Income Taxes and the Demand for Money: A Quantitative Analysis*

A previous paper by the author called attention to a serious shortcoming in the extensive literature dealing with the demand for money.[1] It pointed out that the theorists who had dealt with the subject had ignored the effects that taxes in general and income taxes in particular might have on an individual's choice between holding money and holding other assets. Similarly, no empirical study had taken account of these effects.[2] The paper hypothesized on how this choice could be expected to be affected when an income tax was introduced or was changed. The hypothesis was almost embarrassingly obvious; thus it was surprising that it had not been suggested and tested before.

The empirical verification of the hypothesis in that paper was a simple test covering some 50 years in which the velocity of money

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* At various stages of this research the author received comments and/or suggestions from Professor Michael R. Darby, University of California, Los Angeles, Professor Milton Friedman, University of Chicago, Mr. Richard Goode, Mr. William H. White, and various colleagues in the Tax Policy Division of the Fiscal Affairs Department of the IMF. He wishes to thank all of them while retaining the sole responsibility for any remaining errors. He also wishes to thank Professor Darby and Professor John W Kendrick, George Washington University, for making available their estimates of permanent gross domestic product and net personal stocks, respectively, and Mrs. Chris Wu for computational assistance. At earlier stages, Mrs. Anita Basak-Lonnberg and Mr. José Germán Cárdenas also provided computational assistance. The views expressed are personal ones which may or may not coincide with IMF official positions.

[1] "Demand for Money, Interest Rates and Income Taxation," in this *Review* (December 1974), pp. 319-328.

[2] On the other hand, taxes had not been completely ignored in the various theories dealing with portfolio composition and investment decision under uncertainty. Starting with DOMAR and MUSGRAVE's seminal paper — "Proportional Income Taxation and Risk-Taking," *Quarterly Journal of Economics*, Vol. 58 (May 1944), pp. 388-422 — an extensive literature has developed on the choice of risky versus nonrisky investments in the presence of taxes. For an excellent though concise survey of this literature, see MARTIN FELDSTEIN, "Personal Taxation and Portfolio Composition: An Econometric Analysis," *Econometrica*, Vol. 44 (July 1976), pp. 631-650. A hint of recognition of the need to adjust for the tax effect can be found in footnote 27, p. 425 of J. J. POLAK and WILLIAM H. WHITE, "The Effect of Income Expansion on the Quantity of Money," IMF *Staff Papers*, August 1955.

was made to depend solely on the rate of interest.[3] By regressing velocity, first, against the rate of interest observed in the market and, then, against that same rate corrected for the effect of the income tax on yields, the paper showed that the correction brought about a statistically significant improvement in the fit and thus provided some empirical support for the theoretical hypothesis.

Professor Milton Friedman, while agreeing with the basic hypothesis, which he characterized as "a valid intellectual point and a desirable addition to the [literature]," raised serious and justifiable questions about the empirical part of the paper.[4] He argued, in particular, against the above-mentioned specification and suggested that a real income variable be entered among the arguments of the functional relationship.

The present paper takes account of Professor Friedman's objections and subjects the earlier hypothesis to a somewhat more rigorous empirical test. Section I restates the hypothesis to be tested, section II outlines the tests to be conducted, section III discusses the data used, section IV presents the empirical results, and section V draws some conclusions.

I. Hypothesis

Summarizing the results of the literature on the *theory* of portfolio allocation, Stiglitz wrote:

> "The attempt to derive from portfolio analysis general theorems about the demands for particular assets without imposing severe restrictions on either the asset structures and/or the utility functions seems to have come to a dead end: nor is it surprising that general theorems are not to be had."[5]

This observation led Feldstein to conclude that "further improvements in our understanding now require extensive *empirical* analysis."[6] The present paper is essentially empirical and the basic hypothesis is presented in the simplest way. No attempt has been made to test it theoretically under alternative assumptions.[7] The only valid test is assumed to be the empirical one.

Individuals hold money for a variety of reasons: (a) it is more convenient than alternative assets for transactions purposes; (b) under normal conditions (i.e., when the rate of inflation is low or zero) it carries a lower risk than other assets; (c) somewhat related to (a) above, it can be used without payment of what Baumol has called "brokerage fees" as is the case with other assets;[8] (d) it facilitates speculative and other opportunities. The holding of money, thus, definitely conveys to its holders various benefits that can be broadly defined as "utility." However, such action is costly in terms of income foregone. In a simplified two-asset world in which the alternative to holding money (defined here as currency plus checking deposits) is holding interest-bearing assets, broadly labeled as "bonds," the yield on these assets (if the expected value of capital gains is zero) is a measure of this opportunity cost. Consequently, the higher the yield, the higher *ceteris paribus*, the opportunity cost. Given these considerations, individuals will arrange their portfolios to maximize utility.

