quarter. To reduce the exaggerated effect on the tax rate caused by temporary tax changes, the endogenous and exogenous components of tax receipts were calculated in the following manner: endogenous receipts $(T^{F,EN}) = r^A_{t-1}Y_t$ and exogenous receipts $(T^{F,EX}) = Y_{t-1}dr^A_t$ where $r^A_t = (r_t + r_{t-1} + r_{t-2} + r_{t-3})/4$ and $dr^A_t = r^A_t - r^A_{t-1}$. This technique thus reduces the effect of a temporary change in receipts on the calculated rate in subsequent quarters by smoothing changes in the calculated rate and thereby reduces many of the puzzling sharp reversals in policy from the quarter of a temporary change to the next several quarters. The resulting time series are smoother than the initial series. The change in exogenous receipts again is generally in the same direction as announced changes in tax policy.

The budget constraints for both the monetary and fiscal authorities are implicitly incorporated into the model through their effects upon the wealth variable. Wealth is measured here as MB + KSTK + VGS where MB = monetary base, KSTK = discounted value of net dividend payments to the public, and VGS = discounted value of interest payments on federal debt, which is treated for simplicity as consisting solely of consols. Explicitly, $KSTK_t = DIV_t/i_t^{\ell}$ where DIV_t = current value of net dividend payments to private sector and i_t^{ℓ} = current value of the long term interest rate. $VGS_t = INTG_t/WDR_t$ where $INTG_t$ = current total interest payments on federal government debt held by private sector and WDR_t = a weighted discount rate. The weighted discount rate is the weighted sum of the current period short and long term interest rates where the weight on the long term rate is the proportion of long term debt in the total federal debt and the weight on the short term rate is one minus the weight on the long term rate.

The weighting scheme thus results in all intermediate term debt being treated as short term debt. An alternative weighting scheme would be to treat intermediate term debt as long term debt and weight the short term rate by the proportion of short term debt in the total debt and weight the long term debt by one minus the weight on the short term rate. Since over some time periods the interest rate on intermediate term debt moves similarly to the short term rate (thus giving support to the first weighting scheme) and

over other time periods moves similarly to the long term interest rate (thus giving support to the second weighting scheme), the first weighting scheme was used since the wealth variable including VGS generated with this scheme resulted in a better fit of the consumption function.

Another alternative method of generating a weighted discount rate would be to treat the intermediate term interest rate as endogenous and weight the short term, intermediate term and long term rates by their respective share in total debt. This method was rejected to avoid unduly complicating the model by introducing another stochastic equation.

It should be noted that treating all federal debt as consols rather than explicitly incorporating information about the term to maturity of the debt (which was not done because of the complexity of collecting this information and discounting over the term to maturity of each issue) results in a measure of the value of these securities greater than their actual market value. However, the value of government securities generated by the scheme outlined above should move in a similar fashion to the market value of government securities. Thus it is assumed that the measure of VGS outlined above is an acceptable proxy for the current market value of these securities.

Since the measure of the market value of government securities likely overstates their actual market value, the measure of wealth employed here likely overstates the "true" net wealth of the private sector. However, since a change in an economic variable that affects the "true" net wealth should also affect the measure employed here in a similar manner, it is assumed that the measure used in this study is an acceptable proxy for the "true" measure of private sector net wealth. For example, a rise in market interest rates, ceteris paribus, will reduce VGS and KSTK in our model and should have the same effect upon the "true" wealth measure.

Wealth is treated in the model as an endogenous variable and is regressed on Y_t, i_t^m, and i_t^ℓ. It is assumed that Y_t is a reasonable proxy for DIV_t and $INTG_t$. An increase in DIV_t and $INTG_t$, ceteris paribus, leads to an increase in the wealth measure used here. An increase in MB_t, even though the value of government securities held by the public falls by the same amount, leads to an increase in wealth by reducing market interest rates and thereby increasing the discounted value of DIV_t and $INTG_t$. Thus, as expected, the coefficient on Y_t in equation 4, Table II, is positive and statistically significant. Also as expected, since an increase in market interest rates, ceteris paribus, lowers the discounted value of DIV_t and $INTG_t$ the coefficients on i_t^m and i_t^ℓ in the wealth equation are negative and are statistically significant.

Thus, even though the budget constraints of the monetary and fiscal authorities do not explicitly appear in the wealth equation, their effects appear implicitly through their impact upon the explanatory variables. To understand this, assume for simplicity an initially balanced budget. As was seen in Chapter II, an increase in government expenditures with constant tax receipts has two effects - the deficit, through the post-Accord budget constraint, requires issuance of more government securities which, ceteris paribus, tends to increase wealth, but the financing of the deficit tends to raise market interest rates which, ceteris paribus, tends to reduce wealth.

Both effects are captured in the model. The increased government expenditures tend to raise aggregate demand and output directly and to induce increases in consumption and investment expenditure within the same quarter. Any crowding-out effects on investment of financing the deficit are delayed two quarters. Imports also rise within the same quarter, but given the size of the relevant structural coefficients (on YD_t in the consumption function, on Y_t in the investment function, and on Y_t in the import function) this rise is unlikely to offset the stimulative effects upon C_t and I_t. Thus the increase in Y_t as a result of the deficit tends to increase WE_t (and thereby further increase C_t). At the same time, the increase in Y_t resulting from the deficit tends to raise both the short and long term interest rates and thereby reduce

WE_t (see equations 4, 8, and 11, Table II). Evidence on whether the depressing effect on wealth offsets the stimulatory effect on wealth within the same quarter can be obtained by examining the reduced form equation for wealth. The reduced form equations for WE_t for both Models I and II suggest that these same quarter effects are expansionary.[4]

All coefficients in the investment, import, and inverse money demand equations have the anticipated signs and are significant at the 5 percent level.

A price expectations variable is included in both the inverse money demand function (equation 8) and the inflation equation (equation 12). The price expectations variable, $\dot{P}^E$, is calculated from an autoregression of the current inflation rate on past rates of inflation. Economic units are seen in this approach as basing their expectation of the current rate of inflation solely upon past rates of inflation. Both straight lag structures (regressing $\dot{P}_t$ on $\sum_{i=0}^{n} \dot{P}_{t-i-1}$ with various values for n) and polynomial lag structures were estimated. The best fit was found for the following straight lag structure

$$\dot{P}^E_t - \dot{P}^E_{t-1} = E(\dot{P}_{t-1} - \dot{P}^E_{t-1}).$$

[4]For Model I, the coefficients on G^F_t and $T^{F,EX}_t$ in the reduced form for WE_t are .186 and -.048, respectively. For Model II, the coefficients on G^F_t and $T^{F,EX}_t$ in the reduced form for WE_t are .623 and -.731, respectively.

Lag structures of longer length - both straight and polynominal - were characterized by sign reversals on lags beyond t-3. The equation employed thus implies that economic units form their expectations of inflation based upon the very recent past - the inflation rates for the past three quarters. The autoregressive equation selected is used to generate a time series of expected inflation rates which is then employed as an explanatory variable in the short-term interest rate and inflation rate equations.

