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**AN EMPIRICAL NOTE ON THE EFFECTS OF MONETARY CHANGES
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I. Introduction

One of the key controversies in economic theory involves the effects of changes in the money supply on the price level and the economy's output. In this respect, two major opposing views can readily be identified: the monetarist view and the income expenditure view.¹ Monetarists regard money as an independent source of economic disturbance. In their view, the money supply is exogenously determined and changes in it exert no lasting influence on any real economic variables.² Keynesians, on the other hand, assert that under the conditions of unemployment, changes in the money supply may lead to permanent changes in real variables.³

The above theoretical dispute can be formulated within the confines of the Quantity Theory of Money postulates. It involves two separate issues. The first deals with the question of causality in the money-income relationship; the second involves the effects of the monetary changes on the two components of nominal income, namely the price level and the real output. In terms of the Quantity Theory of Money's equation of exchange where $MV = PY$, it is essential to initially establish the direction of the causality.⁴ Once the causality issue is resolved, it becomes crucial to determine which component of the nominal income (PY) is affected by monetary changes. Essentially, the key theoretical issue is whether changes in the money supply lead only to changes in the price level (monetarist long-run position) or whether the real income is permanently affected (keynesian position)⁵.

Resolving this theoretical dispute can most satisfactorily be accomplished through empirical research. The purpose of this paper is

to search for empirical evidence supporting the two above stated theoretical positions. This study is divided into two parts. Initially, the bivariate causality test procedures are used to gather further empirical evidence on the money-income causality issue. For this purpose, the FPE causality test method outlined by Hsiao (1981, 1982) is used. This method is extended to the trivariate analysis in the following section. The main purpose of the trivariate analysis is to ascertain the impact of the monetary variable on the two components of nominal income: the price level and the real output.

II. Theoretical Considerations

Most causality test procedures are based on the concept of causality suggested by Granger (1969). In this respect, the original work of Sims (1972) is of crucial importance. Recent contributions to the Granger-type of causality testing include the studies of Geweke, Meese, and Dent (1983); Guilkey and Salemi (1982); and Ram (1983). All these studies rely on the arbitrary selection of the lag structure in causality tests. Biswas and Saunders (1985) indicate that the causality test results obtained through the arbitrary lag selection may be unreliable because the distribution of test statistics can be sensitive to lag length.⁶ The FPE procedure developed by Hsiao (1981) not only solves the problem of arbitrary lag selection but also provides a powerful causality test method.⁷ Consequently, this method is adopted for both the bivariate and the trivariate test procedures.

III. Bivariate Test Results

Hsiao's (1981) procedure involves using five statistical steps

for correct system identification.⁸ We implement this method by searching for the optimal lag structure over the previous fifteen quarters. In each case, the criterion of minimum final prediction error (FPE) is used. Minimum FPE can be calculated as $(SEE)^2 \cdot (T + K)/T$, where SEE is the standard error of the regression, T is the number of observations, and K is the number of parameters. Hsiao's definitions of causality are applied to the test results.⁹ Seasonally adjusted data for the real GNP(GNPR), nominal GNP, M_1 , M_2 , consumer price index (CPI), and monetary base are used.¹⁰ The sample test period is 1959-I to 1984-II. All equations are estimated in the natural logarithmic form.

The test results are presented in Tables 1 and 2. Causality implications are outlined in Table 3. As reported in Table 1, the smallest FPEs for M_1 , M_2 , monetary base (B), and nominal GNP are 8, 2, 11, and 3. In order to obtain the results reported in Table 2, it is assumed that each variable is a controlled variable. The other variable is then treated as the manipulated variable. Selecting the lag structure specified in Table 1, the FPE of the controlled variable is computed by varying the order of lags of the manipulated variable from 1 to 15. The specification yielding the smallest FPE is reported in Table 2.¹¹

The summary of the causality implication is given in Table 3. The test results indicate that feedback exists between M_1 and GNP as well as between M_2 and GNP. However, when the monetary base is used as the measure of money, then a direct causal relationship between the monetary base and the nominal GNP exists. Consequently, using the monetary base as a measure of the money stock, empirical support is

TABLE 1

The FPE of Fitting a One-Dimensional Autoregressive Process for GNP, M_1 , M_2 , the Monetary Base (B), Real GNP (GNPR), and Consumer Price Index (CPI) ²