In the familiar two-asset version of Tobin's liquidity preference model, the horizontal axis measures risk, σ, and the vertical axis wealth, W.[9] The more bonds the portfolio contains, the more risk the individual takes. If the individual holds only money, the risk is assumed to be zero, but so is income from that wealth. If the rate of interest on bonds is r and the individual's entire wealth, W_o, is in bonds, expected wealth at the end of the period will be $W_o(1+r)$; the risk would be σ_o. Given the budget line, from point W_o to point $W_o(1+r)$ and the equal-utility indifference curves between risk and wealth, utility is maximized at Point A in Figure 1, where the budget line, defined by the initial wealth and the rate of interest, is

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3 The specification was thus very similar to that used by Henry Allen Latane in his two well-known papers, "Cash Balances and the Interest Rate — A Pragmatic Approach," *Review of Economics and Statistics*, Vol. 36 (November 1954), pp. 456-60, and "Income Velocity and Interest Rates: A Pragmatic Approach," *Review of Economics and Statistics*, Vol. 42 (November 1960), pp. 445-49.

4 Personal communication from Professor Milton Friedman. Similar comments were received from Professor Michael R. Darby.

5 Joseph E. Stiglitz, "Portfolio Allocation with Many Risky Assets," in *Mathematical Methods in Investment and Finance*, Giorgio T. Szego and Karl Shell, eds. (Amsterdam, North-Holland, 1972), pp. 93-94.

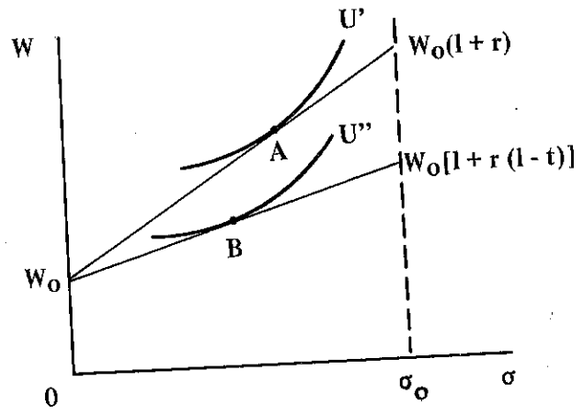
6 *Op. cit.*, p. 631 (emphasis added).

7 Changing the assumptions could change the theoretical results. An idea of how complex and esoteric these theoretical models can become may be found in J. Hirshleifer, *Investment, Interest, and Capital*, Chapter 10 (Englewood Cliffs, New Jersey, 1970).

8 William J. Baumol, "The Transactions Demand for Cash: An Inventory Theoretic Approach," *Quarterly Journal of Economics*, Vol. 66 (November 1952), pp. 545-64.

9 James Tobin, "Liquidity Preference as Behavior Towards Risk," *Review of Economic Studies*, Vol. 25 (February 1958), pp. 65-86.

FIGURE 1



tangent to an indifference curve U'. The indifference curves hold utility (U) constant by trading wealth against risk as follows:

$$U = f(W, \sigma)$$

and are assumed to be characterized by the additional conditions that

$$\frac{\delta U}{\delta W} > 0 \text{ and } \frac{\delta U}{\delta \sigma} < 0$$

At equilibrium point A utility cannot be increased by rearranging the portfolio. At this point, the rate at which wealth is traded against risk is equal to the yield on bonds.

Assume now that the yield on bonds is taxable at rate t while the utility associated with holding money (convenience, etc.) is not. Then point W_o in Figure 1 would not change but the slope of the budget line would. The new budget line would go from point W_o to point $W_o[1+r(1-t)]$. If perverse wealth effects are ruled out, or are more than compensated by wealth-risk substitution effects, the new equilibrium at point B is associated with lower wealth and lower risk, implying that more money and less bonds make up the new portfolio. Money has become relatively cheaper to hold, as its opportunity cost has fallen, and thus the individual will substitute it for bonds. Given the rate of interest, the imposition of an income tax on the yield of assets other than money (or an increase in existing taxes) would disturb the existing equilibrium and should be accompanied by an increase in the demand for money (defined as M1) or, what is the same thing, by a fall in its velocity.[10] However, to the extent that "the greater part of individual balances is intended to allow the holders to take advantage of investment opportunities or to avoid the necessity of borrowing and paying interest... taxable income of the holders will be increased."[11] Thus the net effect might be less than it would appear at first.

Income taxes may also change the demand for money by altering the after-tax income distribution. If the disposable income of wealthier individuals is reduced proportionately more than that of lower-income individuals, some economies of scale would be lost in holding money.[12] Thus, the demand for money might increase, reinforcing the effects of the reduction of net-of-tax yields. In the empirical tests no attempt was made to separate this scale effect from the above-described substitution effect. Finally, high income taxes may induce greater tax evasion, which in turn may generate more currency transactions and thus possibly lead to an increased demand for money.[13] This increase due to evasion might be called the evasion effect.[14]

II. Description of Tests

The federal income tax was introduced in the United States in 1913. Thus, in testing the hypothesis it was necessary to correct the

[10] If the tax is proportional, the new budget line faced by the asset holders, while different from the pretax one, would still be the same for all; therefore, at the point of equilibrium their indifference curves would have the same slope as the new budget lines. If the tax is progressive, different asset holders would face differently sloped budget lines so that the new equilibrium point would imply different rates of substitution between risk and wealth for different individuals. Important welfare implications follow from this. From the hypothesis it follows that a proportional income tax disturbs the optimal conditions among *assets* while a progressive income tax disturbs them among assets as well as among individuals.

