Money and Income:
Is There a Simple Relationship?

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The relationship between money and income has been the subject of a great deal of research over the last two decades. The approach commonly taken is based on the view that income is related to past and present values of money. The results of this research have generally indicated a relatively strong association between money and income with the major impact of money on income occurring several quarters after the initial change in money.[1]

The most common statistical model used in these research efforts is called a "reduced form" model, which contrasts with a large "structural" model of the economy.[2] In the typical reduced form model used by monetarists, emphasis is placed on the effect of money on income, almost completely excluding the potential impact of other variables. At the extreme, the reduced form model has been reduced to a single equation relating income only to money, thereby ignoring the specific impacts of other variables. Examples of the single equation approach are found in works by Michael Keran, Milton Friedman and David Meiselman, and Christopher Sims.[3]

Two problems appear to exist with the results obtained from the single equation model. One is that the users may not have adequately allowed for the presence of trend in the data when examining the relationship between money and income. Failure to adequately account for the presence of trend can severely bias common statistical procedures toward the acceptance of the view that two variables are related when indeed they may not be.[4] The second problem is that users of the single equation model have implicitly assumed that the direction of influence runs only from money to income with no significant feed-

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1/See Milton Friedman and David Meiselman, "The Relative Stability of Monetary Velocity and the Investment Multiplier in the United States, 1897-1958," Commission on Money and Credit, *Stabilization Policies* (Englewood Cliffs, N. J.: Prentice Hall, 1963). Also, several papers dealing with the relationship of money and income have been published in the Federal Reserve Bank of St. Louis *Review*. An example is Michael Keran's "Economic Theory and Forecasting," March 1967. A more recent example of a paper on this subject is Frederick E. Schadrack's "An Empirical Approach to the Definition of Money," *Monetary Aggregates and Monetary Policy,* Federal Reserve Bank of New York, October 1974.

2/The two models differ because the structural model specifies a separate supply and demand equation for each market considered. The reduced form model, however, reduces the structural model to a set of equations that do not distinguish underlying supply and demand equations. It should be noted there need not be a difference in the results obtained from structural and reduced form models. Under certain conditions, having to do with the proper specification of dependent and independent variables and the attainment of equilibrium between demand and supply, both models can be formally equivalent.

3/Keran; Friedman and Meiselman; and Christopher Sims, "Money, Income, and Causality." *American Economic Review,* Vol. 62 (September 1972), pp. 540-52.

4/See Jack L. Rutner, "A Time Series Analysis of the Control of Money," *Monthly Review,* Federal Reserve Bank of Kansas City, January 1975; and Robert D. Auerbach and Jack L. Rutner, "U. S.-Canadian Economic Relationships," *Monthly Review,* Federal Reserve Bank of Kansas City, February 1975.

back from income to **money**.[5] If a feedback effect is present, however, the statistical estimation of the relationship of income to money will also be biased.

Therefore this article examines the extent to which money and income are related in the context of a single equation model when adequate allowance is made for the presence of trend in the data. Also examined is the extent to which the direction of influence runs solely from money to income.

THEORETICAL BACKGROUND ON THE RELATIONSHIP OF MONEY AND INCOME

It is a fairly well established proposition in economics that an individual will desire to hold a certain quantity of money balances. When an individual's money holdings go beyond that point, so that the cost arising from holding an additional dollar of money exceeds the benefits, the individual will attempt to reduce his money balances by acquiring goods and services and other assets. If, on the average, individuals receive too much (little) money and attempt to reduce (increase) their cash balances, there will be changes in output, prices, and interest rates. In brief, it is generally expected that a change in money balances will lead to a change in money income.

The channels of influence may not run only from money to income because there may be feedback effects from income to money. Some of these feedback effects may arise within the normal course of events within the economy, while others may arise from the conscious decisions of monetary authorities to achieve certain national economic objectives, such as stable economic growth, full employment, and reasonable price stability.

One way income may affect money is through the impact a change in income may have on the desire of banks to expand loans and investments.

