A TEST OF MONETARY RULE VERSUS DISCRETION IN WEST GERMANY - 1957 to 1973

by

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This thesis was prepared under the direction of the candidate's thesis advisor, Dr. Milton Redman, Department of Economics, and has been approved by the members of his supervisory committee. It was submitted to the faculty of the College of Social Science and was accepted in partial fulfillment of the requirements for the degree of Master of Arts.

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ABSTRACT

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Using the Modigliani approach, the effects of a fixed rule growth rate and a semi-rule growth rate are compared to the growth rate under the discretionary policy of the West German monetary authorities. This type of analysis has previously been completed for the United States economy which is considered a relatively closed economy. In contrast, the West German economy is open, that is, it is very dependent upon trade for survival. Therefore, the impact of this difference is the major point to be examined.

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CHAPTER I

INTRODUCTION

This thesis will compare the results of actual monetary policy with the simulated outcome under alternate growth rules of the money stock in West Germany. Actual monetary policy reflects the results of discretion as applied by monetary authorities while the alternative growth rules reflect either the results of following a fixed percentage increase in money or of holding the growth rate within a predetermined range.

The issue of discretion versus rule may be stated in the following manner. Would it be better to have a select group arbitrarily determine the monetary policy, or would it be better to have a set percentage rate of growth of the money stock? Discretionists feel that stable growth, while being an important part of monetary policy, is not the only aspect to consider. A straight percentage growth rate according to them would take too much flexibility out of the system. On the other hand, advocates of a monetary rule, such as Friedman (1968) states that the effects of a long and variable lag may greatly handicap any discretionary policy. In addition,

the authorities, being human, are subject to political pressures, as well as diversification of their ultimate goal of stabilization. Both of these effects tend to reduce the effectiveness of discretionary policy.

The merits of discretion versus rule have been subject to various empirical tests for the United States economy which is an essentially closed economy. In contrast, this thesis examines the issue in a country whose economy is open, that is, it is heavily reliant on trade for survival. Therefore, consideration of the foreign sector must be allowed for in determining monetary policy for such an open economy. More specifically, how does the fluctuating stock of foreign reserves affect the growth of the money stock? Professor Manfred Willms (1971) presents two hypotheses concerning the German Central bank's ability to maintain control over the growth of the money supply. The first hypothesis states that given fixed exchange rates the money supply cannot be controlled because a change in the interest rate differential between countries will lead to a neutralizing change by the foreign reserves on the desired monetary impact for the domestic economy. For this to hold, a high interest rate elasticity of international capital flows is required. The alternative hypothesis states that this elasticity is not sufficiently

high to offset the authority's control over its domestic money supply. Professor Willms has empirically shown that for the period in question, the 1960's and early 1970's, this elasticity was below unity and therefore, sufficiently low to allow domestic control of monetary growth. Germany is to be considered, therefore, as a country where rule vs. discretion is a valid question. In Chapter two the methodology of evaluating discretion versus a fixed rule is explored. Chapter three will describe the model to be used for the empirical investigation of rule versus discretion in West Germany on a quarterly basis from 1957 I - 1973 III inclusive. The results from this investigation and the interpretation of them will be analyzed in Chapter four.

CHAPTER II

TESTS OF RULE VERSUS DISCRETION

In an effort to determine whether a rule would produce more desirable results, three approaches have been utilized. First, the use of an optimizing rule as employed by Puckett and Vroman. Second, the use of an econometric macro model of the economy, such as, the FRM-MIT-Penn (FMP) econometric model which was employed by Pierce and by Cooper and Fischer. Third, the quantity theory approach applied by both Bronfenbrenner and Modigliani.

Simulation Using an Optimizing Rule

The Puckett-Vroman approach recommends various rules based upon their analysis of errors in forecasting. This simulation includes a monetarist model; that is, it allows for limits to be placed on discretionary policy. Probably the most significant and unique feature of this approach is its ability to adapt to past errors in forecasting. Stated another way, this simulation has the capacity to learn from previous errors.

Puckett and Vroman look at three decision rules on the narrowly defined money stock. First, the Friedman

fixed-rule view that money stock should grow at 4% per year, so that money stock will grow roughly at the same rate as GNP. Second, a semi-rule approach is observed where growth of the money stock is allowed to fluctuate between set percentage growth rates limits. Should the growth rate of the money stock stray outside these boundaries the closest limit would be used. Third, this rule is basically not a rule at all, but is simply the discretion of the policy makers which places no constraint on the money growth rate.

This simulation is based on three equations.

Social utility function in money GNP

$$U_t = A(YG)^2 + B(YG) + C \qquad A < 0,\ B > 0,\ C \gtreqless 0 \qquad (2.1)$$

Equation representing an underlying "pseudo-reduced form" that links changes in M_1 to changes in GNP

$$\Delta Y_t = a + \sum_{i=0}^{m} b_i \ \Delta M_{t-1} + u_t \qquad a < 0,\ b_i > 0 \qquad (2.2)$$

Forecasting equation used by the authority

$$\Delta Y_t = + \sum_{i=0}^{m} \beta_i \ M_{t-1} \qquad \alpha > 0,\ \beta_i > 0 \qquad (2.3)$$

U_t = utility

Y_t = nominal GNP

YG = growth rate in money GNP

M_t = narrowly defined money stock

u_t = normally distributed error term with zero mean and constant variance

$A, B, C, a, b_i, \alpha, \beta_i$ = parameters

Using this model for the case of pure discretion by policy makers the growth of the money stock to optimize social utility is based on the estimates of the forecasting equation. This derived optimal value of M_t is now substituted into equation (2.2) to determine the flow of GNP. In the case of a semi-rule, the same procedure is used with the exception that the growth rate of money under pure discretion is compared to the upper and lower limits of the semi-rule. If the pure discretion growth rate exceeds these limits, then the value of the limit closest to the actual is substituted for the actual. For the third case, that of a fixed rule as proposed by Friedman, the forecasting equation used by the authority is not used. Instead, the fixed rate of growth in money determines the current money flow, and this is substituted into equation (2.2) to find the flow of GNP.

The results of these rules are measured in two kinds of errors. In the first kind, the forecaster might incorrectly evaluate the GNP trend. The second type of error is one in which the forecaster misjudges the impact of monetary policy. Therefore, there are four possible error combinations which may result from the over- or underestimation of the GNP trend along

with the over- or underestimation of the monetary policy.

This simulation may be taken one step further by allowing policy makers to learn from past mistakes. This is possible by adjusting the forecasting equation, where the adjustment is derived from the difference between the previous period realized and forecasted levels of money GNP.

Empirically, Puckett and Vroman found that no one rule was constantly best. Their conclution was that a steady growth rate of M_1 does well in many instances but not at the four percent rate advocated by Friedman.

Simulation Using a Macro Econometric Model

The second approach, and probably the most efficient, is the simulation of an economy using a macro econometric model such as the FRB-MIT-Penn (FMP) econometric model (May, 1972). The FMP model, in size, is considered to be intermediate to large. It consists of over sixty stochastic equations which are constructed upon the income-expenditure approach. The working of monetary policy within this model is as follows. First, the change in the money supply causes an indirect movement in the interest rate. This shift then has an affect on the cost of capital variables consumption, wealth variables, housing expenditure and credit rationing which, in turn, all have an impact on the movement of

the various investment rates.