An alternative technique of generating expected inflation rates was also tested. The technique tested was suggested by Toyoda and is based upon an adaptive expectations model.[5] The specific model employed is

$$\dot{P}^E_t - \dot{P}^E_{t-1} = E(\dot{P}_{t-1} - \dot{P}^E_{t-1}).$$

This model states that the change in the expected rate of inflation is a function of the discrepancy between the actual and expected inflation rates in the previous period. E is an adjustment coefficient which shows the rate of adjustment to this discrepancy. Rearranging this equation we find

[5] T. Toyoda, "Price Expectations and the Short-Run and Long-Run Phillips Curves in Japan 1956-1968," Review of Economics and Statistics, 54, 3 (August 1972), pp. 267-74.

$$\dot{P}^E_t = E\dot{P}_{t-1} + (1-E)\dot{P}^E_{t-1}.$$

Time series for $\dot{P}^E_t$ can now be constructed by employing the actual inflation series, assuming a particular value for E, assuming a starting value for $\dot{P}^E_{t-1}$ and then recursively solving the equation. Ten series were generated by using values of E from .1 to 1 in increments of .1 and by assuming an initial expected inflation rate of 0. These ten time series were employed in the short-term interest rate and inflation rate equations as measures of $\dot{P}^E$. Estimation of the entire system of equations for each time series measure of $\dot{P}^E$ resulted in equations that had a poorer fit and that often had the opposite sign of the estimated parameters presented in Table I and II. Because of the poorer fit and sign reversals, these measures of expected inflation were rejected in favor of the series generated by the autoregressive equation.

All coefficients in the money supply equation are of the anticipated sign and are statistically significant at the 5 percent level. The estimated equation differs slightly from the equation described in Chapter II. Rather than including i^m_t and $\bar{i}^{DS}_t$ as separate explanatory variables, the difference between i^m_t, and $\bar{i}^{DS}_t$ was employed as a separate explanatory variable. When i^m_t and $\bar{i}^{DS}_t$ were employed as separate explanatory variables, the coefficient on $\bar{i}^{DS}_t$ was positive, the opposite of the anticipated sign. Combining i^m_t and $\bar{i}^{DS}_t$ into a single measure does not alter the theoretical rationale for including both variables in the money supply equation and since the regression results were more acceptable than when the variables were employed

separately, the single measure regression is preferred. It should also be noted that UBR_t is unborrowed reserves adjusted for reserve requirement changes. Thus all of the Federal Reserve's major policy tools are reflected directly or indirectly in this equation.

All coefficients in the term-structure equation are of the anticipated sign and are statistically significant at the 5 percent level.

The inflation equation differs slightly in form from the equation specified in Chapter II. The equation in Chapter II included both the inverse of the total unemployment rate and an aggregate demand variable as separate explanatory variables. Considerable experimentation with the various forms of this equation led to the elimination of the unemployment rate variable from this equation. The unemployment rate variable, whether employed alone or with the aggregate demand variable or whether only the current period value or the current period value and lagged values were employed, consistently had the opposite of the anticipated sign. For this reason the unemployment rate variable was dropped from the equation and only the aggregate demand variable was retained.

The aggregate demand variable employed (RAD_t) is similar to a variable employed by Gordon in a study of inflation in the 1970's.[6]

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[6] R. J. Gordon, "Can the Inflation of the 1970s Be Explained," Brookings Papers on Economic Activity, 1 (1977), p. 269.

The variable is defined in the following manner:

$$RAD_t = [(\frac{YH_t - Y_t}{YH_t}) - (\frac{YH_{t-1} - Y_{t-1}}{YH_{t-1}})]/(\frac{YH_{t-1} - Y_{t-1}}{YH_{t-1}})$$

where YH_t = nominal high employment GNP in the current period.[7] The term $(YH_t - Y_t)/YH_t$ measures the gap between potential and actual GNP as a proportion of potential GNP. The numerator of RAD_t measures the change in the proportional GNP gap from the previous to the current quarter. Thus RAD_t represents the proportional rate of change in the proportional GNP gap. One would expect an increase in RAD_t to reduce $\dot{P}_t$ since the pressure of aggregate demand on capacity is reduced. Therefore the anticipated sign of the coefficient on RAD_t is negative. Other aggregate demand variables were employed both singly and in conjunction with RAD_t. However, the best fitting equation in terms of the match between estimated and anticipated coefficient signs and in terms of statistically significant coefficients on the aggregate demand variable(s) was the equation containing only RAD_t as the aggregate demand variable.[8]

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[7] Nominal high employment GNP (YH_t) is constructed by multiplying real high employment GNP in period t by the actual GNP price deflator in period t.

[8] Other aggregate demand variables tested included $(\frac{YH_t - Y_t}{YH_t})$, $(\frac{YH_{t-1} - Y_{t-1}}{YH_{t-1}})$, and $(\frac{Y_t}{YH_t})$. These measures were used as the sole aggregate demand variable and the first two were used as companions to RAD_t. Equations with various lag structures on these variables were also estimated but rejected.

The estimated inflation equation also differs from the equation specified in Chapter II by the inclusion of the guidepost (GP) and the wage and price control (WPC and WPCAF) dummy variables. One should take into account governmental programs that might temporarily affect the fundamental relationships between $\dot{P}_t$, RAD_t, and $\dot{P}^E_t$. By altering the wage and pricing options available to the private sector, the guideposts and wage and price controls should affect the inflation process and therefore should be controlled for in an empirical study of the inflation process. The effects of the guideposts and wage and price controls are introduced through the use of dummy variables. The guidepost dummy variable has the value of 1 for the period 1963:1 to 1966:2 and 0 for all other periods. Wage and price controls are represented by two dummy variables. The first dummy variable, WPC, covers the period of price freeze and thus has a value of 1 from 1971:3 to 1972:4 and 0 for all other periods. Following Gordon, the second dummy, WPCAF, covers the period 1973:1 to 1975:1, a period which covers the non-freeze portion of the controls and return to no controls.[9]

The anticipated signs on GP, WPC, and WPCAF will now be discussed. To the extent that firms and workers complied with the voluntary guideposts, one expects the inflation rate in the guidepost period to be less than without guideposts. To the extent that

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[9] R. J. Gordon, "World Inflation and Monetary Accommodation in Eight Countries," Brookings Papers on Economic Activity, 2 (1977), p. 450.

the voluntary guideposts were ignored, one expects no effect upon the inflation rate. The coefficient on GP is thus expected to be negative or zero. One would expect that a mandatory freeze on wage and price increases would reduce the inflation rate. Thus the expected sign on WPC is negative. However, when a freeze is lifted and programs like Phases II and III of Nixon's New Economic Policy which relied heavily upon voluntary compliance are implemented, one would expect a surge in the inflation rate as firms and workers attempt to secure previously prevented price and wage increases. The anticipated sign on WPCAF is thus positive.

All coefficients in the inflation rate equation are of the anticipated sign. However, the coefficients on GP and WPC are not statistically significant but the coefficients on all other variables are significant at the 5 percent level. Even though the t-tests on the GP and WPC variables lead to a rejection of the hypothesis that these coefficients differ from zero, they are retained in the inflation equation. Even though the programs proxied by GP and WPC may have had a negligible effect upon the rate of inflation, they may have had a significant effect upon Federal Reserve policy. This proposition will be discussed when the reaction function is analyzed in the next section. The coefficient on WPCAF indicates a very strong rebound effect from the wage and price freeze. The coefficient on $\dot{P}^E$ is significantly different from zero. Furthermore, a t-test of the hypothesis that $\dot{P}^E_t = 1$ leads to the non-rejection of the hypothesis,

a finding that provides some support for the accelerationist approach to the inflation process.[10]

The discussion thus far has focused upon the structural equations of Model II with the exception of the reaction function (equation 10). It was seen that all coefficients are of the anticipated sign and that the $\bar{R}^2$s indicate a reasonably good fit of the data. The reaction function will now be discussed in the following section.