As business expands, for example, commercial banks may wish to expand loans and investments by reducing the stock of excess reserves they carry. This action would increase the deposit component of the money stock and thereby the total stock of money. Another way income may affect money is through the impact a change in income may have on the desire of the nonbank public to hold money balances. During periods of cyclical expansion, for example, individuals may find it more appropriate to carry larger supplies of deposits and as a consequence they may shift money from currency to **deposits**.[6]

There may also be feedback from income to money because the monetary authorities may attempt to alter the money supply in response to previous changes in output, prices, and interest rates. For instance, a decline in income and an increase in unemployment may result in the monetary authorities increasing the money stock. This would make it appear as if income were causing a change in money in the sense that a change in income precedes and is related to the level of money balances. Also, if the monetary authorities attempt to stabilize interest rates while market interest rates are positively correlated with the business cycle, it would again seem as if changes in income precede changes in money.[7]
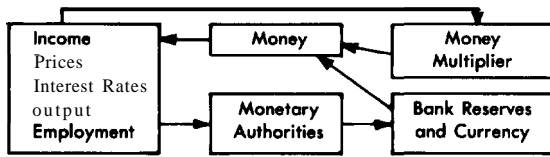
Chart 1 illustrates a hypothetical interactive system between money and income. The effect money has on income, interest rates, prices, and employment is indicated by the arrow from money to income. The line from income to the monetary authorities indicates that a change in income may have an effect on the policy actions of the monetary authorities. The monetary authorities may

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5/**An** important exception to the earlier studies is the work by Sims where he attempted to determine the presence of feedback in a way that has not been previously utilized. Sims reported that he found money caused income and that there was no feedback from income to money. Sims' work, however, is marred by the presence of trend and, for this reason, his results are biased.

6/*Initially*, individuals would probably shift out of currency into time deposits as interest rates rise during the cyclical expansion. The shift of currency into the banking system would supply it with reserves with which to increase demand deposits as well as time deposits. It is also possible that individuals would shift from demand to time deposits in which case the final effects on demand deposits of these various shifts would be ambiguous.

7/**Another** instance would be if prices and nominal income were to increase and the authorities wished to maintain a particular level of real money balances. In this case, the authorities would increase the money stock to maintain the desired level of real money balances. This action also would make it appear as if income were causing the increase in money because the change in income would be related to and would precede the change in money.

Chart 1
AM INTERACTIVE SYSTEM
BETWEEN MONEY AND INCOME

Income Prices Interest Rates output Employment	Money	Money Multiplier
	Monetary Authorities	Bank Reserves and Currency

respond to movements in the economy by altering the stock of bank reserves (or bank reserves and currency) and this, in turn, may affect the stock of money. Finally, there may be feedback from the economy to the money multiplier which is affected by the actions of the private sector, including the amount of excess reserves banks wish to hold relative to deposits.[8]

On the basis of this discussion it would appear there are substantial theoretical grounds to believe that a feedback from income to money would exist. On the same basis there is reason to doubt the validity of some earlier research results suggesting only one-way causality from money to income.[9] The next section explains the method of analysis used in this article to examine the presence or absence of feedback.

METHOD OF ANALYSIS

The first step in determining the presence or absence of feedback between money and income, and the relationship between these two variables in a single equation model, is to adequately account for the presence of trend in the data. As illustrated in Chart 2, both income and money contain a strong upward trend over a period of time, such as 1953-73. The presence of such a strong trend, as mentioned earlier, tends to bias the relationships estimated by ordinary statistical

analysis toward acceptance of the view that the variables are related when they may not be. The presence of a trend may also invalidate statistical tests for measuring the existence or absence of feedback.[10] Thus, before relationships between variables containing a trend can be estimated properly, the effect of the trend must be accounted for in each variable.

The method used to remove the trend from the data employed in this article is the autoregressive technique. This technique removes that part of a variable which is related to its own past history. Chart 3 illustrates the values of money and income during 1953-73 after the trend is removed by use of the autoregressive technique.[11]

Once the trend is removed, the next step is the development of a single equation model that can be used to determine the relationship of money to income and simultaneously detect the presence of feedback. This is accomplished by relating one variable, such as current income, to past, present, and future values of a second variable, such as money. This relationship is summarized by the following simplified equation:[12]

Current Income = f[Current Money, Past Money, Future Money].

If, upon statistical examination, a significant relation is found between current income and

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8/To the extent the monetary authorities can affect the stock of reserves banks must hold relative to deposits, they may also be able to offset this ratio.

9/For an example of these results, see Leonall C. Andersen and Jerry L. Jordan, "Monetary and Fiscal Actions: A Test of Their Relative Importance in Economic Stabilization," *Review,* Federal Reserve Bank of St. Louis, November 1968; and Leonall C. Andersen and Keith Carlson, "A Monetarist Model for Economic Stabilization," *Review,* Federal Reserve Bank of St. Louis, April 1970.