The Order of Lags	FPE of $M_1 \times 10^{-4}$	FPE of $M_2 \times 10^{-4}$	FPE of $B \times 10^{-4}$	FPE of $GNP \times 10^{-4}$	FPE of $GNPR \times 10^{-4}$	FPE of $CPI \times 10^{-4}$
1	0.5249	0.5835	0.2344	1.0486	1.0625	0.5867
2	0.5225	0.4216	0.1805	1.0097	0.9655	0.2488
3	0.5386	0.4338	0.1818	0.9879	0.9407	0.2550
4	0.5245	0.4373	0.1727	1.0181	0.9696	0.2203
5	0.5196	0.4409	0.1738	1.0340	0.9878	0.2210
6	0.5159	0.4546	0.1694	1.1022	0.9738	0.2216
7	0.5287	0.4610	0.1747	1.0455	0.9971	0.2075
8	0.5028	0.4614	0.1807	1.0193	0.9924	0.2047
9	0.5189	0.4701	0.1825	1.0305	0.9713	0.1965
10	0.5309	0.4772	0.1794	1.0510	0.9847	0.2003
11	0.5414	0.4259	0.1689	1.0514	0.9978	0.2072
12	0.5555	0.4612	0.1746	1.0470	1.0281	0.2132
13	0.5622	0.4773	0.1781	1.0396	0.9808	0.2206
14	0.5839	0.4946	0.1847	1.0798	1.0139	0.2291
15	0.5803	0.4996	0.1880	1.1011	1.0308	0.2298

TABLE 2

The Optimum Lags of the Manipulated Variable and the FPE
of the Controlled Variable

Controlled Variable	Manipulated Variable	The Optimum Lag of Manipulated Variable	FPE $\times 10^{-4}$
M ₁ (8)	GNP	7	0.4649
GNP (3)	M ₁	3	0.8945
M ₂ (2)	GNP	2	0.4205
GNP (3)	M ₂	1	0.8074
B (11)	GNP	1	0.1695
GNP (3)	Base	4	0.8185

TABLE 3

Causality Implications of the FPE Procedure for GNP, M_1 , M_2 , and Monetary Base

M_1		M_2		Monetary Base (B)	
Process	Implications	Process	Implications	Process	Implications
<u>GNP Process:</u>		<u>GNP Process:</u>		<u>GNP Process:</u>	
FPE (Step 1)	0.9879 0.9879 > 0.8947	FPE (Step 1)	0.9879 0.9879 > 0.8074	FPE (Step 1)	0.9879 0.9879 > 0.8183
FPE (Step 2)	0.8947 $M_1 \implies \text{GNP}$	FPE (Step 2)	0.8074 $M_2 \implies \text{GNP}$	FPE (Step 2)	0.8183 $B \implies \text{GNP}$
<u>M_1 Process:</u>		<u>M_2 Process:</u>		<u>Base Process:</u>	
FPE (Step 1)	0.5028 0.5028 > 0.4649	FPE (Step 1)	0.4216 0.4216 > 0.4205	FPE (Step 1)	0.1689 0.1689 < 0.1695
FPE (Step 2)	0.4649 $\text{GNP} \implies M_1$	FPE (Step 2)	0.4205 $\text{GNP} \implies M_2$	FPE (Step 2)	0.1695 $B \implies \text{GNP}$

found for the monetarist position concerning the causality in the money-income relationship. When the stock of money is approximated by either M_1 or M_2 , the Keynesian position cannot be rejected. Both measures of money, M_1 and M_2 appear to be more endogenous.

One possible explanation of the above results can be found in economic theory itself. The theory suggests that because of its definition, monetary base or high-powered money is exogenously determined. Both components of the monetary base, currency and reserves, are under control of the Fed.¹² M_1 , on the other hand, is defined as $m \cdot B$, where B is the monetary base and m is the money multiplier. Several components of the money multiplier can be considered endogenous.¹³ The same argument applies for M_2 and for M_3 . Consequently, both theoretically and empirically, the resolution of the causality issue may hinge on which definition of the money stock is chosen.

IV. Trivariate Analysis

The bivariate results reported provide useful information about the causality issue in the money-income relationship. In the case of monetary base, empirical evidence suggests a unidirectional causal flow from money to nominal income. However, the causality test procedures give no indication to what extent the monetary changes affect the two components of nominal income: price level and real income. Resolution of this issue necessitates empirically identifying the existence and strength of the causal flow from the monetary base to the price level and real output. This evidence can be obtained by employing a trivariate analysis of a simple kind.

The Granger method for testing causal relationships in bivariate contexts can be extended to multivariate formulations.¹⁴ However, employing this method has two serious drawbacks. In the first place, the choice of the appropriate lag length presents a difficult problem, and, as previously explained, may seriously influence the test results. Second, degrees of freedom diminish rapidly as the lag length is increased. Both of these problems are overcome when the FPE procedure is used.

