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Authors	R. W. Hafer
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R. W. Hafer
Federal Reserve Bank of St. Louis
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R. W. Hafer

I. INTRODUCTION

The change in the Federal Reserve's operating procedures announced October 6, 1979 was based on the recognition that a more direct control over the growth of money would better achieve the objective of real economic growth at low rates of inflation.[1/] Although there exists a long tradition of investigating the usefulness of different measures to fulfill the role of an intermediate target, the economic record of the past four years has heightened interest in the issue.[2/] The investigation of issues surrounding the choice of an aggregate target has arisen because some argue that the recent variability in economic growth is a direct outcome of focusing exclusively on M1 as the intermediate policy target. Moreover, the changing financial environment has been used by some to argue that the reliable link between a narrow money measure and GNP has been broken and, therefore, that M1 is no longer the preferred intermediate target. This latter argument especially has caused some economists and policymakers to conclude that using a broader monetary measure would reduce the disruptive effects that new financial innovation supposedly have on observed growth rates of M1. (This view undoubtedly is the basis for the FOMC's periodic switching to M2 instead of M1 in formulating policy.)

It also has been suggested that certain nonmonetary measures may serve as intermediate targets. Benjamin Friedman, for example, has advocated the use of a broad debt measure to gauge the direction and influence of monetary policy actions.[3/] This choice is based on his finding that debt "bears as close and as stable a relationship" to economic activity as any monetary aggregate, and that debt is as responsive as money to changes in the direction of policy. The persuasiveness of these findings is, in part, revealed by the FOMC's adoption at its February, 1983 meeting of monitoring range for the growth of total domestic nonfinancial debt. Although this measure was not granted the status to warrant its own "target" range, "the Committee does intend to monitor closely developments with respect to credit for what assistance it can provide in judging appropriate responses to developments in the other aggregates."[4/]

The purpose of this paper is to empirically assess the incorporation of the debt measure into the existing collection of intermediate target variables. Accordingly, we concentrate on comparing the relative usefulness of M1 and debt as intermediate targets for monetary policy. Two necessary characteristics of an intermediate target are examined; namely, that the measure is not unduly influenced by changes in the goal variable, and that the measure provides a reliable prediction of economic activity. This investigation begins in Section II where some crude evidence on the relative stabilities of the debt and M1 income velocities for the 1955-1980 period is presented. We compare the relative stabilities in terms of the levels and the rates of change of the ratios.

Section III investigates the Granger-type causal relationships between the proposed intermediate target variables and GNP. Because there is much uncertainty surrounding the determination of the appropriate lag length in conducting Granger-type tests, two procedures are used: First, we examine the causality issue by searching across a total of 144 different lag length combinations for each pairwise grouping. This methodology is obviously heuristic in nature and is viewed as a method of providing information in the selection of a target measure. The second approach is to utilize several lag length selection tests to determine the "best" lag structure. With this information, the Granger-type tests then are conducted. In general, the evidence indicates some feedback from GNP to both debt and M1.

In Section IV we provide further evidence on the respective links between both debt and M1 and GNP by estimating a version of the Andersen-Jordan (1968) reduced-form GNP equation. The original specification is extended to include the effects of exogenous supply shocks on GNP. Moreover, the statistical procedures used in Section III to determine the optimal lag structure is applied for each variable. These modifications yield statistically stable relationships between debt and GNP and M1 and GNP; they also show that M1 provides a superior explanation of GNP growth.

In Section V we address the crucial issue of whether debt or M1 growth contains any additional information with regard to predicting GNP growth once the other is known. Two procedures are used: First, the relationship between debt and M1 is investigated through the use of the Granger-test procedures employed in Section III. The second approach uses the lag-length selection criteria introduced in Section III to determine the appropriate lags for debt and M1 when both are included in the reduced-form GNP equation. The evidence from these tests indicates that once the effects of M1 growth on GNP growth are accounted for, the debt growth has no additional explanatory significance. Summary remarks and policy implications drawn from this evidence close the paper in Section VI.

II. THE RELATIONSHIP BETWEEN DEBT, M1 AND GNP: COMPARING VELOCITIES

An intermediate target measure must be reliably related to economic activity. This is not to say, however, that the relationship, most simply captured in the ratio of GNP to the measure, must be a numerical constant. Rather, the criterion is that it is predictable across a variety of economic environments.

One piece of evidence on this issue comes from the comparison of the income velocities for debt and M1. In Figure 1 we plot these ratios for the period 1955 to 1980 using quarterly data.[5/] The data indicate that there is a marked difference in the behavior of the two velocities. In contrast to the upward trend in M1 velocity, debt velocity essentially is unchanged across time: debt velocity varies between the values of 0.69 and 0.75 during the sample. M1 velocity, on the other hand, rises from 2.96 in 1955 to a maximum value of 6.61 in 1980.

To better compare the relative variabilities of debt and M1 velocity, coefficients of variation are calculated and are reported in the upper half of Table 1. Results are reported for the full period and two subperiods. The notion that debt velocity is much more stable than that for M1 is substantiated by the results in Table 1. The coefficient of variation for M1 velocity always is much larger than that found for debt velocity, averaging about eight times greater. This evidence has been cited to suggest that debt has a closer, more stable relationship to GNP than does M1 during the 1955-80 period.[6]

Although debt does have a more stable connection with GNP than M1 in terms of levels, the more policy relevant comparison is the relationship between the two measures in terms of their growth rates. In other words, "what is of more immediate concern to the policymaker is the relative stabilities in the growth rates of the different velocity measures."[7] This comparison is made in Figure 2, where the annualized, quarter-to-quarter growth rates of debt and M1 income velocities are plotted. The similarities now are much more apparent than the contrasts of Figure 1, characterized by the coincidental movements of the two series. The growth of debt velocity fluctuates around a mean value of -0.20 percent, and the M1 velocity growth oscillates around a mean of 3.16 percent.

To compare the relative variability in the growth rates of the two income velocities, the coefficients of variation again are calculated: the lower half of Table 1 reports the statistics. We now see that debt velocity, in terms of its growth rate, is much more variable than is the growth of the M1 velocity measure. In fact, for the subperiod I/1955-IV/1968, debt velocity growth is about 32 times more variable than the growth of M1 velocity. Although the differential lessens during the more recent period, the evidence derived from comparing the two series' growth rates rejects the notion that debt is more stably related to GNP than is M1. Because relevant velocity comparisons for policy purposes should be done in terms of growth rates, the evidence does not support the claim that debt--because of its lower income velocity variability--would be a preferable intermediate target for monetary policy.[8/]

III. THE CAUSAL RELATIONSHIP BETWEEN M1, DEBT AND GNP

An intermediate target variable must reliably signal the direction of monetary policy. Consequently, movements in the intermediate target variable should not be influenced unduly by, or result from changes in, some nonpolicy action. Most importantly, if monetary policy actions attempt to control the growth of nominal GNP, changes in GNP growth should be a direct result of changes in monetary actions as evidenced by changes in the intermediate target. Conversely, changes in the intermediate target should not be overly influenced by changes in GNP. In this sense, a variable can be used reliably as an intermediate target if movements in GNP do not "cause" movements of the target variable.[9/]

Cognizant of the controversy that surrounds the determination of "causality" between variables, we have chosen to use Granger's (1969) methodology.[10/] These tests represent (using recent terminological advances) bivariate vector autoregression models where the information set is restricted to GNP, M1 and debt.

The test consists of estimating the equations

$$(1) \quad GNP_t = \sum_{j=1}^{m} \alpha_j GNP_{t-j} + \sum_{j=1}^{n} \beta_j X_{t-j} + \epsilon_t$$

and

$$(2) \quad X_t = \sum_{j=1}^{m} \gamma_j GNP_{t-j} + \sum_{j=1}^{n} \delta_j X_{t-j} + \eta$$

where X represents either M1 or debt. Assuming that $E[\epsilon(t), \epsilon(s)] = 0$, $E[\eta(t), \eta(s)] = 0$ and $E[\epsilon(t), \eta(s)] = 0$ for all t not equal to s, X "causes" GNP if the estimated coefficients on lagged X in equation (1) are statistically significant as a group, and the set of estimated coefficients on the lagged GNP in equation (2) is not statistically different from zero. Conversely, GNP "causes" X if the coefficients on lagged GNP in equation (2) are statistically nonzero as a group and the X coefficients in equation (1) are not different from zero. Feedback from GNP to X occurs when the set of coefficients on lagged X in equation (2) and on lagged GNP in equation (2) are statistically different from zero.

A chief obstacle to empirically implementing this test is the specification of the appropriate lag lengths. One approach used here to investigate the relationship between the two proposed intermediate target measures and GNP is to perform the appropriate test calculations across 144 different lag combinations in the bivariate regressions.[11/] The equations are estimated for the I/1955-IV/1980 period using seasonally adjusted data, each variable expressed as the first-difference of its logarithm, and each regression equation includes a constant term and a linear trend variable.