10/Suppose, for example, a trend is present in money and income with money today being related to income four quarters into the future and to itself six quarters into the future. It might then appear as if movements in income were preceding movements in money by two quarters, and also be concluded that the direction of influence runs from income to money. Actually, however, it may be the simultaneous correlation of money with income four quarters in the future and with itself six quarters in the future that masks the relationship of income with previous movements in money. The removal of the association of income and money with their past values makes it possible to determine the relationship of income to money without the presence of the spurious correlation of money to its past and future values.

11/The technique used in this article is summarized as follows: First, each variable (convened to natural logarithms) is regressed on its past values. Only those coefficients which are significant at a 99 per cent level of confidence are retained. Then, the residuals—i.e., the current values less weighted past values — where the weights are the regression coefficients, are tested through spectral analysis to determine if the trend has been adequately removed. When it is so determined, the residuals are the new variables used in place of the levels.

12/The technique used here was first suggested by C. W. J. Granger, "Investigating Causal Relations by Econometric Models and Cross-Spectral Methods," *Econometrica,* Vol. 37, No. 3 (July 1969), pp. 424-38, and later modified by Sims, "Money, Income and Causality," pp. 540-52.

Chart 2
LEVELS OF GROSS NATIONAL PRODUCT AND MONEY, 1953-73
(Quarterly data)

Billions of Dollars   Billions of Dollars
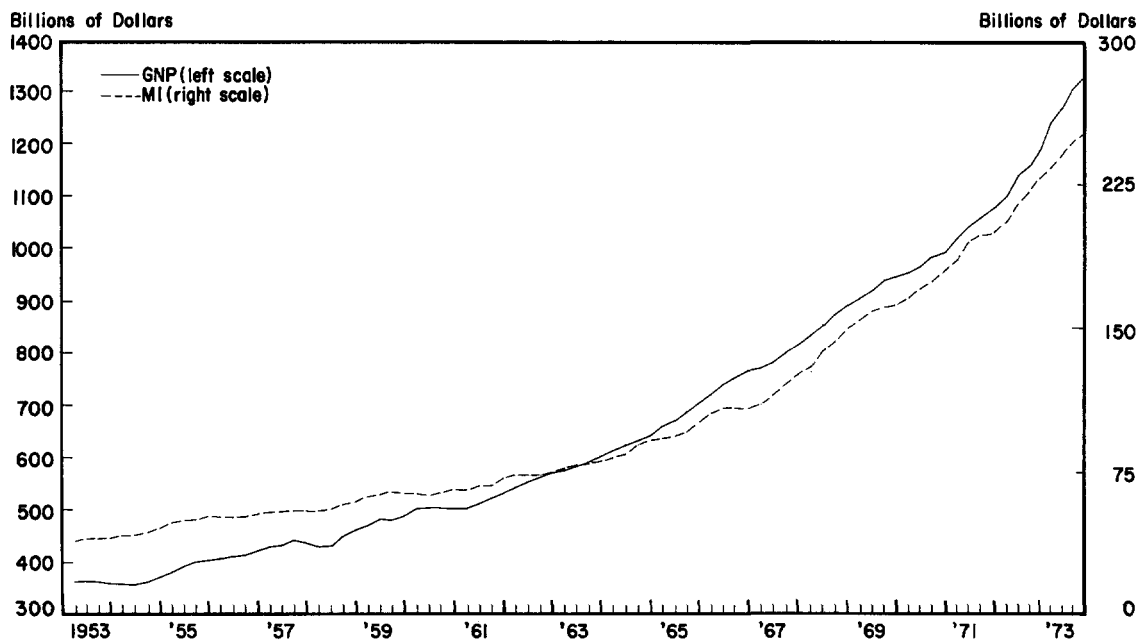

only past values of money, it can be inferred that money affects income but a feedback from income to money does not exist. When feedback is absent, there is said to be one-way or *unidirectional causality.* If future values of money as well as past values of money are found to be related to income, a feedback effect from income to money would exist. When feedback is present, there is said to be two-way or *bidirectional causality.* It should be noted that a significant relationship between money and income must exist before the direction of causality can be determined. A complete examination of the direction of causality also requires that money be made a function of income as well as income being made a function of money. This two-way testing—money on income and income on money—acts to simultaneously confirm the presence or absence of feedback.[13]

EMPIRICAL RESULTS

This section presents the empirical results of examining the relationship of income, or gross national product (GNP), to the M1 definition of money (currency held by the public plus demand deposits) within the context of the single equation model shown above, as well as the reverse relationship of M1 to GNP. Regression analysis was used to examine these relationships using quarterly detrended data for the 20-year period 1953-73, and for a longer period 1921-73. Table 1 summarizes the regression results. The degree of correlation between money

13/It might be possible, for example, that a test of income on money would indicate unidirectional causality from money to income, but a test of money on income would indicate the presence of bidirectional causality. If this occurred, it would indicate that bidirectional causality could·not be ruled out and further tests would have to be performed to accept or reject the hypothesis of bidirectional causality. The tests for causality reported here reveal no such contradictory results.