III. The Federal Reserve Reaction Function

An essential element in the analysis of the relationship between fiscal policy and the money supply is the Federal Reserve reaction function. It is recalled that the reaction function relates the Federal Reserve policy tool to the lagged endogenous and exogenous variables in the system of equations and to the desired values of the arguments in the Federal Reserve's loss function. The coefficients on the explanatory variables in the reaction function are complex mixtures of the structural parameters of the model and the weights in the loss function.

A reaction function derived from the loss function and Model I would contain 18 lagged endogenous and exogenous variables and 4

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[10] For a discussion of statistical tests of the accelerationist hypothesis, see for example, R. J. Gordon, "Recent Developments in the Theory of Inflation and Unemployment," *Journal of Monetary Economies*, 2, 2 (April 1976), pp. 191-96 and A. M. Santomero and J. J. Seater, "The Inflation-Unemployment Trade-Off: A Critique of the Literature," *Journal of Economic Literature*, 16, 2 (June 1978), pp. 525-7.

variables for the desired values of the arguments in the loss function. It was felt that including all 23 variables in the estimation of the reaction function would undesirably reduce the degrees of freedom for the estimation and would also result in a needlessly complex reaction function. Hence, Y_{t-1} was employed as a proxy for all lagged endogenous and exogenous variables except G_t^F, $T_t^{F,EX}$, GP, WPC, and WPCAF.[11] G_t^F and $T_t^{F,EX}$ were retained as individual arguments since the ultimate concern of this study is the effect of fiscal policy upon the money supply. GP, WPC, and WPCAF were retained in order to ascertain if these programs had significant effects upon Federal Reserve behavior and hence the money supply.

The reaction function was thus estimated by regressing the Federal Reserve policy instrument - unborrowed reserves adjusted for reserve requirement changes - on G_t^F, $T_t^{F,EX}$, Y_{t-1}, GP, WPC, WPCAF and desired values for (Y_t/P_t), $\dot{P}_t$, and i_t^m. Real high-employment GNP (RYH_t) was used as a measure of desired real income, the average inflation rate over the previous four quarters was used as a measure of the desired inflation rate ($\dot{P}_t^D$), and the level of the short-term interest rate in the previous quarter (i_{t-1}^m) was used as a measure

[11]Since E_t is an exogenous variable it should be in the reaction function. However, it cannot be assumed that Y_{t-1} is a proxy for E_t. The reaction function was estimated with E_t as a separate explanatory variable. However, the t-statistic indicated the coefficient was not significantly different from zero, and a general linear test of the significance of this coefficient led to nonrejection of the null hypothesis that the coefficient was equal to zero. As a result of this test, E_t was omitted from the reaction function.

of the desired level of i_t^m. It was assumed that the desired balance of trade was neither surplus nor deficit, so that no term for the desired balance of trade appears in the estimated reaction function. In addition to these variables two dummy variables designed to capture any effects of the particular political administration upon Federal Reserve behavior (IIDEMO and IIREP2) appear in the estimated reaction function. The estimated reaction function will now be analyzed.

The coefficient on Federal government expenditures (.022) is positive and the coefficient on exogenous federal tax receipts (-.034) is negative. Both are statistically significant at the 5 percent level. Thus one sees that expansionary fiscal policy as measured by an increase in federal expenditures or by a reduction in exogenous federal taxes leads to an expansion in unborrowed reserves adjusted for reserve requirement changes within the same quarter.[12] These signs are expected when the weight on financial market stability exceeds the weighted sum of the other weights in the Federal Reserve loss function.[13] Thus within the same quarter the Federal Reserve accommodates expansionary or contractionary fiscal policy, thereby reinforcing the effect of fiscal policy variables upon other endogenous variables within the system.

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[12]The reaction function was also estimated using the new CEA estimates of high-employment expenditures and tax receipts; the coefficient on high-employment expenditures was .026 and the coefficient on high-employment receipts was -.015. Both were statistically significant.

[13]See pp. 100-12 in Chapter IV of this study.

The coefficient on Y_{t-1} is positive (.017) and is statistically significant at the 5 percent level. Since Y_{t-1} is employed as a proxy for the aggregate demand effects of the excluded lagged endogenous and exogenous variables, the anticipated sign on Y_{t-1} depends upon the relative weights in the loss function. The positive sign on Y_{t-1} is expected when the weight on financial market stability exceeds the weighted sum of the other weights in the loss function, just as in the case of government expenditures. Since the coefficient is positive, the Federal Reserve is seen as accommodating increases in aggregate demand from the sources proxied by Y_{t-1} in order to offset (at least partially) the effects of an increase in aggregate demand upon the short-term interest rate.

The coefficient on RYH_t is also positive (.003) and is significant at the 5 percent level, thus indicating an expansion (contraction) in UBR_t as desired real income rises (falls). The coefficient on RYH_t is a combination of the weights in the loss function and the reduced form coefficients on UBR_t in the reduced forms for real income, the inflation rate, the short-term interest rate, and the balance of trade derived from Model I. Specifically, the coefficient as derived from the theoretical model developed in Chapter III is $(W_1j_1)/(W_1j_1^2 + W_2j_2^2 + W_3j_3^2 + W_4j_4^2)$ where W_1 = weight on the gap between the actual and the desired real income in the loss function, W_2 = weight on the gap between the actual and the desired inflation rate, W_3 = weight on the gap between the actual

and the desired short-term interest rate, W_4 = weight on the gap between the actual and the desired balance of trade, and j_1, j_2, j_3, j_4 are the reduced form coefficients on UBR_t for real income, the inflation rate, the short-term interest rate, and the balance of trade. From the theoretical model, one expects $j_1, j_2 > 0$ and $j_3, j_4 < 0$; these expectations are borne out by the reduced forms for Model I. Since the W_i, $i = 1, \ldots, 4$, are positive the sum $(W_1j_1^2 + W_2j_2^2 + W_3j_3^2 + W_4j_4^2)$ is > 0 and $W_1j_1 > 0$. Thus the expected sign is positive, and the estimated coefficient is of the expected sign.

To test the proposition that Federal Reserve response to desired real income differed with different political administrations, interaction dummy variables were employed in an estimation of the reaction function. The interaction dummy variables used test whether the coefficient on RYH_t shifted with different administrations. Since the data cover three administrations, two dummy variables were employed. One interaction dummy, IYDEMO, consists of zeroes from 1953:01-1960:04 and 1969:01-1976:04 and the actual values of RYH_t in the period of the Democratic administration, 1961:01-1968:04. The other dummy variable, IYREP2, consists of zeroes from 1953:01-1968:04 and the actual values of RYH_t from 1969:01-1976:04, the period spanning the Nixon-Ford administration. A regression equation containing RYH_t, IYDEMO, IYREP2, and all other variables except IIDEMO and IIREP2 in equation 10, Table II as separate explanatory variables was estimated. The coefficient on RYH_t in this equation was significant at the 5 percent level, but the coefficients on IYDEMO and IYREP2 were not

significant. In general, in multiple regression studies it is not valid to drop a variable from an equation merely because the t-statistic for that variable indicates the variable is not statistically significant. To determine whether a variable can be dropped, a general linear test should be employed.[14] However, tests of statistical significance for dummy variables using the t-statistics for these variables are equivalent to general linear tests of their significance.[15] Thus since the coefficients on IYDEMO and IYREP2 were not significant, these variables were dropped from the model. These results suggest that the response of the Federal Reserve to RYH_t did not differ across political administrations.[16]

A four-quarter average of actual past inflation rates was employed as a measure of the desired inflation rate ($\dot{P}_t^D$).[17] Thus $\dot{P}_t^D = (\dot{P}_{t-1} + \dot{P}_{t-2} + \dot{P}_{t-3} + \dot{P}_{t-4})/4$. The Federal Reserve is thus seen as adjusting its desired inflation rate in response to the past behavior of this variable. Formulation of $\dot{P}_t^D$ in this manner implies

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[14]For a discussion of the general linear test, see J. Neter and W. Wasserman, Applied Linear Statistical Models (Homewood, Illinois: Richard D. Irwin, Inc., 1974), pp. 214-72.