The results from investigating the causal relationship between M1 and GNP are reported in Tables 2 and 3.[12/] Table 2 reveals the statistical outcome when GNP growth is the dependent variable. The evidence indicates that a majority of the lag length combinations produce an F-statistic that is less than the 0.05 critical value. More precisely, 97 out of the 144 possible values (67 percent) are significant at the 0.05 level. Rejection of the hypothesis that M1 causes GNP is concentrated in the area of relatively large lag lengths for both GNP and M1.

To test for bi-directional causation, M1 replaces GNP on the left-hand side. The significance levels for the test that GNP "causes" M1, found in Table 3, suggest that in 40 instances (28 percent), the hypothesis that GNP growth causes M1 growth cannot be rejected. Unlike the pattern in Table 2, the significant F-values are located in the larger lag combinations, between five and 12 lags on M1, and six and 12 lags on GNP. Based on the evidence from Tables 2 and 3, this application of the Granger test suggests some feedback from GNP to M1.[13/]

The Granger-test procedures also are employed to investigate the causal relationship between debt growth and GNP.[14/] The evidence when GNP growth is the dependent variable, reported in Table 4, suggests little statistical relationship. Out of the possible 144 lag combinations reported, the calculated F-statistic exceeds the 0.05 significance percent level only 19 times. These significant F-values occur in two areas: one area bounded by four to seven lags on GNP and two to three lags on debt, the other by four to seven lags on GNP and eight to 10 lags on debt.

The test results to determine the causal effects of GNP on debt are given in Table 5. The reported significance levels indicate that 88 percent of the time we could not reject the hypothesis that GNP growth causes debt growth. The significance levels greater than 0.05 are located primarily with four to seven lags on GNP and three to five lags on debt. Interestingly, if the significance level is increased to 0.10, only one lag combination allows us to reject the hypothesis that GNP causes debt growth.

The preceding causality results admittedly suffer from the fact that no criterion is used to determine the best lag structure. Thus, even though there are relatively more instances in which the calculated F-statistic indicates that M1 causes GNP, it may be that the true lag structure between these two variables is one for which we cannot reject the hypothesis that GNP causes M1.

To determine the "best" lag lengths for the variables in the Granger tests, three different statistical procedures are employed.[15/] One approach is due to Mallows (1973) and is based on a mean square error prediction criterion. Mallows procedure generates a statistic (Cp) defined as

$$(3)\quad C_p = \frac{1}{S^2} RSS_{L-j} - T + 2\,(L+K+1-j) \qquad j = 0, 1, \ldots, L$$

where L is an arbitrarily chosen maximum lag length, j represents the lag length restrictions imposed, and RSS_{L-j} is the residual sum of squares from the regression with j lag restrictions imposed. The "best" lag length is found for that j which the Cp statistic attains a minimum value.

A second procedure is Akaike's (1969) final prediction error criterion (FPE). Selection of the lag length using this method is based on finding the minimum value of the statistic

$$(4)\quad FPE = \frac{T + (L+K+1-j)}{T - (L+K+1-j)} \cdot \frac{RSS_{L-j}}{T} \qquad j = 0, 1, \ldots, L$$

where RSS_{L-j} is the residual sum of squares from the regression with j lag restrictions imposed. As with Mallows' Cp-statistic, the FPE criterion trades off some of the bias from selecting lag lengths that are too short with the loss in efficiency caused by selecting lag lengths that are too long.

The final approach is described in Pagano and Hartley (1981) and is used by Batten and Thornton (1983) on the

Andersen-Jordan version of the GNP equation. Essentially, the Pagano-Hartley (PH) procedure begins by selecting some maximum lag length (L) for the right-hand-side variables. Based on a Gram-Schmidt decomposition, the appropriate lag length is chosen by finding that $\hat{\beta}_{L-j}$ for which its t-statistic exceeds exceeds the chosen critical value. For example, if L = 10, and the t-values for j < 5 exceed the critical value but for j > 5, they do, then the lag length would be set at four.

The optimal lag lengths for the bivariate Granger tests are reported in Table 6. The top half of the table reports the lag length selection outcome for the M1-GNP relationship. When GNP is the dependent variable, the three lag selection procedures uniformily pick no lag terms for GNP and two lags on M1. The resultant F-statistic on the lagged M1 terms is significant at the .02 percent level. Using M1 as the dependent variable results in the lag lengths also found in the upper portion of Table 6. There we see that the lags on GNP are seven, based on Mallows' Cp and the FPE criteria, or six from the Pagano-Hartley test. For M1 the lags are five using Mallows' Cp and Pagano-Hartley, and eight from the FPE test. In each instance, the associated F-statistic is significant at the one-percent level. Based on statistically determined lag structures, therefore, we cannot reject the hypothesis of feedback from GNP to M1.

The results from applying the lag-length selection criteria to the debt-GNP relationship are found in the lower half of Table 6. The lag length selection procedures indicate the use of either four or eight lags on GNP, two or eight lags on debt. The calculated F-statistics indicate that we cannot reject the hypothesis that debt causes GNP at the two and four percent levels based on the Mallows Cp and Pagano-Hartley lag structures, respectively. The FPE-chosen lags, however, yield an F-statistic that is significant at the six percent level. Thus, relative to the M1 results, the debt-to-GNP causation evidence is not as robust. When debt is the dependent variable, the lag length selection tests all choose six lags on GNP and eight lags on debt. The F-statistic based on these lags is significant at the 0.1 percent level.

The Granger-test results indicate that M1 and debt are both subject to feedback from GNP. Strictly speaking, this evidence would suggest that <u>both</u> measures should be viewed cautiously in the role as intermediate targets. Depending on one's priors concerning the choice of the optimal lag structures, however, the evidence does suggest that the incidence of feedback grom GNP to debt is more prelavent and dependable than from GNP to M1.

IV. RESULTS USING REDUCED-FORM GNP ESTIMATES

One procedure often used to assess the relative capabilities of competing intermediate target variables to explain GNP growth is to estimate a reduced-form GNP equation of the form popularized by Andersen and Jordan (1968). This model, which relates the growth of monetary and fiscal actions measures to the growth of GNP, has been used to illustrate the relative closeness in the ability of M1 and debt to explain GNP behavior.

Such reduced-form GNP results have been criticized on various grounds. One argument is that the equation is misspecified because it includes only monetary and fiscal variables on the right-hand-side.[16/] Another criticism concerns the use of polynomial restrictions and endpoint constraints on a distributed lag structure that often times is chosen in an *ad hoc* manner.[17/] This latter concern is especially critical, because the imposition of a kth degree polynomial usually is done with the assumption that the true lag length is known, or the best lag length is selected for a given polynomial. If the true lag length and/or the correct polynomial are not correctly specified using this type of procedure, the parameter estimates generally will be biased or inefficient.[18/] Finally, the exogeneity of the explanatory variables has been questioned. In light of the preceding section's results, this problem remains a concern in interpreting the regression estimates.

In light of these criticisms, we make several changes in the structure of the equation. The first modification concerns the explicit recognition of the effects of exogenous supply shocks which affected economic activity during the sample period. Evidence presented by Rasche and Tatom (1981) indicates that the rapid increase in the relative price of energy during the 1970s reduced the potential productive capacity of the economy. This decline in aggregate supply produces significant transitory effects on nominal GNP, because the price level does not adjust instantaneously to the new equilibrium.

The second adjustment also involves the effect of an exogenous supply shock to the behavior of GNP. The effect of major labor strikes influences GNP growth. Consequently, an additional variable, measured as the change in the quarterly average of days lost due to strikes deflated by the civilian labor force, is included in the specification.[19/]

Finally, the GNP results presented in this paper are based on unconstrained ordinary least square (OLS) estimates instead of more popular form with polynomial and endpoint restrictions. Two points must be addressed: First, imposition of polynomial and endpoint constraints generally is motivated by a desire to estimate more precisely coefficients of colinear variables, a common characteristic of distributed lag models. Because our primary concern is in the total effect of the variables on GNP growth, the fact that OLS will yield estimates of linear combinations of coefficients that are as precise as those obtained by imposing polynomial and endpoint restrictions make OLS estimates quite acceptable.[20/] The second point concerns the selection of the appropriate lag length for each variable. To this end, the statistical procedures described in Section III are used to select the lag length.

