THE EXISTENCE OF A LONG RUN
REACTION FUNCTION OF THE
MONETARY AUTHORITIES

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CHAPTER I

INTRODUCTION

Most economists would agree that since the Federal Reserve--Treasury Accord of 1951, the monetary authorities have exerted considerable influence on the economy of the United States through their exercise of monetary policy. The subject of the efficacy with which their monetary policy has attained the objectives of price stability, economic growth, full employment, and equilibrium in the balance-of-payments has proved quite controversial.

The Federal Reserve, on one hand, maintains that "the relative importance of economic objectives varies with economic conditions."[1] Such a position implies a non-systematic approach to adverse economic disturbances of policy objectives. On the other hand, many economists insist that the monetary authorities implicitly react on a temporally consistent basis to achieve a position of relative priorities among the objectives. The divergent viewpoints continue to produce debate.

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[1] David P. Eastburn, The Federal Reserve On Record, Readings On Current Issues From Statements By Federal Reserve Officials, Federal Reserve Bank of Philadelphia, (1965), p. 21. Also see, Board of Governors of the Federal Reserve System, The Federal Reserve System: Purposes And Functions, (Washington, D.C., 1963), pp. 236-238.

However, studies by A. W. Phillips,[2] G. L. Reuber,[3] William G. Dewald and Harry G. Johnson,[4] Thomas Havrilesky,[5] James W. Christian,[6] and Douglas Fisher[7] have sought to remove these debates from the realm of semantic argumentation to the domain of statistical inference.

The Problem and its Scope

In 1958, using the actual performance of the economy as a basis, Phillips introduced the concept of quantifying the objective trade-offs that occur when policy objectives conflict. Then, in 1962, Reuber published the findings of his attempt to arrive at the implicit trade-offs that the monetary authorities[8] are assumed to make among policy objectives. In identifying these implicit trade-offs, Reuber relied heavily on multiple linear regression analysis in order to estimate

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[2]A. W. Phillips, "The Relation Between Unemployment and the Rate of Change of Money Wage Rates in the United Kingdom, 1861-1957," Economica, Volume 15, (November, 1958), pp. 283-299.

[3]G. L. Reuber, The Objectives Of Monetary Policy, working paper prepared for the Royal Commission on Banking and Finance, (December, 1962).

[4]Harry G. Johnson and William G. Dewald, "An Objective Analysis of the Objectives of Monetary Policy," Banking And Monetary Studies, Deane Carson, Editor, (Homewood, Illinois: Richard D. Irwin, Inc., 1963).

[5]Thomas Havrilesky, "A Test of Monetary Policy," Journal Of Political Economy, Volume 75, (June, 1967).

[6]James W. Christian, "A Further Analysis of the Objectives of American Monetary Policy," Journal Of Finance, Volume 23, (June, 1968).

[7]Douglas Fisher, "The Objectives of British Monetary Policy," Journal Of Finance, Volume 23, (December, 1968).

[8]In this study, the term reaction function refers to a reaction function of the monetary authorities and should not be confused with other definitions. For example see William Fellner, Competition Among The Few, (New York: Alfred A. Knope, 1949), pp. 58-59.

what he termed the reaction function of the monetary authorities. Reaction functions relate how the monetary authorities are assumed to react, as measured by an indicator of monetary policy, when measures of the policy objectives move in adverse directions.

Implicit in the concept of a reaction function is the fact that it must apply on a temporally consistent basis, remaining stable over time. The subject of stability per se, however, has received essentially only superficial treatment. Whereas Christian did use moving regression analysis to examine reaction function equations, he proceeded no further than visual inspection of the magnitude of the changes of the moving regression coefficients in assuming the stability of the estimated function.

Since any meaningful interpretation of a reaction function equation requires the equation to remain stable over the time period concerned, the subject of stability itself seems worthy of examination. Consequently, it is the purpose of this study to investigate whether the evidence supports the existence of a stable reaction function.

Organization and Methodology

As a point of departure, Chapter II provides a review of the literature regarding previous attempts to estimate a reaction function.

Chapter III deals with the subject of reaction function models. A presentation is first made regarding the nature of the monetary process. Tentative reaction function equations are then developed, followed by the results of the multiple linear regression analysis. Finally, an intermediate economic and statistical analysis is made of selected reaction function equations prior to their subjection to stability tests.

After presenting the characteristics of the time periods of the study, Chapter IV reports the results of subjecting the selected reaction function equations to stability tests. The stability tests used are moving regression analysis to which confidence intervals are applied, the Chow test, and the generalized dummy variable test. Next, an economic and statistical analysis of the selected reaction function equations after their subjection to stability tests is presented, followed finally by a discussion of the findings of the study.

Chapter V summarizes the major findings and conclusions.

CHAPTER II

REVIEW OF THE LITERATURE

Reuber first estimated a reaction function of the Canadian monetary authorities in 1962. Dewald and Johnson, borrowing Reuber's reaction function concept, estimated reaction functions of the U.S. monetary authorities. Both Havrilesky and Christian faulted Dewald and Johnson's study in several areas, subsequently attempting to correct the faults by estimating new reaction functions of the U.S. monetary authorities. Fisher, borrowing the reaction function concept, also attempted to estimate reaction functions of the British monetary authorities. The following sections discuss each of these studies.

Reuber

In dealing with the general subject of how economic policy relates to the economy at large, first Phillips, then other economists addressed themselves to the problem of estimating empirically the actual trade-offs among policy objectives. It was Reuber, however, who focused attention on two equally important aspects of the same problem; namely, (1) an estimate of a reaction function where the monetary authorities resolve conflicts among policy objectives and (2) the costs to society for the failure of the monetary authorities to attain an optimum combination of the policy objectives after taking into consideration the actual trade-offs among policy objectives.

Reuber's study attempted to improve upon previous work by providing the Canadian Royal Commission on Banking and Finance quantitative information in the following areas:

1. the trade-offs among full employment, price stability and economic growth, given the present structure of the economy and the present compliment of policy instruments;

2. the trade-offs among these policy objectives in the preference function of the policy-making authorities according to which conflicts among the objectives have in practice been resolved;

3. the relative economic benefits to be gained by advancing one objective at the expense of others, given the structural trade-offs among objectives.[1]

Reuber felt this information could provide bases for evaluating past monetary policy and for deciding the appropriate weights to be given policy objectives in the future. Since the present study concerns itself primarily with the subject of stability in reaction functions, only that part of Reuber's study which pertains to reaction functions will receive treatment.

Reuber encountered two problems in trying to measure the assumed reaction of the monetary authorities to the performance of the economy. The first problem involved trying to determine the policy objectives of the Canadian economy. The second problem involved trying to choose the appropriate indicator of monetary policy.[2] The Bank of Canada's statements indicated that the policy objectives included the following: high employment, price stability, sustained

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[1]Reuber, p. 3.

[2]Ibid., p. 129.

economic growth, distributive justice, economic freedom, and the promotion of national self-sufficiency. Reuber eliminated from his reaction function estimates the last three policy objectives because (1) they appeared too ambiguous to define, (2) they were considered by Canadian monetary authorities as structural features of Canada's economy, and (3) the weights attached to these variables did not appear to change significantly over the time period considered. These three observations imply that between 1949 and 1961, variations in Canadian monetary policy resulted primarily from changes in economic growth, price instability, and changing unemployment conditions. The Canadian monetary authorities did not consider the balance-of-payments variable as an objective of monetary policy because they considered it "as a constraint conditioning policy similar to domestic constraints."[3]

Reuber's second basic problem involved choosing an appropriate indicator of monetary policy. He proceeded to choose indicators on the basis of whether the monetary authorities relied upon them in the past. The indicators chosen include the money supply, the net Canadian cash reserves of the chartered banks, the real money supply, the real net Canadian cash reserves of the chartered banks, the Treasury Bill rate, and absolute changes in the Treasury Bill rate.[4]

Next, Reuber experimented with three different functional forms in trying to estimate a reaction function before selecting the form

$$(1)\quad \log M_t = f'\,(U^{-1}, \log \theta_t, \log P_t, \log I_t, \log M_{t-1}, \log M_{t-2})$$

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[3] Ibid., p. 133.

[4] Ibid., p. 135.

where U^{-1} represents the reciprocal of the unemployment rate, θ_t the productivity index, P_t the consumer price index, I_t the index of manufacturing production, and M_t the money supply.[5] Reuber employed the same functional form in trying to estimate the actual trade-offs among measures of the policy objectives. Employing the same functional form to both reaction function estimates and actual trade-off estimates enabled Reuber to compare the assumed trade-offs among measures of policy objectives with the actual trade-offs determined in the economy.

Reuber tested six indicators of monetary policy but found no significant statistical relationships between the policy objectives and the following three indicators of monetary policy: real net Canadian cash reserves of the chartered banks, the Treasury Bill rate, and absolute changes in the Treasury Bill rate. He did find statistical relationships between the policy objectives and the three remaining indicators of monetary policy. Reuber found the following relationships: a positive relationship between the nominal money supply and all three policy objectives, a positive relationship between nominal net cash reserves and prices, and a positive relationship between the real money supply and unemployment. Reuber found the other relationships statistically insignificant (nominal net cash reserves to the growth and employment objectives and the real money supply to the price stability and growth objectives).

Reuber did not discuss the economic plausibility of the signs of each policy objective coefficient even though he stated they were considered. He did indicate, however, that the price stability

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[5] Ibid., p. 140.

coefficient "reveals the degree of neutrality and accommodation in monetary policy with respect to price changes."[6] Complete neutrality shows a price stability coefficient equaling zero, and complete accommodation shows a price stability coefficient equaling one. As shown on the next page, the price stability coefficients were .40667 and .33153. These positive coefficients imply accommodation to price changes by the monetary authorities—a questionable policy from a theoretical point of view which causes difficulty in the economic interpretation of trade-offs.

In trying to select the best reaction function, Reuber used three criteria: (a) "goodness of fit," meaning the largest coefficient of determination; (b) inclusion of all the policy objectives in the equation, that is, finding all policy objectives statistically significant; and (c) economic criteria to include the economic plausibility of the sign of each parameter, the parameter size, and the distributed lag structure of the total equation.

Reuber found that the following two equations best satisfy his criteria:[7]

$$(1) \quad \log M_t = .51107 - .08648\, U_t^{-1} + .25112 \log \theta_t + .09431 \log P_t + 1.34723 \log M_{t-1} - .57914 \log M_{t-2}$$

$$(2) \quad \log M_t = .62376 - .08282\, U_t^{-1} + .22876 \log \theta_t + .07373 \log R_t + 1.37297 \log M_{t-1} - .59536 \log M_{t-2}$$

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[6] Ibid., p. 144.

[7] Ibid.

The equilibrium values ($\log M_t = \log M_{t-1}$) for equations 1 and 2 follow as equations 1' and 2' respectively.

$$(1') \quad \log M = 2.20374 - .37290\, U^{-1} + 1.08283 \log \theta + .40667 \log P$$

$$(2') \quad \log M = 2.80480 - .37242\, U^{-1} + 1.02864 \log \theta + .33153 \log R.$$

The objective R stands for the implicit GNP price index and represents an alternative measure for the price stability objective.[8]

Reuber's reaction function study focuses on the inferences drawn from the objective trade-off analysis and from the analysis of the structure of the inside lag of monetary policy. A discussion of these two types of inferences drawn from the above estimated reaction functions follows.

Reuber estimated the following implicit trade-offs for the price stability and unemployment objectives from equations 1' and 2' respectively.[9]

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[8]For an explanation of how well these two equations fit Reuber's criteria see Reuber, pp. 142-144.

[9]Trade-offs between objectives are calculated from the total differential of the reaction function after setting it equal to zero. For example:

$$d \log M_t = \frac{\partial \log M_t}{-\partial U_t^{-1}}\, d\, U_t^{-1} + \frac{\partial \log M_t}{\partial \log \theta}\, d \log \theta + \frac{\partial \log M_t}{\partial \log P}\, d \log P$$

By setting the above differential equal to zero and solving for the trade-offs between price stability and unemployment one obtains:

$$\frac{d \log P}{d\, U_t^{-1}} = \frac{\dfrac{\partial \log M_t}{\partial U_t^{-1}}}{\dfrac{\partial \log M_t}{\partial \log P}}$$

Trade-offs show compensating movements among two independent variables that result in no change for the dependent variable. In terms of a reaction function the trade-offs show the necessary compensating movements between two measures of policy objectives, resulting in no change for the indicator of monetary policy.

$$\text{I} \quad \frac{d \log P}{d\, U^{-1}} = \frac{.37290}{.40667} = .91696$$

$$\text{II} \quad \frac{d \log R}{d\, U^{-1}} = \frac{.37242}{.33153} = 1.12333$$

The trade-offs represent off-setting changes in two policy variables, resulting in no change in the indicator of monetary policy ($\log M_t$). In equation I, for example, increases in the price level cause expansionary monetary policy (increase log M),[10] and increases in U^{-1} (reducing the magnitude U) cause contractionary monetary policy (decrease log M). If both events occur simultaneously, what happens to M ? The result depends on how the monetary authorities weigh P and U^{-1}. Equation I indicates that between 1949 and 1961 the money supply ($\log M_t$) did not change when both P and U^{-1} rose simultaneously if log P rose by .91696 of a percentage point when U^{-1} rose by one percentage point. In other words, a .91696 percentage point increase in log P causes log M to rise, but a one percentage point rise in U^{-1} causes log M to decline by the same magnitude; thus the value of log M does not change.

To point out how useful information can be gained from the trade-offs analysis, an example of how Reuber used the results follows.

Reuber calculated the actual trade-off (as determined by the structure of the Canadian economy) between price stability and unemployment as $\frac{d \log Q}{d\, U^{-1}} = .22261$. This trade-off calculation means

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[10]From a theoretical point of view, one expects inflationary pressures to cause contractionary monetary policy; however, as mentioned earlier, Reuber accepts the opposite case.

that every time U^{-1} changes by one percentage point, log Q changes by .22261 percentage points. Reuber used log Q (the consumer price index) as a substitute for log P and log R in estimating the actual trade-offs involving the price stability objective. By comparing the actual trade-offs with the implicit trade-offs of the Canadian monetary authorities (.22261 to .91696 and 1.12333), Reuber concluded:

> . . .the actions of Canada's monetary authorities from 1949 to 1961 as revealed by changes in the nominal money supply suggest that for any given change in the level of unemployment the authorities allowed for a change in prices 4 to 5 times greater than was warranted judging by the evidence on the empirical trade-offs afforded by the performance of the economy. In addition, the inclusion of productivity in these reaction functions suggests that the authorities allowed for trade-offs between economic growth and unemployment and price stability which the evidence on empirical trade-offs suggests do not exist. On both counts, therefore, one might say that the authorities have held views about the empirical trade-offs among objectives that have been wrong by a very substantial margin.[11]

Thus, Reuber's evidence suggests that the Canadian monetary authorities implicitly allowed for trade-offs in a manner far different from one which the actual trade-offs indicate have been followed.

Reuber also drew important inferences from the analysis of the structure of the inside lag of monetary policy. On page 9 of this study, equations 1 and 2 employ a Solow distributed lag form, allowing an estimate of the inside lag of monetary policy to be made--the time period elapsed between when indicators show a need for monetary policy and when the policy response actually occurs.[12] These equations imply that log M takes on a value derived from the weighted

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[11]Ibid., p. 145.

[12]Ibid., p. 277.

sum of the current and past influences of the explanatory variables. The explanatory variables' past pattern of weights derives from the Pascal distribution, allowing the lag structure of the overall relationship to take on a variety of forms. By comparison, the Koyck lag imposes a uniform diminishing lag structure.

TABLE I

PERCENTAGE OF FINAL EFFECT REALIZED BY END OF QUARTERS

Equation No.	Current	1	2	QUARTER 3	4	5	10
1'	23	54	83	104	115	118	98
2'	22	53	81	103	115	119	99

Source: G. L. Reuber, p. 124.

The following discussion develops the implications of the lag structure of the two equations shown in Table I. Assuming that log P permanently rises by one unit, equation (1') shows that log M ultimately increases by .40667 units. The new higher log M level will not be attained instantly, but will be approached gradually. For example, 23 per cent of the policy response occurs by the end of the initial quarter, with a 54 per cent response occurring by the end of the next quarter. In other words, log M rises approximately .22 units by the end of quarter one (not the current quarter). The same explanation applies to the other explanatory variables, even though the ultimate magnitude of change for log M differs.

It is interesting to note that by the end of the first year over 100% of the monetary response had been made. Reuber indicated that this may only "reflect the process of successive approximation" which the Canadian monetary authorities emphasized. That is, as the monetary authorities adjusted to the new incoming data, they tended to overshoot or undershoot their targets. The coefficients in Reuber's two equations show an "oscillatory adjustment path" that can be interpreted as representing the monetary authorities successive approximation approach.

It should be mentioned that Reuber experimented with both the Koyck and Solow distributed lag formulations, and for statistical reasons, chose to use the Solow lag.[13] (Solow and Kareken provide a good example of the computations of the Solow lag.[14]) Alt pointed out, "*a priori* considerations give but little information about the shape of the weight function."[15] This statement means that reading the minutes of the monetary authorities' meetings does not necessarily provide one with an insight as to the structure of the inside lag. The only way to discover the lag structure is to experiment with many alternative lag models.

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[13] Ibid.

[14] John Kareken and Robert M. Solow, "Part I, Lags in Monetary Policy," in Commission on Money and Credit, *Stabilization Policies*, (Englewood Cliffs, N.J.: Prentice-Hall 1963), pp. 28-29.

[15] Franz L. Alt, "Distributed Lags," *Econometrica*, Volume 10, No. 2, (April 1942), p. 114.

Reaction functions reveal the weights attached to the policy variables by the monetary authorities. Reuber assumed a distributed lag in response to adverse movements in measures of the policy objectives by the monetary authorities. A distributed lag implies a series of reactions, rather than a single one. Reuber's distributed lag application imposed a uniform lag on all policy variables, and as Johnson and Winder have indicated, this condition does not present an ideal situation. Unfortunately, an alternative technique for handling this problem does not exist.

> Ideally, one would like to employ a statistical technique that would allow for and detect both shifts in the relative importance attached to different policy objectives and differences in the speed of response of policy to changes in different relevant indicators; but the statistical technique capable of doing these things is, to the best of our knowledge, not yet available.[16]

To summarize, Reuber estimated reaction functions in order to identify the objective trade-offs which the Canadian monetary authorities were assumed to have made. Reuber then compared these estimates to the objective trade-off estimates determined by the structure of the Canadian economy. His conclusions indicated that the Canadian monetary authorities held views concerning the magnitude of the objective trade-offs far different from the actual objective trade-off magnitudes. From the distributed lag form of the reaction functions, Reuber estimated the inside lag of monetary policy. He concluded from the inside lag estimates that the Canadian monetary authorities used a successive approximation approach in attempting to achieve

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[16] H. Johnson and J. Winder, Lags In The Effects Of Monetary Policy In Canada, (working paper prepared for the Royal Commission on Banking and Finance), (Ottawa, Canada 1964), p. 87.

certain target values, a procedure which resulted in overshooting and undershooting the target values.

After the publication of Reuber's reaction function study, other economists applied the same concept to U.S. data. Dewald and Johnson estimated reaction functions for the U.S. and published their findings in 1963. The following section reviews their findings.

Dewald and Johnson

Dewald and Johnson made the first attempt to apply Reuber's reaction function concept to U. S. data.[17] They attempted to estimate a reaction function for two reasons. First, they could apply techniques of statistical inference to both the questions of (1) whether the monetary authorities should pursue certain policy objectives and (2) if so, do they discharge their responsibilities effectively. Second, Dewald and Johnson wanted to estimate the inside lag of monetary policy, thereby providing additional information useful in determining the effectiveness of monetary policy. The following statement by Dewald and Johnson describes their approach to the study:

> We formulate the conduct of monetary policy in terms of a "reaction function" relating a statistical indicator of monetary policy to statistical indicators of the degree to which the various objectives of policy have been achieved, the form of the reaction function expressing the weights attached by the monetary authority to the various objectives and the lag in the reaction of monetary policy to changes in the performance of the economy.[18]

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[17] Harry G. Johnson and William G. Dewald, "An Objective Analysis of the Objectives of Monetary Policy," pp. 171-189.

[18] Ibid., p. 173.

Dewald and Johnson experimented with three indicators of monetary policy: the money supply, Treasury bill rates, and member bank reserve positions. They also used measures of the following policy objectives: the consumer price index, the unemployment rate, the balance-of-payments deficit, and real gross national product.

The reaction functions using the money supply indicator as the dependent variable yielded the best statistical results. From the reaction functions employing monetary aggregate indicators the following regression equation yielded the best results:

$$(3)\quad M_t = 26.87991 + .75385\, M_{t-1} + .45733\, U_t + .03767\, Y_t - .08825\, P_t + .00036\, B_t .$$

U represents the unemployment rate in percentage form; P, the consumer price index in percentage form; Y, the real gross national product in billions of 1954 dollars; and B, the balance-of-payments deficit in millions of dollars, which is defined as U.S. gold sales plus increases in short-term liabilities plus U.S. government securities held by foreign countries. The dependent variable M represents the money supply, defined as currency plus demand deposits adjusted, in billions of dollars. The equilibrium value ($M_t = M_{t-1}$) for equation 3 follows as equation 3'.

$$(3')\quad M = 109.20125 + 1.85793\, U + .15304\, Y - .35852\, P + .00146\, B$$

Dewald and Johnson considered the above equation the best statistical reaction function based on the following (1) the coefficient of determination and (2) the significance of the regression coefficients. They found the first three independent variables significant at the 5 per cent level.

They found all coefficient signs acceptable except the sign for the balance-of-payments coefficient. Dewald and Johnson ignored the latter observation since the balance-of-payments objective coefficient did not differ significantly from zero.

Dewald and Johnson drew the following inferences from equation 3 and other reaction function equations employing a money supply indicator. First, during the 1952-61 time period, the employment and growth objectives represented the primary concerns of the monetary authorities in terms of monetary policy. Second, monetary policy considerations did not involve the balance-of-payments objective. Third, the price stability coefficient did not differ significantly from zero, but it did have the expected sign. Fourth, and most important, the average inside lag ranged from between eight months to slightly over a year. The relatively long inside lag raises some important questions in terms of the flexibility of monetary policy.

Since Dewald and Johnson considered the last finding the most important, the following discussion describes the nature of their inside lag estimates.

Dewald and Johnson assumed that the indicator of monetary policy reacts to changes in measures of policy objectives "subject to an exponentially diminishing distributed lag"--the Koyck lag. Table II indicates the lag structure associated with equation 3. These lags measure the implicit "inside" lag in monetary policy. Equation 3' shows that if unemployment permanently rises by one percentage point, the money supply ultimately increases by $1.85793 billion. Table II shows that in the initial period of a permanent one-percentage-point increase in unemployment, the money supply increases 24.6

percentage points of the distance toward $1.85793 billion ($.45733 billion). By the end of the fourth quarter, the money supply would have risen 75.6 percentage points of the distance toward the ultimate increase ($1.40560 billion).

TABLE II

PERCENTAGE OF FINAL EFFECT BY END OF QUARTER

Policy Indicator	Current	QUARTER 1	2	3	4	Weighted Average Lag
Money Supply . . .	.24615	.43171	.57159	.67704	.75654	3.06

The weighted-average lag serves as a measure of the average length of time that the monetary response lags behind the indication of a need for monetary policy as shown by adverse movements in measures of policy objectives. A relatively large weighted-average lag implies that a large portion of the distributed lag effect occurs in latter time periods, whereas a small weighted-average lag implies that a large portion of the distributed lag effect occurs in earlier time periods. In Table II the weighted-average lag means that 50 per cent of the monetary response to adverse movements in measures of policy objectives occurred by the end of 3.06 quarters (WAL = $\frac{\beta}{1-\beta}$ where β represents the estimated coefficient of the lagged dependent variable).