[15]Neter and Wasserman, Applied Linear Statistical Models, p. 308.

[16]A regression equation containing RYH_t, IYDEMO, IYREP2, and other variables in equation 10, Table II including IIDEMO and IIREP2 was estimated, but the conclusions reached in the earlier test were not altered.

[17]The inflation rate lagged one period was also employed, but the basic results were not altered.

that the Federal Reserve does not want to induce large quarter-to-quarter fluctuations in the inflation rate, perhaps because of a concern that large fluctuations in $\dot{P}_t$ from quarter-to-quarter increase uncertainty in the economy and thereby worsen the performance of the economy.

The coefficient on $\dot{P}_t^D$ from the theoretical model is

$$(W_2 j_2)/(W_1 j_1^2 + W_2 j_2^2 + W_3 j_3^2 + W_4 j_4^2).$$

Since $j_2 > 0$, the expected sign on $\dot{P}_t^D$ is positive. As the desired inflation rate rises (falls) the Federal Reserve increases (decreases) UBR_t. As expected, the coefficient on $\dot{P}_t^D$ in the regression is positive (.051). However, the coefficient on $\dot{P}_t^D$ is not significant in equation 10, which also contains interaction dummies for the desired inflation rate. In a regression excluding the interaction dummies the coefficient is both positive and statistically significant.

To test the proposition that Federal Reserve response to the desired inflation rate differed with different political administrations, the interaction dummies IIDEMO and IIREP2 were employed in an estimation of the reaction function. IIDEMO consists of zeroes from 1953:01-1960:04 and 1969:01-1976:04 and the actual values of $\dot{P}_t^D$ from 1961:01-1968:04. IIREP2 consists of zeroes from 1953:01-1968:04 and the actual values of $\dot{P}_t^D$ from 1969:01-1976:04. The estimated coefficients on both IIDEMO and

IIREP2 are positive and statistically significant. Thus the coefficient on $\dot{P}_t^D$ during the Kennedy-Johnson administration is .223 and the coefficient during the Nixon-Ford administration is .174.

The proposition that the Federal Reserve response to desired inflation varied over different political administrations is thus not rejected. The estimated equation indicates a significantly greater response by the Federal Reserve to the desired inflation rate during the Kennedy-Johnson years and the Nixon-Ford years than during the Eisenhower years. However, even though each interaction dummy variable is significantly different from zero, a t-test revealed no significant difference in the magnitude of the two coefficients. That is, in a statistical sense, the coefficient on IIDEMO (.172) is not significantly larger than the coefficient on IIREP2 (.123).[18]

The Board of Governors of the Federal Reserve System was chaired by two different individuals in the time period covered by this study - William McChesney Martin and Arthur M. Burns. To test whether a change in the chairmanship had an effect upon Federal Reserve policy, a dummy variable consisting of 0's during Chairman Martin's term and 1's during Chairman Burns' term was added to the reaction function. However, the coefficient on this variable was not statistically significant and this variable was dropped from

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[18] For a description of this statistical test, see Neter and Wasserman, Applied Linear Statistical Models, p. 309-10.

the equation. Thus the hypothesis of no significant difference in policy due to the chairman was not rejected.

The short term interest rate in the previous quarter (i^m_{t-1}) is employed as a measure of the desired level of the short-term interest rate. Financial market stability is defined here as the absence of large quarter-to-quarter movements in the short-term interest rate. Large fluctuations in this rate would be avoided if the current rate were equal to or close to in magnitude the previous quarter's short term rate. Hence i^m_{t-1} is employed as the desired short-term rate.[19] Since financial market stability is primarily a concern of the Federal Reserve and thus differs from the macroeconomic goals that the Federal Reserve shares with the fiscal authorities (here represented by the gaps between actual and desired real output, actual and desired inflation, and actual and desired states of the balance of trade), it is felt that tests of varying response by the Federal Reserve to the financial market stability goal across political administrations are not supported by a priori considerations. Thus empirical tests of political interaction effects are not made for this variable.

The coefficient on i^m_{t-1} from the theoretical model is $(W_3j_3)/(W_1j_1^2 + W_2j_2^2 + W_3j_3^2 + W_4j_4^2)$. Since $j_3 < 0$, the expected

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[19]Studies which have used i^m_{t-1} as the desired rate of interest include P. Derosa and G. Stern, "Monetary Control and the Federal Funds Rate," Journal of Monetary Economics, 3, 2 (April 1977), p. 220 and R. T. Froyen, "A Test of the Endogneiety of Monetary Policy," Journal of Econometrics, 2, 2 (July 1974), p. 180.

sign on i^m_{t-1} is negative. That is, an increase (decrease) in the desired short-term rate induces a reduction (increase) in UBR_t. The estimated coefficient on i^m_{t-1} is negative (-.573) and is statistically significant at the 5 percent level, thus conforming to the theoretical expectation.

Since government programs like guideposts and wage and price controls are designed to control the inflation rate, one might expect the Federal Reserve to be more expansionary during periods of guideposts or wage and price controls than it would be without guideposts or controls, given the actual relation between aggregate demand and capacity. Under conditions of controls or guideposts, Federal Reserve policymakers may feel less pressure to curtail any expansion in reserves since the effects of an expansionary policy upon the inflation rate will be muted, at least temporarily. Thus, given behavior by the Federal Reserve of the sort just described, one expects positive coefficients on GP, WPC, and WPCAF.

The estimated coefficients on GP, WPC, and WPCAF are positive thus conforming to the expected signs. The coefficients on WPC and WPCAF are significant at the 5 percent level, but the coefficient on GP is not significantly different from zero. Thus we see that Federal Reserve behavior was significantly affected by the wage and price controls but was not significantly affected by the guideposts.

Estimation of the Federal Reserve reaction function provides statistical evidence of the effect of fiscal policy upon the Federal

Reserve's policy variable. The reaction function specified and estimated here indicates a good fit to the data ($\bar{R}^2 = .998$). The estimated coefficients on the explanatory variables are, in every case, of the anticipated sign and are, with the exceptions of the coefficients on GP and $\dot{P}_t^D$, statistically significant. Expansionary fiscal policy measured by an increase in federal expenditures or by a cut in exogenous tax receipts is associated with an expansion in UBR_t, a relationship that is consistent with Federal Reserve accommodation of expansionary fiscal policy in order to mitigate the effects of fiscal policy upon the short-term interest rate.[20]

IV. Estimated Fiscal Policy Effects Upon the Money Supply

The previous sections of this chapter have examined the estimated structural equations of the macromodel. The immediately preceding section examined the reaction function for the Federal Reserve and the effect of fiscal policy upon the monetary policy variable. The effect of fiscal policy upon UBR_t represents only one channel by which fiscal policy can affect the money supply. Fiscal policy, by changing Y_t and i_t^m, affects private sector behavior which in turn affects the money supply.[21]

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[20]The effect of the time path of G_t^F and $T_t^{F,EX}$ on the time path of UBR_t can be determined by the derivation of dynamic multipliers for G_t^F and $T_t^{F,EX}$. This derivation will be the subject of future research by the author.