The reduced-form GNP model used in this section, based on the foregoing discussion, takes the general form

$$(5) \quad \Delta \ln Y_t = \alpha_o + \beta_1 S_t + \sum_{i=0}^{M} \lambda_i \, \Delta \ln X_{t-i} + \sum_{j=0}^{N} \delta_j \, \Delta \ln E_{t-j} + \sum_{k=0}^{O} \phi_k \, P^E_{t-k} + \varepsilon_t$$

where Y is GNP, X represents debt or M1, E is high-employment federal expenditures, S measures the effects of strikes, and P^E is the change in the relative price of energy.[21/]

The Mallows Cp, FPE and Pagano-Hartley test procedures are used to determine the M, N and O lag lengths in equation (5). The maximum lag length (L) for each variable is set at 10.[22/] The lag lengths selected by the three methods are reported in Table 7. The upper panel of Table 6 indicates that when M1 is used as the intermediate target variable, Mallows' Cp and the FPE selection procedures pick the same lag structures: six lags on M1 growth and relative energy price changes, five lags on the growth of federal expenditures. A slightly different lag pattern was found using the Pagano-Hartley criterion. There we find that this approach chooses six lags on M1, four lags on federal expenditures and, like the others, six lags on relative energy price changes.

The bottom panel of Table 7 reports the outcomes when debt growth is used in equation (5). The three procedures indicate that the lag length for debt is shorter than for M1: both the FPE and Pagano-Hartley lag lengths are four. In contrast, Mallows' Cp-statistic found no lag lengths for the debt variable, selecting only the contemporaneous term. With regard to the other variables, all three procedures find no lag structure for federal expenditures growth. This is quite different from the result using M1, where lags of five appeared. The lags chosen for the change in relative energy prices is found to be seven based on the Cp and Pagano-Hartley results and nine using the FPE criterion.

Reduced-Form Estimates

Equation (5) is estimated based on the suggested lag structures in Table 7. To keep the results manageable, the lag structures used for the regression including M1 is: six lags on M1, four lags on expenditures and six lags on relative energy prices. For the model estimated with debt as the intermediate target variables: four lags on debt, no lags on expenditures and seven lags on energy prices are used. The results using M1 are presented in Table 8. For purposes of comparison, results from estimating the Andersen-Jordan form of the equation, a form used by B. Friedman in his analysis of money and debt, are presented in the Appendix Table A1.

The results using M1 are improved greatly over those presented in Appendix Table A1. Addition of the relative energy price variable and the strike variable are significant improvements of the model, as evidenced by the 40 percent improvement in the corrected R^2. The strike variable is negatively signed, as expected, and highly significant. The effects of the energy price shocks are found to be transitory, the summed coefficient not being significantly different from zero at the 5 percent level. The most important aspect of the modified equation is the finding that the changes in the specification have not altered the conclusion that money growth exerts a significant, lasting effect on GNP growth. Testing the hypothesis that $\Sigma\lambda_i$ in equation (5) equals unity yields a t-statistic of 0.03.

The subperiod results, when compared to those in Appendix Table A1, reveal the importance of the respecifications. Although the equation provides only a slight improvement during the I/1955-IV/1968 sample, explicitly capturing the energy price effects during the 1970s leads to a marked increase in explanatory power from 36 percent to 56 percent.[23/] It also is interesting to note the effect on the $\Sigma\lambda_i$ coefficients for the two periods. The I/1969-IV/1980 $\Sigma\lambda_i$ coefficient increases to 1.28, a value not unlike that in the Appendix (1.21). During the first subperiod, the $\Sigma\lambda_i$ coefficient in the restricted model is much larger (1.20) than that found in Table 8 (0.95). In each case, however, one cannot reject the hypothesis that $\Sigma\lambda_i = 1.0$ 24/. Thus, the results from this model support the proposition that money growth has a reliable relationship to the growth of GNP.

To see what effect the respecification has had on the stability of the model, Chow tests are used. Using the estimates from the Appendix model, we find that the hypothesis of stability is rejected at the 5 percent level of confidence.25/ Using the estimates from Table 8, however, the calculated F-statistic is 0.73, compared to the 5 percent critical value of 1.75. Thus, one clear advantage of our respecification is that structurally stable estimates of the effects of M1 growth on GNP growth are produced.

Equation (5) also is estimated, using the appropriate lag structures from Table 7, with debt growth as the intermediate target. These results are found in Table 9. Again the impact of the respecification on the model's overall explanatory power is evident by comparing these results to those in Appendix Table A2--the Andersen-Jordan model estimated with debt. The corrected R^2 is increased by about 50 percent, a large increase again occurring in the second subperiod. One aspect of the subperiod estimates is the change in the lag structure for debt growth. The pattern in Appendix Table A2, estimated with the polynomial and endpoint constraints, indicates an increase to about 1.5 for the first two periods then declining back to unity. The pattern found in Table 9 is much less regular, beginning with a large contemporaneous term (1.35) followed by a relatively small negative estimate (-0.26). The distribution rises for two quarters to a sum value of 1.72 and then is offset toward unity by a large, negative estimate in the fourth lag. Testing the hypothesis that $\Sigma\lambda_i = 1.0$ reveals that we cannot, however, reject the hypothesis (t = 0.37). Thus, although the lag patter is difficult to explain, the cumulative effect of debt growth on GNP is similar to that for M1.

The subperiod results using debt also reveal a relatively large swing in the summed coefficient across the two periods. Moreover, the pattern of the individual lagged coefficients is quite different over the samples. Applying the Chow test to the results in Table 9 indicates, however, that the estimated model is stable across the IV/1968 break point: the calculated F-statistic is 1.34, compared with the 5 percent critical value of 1.79.

The evidence presented in Tables 8 and 9 yield the following conclusions: First, estimates of reduced-form GNP equations that do not account for the influence of exogenous supply shocks are misspecified. This result is evident in the stability finding once such shocks are recognized in the model. The second result which is of more immediate interest is that debt growth does not explain variations in GNP growth as well as M1 growth: the corrected R^2 for M1 is about 18 percent larger than that for debt.

The evidence thus far does not indicate that debt should replace M1 as the intermediate target variable in the setting of monetary policy. Even so, it has been argued that the closeness in their respective levels of explanatory power suggests using debt growth as an auxiliary target variable, one that provides additional information on the effects of monetary actions. This consideration arises because tests like those above only indiate whether debt and M1 might be substitute targets. The important consideration in assessing the value of a debt target, however, is whether knowing debt growth, given M1 growth, can improve upon our predictions of GNP. We examine this issue in the next section.

V. INFORMATIONAL CONTENT OF M1 AND DEBT: A TEST OF THEIR RELATIVE USEFULNESS

The question of how much better we could predict the variation in GNP growth by concurrently using the information contained in M1 and debt growth is investigated using two approaches. The first involves determining the causal relationship between debt and M1, based on procedures set forth in Section III. The second set of tests investigate the marginal improvement in explaining GNP growth when debt growth is added to a GNP equation that uses M1 and vice-versa. This is accomplished by using the lag length selection criteria and reduced-form GNP specifications detailed earlier.

The Causality Between M1 and Debt

Thus far we have regarded the effects of M1 and debt on GNP growth as independent forces. This, however, seems unlikely given the probable links between money growth, interest rates, economic activity, and credit demands. To examine the causal relationship between debt growth and M1 growth, the Granger-test procedures described in Section III are used. The results for testing whether debt growth "causes" M1 growth, given past M1, are found in Table 10. Recall that the figures reported in the matrix represent marginal significance levels for the F-statistics: values greater than 0.05 allow us to reject the null hypothesis that debt improves upon the information contained in past M1. The evidence in Table 10 is striking in that it overwhelmingly rejects the null hypothesis. Regardless of the lag combination chosen, the calculated F-statistic for adding lagged debt to lagged M1 growth never achieves statistical significance. The closest value is rejection at the 13 percent level for the combination of two lags on M1 and eight lags on debt.

The possibility that M1 causes debt is examined in Table 11. Again using the 0.05 level, the matrix of significance values in Table 11 clearly indicates that M1 improves upon the information contained in past debt to explain debt growth. Adding lagged M1 to lagged debt significantly increases the equation's explanatory power in all but six out of the 144 possible combinations reported. Given the number of tests conducted, this figure could almost be explained solely by chance. Moreover, if the significance level is increased to 0.10, there is no lag combination which does not imply that M1 growth causes debt growth.

The evidence regarding the causal link from M1 to debt is subject to the same criticism as the M1-GNP and debt-GNP tests presented earlier. Although the M1-debt relationship appears to be more uniform, we employed the lag length selection criteria to examine the M1-debt link. Table 12 presents the results. Note that Mallows Cp and the FPE test procedures select no lags on debt when M1 is the dependent variable. When the Pagano-Hartley criterion is used, however, it chooses eight lags on debt. Even so, the calculated F-statistic is significant only at the 21 percent level, easily allowing us to again reject the hypothesis that debt causes M1.

To test for M1-to-debt causation, the lag lengths of six and seven on M1 were used, as dictated by the results in Table 12 when debt is the left-hand-side variable. When six lags for M1 are used, the F-statistic is significant at the four percent level. Based on the Pagano-Hartley lag structure (seven on M1 and eight on debt), the significance level is less than the one percent level. Thus, the evidence from these tests also indicates that M1 causes debt.