Only the monetary variables are dynamic. All other exogenous variable have been set at their historic level and, accompanying this, is a supression of the stochastic specification of the model by setting the corresponding error terms of the behavioral variables at zero. Therefore, this simulation is deterministic and not stochastic in form. From a cost outlook, the deterministic model is far less expensive. However, there are changes in exogenous variables, such as fiscal variables that are not accounted for in the FMP model, but which do effect monetary policy and which the monetary policy must deal with on a period to period basis to present a true picture of the economy. In support of the deterministic approach, the variability of the money multipliers lead to a simulation which encompasses some of the effects which would be found in the more realistic stochastic simulation.

The determination of the money supply is derived from the following equation.

$$\frac{M_t - M_{t-1}}{M_{t-1}} = a_1 - a_2\left(\frac{P_{t-1} - P_{t-2}}{P_{t-2}} - a_3\right) + a_4(u_{t-1} - a_5) - a_6\left(\frac{P_{t-1} - P_{t-2}}{P_{t-2}} - \frac{P_{t-2} - P_{t-3}}{P_{t-2}}\right) + a_7(u_{t-1} - u_{t-2}) \tag{2.4}$$

$$a_i \geq 0, \quad i = 2,4,6,7$$

M = money supply

P = GNP deflator

u = unemployment rate

a_1 = average growth rate of the monetary aggregate (M)

a_2 = proportional control parameter for the adjustment of the rate of growth of M when the rate of inflation deviates from its target.

a_3 = targeted rate of inflation

a_4 = proportional control parameter for the adjustment of the rate of growth of M when the rate of unemployment deviates from its target.

a_5 = tarted rate of unemployment

a_6 = derivative control parameter for the adjustment of the rate of growth of M when the rate of inflation is itself changing, regardless of its relation to its target.

a_7 = derivative control parameter for the readjustment of the rate of growth of M when the rate of unemployment is itself changing, regardless of its relation to its target.

The solution of this model is expressed in terms of means and standard deviations. That is, for a given mean, the rule which produces the lowest standard deviation for both inflation and unemployment is considered to be the one preferred.

The significant advantage which a simulation model such as the FMP model adds to the evaluation of the

rules-discretion question are the following: first, it allows two way input by taking into account feedback of the real on the monetary subsector; second, it allows for long lags before assuming monetary policy takes effect; and third, the effects of monetary policy have the ability to fluctuate due to movement through the cycle or changes in other exogenous variable. Specifically, a model, which is based on a macro model of the economy, can examine the behavior of unemployment and inflation in the long run had a rule been applied. It is this advantage which tends to make the macro model analysis superior to the forerunners, the Bronfenbrenner and Modigliani models.

However, use of this more sophisticated system does have its drawbacks. Its most important need, that of a macro model for each economy involved suggest that a less complicated and expensive approach should be adapted for the initial analysis of each country. This, of course, would be the Modigliani-Bronfenbrenner approach. We shall now explore the severity of the drawbacks involved with this approach to the question of rule versus discretion.

Simulation Using the Quantity Theory

Modigliani evaluted the rule versus discretion

within the context of the quantity theory approach. This approach hypotheses that there is a direct relationship between the stock of money (M) and Gross National Product which is the product of the average price level (P) and the real national product or output (Q). An important point of this hypothesis is that the rate at which the stock of money is annually turned over, is a constant. This is referred to as the velocity (V) of the money supply. This may now be stated as the following equation,

$$MV \equiv PQ \tag{2.5}$$

which does not show a cause or effect relationship of one variable on another, but which does indicate a direct relationship between M and PQ when V is held constant.

The Modigliani method requires an estimate of the full employment money supply, a comparison of the actual money supply to that of full employment, and a comparison of the money supply under a fixed rule to the full employment supply of money. Modigliani defined full employment money supply (M_t) as "the stock of means of payments that would have been needed in period 't' to transact a full employment income 'X_t', at the targeted price level for the period, 'P_t'". Symbolically, this may be expressed as follows:

$$M_t = (X_t P_t)/m_t = Y_t/n_t \qquad (2.6)$$

where $Y_t = X_t P_t$ target money income (2.7)

$$m_t = Y_t/M_t \qquad \text{velocity} \qquad (2.8)$$

Velocity (m_t) may be more fully defined as the ratio of target income to money supply needed to achieve that income. That is, the velocity of circulation which would have occurred in any one time period had the targeted money supply been available for that period. Having determined what the targeted or full employment money supply and income should be, one may now make the two previously mentioned comparisons used in the model. After finding the difference of actual targeted money supply, and the difference from a fixed rule to the target, an evaluation of the two differences may be made to determine which policy is better for that period of time.

Empirical approximations of target real income (X), target price level (P) and target income velocity (m) is the next step in solution of the model.

The target real income is based on full employment. This has been arbitrarily set at 96% of the labor force, however, should the actual employment level be higher, then that value will be used. The average employment rate for the period will be denoted at e_t. Then, Modigliani by making his first assumption, suggests that

income is proportional to employment. By doing so, he is able to derive an empirical estimation of real income X_t by the following means.

$$x_t = X_t U_t \tag{2.9}$$

$$U_t = \begin{matrix} 1, \text{ if } e_t \geq 0.96 \\ 0.96/e_t, \text{ if } e_t < 0.96 \end{matrix} \tag{2.10}$$

$$X_t = \text{real GNP} \tag{2.11}$$

Next, target price level P_t is defined as follows.

$$P_t = P_t'$$

where P_t' is the price level at the beginning of the period.

The implication of his second assumption is that the Authority should not attempt to change the prior level within the current period, but should a change occur due to errors in the money supply or sellers' inflation it should be accepted and used as the new price level for the following period. This brought Modigliani to the question of which price level to stabilize. There were two good possibilities from which to choose: the implicit GNP deflator, or the price level of consumer goods. From the previous definition of target income and target GNP, Modigliani decided upon the implicit GNP deflator, however, both of these indices moved relatively the same over the time period in question.

We may now make an empirical estimation of target income. From the symbolic definition of $Y = X_t P_t$, by substitution,

$$Y_t = X_t U_t P_t' \tag{2.12}$$

Finally, this leaves only the estimation of target-income velocity (m_t). Modigliani's third and final assumption is that m_t can be approximated by the actual velocity in that time period, as stated in equation (2.8).

$$m_t = Y_t/M_t$$

Given that the change in M_t from one period to the next is moderate, he felt that this assumption is valid.

Now, having found empirical estimations for each component of the equation, substitute X_t, P_t', M_t back into the original equation $M_t = (X_t P_t)/m_t$. The result is the target money supply M_t;

$$M_t = \frac{X_t U_t P_t'}{Y_t} M_t \tag{2.13}$$

Then, to determine the effectiveness in discretionary monetary policy, simply compute the error in the actual money supply for the given period, $E[M_t]$, as a percentage. This is found by taking the actual money supply minus the target money supply and dividing this result by the

targeted supply; this also holds for actual and target GNP as shown below

$$E[M_t] = \frac{M_t - M_t}{M_t} = \frac{Y_t - Y_t}{Y_t} = E[Y_t] \qquad (2.14)$$

A positive error is indicative of an excessive money supply while a negative value indicates a tight monetary policy. Modigliani was aware that his model tended to underestimate the true magnitude of error in the money supply achieved under both discretion and rule. However, he empirically showed this effected both equally, and therefore, resulted in virtually no net effect.