[21]For a detailed description of this process, see Chapters II and III of this study.

The immediate response of the money supply to the fiscal policy variables can be estimated by solving the simultaneous system of equations for the reduced form money supply equation. In order to compare the immediate response of M1 to the fiscal variables when the Federal Reserve is treated as exogenous and when the Federal Reserve is treated as endogenous, the reduced form equations for both Model I and Model II will be analyzed. These equations are presented in Table IV.

As noted earlier, the coefficients on the explanatory variables in the reduced form equations are estimates of the immediate effects - the impact multipliers - of these variables on the dependent variable. Thus from Table IV we see that for Model I the impact multipliers for government expenditures and exogenous tax receipts are .058 and -.015 respectively. The signs of these coefficients are as anticipated.[22] Thus an increase in G_t^F of $1 billion leads to an increase in M1 of $.058 billion and a tax cut of $1 billion leads to an increase in M1 of $.015 billion within the same quarter. The change in the money supply in this model stems solely from the private sector response to the effects of fiscal policy on such variables as Y_t and i_t^m.

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[22]See Chapter II, pp. 80-84 of this study.

Table IV

Reduced Form Money Supply Equations

Explanatory Variable	Model I	Model II
Constant	49.28	72.95
G_t^F	.058	.181
$T_t^{F,EX}$	-.015	-.207
G_t^{SL}	.058	.058
T_t^{SL}	-.015	-.018
KCA_t	-.015	-.018
E_t	.058	.058
i_{t-1}^{ℓ}	-.047	-.046
i_{t-2}^{ℓ}	-.192	-.167
C_{t-1}	.042	.039
dY_{t-1}	.001	.011
I_{t-1}	.040	.040
IM_{t-1}	-.056	-.056
$\dot{P}_t^E$	1.663	1.620
$\bar{i}_t^{DS}$	-2.895	-2.840
UBR_t	5.566	--
RYH_t	--	.017
$\dot{P}_t^D$	--	.284
IIDEMO	--	.959
IIREP2	--	.686
i_{t-1}^m	--	-3.194
GP	--	.268
WPC	--	1.906
WPCAF	--	3.249

The impact multipliers for G_t^F and $T_t^{F,EX}$ from Model II are .181 and -.207, respectively. A $1 billion increase in G_t^F leads to an increase in M1 of $.181 billion and a cut in $T_t^{F,EX}$ leads to an expansion in M1 of $.207 billion within the same quarter.

A comparison of the impact multipliers for Models I and II reveals a substantial difference in the size of these multipliers for both G_t^F and $T_t^{F,EX}$, even though (with one exception) statistical test revealed no significant difference in the size of the structural coefficients for the equations common to both models. The size difference stems from the inclusion of the Federal Reserve reaction function in Model II. In Model II the change in the money supply is a result of changes in UBR_t from Federal Reserve response to the state of fiscal policy and private sector response both to the state of fiscal policy and to changes in the monetary policy variable.

Thus we have seen that analysis of the response of the money supply to the state of fiscal policy requires consideration of Federal Reserve reaction to fiscal policy. Ignoring Federal Reserve response to fiscal policy and its economic effects leads one to underestimate the effect of fiscal policy upon the money supply within the same quarter. Assuming that the reaction function employed here is correctly specified, we find that the impact multiplier for G_t^F from the model without the reaction function is .058, a value substantially lower than the "true" impact multiplier of .181 from the model with the reaction

function. The same relationship is found for $T_t^{F,EX}$. These results should be useful to fiscal policymakers in designing countercyclical fiscal policy. If these policymakers ignore Federal Reserve response to G_t^F and $T_t^{F,EX}$ in the design of fiscal policy, the resulting fiscal policy may prove to be overly stimulative in the case of expansionary fiscal policy and overly contractionary in the case of contractionary fiscal policy.

V. Conclusion

The estimation of two structural models and the Federal Reserve reaction function has been analyzed in this chapter. It was seen that the estimated structural coefficients for both Model I (Federal Reserve exogenous) and Model II (Federal Reserve endogenous) were of the anticipated sign and were, with the exception of the coefficients on GP and WPC in the inflation equation, statistically significant at the 5 percent level. Consideration of the $\bar{R}^2$s for the estimated equations indicated reasonably good fits to the data. Furthermore, t-tests led to the conclusion that (with one exception - RAD_t) there were no significant differences (again at the 5 percent level) in magnitude between the estimated parameters in the equations common to both Models I and II.[23]

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[23]Goldfeld and Blinder note that in principle misspecifying policy variables as exogenous when they are in fact endogenous may result in inconsistent estimates of structural parameters. However, they point out that as a practical matter this misspecification as exogenous may not significantly affect the structural parameter

The estimated reaction function suggests that the Federal Reserve systematically reacts to the state of the economy. The basis of this systematic reaction is Federal Reserve concern with macroeconomic stabilization goals and with financial market stability. Of immediate concern to this study is the significant relationship between fiscal policy variables and the monetary policy variable. Furthermore, given the structure of the economy and the loss function specified in this study, the signs of the coefficients on the fiscal variables, in the reaction function, positive on G_t^F and negative on $T_t^{F,EX}$, imply that the Federal Reserve weights concern for financial market stability relatively more than macroeconomic stabilization goals in its short-term response to fiscal policy.

The results presented in this chapter support the contention that unborrowed reserves are endogenous. Since unborrowed reserves are endogenous, it must also be concluded that the money supply is endogenous. Treatment of unborrowed reserves and the money supply as exogenous thus results in misspecification of the model. While this particular misspecification may not drastically alter the

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estimates because in a structural model the misspecified policy variables are generally small in number relative to the total number of lagged endogenous and exogenous variables. Furthermore, only a few equations may be seriously affected since the policy variables generally appear in only a few equations. Using the Moroney-Mason model, Goldfeld and Blinder found no serious estimation biases for the structural parameters when a variable that was endogenous was incorrectly treated as exogenous. See S. M. Goldfeld and A. S. Blinder, "Some Implications of Endogenous Stabilization Policy," Brookings Papers on Economic Activity, 3 (1972), pp. 588-9 and 613-7.

estimates of the structural parameters of the model, it will bias the estimated multipliers for monetary and fiscal policy variables.[24] Thus we saw that the impact multipliers for G_t^F and $T_t^{F,EX}$ in the reduced form equation for M1 from Model I severly underestimated the "true" impact multipliers for G_t^F and $T_t^{F,EX}$ when unborrowed reserves are endogenous.[25]

It is thus important for fiscal policymakers to be cognizant of the systematic reaction of the Federal Reserve to the state of the economy. Fiscal policy formulated without regard to this systematic reaction may result in overly expansionary or contractionary fiscal policy.

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[24]Goldfeld and Blinder, "Some Implications," pp. 617-21.

[25]The derivation of dynamic multipliers for G_t^F and $T_t^{F,EX}$ for M1 will be the subject of future research by the author.