The evidence taken from Tables 10, 11 and 12 suggests that the ability of debt growth to explain a relatively high degree of the variation in GNP growth derives from its relationship to M1 growth. The overwhelming nature of the Granger-test results indicates that the informational content in the growth of debt reflects movements in M1. Consequently, the finding that debt has a "close" relationship to GNP is explained not by the unique informational content of the debt series but, rather, by the fact that debt is proxying for M1 growth in those regressions.

GNP, M1 and Debt

The issue of the relative informational content of the M1 and debt series can be investigated further by testing the hypothesis that debt (M1) adds no additional information to the explanation of GNP once M1 (debt) is known. One procedure used to investigate this question is to employ the three lag-length selection criteria. In this application, M1 and debt are included concurrently as explanatory variables. The lag length selection results are found in Table 13.[26/]

The lag length procedures indicate that the correct lag for M1 is two, based on Mallows' Cp-statistic, or six lags as suggested by FPE and Pagano-Hartley methods. Recall that six lags were chosen earlier when debt was not included. The most striking result reported is the finding that no lag on the debt variable is chosen once M1 growth is included in the model. This result corroborates the evidence from Tables 10 and 11, indicating that debt adds nothing to the explanation of GNP growth once M1 growth is known.

As a second test, the reduced-form GNP equations presented in Tables 8 and 9 are used. In each instance, we test the significance of adding the contemporaneous and lagged debt (M1) variables to the model that contains M1 (debt).[27]
A standard F-test for the significance of additional variables then is performed. If the calculated F-statistic is significant, we cannot reject the hypothesis that the extra variable provides additional, significant information to explain GNP growth. If the F-statistic is not significant, however, the additional variable adds no marginal information.

The basic equations are reported in Table 14 along with the "informationally unrestricted" test equations. Equation (3) in the table represents the M1 equation to which contemporaneous and lagged debt growth terms are added. Comparing equations (1) and (3), there is a minor change in the overall fit of the model. The debt growth variables never achieve statistical significance at any level, and the sum coefficient is not statistically different from zero ($t = 0.78$). Although adding this set of variables reduces the summed coefficient for M1, it maintains significance ($t = 2.53$). Moreover, one cannot reject the hypothesis that the summed effect of money is equal to unity ($t = 0.81$). The important finding is that the F-statistic for testing the significance of adding the group of debt variables is only 1.18, far below the 5 percent critical value of 2.33. This evidence rejects the hypothesis that the information contained in the growth of debt improves upon that in M1 growth in explaining the behavior of GNP.

Including contemporaneous and lagged M1 growth into a model that already accounts for the effects of debt growth yields equation (4) in Table 14. There are some noticeable differences between equations (3) and (4). For example, the sum coefficient on M1 growth is less than unity, although not so statistically (t = 1.20). Moreover, two of the lagged debt growth coefficients achieve statistical significance, even though the cumulative effect continues to be zero. Because the difference between equations (3) and (4) in Table 14 is in the specification of the federal expenditures lag (and one lag for energy prices), this suggests that the influence of debt growth also may be influenced by the presence of lagged expenditures on GNP. At any rate, testing the significance of adding M1 growth to the equation that includes debt growth yields an F-statistic of 3.50, reliably greater than the 5 percent critical value of 2.12. Consequently, we cannot reject the hypothesis that M1 growth significantly improves the explanation of GNP growth knowing only the information in debt growth.

The tests presented in this section again reject the usefulness of debt, relative to M1, as an intermediate policy target. The evidence indicates that knowing past M1 growth significantly improves upon predictions of debt growth, given past debt. The limited marginal informational content of debt is verified further by tests which show that adding current and past values of debt growth to a reduced-form GNP equation that already accounts for the influence of M1 growth also does not significantly improve the explanatory power of the model. Conversely, adding M1 growth to an equation that already uses debt growth significantly increases the fit of the model. Thus, findings that show debt growth to explain the variation in GNP growth as well as M1 growth merely reflect the underlying dependence of debt growth on M1 growth.

VI. SUMMARY AND POLICY IMPLICATIONS

Uncertainty in the wake of financial deregulation and recent economic developments has renewed the search for that economic variable that would serve best as an intermediate target for monetary policy. In this paper, we have investigated the relationship between GNP and two such candidates: M1 and total domestic nonfinancial debt. Although numerous recent papers have shown M1 to be preferable to other monetary measures for this purpose, evidence has been advanced by others to suggest that the debt measure may work just as well as M1.

The evidence provided in this paper suggests otherwise.[28/] Causality test results indicate that both M1 and debt are subject to some feedback from GNP. The most important outcome of our study, however, is discovering that the marginal effect of debt on GNP is nil once the influence of

M1 is accounted for. This conclusion is based on two different tests: One that shows unidirectional causation from M1 to debt and another that information on debt growth does not significantly increase the explanatory power of a reduced-form GNP equation containing M1. This result is supported further by the significance of adding M1 to a reduced-form GNP equation which contains debt growth.

The implications of our results for the policymakers are clear enough. In contrast to recent claims that a multiple-target strategy would enhance monetary control, our findings indicate that such a framework, especially one that employs total domestic nonfinancial debt, would be, at best, an exercise in duplication. Although such an activity is not unheard of in bureaucratic organizations subject to scrutiny, the credibility of this policy must be doubted.

FOOTNOTES

[1]/Monetary growth objectives had been stated by policymakers since the early 1970s. It is difficult to argue that they were used as intermediate targets. Perhaps the most damaging evidence against the position that money growth targets were actively pursued is the constant re-basing of the growth paths. Such "base drift" did not foster much credibility on stated long-term targets. Although there is some evidence of a change in policy, some have argued that the Federal Reserve continues its practice of fine-tuning. For evidence, see Feige and McGee (1979), and M. Friedman (1983).

[2]/See, inter alia, Cagan (1982), Fellner (1982), B. Friedman (1981, 1982a, 1982b, 1983a, 1983b), and Davidson and Hafer (1983).

[3]/See the references for B. Friedman.

[4]/Frank Morris, President of the Federal Reserve Bank of Boston, has strongly endorsed the use of debt measure in place of M1. See Morris (1982, 1983). For another recent advocacy of the debt measure, see Kopcke (1983). A more skeptical view of the adoption of the debt monitoring range is that it merely reflected the interest shown by Representative Henry Reuss, former Chairman of the Joint Economic Committee. See also, Volcker (1983).

[5]/This sample period is used throughout this study. Because it is the sample period used by Friedman, it allows more direct comparison of results.

[6] This stability result is often the raison d'etre for those advocating the use of debt as an intermediate target. See, for example, B. Friedman (1981) and Morris (1983).

[7] Davis (1973) criticizes Milton Friedman's adherence to M2 over M1 by pointing out that "Friedman's argument is couched in terms of the substantially larger range of the level of the M1 income velocity relative to the range of the level of the M2 income velocity in the 1962-72 period. The relevant issue, however, is the variance of the rates of growth of these two velocity measures--at least as far as setting intermediate-run or countercyclical monetary growth targets is concerned."

[8] The difficulty with such statistical comparisons comes from the fact that the coefficient of variation is affected greatly by the mean value. The relatively low mean value for debt growth distorts the measure of variability. Indeed, on the basis of comparing standard deviations for the full period, one finds that the standard deviation of the growth of debt velocity is 3.55 percent compared with a value of 3.64 for M1 velocity growth.

[9] We use the word "cause" advisedly. Our interpretation follows Granger in the sense that if knowing past values of X reduces the forecast error variance in Y relative to knowing only past Y, then X "causes" Y. For an interesting discussion of the usefulness of this approach to causation, see Zellner (1979).

10/ An alternative approach is presented by Sims (1972). For a comparison of causality test procedures, see Geweke, et. al. (1983) and Guilkey and Salemi (1982). Each study indicates that the Granger procedure is preferred.

11/ See Batten and Thornton (1984) for a similar approach.

12/ The tables consist of significance levels of the respective F-statistic. Significance levels rather than F-values are used, because reported F-values would not be comparable due to differing degrees of freedom.

13/ Similar results are reported by Feige and Pearce (1979).

14/ Causality results using vector autoregression models with debt are reported by Friedman (1981, 1982a, 1982b, 1983a, 1983b). In a recent paper, Porter and Offenbacher (1983) present evidence showing that Friedman's earlier findings do not obtain with slight changes in the lag structure.

15/ The following discussion draws from Batten and Thornton (1984).

16/ Although (B.) Friedman notes the controversy, he employs the version originally used by Andersen and Jordan, disregarding recent advancements in the content and estimation of such equations. For examples of the criticisms surrounding the use of this equation, see Goldfeld and Blinder (1972), Gordon (1976) and Modigliani and Ando (1976). It also has been suggested that the equation should incorporate the effects of the foreign sector on GNP. The evidence presented in Batten and Hafer (1983) suggests, however, that accounting for export activity is not statistically important for the U.S.