The trivariate results are reported in Table 4. The optimal specification of the real output equation (1) and the price level equation (2) are reported in Table 5. The format of the trivariate results reported in Table 4 is adopted from Hsiao (1981). The last two rows of this table enable us to draw inferences about the causal flow from the monetary base to the price level and the real output. There appears to be no evidence of a causal flow from the monetary base to the price level. Adding the lagged monetary base variable to the inflation equation does not reduce the FPE. In fact, the FPE increases from 0.1544 to 0.1569. On the other hand, adding the lagged monetary base variable to the real output equation decreases the FPE from 0.8329 to 0.7395. Interpreting these results is straightforward. The major impact of monetary changes on nominal income operates through an increase in real output and not through an increase in the price level.

Further statistical inferences can be made by analyzing the coefficients in equations (1) and (2) as reported in Table 5. The coefficient of the first lagged monetary base term in the real output equation is 0.52. One interpretation of this result is that the positive effect of the monetary base on real output is large and quite fast.

TABLE 4

Trivariate Results. Causality Testing by Computing Final Prediction Error of the Controlled Variable. Numbers in Parentheses are Lags for Minimum FPE

Controlled Variable	First Manipulated Variable	Second Manipulated Variable	FPE x 10 ⁻⁴
GNPR (3)			0.9407
B (11)			0.1689
CPI (9)			0.1965
GNPR (3)	CPI (3)		0.8329
CPI (9)	GNPR (2)		0.1544
GNPR (3)	CIP (3)	B (8)	0.7395
CPI (9)	GNPR (2)	B (1)	0.1569

TABLE 5

Autoregressive Estimates of Equations (1) and (2)

Equation 1				Equation 2			
Statistics	Lags	Coefficients (t-statistics)		Statistics	Lags	Coefficients (t-statistics)	
R ²	0.998867	ln GNP (-1)	1.021 (9.529)	R ²	0.999929	ln CPI (-1)	1.529 (14.675)
S.E. of regression	0.007986	(-2)	-0.095 (0.609)	S.E. of regression	0.00371	(-2)	-0.770 (-3.9591)
DW	2.0263	(-3)	-0.065 (-0.6611)	DW	1.868	(-3)	0.905 (4.499)
F	4973			F	94142	(-4)	-0.660 (-3.121)
		ln CPI (-1)	-0.419 (-2.215)			(-5)	0.148 (0.699)
		(-2)	0.124 (0.346)			(-6)	-0.358 (-1.7691)
		(-3)	0.194 (0.935)			(-7)	0.010 (0.0531)
		ln B (-1)	0.521 (2.260)			(-8)	0.030 (0.1361)
		(-2)	-0.665 (-1.722)			(-9)	0.152 (1.442)

TABLE 5. Continued

Equation 1			Equation 2		
Statistics	Lags	Coefficients (t-statistics)	Statistics	Lags	Coefficients (t-statistics)
	ln B (-3)	0.704 (1.728)		ln GNPR (-1)	0.172 (3.328)
	(-4)	-0.651 (-1.662)		(-2)	-0.166 (-3.444)
	(-5)	0.634 (1.5791)		ln B (-1)	0.014 (0.686)
	(-6)	-0.479 (1.208)			
	(-7)	0.186 (0.489)			
	(-8)	-0.099 (-0.424)			

By the same token, the coefficient of the lagged monetary base term in the price level equation is negligibly small, approximately equalling to 0.01. Consequently, it appears that the effect of the monetary variable on the price level is also negligible.

V. Concluding Remarks

The present study finds clear evidence of a causal flow from money (as approximated by the monetary base) to nominal income (measured by the nominal GNP). Utilizing the FPE causality test procedure, the monetary base is found to be superior to either M_1 or M_2 as the measure of the money stock because of its unambiguous causal flow. This result supports the monetarist position on the causality in the money-income relationship. However, contrary to the monetarist position, changes in the monetary variable appear to affect the real output and not the price level. This evidence is consistent with the prevailing Keynesian view concerning the influence of money on the economy's real output.

The results of this study may have important implications for the economic policy decisions. One obvious interpretation of these results is that the economy's real output can be positively affected by increasing the money supply. Furthermore, this increase does not appear to lead to any substantial inflation. Instead, it appears to lead to a rapid increase in the economy's real output.

However, at this stage a word of caution is needed. The key qualification is the distinction between short-run versus long-run effects of monetary changes on the real output and the price level. The statistical methods used in this study do not allow any inferences to be

made about the short run versus the long run. Therefore, it conceivably could be argued that the empirical evidence presented in this study concerns the short-run situation only. In that sense the results would be consistent with both the monetarist and the Keynesian positions.¹⁵ In this respect, further research into the short-run versus the long-run effects of monetary changes on the two components of nominal income would be desirable.