CHAPTER VI

SUMMARY AND CONCLUSIONS

The major purpose of this study is to analyze the theoretical linkages between fiscal policy and the money supply and to empirically estimate the effect of fiscal policy upon the money supply. The theoretical linkages are analyzed within the context of a linear variant of the IS-LM model that incorporates endogenous taxes, inflationary expectations, and budget constraints for both the monetary and fiscal authorities into the structure of the model. The empirical estimates of the effects of fiscal policy upon the money supply are obtained by estimating a version of the IS-LM model which contains a reaction function for the monetary authority.

In deriving the theoretical linkages, the monetary authority is viewed as minimizing a static quadratic loss function subject to its perception of the structure of the economy. The loss function contains as arguments the weighted squared deviations of actual from desired values for real output, the inflation rate, the balance of trade, and the short-term interest rate. The first three arguments in the loss function are measures of macroeconomic stabilization goals pursued by the monetary authority. The IS-LM model specified in this study is assumed to be an acceptable proxy for the structure of the economy perceived by the monetary authority.

Solution of the monetary authority's optimization problem leads to specification of a reaction function for the monetary authority. This reaction function relates the monetary policy variable to the lagged endogenous and exogenous variables of the model and to the desired values of the arguments in the loss function. Specification of the reaction function permits analysis of the effects of fiscal policy upon the monetary policy variable since the fiscal policy variables (federal government purchases of goods and services and exogenous federal net tax receipts) are exogenous variables. The anticipated effects of fiscal policy upon the policy variable can be analyzed by examining the fiscal variable coefficients in the reaction function. These coefficients are complex mixtures of the weights in the loss function and the structural parameters of the model.

Analysis of the fiscal variable coefficients in the reaction function leads to the conclusion that the coefficients on federal government expenditures and on exogenous federal net taxes will be positive and negative, respectively, if the weight on financial market stability exceeds a weighted sum of the weights on the macroeconomic stabilization goals, given traditionally accepted signs on the structural coefficients. Thus, if this weight pattern holds, an expansionary fiscal policy will induce an expansion in the policy variable within the same quarter. That is, with this weight pattern, the monetary authority will accommodate an expansionary fiscal policy by increasing the policy variable.

The effects of fiscal policy upon the money supply are then analyzed by solving the structural model with the reaction function for the reduced form money supply equation and examining the fiscal variable coefficients in this equation. The signs of these coefficients depend upon the reaction of the monetary authorities to fiscal policy and upon the effects of fiscal policy upon output and interest rates. Accommodation of expansionary fiscal policy by the monetary authority is a sufficient but not necessary condition for the reduced form coefficients on expenditures and net taxes to be positive and negative, respectively. That is, if the monetary authority accommodates expansionary fiscal policy, the reduced form coefficients on expenditures and net tax receipts must be positive and negative, respectively. However, even if the monetary authority is not accommodating, the reduced form coefficients could still be positive and negative, respectively, if the expansionary fiscal policy offsets the induced contraction in the monetary policy variable and raises output and demand sufficiently. In terms of money demand and supply, if the net effect of the combined expansionary fiscal policy and the induced contraction in the monetary policy variable is to shift the money demand curve to the right more than the money supply shifts to the left, the quantity of money will rise.

To empirically test the direction of effect of fiscal policy upon the monetary policy variable and the money supply, the IS-LM model with the derived reaction function is estimated utilizing

iterative three-stage least squares. The estimated reaction function provides strong evidence that the monetary policy variable, unborrowed reserves adjusted for reserve requirement changes, is endogenous; that is, the monetary authority systematically reacts to the movement of economic variables. Thus models that treat the policy variable as exogenous are misspecified, although the misspecification may not have serious consequences for the estimation of the other structural equations.

The estimated coefficients on federal expenditures and exogenous federal net tax receipts in the reaction function are positive and negative, respectively. The signs of these coefficients imply that the monetary authority weights financial market stability more heavily than the macroeconomic stabilization goals. Thus in the period covered by the estimation, 1953:01-1976:04, the Federal Reserve accommodated expansionary fiscal policy, thereby reinforcing the effect of fiscal policy upon the economy. However, it should be noted that while within the same quarter financial market stability seems to dominate other goals, Federal Reserve behavior is significantly influenced by these other goals. The coefficient on real high employment GNP is of the anticipated sign and statistically significant. The coefficient on the desired inflation rate is of the anticipated sign but is not statistically significant. However, the significant coefficients on the interaction dummy variables for the desired inflation rate suggest that Federal Reserve

response to the desired inflation rate varied significantly with the particular political administration, thus indicating some interaction between the varying attitudes toward macroeconomic stabilization goals introduced by a change in presidental administrations and Federal Reserve reaction to these stabilization goals.

The effect of fiscal policy upon the money supply is analyzed by solving the estimated system of equations for the reduced form money supply equation. The coefficients on the fiscal variable in this equation reveal the immediate effect of these variables upon the money supply. Thus these coefficients can be interpreted as impact multipliers for the fiscal variables. Since the signs of the coefficients in the estimated reaction function imply accommodation of fiscal policy, the expected signs on federal expenditures and exogenous net taxes in the reduced form equation are unambiguously positive and negative, respectively. Solution of the reduced form money supply equation reveals that the coefficients on these variables are indeed positive and negative, respectively. Thus an increase in federal expenditures is associated with a same quarter increase in the money supply; the impact multiplier for expenditures is .181. A reduction in exogenous tax receipts is also associated with a same quarter increase in the money supply; the impact multiplier for taxes is -.207.

The results outlined above are derived from the model with the Federal Reserve endogenous (Model II). To determine the effect upon the money supply impact multipliers for the fiscal policy

variables when the Federal Reserve's policy instrument is mistakenly viewed as exogenous, the reduced form money supply equation was derived from the model estimated without a reaction function for the monetary authority (Model I). Even though the forms of the equations in Model I are identical to Model II and the estimated coefficients are not significantly different (with one exception), the money supply impact multipliers differ considerably. In Model I the impact multiplier for federal expenditures is estimated as .058 and the impact multiplier for federal net taxes is estimated as -.015. These multipliers reflect only private sector response to the fiscal variables, but the multipliers for the model with the Federal Reserve endogenous reflect both private sector and Federal Reserve response to fiscal policy. One concludes that failure to consider the response of the Federal Reserve to fiscal policy leads to underestimating the effects of fiscal variables upon the money supply.

This study thus shows that mistakenly treating the Federal Reserve as exogenous does not significantly affect the estimated parameters in the structural model but does significantly affect the estimates of the effect of fiscal policy upon the money supply. Thus unless fiscal policymakers take into account the response of monetary policymakers to their actions, fiscal policy designed to counter a recession may be overstimulative or fiscal policy designed to counter inflation may be overly contractionary. Furthermore, as noted by Goldfeld and Blinder, an outside observer who attempts

to assess the effects of fiscal policy upon the money supply or upon other endogenous variables will misestimate these effects unless the reaction function for the monetary authority is explicitly considered.[1]

Finally, it should be noted that the results of this study should be taken as indicative but not definitive estimates of the effects of fiscal policy upon the money supply. The results presented in this paper are conditioned upon the proper specification of the loss function for the monetary authority and upon the proper specification of the structure of the economy perceived by the monetary authority. Specification of a multi-period loss function or employment of a large scale econometric model may modify the estimates presented here, although the estimates of the impact multipliers of fiscal policy upon the money supply are not altered drastically when different fiscal variables are employed in the reaction function. However, it should be noted that the one-period loss function used here is widely employed in reaction function studies and the model estimated here, although linear, is similar in nature to an econometric model employed by the Federal Reserve in policy determination.[2]

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[1] S. M. Goldfeld and A. S. Blinder, "Some Implications of Endogenous Stabilization Policy," Brookings Papers on Economic Activity, 3 (1972), p. 623. Goldfeld and Blinder note that policy multipliers may be seriously misestimated. The examination of fiscal multipliers for other endogenous variables such as Y, i^m, and P in the estimated model will be the subject of future research by the author.