[17/] See Schmidt and Waud (1973). Batten and Thornton (1983) provide a methodology for selection of lag lengths and polynomial restrictions.

[18/] See Judge, et. al. (1982).

[19/] On the use of this variable, see Andersen (1975) or Tatom (1981).

[20/] Theil (1971).

[21/] The relative price of energy is defined as the ratio of the producer price index for fuels and related products and power to the price deflator for private business section output.

[22/] The choice of 10 maximum lags was made a priori. Because of the number of variables tested and to reduce somewhat the computer time used to generate the results, 10 seemed a reasonable number.

[23/] Friedman (1983b) points to the post-1970 fit of the Andersen-Jordan form of the equation as evidence of a deterioration in the money-GNP link. During this sample period (1970-78), Friedman finds the R^2 for M1 and debt to be equal (0.20).

24/ The relevant t-statistic for the 1955-1968 period is 0.14, and for the 1969-1980 sample is 0.67.

25/ The calculated F-statistic is 2.68, the 5 percent critical value being 2.11.

26/ Because of computing difficulties and in light of earlier findings, the experiments conducted here fix the lag length for changes in the relative price of energy at six.

27/ The lag lengths for M1 and debt in this experiment are those determined in Section III.

28/ Similar conclusions are reached by Porter and Offenbacher (1983) and McMillin and Fackler (1984).

Table 1
Coefficients of Variation: Velocities

Variable	Period I/1955-IV/1980	I/1955-IV/1968	I/1969-IV/1980
GNP/M1	0.225	0.129	0.120
GNP/Debt	0.022	0.026	0.013
Δln(GNP/M1)	1.150	1.138	1.176
Δln(GNP/Debt)	-17.494	-31.894	-10.987

Table 2
Causality Test Results: GNP on M1 (significance levels)

Lags of M1	Lags of GNP											
	1	2	3	4	5	6	7	8	9	10	11	12
1	.005	.005	.005	.012	.011	.017	.014	.004	.004	.005	.005	.016
2	.002	.001	.001	.002	.002	.002	.002	.002	.001	.002	.002	.006
3	.007	.003	.002	.003	.003	.004	.003	.006	.005	.006	.006	.017
4	.009	.005	.004	.007	.008	.011	.008	.013	.012	.014	.015	.037
5	.019	.011	.009	.014	.013	.017	.012	.024	.022	.026	.026	.051
6	.029	.017	.015	.025	.025	.033	.024	.045	.040	.046	.048	.080
7	.038	.020	.016	.029	.032	.043	.021	.054	.048	.056	.058	.083
8	.041	.022	.016	.022	.025	.035	.013	.070	.069	.078	.081	.107
9	.064	.035	.027	.037	.042	.057	.023	.108	.098	.112	.116	.152
10	.079	.043	.034	.044	.048	.063	.025	.123	.122	.125	.127	.163
11	.116	.066	.054	.068	.074	.095	.039	.166	.162	.171	.178	.214
12	.160	.094	.078	.094	.101	.127	.060	.214	.211	.220	.225	.276

Table 3
Causality Test Results: M1 on GNP (significance levels)

Lags of GNP	Lags of M1											
	1	2	3	4	5	6	7	8	9	10	11	12
1	.571	.473	.889	.896	.975	.926	.877	.875	.942	.942	.932	.952
2	.848	.712	.990	.990	.999	.992	.958	.944	.949	.951	.951	.932
3	.312	.261	.762	.761	.623	.651	.517	.413	.444	.449	.446	.448
4	.459	.398	.882	.877	.736	.782	.677	.544	.598	.603	.601	.594
5	.192	.183	.478	.455	.127	.158	.232	.190	.264	.266	.262	.259
6	.055	.051	.116	.110	.014	.009	.024	.030	.043	.038	.030	.025
7	.051	.043	.098	.087	.011	.010	.013	.012	.021	.018	.017	.019
8	.042	.043	.078	.071	.013	.012	.019	.022	.035	.031	.031	.032
9	.067	.069	.120	.110	.023	.021	.033	.037	.058	.052	.052	.052
10	.094	.097	.173	.160	.038	.035	.052	.060	.090	.079	.076	.075
11	.042	.044	.096	.074	.026	.026	.038	.041	.062	.060	.064	.073
12	.064	.067	.038	.108	.039	.040	.056	.057	.085	.082	.088	.106

Table 4
Causality Test Results: GNP on Debt (significance levels)

Lags of Debt	Lags of GNP											
	1	2	3	4	5	6	7	8	9	10	11	12
1	.318	.182	.114	.059	.058	.064	.057	.083	.092	.086	.088	.148
2	.522	.258	.110	.022	.017	.018	.017	.059	.065	.061	.062	.077
3	.498	.265	.175	.055	.040	.037	.035	.109	.124	.118	.121	.157
4	.546	.327	.219	.105	.082	.074	.072	.191	.211	.198	.202	.249
5	.650	.418	.302	.144	.128	.129	.124	.291	.316	.301	.306	.363
6	.728	.499	.363	.192	.166	.183	.159	.406	.438	.420	.426	.480
7	.801	.604	.471	.280	.247	.266	.232	.490	.501	.512	.520	.576
8	.235	.162	.104	.035	.023	.023	.024	.112	.128	.086	.063	.074
9	.290	.190	.122	.049	.035	.038	.040	.166	.188	.122	.078	.112
10	.280	.217	.125	.048	.037	.043	.044	.190	.206	.148	.112	.118
11	.351	.279	.155	.071	.056	.065	.066	.241	.263	.202	.155	.166
12	.424	.332	.194	.105	.084	.095	.096	.315	.339	.266	.202	.196

Table 5
Causality Test Results: Debt on GNP (significance levels)

Lags of GNP	Lags of Debt											
	1	2	3	4	5	6	7	8	9	10	11	12
1	.006	.005	.005	.010	.009	.012	.012	.006	.002	.002	.002	.002
2	.014	.019	.020	.033	.030	.040	.039	.020	.008	.008	.008	.009
3	.036	.042	.046	.068	.062	.077	.074	.037	.015	.016	.014	.015
4	.047	.029	.034	.078	.076	.094	.084	.035	.019	.019	.018	.016
5	.064	.029	.029	.099	.082	.093	.082	.024	.019	.019	.019	.019
6	.014	.005	.003	.020	.005	.007	.004	.001	.001	.001	.001	.001
7	.027	.010	.007	.036	.008	.013	.008	.001	.002	.002	.001	.002
8	.018	.012	.008	.039	.005	.007	.007	.001	.002	.003	.002	.002
9	.028	.018	.014	.061	.008	.010	.012	.002	.004	.005	.004	.004
10	.041	.027	.022	.086	.014	.018	.018	.002	.004	.004	.004	.005
11	.037	.028	.022	.085	.018	.023	.024	.003	.008	.008	.008	.009
12	.048	.035	.030	.106	.025	.032	.032	.005	.010	.011	.012	.014

Table 6
Lag Selection for Granger Causality Tests

Dependent Variable	Criteria	Variable: GNP	M1	Debt
GNP	Mallows CP	0	2	-
	FPE	0	2	-
	Pagano-Hartley	0	2	-
M1	Mallows CP	7	5	-
	FPE	7	8	-
	Pagano-Hartley	6	5	-
GNP	Mallows CP	4	-	2
	FPE	8	-	2
	Pagano-Hartley	4	-	8
Debt	Mallows CP	6	-	8
	FPE	6	-	8
	Pagano-Hartley	6	-	8

Table 7
Lag Specification for GNP Equation

Criteria	Variable[1/] M1	E	P^E
Mallows CP	6	5	6
FPE	6	5	6
Pagano-Hartley	6	4	6

Criteria	Variable[1/] Debt	E	P^E
Mallows CP	0	5	6
FPE	4	0	9
Pagano-Hartley	4	0	7

1/ M1 is the narrow definition of money, debt is total domestic nonfinancial debt, E is high-employment federal expenditures and P^E is the relative price of energy.