Thomas Mayer discussed two common uses for the weighted-average lag measure.[19] First, in the absence of knowledge concerning the distributed lag structure, the weighted-average lag serves as an approximation for the distributed lag structure.[20] Second, the weighted-average lag measure reduces all lag structures to a common denominator, allowing comparisons of inside lag estimates among different studies.

After Dewald and Johnson evaluated all of their reaction function estimates, they drew the following general conclusions. First, the monetary authorities gave primary concern to the growth and employment objectives in terms of monetary policy. Second, the price stability objective held a position of secondary importance in terms of monetary policy. Third, the balance-of-payments objective caused negligible response by the monetary authorities. Fourth, reaction functions employing monetary aggregate indicators showed relatively longer inside lag estimates than did reaction functions employing money market indicators. In terms of the last conclusion, Dewald and Johnson noted the following:

> . . . the monetary authorities appear to react more quickly to changes in the environment if they are assumed to aim at controlling money market conditions than if they are assumed to aim at controlling the quantity of money. The former assumption is probably more consistent with generally accepted views of how monetary policy is conducted in practice than the latter, and adoption

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[19] Thomas Mayer, "The Lag in the Effect of Monetary Policy: Some Criticisms," Western Economic Journal, Volume 5, No. 4 (September 1967), pp. 324-342.

[20] Ibid.

> of it leads to conclusions about the flexibility of monetary policy much more flattering to the monetary authorities. On the other hand, the behavior of the money supply lends itself more readily to statistical explanation in terms of performance indicators reflecting the objectives of economic policy than does the behavior of the various indicators of money market conditions.[21]

Dewald and Johnson made one final observation concerning their findings. They noted that critics of monetary policy have charged that since 1957, the monetary authorities had given undue weight to the price stability objective. They concluded that their evidence did not support this allegation.

In summary, Dewald and Johnson attempted to discover (1) the weights which the monetary authorities attached to the policy objectives under consideration and (2) the nature of the inside lag of monetary policy. In terms of their first goal, Dewald and Johnson's study revealed that the monetary authorities placed primary importance on the employment and growth objectives and secondary importance on the price stability objective, while placing no importance on the balance-of-payments objective. In terms of their second goal, Dewald and Johnson found that reaction function estimates employing monetary aggregates showed longer weighted-average lags than reaction functions employing money market indicators. They judged the best reaction function to be one employing the money supply variable as the indicator. The resulting inside lag turned out to be relatively long, implying that monetary policy lacked adequate flexibility.

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[21]Dewald and Johnson, p. 189.

Other economists found fault with various aspects of Dewald and Johnson's study and subsequently attempted to correct them by estimating new reaction functions. A discussion of these attempts follows.

Havrilesky

In an attempt to improve upon Dewald and Johnson's study, Havrilesky conducted a subsequent study that involved estimation of a reaction function for the United States monetary authorities for the period 1952-1965. He pursued the study for the following reasons:

> Developing and testing the monetary policy action function could contribute to recent dialogue on appropriate indicators of monetary policy. It could also provide insights into the systematic responses of the policy maker to the explanatory variables. Finally, it could establish part of the groundwork for longer-run monetary policy strategy.[22]

Havrilesky took issue with the methodology used in previous studies to select the most appropriate indicators of monetary policy. Instead of experimenting with various indicators as had previous researchers, he established the following criteria for choosing the best indicator. First, Havrilesky indicated that the non-policy endogenous and exogenous forces affecting the variable should be known and easily compensated for by the monetary authorities; second, the indicator should be influenced by the tools of monetary policy. Havrilesky decided that total reserves adjusted for changes in the legal reserve requirement, R_t, best satisfied his criteria.

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[22] Havrilesky, p. 299.

It should be pointed out that Havrilesky failed to provide a theoretical basis for his criteria. He also failed to provide empirical justification for choosing the adjusted total reserves variable as the indicator of monetary policy.[23] In other words, Havrilesky fell short of his first objective--that of contributing to the dialogue on the problem of identifying an ideal indicator of monetary policy.

Havrilesky employed five policy objectives: the unemployment rate U (percentage of total civilian labor force unemployed); the balance-of-payments surplus or deficit B (surplus or deficit on a basic balance basis which is defined as (1) the net official reserves balance, plus (2) the increase in short-term liabilities to foreigners, minus (3) increase of foreign short-term assets of the U.S., plus (4) errors and omissions); the level of income Y (GNP in billions of current dollars); the price level variable $(P-P')^2$ (where P = the wholesale price index, base 1958 = 100, and P' = the wholesale price index goal, bases 1952-57 = 92, 1958-65 = 100); and foreign economic activity i_f (a weighted-average of foreign long-term interest rates). Havrilesky expected the following signs: negative for the $(P-P')^2$, B, and i_f objectives and positive for the U and Y objectives. He estimated the following reaction function, which showed all objective coefficients, with the exception of the B coefficient, significant at the 5 per cent level.

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[23]For a thorough discussion of the nature of the indicator problem see Karl Brunner and Allan H. Meltzer, "The Meaning of Monetary Indicators," in George Horwich, Money Process And Policy: A Symposium, (Homewood, Ill.: Richard D. Irwin, 1967).

(4) $R_t = 9753.8 + 19.683\ Y_t + 151.84\ U_t - 10.428\ (P-P')^2 - 138.33\ i_{ft} - .04916\ B_t$

All objectives except $(P-P')^2$ showed a linear relationship to adjusted total reserves. Havrilesky's explanation for using the $(P-P')^2$ objective follows:

> The sensitive Wholesale Price Index favored by the policy maker rose only slightly from a level of 92 for the 1952-55 period; in 1956-57 it climbed rapidly to 100; in 1958-64 it varied little from the 100 level; in 1965 it began rising rapidly again. Because of this pattern, two price level goals (P') are introduced, a WPI of 92 for the 1952-57 period and a WPI of 100 for the 1958-65 period. The behavior of adjusted total reserves during period of rapid inflation suggested that the quantity (P-P') be introduced into the regression in squared form to capture policy reactions to increases in the price level above these targets.[24]

Havrilesky does not discuss the economic interpretation of the $(P-P')^2$ objective in equation 4. The lack of discussion could indicate that Havrilesky used the variable because of its high statistical correlation with R_t.

Havrilesky included i_f (a weighted - average of foreign long-term interest rates) as a policy objective because the Federal Reserve System claims to consider exogenous forces affecting the other policy objective, even though monetary policy does not directly affect the exogenous forces.

Havrilesky's reaction function estimate assumed that all policy responses occurred in the initial quarter. He also assumed that the explanatory variables respond to changes in the indicator after a one-quarter lag.

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[24] Havrilesky, pp. 301-302.

According to Havrilesky:

> The presence of a lag of this type permits the establishment of unilateral causality between the explanatory variables and the indicator.[25]

Thus, Havrilesky eliminated from consideration the "inside" lag of monetary policy and assumed the "outside" lag to be greater than one quarter. He did not, however, provide empirical evidence to support his assumptions.

Havrilesky's conclusions drawn from the analysis of equation 4 include (1) statements to the effect that the monetary authorities respond to adverse movements in the price stability, employment, and income growth objectives, and (2) the monetary authorities do not respond to adverse movements in the balance-of-payments objective; however, they are cognizant of foreign economic activity.

In summary, Havrilesky attempted to improve Dewald and Johnson's study in two ways. First, he attempted to specify the criteria for selecting an indicator of monetary policy to use in his reaction function estimate. Havrilesky felt that by specifying the criteria, he would contribute to the dialogue concerning "ideal" indicators of monetary policy, and at the same time, choose an indicator more closely approaching the "ideal" condition. He chose total reserves adjusted, R_t, as the indicator to be used.

Havrilesky attempted to improve Dewald and Johnson's study a second way by finding policy objectives other than growth and employment that caused the monetary authorities to respond. He concluded that

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[25]Ibid., p. 301.

the monetary authorities responded to the price stability, employment, growth, and foreign economic activity objectives. He found no systematic response by the monetary authorities for the balance-of-payments objective.

It is questionable whether Havrilesky's criteria for selecting an indicator of monetary policy, his attempt to discover a significant price stability objective, or his assumptions concerning the inside and outside lags of monetary policy represents a contribution.

Following Havrilesky, Christian made the next attempt to improve upon Dewald and Johnson's study.

Christian

Christian[26] believed that Dewald and Johnson made two errors in estimating their reaction functions. First, they did not indicate that a regression coefficient shows the combined influence of effect and weight, thus the two cannot be separated without independent information. The lack of independent information meant that the absolute values of the regression coefficients did not reflect the true weights. The second criticism concerned the absence of stability tests for the reaction functions estimated by Dewald and Johnson. A stable reaction function assumes a "temporally consistent policy-formulating framework," implying that the respective regression coefficients remain statistically invariant over time.[27]

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[26]James W. Christian, "A Further Analysis of the Objectives of American Monetary Policy," pp. 465-477.

[27]Ibid., p. 466.

The independent variables used in reaction functions are of two types--lagged indicators of monetary policy and measures of policy objectives. If the coefficient of the lagged variable does not exhibit stability over time, then questions arise as to the reliability of the implied distributed lag. As the time periods used for estimating the reaction function change, different distributed lag structures would result. Christian indicated that if the coefficients for the policy objectives exhibited instability over time, two alternative interpretations existed. The first interpretation implies that either a temporally consistent policy-formulating framework does not exist, or if it does exist, that the relationships are non-linear. The second interpretation implies that the policy objectives lack independence. This interpretation suggests that the implicit trade-offs among objectives may approach a lexicographic ordering. In other words, the attainment of one objective depends upon the attainment of others.

The main emphasis of Christian's study concerned applying moving regression analysis to reaction functions similar to those estimated by Dewald and Johnson. He reported applying the moving regression stability test to three different reaction functions. One reaction function employed a measure of the money supply as an indicator of monetary policy; another used free reserves as the indicator; and the remaining reaction function employed the Treasury bill rate as the indicator. Christian found the stability results roughly comparable for all three reaction functions tested. For that reason, only the conclusions drawn from the reaction function employing the money supply indicator follow:[28]

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[28] Ibid., pp. 470-471.

1) During the periods of concern, there existed a relatively "close correspondence between the size and significance of the regression coefficients" and the changes in the moving average variables.

2) The regression coefficient of the lagged dependent variable changed considerably during the time period considered.

3) The price stability variable in the Dewald and Johnson analysis was not generally significant; however, during inflationary periods it became significant.

4) The balance-of-payment variable became significant toward the end of the period; whereas, in the Dewald and Johnson analysis, it never became significant.

5) During periods of concern, the regression coefficients became generally larger than Dewald and Johnson's result.

6) Based on an analysis of the "moving regressions" doubt was cast as to the temporal consistency of the policy-making framework.

Christian did find evidence showing a case for temporal consistency with respect to the unemployment, U, and growth, G, objectives.

Christian's application of moving regression analysis provided additional insight into the stability characteristics of reaction functions. Perhaps, however, he could have attained more precision by subjecting the moving regression coefficients to confidence interval analysis, rather than relying upon visual inspection of the coefficients.

In summary, Christian applied the moving regression test to alternative formulations of reaction functions. His tests did not identify a stable reaction function of the monetary authorities.

However, he provided evidence which he felt suggested that the monetary authorities react with temporal consistency to the employment and growth objectives.

Fisher made the next attempt to estimate reaction functions of the monetary authorities in Great Britain.

Fisher

Following Reuber's and Dewald and Johnson's leads, Fisher[29] attempted to estimate reaction functions of the British monetary authorities for the time period 1951 to 1964. Fisher's purpose in estimating reaction functions is :

> The core of this paper is a model of recent British monetary policy in which the objectives, the techniques employed, and, implicitly, the trade-offs between objectives, are simultaneously identified.[30]

Fisher's conception of a reaction function differs from other reaction function studies reviewed. Instead of using an indicator of monetary policy to measure the assumed reactions of the monetary authorities, Fisher employs various targets of monetary policy. The following statement relates Fisher's conception of a reaction function:

> Thus, one first assumes that a particular variable for example, the money stock, has been controlled (or dictated as in the case of interest rates) and then tests it against all of the various possible objectives in order to see which of the objectives has been served and to what extent. In a regression equation the various proximate objectives become independent variables and the instruments become dependent variables. In this event, both objectives and instruments are defined by a successful regression.[31]

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[29] Douglas Fisher, "The Objectives of British Monetary Policy, 1951-1964."

[30] Ibid., p. 821.

[31] Ibid., p. 824.

Three general types of instruments (dependent variables) are tested by Fisher in reaction function models. Interest rates make up the first general category of instruments tested. The specific interest rate measures include the Bank Rate, Treasury Bill Rate, One Year Rate, and the Consol Rate. The second general category of instruments includes money supply measures. The specific measures include broad money, narrow money, total deposits, and current deposits. The third general category of instruments includes liquid assets. The specific measures include liquid assets (primarily cash, call money, and both public and private bills), the liquid assets ratio (liquid assets divided by total deposits), and Bills outstanding.

The policy ojbectives tested include the price stability objective P, the balance-of-payments objective B, the employment objective E, and the growth objective G. Measures of the policy objectives include a price index for the P objective; foreign exchange and gold reserves in billions of dollars for the B objective; unemployment as a per cent of the labor force for the U objective; and consumption, deflated in £ 100 million for the G objective. Quarterly data were employed.

A representative reaction function estimated by Fisher is shown in Table III.[32] (Fisher does not report any of the constant terms.)

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[32]Reaction functions employing money supply and liquid asset instruments did not generally show the objective coefficients being significantly different from zero.

TABLE III

THE OBJECTIVES OF BRITISH MONETARY POLICY - BANK RATE

	Lagged Value	Price Level (Per Cent)	Foreign Exchange and Gold Reserves (billions of dollars)	Unemployment (Per Cent of labor force)	Consumption (£ 100 million)
Bank Rate	.5559**	.0547	-.7350**	-.6840**	-.0005

** = significant at the .01 level

Fisher interprets the coefficient of the lagged dependent variable as showing "the percentage of variation in the policy instrument which is long run."[33] This means that 56 per cent of the policy response to adverse movements in measures of policy objectives, as shown by changes in the Bank Rate, occurs after the initial quarter. In other words, 44 per cent of the policy response occurs in the initial quarter. For comparative purposes with other studies, the weighted average inside lag equals slightly over one quarter--a result consistent with the findings of Dewald and Johnson and Christian. In terms of the P, B, and U objective coefficients, Fisher concludes that the signs are consistent with short run orthodoxy. This means that all reactions are in the anti-cyclical direction.

The P and G objective coefficients are not statistically significant. He concludes that the insignificant coefficient associated

[33]Ibid., p. 824.

with the growth objective provides evidence to support the contention that growth represents a long run policy objective and is not a relevant objective for short run monetary policy. Fisher argues that the British monetary authorities respond primarily to short run objectives (P, B, and U)[34] and that growth does not belong in a reaction function because of its long run implications.

As indicated earlier, the relevant objectives and instruments in terms of monetary policy are defined by a successful regression. Since the reaction functions employing the short-term interest rates as instruments produce the best results, Fisher concludes that the British monetary authorities "adopted the technique of price setting in the short-term Government securities market. . . ."[35] In other words, short-term interest rates are used as targets for transmitting monetary policy to the economy. Fisher goes on to point out that the Bank Rate represents "the ultimate policy weapon of the Bank of England."[36] Thus, the stabilization techniques employed by the British monetary authorities include adjusting the Bank Rate to target levels. As the Bank Rate adjusts, the rest of the money market responds,[37] and ultimately, the measures of the policy objectives change.

Finally, Fisher examines the implications of the implicit trade-offs shown in Table IV. The trade-offs are calculated from the reaction

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[34]Ibid., pp. 824-826.

[35]Ibid., p. 823.

[36]Ibid.

[37]Ibid.

function shown in Table III after solving for the equilibrium value of the instrument variable (Bank Rate).

TABLE IV

TRADE-OFFS BETWEEN THE OBJECTIVES OF BRITISH MONETARY POLICY - BANK RATE

	Price Level Index Numbers	Foreign Exchange and Gold Reserves Billions of Dollars	Unemployed Per Cent of labor force unemployed
1 index number rise in prices	X	.07	.08
1 billion dollar rise in reserves	13.46	X	-1.07
1 per cent rise in unemployment	12.52	-.93	X

Table IV indicates that between 1951 and 1964 in Great Britain, Bank Rate did not change when both P and B rose simultaneously if P rose by 13.46 index numbers when B rose by one billion dollars. In other words, a 13.46 percentage increase in P causes Bank Rate to rise, but a one billion dollar rise in B causes Bank Rate to decline by the same magnitude; thus the value of Bank Rate does not change. An alternative interpretation of the implicit trade-offs would be that every time foreign exchange and gold reserves decline by one billion dollars, the British monetary authorities are willing to accept an increase of 1.07 percentage points in the unemployment rate. Thus, a fairly large amount of unemployment would be acceptable by the British monetary authorities every time a one billion dollar decrease in foreign exchange and gold reserves occurs. According to Fisher, this trade-off rate may even be an understatement of the actual trade-offs in a balance-of-payments crisis situation in Great Britian. Both Tables III and IV also show that the British monetary authorities place the greatest weight on the B and U objectives.

Three criticisms of Fisher's study can be made in light of the other reaction function studies reviewed. First, it appears that Fisher may have confused targets of monetary policy with indicators of monetary policy. At no point does Fisher indicate the difference between the two concepts. As Saving points out, this confusion could lead to spurious results because the target value reflects both the policy effects and the exogenous effects.[38] The purpose of an indicator of monetary policy is to separate out the policy effects only. Second, Fisher does not consider the temporal stability of his reaction functions, even though they were estimated for the time period 1951 to 1964. Third, Fisher fails to mention that reaction functions and the economy are contemporaneous which means that the weights and effects applied to the objective coefficients are inseparable without independent information. Thus, the coefficients in Fisher's reaction functions are biased--a difficulty plaguing all reaction function studies.

In summary, Fisher presents evidence on the following three issues: first, the British monetary authorities respond to the following short

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[38]Thomas R. Saving, "Monetary Policy Targets and Indicators," p. 450.

run policy objectives—price stability, balance-of-payments, and unemployment. He concludes that the British monetary authorities do not respond to economic growth—a concept more appropriate for long run policy considerations. Second, Fisher concludes that the British monetary authorities attempt to control the Bank Rate in order to influence the measures of the policy objectives. Third, Fisher shows that the British monetary authorities implcitly allow for high rates of unemployment whenever decreases occur in foreign exchange and gold reserves. Also, the B and U objectives are weighted the heaviest by the British monetary authorities.

Summary

After estimating both actual and implicit trade-offs among policy objectives for the Canadian economy, Reuber found that they differed considerably, with a resultant high economic cost to society. Additionally, Reuber concluded that the lag in monetary policy, which showed an oscillatory reaction pattern, suggested that the Canadian monetary authorities might have been trying to reach their objectives through successive approximations. To reach both major conclusions, Reuber relied extensively on reaction function equations.

Dewald and Johnson borrowed Reuber's reaction function concept and applied it to data from the United States. They found that the monetary authorities respond almost entirely to the growth and employment objectives. Additionally, they found that the inside lag was noticeably long when money supply indicators of monetary policy were used.

Havrilesky attempted to improve Dewald and Johnson's contribution in two ways: first, he attempted to specify an indicator of monetary policy that would approach being ideal; and second, he attempted to discover policy objectives--other than full-employment and growth--that cause the monetary authorities to respond. On both counts Havrilesky fell short of his intended goals. In terms of an ideal indicator of monetary policy, Havrilesky's discussion did not satisfactorily justify his choice of an indicator over other indicators commonly used. In terms of the price stability objective, he did not present a theoretical justification for the variable used.

Christian undertook a reaction function study because of two shortcomings in the Dewald and Johnson study. First, Christian pointed out that the weights Dewald and Johnson estimated for the objectives reflect both effect and weights, thus the two cannot be separated without independent information. Such information was not available. Second, Dewald and Johnson made no report on the stability of their estimated reaction functions.

Using moving regression tests, Christian tested equations similar to Dewald and Johnson's for stability; but he was unable to identify a stable reaction function. However, he identified two objectives which he judged relatively stable--the employment and growth objectives. Christian was also unable to identify a stable lagged-dependent-variable coefficient, the absence of which cast doubt on the reliability of Dewald and Johnson's estimated inside lags. Finally, Christian noted that the price and balance-of-payments objectives became statistically significant during some time periods, a fact concealed from Dewald and Johnson by the nature of their study.

Fisher estimated reaction functions of the British Monetary authorities in order to provide evidence on: (1) the short run policy objectives pursued by the monetary authorities, (2) the targets of monetary policy used in trying to attain desirable measures of the policy objectives, and (3) the implicit trade-offs among the policy objectives. Fisher found that in the short run the British monetary authorities respond primarily to the price stability, employment, and balance-of-payments policy objectives. He also found the most important target variable to be an interest rate measure--Bank Rate. Finally, Fisher found that the British monetary authorities put the heaviest weights on the B and U objectives, and that relatively large amounts of unemployment are acceptable whenever foreign exchange and gold reserves decline.

Reaction functions of the monetary authorities have been estimated for three different countries. For comparative purposes, the Canadian monetary authorities respond to the employment, productivity, and price stability objectives. The British monetary authorities respond primarily to the employment, price stability, and balance-of-payments objectives. The United States monetary authorities respond primarily to the employment and growth objectives with possible secondary emphasis to the price stability objective.

Chapter III shows how the reaction function equations are first derived and estimated, then, by economic and statistical criteria, selected for subsequent stability analysis.

CHAPTER III

REACTION FUNCTION MODELS

A reaction function relates the way in which the monetary authorities are assumed to react when the measures of the policy objectives are not at their desired levels. In order to provide a better understanding of the nature of reaction functions, section one presents the Federal Reserve's interpretation of the monetary process. No official statement by the Federal Reserve System describing the theoretical nature of the monetary process exists; however, Federal Reserve and academic economists have gathered various official statements of the process and have derived an interpretation that will be presented in this chapter.[1]

Section two deals with tentative reaction function equations development, including the subjects of indicators of monetary policy, policy objectives measurement, functional forms, and predicted coefficient signs. The results of the multiple linear regression analysis are presented in section three, followed by an intermediate economic and statistical analysis of the reaction function equations in the final section. The following description of the monetary process provides definitions of the various components of a reaction function.

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[1]This theory, as it has been used in the past, is not fully developed. Leonal C. Andersen and Jules E. Levine, "A Test of Money Market Conditions As a Means of Short-Run Monetary Management," <u>National Banking Review</u>, Vol. 4, No. 1, (September 1966), pp. 41-51.

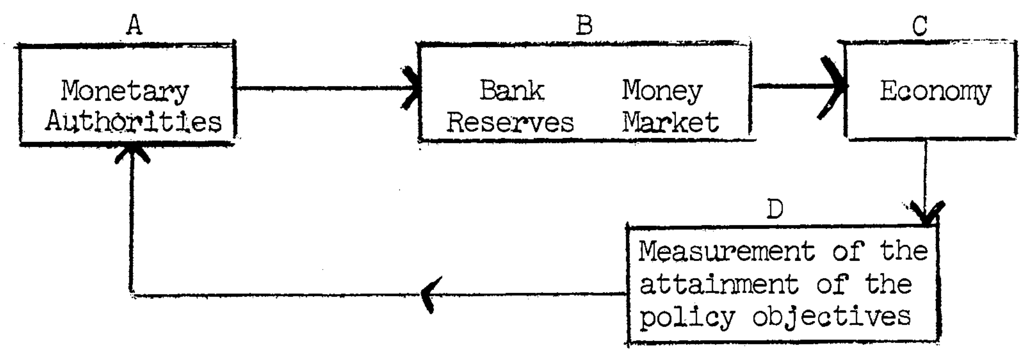
The description also lays the groundwork for a discussion of the nature of reaction functions.

The Nature Of The Monetary Process

The monetary process begins with monetary policy affecting the money market. As the money market adjusts, the monetary policy influences spread to the economy; as the economy responds, measures of the policy objectives change. The following diagram facilitates the discussion of the monetary process.