Notes

1. The monetarist view is based, to a large extent, on the postulates of the Quantity Theory of Money. According to this theory, money has no lasting influence on any real variables in an economy. For a further explanation of this view, see Humphrey (1974) and others.
2. For a further theoretical discussion of this view and the distinction between the short-run and the long-run effects of monetary changes on an economy, see Makinen (1977, pp. 53-93).
3. Within the Keynesian framework changes in the stock of money affect the real sector of an economy via their effect on interest rates and investment. For a further discussion of this point, see Keynes (1936, p. 298).
4. The variables in the equation of exchange are: M --stock of money, V --velocity of money, P --price level, and Y --economy's output.
5. For a detailed discussion of this point, see Friedman (1970, 1971, and 1972), Tobin (1972), Patinkin (1972), and others.
6. Biswas and Saunders (1985) use the Granger causality test procedure to test the exogeneity of M_1 , M_2 , and the monetary base. The causality test results are directly dependent upon the arbitrary selection of the lag structure.
7. Hsiao (1981, pp. 90-91) outlines the causality implications of the FPE procedure.
8. This procedure is outlined in detail by Hsiao (1981, pp. 92-93).
9. Hsiao (1981, pp. 90-91) gives his three definitions of causality.
10. All the data used are seasonally adjusted at the source. However, the lag distributions used in this study are long enough to prevent any bias from the source to seriously affect the test results. Sims (1972, p. 546) offers a further explanation of this point.
11. For a further description of this procedure, see Hsiao (1981, pp. 92-93).
12. For a further discussion of the exogeneity issue and some empirical evidence, see Cagan (1965), Brunner and Meltzer (1964), and Fand (1970).
13. Siegel (1982, pp. 134-144) outlines in detail the money multiplier components.

14. For this type of a trivariate analysis, see Jarrett and Selody (1982, pp. 363-366).
15. According to monetarists, changes in the money supply can have a temporary effect on real output so long as the market participants do not correctly anticipate inflation. Consequently, in the short run, the Phillip's curve type of relationship is possible. See Friedman (1977).

References

- Biswas, B.; and Saunders, P. J. 1985. Money-income causality: Further empirical evidence. Economic Research Institute Study Paper #85-15. Utah State University. March.
- Brunner, K.; and Meltzer, A. 1964. Some further investigations of demand and supply functions of money. **Journal of Finance** 19 (May).
- Cagan, P. 1965. **Determinants and effects of changes in the stock of money, 1875-1960**. New York: Columbia University Press.
- Fand, D. J. 1970. Some issues in monetary economics. **Review** (January). Federal Reserve Bank of St. Louis.
- Friedman, M. 1970. A theoretical framework for monetary analysis. **Journal of Political Economy** 78(2, March/April).
- _____. 1971. A monetary theory of nominal income. **Journal of Political Economy** 79(2, March/April).
- _____. 1972. Comments on critics. **Journal of Political Economy** 80 (5, September/October).
- _____. 1977. Nobel lecture: Inflation and unemployment. **Journal of Political Economy** 85(3).
- Geweke, J.; Meese, J.; and Dent, W. T. 1983. Comparing alternative tests of causality in temporal systems: Analytical results and experimental evidence. **Journal of Econometrics** 21(February).
- Granger, C. W. J. 1969. Investigating causal relationship by econometric models and cross-spectral methods. **Econometrica** 37(3, July).
- Guilkey, D. K.; and Salemi, M. K. 1982. Small sample properties of three tests for Granger-causal ordering in a bivariate stochastic system. **Review of Economics and Statistics** 64(November).
- Hsiao, C. 1981. Autoregressive modeling and money-income causality detection. **Journal of Monetary Economics** 7.
- _____. 1982. Autoregressive modeling and causal ordering of economic variables. **Journal of Economic Dynamics and Control** 4.
- Humphrey, T. M. 1974. The quantity theory of money: Its historical evolution and role in policy debates. **Economic Review** (May/June). Federal Reserve Bank of Richmond.
- Jarrett, J. P.; and Selody, J. G. 1982. The productivity-inflation nexus in Canada. **Review of Economics and Statistics** 3(August).

- Keynes, J. M. 1936. **The general theory of employment, interest, and money.** London: Macmillan.
- Makinen, G. E. 1977. **Money, the price level, and interest rates: An introduction to monetary theory.** New Jersey: Prentice-Hall, Inc.
- Patinkin, D. 1972. Friedman on Quantity Theory of Money. **Journal of Political Economy.** 80(5, September/October).
- Ram, R. 1983. Causal ordering across inflation and productivity growth in the post-war United States. **Review of Economics and Statistics.**
- Siegel, B. N. 1982. **Money, banking, and the economy: A monetarist view.** New York: Academic Press.
- Sims, C. A. 1972. Money, income, and causality. **American Economic Review** 62.
- Tobin, J. 1972. Friedman's theoretical framework. **Journal of Political Economy** 80(5, September/October).