Richard Attiyeh (1965), Milton Friedman (1968), and Thomas Mayer (1964) in separate critiques of the Modigliani Model were more probing as to the shortcomings of the model. They attack the assumptions made about (1) the income velocity of money, (2) the lagged effects of monetary policy, (3) the size of the output gap; and (4) price stability.

The essence of Friedman's attack revolves around the variability of the lag. It is this which Karaken and Solow (1962) challenge and attempt to refute by dismissing Friedman's method of determining lags as invalid. They object to his comparison of the rate of change of money with the level of business activity. Nor do they believe that there is a causal relationship

between changes in the monetary series and changes in the cyclical turning point. Their final point of discord concerns the proper criterion for the lag. They state that it should be the date at which the monetary policy effects income, and not as Friedman has used the cyclical turning point. Thomas Mayer (1967) has taken a stand somewhere between two extremes. He asserts that the variability in the lag depends upon whose data one uses, but that there definitely is a lagged effect. Attiyeh states that even if one assumes constant velocity were a reality in the long run, it could not possibly be in a short run with lagged monetary effects, since with a lagged effect a change in M will have an effect on velocity. Modigliani's first assumption concerning the output gap states that the percentage difference between actual output and potential output is equivalent to the percentage difference between actual employment and full employment which as previously stated is 96 percent of the civilian labor force. Modigliani admits that his gap estimate is an understatement, but asserts that it will have no significant effect on the results. In a work unrelated to the Modigliani model, Arthur Okun (1962) has made estimates of the output gap which are three to four times larger than the Modigliani estimate. The second assumption in question is, whether or not a zero rate

of change of the GNP deflator is consistent with price stability. Empirically, due to an upward bias in the GNP deflator, a 1.5 percent per year increase in it has been consistent with stable prices since 1958 in the United States.

The third assumption concerning the approximation of targeted velocity, has been empirically shown to have little effect as long as the error in the money supply $\equiv \frac{M_t - M_t}{t}$ is relatively low. Therefore, in setting up an effective model based on the Modigliani type it is obvious that several modifications must first be made.

CHAPTER III

THE MODEL

The Model I shall use will be the basic Modigliani model with several refinements. A lag effect option has been added to allow comparison of the straight Modigliani results to the modified results due to a lag as suggested by Thomas Mayer where the target change in the money stock leads the actual change by the number of periods of the lag. The lag is an important component for the case of rule over discretion in empirical studies of the U.S. Second, to allow for a non-zero price level change to maintain stability, for U.S. data, an option to increase price level by 1.5 percent during the 1950's and 2.0 percent in the 1960's is available. The third modification is to allow a choice between two procedures of determining monetary growth. First, by using fixed rule growth, the money stock increases at an annual rate of growth of X percent. Conversely, under semi-rule growth, the actual growth rate is used as long as it is within the acceptable growth range of six to ten percent inclusive for the period. Should it stray outside this range, the extreme growth rate closer to the actual rate

will be substituted accordingly. The results from this model are presented as root mean square errors for the period in question.

This analysis will not include the Arthur Okun method for determining the output gap. Utilizing Okun's first of three methods for determining the ratio of output gap to unemployment, namely the method of first differences, I explored the relationship of these two variables for West Germany, and found that the empirical estimations of percentage change in GNP to the first differences of the unemployment rate showed a dismally poor correlation ($r = .08$) for the period. However, West Germany presents a sharp contrast to the United States in both its type of economy and its level of "hard core" unemployed. The United States is considered a closed economy, that is, relatively self-sufficient where in contrast West Germany is extremely dependent upon world trade for survival. Due to this reliance on trade, monetary policy might be more sensitive to balance of payments than to full employment GNP. However, when one looks at the unemployment picture in West Germany, it is clear that for the sixty-seven quarters in question, 1957 I - 1973 III, unemployment has caused West Germany far fewer problems than it has caused in the United States where there is approximately a four

percent rate of "hard core" unemployable people as compared with West Germany which has virtually no "hard core" unemployment. But to further explore the possibility of a GNP to unemployment correlation, I separately regressed both percentage of change and first differences in money GNP and first differences in real GNP on the first differences of the unemployment rate. The correlation of the first differences and percentage change of the money GNP were .06 and .08 respectively. The coefficient using first differences of real GNP to the first differences of the unemployment rate was .04, which restates the lack of correlation found in the original analysis.

To further try to explain the extremely poor correlation, basically two areas should be explored - technical progress and actual rate of unemployment. The OECD has stated that according to their production function estimates of the German economy, this economy could grow at a rate of three percent per year without any increase in the factors of production, due solely to technical progress. The second factor to consider is the rate of unemployment which when compared to that of the United States is virtually non-existent for most of the period under analysis. That is to say, that when an economy is at full employment actual and potential GNP should be the same and therefore, any fluctuations

in GNP would have to be caused by some external effects. The data tend to substantiate this. When regressed for the period of highest unemployment, 1957 I - 1959 IV, where the unemployment rate fluctuated from a high of 3.32% to a low of 1.33% the correlation coefficient while still being far from significant, almost doubled from .08 to .15.

The following semi-annual OECD figures further tend to substantiate the findings that the low unemployment rate results in virtually no gap between potential and actual output.

Table 1

ESTIMATION OF GNP GAP

	Actual GNP	Potential GNP	GNP Gap	
	Seasonally adjusted at constant price Indices 1963 actual GNP = 100		In per cent of potential GNP	In per cent of average utilisation
1957 I	72.0	71.9	0.1	1.1
II	73.7	73.7	-0.1	0.9
1958 I	74.0	76.2	-3.0	-2.0
II	76.9	78.8	-2.5	-1.5
1959 I	78.8	80.9	-2.7	-1.7
II	83.2	84.2	-1.3	-0.3
1960 I	86.3	86.7	-0.5	0.5
II	90.0	98.1	1.0	2.0
1961 I	92.4	91.4	1.1	2.1
II	93.4	94.0	-0.6	0.4
1962 I	94.9	96.5	-0.6	0.4
II	97.4	98.8	-1.4	-0.4
1963 I	97.3	101.2	-3.8[a]	-2.8[a]
II	102.7	103.7	-1.0	0
1964 I	104.9	106.0	-1.0	0
II	108.3	108.3	0	1.0
1965 I	111.8	111.1	0.6	1.6
II	113.4	113.7	-0.3	0.7
1966 I	116.6	116.5	0.1	1.1
II	115.2	119.0	-3.2	-2.2
1967 I	114.3	121.5	-5.9	-4.9
II	116.9	124.1	-5.8	-4.8

Table 1 (Cont.)

		Actual GNP	Potential GNP	GNP Gap	
		Seasonally adjusted at constant price Indices 1963 actual GNP = 100		In per cent of potential GNP	In per cent of average utilisation
1968	I	121.3	126.7	-4.3	-3.3
	II	126.9	129.4	-2.0	-1.0
1969	I	131.4	132.7	-1.0	0
	II	137.2	135.9	0.9	1.9
1970	I	140.6	138.9	1.3	2.3
	II	143.5	141.8	1.2	2.2
1971	I	146.2	144.7	1.0	2.0
	II	145.6	147.9	-1.5	-0.5
1972	I	149.7	151.3	-1.1	-0.1
	II	150.7	154.9	-2.7	-1.7

a) affected by cold winter in 1963 Q1.