Table 8
Reduced-Form GNP Estimates: M1 (full period and subperiods)

Variable	Period: I/1955-IV/1980	I/1955-IV/1968	I/1969-IV/1980
Constant	3.029 (3.90)	3.317 (3.06)	-0.278 (0.11)
STRIKE	-0.501 (4.08)	-0.474 (2.22)	-0.366 (1.25)
M_0	0.590 (5.08)	0.680 (2.79)	0.563 (3.60)
M_{-1}	0.273 (2.21)	0.086 (0.29)	0.294 (1.88)
M_{-2}	0.321 (2.29)	0.425 (1.51)	0.278 (1.29)
M_{-3}	0.241 (1.42)	0.326 (1.01)	0.248 (0.91)
M_{-4}	-0.156 (0.88)	-0.151 (0.50)	-0.218 (0.82)
M_{-5}	0.039 (0.21)	-0.022 (0.06)	0.288 (0.96)
M_{-6}	-0.312 (1.89)	-0.393 (1.28)	-0.171 (0.54)
ΣM_{-i}	0.996 (6.74)	0.951 (2.82)	1.281 (3.05)
E_0	0.089 (2.17)	0.081 (1.09)	0.038 (0.54)
E_{-1}	0.043 (1.08)	0.060 (0.89)	0.037 (0.44)
E_{-2}	-0.074 (1.88)	-0.008 (0.11)	-0.080 (0.96)
E_{-3}	0.012 (0.34)	-0.023 (0.35)	0.111 (1.49)
E_{-4}	-0.074 (2.10)	-0.118 (1.99)	0.065 (1.04)
ΣE_{-i}	-0.003 (0.04)	-0.009 (0.08)	0.170 (0.65)
P^E_0	-0.032 (0.94)	0.038 (0.38)	-0.062 (1.50)
P^E_{-1}	0.053 (1.25)	0.042 (0.44)	0.098 (1.77)
P^E_{-2}	-0.028 (0.62)	0.011 (0.11)	-0.036 (0.61)
P^E_{-3}	-0.022 (0.50)	0.026 (0.26)	-0.043 (0.65)
P^E_{-4}	-0.037 (0.86)	-0.060 (0.63)	-0.037 (0.63)
P^E_{-5}	0.011 (0.24)	-0.026 (0.27)	0.018 (0.31)
P^E_{-6}	0.117 (3.30)	0.155 (1.65)	0.086 (1.66)
ΣP^E_{-i}	0.061 (1.27)	0.186 (0.50)	0.026 (0.28)
$\bar{R}^2$	0.594	0.475	0.556
SE	2.783	3.002	2.721
DW	1.965	1.580	2.434

Table 9
Reduced-Form GNP Estimates: Debt (full period and subperiods)

Variable	Period I/1955-IV/1980	I/1955-IV/1968	I/1969-IV/1980
Constant	-0.549 (0.40)	-3.263 (0.89)	-0.427 (0.18)
STRIKE	-0.579 (4.18)	-0.703 (3.50)	-0.751 (3.10)
D_0	1.351 (5.37)	1.648 (3.97)	1.594 (4.11)
D_{-1}	-0.255 (0.89)	0.086 (0.20)	-0.685 (1.46)
D_{-2}	0.262 (0.84)	0.513 (1.11)	-0.441 (0.95)
D_{-3}	0.358 (1.18)	0.131 (0.30)	1.256 (2.38)
D_{-4}	-0.782 (2.54)	-1.061 (2.35)	-0.713 (1.37)
ΣD_{-i}	0.934 (5.23)	1.317 (2.06)	1.011 (3.93)
E_0	0.095 (2.16)	0.162 (2.28)	0.004 (0.06)
P^E_0	0.002 (0.04)	0.106 (1.00)	-0.032 (0.68)
P^E_{-1}	0.030 (0.64)	0.084 (0.81)	0.076 (1.41)
P^E_{-2}	-0.071 (1.50)	-0.014 (0.13)	-0.064 (1.19)
P^E_{-3}	0.061 (1.21)	0.137 (1.22)	-0.002 (0.03)
P^E_{-4}	-0.119 (2.36)	-0.247 (2.24)	-0.048 (0.80)
P^E_{-5}	0.012 (0.21)	-0.051 (0.44)	0.003 (0.04)
P^E_{-6}	0.177 (3.57)	0.245 (2.31)	0.118 (1.91)
P^E_{-7}	-0.093 (2.33)	-0.080 (0.77)	-0.048 (1.10)
ΣP^E_{-i}	-0.002 (0.04)	0.181 (0.38)	0.001 (0.01)
$\bar{R}^2$	0.504	0.407	0.562
SE	3.073	3.190	2.702
DW	1.804	1.759	2.258

Table 10
Causality Test Results: M1 on Debt (significance levels)

Lags of Debt	Lags of M1											
	1	2	3	4	5	6	7	8	9	10	11	12
1	.266	.171	.470	.475	.503	.464	.398	.194	.247	.249	.244	.202
2	.448	.228	.594	.584	.518	.502	.384	.246	.370	.373	.357	.300
3	.579	.381	.786	.780	.718	.712	.593	.425	.576	.578	.560	.485
4	.504	.434	.704	.661	.516	.589	.652	.524	.671	.675	.641	.573
5	.645	.571	.818	.787	.621	.697	.784	.637	.773	.776	.747	.709
6	.567	.522	.690	.694	.584	.659	.810	.756	.852	.855	.830	.802
7	.491	.455	.575	.583	.571	.641	.840	.836	.875	.877	.861	.833
8	.142	.139	.213	.217	.233	.241	.333	.469	.374	.293	.294	.292
9	.204	.197	.290	.295	.310	.323	.429	.562	.422	.301	.266	.306
10	.252	.229	.323	.330	.356	.377	.491	.643	.472	.377	.349	.378
11	.274	.259	.287	.295	.323	.354	.430	.565	.486	.420	.364	.418
12	.349	.334	.367	.376	.407	.440	.519	.654	.577	.504	.436	.479

Table 11
Causality Test Results: Debt on M1 (significance levels)

Lags of M1	Lags of Debt											
	1	2	3	4	5	6	7	8	9	10	11	12
1	.038	.006	.007	.012	.011	.012	.013	.023	.009	.010	.010	.012
2	.001	.006	.007	.021	.018	.022	.024	.043	.017	.015	.016	.019
3	.013	.013	.013	.031	.034	.038	.040	.075	.033	.030	.031	.035
4	.021	.011	.008	.032	.038	.029	.028	.037	.015	.015	.016	.011
5	.040	.018	.011	.044	.045	.031	.023	.023	.013	.012	.012	.010
6	.065	.030	.015	.067	.061	.052	.038	.022	.015	.014	.016	.012
7	.004	.003	.011	.008	.002	.003	.003	.001	.002	.002	.002	.002
8	.006	.004	.002	.010	.002	.003	.003	.002	.003	.004	.004	.004
9	.010	.007	.003	.018	.003	.005	.006	.003	.006	.007	.007	.007
10	.017	.012	.006	.030	.006	.009	.011	.004	.009	.010	.010	.011
11	.022	.018	.010	.042	.009	.014	.016	.007	.015	.017	.018	.020
12	.033	.028	.016	.064	.016	.022	.027	.012	.025	.027	.029	.029

Table 12
Lag Selection for Granger Causality Tests

Dependent Variable	Criteria	Variable: M1	Variable: Debt
M1	Mallows CP	2	0
	FPE	2	0
	Pagano-Hartley	3	8
Debt	Mallows CP	6	7
	FPE	6	7
	Pagano-Hartley	7	8

Table 13
Lag Specification for GNP Equation Including M1 and Debt

Criteria	M1	Debt	E	P^E
	Variable			
Mallows CP	2	N.A.	5	6
FPE	6	N.A.	5	6
Pagano-Hartley	6	N.A.	4	6