Chart **3**
DETRENDED VALUES OF GROSS NATIONAL PRODUCT AND MONEY, 1953-73
(Quarterly data)
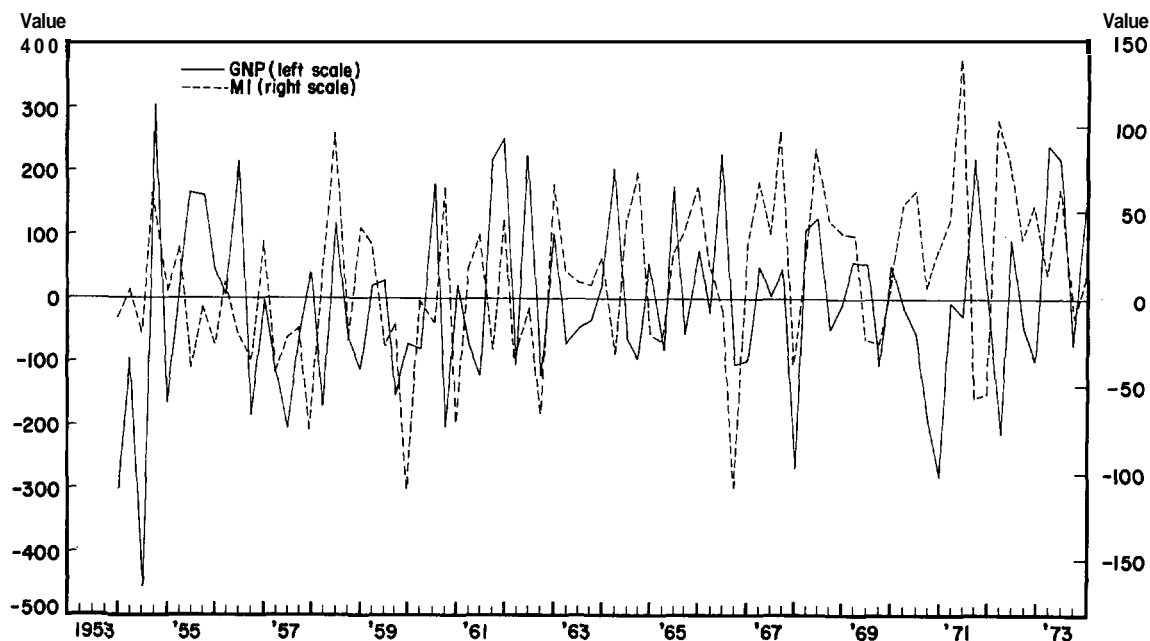
and income is shown by the correlation coefficient R^2, with a high value denoting a high degree of correlation. The direction of causality is also shown with bidirectional causality indicating a feedback relation was found.[14]

Table 1 contains the surprising result that within the context of the single equation model there was no relationship in the **1953-73** period between money and income when the trend was removed. The absence of a significant relationship between money and income for this period

makes it meaningless to test for **causality.**[15] For the longer period **1921-73,** the association between income and money, while not very high, was nonetheless significant. For this period, there was direct evidence of feedback from income to money in that current income affected money in the future.

The finding of no relationship in the **detrend**ed money and income data for the **1953-73** period and the presence of feedback in the longer period data suggest two things. The first is that previous tests of the monetary process which reported a high and significant association between income and money using reduced form models are open to question. These earlier tests were apparently biased in the direction of accepting the **hypoth-**

14/In practice, four regressions were fitted for each pair of variables. First, one variable was regressed on 1 synchronous, 8 past, and 4 future values of the other variable. Then a second equation was fitted with the dependent and independent variables reversed. Two additional equations were fitted by attaching seasonal dummies and a time variable to the first two equations. The equations in Table 1 were selected because they were considered most representative of the general findings. The entire table of regressions with R^2's will be furnished on request.

15/As if to confirm this conclusion, none of the coefficients of the income or monetary variables for the 1953-73 period were significant.