There is however, one last important observation to be made concerning a model for an open economy where the external balance is in disequilibrium. The monetary authorities may be more concerned with external balance of trade than achieving full employment equilibrium income. Under such circumstances failure to incorporate the effects of the external balance in the model will most likely distort the evaluation of the performance of the monetary authority. If, for instance, a deficit emerges in the external balance, the monetary authority is likely to restrict the growth rate of money below what it would have had full employment been the primary concern. Any simulation model which compares the actual growth rates of money during this period with targeted growth rates which do not incorporate the impact of the external sector will overstate the targeted growth rate of money and will evaluate the policy of the authority as being under expansive. On the other hand, if there is a surplus in the trade balance the bias will favor the authority.

This balance of payment effect may be taken into account, by calculating targeted income using external balance of payments as the criteria rather than full employment stability. This in turn would naturally lead to the alternative targeted money supply. This may be expressed in equation form using the following notation

E = exports

K = net capital inflow of the non-banking sector

M = imports

M_{BP} = targeted money supply (BALANCE of PAYMENTS)

p = propensity to import

V = velocity

V_{FE} = targeted income (FULL EMPLOYMENT)

Y_{BP} = targed income (BALANCE of PAYMENT)

The basic equations are:

$$E_t + k_t = M_t \qquad \text{(external balance)} \qquad (3.1)$$

$$M_{BP} = \frac{Y_{BP}}{V} \qquad \text{(equilibrium imports)} \qquad (3.2)$$

$$M_t = PY_{BP} \qquad \text{(target money stock)} \qquad (3.3)$$

$$E_t = \bar{E}_t \qquad \text{(exogenous exports)} \qquad (3.4)$$

$$K_t = \bar{K}_t \qquad \text{(exogenous net capital inflow)} \qquad (3.5)$$

substituting equations (3.3 - 3.5) into (3.1) and solving for Y_{BP},

$$Y_{BP} = \frac{\bar{E}_t + \bar{K}_t}{p} \qquad (3.6)$$

The targeted money stock necessary to achieve Y_{BP} is found by substituting equation (3.6) into equation (3.2)

$$M_{BP} = \frac{\bar{E}_t + \bar{K}_t}{pV} \qquad (3.7)$$

If the level of income given by equation (3.6) is compatible with the level of income given by equation (2.12) then the target money stock from equation (3.7) will conform with that given by equation (2.13). Conversely if $Y_{BP} < Y_{FE}$ then $M_{FE} > M_{BP}$.

Consequently, the question which now must be considered is: how much of an impact will this alternative have on the outcome of the evaluation of the German economy in the period under examination. The key to this question is whether or not the balance of payment of the country are in balance through time. In the case of the German economy where much attention was paid to domestic price levels, the result was continual adjusting, by the monetary authority, to prevent the economy from overheating. This in turn, prevented the rapid increase of imports and thus maintained a healthy trade balance. For the German economy the effect of choosing one target income versus the other would be miniscule due to the excellent trade balance and nearly full employment which Germany maintained for the period of analysis. Therefore, given the crudeness of the quarterly data for making a balance of payments, income estimate and the likelihood that the discrepancy is small, the full employment targeted income approach

will be used for this study.

The Empirical Data

The variables for which quarterly empirical estimations are needed are money Gross National Product, GNP deflator, real Gross National Product, unemployment percentage, average current money stock and average lagged money stock. The money Gross National Product was taken from the International Financial Statistics which is published by the International Monetary Fund. Since a GNP deflator was not available on a quarterly basis, the Consumer Price Index was substituted. From this data real GNP may be calculated by dividing money GNP by the Consumer Price Index.

$$\text{Real GNP} = \frac{\text{Money GNP}}{\text{Consumer Price Index}}$$

The unemployment percentage was estimated by dividing the unemployed by the potential labor force.

$$\% \text{ Unemployed} = \frac{\text{Unemployed}}{\text{Total Labor Force}}$$

Average current money stock was found by taking the summation of the money stock from the end of the previous quarter plus the money stock from the end of the present quarter and dividing that sum by two.

$$\text{Avg. Current M} = \frac{M_{t-1} + M_t}{2}$$

In similar fashion, average lagged money stock was found by taking the money stock from the end of the quarter which was two quarters prior to the one being calculated and adding it to the money stock of the previous quarter, then, once again, dividing by two to find the average.

$$\text{Avg. Lagged M} = \frac{M_{t-2} + M_{t-1}}{2}$$

The data from which my results were derived may be seen in Appendix I.

The Program

The program used is an adaptation of the program developed by David Ralston and Milton Redman under NSF research grant No. G2-2275. It is designed to test the question of rule versus discretion using the Modigliani approach which has had incorporated in it the three modifications discussed previously in the study of the model. It is written in the UNIVAC Basic programing language and therefore, must contain the data to be inputted within the program itself. The input data are handled in matrix form D(Z,V) where Z is the number of observations and V denotes one of the nine specific variables for each observation. As an additional aid in understanding the functioning of the program, note that

the symbols on the left below represent the corresponding inputs.

X	Real GNP
U	Unemployment Percent
P_1	Consumer Price Index
Y_2	Money GNP
M_2	Average Money Stock (current)
M_1	Average Money Stock (lagged)

The program is found in Appendix II.

CHAPTER IV

RESULTS AND CONCLUSIONS

Results

The results concerning the question of rule versus discretion are succinctly stated in the three tables at the end of this chapter. These tables deal with data gathered on a quarterly basis from 1957 I to 1973 III. The first interval includes the entire period of 1957 I to 1971 III (Table 2) which allows for up to an eight period lag. Just preceding the second quarter of 1961 the deutchmark was revalued; therefore, the second period, 1961 II - 1971 III (Table 3) represents the post-Deutchmark revaluation. The final period, 1967 I - 1973 III (Table 4) was chosen to evaluate whether improved policies by the United States authorities following the "credit crunch" of 1966 in the United States may have resulted in improved performance by the West German authorities.

Each of these time periods is further broken down by allowing the money stock to be lagged. In the German case, a zero to eight period lag was investigated. Finally, for each of these lag periods, the following four growth rate options were applied. First, a

semi-rule, which allowed the German economy to fluctuate between a six and ten percent rate of growth, was tried; then fixed growth rates of five, eight and ten percent respectively were employed.

My findings for the total period, 1957 I - 1973 III, showed that after a two period lag, discretion did better only for the five percent fixed growth rate which is actually an unrealistically low rate of growth for a German economy that averaged nine percent growth for this period.

In the case of the post-Deutchmark revaluation, 1961 II - 1973 III, semi-rule became better starting with a one period lag as did the eight percent fixed growth rate. The ten percent fixed growth rate and even the five percent rate became the preferred with a two or more quarter lag. Finally, in the post-credit crunch of the United States time span, 1967 I - 1971 III, the results resemble those for the 1957 I - 1971 III time period. Semi-rule and the eight and ten percent fixed rules were more effective than discretion beginning with a one period lag while discretion was best for the unrealistic five percent growth rate for the first seven period lags. Compared to the results gathered by McPheters and Redman (1974) for a similar period in the United States, it may be seen that the experience gained from the

credit crunch in the U.S. had an insignificant direct impact on the performance of discretionary policy in Germany. In the United States under semi-rule, discretion was better for a lag of zero to three quarters and six to eight quarters. Also, using a five percent fixed growth rate which is realistic in the United States as an eight or ten percent rate is in Germany, discretion proved to be better for a lag of zero to two quarters, and seven to eight quarters.