Table 14
Tests for Marginal Significance of M1, Debt

Variable	Equation (1)	(2)	(3)	(4)
Constant	3.029 (3.90)	-0.549 (0.40)	1.940 (1.14)	1.583 (0.95)
STRIKE	-0.501 (4.08)	-0.579 (4.18)	-0.536 (4.13)	-0.592 (4.58)
M_0	0.590 (5.08)		0.514 (3.78)	0.435 (3.09)
M_{-1}	0.273 (2.21)		0.331 (2.25)	0.324 (2.18)
M_{-2}	0.321 (2.29)		0.318 (1.97)	0.323 (1.98)
M_{-3}	0.241 (1.42)		0.119 (0.65)	0.058 (0.31)
M_{-4}	-0.156 (0.88)		-0.148 (0.78)	-0.160 (0.85)
M_{-5}	0.039 (0.21)		-0.032 (0.16)	-0.035 (0.18)
M_{-6}	-0.312 (1.89)		-0.344 (1.92)	-0.306 (1.71)
ΣM_{-i}	0.996 (6.74)		0.757 (2.53)	0.640 (2.13)
D_0		1.351 (5.37)	0.286 (0.98)	0.473 (1.55)
D_{-1}		-0.255 (0.89)	-0.485 (1.60)	-0.614 (2.03)
D_{-2}		0.262 (0.84)	0.165 (0.50)	0.248 (0.76)
D_{-3}		0.358 (1.18)	0.495 (1.67)	0.632 (2.04)
D_{-4}		-0.782 (2.54)	-0.197 (0.63)	-0.425 (1.31)
ΣD_{-i}		0.934 (5.23)	0.264 (0.78)	0.313 (0.91)
E_0	0.089 (2.17)	0.095 (2.16)	0.091 (2.20)	0.074 (1.80)
E_{-1}	0.043 (1.08)		0.042 (1.03)	
E_{-2}	-0.074 (1.88)		-0.060 (1.50)	
E_{-3}	0.012 (0.34)		0.009 (0.25)	
E_{-4}	-0.074 (2.10)		-0.078 (2.18)	
ΣE_{-i}	-0.003 (0.04)		0.005 (0.06)	
P^E_0	-0.032 (0.94)	0.002 (0.04)	-0.018 (0.47)	0.002 (0.06)
P^E_{-1}	0.053 (1.25)	0.030 (0.64)	0.043 (0.94)	0.038 (0.83)
P^E_{-2}	-0.028 (0.62)	-0.071 (1.50)	-0.044 (0.92)	-0.051 (1.05)
P^E_{-3}	-0.022 (0.50)	0.061 (1.21)	0.012 (0.25)	0.031 (0.61)
P^E_{-4}	-0.037 (0.86)	-0.119 (2.36)	-0.077 (1.63)	-0.102 (2.12)
P^E_{-5}	0.011 (0.24)	0.012 (0.21)	0.023 (0.50)	0.016 (0.33)
P^E_{-6}	0.117 (3.30)	0.177 (3.57)	0.118 (3.16)	0.165 (3.51)
P^E_{-7}		-0.093 (2.33)		-0.072 (1.86)
ΣP^E_{-i}	0.061 (1.27)	-0.002 (0.04)	0.058 (1.06)	0.028 (0.52)
$\bar{R}^2$	0.594	0.504	0.598	0.587
SE	2.783	3.073	2.767	2.807
DW	1.965	1.804	1.976	1.894
F			1.18	3.50
F (5 percent)			2.33	2.12

APPENDIX A

A reduced-form GNP equation of the form used by Andersen and Jordan (1968) is estimated in this Appendix. Although much maligned in the literature, this type of specification has proven indispensable in most studies attempting to assess the relative usefulness of different measures to explain GNP. The equation to be estimated is:

$$\text{(A1)} \quad \Delta \ln Y_t = \alpha_0 + \sum_{i=0}^{N} \beta_i \, \Delta \ln X_{t-i} + \sum_{j=0}^{M} \delta_j \, \Delta \ln E_{t-j} + \epsilon_t$$

where Y is nominal GNP, E is the high-employment measure of government expenditures, and X is either debt or M1. To make our results comparable with those presented by Friedman, each lag structure is constrained to lie on a fourth degree polynomial, and the endpoint restrictions that $\beta_{-1} = \beta_5 = \delta_{-1} = \delta_5 = 0$ are imposed. The results of estimating equation (A) using the M1 are presented in Table A1. The sample periods used are 1955/I - 1980/IV and two equal subperiods, I/1955-IV/1968 and I/1969-IV/1980.

The parameter estimates using M1 conform with previous findings.[1/] The effect tends to peak in the first lag and then trail off to zero. The cumulative effect is statistically significant in each period, and the hypothesis that there is a one-to-one long-run effect from M1 to GNP cannot be rejected.[2/] The DW statistics also indicate no problems of autocorrelation. As demonstrated by Friedman (1983b), the model is not stable across the sample. The calculated F-statistic from the Chow test is 2.68, a value greater than the 5 percent critical of 2.11.

The results using debt as the policy variable, found in Table A2, indicate that it has certain desirable properties. Although somewhat lower than M1, the degree of explanatory power is not unreasonable for such equations. Moreover, the hypothesis of nonautocorrelated residuals cannot be rejected. More important, the growth of debt also is found to have a lasting and highly significant effect on GNP growth. The lag structure for debt suggests a one-to-one contemporaneous influence from a change in debt growth to GNP growth. In fact, after two quarters a one percentage point increase in debt growth precipitates a 1.5 percentage point rise in GNP growth. The impact of debt growth during the remaining three lags turns negative, giving rise to a sum coefficient of unity. Although the lag pattern is hard to explain, the fact that the summed effect is unity is most important.

The subperiod results reveal a fairly substantial swing in the cumulative effects of debt growth. This is especially noticeable during the first period where the sum coefficient rises to 1.57. A test of the hypothesis that the sum coefficient equals unity cannot, however, be rejected at any reasonable level of significance ($t = 1.21$). The changes evident in the overall performance of the equation are sufficient to render the model structurally unstable. Based on the IV/1968 sample split, a standard Chow test provides an F-statistic of 3.74, a value far above the 5 percent critical of 2.11. Thus, although the model is statistically unstable, the subperiod results do not permit us to reject the claim that changes in the growth of debt have a lasting and one-to-one effect on GNP growth.[3/]

The results found using debt and M1 for the subperiods indicate that M1 provides a slight improvement over debt in explaining the growth of GNP. In the 1955-1968 period, M1 improves upon the debt equation's explanatory power by 10 percent. In the 1969-1980 period, the improvement increases to 16 percent.

FOOTNOTES TO APPENDIX A

1/Again the estimated effects for the expenditures vary considerably across the two samples. Similar results are reported in Hafer (1982). It also is interesting to note the differences in the estimates obtained when M1 replaces the debt measure.

2/Testing the hypothesis that $\Sigma\beta_{-i} = 1.0$, the period and t-statistics are: I/1955-IV/1980, 0.68; I/1955-IV/1968, 0.85; and I/1969-IV/19800, 0.56.

3/One aspect of the subperiod results is the change in the estimates for government expenditures. Although the cumulative impact does not differ significantly from zero in each period, there is substantial shifts in magnitude and significance of the short-term impacts. For example, during the I/1955-IV/1968 period, government expenditures exert a highly significant effect, summing to about 0.35 by the second lag. During the next two lags this is offset. The high significance value of these latter coefficients suggests that a longer lag structure may be appropriate. The results for the I/1969-IV/1980 period indicate that fiscal actions exert little effect on GNP growth in the short or long-run. The first three coefficients are negative and very small, a finding quite different from the previous sample.

Appendix Table A1
Andersen-Jordan Regression Results: M1 (full period and subperiods)

Variable[1/]	Period I/1955-IV/1980	I/1955-IV/1968	I/1969-IV/1980
Constant	2.716 (3.31)	2.608 (2.87)	-0.216 (0.08)
M_0	0.449 (4.35)	0.315 (2.21)	0.553 (3.52)
M_{-1}	0.456 (6.76)	0.406 (4.95)	0.550 (4.80)
M_{-2}	0.255 (2.74)	0.326 (2.66)	0.295 (2.15)
M_{-3}	0.029 (0.46)	0.155 (1.77)	-0.008 (0.07)
M_{-4}	-0.084 (0.76)	0.001 (0.01)	-0.164 (0.90)
ΣM_{-i}	1.105 (7.20)	1.204 (5.00)	1.206 (3.30)
E_0	0.053 (1.39)	0.047 (0.95)	0.035 (0.63)
E_{-1}	0.047 (1.61)	0.103 (2.89)	0.008 (0.18)
E_{-2}	0.003 (0.11)	0.061 (1.49)	0.011 (0.22)
E_{-3}	-0.047 (1.87)	-0.069 (2.46)	0.061 (1.24)
E_{-4}	-0.065 (1.90)	-0.167 (4.03)	0.100 (1.76)
ΣE_{-i}	-0.008 (0.10)	-0.024 (0.30)	0.214 (1.46)
$\bar{R}$	0.421	0.464	0.364
SE	3.322	3.033	3.258
DW	2.011	1.852	2.353

1/ All variables enter as first-difference of logarithms. Equations are estimated with fourth order polynomial, endpoints constrained to zero, $\bar{R}^2$ is the adjusted coefficient of determination, SE is the regression standard error and DW is the Durbin-Watson test statistic.

Appendix Table A2
Andersen-Jordan Regression Results: Debt (full period and subperiods)

Variable 1/	Period I/1955-IV/1980	I/1955-IV/1968	I/1969-IV/1980
Constant	-0.714 (0.52)	-4.782 (1.55)	-1.423 (0.49)
D_0	1.005 (4.46)	1.010 (3.16)	1.262 (3.96)
D_{-1}	0.508 (4.01)	0.798 (4.79)	0.293 (1.59)
D_{-2}	-0.153 (0.71)	0.214 (0.78)	-0.575 (1.85)
D_{-3}	-0.324 (2.62)	-0.208 (1.22)	-0.392 (2.30)
D_{-4}	-0.036 (0.16)	-0.247 (0.80)	0.406 (1.15)
ΣD_{-i}	1.000 (5.58)	1.567 (3.34)	0.993 (3.19)
E_0	0.069 (1.64)	0.092 (1.76)	-0.030 (0.45)
E_{-1}	0.062 (1.93)	0.158 (4.29)	-0.048 (0.94)
E_{-2}	0.013 (0.39)	0.098 (2.26)	-0.006 (0.12)
E_{-3}	-0.040 (1.46)	-0.067 (2.24)	0.080 (1.55)
E_{-4}	-0.058 (1.59)	-0.189 (4.37)	0.130 (2.23)
ΣE_{-i}	0.046 (0.57)	0.092 (1.07)	0.126 (0.78)
$\bar{R}^2$	0.333	0.423	0.313
SE	3.565	3.147	3.385
DW	1.951	1.980	2.394

1/ All variables enter as first-difference of logarithms. Equations are estimated with fourth order polynomial, endpoints constrained to zero, $\bar{R}^2$ is the adjusted coefficient of determination, SE is the regression standard error and DW is the Durbin-Watson test statistic.