Chart 1

The Monetary Process



The monetary authorities conduct monetary policy which directly influences member bank reserves and causes conditions in the money market to change. The reaction of the money market creates forces which affect the entire economy; and as the economy adjusts, the measures of the policy objectives change. When the measures of policy objectives change, the monetary authorities react.

Keir's interpretation of the Federal Reserve's conceptual process of how monetary policy eventually affects the measures of the policy objectives follows:

> Changes in the availability and cost of reserves are reflected immediately in money market conditions. Their influence spreads to bank credit and money, to interest rates in markets for longer-term debt, and to the entire range of spending financed by borrowed funds. In the end the ultimate targets of policy actions--total income and spending, total output and employment, the general level of prices, and international trade and capital flows—come to be influenced.[2]

To provide a better understanding of the nature of the money market, the following section describes its components, including the money market, the transmission of monetary policy influence, and the policy objectives.

The Money Market

In Chart 1, the money market serves two primary functions. First, it includes the variables frequently used as money market guides and indicators of monetary policy; Treasury Bill rates, free reserves, the basic reserve deficiencies of eight New York money market banks, the basic reserve deficiencies of thirty-eight money market banks outside New York, member bank borrowings, borrowings by Government security dealers, the Federal Funds rate, and the discount rate.[3] Second, the money market serves as the first connecting link between monetary policy

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[2]Peter M. Keir, "The Open Market Policy Process," Federal Reserve Bulletin, 49, Part II, (July 1963), p. 1360.

[3]Leonall C. Andersen, "Money Market Conditions As A Guide For Monetary Management," Monetary Economics: Readings, Alan D. Entine, Editor, (Belmont, California, 1969), p. 230.

and the economy. As shown in Chart 1, monetary policy initially affects bank reserves; then as the cost and availability of reserves change, money market conditions reflect those changes. As money market conditions change, three variables--known as intermediate guides of monetary policy--adjust.[4] The monetary authorities hope to influence these intermediate guides. The guides--which include the stock of money, long-term interest rates, and bank credit--play a critical role in the conception of how monetary policy influences spread throughout the economy.

Transmission Of Monetary Policy Influence To The General Economy

Four alternative theories describe the manner in which the influence of monetary policy moves from the money market to the economy where it alters policy objective measures. Economists generally make the following association between theories and key variables: Keynesian theory and long-term interest rates;[5] the quantity theory of money and the money supply;[6] the Federal Reserve authorities have

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[4]It has been postulated that increased pressure in the money market will result in decreasing rates of change in money and bank credit and rising long-term interest rates. The opposite is postulated if there is less pressure or increased ease in the money market. Andersen and Levine, p. 43.

[5]Laurence S. Ritter, "The Role of Money in Keynesian Theory," Banking And Monetary Studies, Dean Carson, Ed., (Homewood, Illinois, 1963), pp. 134-150.

[6]Milton Friedman, "The Quantity Theory of Money--A Re-statement," Studies In The Quantity Theory Of Money, (Chicago, University of Chicago Press, 1956), pp. 3-21.

an implicit theory for bank credit;[7] and finally, the general liquidity theory encompasses all three intermediate guides in its framework.[8]

Monetary authorities purportedly employ an eclectic combination of the foregoing guides to influence the economy. As the economy responds, measures of the policy objectives change. These policy objective changes are examined next.

Policy Objectives

During the decade of the 1930's this country experienced its most severe depression. Toward the end of the depression, the United States entered World War II. As the end of the war approached, many people feared a return to the complacent economic conditions that prevailed in the 1930's. The Employment Act of 1946 illustrates the high priority given economic stability because of these fears. The Declaration of Policy states the purpose of the Act.

> The Congress declares that it is the continuing policy and responsibility of the Federal Government to use all practicable means consistent with its needs and obligations and other essential considerations of national policy, with the assistance and cooperation of industry, agriculture, labor, and State and local governments, to coordinate and utilize all its plans, functions, and resources for the purpose of creating and maintaining, in a manner calculated to foster and promote free competitive enterprise and the general welfare, conditions under which there will

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[7]Board of Governors of the Federal Reserve System, "Processes and Procedures Involved in the Formulation and Execution of Monetary Policy," The Federal Reserve And The Treasury: Answers To Questions From The Commission On Money And Credit, (Englewood Cliffs, N.J.: Prentice-Hall, Inc., 1963), p. 5.

[8]Leonall C. Andersen, "Liquidity Considerations and Monetary Management," a paper presented to the Federal Reserve System Committee on Financial Analysis, Philadelphia meeting, (April 20, 1966), pp. 1-3.

> be afforded useful employment opportunities, including self-employment, for those able, willing, and seeking to work, and to promote maximum employment, production, and purchasing power.[9]

The legislative background and the general opinions prevailing during the mid-1940's implied that the procedures for attaining the policy objectives include both monetary and fiscal policy.[10]

With respect to the policy objectives of monetary policy, the Board of Governors stated:

> Today it is generally understood that the primary purpose of the System is to foster growth at high levels of employment, with a stable dollar in the domestic economy and with over-all balance in our international payments.[11]

More specifically, these four policy objectives mean

(1) maintaining a maximum rate of sustainable economic growth,

(2) keeping the unemployment rate at the level consistent with full-employment,

(3) providing for stability in the overall price level, and

(4) maintaining a balance-of-payments equilibrium.[12]

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[9] This act as originally approved February 20, 1946, and its amendments through the first session of the 83rd Congress are reprinted in The Economic Report Of The President, Transmitted To The Congress January 28, 1954. (United States Government Printing Office, Washington, 1954) Appendix B.

[10] Lester V. Chandler, "Economic Stability," The Nation's Economic Objectives, (Chicago: University of Chicago Press, 1964), p. 40.

[11] Board of Governors of the Federal Reserve System, The Federal Reserve System: Purpose And Functions, (Washington, D.C., 1963), 50th Anniversary Edition, p. 2.

[12] It should be noted that 1963 represented the first year the Board of Governors explicitly mentioned the balance-of-payments as an objective. International considerations have had an influence on monetary policy in the past; however, during most of the 1950's the Federal Reserve's attention focused on domestic problems.

Within the framework of the foregoing discussion, this study now addresses itself to the problem of formulating tentative reaction function equations.

Tentative Reaction Function Equations

A reaction function consists of an indicator of monetary policy (dependent variable) functionally related to measures of the policy objectives (independent variables). The first two subsections discuss the choice of (1) indicators of monetary policy and (2) measures of policy objectives used in this study. Subsection three shows the general reaction function equation chosen for this study, including the specific form it takes when the variables in (1) and (2) above are inserted. Subsection four reports the predicted signs of the policy objective coefficients. Finally, subsection five presents a critique of reaction function analysis.

Indicators Of Monetary Policy

The monetary authorities attempt to influence measures of the policy objectives through manipulation of policy instruments after first taking into consideration the structure of the economic system. The theoretical problem of implementing monetary policy arises because of the general lack of knowledge concerning the complete structure of the economic system.

Most economists agree on the general nature of theories concerning the structure of the economy. The key variables in these theories often serve as indicators of the influence of monetary policy on economic activity. A problem arises when two important key variables give conflicting signals, as occurred, for example, in the first part of 1966 when interest rates and monetary aggregates rose simultaneously.

Repeated occurrence of this problem caused Brunner and Meltzer to formalize the indicator problem.[13] Their study clearly identified the endogenous characteristics of monetary policy indicators. When the non-monetary policy forces dominate the monetary policy forces, then the indicator variables will move in directions not dictated by monetary policy, thus giving contradictory signals.

An ideal indicator (one that would always give correct signals) would satisfy the following criteria. First, the indicator would relate to the target variable, but would remain mathematically independent. Second, the monetary authorities would represent the primary influence on indicators. The exogenous variables which affect the target variable would not affect the indicator. Third, the indicator would occupy an important position in the beginning of the process so that the monetary authorities could have frequent and early readings.[14]

Since the time that Brunner and Meltzer formalized the indicator problem, many researchers have pointed out the "endogenous" characteristics of the commonly used indicators. As a result, a known indicator which satisfies the criteria for an ideal indicator does not exist today.[15] Despite the foregoing restraint, the monetary

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[13]Brunner and Meltzer, "The Meaning of Monetary Indicators."

[14]Thomas R. Saving, "Monetary Policy Targets and Indicators," Journal Of Political Economy, Supplement, Vol. 75, (August 1967), pp. 448-449. Also George G. Kaufman, "Indicators of Monetary Policy: Theory and Evidence," National Banking Review, Volume 4 (June 1967), p.482.

[15]One purpose of this paper is to test alternative indicators that have been used by the monetary authorities; it is not to identify the "best" indicator by comparing alternative indicators to a set of arbitrary criteria, as was done in Havrilesky's study.

authorities still rely upon indicators of monetary policy when making policy decisions.

Those indicators selected for use in this study meet the following conditions: (1) the monetary authorities used the indicators during the time period to which this study relates and (2) the indicators fit into the conceptual framework of the transmission process of monetary policy.

This study excludes several well-known indicators from use because the monetary authorities did not use them during the time period covered. The excluded indicators include the neutralized money stock, effective non-borrowed reserves, and the monetary base. The first two variables appeared in the literature in 1968 and 1969 respectively.[16] The monetary base has frequently appeared in the literature in the last eight years in money supply studies and studies concerning indicators of monetary policy. However, Saving indicates the probable reasons for the monetary authorities' not using the monetary base as an indicator. Only in a time period when the discount rate and required reserves remain unchanged and monetary policy consists only of open market operations, "the monetary base will not deviate from the ideal indicator and hence will relect the direction of the effect of policy on aggregate demand."[17] Since the time period covered in this study does include many changes in the levels of the discount

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[16] P. H. Hendershott, The Neutralized Money Stock, (Homewood, Illinois, 1968), and E. DeLeeuw and J. Kalchbrenner, "Monetary and Fiscal Actions: A Test of their Relative Importance in Economic Stabilization--Comment," Review, Federal Reserve Bank of St. Louis, (April, 1969), pp. 6-11

[17] Saving, p. 455.

rate and required reserves, the monetary base is not used as an indicator.

The indicators used in this study include the money supply M, the percentage change in the money supply M', the interest rate r, total reserves T, free reserves F, member bank borrowing B, and the index of money market tightness I. The I variable consists of weighted movements of seven money market variables and represents money market pressure (see Appendix C). All of these variables appear in block B of Chart 1 in the transmission process of monetary policy. The T and F variables are associated with bank reserves while the F, r, B, and I variables are associated with the money market. The M and M' variables, considered intermediate money market variables, are associated with the quantity theory of money.

During the time period under consideration, the "Record of Policy Actions" of the Federal Open Market Committee consistently referred to the M and M' variables. Phrases such as "total money supply," "growth in the money supply," or "increase in money supply," frequently appeared during the latter part of the time period. In the early 1950's the words "supply, availability and cost of money" appeared inseparable because of the belief that no "meaningful distinction" could be made between the variables in terms of their influence on the economy. Given these early limitations, references to "the flow of money" still appeared. Weintraub showed, however, that given the Federal Reserve's 1952 conception of the monetary process, extracting the money supply as an indicator of monetary policy would still produce meaning.[18]

The "Record of Policy Actions" discussed many different kinds of interest rates throughout the time period under consideration. Meltzer indicated that "central bankers" rely on short-term interest rates to judge conditions in the money market.[19] The popular textbook Keynesian model provides a possible reason why the monetary authorities used interest rates as indicators.

The total reserve variable, T, though not a widely used indicator in comparison to money, interest rates, or other bank reserve indicators, is used because the Federal Reserve System indicates that total reserves represent the first variable affected by monetary stabilization policy. As reserves change, banks tend to alter their "lending and investment policies," an action which affects money, the availability of credit, and interest rates.[20] Former Chairman William McChesney Martin indicated that the T variable represents one of many variables which monetary authorities jointly use to assess the stance of monetary policy.[21] The T variable provides an indicator of the

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[18] Robert Weintraub, "The Federal Reserve's Conception of Monetary Processes 1952 and 1968," in D.P. Jacobs and R. T. Pratt, eds., Savings And Residential Financing, 1969 Conference Proceedings (Chicago, 1969), p. 73.

[19] A. H. Meltzer, "The Appropriate Indicators of Monetary Policy," in D.P. Jacobs and R. T. Pratt, eds., Savings And Residential Financing, 1969 Conference Proceedings, (Chicago 1969), p. 13.

[20] Board of Governors, The Federal Reserve System, Purposes And Functions, p. 128.

[21] Martin's statement is reprinted in Weintraub, p. 74.

banking system's capacity to expand credit at the appropriate rate.[22] The "Record of Policy Actions" included the T variable throughout most of the time period covered. Thus, the monetary authorities have used T as an indicator.

Free reserves, F, represent another variable widely used by the monetary authorities as an indicator of monetary policy. The Board of Governors refers to F as an indicator.[23] Brunner and Meltzer emphasized this point in their study of the "Genesis and Development of the Free Reserve Conception of Monetary Processes."[24] The Board of Governors use F as an indicator because of the belief that a high level of free reserves causes an accelerated rate of credit expansion and that low levels of free reserves cause a decelerated or contracted rate of credit expansion. In the "Record of Policy Actions," the words "free reserves" or "net reserve position" did not appear frequently in the 1950's. The concept of free reserves' playing a key role in the transmission process of monetary policy did not occur until the late 1940's or early 1950's. Consequently, the concept did not become popular until the 1960's.[25]

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[23]Board of Governors, The Federal Reserve System, Purposes And Functions, pp. 221-222.

[24]Karl Brunner and Allan H. Meltzer, "Some General Features of the Federal Reserve's Approach to Policy," A staff analysis, subcommittee on Domestic Finance. Committee on Banking and Currency, House of Representatives, 88th Congress, 2nd Session, (February 10,1964).

[25]Karl Brunner and Allan H. Meltzer, "Genesis and Development of the Free Reserves Conception of Monetary Processes," Readings In Money, National Income, And Stabilization Policy, W. L. Smith and R. L. Teigen, Editors, (Homewood, Illinois: Richard D. Irwin, Inc., 1965), p. 203.

The Federal Reserve System frequently uses member bank borrowing, B, as an indicator.[26] Banks reluctant to borrow from the Federal Reserve System tend to restrict loans as member-bank borrowing increases. Warren Smith points out that this tendency may restrict loans immediately or restrict them at some point in the future.[27] Reduced member bank borrowing indicates fewer restrictions on loans. The words "member bank borrowing" did not always appear in the "Record of Policy Actions;" however, the annual reports of the Board of Governors frequently mention B during the time period under consideration.

The index of money market tightness, I, represents money market conditions. In this study, I reflects the fact that monetary authorities did use some reading of money market pressure as an indicator. Throughout the time period considered, the "Record of Policy Actions" thoroughly discussed money market conditions. For a discussion of how the I index is calculated, refer to Appendix C.

Measures Of Policy Objectives

As in the case of indicator variables, policy objectives may be identified by alternative measures. The following discussion describes the measures of the attainment of each policy objective used in this study.

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[26]Andersen, "Money Market Conditions as a Guide for Monetary Management," p. 230.

[27]Warren L. Smith, "The Instruments of General Monetary Control," Readings In Money, National Income; And Stabilization Policy, W. L. Smith and R. L. Teigen, editors, (Homewood, Illinois: Richard D. Irwin, Inc., 1965), p. 216.

The price stability objective employs only one measure—the current quarters' wholesale price index minus the previous four quarters' average wholesale price index divided by the previous four quarters' average wholesale price index. The monetary authorities use the P measure because they desire to stabilize prices from the current time period on into the future. The monetary authorities do not desire a return to previously lower price levels because of the probable accompaniment of a recession or depression. A zero rise of the P measure represents price stability. The "Record of Policy Actions" mentions the wholesale price index more times than other price indexes; therefore, the calculation of the P ratio incorporated the wholesale price index.

Four measures of the attainment of the growth objective include G (real gross national product), G' (the percentage change in real gross national product), Y (potential real GNP minus actual real GNP, and Y* (Y divided by potential real GNP.)[28]

Measures of the attainment of growth in economic studies commonly employ the G and G' variables. The Y and Y* variables require an interpretation because of their infrequent use by other studies. The assumed real GNP growth for the Y objective follows: 3 1/2 per cent between 1951-I and 1962-IV, with mid-1955 as the base year; 3 3/4 per cent between 1962-IV and 1965-IV; and 4 per cent between 1965-IV and

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[28]G is a variable commonly employed as a measure of the growth objective in other reaction function studies (Dewald and Johnson, Havrilesky, and Christian) because the economic growth objective is a conceptually difficult objective to relate to monetary policy. Harry G. Johnson, "Objectives, Monetary Standards, and Potentialities," Review Of Economics And Statistics, Volume 45, (February, 1963).

1969-IV. Therefore, if Y = 0 for all observations, then actual growth of real GNP falls between 3 1/2 per cent and 4 per cent as indicated above. The same interpretation applies if Y* = 0 for all observations.

The "Record of Policy Actions" continuously refers to U (the seasonally adjusted unemployment rate) throughout the time period covered. U also appears frquently as a measure of the attainment of employment in other economic studies; therefore, this study employs the U measure.

The balance-of-payments measures used in this country consist of five separate balances. The monetary authorities can tangibly affect only two of these balances--the net exports balance and the net capital flows balance. This study employs the foregoing two measures as a substitute for the balance-of-payments policy objective measures. Other reaction function studies employ only one balance-of-payments measure. The approach employed in this study may provide more meaningful results because the use of only a single balance-of-payments measure includes aspects that do not cause a policy response by the monetary authorities. A description of these two balances usually appears in the "Record of Policy Actions."

The balance-of-trade objective employs two measures. First, the studies of reaction function estimates covering the time period 1951-III to 1969-IV employ X (exports minus military exports minus imports), which includes exports financed by government grants and capital. Second, reaction function estimates covering the time period 1961-I to 1969-IV employ X* (X minus exports financed by government grants and capital). The information to calculate X* did not exist in the 1950's.

This study uses two measures of the net capital flow balance. The L variable shows the spread between the London and U.S. 90-day Treasury Bill rates, with the London rate being used as a measure for all foreign short-term rates. If L rises, then short-term capital from this country will probably flow to foreign countries. Since 1961, the Federal Reserve System has attempted to keep the L variable as low as possible to discourage outflows and encourage short-term inflows. The E variable measures the spread between the London Euro-dollar rate and the U.S. 90-day Treasury Bill rate and represents the difference between the U.S. short-term rates and foreign rates. Reaction function estimates during the 1960's employ the E objective; reaction function estimates during the 1950's and 1960's combined employ the L objective because published Euro-dollar rates did not exist in the 1950's. Since the E objective is not available for the entire period of this study, the L objective is used.

Functional Forms And Variable Designation

This section presents the functional forms later to be subjected to multiple linear regression analysis.[29] The variables used are identified and defined. This study employs two general types of models, with the first type utilizing monetary aggregates as the indicator and the second utilizing money market variables as the indicator. The functional forms of the models and the definitions follow.

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[29] Since the reaction function equations which were discussed earlier in this study were identified by (1), (2), (3), (4), the ordering of the equations on page 54, begins with (5) in order to avoid confusion as to which equation is referenced.

INDICATOR MODELS

(5) $M = (P, G', U, X, L, M_{t-1})$

(6) $M = (P, G, U, X, L, M_{t-1})$

(7) $M' = (P, G', U, X, L, M'_{t-1})$

(8) $M' = (P, G, U, X, L, M'_{t-1})$

(9) $r = (P, G', U, X, L, r_{t-1})$

(10) $r = (P, G, U, X, L, r_{t-1})$

(11) $r = (P, Y^*, U, X, L, r_{t-1})$

(12) $T = (P, G', U, X, L, T_{t-1})$

(13) $T = (P, G, U, X, L, T_{t-1})$

(14) $F = (P, G', U, X, L, F_{t-1})$

(15) $F = (P, G, U, X, L, F_{t-1})$

(16) $B = (P, G, U, X, L, B_{t-1})$

(17) $B = (P, G', U, X, L, B_{t-1})$

(18) $I = (U, G', P, L, X, I_{t-1})$

(19) $I = (U, G', P, L, X^*, I_{t-1})$

(20) $I = (U, G', P, E, X, I_{t-1})$

(21) $I = (U, G', P, E, X^*, I_{t-1})$

(22) $I = (Z, Y, P, E, X^*, I_{t-1})$

(23) $I = (Z, Y^*, P, E, X^*, I_{t-1})$

NOTATION

Indicators of Monetary Policy

- M Money supply adjusted for seasonal variation (currency outside banks and demand deposits), trillions of dollars.
- M' Percentage change in the money supply, per cent.
- r Three month Treasury Bill rate, per cent.
- T Total reserves held at all member banks of the Federal Reserve System, millions of dollars.
- F Free reserves or net borrowed reserves (excess reserves of member banks minus member bank borrowing at Federal Reserve Banks), billions of dollars.
- B Member bank borrowings from Federal Reserve Banks, billions of dollars.
- I Index of money market tightness, the larger the index, the greater the money market tightness.

Policy objectives of the monetary authority.

G Gross National Product in constant (1958) dollars, trillions of dollars.

G' Percentage change in Gross National Product in constant (1958) dollars, per cent.

P The current quarters' wholesale price index minus the previous four quarters' average wholesale price index divided by the previous four quarters' average wholesale price index.

U The unemployment rate, per cent.

X Net merchandise flows (non-military exports - non-military imports), billions of dollars.

X* Net merchandise flows (non-military exports - non-military imports - exports financed by Government grants and capital), billions of dollars.

L London 90-day Treasury Bill rate - U.S. 90-day Treasury Bill Rate, per cent.

E Three month London Euro-dollar rate - U.S. 90-day Treasury Bill Rate, per cent.

Y Potential Gross National Product in constant (1958) dollars minus actual Gross National Product in constant (1958) dollars, billions of dollars.

Y* Y divided by potential Gross National Product in constant (1958) dollars, per cent.

Predicted Signs Of Policy Objective Coefficients

The following material shows the expected signs of the coefficients of policy objectives from a theoretical basis.

Chart 2

Expected Signs

	P	U	X	L	G'	G	Y*	Y	E	X*	Z
M	−	+	+	−	+	+					
M'	−	+	+	−	+	+					
r	+	−	−	+	−	−	−				
T	−	+	+	−	+	+					
F	−	+	+	−	+	+					
B	+	−	−	+	−	−					
I	+	−	−	+	−		−	−	+	−	+

Knowing the direction in which the indicator moves to denote tightness (or ease) facilitates the derivation of the expected signs of the policy objective coefficients. The r, B, and I variables rise to denote tightness, while the F, M, M', and T variables decline. Tightness refers to a less expansionary or more restrictive policy, while ease refers to a more expansionary or less restrictive policy. Those indicators that move in the same direction to denote tightness should have the same expected sign for each policy objective coefficient.

Those indicators that move in the opposite directions to denote tightness have the opposite partial derivative expected signs. For example, one may expect a negative sign for $\partial r/\partial u$, whereas, one would expect a positive sign for $\partial F/\partial U$. Because of this relationship, an explanation for each policy objective with respect to one indicator follows.

The expected negative sign of $\partial M/\partial P$ will result when the monetary authorities react to an increase in P by decreasing the absolute money supply level. Such expectation follows from the Keynesian model.

The expected sign of $\partial M/\partial G'$ remains ambiguous. First, the coefficient of the growth objective could be zero. This situation occurs if growth does not represent a legitimate objective of monetary policy--the monetary authorities do not respond to economic growth.

Second, a positive sign of $\partial M/\partial G'$ results if the monetary authorities attempt to facilitate that rate of economic growth consistent with the desires of society. For example, if society adjusts the level of savings and investment to a level that results in a positive rate of economic growth, then the monetary authorities would increase the level of the money supply. Likewise, if society adjusts the level of savings and investment to a level that results in a negative rate of economic growth, the monetary authorities would decrease the level of the money supply. This situation represents a monetary policy of accommodation, as opposed to the above situation where the monetary authorities do not respond to economic growth.