Conclusion

These results tend to support the findings of Modigliani and those of Mayer. That is, remembering that Modigliani used no lags in his analysis, he predicted that discretion would be better than a rule. Then as advocated by Mayer a lag was incorporated into the system. The effect was obvious in almost all cases after a one or two period lag. As predicted by Mayer, the introduction of a lag shifted the outcome of the root mean square errors in favor of both semi-rule over discretion and a realistic fixed rule over discretion.

Superficially, this may indicate that the authorities in Germany are inefficient when in reality the explanation for their behavior is that they consider a wider range of goals than simply that of full employment stability. If

balance of payments is considered to be more important than full employment with price stability, then it is possible that a rule which has full employment stability as its only goal would outperform the actions of the authorities. Therefore, we may conclude that the German case further reinforces the criticisms made by Mayer of Modigliani's original approach, given the restrictions that each places on the system. One question that is left concerns the objectives of the German authority. In retrospect, it is fairly obvious that the diversity of their nature would tend to skew the results in favor of the rule.

The results in the German case suggest the need for further research with respect to Friedman's assertation that any rule will be better than discretion. It is clear that for Germany there are special circumstances, namely the capacity to increase growth through a fluctuating foreign labor force, that may operate to contradict Friedman's conclusion about any fixed rule. Discretion, we note, proved better than a five percent fixed rule. Are there special circumstances in every economy which would negate Friedman's hypothesis that any fixed rule will outperform discretion, or is Germany really a unique case? An indepth study of other major economies of the world might contribute to a resolution of this

issue in the debate over rule versus discretion.

Table 2

ROOT MEAN SQUARE ERROR FOR FIXED RULE,
SEMI-RULE, AND DISCRETION, 1957 I - 1971 III

GROWTH RULE	0	1	2	3	4
	DISCRETION	DISCRETION	DISCRETION	SEMI-RULE	SEMI-RULE
SEMI	RULE 1.54 DISC 1.00	RULE 1.65 DISC 1.58	RULE 1.69 DISC 1.65	RULE 1.58 DISC 1.59	RULE 1.55 DISC 1.57
	DISCRETION	DISCRETION	DISCRETION	DISCRETION	DISCRETION
5 % FIXED	RULE 2.10 DISC 1.00	RULE 2.08 DISC 1.58	RULE 2.05 DISC 1.65	RULE 1.93 DISC 1.59	RULE 1.84 DISC 1.57
	DISCRETION	DISCRETION	DISCRETION	FIXED RULE	FIXED RULE
8 % FIXED	RULE 1.71 DISC 1.00	RULE 1.69 DISC 1.58	RULE 1.66 DISC 1.65	RULE 1.53 DISC 1.59	RULE 1.45 DISC 1.57
	DISCRETION	DISCRETION	FIXED RULE	FIXED RULE	FIXED RULE
10 % FIXED	RULE 1.58 DISC 1.00	RULE 1.56 DISC 1.58	RULE 1.54 DISC 1.65	RULE 1.42 DISC 1.59	RULE 1.34 DISC 1.57

Table 2 (Cont.)

GROWTH RULE	5	6	7	8
	SEMI-RULE	SEMI-RULE	SEMI-RULE	SEMI-RULE
SEMI	RULE 1.51 DISC 1.56	RULE 1.43 DISC 1.47	RULE 1.41 DISC 1.54	RULE 1.51 DISC 1.77
	DISCRETION	DISCRETION	DISCRETION	FIXED RULE
5 % FIXED	RULE 1.78 DISC 1.56	RULE 1.71 DISC 1.47	RULE 1.65 DISC 1.54	RULE 1.65 DISC 1.77
	FIXED RULE	FIXED RULE	FIXED RULE	FIXED RULE
8 % FIXED	RULE 1.40 DISC 1.56	RULE 1.33 DISC 1.47	RULE 1.28 DISC 1.54	RULE 1.36 DISC 1.77
	FIXED RULE	FIXED RULE	FIXED RULE	FIXED RULE
10 % FIXED	RULE 1.30 DISC 1.56	RULE 1.23 DISC 1.47	RULE 1.22 DISC 1.54	RULE 1.35 DISC 1.77

Table 3

ROOT MEAN SQUARE ERROR FOR FIXED RULE
SEMI-RULE, AND DISCRETION, 1961 II - 1971 III

GROWTH RULE	0	1	2	3	4
	DISCRETION	SEMI-RULE	SEMI-RULE	SEMI-RULE	SEMI-RULE
SEMI	RULE 0.77 DISC 0.43	RULE 0.97 DISC 1.02	RULE 1.12 DISC 1.38	RULE 1.16 DISC 1.46	RULE 1.19 DISC 1.49
	DISCRETION	DISCRETION	FIXED RULE	FIXED RULE	FIXED RULE
5 % FIXED	RULE 1.27 DISC 0.43	RULE 1.28 DISC 1.02	RULE 1.30 DISC 1.38	RULE 1.33 DISC 1.46	RULE 1.35 DISC 1.49
	DISCRETION	FIXED RULE	FIXED RULE	FIXED RULE	FIXED RULE
8 % FIXED	RULE 1.00 DISC 0.43	RULE 1.01 DISC 1.02	RULE 1.03 DISC 1.38	RULE 1.05 DISC 1.46	RULE 1.07 DISC 1.49
	DISCRETION	DISCRETION	FIXED RULE	FIXED RULE	FIXED RULE
10 % FIXED	RULE 1.06 DIS 0.43	RULE 1.06 DISC 1.02	RULE 1.07 DISC 1.38	RULE 1.09 DISC 1.46	RULE 1.10 DISC 1.49

Table 3 (Cont.)

GROWTH RULE	5	6	7	8
	SEMI-RULE	SEMI-RULE	SEMI-RULE	SEMI-RULE
SEMI	RULE 1.19 DISC 1.47	RULE 1.22 DISC 1.45	RULE 1.26 DISC 1.56	RULE 1.44 DISC 1.85
	FIXED RULE	FIXED RULE	FIXED RULE	FIXED RULE
5 % FIXED	RULE 1.38 DISC 1.47	RULE 1.41 DISC 1.45	RULE 1.41 DISC 1.56	RULE 1.54 DISC 1.85
	FIXED RULE	FIXED RULE	FIXED RULE	FIXED RULE
8 % FIXED	RULE 1.07 DISC 1.47	RULE 1.09 DISC 1.45	RULE 1.12 DISC 1.56	RULE 1.31 DISC 1.85
	FIXED RULE	FIXED RULE	FIXED RULE	FIXED RULE
10 % FIXED	RULE 1.08 DISC 1.47	RULE 1.09 DISC 1.45	RULE 1.12 DISC 1.56	RULE 1.36 DISC 1.85