Table 1
REGRESSION RESULTS ON PME
RELATIONSHIP OF MONEY AND INCOME
Detrended quarterly data,
1921-73 and 1953-73

Dependent Variable	Independent Variable	R^2	Direction of Causality
	1953-73		
GNP	M1	.02	None
M1	GNP	.04	None
	1921-73		
GNP	M1	.14*	Bidirectional
M1	GNP	.13*	Bidirectional

NOTE: R^2 is the multiple correlation coefficient adjusted for degrees of freedom. The R^2 with an asterisk * indicates a significant R^2 at the 95 per cent level.

esis that money and income were related because of inadequate trend removal.[16] The process generating the trend may have been the same in both cases, but it is this process that must be determined and not simply the fact that two series have a common trend. Secondly, the presence of feedback from income to money shown for the longer period suggests it is necessary to formulate a model which allows for feedback effects from income to the demand and supply for money.

The results in Table 1 must be interpreted with care. The results do not indicate that money and income are unrelated. Indeed, an earlier article in this *Review* using spectral analysis found

16/An early example of the extreme bias of the single equation reduced form model is presented below for illustrative purposes. An equation relating GNP to one past value of money was fitted for the period 1958-66 using first differences (A) and appeared in Keran's "Economic Theory and Forecasting."

$$\Delta GNP_t = 5.61 + 3.94 \, \Delta(M1)_{t-3} \qquad R^2 = .55$$

This equation suffers from both the feedback problem and the trend problem. First, the equation assumes without testing that the only direction of influence is from money to income. In other words, the researcher has essentially imposed a cause and effect model of a particular son on two variables which may have a more complicated two-way causal relationship. Second, in view of the results reported in Table I for the 1953-73 period, the R^2 of .55 does not mean that the change in money accounts for 55 per cent of the variability of the change in GNP or even the reverse. The R^2 is a spurious statistic produced by the common trend in both variables.

The recent work of Sims takes a step in the right direction by examining directly for the presence of feedback between income and money. See Sims, "Money, Income, and Causality." Sims' results for the postwar period indicate a strong relationship between income and money with the direction of influence going only from money to income. The results of Table 1, however, indicate no relationship for this period, with the consequence that questions concerning causality are unanswerable. The difference between these two results is the inadequate treatment of trend by Sims.

a fairly high association between money and income.[17] Rather, the results indicate that within the context of the reduced form model there is little or no relationship.[18] In addition, to the extent that money and income are related in the period 1921-73, bidirectional causality is indicated. The evidence of bidirectional causality does not necessarily indicate that changes in income directly cause changes in money. Embedded in this result may be the policy reaction of the monetary authorities to prior changes in income as well as the reaction of the economy to movements in prices, output, and interest rates. What the finding of bidirectional causality indicates is that the single equation model—with income a function of only present and past values of money—is incorrectly specified. One alternative is a model which takes into account the effect of income on money, such as a structural model.

CONCLUSION

In summarizing the results of the tests conducted in this study, it can be said that for the 1953-73 period no relationship was found between money and income in the context of the reduced form model. Since the reduced form model fails to show any association between income and money in this period, one cannot ascertain whether or not feedback exists. For the longer period 1921-73, a weak but significant relationship between money and income was found with the presence of feedback indicated. *These findings suggest that the simple reduced form regression models used to test for the re-*

17/See Jack L. Rutner, "A Time Series Analysis of Income and Several Definitions of Money," Monthly Review, Federal Reserve Bank of Kansas City, November 1974. The discrepancy between the regression tests and the spectral tests arises, even with the same data, because the single equation models are incapable of picking out those cycles for which money and income are related. Spectral analysis, however, is precisely geared for this type of analysis if the lags between one variable and its effects on another variable are related to cycle lengths and not chronological time periods.

18/A possible explanation for the lack of relationship during the 1953-73 period might be that the monetary authorities were quite adept at offsetting deviations of income from its trend, thereby reducing the simple association between income and money.

lationship between income and money may be **misspecified** *unless they allow for the effect of feedback from past income to money.* Other statistical tools, however, such as spectral analysis, which can simultaneously accommodate cycle leads and lags between two variables, have shown a strong and significant association between money and income. *Finally, whether one uses a single equation regression model or spectral analysis, the trend must be accounted for or removed. otherwise the results will be biased, often giving the impression of strong relationships where none might exist.* This conclusion is probably applicable to a great deal of contemporary empirical research because of the common trend in most post-World War II economic time series.