Third, either a negative or a positive sign of $\partial M/\partial G'$ occurs if the actual growth rate differs from the growth rate desired by society. If the growth rate is positive, but below the desired rate, the monetary authorities would increase the money supply, resulting in a positive sign. If the growth rate is negative, then the monetary authorities would increase the money supply, resulting in a negative sign. Finally, if the growth rate is expanding at a rapid level not sustainable in the long run, then the monetary authorities would reduce the money supply, resulting in a negative sign.

Since theory cannot answer the question as to which sign to expect for $\partial M/\partial G'$, the problem becomes an empirical issue. The growth coefficients of the reaction functions, therefore, provide empirical evidence on the question at issue.

The expected positive sign of $\partial M/\partial U$ results when the monetary authorities increase M as the U objective rises. If U falls below the desirable level (and becomes associated with a slowing of growth and rising inflation), one would expect M to decline (producing a positive sign).

The expected positive sign of $\partial M/\partial X$ results when the monetary authorities attempt to influence X by encouraging stable domestic prices. If domestice prices rise relative to foreign prices, then one would expect X to decrease. If X decreases, the monetary authorities will attempt to stabilize the price level by decreasing M (resulting in a positive sign). If X increases, then the reaction by the monetary authorities would probably be one of maintaining the current conditions. The expected sign of $\partial M/\partial X^*$, remains positive for the same reasons.

The expected negative sign of $\partial M/\partial L$ results because the monetary authorities would react to an increase in L by attempting to raise U.S. interest rates relative to foreign rates in order to prevent large short-term capital outflows. If one assumes a simple IS-LM model as opposed to a Friedman model, then interest rates would rise when M decreased (resulting in a negative sign). If L declines, short-term capital would either start leaving the country at a slower rate or start coming in at a faster rate; under such conditions, the monetary authorities would be expected to maintain the prevailing conditions or if the international situation dictated, attempt to lower L even further by lowering M. The expected sign of $\partial M/\partial E$ remains negative for the same reasons.

The expected negative sign of $\partial r/\partial Y^*$ results because as Y* increases, the monetary authorities would be expected to lower r in hope of stimulating aggregate demand. If Y* decreases and approaches zero, the monetary authorities would be expected to raise r to reduce investment and aggregated demand because of probable inflationary pressures. The expected sign of $\partial r/\partial Y$ remains negative for the same reasons.

Critique Of Reaction Function Analysis

Christian,[30] Keran and Babb,[31] and Wood[32] have pointed out certain criticisms of reaction function analysis. They point out the contemporaneous reaction functions and the structure of the economy; as a consequence, biased objective coefficients result because the "effects" from endogenous relationships cannot be separated from the "weights"

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[30]Christian, p. 467.

[31]Michael W. Keran and Christoper T. Babb, "An Explanation of Federal Reserve Actions (1933-68)," Review, Volume 51, No. 7, Federal Reserve Bank of St. Louis, July, 1969, pp. 19-20.

[32]John H. Wood, "A Model of Federal Reserve Behavior," Monetary Process And Policy: A Symposium, George Horwich, editor, (Homewood, Illinois: Richard D. Irwin, Inc., 1967), p. 142.

given to policy objectives by the monetary authorities without independent information. This criticism has two aspects, one concerning the endogenous characteristics of indicators of monetary policy and the other concerning the direction of causation. First, and as indicated previously, "ideal" indicators of monetary policy do not exist, meaning the indicators used in this study are influenced by monetary policy and other forces in the economy. Therefore, the policy objective coefficients do not reveal the "true" magnitude of the weights; only an "ideal" indicator will reveal the "true" magnitude of the weights.

Even if ideal indicators were used, the second aspect of the problem could make the single-equation coefficients inconsistent. Such a situation could occur if the monetary authorities influence the variables to which they respond (policy objectives) in a time period less than the time period of observations (one quarter). If the length of time it takes monetary policy to affect the policy objectives falls short of the time period of observation (one quarter in this study), then a problem of separating "effects" and "weights" exists, assuming that conditions in the current time period primarily influence monetary policy and the policy objective measures. More explicitly, if the outside lag occurs within one quarter, inconsistent reaction function estimates will result.

The length of the outside lag is an empirical question. Thomas Mayer, in a survey article, indicates that the outside lag for the M, M', and F indicators ranged from between two and eight quarters.[33]

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[33] Thomas Mayer, Monetary Policy In The United States, (New York: Random House, 1968), pp. 182-189.

Therefore, the reaction functions employing the M, M', and F indicators do not encounter the difficulty of inconsistent reaction function estimates. The outside lag for the other indicators remains unknown.

This study deals primarily with determining whether the evidence supports the existence of stability in the reactions of the monetary authorities as they encounter conflicting objectives. This purpose can be achieved, even though the "true" weights attached to the policy objectives remain concealed, by testing to see whether the relative weights of the objective coefficients remain significantly the same over time.

Results Of Multiple Linear Regression Analysis

Reaction function estimates employ the statistical techniques of multiple linear regression analysis. This section presents the estimates. The reaction function equations employ quarterly data (see Appendix A). The time period chosen for this study includes 1951-III to 1969-IV because stabilization related monetary policy was difficult to pursue prior to the Treasury-Federal Reserve Accord of March 4, 1951. The only exceptions to this time period involve the regression equations containing I as the dependent variable. Because the data to calculate I became available for the first time in 1961-I, the I indicator equations are estimated only between the periods 1961-I to 1969-IV.

This study employs a Koyck lag, used by Dewald and Johnson in order to simulate the procedures of the monetary authorities in enacting monetary policy when making continuous adjustments to errors in the economy. The use of the Koyck distributed lag technique imposes the assumption of an exponentially diminishing distributed lag on the indicator of monetary policy when the monetary authorities respond to changes in the measures of the policy objectives. Thus, the same pattern of response weights applies to each policy objective. Because of the foregoing restrictive assumption and because the primary purpose of this study involves testing policy objective coefficients for stability, this study uses only the Koyck lag. The empirical rationale and interpretation of distributed lags was discussed in Chapter II and will be further treated in Chapter IV.

This study conducts two tests to determine whether multicollinearity seriously impairs interpretation of some of the parameters of the regression equation. First, the matrix of simple correlation coefficients for each reaction function is examined. Table V presents the results from equation 16 in order to illustrate the examination procedure.

TABLE V

MATRIX OF SIMPLE CORRELATION COEFFICIENTS

	P	G	U	X	L	B_{t-1}
P	1.000					
G	.073	1.000				
U	.064	-.727	1.000			
X	.061	-.127	-.008	1.000		
L	-.093	-.309	.174	-.102	1.000	
B_{t-1}	.064	.324	-.383	-.214	-.082	1.000

Table V shows the G and U correlation coefficients large enough to cause some concern. Therefore, an additional test is employed in order to examine further the importance of the inter-correlations. The second test for multicollinearity involves re-estimating equation 16 (or any other reaction function) six different times--each time eliminating one of the policy objectives.[34] If upon deletion of the X objective, the U coefficient noticeably changes, then examination of how the X coefficient changes when the U objective is deleted should follow. (See Table VI).

TABLE VI

MULTICOLLINEARITY TEST BY VARIABLE DELETION

Dependent Variable	P	G	U	X	L	B_{t-1}
B	.012	4.969	-.080	-.007	-.024	.316
B		5.953	-.066	-.001	-.025	.329
B	.014		-.123	-.018	-.031	.316
B	.009	9.678		.007	-.020	.353
B	.012	6.280	-.075	.000		.319
B	.016	4.911	-.134	-.041	-.026	

If the U and X coefficients noticeably change in both cases, then grounds exist for suspecting multicollinearity problems between the two objectives. If only one of the coefficients noticeably changes, then one may not conclude that multicollinearity exists. If neither

[34]A visual inspection method is used to determine if the coefficients change enough to be of concern. Emanuel Melichar, "Least Squares Analysis of Economic Survey Data," 1965 Proceedings Of The Business And Economics Section Of The American Statistical Association, (Philadelphia 1965), p. 382.

coefficient changes noticeably, then one may conclude that multicollinearity problems do not exist between the two variables.

For equation 16, the variable deletion test, as shown in Table VI, indicates possible multicollinearity problems between G and U, X and P, X and L, X and U, X and B_{t-1}, and L and G. G and U represent the only combination to indicate multicollinearity. When one deletes the G objective, the U coefficient noticeably changes; and when one deletes the U objective, the G coefficient noticeably changes. In terms of the evidence, one may not conclude multicollinearity exists between the other variables.

This study does not show the two multicollinearity tests for all nineteen equations; however, the following paragraph points out any existing multicollinearity problems.

Multicollinearity problems in this study are assumed to exist if both tests indicate high intercorrelations among the independent variable combinations. Between equation 5 and 17, multicollinearity problems appear between two variables. The two variables with simple correlation coefficients in parentheses include G and U (-.727) in equations 6 and 16. The correlated variables in equations 18 to 23 include P and I_{t-1} (.825); in equations 18 and 19, U and E (-.391); in equation 20, Z and I_{t-1}(.919); in equations 22 and 23, Z and Y (-.900); and in equation 22, Z and Y* (-.906) in equation 23.

Autocorrelation refers to statistical relationships which violate the assumption of serial independence of the disturbance term: successive disturbances would thus show correlation. Omission of certain variables or measurement errors cause autocorrelation problems.

The Durbin-Watson "d" statistic provides a suitable test for detecting the presence of positive autocorrelation if the form of the model does not contain a lagged dependent variable. Since all of the equations being tested in this study employ a lagged dependent variable, the Durbin-Watson "d" statistic becomes inappropriate. For cases in which a lagged dependent variable is present, Durbin suggests using a test "asymptotically valid for the large-sample" case.[35] This study refers to the test as the Durbin "h" statistic or test.[36] The equations in which the "h" test indicates the absence of positive autocorrelation include those employing the M', T, and I dependent variables.

Autocorrelation problems can be eliminated by transforming the variables, using first difference transformations.[37] After the transformation, the Durbin "h" statistic indicated no autocorrelation problems, except for one equation with F as the dependent variable.

The following material presents the results of subjecting the nineteen tentative models to multiple linear regression analysis. The number in parentheses below each coefficient represents the

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[35] J. Durbin, "Testing for Serial Correlation in Least-Squares Regression When Some of the Regressions Are Lagged Dependent Variables," Econometrica, 38, No. 3 (May 1970), pp. 410-419.

[36] Since the Durbin "h" statistic follows the standard normal distribution (zero mean and unity variance), a 95% confidence level was used with a critical value of +1.645.

[37] Ronald J. Wonnacott and Thomas H. Wonnacott, Econometrics, (New York: John Wiley and Sons, Inc., 1970), p. 140.

standard error of the respective coefficient. The coefficient of determination, R^2, the standard error of the estimate, SEE, the Durbin "h" statistic, h, and the F ratio, F, represent statistical measures listed below each equation.

(5) $$\underset{}{M = -.00027} - \underset{(.00005)}{.00002\,P} + \underset{(.00009)}{.00009\,G'} + \underset{(.00022)}{.00005\,U} + \underset{(.00024)}{.00015\,X} - \underset{(.00014)}{.00011L} + \underset{(.09147)}{.74408\,M_{t-1}}$$

R^2 = .55589 SEE = .00076 F = 13.76871 h = 1.206

(6) $$M = .00000 - \underset{(.00005)}{.00005\,P} + \underset{(.02633)}{.06839\,G} + \underset{(.00030)}{.00060\,U} + \underset{(.00023)}{.00023\,X} - \underset{(.00013)}{.00006L} + \underset{(.08895)}{.69318\,M_{t-1}}$$

R^2 = .59052 SEE = .00073 F = 15.86303 h = .711

(7) $$M' = -.01648 + \underset{(.02479)}{.01810\,P} + \underset{(.05828)}{.09113\,G'} - \underset{(.05756)}{.00414\,U} + \underset{(.11866)}{.11633\,X} + \underset{(.05887)}{.04226L} + \underset{(.10195)}{.67498\,M'_{t-1}}$$

R^2 = .50988 SEE = .48087 F = 11.61709 h = 1.200

(8) $$M' = -.31195 + \underset{(.02571)}{.00870\,P} + \underset{(.62093)}{.55228\,G} + \underset{(.05725)}{.01899\,U} + \underset{(.12011)}{.12593\,X} + \underset{(.06092)}{.01438\,L} + \underset{(.10370)}{.70022\,M'_{t-1}}$$

R^2 = .49793 SEE = .48670 F = 11.07453 h = 1.113

(9) $$r = .69856 + \underset{(.02207)}{.04195\,P} + \underset{(.03624)}{.03363\,G'} - \underset{(.09963)}{.31881\,U} - \underset{(.09350)}{.12928\,X} - \underset{(.05603)}{.23996L} + \underset{(.10699)}{.23222\,r_{t-1}}$$

R^2 = .48799 SEE = .30825 F = 10.48390 h = .369

(10) $$r = -.05593 + \underset{(.02247)}{.03902}\,P + \underset{(11.24189)}{3.22020}\,G - \underset{(.14538)}{.30030}\,U - \underset{(.09584)}{.13271}\,X - \underset{(.05667)}{.24830}\,L + \underset{(.10482)}{.20847}\,r_{t-1}$$

$$R^2 = .48196 \qquad SEE = .31006 \qquad F = 10.23344 \qquad h = .453$$

(11) $$r = -.07142 + \underset{(.02229)}{.03943}\,P - \underset{(.05967)}{.01579}\,Y^* - \underset{(.15257)}{.30006}\,U - \underset{(.09492)}{.13443}\,X - \underset{(.05661)}{.24869}\,L + \underset{(.10656)}{.20997}\,r_{t-1}$$

$$R^2 = .48186 \qquad SEE = .31009 \qquad F = 10.22960 \qquad h = .440$$

(12) $$T = -.87149 + \underset{(.01790)}{.02042}\,P + \underset{(.03774)}{.03381}\,G' - \underset{(.04299)}{.01953}\,U + \underset{(.08676)}{.11617}\,X \quad \underset{(.04225)}{.01733}\,L + \underset{(.02063)}{1.04361}\,T_{t-1}$$

$$R^2 = .98432 \qquad SEE = .33616 \qquad F = 700.83301 \qquad h = .413$$

(13) $$T = .51106 + \underset{(.01709)}{.01852}\,P + \underset{(.90636)}{2.30023}\,G - \underset{(.04673)}{.07145}\,U + \underset{(.09342)}{.00900}\,X + \underset{(.03975)}{.00949}\,L + \underset{(.04730)}{.93649}\,T_{t-1}$$

$$R^2 = .98551 \qquad SEE = .32302 \qquad F = 759.96313 \qquad h = .564$$

(14) $$F = .01420 - \underset{(.01243)}{.01040}\,P - \underset{(.01953)}{.03859}\,G' + \underset{(.05327)}{.14873}\,U - \underset{(.05481)}{.03052}\,X + \underset{(.03108)}{.02226}\,L + \underset{(.11440)}{.38910}\,F_{t-1}$$

$$R^2 = .39876 \qquad SEE = .17117 \qquad F = 7.02582 \qquad h = 1.318$$

(15) $$F = -.01703 - \underset{(.01286)}{.00665}\,P - \underset{(6.20688)}{6.52400}\,G + \underset{(.07644)}{.09823}\,U - \underset{(.05654)}{.02376}\,X + \underset{(.03183)}{.02946}\,L + \underset{(.11471)}{.35123}\,F_{t-1}$$

$$R^2 = .36432 \qquad SEE = .17470 \qquad F = 6.30429 \qquad h = 1.655$$

(16) $$B = .01342 + \underset{(.01180)}{.01196}\,P + \underset{(5.75653)}{4.96924}\,G - \underset{(.06955)}{.08038}\,U - \underset{(.05143)}{.00710}\,X - \underset{(.02955)}{.02358}\,L + \underset{(.11474)}{.31638}\,B_{t-1}$$

$R^2 = .30961$ SEE $= .16212$ $F = 4.93301$ $h = 1.578$

(17) $$B = -.01066 + \underset{(.01140)}{.01536}\,P + \underset{(.01798)}{.03519}\,G' - \underset{(.04806)}{.11965}\,U - \underset{(.04965)}{.00039}\,X - \underset{(.02884)}{.01509}\,L + \underset{(.11351)}{.34987}\,B_{t-1}$$

$R^2 = .34009$ SEE $= .15850$ $F = 5.66899$ $h = 1.416$

(18) $$I = 1.09783 - \underset{(.37158)}{.13833}\,U - \underset{(.39561)}{.11607}\,G' + \underset{(.22309)}{.55628}\,P + \underset{(.29830)}{.13758}\,L - \underset{(.53910)}{.81329}\,X + \underset{(.11303)}{.78585}\,I_{t-1}$$

$R^2 = .95068$ SEE $= 1.21072$ $F = 93.15826$ $h = -.019$

(19) $$I = -.41095 + \underset{(.37618)}{.08061}\,U - \underset{(.37953)}{.04475}\,G' + \underset{(.21258)}{.58474}\,P + \underset{(.28913)}{.04708}\,L - \underset{(.52925)}{1.21476}\,X^{*} + \underset{(.10735)}{.77116}\,I_{t-1}$$

$R^2 = .95498$ SEE $= 1.15666$ $F = 102.53207$ $h = -.060$

(20) $$I = 1.89493 - \underset{(.46103)}{.54443}\,U + \underset{(.39610)}{.11846}\,G' + \underset{(.22713)}{.45954}\,P + \underset{(.58712)}{.84920}\,E - \underset{(.51248)}{.71882}\,X + \underset{(.13535)}{.65616}\,I_{t-1}$$

$R^2 = .95365$ SEE $= 1.17355$ $F = 99.46519$ $h = .154$

(21) $$I = .34577 - \underset{(.48006)}{.26940}\,U + \underset{(.38055)}{.11498}\,G' + \underset{(.21986)}{.50373}\,P + \underset{(.57972)}{.66527}\,E - \underset{(.51253)}{1.06240}\,X^{*} + \underset{(.13062)}{.67523}\,I_{t-1}$$

$R^2 = .95689$ SEE $= 1.13171$ $F = 107.31831$ $h = .127$

(22) $$I = -5.19460 + \underset{(.08255)}{.19817}\,Z + \underset{(.03579)}{.06101}\,Y + \underset{(.21870)}{.74502}\,P + \underset{(.56367)}{.18826}\,E$$

$$- \underset{(.51177)}{.70023}\,X^{*} + \underset{(.14681)}{.490151}\,I_{t-1}$$

$R^2 = .96356$ SEE = 1.04066 F = 127.80273 h = .479

(23) $$I = -5.13589 + \underset{(.08804)}{.19553}\,Z + \underset{(.21332)}{.31697}\,Y^{*} + \underset{(.22165)}{.72428}\,P + \underset{(.57726)}{.24287}\,E$$

$$- \underset{(.52102)}{.61406}\,X^{*} + \underset{(.14847)}{.49361}\,I_{t-1}$$

$R^2 = .96273$ SEE = 1.05236 F = 124.86963 h = .631

The next procedure involves evaluating the reaction function equations by using economic and statistical criteria in order to choose the selected equations.

Economic And Statistical Analysis Of The Reaction Function Equations Before Stability Tests

At least two regression equations per indicator of monetary policy exist. The criteria for determining the best equation with respect to each indicator of monetary policy follow. In Chapter IV, this study submits the selected equations to stability analysis.

The criteria used for selecting the best equations include

(1) the sign of the regression coefficients,

(2) the adjustment speed of the distributed lag structure,

(3) an examination of the goodness of fit (SEE and R^2), and

(4) the significance of the regression coefficients and the total equation (t tests and F tests).

Equations 5 and 6 are compared first. Both equations show the expected signs. Both equations also show a relatively slow adjustment speed, as did similar equations estimated by Dewald and Johnson. Equation 5 shows a weighted-average lag of 2.91 quarters and equation 6 shows a weighted-average lag of 2.26 quarters. In terms of the goodness of fit criterion, both equations show the coefficients of determination not being very high, with equation 6 being slightly better. Equations 5 and 6 show the SEE equaling .00076 and .00073 respectively. Equation 5 shows M_{t-1} significant at the 1% level. Equation 6 shows slightly better results in terms of significance because M_{t-1} and G appear significant at the 1% level and U shows significance at the 5% level. Equation 6 appears to be the better equation.

In equation 7 the unexpected signs include P, U, and L coefficients, and in equation 8, unexpected signs include the P and L coefficients. Both equations show slow adjustment speeds—a weighted-average lag of 2.13 quarters for equation 7 and 2.34 quarters for equation 8. In terms of the goodness of fit criterion, both coefficients of determination turned out relatively low, and the SEE's equaled .48087 and .48670 for equations 7 and 8 respectively. In both equations, the only statistically significant variables included the M'_{t-1} variables at the 1% level. Equation 8 appeared to be the better of the two equations.

In comparing equations 9, 10, and 11, all of the equations show an unexpected sign for the L variable. The adjustment speed for all three equations is relatively fast in comparison to equations 5 through 8. The average weighted lag for equation 9 equals .30 quarters; for equation 10, .26 quarters; and for equation 11, .27 quarters. The goodness of fit criterion shows all three equations having almost the same relatively low coefficient of determination. The SEE for equations 9, 10, and 11 turned out to be .30825, .31006, and .31009 respectively. Equation 9 shows the U, L, r_{t-1} variables statistically significant at the 1 per cent level and P statistically significant at the 5 per cent level. Equations 10 and 11 show L significant at the 1 per cent level and P, U, r_{t-1} significant at the 5 per cent level. Equation 9 will be tested for stability.

When comparing equations 12 and 13, both equations show P, U, and L to have unexpected signs. The adjustment speeds are unrealistic in comparison to other estimates. Equation 13 shows a weighted-average lag of 14.75 quarters and equation 12 shows a weighted-average lag that cannot be given an economic interpretation--it equals minus 23.93 quarters. The goodness of fit criterion shows both coefficients of determination high and the SEE's equaling .33616 and .32302 for equations 12 and 13 respectively. Equation 12 shows the T_{t-1} variable statistically significant at the 1 per cent level. Equation 13 shows T_{t-1} and G significant at the 1 per cent level. Equation 13 is slightly stronger than equation 12 in terms of the criteria, and will be tested for stability.

In terms of comparing equations 14 and 15, both equations show unexpected signs for X and L objectives. The adjustment speeds are faster than those shown by Dewald and Johnson. The weighted-average lag for equation 14 equals .64 quarters and for equation 15 it equals .54 quarters. The goodness of fit criterion shows equation 14 having a larger coefficient of determination. In both equations 14 and 15 the

SEE's equal .17117 and .17470 respectively. Equation 14 shows U and F_{t-1} significant at the 1 per cent level and G' significant at the 5 per cent level. Equation 15 shows F_{t-1} significant at the 1 per cent level. Equation 14 is chosen to be tested for stability.

In comparing equations 16 and 17, both have an unexpected sign for the L variable. Both equations show a relatively fast speed, with equation 16 showing a weighted-average lag of .46 quarters and equation 17 showing a weighted-average lag of .54 quarters. The goodness of fit criterion shows equation 17 having a higher coefficient of determination. The SEE for equations 16 and 17 equal .16212 and .15850 respectively. In terms of significance of parameters, equation 16 shows B_{t-1} significant at the 1 per cent level, and equation 17 shows U and B_{t-1} significant at the 1 per cent level and G' significant at the 5 per cent level. Equation 17 will be tested for stability.

Equations 18 to 23 are compared next. The unexpected signs include U in equation 19 and Y and Y* in equations 22 and 23 respectively. The adjustment speeds varied greatly among the equations. The weighted-average lag for each equation follows: 3.67 quarters for equation 18, 3.37 quarters for equation 19, 1.91 quarters for equation 20, 2.08 quarters for equation 21, .96 quarters for equation 22, and .97 quarters for equation 23.

The goodness of fit criterion shows similar results for both the coefficient of determination and the SEE tests. The equations show high coefficients of determination, and the SEE's equal 1.21072 for equation 18, 1.15666 for equation 19, 1.17355 for equation 20, 1.13171 for equation 21, 1.04066 for equation 22, and 1.05236 for equation 23. In terms of significance of parameters, equation 18 shows I_{t-1} and P significant at the 1 per cent level and X* significant at the 5 per cent level.