Table 4

ROOT MEAN SQUARE ERROR FOR FIXED RULE,
SEMI-RULE, and DISCRETION, 1967 I - 1971 III

GROWTH RULE	0	1	2	3	4
	DISCRETION	SEMI-RULE	SEMI-RULE	SEMI-RULE	SEMI-RULE
SEMI	RULE 0.88 DISC 0.61	RULE 1.14 DISC 1.23	RULE 1.31 DISC 1.55	RULE 1.38 DISC 1.60	RULE 1.21 DISC 1.31
	DISCRETION	DISCRETION	DISCRETION	DISCRETION	DISCRETION
5 % FIXED	RULE 1.49 DISC 0.61	RULE 1.56 DISC 1.23	RULE 1.62 DISC 1.55	RULE 1.71 DISC 1.60	RULE 1.58 DISC 1.31
	DISCRETION	FIXED RULE	FIXED RULE	FIXED RULE	FIXED RULE
8 % FIXED	RULE 1.08 DISC 0.61	RULE 1.10 DISC 1.23	RULE 1.15 DISC. 1.55	RULE 1.25 DISC 1.60	RULE 1.12 DISC 1.31
	DISCRETION	FIXED RULE	FIXED RULE	FIXED RULE	FIXED RULE
10 % FIXED	RULE 0.99 DISC 0.61	RULE 0.97 DISC 1.23	RULE 1.01 DISC 1.55	RULE 1.08 DISC 1.60	RULE 0.97 DISC 1.31

Table 4 (Cont.)

GROWTH RULE	5	6	7	8
	SEMI-RULE	SEMI-RULE	SEMI-RULE	SEMI-RULE
SEMI	RULE 1.19 DISC 1.25	RULE 1.21 DISC 1.28	RULE 1.37 DISC 1.56	RULE 1.75 DISC 2.08
	DISCRETION	DISCRETION	DISCRETION	FIXED RULE
5 % FIXED	RULE 1.60 DISC 1.25	RULE 1.68 DISC 1.28	RULE 1.69 DISC 1.56	RULE 1.95 DISC 2.08
	FIXED RULE	FIXED RULE	FIXED RULE	FIXED RULE
8 % FIXED	RULE 1.13 DISC 1.25	RULE 1.16 DISC 1.28	RULE 1.21 DISC 1.56	RULE 1.58 DISC 2.08
	FIXED RULE	FIXED RULE	FIXED RULE	FIXED RULE
10 % FIXED	RULE 0.98 DISC 1.25	RULE 0.96 DISC 1.23	RULE 1.03 DISC 1.56	RULE 1.55 DISC 2.08

APPENDIX I

YEAR	QTR	REAL GNP	UNEMPLOYED PERCENT	CONSUMER PRICE INDEX 1963=100	MONEY GNP	AVERAGE MONEY STOCK (CURRENT)	AVERAGE MONEYSTOCK (LAGGED)	OBS #
1957	1	222.7	2.83	87.1	194.0	30.3	29.7	0
	2	234.2	3.22	87.6	205.2	31.0	30.3	1
	3	242.2	3.03	88.7	214.8	32.5	31.0	2
	4	252.4	3.00	88.9	224.4	33.7	32.5	3
1958	1	230.1	3.32	89.7	206.4	34.5	33.7	4
	2	239.7	3.04	90.6	217.2	35.6	34.5	5
	3	255.1	2.72	89.7	228.8	36.6	35.6	6
	4	263.7	2.58	89.8	236.8	37.7	36.6	7
1959	1	244.8	2.49	90.2	220.8	39.1	37.7	8
	2	266.8	2.05	90.1	240.4	40.6	39.1	9
	3	280.4	1.58	91.3	256.0	41.7	40.6	10
	4	295.4	1.33	91.8	271.2	42.4	41.7	11
1960	1	283.5	1.17	91.7	260.0	43.3	42.4	12
	2	198.8	0.99	92.1	275.2	44.4	43.3	13
	3	310.6	0.86	92.2	286.4	45.0	44.4	14
	4	327.5	0.77	92.7	303.6	45.5	45.0	15
1961	1	311.3	0.70	93.3	290.4	46.6	45.5	16
	2	322.9	0.69	93.9	303.2	48.0	46.6	17
	3	331.2	0.68	94.7	313.6	49.5	48.0	18
	4	346.2	0.61	95.2	329.6	51.5	49.5	19
1962	1	325.5	0.59	96.1	312.8	52.8	51.5	20
	2	341.5	0.58	97.1	331.6	53.4	52.8	21
	3	370.9	0.57	97.5	361.6	54.5	53.4	22
	4	391.0	0.59	97.7	382.0	55.6	54.5	23

YEAR	QTR	REAL GNP	UNEMPLOYED PERCENT	CONSUMER PRICE INDEX 1963=100	MONEY GNP	AVERAGE MONEY STOCK (CURRENT)	AVERAGE MONEY STOCK (LAGGED)	OBS #
1963	1	338.2	0.77	99.7	337.2	56.3	55.6	24
	2	372.8	0.63	99.9	372.4	57.0	56.3	25
	3	388.8	0.62	99.6	387.2	58.3	57.0	26
	4	407.1	0.63	100.8	410.4	59.6	58.3	27
1964	1	369.7	0.66	101.6	375.6	60.8	59.6	28
	2	398.4	0.63	101.8	405.6	62.0	60.8	29
	3	409.0	0.61	102.6	419.6	63.3	62.0	30
	4	439.5	0.58	103.3	454.0	64.7	63.3	31
1965	1	395.4	0.59	104.0	411.2	66.5	64.7	32
	2	420.6	0.52	105.1	442.0	68.2	66.5	33
	3	426.6	0.50	106.7	445.2	69.3	68.2	34
	4	451.0	0.51	107.4	484.4	70.0	69.3	35
1966	1	408.9	0.48	108.4	443.2	70.9	70.0	36
	2	434.0	0.51	109.5	475.2	71.9	70.9	37
	3	441.2	0.61	109.8	484.4	72.2	71.9	38
	4	469.6	0.93	110.4	518.4	71.9	72.2	39
1967	1	405.4	1.49	110.6	448.4	72.2	71.9	40
	2	423.8	2.18	111.1	470.8	73.1	72.2	41
	3	430.9	2.09	111.4	480.0	74.4	73.1	42
	4	480.9	1.77	111.3	535.2	77.1	74.4	43
1968	1	454.8	1.37	112.5	511.6	78.5	77.1	44
	2	462.2	1.31	112.6	520.4	78.9	78.5	45
	3	471.0	1.07	113.3	533.6	79.9	78.9	46
	4	480.4	0.87	114.4	549.6	82.4	79.9	47