[2] See for example, J. L. Pierce, "Quantitative Analysis for Decisions at the Federal Reserve," Annals of Economic and Social Measurement, 3, 1 (1974), pp. 11-19.

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APPENDIX ONE
MATRIX DERIVATION OF THE FEDERAL RESERVE POLICY REACTION FUNCTION

In matrix form the loss function can be written as:

$$\ell = (Y_t - Y_t^*)'W(Y_t - Y_t^*)$$

where

Y_t = 4 x 1 vector of actual values of the arguments in the loss function

Y_t^* = 4 x 1 vector of desired values of the arguments in the loss function

and

W = 4 x 4 diagonal matrix of weights in the loss function.

These matrices are given by:

$$Y_t = \begin{bmatrix} d(\frac{Y_t}{P_t}) \\ d\dot{P}_t \\ dBT_t \\ di_t^m \end{bmatrix}; \qquad Y_t^* = \begin{bmatrix} dy_t^* \\ d\dot{P}_t^* \\ dBT_t^* \\ di_t^{m*} \end{bmatrix}; \text{ and } \qquad w = \begin{bmatrix} w_1 & 0 & 0 & 0 \\ 0 & w_2 & 0 & 0 \\ 0 & 0 & w_3 & 0 \\ 0 & 0 & 0 & w_4 \end{bmatrix}$$

The structure of the economy can be written as: $Y_t = JR_t + HZ_t$

where

R_t = 1 x 1 vector of the Federal Reserve policy variable,

J = 4 x 1 vector of coefficients on the policy variable,

H = 4 x 12 matrix of coefficients on the exogenous and lagged endogenous variables, and

Z_t = 12 x 1 vector of exogenous and lagged endogenous variables.

These matrices are given by:

$$R_t = [dUBR_t],$$
1x1

$$J = \begin{bmatrix} J_1 \\ J_2 \\ J_3 \\ J_4 \end{bmatrix},$$
4x1

where

$$J_1 = \frac{A_{11}}{A_2}\left(\frac{1}{P_{t-1}} + A_{25}\right)$$

$$J_2 = \frac{A_{11}}{A_2}\, j_2\left(\frac{1}{Y^{POT}_{t-1}}\right)$$

$$J_3 = -C_1\,\frac{A_{11}}{A_2}$$

$$J_4 = -\,\frac{A_{21}}{A_2}$$

$$A_{25} = (Y/P^2_{t-1})P_{t-1}j_2$$

and A_2, A_{11}, and A_{21} are as defined in Chapter Three,

$$Z_t = \begin{bmatrix} d\bar{G}_t \\ Ydr_1 \\ [\bar{G}_{t-1} - T_{t-1} + D_{t-1} + dX_t + dA_t + (\frac{1}{i^{\ell}_{t-1}}) d\bar{K}_t] \\ di^{\ell}_{t-2} \\ dY_{t-1} \\ dI_{t-1} \\ d\bar{E}_t \\ di^{DS}_t \\ d\dot{P}^E_t \\ d(\frac{1}{U_t}) \\ dY^{POT}_t \\ 1 \end{bmatrix};$$

and

$$H = \begin{bmatrix} H_{11} & H_{12} & \cdots & H_{1,12} \\ H_{21} & H_{22} & \cdots & H_{2,12} \\ H_{31} & H_{32} & \cdots & H_{3,12} \\ H_{41} & H_{42} & \cdots & H_{4,12} \end{bmatrix}$$

where

$$H_{11} = A_3/A_2(\frac{1}{P_{t-1}} + A_{25})$$

$$H_{12} = -A_4/A_2(\frac{1}{P_{t-1}} + A_{25})$$

$$H_{13} = A_5/A_2(\frac{1}{P_{t-1}} + A_{25})$$

$$H_{14} = -A_6/A_2(\frac{1}{P_{t-1}} + A_{25})$$

$$H_{15} = A_7/A_2(\frac{1}{P_{t-1}} + A_{25})$$

$$H_{16} = A_8/A_2(\frac{1}{P_{t-1}} + A_{25})$$

$$H_{17} = A_9/A_2(\frac{1}{P_{t-1}} + A_{25})$$

$$H_{18} = -A_{10}/A_2(\frac{1}{P_{t-1}} + A_{25})$$

$$H_{19} = \{-A_{12}/A_2(\frac{1}{P_{t-1}} + A_{25}) + A_{26}\}$$

$$H_{1,11} = A_{24}(Y_{t-1}/Y_{t-1}^{POT})$$

$$H_{1,12} = A_{23}$$

$$H_{21} = A_3/A_2\ j_2(\frac{1}{Y_{t-1}^{POT}})$$

$$H_{22} = -A_4/A_2\ j_2(\frac{1}{Y_{t-1}^{POT}})$$

$$H_{23} = A_5/A_2\ j_2(\frac{1}{Y_{t-1}^{POT}})$$

$$H_{24} = A_6/A_2\ j_2(\frac{1}{Y_{t-1}^{POT}})$$

$$H_{25} = A_7/A_2\ j_2(\frac{1}{Y_{t-1}^{POT}})$$

$$H_{26} = A_8/A_2\ j_2(\frac{1}{Y_{t-1}^{POT}})$$

$$H_{27} = A_9/A_2\ j_2(\frac{1}{Y_{t-1}^{POT}})$$

$$H_{28} = A_{10}/A_2\ j_2(\frac{1}{Y_{t-1}^{POT}})$$

$$H_{29} = A_{12}/A_2\ j_3 j_2(\frac{1}{Y_{t-1}^{POT}})$$

$H_{2,10} = -j_1$

$H_{2,11} = j_2(Y_{t-1}/Y^{POT}_{t-1})$

$H_{2,12} = 0$

$H_{31} = -A_3/A_2\ C_1$

$H_{32} = A_4/A_2\ C_1$

$H_{33} = -A_5/A_2\ C_1$

$H_{34} = A_6/A_2\ C_1$

$H_{35} = -A_7/A_2\ C_1$

$H_{36} = -A_8/A_2\ C_1$

$H_{37} = [1 - C_1(A_9/A_2)]$

$H_{38} = A_{10}/A_2C_1$

$H_{39} = + A_{12}/A_2\ C_1$

$H_{3,10} = 0$

$H_{3,11} = 0$

$H_{3,12} = 0$

$H_{41} = A_{13}/A_2$

$H_{42} = -A_{14}/A_2$

$H_{43} = A_{15}/A_2$

$H_{44} = -A_{16}/A_2$

$H_{45} = A_{17}/A_2$

$H_{46} = A_{18}/A_2$

$H_{47} = A_{19}/A_2$

$H_{48} = A_{20}/A_2$

$H_{49} = A_{22}/A_2$

$H_{4,10} = 0$

$H_{4,11} = 0$

$H_{4,12} = 0$

$A_{23} = (Y/P^2_{t-1})(1+\dot{P}_t)dP_{t-1}$

$A_{24} = (Y/P^2_{t-1})P_{t-1}$

$A_{26} = A_{24}j_3$

and all other terms are as previously defined in this chapter and in Chapter Three.