Equation 19 shows I_{t-1} and P significant at the 1 per cent level and X* significant at the 5 per cent level. Equation 20 shows I_{t-1} significant at the 1 per cent level and P significant at the 5 per cent level. Equation 21 shows I_{t-1} significant at the 1 per cent level and P and X* significant at the 5 per cent level. Equation 22 shows I_{t-1}, Z, and P significant at the 1 per cent level and Y and Z significant at the 5 per cent level. Equations 19 and 22 are chosen to be tested for stability.

The Z variable, which represents a time-trend variable, replaced the U variable in equations 22 and 23 because unemployment did not represent a major problem throughout most of the 1960's. The Z variable functions only to improve the statistical fit of the equation. The positive expected sign of $\partial I/\partial Z$ results because the money market index, I tended to rise throughout most of the time period.

To facilitate the discussion in this section, the eight equations selected for subsequent stability test analysis are presented as follows

(6) $M = .00000 - .00005\ P + .06839\ G + .00060\ U + .00023\ X$
$-.00006\ L + .69318\ M_{t-1}$

(8) $M' = -.31195 + .00870\ P + .55228\ G + .01899\ U + .12593\ X$
$+.04226\ L + .70022\ M'_{t-1}$

(9) $r = .69856 + .04195\ P + .03363\ G' - .31881\ U - .12928\ X$
$- .23996\ L + .23222\ r_{t-1}$

(13) $T = .51106 + .01852\ P + 2.30023\ G - .07145\ U + .00900\ X$
$+ .00949\ L + .93649\ T_{t-1}$

(14) $F = .01420 - .01040\ P - .03859\ G' + .14873\ U - .03052\ X$
$+ .02226\ L + .38910\ F_{t-1}$

$$(17)\quad B = -.01066 + .01536\ P + .03519\ G' - .11965\ U - .00039\ X - .01509\ L + .34987\ B_{t-1}$$

$$(19)\quad I = -.41095 + .08061\ U - .04475\ G' + .58474\ P + .04708\ L - 1.21476\ X^{*} + .77116\ I_{t-1}$$

$$(22)\quad I = -5.19460 + .19817\ Z + .06101\ Y + .74502\ P + .18826\ E - .70023\ X^{*} + .490151\ I_{t-1}$$

Considering all of the eight selected equations, the measures of the attainment of the growth objectives show the most consistent influence on monetary policy because they appear significant in five out of the eight equations. The measure of the employment objective shows the next most consistent influence on monetary policy because it appears significant in four out of seven equations (the employment objective does not appear in equation 22). The measure of the price stability objective shows some influence on monetary policy because it appears significant in three out of eight equations. Measures of the trade balance and short-term capital flow objectives show influence on monetary policy in only one out of eight equations.

The equations show conflicting results in terms of the length of the estimated inside lag. Equations employing monetary aggregates (6 and 8) show a weighted-average lag of over two quarters. In contrast, however, some equations employing money market condition indicators (9, 14, and 17) show a weighted-average lag of between .3 and .6 of a quarter. Equation 13 shows a weighted-average lag of over fourteen quarters—a result difficult to accept. Equations 19 and 22 use I as the indicator of monetary policy; however, the weighted-average lag for the two equations differ considerably. In equation 19 it equals 3.4 quarters; in equation 22 it equals .96 quarters.

The results from comparing the eight selected equations tentatively suggest that monetary policy (during the time period covered) was primarily influenced by the growth and employment objectives and secondarily influenced by the price stability objective. The results also suggest that the two balance-of-payments objectives influenced monetary policy the least. In terms of the inside lag, it can generally be concluded that money market indicators result in relatively short lags, whereas monetary aggregate indicators result in relatively long lags.

Equation 6 is selected as the best reaction function equation based on three criteria: the significance of the regression coefficients, the expected signs, and the structure of the distributed lag. Equation 6 shows the monetary authorities responding in a strong and significant manner to adverse movements in the measures of the growth objective and in a less strong, but still significant, manner to adverse movements in the measures of the employment objective. The price stability, balance-of-trade, and short-term capital flow policy objective coefficients are not significant at the 5 per cent level; however, the signs are as expected. The relatively long weighted-average lag of equation 6 (2.26 quarters) raises some important questions as to the speed and flexibility of monetary policy.

Examination of equation 6 tentatively indicates that the monetary authorities respond primarily to the growth and employment objective measures, with secondary emphases on the price stability, balance-of-trade, and short-term capital flow objective measures. The relatively long weighted-average inside lag implies that monetary policy responds slowly to adverse movements in the measures of the policy objectives.

Both the eight selected equations and equation 6 show the monetary authorities giving primary emphasis to the growth and employment objectives. Both also show the price stability, balance-of-trade, and capital flow objectives being given a secondary emphasis. In the eight selected equations, the price stability objective ranked first among those objectives given secondary emphasis. In equation 6, the price stability objective also received secondary emphasis (along with the balance-of-trade and short-term capital flow objectives), but with no rank ordering of the secondarily emphasized objectives possible. Also, in terms of the inside lag, equation 6 showed a relatively long lag structure, a result consistent with the analysis of the lag structures of the eight selected equations.

To this point, multiple linear regression analysis has been applied to economic data in order to arrive at estimates of the reaction function of monetary authorities. Findings thus far have essentially paralleled those of previous studies, with the additonal finding of some evidence that the monetary authorities respond to measures representing the balance-of-payments objective.

In Chapter IV, the eight selected equations will be subjected to stability tests, with the findings to be compared with those of Chapter III.

CHAPTER IV

STABILITY ANALYSIS

The first section of this chapter covers the policy objective characteristics of the time period covered in this study. Section two presents the moving regression and confidence interval analyses; section three presents the Chow test analysis; and section four presents the generalized dummy variable test analysis. Section five presents an economic and statistical analysis of the eight selected equations after they have been subjected to stability tests; the analysis allows identification of the equation which seems to describe best the reaction function of the monetary authorities. Section six involves interpretation of the major findings of the study.

Characteristics Of The Time Periods Covered

Before applying the stability tests, the characteristics of the time period under consideration (1951-III to 1969-IV) require analysis so that appropriate periods of concern for each policy objective may be chosen. Chart 3, which follows, provides a visual description of the time period under consideration. The three time periods between the vertical lines indicate three recessionary periods specified by the National Bureau of Economic Research.

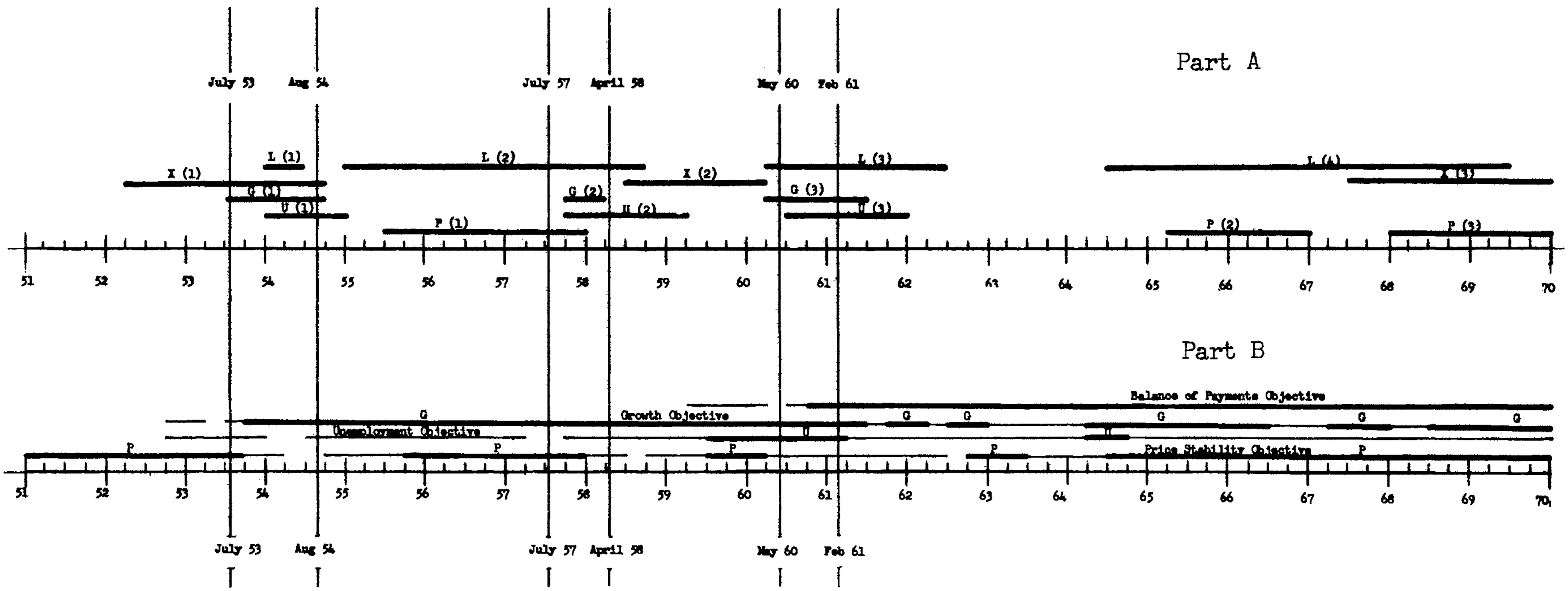

CHART 3

Time Period Analysis

Part A indicates the time periods when measures of the policy objectives fell short of attaining a desired level; the heavy lines represent the periods of concern. The following material provides the rationale for identifying the periods of concern.

Between 1952-I and 1969-IV, the rates of inflation varied from between .1 and 5.4 percentage points.[1] Three different groups of quarterly observations noticeably rose. The first two groups (1955-III to 1957-IV and 1965-II to 1966-IV) rose and then fell, and the third group (1968-I to 1969-IV) rose to a peak corresponding in time to the last quarterly time period of this study.

Between 1951-III and 1969-IV, the unemployment rate varied between 2.57 per cent and 7.37 per cent. During the time period covered by this study, the approximate acceptable unemployment rate fluctuated between 3 per cent and 5 per cent.[2] The three periods of concern indicated for the employment objective represent groups of quarterly observations in which the unemployment rate tended to rise to a peak, then begin to decline, either abruptly or gradually.

The growth objective fluctuated between -2.39 per cent and 2.96 per cent during the time period covered by the study. The three periods of concern were identified as those periods which tended to show negative growth in consecutive quarters.

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[1]The third and fourth quarters for 1951 showed over a 10 per cent rate of inflation but were not included as a period of concern because the data in all equations were transformed, using first differences. This procedure reduced the period of concern to one observation; periods of concern in this study include only multi-observations.

[2]George Leland Bach, Economics, An Introduction To Analysis And Policy, (Englewood Cliffs, N.J.: Prentice-Hall, Inc., 1971, Seventh Edition), p. 136.

The balance-of-trade objective measure (X) was identified as a period of concern during the three time periods when the measure approached zero or actually became negative. For those time periods, imports almost exceeded or did exceed exports.

The short-term capital flow objective showed four distinct groupings when the London Treasury bill rate exceeded the U.S. Treasury bill rate from between approximately 1 per cent to approximately 4 per cent.

The heavy lines in Part B of Chart 3 show the time periods when the policy directives from the FOMC meetings specifically mention each policy objective. The light lines show the time periods when the participants of the FOMC meetings discuss, but do not specifically mention in the directive, each policy objective.[3]

Part A shows a balance-of-payments variable for most of the 20-year period, while Part B shows the balance-of-payments variable important only during the 1960's. The price variable consistently occurs in Part B but appears only three times in Part A. Growth also consistently appears in Part B, but appears only during recession periods in Part A. Finally, employment appears during the recessions in Part A but appears only in two periods in Section B. For the entire 20-year periods, each policy objective encountered undesirable measurement levels more than once, with the monetary authorities encountering circumstances requiring reaction. Thus, the time period of this study would appear to be suitable for reaction function analysis.

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[3]This information was derived from the "Record of Policy Actions of the Board of Governors" published in the Annual Report of the Board of Governors of the Federal Reserve System from the years 1951 to 1969.

In terms of the equations involving the I indicator, the time period covered includes 1961-I to 1969-IV; as Chart 3 shows, the results could be biased since the growth and employment policy objectives did not present a problem during the period. The only variables in the time period 1961-I to 1969-IV that appear likely to reflect consistent reactions by the monetary authorities include the P and balance-of-payments objectives.

Table VII is shown so that the exact periods of concern as related to each objective may be easily identified.

TABLE VII

PERIODS OF CONCERN

	I	II	III	IV
P	55-3 to 57-4	65-2 to 66-4	68-1 to 69-4	
U	54-1 to 54-4	57-4 to 59-1	60-3 to 61-4	
G	53-3 to 54-3	57-4 to 58-1	60-2 to 61-2	
X	52-1 to 54-3	58-3 to 60-1	67-3 to 69-4	
L	54-1 to 54-2	55-1 to 58-3	60-2 to 62-2	64-3 to 69-2
Y*	53-4 to 55-1	56-1 to 65-2		
E	61-1 to 62-4	66-2 to 69-4		
X*	66-3 to 69-4			

Table VIII shows the periods of concern superimposed on a moving regression table.

TABLE VIII

PERIODS OF CONCERN IN THE MOVING REGRESSION TABLES

Date	P	G	U	X	L	Y*	E
51-4 to 56-3							
52-1 to 56-4				I			
52-2 to 57-1							
52-3 to 57-2							
52-4 to 57-3		I	I		I	I	
53-1 to 57-4							
53-2 to 58-1							
53-3 to 58-2	I						
53-4 to 58-3							
54-1 to 58-4							
54-2 to 59-1					II		
54-3 to 59-2							
54-4 to 59-3							
55-1 to 59-4							
55-2 to 60-1		II	II				
55-3 to 60-2							
55-4 to 60-3				II			
56-1 to 60-4							
56-2 to 61-1						II	
56-3 to 61-2							
56-4 to 61-3							
57-1 to 61-4							
57-2 to 62-1							
57-3 to 62-2							
57-4 to 62-3							
58-1 to 62-4							
58-2 to 63-1							
58-3 to 63-2		III	III		III		
58-4 to 63-3							
59-1 to 63-4							
59-2 to 64-1							
59-3 to 64-2							
59-4 to 64-3							
60-1 to 64-4							
60-2 to 65-1							
60-3 to 65-2							
60-4 to 65-3							I
61-1 to 65-4							
61-2 to 66-1							
61-3 to 66-2							II
61-4 to 66-3							

TABLE VIII
(Continued)

DATE	P	G	U	X	L	Y*	E
62-1 to 66-4							
62-2 to 67-1							
62-3 to 67-2	II						
62-4 to 67-3							
63-1 to 67-4							
63-2 to 68-1							
63-3 to 68-2							
63-4 to 68-3				III			
64-1 to 68-4							
64-2 to 69-1							
64-3 to 69-2	III						
64-4 to 69-3					IV		
65-1 to 69-4							

As shown in Table VIII some of the periods of concern overlap. The reason for the overlapping can be determined by an examination of the first and second periods of concern for policy objective G. The first period of concern includes all moving regression equations containing the time period 1953-III to 1954-III; the second period of concern includes all moving regression equations containing the time period 1957-IV to 1958-I. Moving regression equations 1953-II to 1958-I and 1953-III to 1958-II contain both of the periods of concern, thus, the reason for the overlapping time periods.

Appendix D shows the moving regression tables. Instead of presenting a detailed description of the analysis of each variable in each equation, a tabular summary of the results follows on page 85.

Moving Regression And Confidence Interval Analyses

The technique of moving regressions allows one to observe and test for significant movements of the coefficients of the policy objectives over a period of time.[4] In this study, with 74 quarterly observations in the single equation and with each sub-period arbitrarily chosen to contain twenty observations, fifty-four sub-period equations result, with the first sub-period containing observations one to twenty, the second sub-period containing observations two to twenty-one, and so on. As Christian pointed out, this technique provides a systematic scheme for specifying sub-periods to compare after the number of observations in each sub-period is chosen.

After constructing moving regression tables for each of the eight selected reaction function equations, one may test to see whether the regression coefficients significantly change over time.[5] A method that can be used to test for stability involves calculating confidence intervals for each regression coefficient. If the confidence intervals overlap, then one may not conclude that the regression coefficients differ. If the confidence intervlas do not overlap, then the regression coefficients differ statistically.

This study initially establishes confidence intervals at the 95 per cent level for each regression coefficient.[6] Next, two types of comparisons

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[4]Christian employed only the moving regression technique. "A Further Analysis of the Objectives of American Monetary Policy."

[5]A major shortcoming of Christian's study involves his failure to apply a statistical test to his moving regression equations in order to judge the temporal stability of the regression coefficients.

[6]Wonnacott and Wonnacott, p. 254.

are made. First, taking one of the eight selected equations at a time, using one objective at a time, the confidence interval of the regression coefficient of the particular objective of the particular selected equation concerned is compared to the confidence interval of each regression coefficient of each of the moving regression equations concerned. For example, one may observe how the confidence interval for the P variable in equation 9 (employing data from 1951-IV to 1969-IV) compares with all of the confidence intervals of the P variables in the moving regressions.

Second, for each of the eight sets of moving regression coefficients, the confidence intervals of the regression coefficients of the moving regression equation which are involved in a period of concern are compared to the confidence intervals of the regression coefficients of the other moving regression equations involved in the period or periods of concern. That is, periods of concern are compared with each other. For example, inflationary pressures occurred in the last half of the 1950's and the 1960's. By comparing the confidence intervals of the moving regressions for these two time periods, one may make a judgment as to the temporal consistency of monetary policy with respect to inflationary pressures. Table IX shows those variables which satisfy both of the foregoing comparisons.

Observations are made in two areas in terms of the moving regression and confidence interval analysis. The first observation concerns the temporal stability of reactions by the monetary authorities. The second observation concerns the stability of the coefficient of the lagged dependent variable. Table IX, on the following page, facilitates the discussion.

TABLE IX

EVIDENCE OF TEMPORALLY CONSISTENT REACTIONS TO THE POLICY OBJECTIVES AND STABLE LAGGED DEPENDENT VARIABLE COEFFICIENTS

EQUATION	POLICY OBJECTIVE COEFFICIENTS						STABLE LAGS
6	P	G	U	X	L		
8	P		U	X	L		M'_{t-1}
9	P		U	X			r_{t-1}
13	P		U	X			
14			U	X			F_{t-1}
17					L		B_{t-1}
19	P	G'	U	X*	L		I_{t-1}
22	P	Y		X*	E	Z	I_{t-1}

Observation one relates to the policy objective measures shown in Table IX. Two general comparisons of the confidence interval tests indicate that one may not conclude that the monetary authorities reacted differently or inconsistently over time. Out of the eight equations tested, seven equations showed evidence of a temporally consistent policy-formulating framework for the balance-of-trade variables (X and X*). The unemployment, U, and price stability, P, variables showed evidence of temporal stability in six out of eight equations.[7] The short-term capital flow variables (L and E) showed evidence of temporal stability in five out of eight equations, and the growth objective showed evidence in three equations. From equation 22, the time trend variable, Z showed temporal stability characteristics. Thus, the evidence supports the view that the monetary authorities employ a consistent policy-formulating framework.

Observation two relates to the interpretation of stability of the coefficients of the lagged dependent variables in terms of confidence intervals. Since the coefficients of the lagged dependent variables have no periods of concern, the single-equation coefficient of the lagged dependent variable of each of the eight selected equations is compared to the coefficients of the lagged dependent variables in the related moving regression equations. If the confidence intervals for the two coefficients overlap, then one may not conclude that statistical differences exist between the two lagged dependent variable coefficients. Overlapping confidence intervals imply that a probability exists in terms of the two coefficients' being statistically the same.

The coefficients of the lagged dependent variables in equations 8, 9, 14, 17, 19, and 22 show evidence of temporal stability, findings which indicate that the distributed lag structure can be accepted with confidence. The confidence intervals for equations 6 and 13 did not overlap in every instance, therefore no confidence can be attached to the lag structure.

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[7]Equation 22 did not use the U objective variable.

Chow Test Analysis

The Chow test[8] shows whether reaction functions estimated in two different time periods are significantly different . In order to apply the Chow test, the data must be divided into two periods. Except for the equations having I as the dependent variable, the two time periods are divided between 1962-IV and 1963-I. The first period covers from 1951-III to 1962-IV, and the second period covers from 1963-I to 1969-IV.

The characteristics of the first time period appear to be different from the characteristics of the second period.

In Part A of Chart 3, the data indicate that the growth and unemployment measures do not exhibit adverse movements in time period two; whereas, all measures of the policy objectives move adversely in the first time period. Part B of Chart 3 shows that the balance-of-payments problem appeared at the end of time period one; whereas it continuously appeared in time period two.

For the equations having I as the indicator of monetary policy, the two time periods are divided between 1964-IV and 1965-I. The first time period covers from 1961-I to 1964-IV; the second time period covers from 1965-I to 1969-IV. Dividing the time periods at the 1964-IV date places both the inflationary periods and the 1966 credit crunch in the second period.

The Chow test determines only whether "two sets of observations can be regarded as belonging to the same regression model," that is,

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[8] Gregory C. Chow, "Tests of Equality Between Sets of Coefficients in Two Linear Regressions," Econometrica, Volume 28, Number 3, (July 1960), pp. 591-605.

whether the regression models remain statistically the same in two time periods concerned.[9] If the equations remain statistically the same in two time periods, then the implication of stability exists for the single regression model. In this study the two sets of observations refer to the division of each reaction function into two time periods with N_1 and N_2 observations per period.

The Chow test is applied by using the following procedure.

(1) Combine the N_1 and N_2 observations and statistically estimate the regression equation. From the analysis of variance table, use the sum of squared residuals, S_1, with $N_1 + N_2 - k$ degrees of freedom where k equals the number of parameters estimated.

(2) Statistically estimate a regression equation for each time period and then obtain the two sums of squared residuals, S_2 and S_3, with $N_1 - k$ and $N_2 - k$ degrees of freedom, respectively.

(3) Add S_2 and S_3 together and obtain S_4, with $N_1 + N_2 - 2k$ degrees of freedom.

(4) Obtain $S_5 = S_1 - S_4$.

(5) Apply the F test:

$$F = \frac{S_5/k}{S_4/(N_1 + N_2 - 2k)}$$

with k and $N_1 + N_2 - 2k$ degrees of freedom.

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[9] Ibid., p. 591.

(6) If F > F (tabulated), then reject the hypothesis that the intercept and slope coefficients for the two sets of data come from the same regression model.

Table X shows the results of the Chow test as applied to the equations being tested for stability.

TABLE X

CHOW TEST

EQUATION	CHOW TEST	F TABULATED (5% LEVEL)
6	$F = \dfrac{\frac{.00002}{7}}{\frac{.00002}{59}} = 8.429$	2.15
8	$F = \dfrac{\frac{3.92597}{7}}{\frac{11.94482}{60}} = 2.817$	2.15
9	$F = \dfrac{\frac{.43464}{7}}{\frac{5.83648}{59}} = .628$	2.15
13	$F = \dfrac{\frac{.71930}{7}}{\frac{6.27142}{60}} = .983$	2.15
14	$F = \dfrac{\frac{.10696}{7}}{\frac{1.82670}{59}} = .494$	2.15

TABLE X
(Continued)

EQUATION	CHOW TEST	F TABULATED (5% LEVEL)
17	$F = \frac{\frac{.15918}{7}}{\frac{1.49880}{59}} = .895$	2.15
19	$F = \frac{\frac{14.07472}{7}}{\frac{24.72362}{22}} = 1.789$	2.35
22	$F = \frac{\frac{4.67375}{7}}{\frac{26.73250}{22}} = .549$	2.35

Examination of the data reveals that the Chow F test statistic exceeded the tabulated F statistic in the cases of both equations 6 and 8; thus, the two equations do not belong to the same regression model. Since according to the Chow test, both of the monetary aggregate models (equations 6 and 8) did not remain statistically the same for the two time periods, the findings indicate that the monetary authorities reacted with consistency only to the money market indicator models.