YEAR	QTR	REAL GNP	UNEMPLOYMENT PERCENT	CONSUMER PRICE INDEX 1963=100	MONEY GNP	AVERAGE MONEY STOCK (CURRENT)	AVERAGE MONEY STOCK (LAGGED)	OBS #
1969	1	493.6	0.77	114.9	567.2	84.8	82.4	48
	2	513.9	0.61	115.5	593.6	86.9	84.8	49
	3	529.3	0.57	116.3	615.6	89.0	86.9	50
	4	537.9	0.54	117.5	632.0	90.1	98.0	51
1970	1	541.6	0.58	118.9	644.0	90.9	90.1	52
	2	570.7	0.50	120.0	684.8	92.6	90.9	53
	3	572.2	0.53	121.0	692.4	94.2	92.6	54
	4	578.3	0.54	122.3	707.2	96.9	94.2	55
1971	1	595.0	0.58	123.9	737.2	99.8	96.9	56
	2	599.2	0.69	125.9	754.4	102.8	99.8	57
	3	599.8	0.77	127.7	766.0	106.4	102.8	58
	4	593.4	0.84	129.5	768.4	109.7	106.4	59
1972	1	621.4	0.81	131.5	817.2	113.6	109.7	60
	2	611.0	1.02	132.0	812.0	118.2	113.6	61
	3	615.1	1.07	134.8	829.2	121.8	118.2	62
	4	624.5	0.99	137.2	856.8	124.9	121.8	63
1973	1	649.8	0.80	140.3	911.6	129.1	124.9	64
	2	638.3	1.05	143.2	914.0	129.3	129.1	65
	3	641.1	1.20	144.2	924.4	125.3	129.3	66