As noted in the text of Chapter Four, the solution to the minimization problem is given by:

$$R_t = [J'WJ]^{-1}J'WY^*_t - [J'WJ]^{-1}J'WHZ_t.$$

Performance of the necessary matrix algebra yields the policy reaction function given in the text:

$$\begin{aligned} dUBR_t = & -V_0 - V_1 d\bar{G}_t + V_2 Ydr_1 - V_3[\bar{G}_{t-1} - T_{t-1} + D_{t-1} + dX_t + dA_t + (\frac{1}{i^{\ell}_{t-1}})d\bar{K}_t] \\ & + V_4 di^{\ell}_{t-2} - V_5 dY_{t-1} - V_6 dI_{t-1} - V_7 d\bar{E}_t + V_8 d\bar{i}^{DS}_t \\ & + V_9 d\dot{P}^E_t + V_{10} d(\frac{1}{U_t}) - V_{11} dY^{POT}_t + V_{12} dy^*_t \\ & + V_{13} d\dot{P}^*_t - V_{14} dBT^*_t - V_{15} di^m_t. \end{aligned}$$

APPENDIX TWO

DATA APPENDIX

I. Product Sector and Inflation Equation Data

<u>General Comments</u>: All data are in current dollars unless otherwise specified and are seasonally adjusted at annual rates.

The following data were collected from the January 1976 and subsequent issues of the *Survey of Current Business*.

Y = Gross National Product, (billions of dollars)

C = Personal Consumption Expenditures, Durables and Nondurables, (billions of dollars)

I = Gross Private Domestic Investment, (billions of dollars)

E = Exports, (billions of dollars)

IM = Imports, (billions of dollars)

KCA = Capital Consumption Allowances, (billions of dollars)

$G^{F,T}$ = Total Federal Government Expenditures, (billions of dollars)

G^{F} = Federal Government Expenditures on Goods and Services, (billions of dollars)

$T^{SL,T}$ = Total Receipts, State and Local Governments, (billions of dollars)

$G^{SL,T}$ = Transfer Payments (Including Net Interest Paid), State and Local Government, (billions of dollars)

$G^{F,GIA}$ = Federal Grants-in-Aid to State and Local Government, (billions of dollars)

FDEF = Federal Government Deficit, National Income and Product Accounts, (billions of dollars)

DIV = Net Dividend Payments, (billions of dollars)

$\dot{P}$ = Percent Change in Implicit GNP Deflator

The following data were supplied by the Research Division of the Federal Reserve Bank of St. Louis.

YH = Nominal Potential GNP, New CEA Estimates, (billions of dollars)

RYH = Real Potential GNP, New CEA Estimates, (billions of dollars)

ENCEA = High-Employment Federal Expenditures, New CEA Estimates, (billions of dollars)

RNCEA = High-Employment Federal Receipts, New CEA Estimates, (billions of dollars)

The following data were collected from the Treasury Bulletin, various issues.

INTGN = Interest Payments to the Public on Federal Debt, Not Seasonally Adjusted, (billions of dollars)

WE1 = Short-Term Federal Debt as Proportion of Total Federal Debt, (percentage)

WE2 = Long-Term Federal Debt as Proportion of Total Federal Debt, (percentage)

Specific Comments: Other variables employed in the study were constructed from the data listed above. The construction of these variables will now be discussed.

Net taxes for state and local governments were derived by subtracting state and local transfer payments ($G^{SL,T}$) and federal grants-in-aid to state and local governments ($G^{F,GIA}$) from total receipts for state and local governments ($T^{SL,T}$).

Net federal taxes were generated by first generating a time series for total federal receipts. Total federal receipts were obtained by adding total federal expenditures ($G^{F,T}$) to the federal deficit (FDEF). Net tax receipts were obtained by subtracting transfer payments (generated by subtracting federal purchase of goods and services (G^{F}) from $G^{F,T}$) from total federal receipts.

These net tax measures along with KCA were used to generate personal disposable income (YD). To derive YD, KCA, net taxes for state and local governments, and net taxes for the federal government were subtracted from GNP(Y).

Seasonally adjusted federal interest payments to the public on federal debt were obtained by seasonally adjusting INTGN with the Census Bureau's X-11 seasonal adjustment program.

Measures of exogenous and endogenous federal net taxes were derived in the manner outlined in Chapter IV.

Private net wealth (NW) was then derived in the manner outlined in Chapter IV.

Descriptions of the construction of the aggregate demand proxy (RAD), the expected rate of inflation ($\dot{P}^{E}$) and the dummy variables WPC, WPCAF, and GP are presented in Chapter IV.

II. Monetary Sector Data

The following data were collected from Banking and Monetary Statistics (Board of Governors, Federal Reserve System), Annual Statistical Digest (Board of Governors, Federal Reserve System), and the Federal Reserve Bulletin.

i^M = Three-Month Treasury Bill Rate (Market Yield), (percentage)

i^ℓ = Long-Term Government Security Rate, (percentage)

i^{DS} = Discount Rate, Federal Reserve Bank of New York, (percentage)

M^S = M1, Current Dollar, Seasonally Adjusted, (billions of dollars)

The following data were obtained from the Research Division of the Federal Reserve Bank of St. Louis. All data are in current dollars.

MB = Source Base (Monetary Base Unadjusted for Reserve Requirement Changes), Seasonally Adjusted, (billions of dollars)

SBN = Source Base, Not Seasonally Adjusted, (billions of dollars)

BRN = Member Bank Borrowings from the Federal Reserve, Not Seasonally Adjusted, (billions of dollars)

CN = Currency Held by the Public, Not Seasonally Adjusted, (billions of dollars)

RAM = Reserve Adjustment Magnitude, (billions of dollars)

Specific Comments: Other variables employed in this study were constructed from the data listed above. The construction of these variables will now be discussed.

A seasonally adjusted time series for unborrowed reserves adjusted for reserve requirement changes (UBR) was constructed in the following manner. Unborrowed reserves adjusted for reserve requirement changes (not seasonally adjusted) were generated by subtracting CN and BRN from SBN and adding RAM to this result. This time series was then seasonally adjusted with the X-11 program to obtain UBR.

The dummy variables IIDEMO and IIREP2 and the Federal Reserve's desired rate of inflation ($\dot{P}^D$) were constructed in the manner described in Chapter IV.

VITA

William Douglas McMillin was born on September 27, 1949, in Bossier City, Louisiana, the son of John William and Amy Benoit McMillin. He was graduated cum laude from McNeese State University, Lake Charles, Louisiana, in 1971 with a Bachelor of Science degree in Economics. After graduation from McNeese State University, he served two years as an officer in the U.S. Army Finance Corps. Upon discharge from the U.S. Army, he began graduate studies at Louisiana State University, Baton Rouge, Louisiana. He was awarded the Master of Science degree in Economics in 1975 and, after graduation, continued graduate studies in Economics with a minor in Quantitative Methods at Louisiana State University. He was selected as a Research Fellow in the Economic Studies Program at The Brookings Institution for 1978-1979. He will join the faculy at the University of Kentucky, Lexington, Kentucky, as an Assistant Professor of Economics in the Fall, 1979.

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February 2, 1979