Generalized Dummy Variable Analysis

The "generalized dummy variable test"[10] shows whether specific coefficients in reaction functions estimated in two different time periods remain significantly the same.

This approach provides additional information because it allows one to determine whether two regression equations differ in intercept terms, or in specific slope coefficients, or both.

A simple example illustrates the generalized dummy variable technique. Assume that one wants to estimate the following relationships over a ten-year period to find out whether the observations from the first five-year period are governed by the same relationships as the second five-year period.

$$Y = f \ (X_1, X_2)$$

The procedure involves estimating an equation of the following form

$$Y = \alpha_0 + \alpha_1 \ D + \alpha_2 \ X_1 + \alpha_3 \ (D \ X_1) + \alpha_4 \ X_2 + \alpha_5 \ (D \ X_2)$$

where

$D = 1$, if the observations lie in the first five-year period

$= 0$, if the observation lies in the second five-year period.

α_1 represents the differential intercept coefficient while α_3 and α_5 represent the differential slope coefficients. If α_1 becomes statistically significant, then α_0 represents the intercept term

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[10] Damodar Gujarati, "Use of Dummy Variables in Testing for Equality Between Sets of Coefficients in Linear Regressions: A Generalization," American Statistician, 24, No. 5, (December, 1970).

for the second five-year period equation, and $\alpha_0 + \alpha_1$ represent the intercept term for the first five-year period equation. If α_1 becomes statistically insignificant, then α_0 represents the common intercept term for both five-year period equations. If α_3 becomes statistically significant, then α_2 represents the slope for X_1 in the second five-year period equation, and $\alpha_2 + \alpha_3$ represents the same slope for the first five-year period equation. If α_3 becomes statistically insignificant, then α_2 represents the common slope for X_1 in both equations. The same analysis holds for α_5 and α_4.

Therefore, with dummy variables, it becomes possible to specify whether the intercept and the slope coefficients remain statistically the same between two equations. The following dummy variable equations are statistically estimated to determine whether the intercept or slope values are consistent between the two time periods. The time periods used are the same as those used to divide the equations in the Chow test.

$$(6)\quad M = .00015 - .00026\ D - .00034\ P + \underline{.00031\ DP} + .11160\ G - .07678\ DG + .00095\ U - .00068\ DU + .00015\ X + .00006\ DX - .00055\ L + .00053\ DL + .72821\ M_{t-1} - .14894\ DM_{t-1}$$

$$(8)\quad M' = 3.55935 - 1.99484\ D - .25283\ P + \underline{.27419\ DP} - .50217\ G - 4.32887\ DG - .49593\ U + .62282\ DU + .04624\ X + .09619\ DX - .13560\ L + .14635\ DL + .48578\ M'_{t-1} + .16457\ DM'_{t-1}$$

$$(9)\quad r = -.09505 + .04054\ D + .13884\ P - .1171\ DP + .15975\ G' - .14145\ DG' + .00680\ U - .33615\ DU - .09178\ X + .00671DX - .28514\ L + .04902\ DL + .26899\ r_{t-1} - .06376\ Dr_{t-1}$$

(13) $T = -8.35156 + 10.94699\ D + .01579\ P - .01763\ DP + 24.07126\ G$
$\underline{-23.47145\ DG} + .58495\ U - .63397\ DU - .09918\ X + .25180\ DX$
$+ .00881\ L - .03265\ DL + .59237\ T_{t-1} + .26708\ DT_{t-1}$

(14) $F = .02075 - .00856\ D - .06727\ P + .06191\ DP - .01119\ G'$
$- .02717\ DG' + .04365\ U + .10311\ DU - .04471\ X + .04031\ DX$
$- .05156\ L + .08958\ DL + .25542\ F_{t-1} + .12923\ DF_{t-1}$

(17) $B = - .01070 + .00218\ D + .08791\ P\ \underline{- .07976\ DP} + .00805\ G'$
$+ .02613\ DG' - .06690\ U - .03838\ DU + .01529\ X - .03339\ DX$
$+ .06743\ L - .10252\ DL + .15523\ B_{t-1} + .22680\ DB_{t-1}$

(19) $I = 2.29894 - .36105\ D - 1.73703\ U + 1.60637\ DU - .15849\ G'$
$+ .22833\ DG' + .90106\ P - .54835\ DP + 2.34196\ L$
$\underline{-2.17636\ DL} - .28059\ X^* - \underline{1.05030\ DX^*} + .88186\ I_{t-1} + .18627\ DI_{t-1}$

(22) $I = -4.56117 - 4.49199\ D + .14514\ Z + .28273\ DX + .04137\ Y$
$+ .04958\ DY + .80202\ P + .02976\ DP + .60419\ E - 2.18610\ DE$
$-1.19138\ X^* + 1.08060\ DX^* + .44969\ I_{t-1} - .52240\ DI_{t-1}$

The results from application of the generalized dummy variable technique indicate that all of the intercept coefficients remain statistically the same in the two time periods tested. However, five out of the eight equations tested for stability showed differential slope coefficients to be significant, implying that the regression coefficients for the respective policy objectives significantly changed between the two time periods tested.

Equations 6, 8, and 17 showed the price stability coefficient to be statistically different between the two periods tested. Equation 13 showed the growth coefficient to be statistically different between the two periods. Equation 19 showed both the short-term capital flow and the balance-of-trade coefficients to be statistically different between the two periods. Equations 9, 14, and 22 showed all coefficients to be statistically the same for the two time periods tested.

Economic And Statistical Analysis Of Reaction Function Equations After Stability Tests

This section first considers the eight selected equations relative to the following criteria: (1) stability analysis, (2) expected signs of the coefficients, and (3) statistical significance of the coefficients. Since this first consideration involves comparison of individual regression coefficients only, inclusion of the Chow test in the stability analysis criterion would be inappropriate. In the second area of discussion, which involves the selection of the equation appearing most representative of the reaction function of monetary authorities, the Chow test is included with the other two stability tests in the first criterion.

Collectively, the equations imply that the monetary authorities respond primarily to the employment and price stability objectives. The employment objective satisfied the criteria in three out of seven equations; the price stability objective, in three out of eight equations. The growth and balance-of-trade objectives appeared to be of secondary concern because they satisfied the criteria only one of eight times. The short-term capital flow objective did not satisfy the criteria, implying that it received minimal concern. In terms of the inside lag results, all equations, except equation 6, satisfied the criteria.

From the eight equations tested for stability, equation 9 appears to be the most acceptable reaction function equation. In terms of the stability criterion, for all regression coefficients to be found stable, they must pass both the moving regression and the dummy variable tests for stability. For the reaction function equations to be considered stable, they must pass the Chow test for stability.

Equation 9 shows the price stability, P, unemployment, U, and lagged interest rate indicator, r_{t-1} variables satisfying the three criteria. The monetary authorities show the strongest reaction to unemployment pressures, with less strong reactions to pressures of price instability. The weighted-average lag in response is .30 quarters, relatively fast compared to other estimates. The balance-of-trade variable, X, had the expected sign and satisfied the stability criteria; however, it was not statistically significant. The growth variable, G, failed all but the expected sign criteria; and the L objective was statistically significant, but failed the other two criteria.

The foregoing findings imply that the monetary authorities react primarily to the employment and price stability objectives and secondarily to the balance-of-trade objective. No reaction was found for the growth objective. An unexpected sign and inconsistent reaction was found for the L objective coefficient. The results also imply that the monetary authorities' average responses to adverse movements in the objective measures was approximately one month.

Discussion Of Findings

Dewald and Johnson found that the monetary authorities reacted primarily to the growth and employment objectives, secondarily to the price stability objective, and negligibly to the balance-of-payments objective. They found the inside lag to be relatively long when the indicator variable was a monetary aggregate and relatively short when the indicator was a money market variable.

Christian found that the monetary authorities react on a temporally consistent basis to growth and employment objectives. He found the price stability and balance-of-payments objectives and the lagged dependent variables unstable.

Prior to stability test analysis, this study found that the monetary authorities reacted primarily to the growth and employment objectives, and secondarily to the price stability, balance-of-trade, and short-term capital flow objectives. The inside lag was found in most cases to be relatively long when a monetary aggregate indicator was used, and relatively short when a money market indicator was used.

After stability test analysis, this study found that the monetary authorities react primarily to the employment and price stability objectives, and secondarily to the balance-of-trade objective. The short-term capital flow and growth objectives were found to be of minimal importance.

CHAPTER FIVE

SUMMARY AND CONCLUSIONS

The monetary authorities maintain that they react to the confluence of circumstance at any particular time in reaching decisions about monetary policy; such a procedure implies a non-systematic reaction to policy objectives. Many economists argue, on the other hand, that the monetary authorities react on an implicit, temporally consistent basis. In order to determine which position actually prevails, a number of economists have investigated the reaction function of the monetary authorities.

Phillips identified some of the objective trade-offs that monetary authorities make when attempting to resolve conflicting policy goals. Reuber then estimated a reaction function for the implicit trade-offs.

Drawing upon Reuber's research, which he undertook for the Canadian Royal Commission on Banking and Finance, Dewald and Johnson undertook a similar study of the U.S. economy. They found that the monetary authorities reacted primarily to the unemployment and growth objectives, secondarily to the price stability objective, and negligibly to the balance-of-payments objective. They found the inside lag relatively long when they employed monetary aggregate indicators, and relatively short with money market indicators.

Subsequently, operating independently, Havrilesky and Christian attempted to improve upon the Dewald and Johnson study.

Havrilesky found that the monetary authorities reacted to the unemployment, growth, price stability, and foreign economic activity objectives. He assumed that the inside lag occurs within the initial quarter. Reflection upon the rationale of Havrilesky's economic methodology causes serious questions as to whether the findings are reliable.

Christian, as well as the previously mentioned researchers, used multiple linear regression analysis to estimate reaction functions. However, his methodology was refined by inclusion of moving regression analysis. Christian found that the monetary authorities responded consistently to the unemployment and growth objectives, but not to the price stability objective. He further found the distributed lag coefficient unreliable.

Borrowing the reaction function analysis from Reuber's and Dewald and Johnson's studies, Fisher used multiple linear regression analysis to estimate reaction functions of the British monetary authorities. His findings show the British monetary authorities responding to adverse movements in the measures of the employment, balance-of-payments, and price stability objectives. No policy response could be found for the growth objective. Fisher also found the inside lag to be relatively short.

The present study also treats the subject of reaction function analysis, but with still further methodological refinement. Christian anticipated the need for investigating the stability of reaction function equations when he employed moving regression analysis; instead of attaching confidence intervals to his regression coefficients, however, he relied upon visual inspection. Since multiple linear regression analysis of reaction functions assumes stability, the question of stability itself appears in need of examination.

Accordingly, this study, by employing multiple linear regression analysis with a distributed lag formulation, first proceeds to estimate nineteen tentative reaction function equations. Then the eight most representative equations are subjected to stability analysis. Stability tests used are moving regression analysis to whose coefficients confidence intervals are attached, the Chow test, and the dummy variable test.

Before stability analysis, the intermediate findings of this study show that the monetary authorities responded primarily to the unemployment and growth objectives, and secondarily to the price stability, balance-of-trade, and short-term capital flow objectives. Analysis of the inside lag reveals generally that monetary aggregate indicators resulted in relatively long lag estimates, and that money market indicators resulted in relatively short lag estimates. From the eight reaction function equations tentatively selected for stability analysis, a monetary aggregate equation appeared best to fit the economic and statistical criteria.

After stability analysis, the ultimate findings of this study show that the monetary authorities responded primarily to the unemployment and price stability objectives, secondarily to the balance-of-trade objective, with no response to the growth and short-term capital flow objectives. Analysis of the inside lag reveals findings similar to those before stability analysis. After the eight selected equations were re-evaluated in light of the application of stability tests, a money market indicator model appeared best to fit the economic and statistical criteria.

Finally, from the different reaction function studies, it is possible to compare the sets of policy objectives that cause the Canadian, British, and United States monetary authorities to respond when measures of the policy objectives move adversely. The Canadian monetary authorities respond primarily to the employment, productivity, and price stability objectives. The British monetary authorities respond primarily to the employment, price stability, and balance-of-payments objectives, and the United States monetary authorities respond primarily to the employment and price stability objectives and secondarily to the balance-of-trade objective.

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A P P E N D I X   A

REGRESSION DATA

REGRESSION DATA

YEAR / VARIABLE	B (Billions of Dollars)	F (Billions of Dollars)	T (Millions of Dollars)	M' (%)	r (%)	M (Trillions of Dollars)
51-3	.27500	.45200	19.266	1.270	1.628	.1197
51-4	.36400	.46000	19.990	1.838	1.649	.1219
52-1	.29400	.54400	20.224	1.313	1.640	.1235
52-2	.50300	.15900	19.895	.836	1.678	.12453
52-3	.93100	-.25200	20.452	1.017	1.829	.1258
52-4	1.39100	-.71500	20.845	1.007	1.924	.12707
53-1	1.28600	-.64200	20.631	.393	2.047	.12757
53-2	.84400	-.20600	20.063	.679	2.203	.12843
53-3	.51200	.20300	19.577	.156	2.022	.12863
53-4	.43000	.28000	19.725	.078	1.486	.12873
54-1	.19400	.55900	19.770	.285	1.084	.1291
54-2	.14700	.63300	19.532	.232	.814	.1294
54-3	.08200	.73400	18.682	.953	.870	.13063
54-4	.16400	.58200	19.126	1.021	1.036	.13197
55-1	.37700	.25400	18.856	1.162	1.256	.1335
55-2	.42100	.15800	18.754	.599	1.514	.1343
55-3	.71400	-.12800	18.754	.396	1.861	.13487
55-4	.91300	-.36500	19.004	.173	2.349	.1351
56-1	.86600	-.31000	18.924	.346	2.379	.13557
56-2	.93300	-.41100	18.838	.270	2.597	.13593
56-3	.80900	-.23100	18.881	.025	2.597	.13597
56-4	.71600	-.12800	19.214	.466	3.064	.1366
57-1	.62700	-.10900	18.998	.195	3.172	.13687
57-2	.97500	-.48500	18.965	.073	3.157	.13697
57-3	.97000	-.44000	18.973	.000	3.382	.13697
57-4	.77500	-.25700	19.139	-.536	3.343	.13623
58-1	.27700	.31400	19.009	-.122	1.838	.13607
58-2	.13000	.50800	18.409	1.396	1.018	.13797
58-3	.27900	.34100	18.538	.749	1.711	.139
58-4	.48900	.02500	18.638	1.223	2.788	.1407
59-1	.55500	-.08200	18.633	.947	2.80	.14203
59-2	.78800	-.36400	18.565	.751	3.019	.1431
59-3	.95600	-.52800	18.626	.396	3.533	.14367
59-4	.89600	-.43900	18.721	-.812	4.299	.1425
60-1	.78500	-.32000	18.373	-.842	3.943	.1413
60-2	.51000	-.06300	18.212	-.637	3.092	.1404
60-3	.31200	.26000	18.530	.285	2.390	.1408
60-4	.12600	.58800	19.007	.142	2.361	.1410

REGRESSION DATA

YEAR / VARIABLE	B (Billions of Dollars)	F (Billions of Dollars)	T (Millions of Dollars)	M' (%)	r (%)	M (Trillions of Dollars)
61-1	.08500	.56600	19.029	.449	2.377	.14163
61-2	.07200	.51800	18.927	.730	2.325	.14267
61-3	.05200	.53800	19.218	.514	2.325	.1434
61-4	.10600	.45900	19.873	1.046	2.475	.1449
62-1	.07600	.45700	19.737	.598	2.739	.14577
62-2	.07700	.42400	19.823	.297	2.716	.1462
62-3	.09900	.41800	20.000	-.159	2.858	.14597
62-4	.16300	.38700	19.950	.639	2.803	.1469
63-1	.14200	.31500	19.710	1.067	2.909	.14847
63-2	.18900	.23300	19.660	.920	2.941	.14983
63-3	.32400	.12800	19.895	.934	3.281	.15123
63-4	.33900	.11200	20.288	1.124	3.499	.15293
64-1	.27300	.12100	20.344	.567	3.538	.1538
64-2	.24600	.12300	20.362	.824	3.481	.15507
64-3	.31000	.10200	20.720	1.440	3.504	.1573
64-4	.32700	.08000	21.267	1.060	3.685	.15897
65-1	.37400	.02200	21.366	.608	3.90	.15993
65-2	.50100	-.15600	21.564	.750	3.879	.16113
65-3	.53900	-.15100	21.740	1.262	3.86	.16317
65-4	.46500	-.07700	22.212	1.675	4.159	.1659
66-1	.47700	-.13200	22.381	1.627	4.631	.1686
66-2	.67400	-.32400	22.516	1.107	4.597	.17047
66-3	.75300	-.37300	22.995	-.255	5.048	.17003
66-4	.63400	-.27300	23.471	.118	5.246	.17023
67-1	.31700	.07200	23.730	.881	4.534	.17173
67-2	.11900	.24700	23.388	1.534	3.657	.17437
67-3	.08900	.27900	23.966	2.447	4.345	.17863
67-4	.16600	.17900	24.869	1.381	4.787	.1811
68-1	.42300	-.04400	25.675	1.252	5.064	.18337
68-2	.70700	-.36000	25.588	1.818	5.510	.1867
68-3	.53500	-.18300	26.049	2.125	5.226	.19067
68-4	.58300	-.23600	26.886	1.433	5.581	.1934
69-1	.81300	-.59200	27.369	1.499	6.138	.1963
69-2	1.26800	-1.00300	27.433	1.104	6.240	.19847
69-3	1.16900	-.95000	27.010	.319	7.047	.1991
69-4	1.15400	-.91300	27.712	.117	7.318	.19933

REGRESSION DATA

YEAR / VARIABLE	P (%)	G (Trillions of [1958] Dollars)	G' (%)	U (%)	X (Billions of Dollars)	L (%)
51-3	10.300	.38870	1.890	3.17000	.92400	-1.11800
51-4	10.200	.38870	.000	3.37000	1.32209	- .87200
52-1	-1.900	.39140	.690	3.07000	1.02100	- .31700
52-2	-2.900	.38960	-.460	2.97000	.79700	.70500
52-3	-2.600	.39390	1.100	3.23000	.27900	.64100
52-4	-3.800	.40530	2.890	2.83000	.38400	.48300
53-1	-1.600	.41210	1.680	2.70000	.18500	.35600
53-2	-1.800	.41640	1.040	2.57000	.28800	.18400
53-3	- .700	.41370	-.650	2.73000	.24200	.30500
53-4	-1.400	.40880	-1.180	3.70000	.58900	.62100
54-1	.400	.40290	-1.440	5.27000	.30400	1.01300
54-2	.500	.40210	-.200	5.80000	.73900	1.01600
54-3	.200	.40720	1.270	5.97000	.46900	.73000
54-4	-.300	.41570	2.090	5.33000	.94800	.62100
55-1	-.100	.42800	2.960	4.73000	.69600	1.58700
55-2	-.100	.43540	1.730	4.40000	.74900	2.38600
55-3	.600	.44210	1.540	4.10000	.57600	2.15200
55-4	1.000	.44640	.970	4.23000	.72700	1.73400
56-1	1.500	.44360	-.630	4.03000	.70500	2.26800
56-2	3.100	.44560	.450	4.20000	1.24700	2.44000
56-3	3.600	.44450	-.250	4.13000	.95600	2.45300
56-4	4.700	.45030	1.300	4.13000	1.66700	1.93300
57-1	2.300	.45340	.690	3.93000	1.81100	1.18100
57-2	2.600	.45320	-.040	4.10000	1.81400	.75000
57-3	3.400	.45520	.440	4.23000	1.19700	1.03100
57-4	3.400	.44820	-1.540	4.93000	1.27700	3.18000
58-1	1.400	.43750	-2.390	6.30000	.91900	4.18500
58-2	1.500	.43950	.460	7.37000	1.02700	3.89900
58-3	1.300	.45070	2.550	7.33000	.21100	2.15900
58-4	1.300	.46160	2.420	6.37000	.67400	.63500
59-1	.200	.46860	1.520	5.83000	.21300	.37000
59-2	.500	.47990	2.410	5.10000	.19500	.32400
59-3	.200	.47500	-1.020	5.27000	.21100	- .06000
59-4	-.200	.48040	1.140	5.60000	.36900	- .82200
60-1	.100	.49020	2.040	5.13000	.78900	.46000
60-2	.200	.48970	-.100	5.23000	1.15000	1.61100
60-3	-.100	.48730	-.490	5.57000	1.14000	3.17300
60-4	.100	.48370	-.740	6.30000	1.66400	2.48600

REGRESSION DATA

YEAR \ VARIABLE	P (%)	G (Trillions of [1958] Dollars)	G' (%)	U (%)	X (Billions of Dollars)	L (%)
61-1	.300	.48260	- .230	6.80000	1.61900	1.97000
61-2	-.700	.49280	2.110	7.00000	1.46300	3.11800
61-3	-.700	.50150	1.770	6.77000	.99200	3.81200
61-4	-.600	.51170	2.030	6.20000	1.34800	3.09200
62-1	.400	.51950	1.520	5.63000	1.07100	2.46800
62-2	-.100	.52770	1.580	5.53000	1.37100	1.28400
62-3	.400	.53340	1.080	5.57000	.94700	.93500
62-4	.300	.53830	.920	5.53000	.99800	.90400
63-1	-.300	.54120	.540	5.77000	1.04000	.59400
63-2	-.600	.54600	.890	5.67000	1.48500	.74900
63-3	-.100	.55470	1.590	5.50000	.90300	.44200
63-4	.000	.56210	1.330	5.57000	1.62900	.22100
64-1	.300	.57110	1.600	5.43000	1.80200	.43900
64-2	-.200	.57860	1.310	5.23000	1.71400	.88200
64-3	.200	.58580	1.240	5.03000	1.27700	1.11900
64-4	.400	.58850	.460	4.93000	1.85600	1.81200
65-1	.700	.60150	2.210	4.83000	.99100	2.61000
65-2	1.700	.60970	1.360	4.67000	1.53600	2.23800
65-3	2.400	.62070	1.800	4.43000	.83300	1.69300
65-4	3.100	.63440	2.210	4.13000	1.36800	1.29100
66-1	2.600	.64540	1.730	3.80000	1.14800	.92900
66-2	3.100	.64930	.600	3.83000	1.08200	1.05600
66-3	4.000	.65480	.850	3.80000	.42200	1.53900
66-4	3.400	.66110	.960	3.67000	.98300	1.37700
67-1	.200	.66650	.820	3.67000	.94300	1.46600
67-2	.000	.67050	.600	3.83000	1.28900	1.64000
67-3	.400	.67800	1.120	3.93000	.71600	.98800
67-4	.500	.68350	.810	3.97000	.52900	1.77000
68-1	1.600	.69330	1.430	3.60000	.26300	2.32900
68-2	2.200	.70580	1.800	3.60000	.44400	1.63700
68-3	2.700	.71280	.990	3.60000	-.16600	1.72100
68-4	3.200	.71850	.800	3.43000	.08500	1.07900
69-1	2.300	.72310	.640	3.33000	.11000	1.03500
69-2	3.600	.72670	.500	3.47000	.15300	1.59300
69-3	4.300	.73060	.540	3.63000	-.18600	.77300
69-4	5.400	.72980	-.110	3.60000	.61300	.33900