APPENDIX II

```
10 REM THIS IS LROD: LAGGED RULE OR DISCRETION
20 PRINT '    THIS IS A PROGRAM WHICH COMPARES ERRORS IN
   ACHIEVING FULL'
30 PRINT 'EMPLOYMENT MONEY STOCK UNDER DISCRETION AND UNDER
   ALTERNATIVE'
40 PRINT 'FIXED GROWTH POLICIES OF THE MONEY STOCK.'
40 PRINT ' '
50 DIM E(100,2)
60 DIM D(100,9)
70 DIM J(100,2)
100 Z=0
105 DO=1
110 P=0
115 W9=0
120 W0=0
125 L=0
126 PRINT ' '
127 PRINT 'YOU HAVE THE FOLLOWING OUTPUT OPTIONS'
128 PRINT ' A - QUARTERLY DATA ONLY'
129 PRINT ' B - ROOT MEAN SQUARE ERROR ONLY'
130 PRINT ' C - BOTH OF THE ABOVE'
131 PRINT ' '
132 PRINT 'ENTER THE LETTER OF THE OUTPUT OPTION THAT YOU
    WISH TO USE';
133 INPUT C$
134 PRINT 'DO YOU WANT 1. SEMI RULE OR 2. FIXED RULE.
    TYPE 1 OR 2';
135 INPUT R$
137 IF R$='1' GO TO 142
138 PRINT'ENTER THE GROWTH RATE YOU WISH TO WORK WITH AS A'
139 PRINT'  PERCENTAGE. (4 PER CENT AS 4.0)';
140 INPUT G
141 G=G*.01
142 IF B$='B' GO TO 480
143 IF B$='G" GO TO 480
144 PRINT ' '
145 PRINT 'ENTER THE NUMBER OF PERIODS THAT YOU WISH TO
150 PRINT '  LAG.  THIS NUMBER MAY BE 0 TO 8.';
155 INPUT L2
160 IF L2=>0 GO TO 170
165 GO TO 175
170 IF L2=<8 GO TO 200
175 PRINT 'PERIODS OF LAG NOT WITHIN CONSTRAINT, PLEASE
    CORRECT.'
180 GO TO 145
200 IF B$='C' GO TO 480
205 PRINT ' '
```

```
210 PRINT'ENTER THE FIRST YEAR AND QUARTER AND FINAL
    YEAR AND QUARTER,'
220 PRINT'  SEPARATED BY COMMAS';
230 INPUT B,Q1,C,Q2
240 IF B><C GO TO 280
250 IF Q1<Q2 GO TO 280
260 PRINT 'QTR OUT OF ORDER'
270 GO TO 200
280 IF B>C GO TO 400
290 IF B<1957 GO TO 360
300 IF C>1973 GO TO 360
310 IF Q1<= 0 THEN 380
320 IF Q2<= 0 THEN 380
330 IF Q1>4 THEN 380
340 IF Q2>4 THEN 380
350 GO TO 420
360 PRINT 'THE ONLY AVAILABLE DATA IS NOT WITHIN YOUR STATED
    RANGE.'
370 GO TO 210
380 PRINT 'QUARTER MUST BE 1,2,3, or 4.'
390 GO TO 200
400 PRINT 'YOUR YEARS ARE OUT OF ORDER.  PLEASE INPUT
    PROPERLY'
410 GO TO 200
420 IF B$='A' GO TO 480
425 PRINT 'CHOOSE MODIGLINAI OR OKUN.  TYPE MOG OR OGG.';
426 INPUT U$
430 IF U$='MOG' GO TO 480
440 PRINT 'CHOOSE  1. NO ADJUSTMENT TO PRICE OR 2. A 1.5%'
445 PRINT '  ANNUAL INCREASE.  TYPE 1 OR 2';
450 INPUT DO
480 Z=Z+1
490 FOR V=1 TO 9
500 READ D(Z,V)
510 NEXT V
520 IF D(Z,1)=B GO TO 550
530 IF D(Z,1)=C GO TO 590
540 GO TO 480
550 IF D(Z,2)=Q1 GO TO 570
555 IF D(Z,1)=C GO TO 590
560 GO TO 480
570 D1=D(Z,9)
580 GO TO 480
590 IF D(Z,2)=Q2 GO TO 610
600 GO TO 480
610 D2=D(Z,9)
620 IF D1=>0 GO TO 650
630 PRINT 'FIRST AVAILABLE QUARTER HAS BEEN PRECEEDED BY
    YOUR REQUEST.'
```

```
635 Z=0
637 RESTORE
640 GO TO 200
650 RESTORE
652 Z=0
655 IF D2+L2 < 87 GO TO 680
660 PRINT'TAKING INTO CONSIDERATION YOUR LAG  OF ';L2;'
    PERIODS'
670 PRINT'  YOU HAVE EXCEEDED THE LAST AVAILABLE QUARTER'
675 GO TO 145
680 REM DETERMINE @ OF QTRS OF DATA DESIRED
720 S2=D1+L2
730 S3=D1
930 REM CALCUATE N
940 FOR P3=1 TO S2
950 Z=Z+1
960 FOR V=1 TO 9
970 READ D(Z,V)
980 NEXT V
990 NEXT P3
1000 F=0
1010 FOR P4=1 TO 04
1020 Z=Z+1
1025 F=F+1
1030 FOR V=1 TO 9
1040 READ D(Z,V)
1050 NEXT V
1060 X=D(Z,3)
1070 U=D(Z,4)
1080 P1=D(Z,5)*.01
1090 Y2=D(Z,6)
1108 M1=D(Z,8)
1110 M2=D(Z,7)
1112 IF U > .08 GO TO 1118
1114 U = 1
1116 GO TO 1119
1118 U = 99.2/(100-(D(Z,4)))
1119 IF U$='MOG' GO TO 1125
1120 IF D(Z,1) => 1960 GO TO 1123
1121 Q8=((1.032)**.25)-1
1122 GO TO 1124
1123 Q8 = ((1.040)**.25)-1
1124 U=U*(1+Q8)
1225 IF DO=1 GO TO 1128
1126 IF D(Z,1) => 1960 GO TO 129
1127 Q7 = (1.020**.25)-1
1128 GO TO 1130
1129 Q7 = (1.020**.25)-1
1130 P1=P1*(1+Q7)
```

```
1131 Y=X*U*P1
1132 M=((Y/Y2)*M2)
1140 E(F.2)=((M-M1)/M1)
1150 NEXT P4
1155 F=0
1160 Z=0
1170 RESTORE
1175 IF C$='B' GO TO 1250
1180 REM HEADING PRINTOUT INSTRUCTIONS
1183 PRINT ' '
1186 PRINT ' '
1190 PRINT '                                        % %     % %     %  %
                    % %'
1200 PRINT '                                    ERROR TARGET ACTUAL
      M             ERROR'
1210 PRINT '                                    UNDER CHANGE CHANGE
     UNDER          UNDER'
1220 PRINT 'YEAR QTR TARGET  TARGET DISCRE-     IN      IN
     FIXED          FIXED'
1230 PRINT '           M       Y    TION       M       M
      RULE           RULE'
1240 PRINT '-------------------------------------------------
     ----------------------
1250 REM CALCUATE NON-LAGGED VARIABLES
1260 FOR P5=1 TO S3
1270 Z=Z+1
1280 FOR V=1 TO 9
1290 READ D(Z,V)
1300 NEXT V
1310 NEXT P5
1330 FOR P6=1 TO Q4
1340 Z=Z+1
1345 F=F+1
1350 FOR V=1 TO 9
1360 READ D(Z,V)
1370 NEXT V
1380 REM VARIABLE ASSIGNMENTS
1390 X=D(Z,3)
1400 U=D(Z,4)
1410 IF U<=.08 GO TO 1430
1420 IF U>.08 GO TO 1450
1430 U=1
1440 GO TO 1455
1450 U=96/(100-(D(Z,4)))
1455 IF U$='MOG' GO TO 1460
1456 IF D(Z,1) => 1960 GO TO 1459
1457 Q8=((1.032)**.25)-1
1458 GO TO 1460
1459 Q8 = (1.040**.25)-1
```

```
1460 U=U*(1+Q8)
1462 P1=D(Z,5)*.01
1480 Y2=D(Z,6)
1498 M1=D(Z,8)
1500 M2=D(Z,7)
1510 REM CALCULATIONS
1514 IF D0=1 GO TO 1520
1515 IF D(Z,1) +> 1960 GO TO 1518
1516 Q7 = (1.015**.25)-1
1517 GO TO 1519
1518 Q7 = (1.015**.25)-1
1519 P1=P1*(1+Q7)
1520 Y=X*U*P1
1530 H(2)=Y
1540 M=((Y/Y2)*M2)
1550 H(1)=M
1560 E2=(Y2-Y)/Y
1580 N=F(F.2)
1590 H(5)=N
1600 A=((M2=M1)/M1)
1601 IF R$='2' GO TO 1610
1602 G=((1+A)**4)-1
1603 IF G<.06 GO TO 1605
1604 IF G>.10 GO TO 1607
1605 G=.06
1606 GO TO 1610
1607 G=.10
1608 GO TO 1610
1610 H(6)=A
1620 F1=A-N
1630 H(4)=E1
1653 B=((1+G)**.25)-1
1654 M5=M1*(1+R)
1656 H(3)=M5
1660 A1=((M5-M1)/M1)
1670 F4=A1-N
1680 H(7)=E4
1690 FOR T=4 TO 7
1700 H(T)=INT(H(T)*1000)/10
1710 NEXT T
1720 FOR T=1 TO 3
1730 H(T)=(TNT(H(T)*100))/100
1740 NEXT T
1750 W2=H(4)
1760 W1=H(7)
1770 P=P+1
1780 J(P,2)=W2
1790 J(P,1)=W1
```

```
1800 REM PRINTOUT INSTRUCTIONS
1805 IF C$='B' GO TO 1230
1810 PRINTD(Z,1):TAB(6):D(Z,2):TAB(8):H(1):TAB(16):
     J(2):TAB(26):H(4):
1820 PRINT TAB(32):H(5):TAB(39):H(6):TAB(46)H(3):TAB(61)
     H(7)
1830 L=L+1
1844 NEXT P6
1845 IF C$='B' GO TO 1870
1850 PRINT '          ************************************
     *****'
1860 PRINT ' '
1865 IF CS='Δ' GO TO 2180
1870 FOR R = 1 TO L
1880 W7=J(P,1)
1890 W7=W7**2
1900 W9=W9+W7
1910 W8=J(P,2)
1920 W8=W8**2
1930 W0=W0+W8
1940 NEXT P
1950 W9=W9/L
1960 W9=SQR(W9)
1970 W0=W0/L
1980 W0 = SQR(W0)
1990 IF W9>W0 GO TO 2140
2000 IF W9<W0 GO TO 2160
2010 W$='SAME'
2020 IF C$='B' GO TO 2090
2025 PRINT 'COMPARISON OF % ERROR UNDER DISCRETION TO %
     ERROR UNDER'
2030 PRINT 'FIXED RULE USIN G ROOT MEAN SQUARE ERROR.'
2040 PRINT 'WHERE THE EXPECTED VALUE OF THE MEAN IS ZERO
2050 PRINT ' '
2060 PRINT ' '
2070 PRINT '    TIME PERIOD       FIXED RULE       DISCRETION'
2080 PRINT '    -----------       ----------       ----------'
2090 PRINTB:01:'-':C:02:TAB(22):W9:TAB(36):W0:TAB(54)W$
2100 PRINT ' '
2110 PRINT ' '
2120 PRINT ' '
2130 GO TO 2180
2140 W$='DISCRETION'
2150 GO TO 2020
2160 W$='FIXED RULE'
2170 GO TO 2020
2180 PRINT 'DO YOU WANT ANOTHER RUN':
2190 INPUT A$
```

```
2200 IF A$='NO' GO TO 9999
2210 RESTORE
2220 D=D+1
2230 IF D>1 GO TO 2290
2240 PRINT ' YOU HAVE THE FOLLOWING OPTIONS FOR SUCCESSFUL
     RUNS'
2250 PRINT ' A - CHANGE OF TIME PERIOD ONLY'
2260 PRINT ' B - CHANGE OF GROWTH RATE ONLY'
2270 PRINT ' C - CHANGE OF THE NUMBER OF PERIODS LAGGED'
2275 PRINT ' D - CHANGE ANY OR ALL THREE OPTIONS'
2278 PRINT ' E - CHANGE ANY OR ALL THREE OPTIONS A N D THE
     TYPE(S)'
2279 PRINT '                                          OF OUTPUT
     DESIRED.'
2282 PRINT ' G - CHANGE OF SEMI RULE OR FIXED RULE'
2284 PRINT ' H - CHANGE OF M O G OR O O G'
2289 PRINT ' '
2290 PRINT 'ENTER THE LETTER OF THE OPTION YOU WISH TO USE':
2300 INPUT B$
2310 PRINT' '
2320 PRINT' '
2325 F=0
2330 P=0
2340 Z=0
2344 MAT D = ZER
2345 MAT E = ZER
2346 MAT J = ZER
2350 L=0
2360 W9=0
2365 W0=0
2370 IF B$='H' GO TO 425
2371 IF B$='G' GO TO 134
2373 IF B$='E' GO TO 127
2375 IF B$='D' GO TO 135
2380 IF B$='C' GO TO 145
2390 IF B$='B' GO TO 138
2400 IF B$='A' GO TO 210
2410 GO TO 2290

[DATA]

9999 END
```

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