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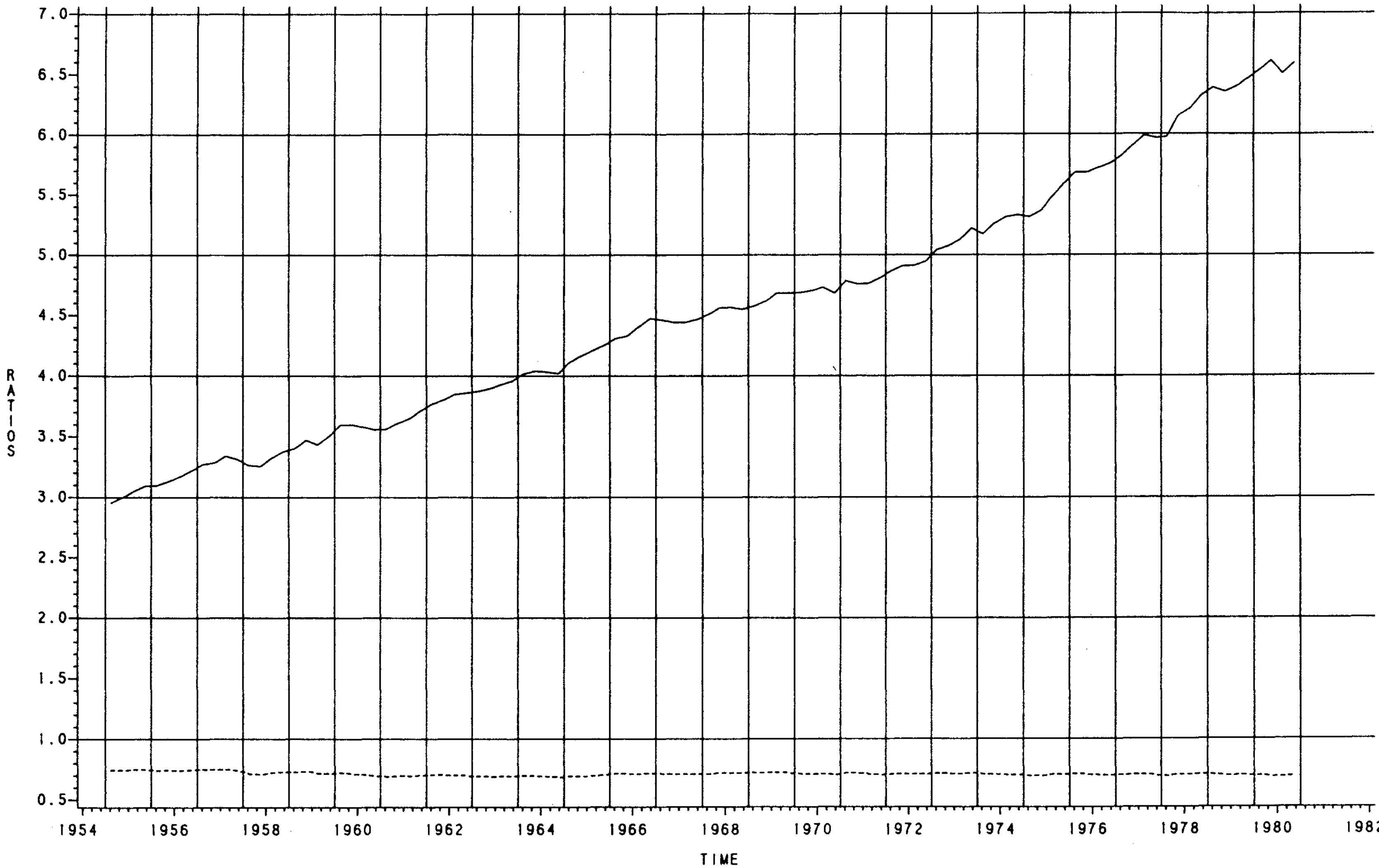
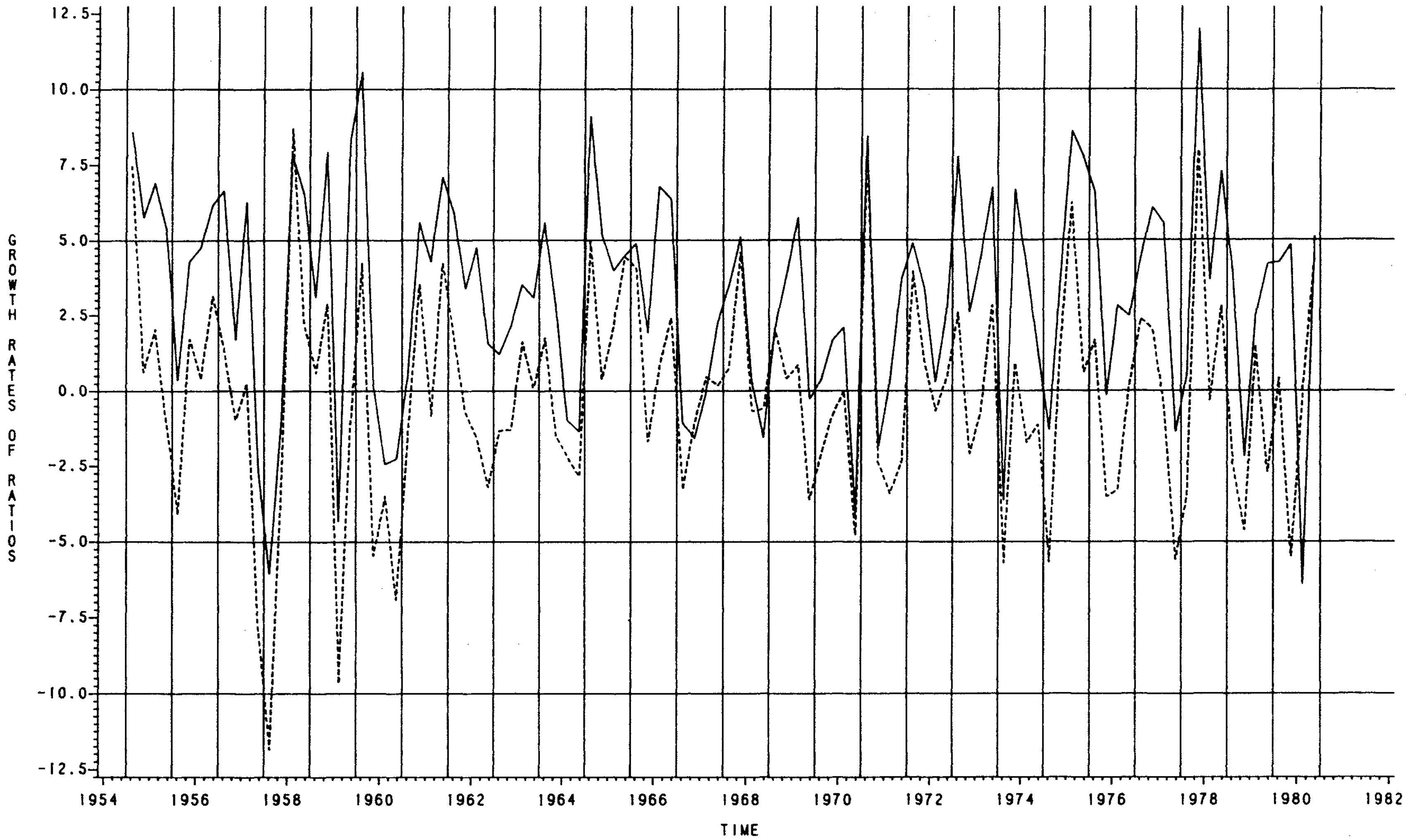
FIGURE 1
TIME PLOTS OF GNP/M1 AND GNP/DEBT
I/1955 - IV/1980



VELOCITY: SOLID LINE   DEBT RATIO: DASHED LINE

FIGURE 2
TIME PLOTS OF GROWTH IN GNP/M1 AND GNP/DEBT
I/1955 - IV/1980



VELOCITY: SOLID LINE   DEBT RATIO: DASHED LINE