REGRESSION DATA

YEAR	VARIABLE	Y* (%)	E (%)	X* (Billions of Dollars)	Z (Numbers)	Y (Billions of Dollars)	I (Index)
61-1		9.66	1.5	1.052	1.	51.6	-5.87170
61-2		8.54	1.325	.985	2.	46.0	-6.30090
61-3		7.71	1.072	.460	3.	41.9	-6.33840
61-4		6.64	1.008	.705	4.	36.4	-5.07740
62-1		6.02	.784	.467	5.	33.3	-4.48220
62-2		5.36	.857	.818	6.	29.9	-5.14600
62-3		5.16	.932	.336	7.	29.0	-4.70230
62-4		5.11	1.220	.383	8.	29.0	-3.92660
63-1		5.47	.738	.393	9.	31.3	-3.57510
63-2		5.50	.829	.701	10.	31.8	-3.79800
63-3		4.89	.739	.233	11.	28.5	-2.34220
63-4		4.50	.701	.937	12.	26.5	-1.88410
64-1		3.86	.652	1.131	13.	22.9	-2.15340
64-2		3.49	.749	1.031	14.	20.9	-2.88180
64-3		3.19	.766	.535	15.	19.3	-2.02740
64-4		3.64	1.025	1.14	16.	22.2	-1.48480
65-1		2.40	.683	.420	17.	14.8	- .45780
65-2		1.98	.894	.683	18.	12.3	- .27220
65-3		1.13	.85	.155	19.	7.1	.13940
65-4		-.13	.924	.702	20.	- .8	.57590
66-1		-.88	.726	.434	21.	-5.6	.77080
66-2		-.50	1.193	.289	22.	-3.2	1.75310
66-3		-.35	1.369	-.265	23.	-2.3	3.06580
66-4		-.33	1.861	.165	24.	-2.2	3.03720
67-1		-.17	1.386	-.023	25.	-1.1	2.28810
67-2		.21	1.343	.356	26.	1.4	1.25880
67-3		.09	.862	-.074	27.	.6	-1.41390
67-4		.26	1.193	-.305	28.	1.8	- .95310
68-1		-.17	.856	-.684	29.	-1.2	1.38220
68-2		-.99	1.41	-.453	30.	-6.9	4.57300
68-3		-.99	1.277	-.919	31.	-7.0	6.55540
68-4		-.81	.962	-.649	32.	-5.8	6.56720
69-1		-.47	1.545	-.517	33.	-3.4	6.67950
69-2		.01	2.843	-.928	34.	.1	11.50700
69-3		.46	3.583	-.836	35.	3.4	10.28730
69-4		1.54	3.192	-.131	36.	11.4	12.62740

FACTOR ANALYSIS DATA

Date	BRD of 8 N.Y. Money Market Banks	BRD of 38 other Money Mkt. Banks	Member Bank Borrowing	Gov. Security Dealer Borrowing	Fed. Res. Discount Rate
	Millions of Dollars	Millions of Dollars	Millions of Dollars	Millions of Dollars	%
1961-1	165.0	228.0	85.0	2564.0	3.00
1961-2	13.0	120.0	72.0	2396.0	3.00
1961-3	108.0	11.0	52.0	2555.0	3.00
1961-4	337.0	178.0	106.0	3360.0	3.00
1962-1	250.0	184.0	76.0	2687.0	3.00
1962-2	230.0	93.0	77.0	3753.0	3.00
1962-3	357.0	223.0	99.0	2994.0	3.00
1962-4	418.0	407.0	163.0	4002.0	3.00
1963-1	539.0	380.0	142.0	3881.0	3.00
1963-2	415.0	177.0	189.0	3558.0	3.00
1963-3	433.0	241.0	324.0	3429.0	3.50
1963-4	381.0	490.0	339.0	3368.0	3.50
1964-1	401.0	388.0	273.0	3421.0	3.50
1964-2	275.0	175.0	246.0	3004.0	3.50
1964-3	288.0	447.0	310.0	4118.0	3.50
1964-4	214.0	516.0	327.0	3468.0	4.00
1965-1	632.0	343.0	374.0	3677.0	4.00
1965-2	208.0	502.0	501.0	3774.0	4.00
1965-3	208.0	749.0	539.0	3775.0	4.00
1965-4	365.0	733.0	465.0	2957.0	4.50
1966-1	241.0	774.0	477.0	2325.0	4.50
1966-2	416.0	467.0	674.0	2700.0	4.50
1966-3	438.0	988.0	753.0	2255.0	4.50
1966-4	495.0	1041.0	634.0	3385.0	4.50
1967-1	876.0	1423.0	317.0	4584.0	4.50
1967-2	775.0	1364.0	119.0	3679.0	4.00
1967-3	469.0	848.0	89.0	2511.0	4.00
1967-4	120.0	720.0	166.0	2691.0	4.50
1968-1	243.0	763.0	423.0	3220.0	5.00
1968-2	647.0	816.0	707.0	3231.0	5.50
1968-3	1876.0	1290.0	535.0	5108.0	5.25
1968-4	1092.0	1953.0	583.0	4380.0	5.50
1969-1	615.0	1556.0	813.0	2694.0	5.50
1969-2	1109.0	2295.0	1268.0	3163.0	6.00
1969-3	440.0	2299.0	1169.0	2499.0	6.00
1969-4	1101.0	2961.0	1154.0	3202.0	6.00

APPENDIX B

SOURCES OF THE REGRESSION DATA

APPENDIX B

SOURCES OF THE REGRESSION DATA

Variable	Source
B	1951-1969, computed from averages of daily figures. The 1951 to 1966 quarterly averages were computed from data found in *Business Statistics, The Biennial Supplement To The Survey of Current Business, 1967*. pp. 87 and 235 to 236. The data for 1967 to 1969 quarterly averages were found in the February issues of the *Federal Reserve Bulletin* from 1968 to 1970.
M	1951-1969, computed from averages of monthly figures. The monthly figures from 1951 to February 1969 are from the *Federal Reserve Bulletin*, October 1969, pp. 790-793. The remainder of the 1969 monthly data are from the *Federal Reserve Bulletin*, April 1970, p. 17.
M'	1951-1969, computed from averages of monthly figures. The monthly figures from 1951 to February 1969 are from the *Federal Reserve Bulletin*, October 1969, pp. 790-793. The remainder of the 1969 monthly data are from the *Federal Reserve Bulletin*, April 1970, p. 17.
r	1951-1969, computed from monthly averages of new issues from New York City Open Market rates. The 1951 to 1966 quarterly averages were computed from data found in *Business Statistics, The Biennial Supplement To The Survey Of Current Business*, U.S. Department of Commerce, 1967, pp. 90 and 237. The data for 1967 to 1969 quarterly averages were found in the February issues of the *Federal Reserve Bulletin* from 1968 to 1970.
T	1951-1969, computed from averages of daily figures. The 1951 to 1966 quarterly averages were computed from data found in *Business Statistics, The Biennial Supplement To The Survey Of Current Business, 1967*, pp. 87 and

Variable	Source
	235 to 236. The data for 1967 to 1969 quarterly averages were found in the February issues of the Federal Reserve Bulletin from 1968 to 1970.
I	1961-1969, computed from a factor analysis of seven money market variables. For the source of the treasury bill rate, see r and for the source of free reserves, see F. Data for basic reserve deficiencies for 8 New York Money Market and 38 other Money Market Banks, member bank borrowing, government security dealer borrowing, and the Federal Reserve discount rate are in the Federal Reserve Bulletins for the years 1961 to 1970.
G	1951-1969, quarterly totals at annual rates. The 1951 to 1966 data were found in Business Statistics, The Biennial Supplement To The Survey Of Current Business, 1967, pp. 1 and 195. The remaining data came from the Survey Of Current Business, March 1970, p. s-1.
G'	1951-1969, computed from averages of monthly data. The 1951 to 1966 data were found in Business Statistics, The Biennial Supplement To The Survey Of Current Business, 1967, pp. 1 and 195. The remaining data came from the Survey Of Current Business, March 1970, p. s-1.
U	1951-1969, computed from averages of monthly data. The 1951 to 1966 data were found in Business Statistics, The Biennial Supplement To The Survey Of Current Business, 1967, pp. 66 and 228. The remaining data came from the Survey Of Current Business, February 1968 to 1970.
P	1951 to 1969, computed from monthly averages of the Wholesale Price Index where 1957 to 1959 equals 100. The 1951 to 1966 data were found in Business Statistics, The Biennial Supplement To The Survey Of Current Business, 1967, pp. 41 and 220. The remaining data came from the Survey Of Current Business, February 1968 to 1970.

Variable	Source
L	1951-1969, computed from the difference between the London Treasury Bill rate and the United States Treasury Bill rate (see r). The London Treasury Bill rates are computed from monthly averages. The 1951 to 1960 data were found in Supplement to Banking And Monetary Statistics (Section 15, International Finance), Board of Governors of the Federal Reserve System, March 1962, pp. 75-77. The 1961 to 1969 data were found in the February issues of the Federal Reserve Bulletin for the years 1962 to 1970.
E	1961-1969, computed from the difference between the London Euro-Dollar rate and the United States Treasury Bill rate (see r). The London Euro-Dollar rates are computed from monthly averages. The 1960 to 1968 data are found in "An Analytical Record of Yields and Yield Spreads," Salomon Brothers and Hutzler, 1969, pp. 68 to 77. The 1969 data were found in a supplement to the above source, p. 16.
X	1951-1969, computed from the difference between non-military exports and non-military imports which were computed from monthly averages. The 1951 to 1952 data were found in the Balance Of Payments Statistical Supplement, U.S. Department of Commerce, Office of Business Economics, 1958, p. 16. The remaining data were taken from the June issues of the Survey Of Current Business.
X*	1961-1969, computed from the difference between non-military exports and the sum of non-military imports minus exports financed by Government grants and capital. The non-military exports and the non-military imports data are from the same sources as X. The data for exports financed by Government grants and capital are taken from the following issues of Survey Of Current Business, June 1965, December 1965, March 1967, June 1967, December 1968, and March 1970.

Variable	Source
Y	1951-1969, computed from the difference between potential GNP and actual GNP. See G for the source of data. The third quarter of 1955 is the "full-employment" quarter which is used as the base period to calculate potential GNP and the unemployment rate was 4.1%. From 1951 to 1962, growth was assumed to be 3.5%, from 1963 to 1965 it was assumed to be 3.75% and from 1966 to 1969 it was assumed to be 4%.
Y*	1951-1969, computed by dividing potential GNP into Y. For the source of the data see Y.

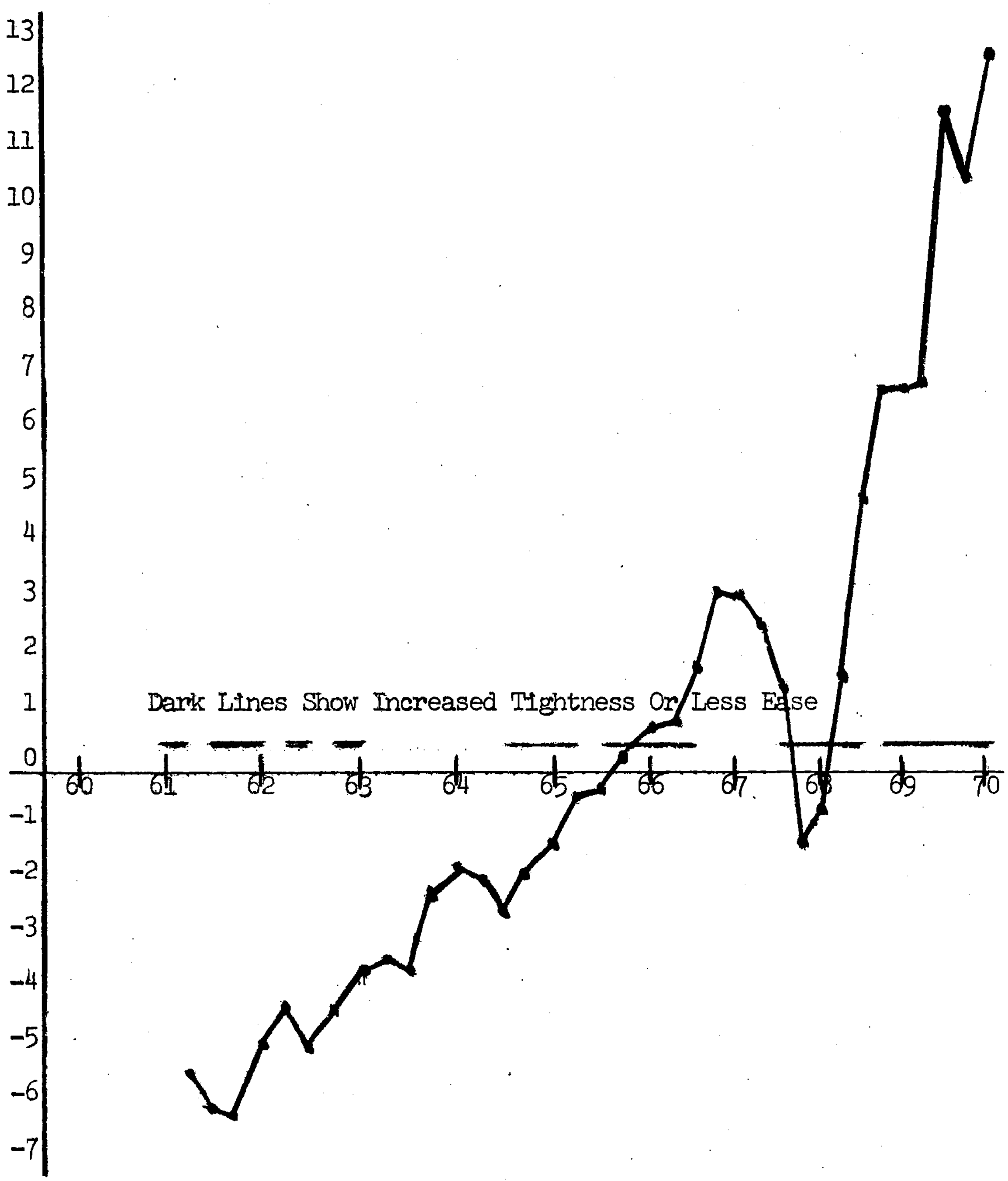
A P P E N D I X   C

MONEY MARKET INDEX

Chart 4 shows the money market index (I) as it changes over time. The index is calculated on a quarterly basis and the larger the index becomes (in positive values), the greater the money market pressure.

Chart 4

Money Market Index



It is interesting to note how closely the I index corresponds to the periods when the FOMC directed the trading desk to either increase tightness or reduce the ease of monetary policy.[1] Thus, the I index was used as an indicator of monetary policy in this study.

The technique of deriving the index of money market tightness is the same as that used by Andersen and Levine.[2] The first step involves applying factor analysis to the variables used to indicate tightness or ease in the money market. In this study the variables include the 90-day Treasury bill rate, free reserves, the basic reserve deficiency of eight New York money market banks, the basic reserve deficiency of thirty-eight non-New York money market banks, member bank borrowing, government security dealer borrowings, and the Federal Reserve discount rate. From the factor analysis results, hypothetical variables called factors are derived such as the factor shown in Table XI.

The column in Table XI is referred to as a factor and the variables are referred to as factor loadings. The factor in Table XI has an eigenvalue of 5.00583 and Andersen and Levine indicate that

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[1]Except for 1963 and the last three quarters of 1969, the stance of monetary policy is based on Allan Meltzer's "Scaling of the Federal Reserve's Policy Decisions." The exceptions are time periods following Meltzer's study; an examination of summaries of the FOMC meetings printed in the Annual Report of the Board of Governors of the Federal Reserve System is used to scale the period. Karl Brunner and Allan Meltzer, "The Federal Reserve's Attachment to the Free Reserve Concept." A Staff Analysis, Subcommittee on Domestic Finance. Committee on Banking and Currency, House of Representatives, 88th Congress, 2nd Session, 1964. Also, Allan Meltzer, "The Appropriate Indicators of Monetary Policy."

[2]Leonall C. Andersen and Jules E. Levine, "A Test of Money Market Conditions as a Means of Short-Run Monetary Management," National Banking Review, Vol. 4, No. 1 (September, 1966), pp. 41-51.

TABLE XI

FACTOR LOADINGS

Treasury Bill Rate	.96914
Free Reserves	-.95388
Basic Reserve Deficiency of 8 New York Money Market Banks	.68458
Basic Reserve Deficiency of 38 non-New York Money Market Banks	.93135
Member Bank Borrowing	-.93362
Government Security Dealer Borrowing	.13243
Federal Reserve Discount Rate	.96512

any eigenvalue magnitude of 1.0 or greater can be judged significant.[3] Also, the eigenvector in Table XI accounts for 71.5 per cent of the total variance of the seven money market variables used in the factor analysis.

It should also be noted that the signs of the factor loadings in Table XI are consistent with theory except for the B variable. The theory indicates that money market pressure is negatively related to free reserves and positively related to the remaining money market variables.

The factor may represent "nation-wide" money market pressure because the variables "which are generally national in scope" are weighted more heavily than the variables which are primarily related to the New York money market (the basic reserve deficiency of eight New York money market banks and government security dealer borrowings).[4]

Step two utilizes the factor loading weights in calculating the money market index I, shown in Chart 4. The I is calculated as follows:

$$I_t = \sum_j F_{ij} U_j \text{ ; where}$$

I_t = the money market index

F_{ij} = the factor loading for the j^{th} variable in the i^{th} factor. In this case the i is equal to the factor in Table XI.

$$U_j = \frac{X_j - \bar{X}_j}{\sigma X_j}$$

[3]Ibid., p. 47.

[4]Ibid., p. 48.

X_j = observations of each money market variable.[5]

The data used for each of the money market variables includes quarterly averages calculated from daily averages; not seasonally adjusted. The I values calculated from 1960-IV to 1969-IV are shown in Appendix A.

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[5] Ibid.

APPENDIX D

MOVING REGRESSION TABLES

EQUATION 6

MOVING REGRESSIONS

DATE	P	G	U	X	L	M_{t-1}
51-4 to 69-4	-.000	.068**	.001*	.000	-.000	.693**
51-4 to 56-3	-.000	.042	.000	.000	.000	.567*
52-1 to 56-4	-.000*	.076**	.000	-.000	.000	-.066
52-2 to 57-1	-.000	.081**	.000	-.000	.000*	-.063
52-3 to 57-2	-.000	.099**	.000	.000	.000*	-.209
52-4 to 57-3	-.000	.086**	.000	.000	.000*	-.056
53-1 to 57-4	-.000	.087**	.000	.000	-.000	.142
53-2 to 58-1	-.000	.087**	.000	-.000	-.000	.179
53-3 to 58-2	-.000	.125**	.001*	-.000	-.000	.049
53-4 to 58-3	-.000	.146**	.001*	.000	.000	-.243
54-1 to 58-4	-.000	.141**	.001	.000	-.000	-.264
54-2 to 59-1	-.000	.138**	.000	.000	.000	-.260
54-3 to 59-2	-.000	.134**	.000	.000	.000	-.236
54-4 to 59-3	-.000	.086*	.000	.000	-.000	.164
55-1 to 59-4	-.000	.057	-.000	.000	-.000	.113
55-2 to 60-1	.000	.003	.000	.000	-.000	.510
55-3 to 60-2	.000	-.000	.000	.000	-.000	.478
55-4 to 60-3	.000	.002	.000	.000	-.000	.395
56-1 to 60-4	.000	.008	.000	-.000	-.000	.386
56-2 to 61-1	.000	.017	.000	-.000	-.000	.383
56-3 to 61-2	.000	.033	.000	.000	-.000	.430
56-4 to 61-3	.000	.034	.000	-.000	-.000	.466
57-1 to 61-4	.000	.036	.000	.000	-.000	.468
57-2 to 62-1	-.000	.033	.000	.000	-.000	.442
57-3 to 62-2	-.000	.026	.000	-.000	-.000	.416
57-4 to 62-3	-.000	.025	.000	.000	-.000	.486
58-1 to 62-4	-.000	.018	.000	.000	-.000	.552
58-2 to 63-1	-.000	.015	.000	.000	.000	.611
58-3 to 63-2	-.000	-.040	-.001	.000	-.000	.577*
58-4 to 63-3	-.000	-.032	-.001	-.000	-.000	.590*
59-1 to 63-4	-.000	-.010	-.000	.000	.000	.780**
59-2 to 64-1	-.000	-.028	-.000	-.000	.000	.722**
59-3 to 64-2	-.000	-.031	-.001	-.000	.000	.731**
59-4 to 64-3	-.001	-.119	-.001	-.000	.000	.905**
60-1 to 64-4	-.001*	-.062	-.001	-.000	-.000	.747**
60-2 to 65-1	-.001	-.051	-.001	-.000	-.000	.650**
60-3 to 65-2	-.000	-.015	-.001	.000	.000	.377
60-4 to 65-3	-.000	-.000	-.001	.000	-.000	.425
61-1 to 65-4	-.000	.036	.000	.000	-.000	.481
61-2 to 66-1	-.000	.040	-.000	.000	-.000	.598*
61-3 to 66-2	-.000	.044	-.000	.000	-.000	.585**
61-4 to 66-3	-.000	.075	-.000	.000	-.000	.483*
62-1 to 66-4	-.000	.072	-.000	.000	-.000	.574*

EQUATION 6
(Continued)

DATE	P	G	U	X	L	M_{t-1}
62-2 to 67-1	-.000	.032	-.002	.000	-.000	.568**
62-3 to 67-2	-.000*	.044	-.000	.000	-.000	.669**
62-4 to 67-3	-.000	.037	.001	.000	-.001**	.731**
63-1 to 67-4	-.000	.045	.001	.000	-.001**	.748**
63-2 to 68-1	-.000	.031	.000	.000	-.001**	.757**
63-3 to 68-2	-.000	.033	.000	.000	-.001**	.766**
63-4 to 68-3	-.000	.012	.000	-.000	-.001**	.813**
64-1 to 68-4	-.000	.071	.002	-.000	-.001*	.644**
64-2 to 69-1	-.000	.080	.002	-.000	-.001*	.653*
64-3 to 69-2	-.000	.080	.002	.000	-.001*	.665**
64-4 to 69-3	-.000	.165*	.002	.001	-.001	.807**
65-1 to 69-4	-.000	.158*	.002	.000	-.001	.781**

EQUATION 8

MOVING REGRESSIONS

DATE	P	G	U	X	L	M'_{t-1}
51-3 to 69-4	.009	.552	.109	.126	.014	.700**
51-3 to 56-2	.034	-1.889	.114	-.003	-.138	.662**
51-4 to 56-3	.041	-1.536	.124	-.068	-.171	.691**
52-1 to 56-4	-.116	5.571	.157*	.383	-.151	.391*
52-2 to 57-1	-.083	.624	.141	.139	-.037	.411
52-3 to 57-2	-.074	-4.170	.111	.174	.044	.461
52-4 to 57-3	-.077	- .408	.145	.103	.007	.450
53-1 to 57-4	.005	4.105	.193*	-.169	-.183	.641*
53-2 to 58-1	-.018	3.122	.173	-.137	-.140	.661**
53-3 to 58-2	-.021	8.608	.384**	-.161	-.128	.683**
53-4 to 58-3	-.073	-3.829	.201*	.288	.009	.455
54-1 to 58-4	-.123	2.379	.226*	.212	-.070	.322
54-2 to 59-1	-.112	.564	.221*	.196	-.069	.308
54-3 to 59-2	-.088	-4.545	.241**	.131	-.124	.249
54-4 to 59-3	-.062	-8.587	.252**	.110	-.136	.259
55-1 to 59-4	.020	-17.586	.244*	.136	-.070	.605*
55-2 to 60-1	.020	-9.925	.226	.171	.003	.628*
55-3 to 60-2	-.030	-7.762	.198	.271	.055	.711*
55-4 to 60-3	-.057	1.089	.171	.388	.174	.840**
56-1 to 60-4	-.016	-4.882	.151	.114	.106	.639*
56-2 to 61-1	.047	-1.263	.220	.133	.086	.630*
56-3 to 61-2	.049	- .895	.227	.140	.084	.632*
56-4 to 61-3	.044	-4.106	.238	.151	.044	.573**
57-1 to 61-4	-.068	-5.044	.171	.175	.092	.652**
57-2 to 62-1	-.076	-5.565	.169	.180	.091	.649**
57-3 to 62-2	-.034	-2.888	.222	.087	.091	.600*
57-4 to 62-3	-.109	-3.814	.245	.022	.114	.591*
58-1 to 62-4	.228	1.927	.170	.108	.116	.563*
58-2 to 63-1	.295	3.769	.174	.027	.151	.510*
58-3 to 63-2	.156	3.838	.081	.131	.099	.640**
58-4 to 63-3	.317	6.797	.312	-.155	.133	.606**
59-1 to 63-4	.055	6.586	.108	-.024	.133	.635**
59-2 to 64-1	-.053	7.554	.122	-.105	.153	.516*
59-3 to 64-2	-.160	10.108*	.237	-.041	.131	.356
59-4 to 64-3	-.191	18.127**	.468*	.022	.166*	.038
60-1 to 64-4	-.222	17.219**	.483	-.038	.132	.051
60-2 to 65-1	-.396	10.957*	.295	.046	.016	.128
60-3 to 65-2	-.357*	9.577*	.160	.096	.016	.007
60-4 to 65-3	-.108	12.234*	.441	-.090	-.021	.127
61-1 to 65-4	.062	11.142	.503	-.060	-.047	.269
61-2 to 66-1	.075	10.806	.489	-.089	-.054	.326
61-3 to 66-2	.007	10.347	.377	-.059	-.035	.253
61-4 to 66-3	-.162	6.141	-.004	.290	-.002	.268

EQUATION 8
(Continued)

DATE	P	G	U	X	L	M'_{t-1}
62-1 to 66-4	-.240	2.853	-.343	.211	-.131	.421*
62-2 to 67-1	-.153	5.218	-.056	.266	-.164	.426*
62-3 to 67-2	-.189	-1.885	-.516	.326	-.132	.436*
62-4 to 67-3	-.240*	3.473	-.216	-.001	-.184	.507*
63-1 to 67-4	-.224	- .835	-.519	.205	-.228	.426*
63-2 to 68-1	-.216	1.048	-.462	.283	-.202	.442*
63-3 to 68-2	-.166	9.074	.046	.292	-.228	.393*
63-4 to 68-3	-.109	16.022	.481	.315	-.219	.387
64-1 to 68-4	-.142	12.609	.272	.302	-.164	.368
64-2 to 69-1	-.106	17.486	.788	.394	-.321	.356
64-3 to 69-2	-.155	16.890	1.002	.282	-.549*	.291
64-4 to 69-3	-.222*	5.974	-.082	.352	-.228	.491
65-1 to 69-4	-.254*	3.732	-.105	.321	-.223	.572**

EQUATION 9

MOVING REGRESSIONS

DATE	P	G'	U	X	L	r_{t-1}
51-4 to 69-4	.042*	.034	-.319**	-.129	-.240**	.232**
51-4 to 56-3	.015	.043	-.207	-.070	-.086	.431
52-1 to 56-4	.017	.067	-.198	-.009	-.107	.474
52-2 to 57-1	.080*	.075	-.235*	.010	-.077	.443
52-3 to 57-2	.108**	.104*	-.178	.031	-.124	.614*
52-4 to 57-3	.111**	.123*	-.154	-.040	-.119	.673*
53-1 to 57-4	.088*	.163**	-.059	-.032	-.011	.909**
53-2 to 58-1	.188**	.062	-.380*	.122	-.072	.432
53-3 to 58-2	.190**	.072	-.365*	.118	-.067	.466
53-4 to 58-3	.203**	-.041	-.527**	-.054	-.199*	.075
54-1 to 58-4	.207**	-.038	-.535**	-.058	-.211*	.099
54-2 to 59-1	.210**	-.084	-.609**	.024	-.205*	-.100
54-3 to 59-2	.216**	-.086	-.529**	.032	-.229*	-.048
54-4 to 59-3	.223**	-.132	-.555**	.059	-.246**	-.129
55-1 to 59-4	.212*	-.015	-.328	.078	-.284**	.258
55-2 to 60-1	.242*	-.061	-.203	.054	-.391**	.247
55-3 to 60-2	.281**	-.026	-.027	-.036	-.468**	.452
55-4 to 60-3	.254*	-.027	-.124	-.036	-.412**	.337*
56-1 to 60-4	.250*	-.023	-.140	-.047	-.403**	.334
56-2 to 61-1	.250*	-.029	-.170	-.050	-.392**	.325
56-3 to 61-2	.238*	-.007	-.170	-.046	-.376**	.339*
56-4 to 61-3	.268*	-.012	-.235	-.173	-.333**	.325
57-1 to 61-4	.265*	-.013	-.202	-.222	-.328**	.343
57-2 to 62-1	.288	.005	-.138	-.187	-.302**	.362
57-3 to 62-2	.339*	.001	-.099	-.238	-.297**	.383*
57-4 to 62-3	.331*	.008	-.105	-.222	-.287**	.383
58-1 to 62-4	.210	.019	-.280	-.196	-.350**	.238
58-2 to 63-1	.062	-.001	-.128	-.254	-.334**	.290
58-3 to 63-2	.067	.029	-.080	-.188	-.332**	.203
58-4 to 63-3	.080	.027	-.064	-.171	-.323**	.232
59-1 to 63-4	.128	.032	.148	-.229	-.262**	.305
59-2 to 64-1	-.008	.000	.081	-.340*	-.271**	.432
59-3 to 64-2	.001	-.010	.200	-.351*	-.259**	.505**
59-4 to 64-3	.084	.093	.084	-.251	-.237**	.303
60-1 to 64-4	.109	.054	-.063	-.139	-.208**	.186
60-2 to 65-1	.215*	.113*	-.022	-.003	-.108	.400*
60-3 to 65-2	.121	.027	-.002	-.071	-.081	.373*
60-4 to 65-3	.092	.022	-.050	-.001	-.004	.080
61-1 to 65-4	.124*	.045	-.066	.054	-.003	-.072
61-2 to 66-1	.025	-.002	-.183	-.042	-.026	.278
61-3 to 66-2	-.003	.042	-.200	-.011	-.035	.092
61-4 to 66-3	.037	.032	-.148	-.046	.013	-.017
62-1 to 66-4	.022	.042	-.191	-.032	.013	.029
62-2 to 67-1	.181**	.067	-.097	.021	-.005	.093

EQUATION 9
(Continued)

DATE	P	G'	U	X	L	r_{t-1}
62-3 to 67-2	.191**	.072	-.270	-.062	-.047	.646**
62-4 to 67-3	.191*	.106	-.082	.117	-.230	.247
63-1 to 67-4	.204*	.095	.113	-.150	-.191	.363
63-2 to 68-1	.199*	.089	.068	-.147	-.188	.341
63-3 to 68-2	.201*	.085	.086	-.157	-.197	.349
63-4 to 68-3	.184*	.168	-.102	-.029	-.164	.257
64-1 to 68-4	.183*	.152	-.234	-.045	-.174	.205
64-2 to 69-1	.152	.171	-.202	-.024	-.199	.276
64-3 to 69-2	.141	.164	-.301	-.038	-.206	.249
64-4 to 69-3	.154	.177	-.046	-.073	-.299	.308
65-1 to 69-4	.138	.237	.062	-.198	-.429*	.404

EQUATION 13

MOVING REGRESSIONS

DATE	P	G	U	X	L	T_{t-1}
51-3 to 69-4	.019	2.300*	-.071	.009	.009	.936**
51-3 to 56-2	-.029	-11.033	-.192*	.116	-.014	.448
51-4 to 56-3	-.001	-13.373	-.233*	-.063	-.024	.349
52-1 to 56-4	-.025	- 7.809	-.187	.207	-.040	.493*
52-2 to 57-1	-.006	-11.359	-.219	.119	-.020	.429
52-3 to 57-2	-.037	-25.776**	-.329**	.568*	.185	.417*
52-4 to 57-3	-.017	-18.267	-.275*	.391	.068	.445*
53-1 to 57-4	.043	-15.837	-.220*	.223	.054	.479*
53-2 to 58-1	.033	-16.940*	-.189*	.270	.082	.386*
53-3 to 58-2	.059	-21.833**	-.221**	.284	.080	.214
53-4 to 58-3	.064	-12.356	-.126*	.004	-.016	.259
54-1 to 58-4	.090	-10.543	-.077	-.022	-.044	.211
54-2 to 59-1	.055	- 7.435	-.064	.089	-.039	.098
54-3 to 59-2	.027	- 5.194*	-.087*	.172	-.003	-.184
54-4 to 59-3	.056	- 7.123*	-.067	.059	-.045	.048
55-1 to 59-4	.053	- .338	-.082*	.016	.001	.219
55-2 to 60-1	.090*	- 6.593	-.056	-.106	-.069	.392
55-3 to 60-2	.085*	- 7.155	-.058	-.104	-.071	.390
55-4 to 60-3	.042	- 7.628	-.099*	-.016	-.023	.077
56-1 to 60-4	.045	- 3.547	-.034	.133	-.018	.145
56-2 to 61-1	.104	2.848	.045	.142	-.023	.365
56-3 to 61-2	.106	3.566	.046	.135	-.018	.406
56-4 to 61-3	.142	9.236	.044	.026	.027	.588*
57-1 to 61-4	.159	13.852*	.041	-.049	.050	.815**
57-2 to 62-1	.095	9.137	.023	.042	.045	.634**
57-3 to 62-2	.109	10.289	.039	.001	.053	.614**
57-4 to 62-3	.104	10.618*	.049	-.019	.057	.615**
58-1 to 62-4	-.040	9.118*	.108	-.095	.049	.653**
58-2 to 63-1	.025	15.293*	.214	-.101	.019	.378
58-3 to 63-2	-.010	3.472	.075	-.051	.086	.805**
58-4 to 63-3	.079	8.774	.191	-.156	.083	.633**
59-1 to 63-4	.146	11.894*	.243	-.115	.056	.519*
59-2 to 64-1	.131	11.725*	.232	-.112	.060	.523*
59-3 to 64-2	.145	11.819*	.246	-.127	.059	.516*
59-4 to 64-3	.158	13.305*	.259	-.104	.073	.485*
60-1 to 64-4	.233	14.495**	.194	.085	.181**	.528**
60-2 to 65-1	.171	13.744*	.188	.164	.140**	.494*
60-3 to 65-2	.082	10.690*	-.001	.160	.114*	.477*
60-4 to 65-3	.102	11.499**	-.293*	.146	.162**	.168
61-1 to 65-4	.175**	12.217**	-.426*	.208*	.185**	-.053
61-2 to 66-1	.177*	11.663**	-.418*	.207	.180**	-.010
61-3 to 66-2	.176*	11.546**	-.443	.195	.180**	-.010
61-4 to 66-3	.247**	14.685**	-.158	.097	.196**	-.022

EQUATION 13
(Continued)

DATE	P	G	U	X	L	T_{t-1}
62-1 to 66-4	.110	7.193	-.246	.101	.049	.506*
62-2 to 67-1	.002	3.841	-.352	.062	.041	.712**
62-3 to 67-2	.015	3.317	-.557	.042	.053	.568**
62-4 to 67-3	.000	17.286*	.067	-.092	.009	.477*
63-1 to 67-4	.025	31.104**	.800*	-.133	.032	.424
63-2 to 68-1	.086	18.994	.922*	-.196	.019	.845**
63-3 to 68-2	.067	25.227*	.653	-.256	.080	.521*
63-4 to 68-3	-.001	24.244	.592	-.261	.078	.520*
64-1 to 68-4	.034	21.249	.611	-.223	.054	.644**
64-2 to 69-1	.032	14.766	.508	-.250	-.002	.774**
64-3 to 69-2	.006	15.342	.509	-.307	-.058	.732**
64-4 to 69-3	-.035	14.405	.053	-.274	.129	.661
65-1 to 69-4	.068	33.205*	.402	-.012	.234	.441*

EQUATION 14

MOVING REGRESSIONS

DATE	P	G'	U	X	L	F_{t-1}
51-4 to 69-4	-.010	-.039*	.149**	-.031	.022	.389**
51-4 to 56-3	-.014	-.107**	.092	.126	.212	.489*
52-1 to 56-4	-.015	-.112*	.098	-.048	-.227*	.469*
52-2 to 57-1	.080*	-.095*	.046	-.043	-.186*	.530*
52-3 to 57-2	.052	-.083*	.027	-.057	-.023	.575*
52-4 to 57-3	.051	-.060	.048	-.164	-.028	.522*
53-1 to 57-4	.042	-.058	.060	-.147	-.007	.482
53-2 to 58-1	-.011	-.039	.115	-.199	.026	.535*
53-3 to 58-2	-.008	-.032	.139	-.178	.046	.443*
53-4 to 58-3	-.070	.034	.276**	.014	.068	-.155
54-1 to 58-4	-.069	.016	.273**	.031	.055	-.066
54-2 to 59-1	-.073	.018	.267*	.031	.057	-.075
54-3 to 59-2	-.074	.018	.278**	.040	.054	-.081
54-4 to 59-3	-.076	.028	.262*	.042	.068	-.075
55-1 to 59-4	-.076	.028	.261**	.041	.068	-.071
55-2 to 60-1	-.089*	.050	.173*	.019	.131**	-.032
55-3 to 60-2	-.086*	.037	.152*	.029	.145**	.040
55-4 to 60-3	-.077	.034	.138	.006	.145**	.073
56-1 to 60-4	-.063	.020	.200*	.064	.108*	.068
56-2 to 61-1	-.074	.027	.203*	.080	.112**	.041
56-3 to 61-2	-.042	.011	.205*	.089	.101*	.086
56-4 to 61-3	-.063	.019	.217**	.141	.101**	.068
57-1 to 61-4	-.071	.015	.204**	.120	.101**	.088
57-2 to 62-1	-.045	.004	.174*	.066	.089*	.153
57-3 to 62-2	-.021	-.007	.200**	.064	.072*	.142
57-4 to 62-3	-.055	-.016	.152*	.076	.067*	.301
58-1 to 62-4	-.031	-.017	.192*	.081	.083**	.216
58-2 to 63-1	.036	-.006	.169*	.097	.081**	.165
58-3 to 63-2	.040	-.004	.179*	.078	.077**	.236
58-4 to 63-3	.035	-.005	.175*	.077	.075*	.254
59-1 to 63-4	.021	-.008	.141	.064	.066*	.325
59-2 to 64-1	.096	.005	.215*	.111	.080**	.268
59-3 to 64-2	.082	.007	.152	.103	.076**	.303
59-4 to 64-3	.073	-.008	.172*	.101	.073**	.219
60-1 to 64-4	.029	-.034	.056	.045	.058*	.545**
60-2 to 65-1	.024	-.040	.077	.030	.052*	.505*
60-3 to 65-2	-.019	-.036	.051	-.006	.043	.583**
60-4 to 65-3	.004	-.027	.098	-.030	.006	.309
61-1 to 65-4	-.004	-.004	-.043	-.012	.014	.118
61-2 to 66-1	-.001	-.000	-.043	-.004	.018	-.001
61-3 to 66-2	-.018	.022	-.090	.009	.017	.042
61-4 to 66-3	-.009	.028	-.061	.012	.001	.011
62-1 to 66-4	-.040	.037	-.167	.037	-.001	-.137

EQUATION 14
(Continued)

DATE	P	G'	U	X	L	F_{t-1}
62-2 to 67-1	-.106**	.031	-.175	.019	.011	-.229
62-3 to 67-2	-.078**	.054	-.018	.025	-.025	.338
62-4 to 67-3	-.082**	.062*	-.053	.041	-.012	.329
63-1 to 67-4	-.083**	.065*	-.061	.045	-.023	.320*
63-2 to 68-1	-.093**	.058*	.106	.039	-.054	.232
63-3 to 68-2	-.095**	.052	-.031	.039	-.007	.419*
63-4 to 68-3	-.102**	-.001	.090	-.033	-.014	.110
64-1 to 68-4	-.102**	-.001	.086	-.036	-.012	.107
64-2 to 69-1	-.071	-.009	.087	-.058	-.005	.232
64-3 to 69-2	-.078*	-.020	-.041	-.088	-.018	.365
64-4 to 69-3	-.082*	-.010	.081	-.086	-.060	.231
65-1 to 69-4	-.072	-.005	.124	-.077	-.089	.271

EQUATION 17

MOVING REGRESSIONS

DATE	P	G'	U	X	L	B_{t-1}
51-4 to 69-4	.015	.035*	-.120**	-.000	-.015	.350**
51-4 to 56-3	.014	.093*	-.059	.067	.133	.479*
52-1 to 56-4	.017	.109**	-.073	-.045	.148	.439*
52-2 to 57-1	-.055	.099**	-.031	-.052	.131	.498*
52-3 to 57-2	-.035	.086*	-.032	-.075	.005	.451*
52-4 to 57-3	-.035	.058	-.051	.063	.013	.414
53-1 to 57-4	-.015	.049	-.070	.038	-.007	.308
53-2 to 58-1	.030	.027	-.103	.089	-.043	.434
53-3 to 58-2	.027	.020	-.127	.072	-.062	.328
53-4 to 58-3	.082*	-.038	-.232**	-.048	-.076	-.233
54-1 to 58-4	.083*	-.024	-.234**	-.075	-.058	-.188
54-2 to 59-1	.098*	-.032	-.208*	-.082	-.068	-.200
54-3 to 59-2	.099*	-.031	-.225**	-.095	-.064	-.209
54-4 to 59-3	.103*	-.044	-.212**	-.095	-.078*	-.210
55-1 to 59-4	.094*	-.033	-.186**	-.080	-.082*	-.102
55-2 to 60-1	.102**	-.048*	-.131*	-.061	-.121**	-.076
55-3 to 60-2	.098*	-.034	-.111	-.073	-.133**	.018
55-4 to 60-3	.087*	-.030	-.106	-.056	-.124**	.027
56-1 to 60-4	.080*	-.025	-.153*	-.100	-.103**	-.041
56-2 to 61-1	.084*	-.027	-.156*	-.102	-.100**	-.022
56-3 to 61-2	.061	-.016	-.158*	-.108	-.092**	.013
56-4 to 61-3	.080	-.023	-.170**	-.151*	-.092**	-.014
57-1 to 61-4	.087*	-.019	-.159**	-.130	-.092**	.003
57-2 to 62-1	.050	-.008	-.135*	-.073	-.080*	.078
57-3 to 62-2	.029	.006	-.144**	-.061	-.061**	.155
57-4 to 62-3	.050	.013	-.115*	-.076	-.057*	.286
58-1 to 62-4	.042	.013	-.130*	-.075	-.064*	.246
58-2 to 63-1	-.015	.004	-.109*	-.092	-.061**	.186
58-3 to 63-2	-.022	.002	-.123*	-.077	-.056*	.249
58-4 to 63-3	-.008	.004	-.112*	-.075	-.050	.320
59-1 to 63-4	-.001	.006	-.095	-.069	-.043	.368
59-2 to 64-1	-.060	-.005	-.146*	-.106*	-.055*	.333
59-3 to 64-2	-.052	-.007	-.092	-.103*	-.052*	.351*
59-4 to 64-3	-.031	.013	-.112*	-.102*	-.050*	.209
60-1 to 64-4	-.013	.031	-.040	-.073*	-.034	.527**
60-2 to 65-1	-.006	.037*	-.069	-.042	-.028	.458**
60-3 to 65-2	.021	.021	-.064	-.015	-.016	.448**
60-4 to 65-3	.017	.018	-.076	.000	-.004	.311
61-1 to 65-4	.013	-.001	-.004	-.021	-.008	.163
61-2 to 66-1	.041	-.001	.068	-.018	-.015	-.143
61-3 to 66-2	.067	-.014	.146	-.023	-.016	-.353
61-4 to 66-3	.058	-.019	.118	-.032	-.000	-.235
62-1 to 66-4	.084*	-.026	.227*	-.048	.004	-.371

EQUATION 17
(Continued)

DATE	P	G'	U	X	L	B_{t-1}
62-2 to 67-1	.115*	-.030	.175	-.043	-.004	-.361
62-3 to 67-2	.078**	-.060*	-.041	-.071*	.024	.289
62-4 to 67-3	.081**	-.066*	-.015	-.083*	.015	.279*
63-1 to 67-4	.083**	-.067*	-.015	-.085*	.023	.266*
63-2 to 68-1	.091**	-.061*	-.124	-.079*	.047	.218
63-3 to 68-2	.089**	-.064	.005	-.097*	.003	.459**
63-4 to 68-3	.098**	-.002	-.106	-.001	.015	.130
64-1 to 68-4	.099**	-.004	-.124	-.005	.012	.102
64-2 to 69-1	.077*	.004	-.130	.013	.010	.189
64-3 to 69-2	.093*	.014	.050	.044	.034	.311
64-4 to 69-3	.098*	.006	-.081	.050	.078	.129
65-1 to 69-4	.089*	.000	-.119	.052	.108	.188

EQUATION 19

MOVING REGRESSIONS

DATE	U	G'	P	L	X*	I_{t-1}
61-1 to 69-4	.081	-.045	.585**	.047	-1.215*	.771**
61-1 to 65-4	-.554	-.005	-.091	.075	- .849	.877**
61-2 to 66-1	-.695	.136	-.248	.071	- .914	.878*
61-3 to 66-2	-.597	.019	-.165	.085	- .951	.893**
61-4 to 66-3	.075	-.040	-.027	.214	-1.110*	1.012**
62-1 to 66-4	-.313	-.025	-.077	.059	-1.020*	.921**
62-2 to 67-1	.206	-.023	.313*	.108	- .679	.849**
62-3 to 67-2	.051	.058	.330**	.150	- .582	.760**
62-4 to 67-3	.422	-.132	.547**	.362	- .296	.720**
63-1 to 67-4	.281	-.176	.548**	.369	- .361	.649**
63-2 to 68-1	.149	-.217	.548**	.423	- .669	.547**
63-3 to 68-2	.346	.068	.517*	.347	-1.199	.613*
63-4 to 68-3	.888	.020	.548*	.421	-1.562*	.757**
64-1 to 68-4	.569	.037	.542*	.597	-1.350*	.732**
64-2 to 69-1	.383	-.023	.531*	.746	-1.274*	.758**
64-3 to 69-2	1.056	-.336	.692**	1.076	-1.722*	.875**
64-4 to 69-3	-1.292	-.370	.750**	2.398**	- .461	.815**
65-1 to 69-4	-1.734	-.159	.901	2.340*	- .282	.882**

EQUATION 22

MOVING REGRESSIONS

DATE	Z	Y	P	E	X*	I_{t-1}
61-1 to 69-4	.198**	.061*	.745	.188	-.700	.490**
61-1 to 65-4	.439**	.089*	.823*	-1.628*	-.055	-.106
61-2 to 66-1	.397**	.072	.724*	-1.425	-.131	-.029
61-3 to 66-2	.353**	.056	.558	- .655	-.396	.124
61-4 to 66-3	.318**	.067	.529	- .110	-.631	.276
62-1 to 66-4	.311**	.080*	.537*	- .422	-.767*	.403*
62-2 to 67-1	.324**	.075**	.465**	- .343	-.775**	.387*
62-3 to 67-2	.252**	.073*	.548**	- .507	-.777*	.498**
62-4 to 67-3	-.097	.003	.487*	.277	-.291	.872**
63-1 to 67-4	-.112	-.054	.334	1.518	-.335	.497*
63-2 to 68-1	-.032	-.014	.475*	.965	.822	.449*
63-3 to 68-2	-.015	-.011	.468	1.659	-1.022	.336
63-4 to 68-3	.045	.067	.660*	.679	-1.495	.637**
64-1 to 68-4	.044	.057	.645*	.770	-1.449	.608**
64-2 to 69-1	.050	.058	.650*	.811	-1.441	.608**
64-3 to 69-2	.062	.085	.722*	1.513*	-1.589	.594**
64-4 to 69-3	.100	.043	.696*	.691	-1.410	.457*
65-1 to 69-4	.145	.041	.802**	.604	-1.191	.450*

** = .01 level

* = .05 level

VITA

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Candidate for the Degree of

Doctor of Philosophy

Thesis: THE EXISTENCE OF A LONG RUN REACTION FUNCTION OF THE MONETARY AUTHORITIES

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