[11] See RICHARD GOODE, *The Individual Income Tax* (Washington, Brookings Institution, 1976), p. 141.

[12] See BAUMOL, *op. cit.*

[13] However, to the extent that the greater demand for currency is accompanied by an equivalent lower demand for checking deposits, the total demand for money, defined as M1, would not change.

[14] The possibility that high income taxes by raising the rewards to evasion may induce greater demand for *currency* was suggested and tested some years ago by Phillip Cagan for the United States and George Macesich for Canada. They both found that the tax variable — in their analysis, the ratio of income tax revenue to personal income — played a significant role in explaining the demand for currency. See PHILLIP CAGAN, *The Demand for Currency Relative to Total Money Supply*, National Bureau of Economic Research, Occasional Paper No. 62 (New York, 1958), and GEORGE MACESICH, "Demand for Currency and Taxation in Canada," *Southern Economic Journal*, Vol. 29 (July 1962).

market rates of interest for the period after 1913 but not for the pre-1913 period. After 1913 tax rates for top income brackets increased in many years and at times exceeded 90 per cent.[15] Therefore, the tax-induced reduction in after-tax yields was substantial for some periods and for some individuals.

An empirical investigation of the factors that affect the demand for money should consider not only the tax rates but also changes in the method of tax payment. From 1913 to 1942 there was no tax withheld at the source of income. Rather, federal income taxes were paid in quarterly installments in the year following receipt of income. The method of payment was changed in 1943 to reflect the pay-as-you-earn principle, with the introduction of tax withholding on income from wages and salaries and of quarterly instalments based on estimated tax due and payable in the year the income is received for other incomes. The net effect of these tax changes should reduce the demand for money. Until 1942 individuals whose incomes consisted of wages and salaries had to set aside some money for the payment of the tax, or at least had to invest in assets which could be safely, cheaply, and quickly converted into cash. To the extent that rational behavior (and/or low "brokerage fees") implies that the needed additional balances were kept in relatively liquid income-earning assets, rather than in cash or checking accounts, the change in the method of tax payment should be relevant for M2 rather than for M1. Therefore, the demand for M2 should, *ceteris paribus*, have decreased for the period after 1942.

To test the hypothesis it was necessary to run some money demand equations, taking into account the tax level as well as the method of tax payment. The latter was accounted for by using a dummy variable which separated the 1913-42 period from the post-1942 period, when the withholding method was in effect. The tax level may be accounted for either through the adjustment of the yield on assets or through the use of an additional variable to reflect the tax rates. The first alternative is considered preferable.

It should be clarified that the effect of the changes in the tax rates should be stronger with respect to M1 than to other definitions of money because only M1 is made up entirely of assets on which no interest is paid.[16] If M2 or some broader definition of money

[15] This was true in 1944-45 and 1950-63.

[16] Up to the depression years interest was paid on checking deposits. These interest payments were small, however, so that they are ignored here. Of course the statement is not necessarily valid for countries other than the United States.

was considered, it would in part be made up of assets (time deposits, certificates, etc.) that bear a taxable income, and the test of the hypothesis would no longer be clear-cut. On the other hand, for the reasons given above, the effect of the change in the method of payment can be expected to be stronger for M2.

To test the impact of income taxes on the demand for money the following regression equations were estimated:

$$[1] \qquad 1nM_t = a_0 + a_1 1nR_t + a_2 1nY_t + a_3 Z_t + U_t$$

$$[2] \qquad 1nM_t = a_0 + a_1 1nR^T_t + a_2 1nY_t + a_3 Z_t + U_t$$

$$[3] \qquad 1nM_t = a_0 + a_1 1nR^T_t + a_2 1nY_t + a_3 Z_t + a_4 D + U_t$$

In equation [1], the demand for money is made to depend on a market rate of interest, R, an income (or wealth) variable, Y, and a trend variable Z. U is an error term. The trend variable attempts to capture technological changes (i.e., credit cards, etc.) and changes in cultural attitudes or preferences which may have influenced the demand for money over the period covered. Equation [2] is the same as [1] except that the market rate of interest has been corrected for the effect of taxes on yields. (The method used is outlined below.) Equation [3] is identical to equation [2] except for the addition of a dummy variable, D, to account for the effect of the 1943 change in the method of tax payment. This dummy is one for the period 1913-1942 and zero for all other years. In all cases the variables are expressed at constant 1958 prices, which implies that the demand for money is homogenous of degree zero in prices. The regression equations were run for per capita rather than total values, taking alternatively M1 and M2 as the dependent variable. The real per capita relation is preferable since it removes the effects of common time trends.[17]

The expectations are as follows: First, if the hypothesis is valid, there should be a better statistical fit for the equations that correct for the tax factor — equations [2] and [3] — than for the uncorrected ones. Also, if the specific hypothesis about the influence of the change in the method of tax payment on the demand for money is valid, equation [3] should be better than equation [2], especially when M2 is used as the dependent variable. Second, as mentioned

[17] See Rodney L. Jacobs, "Estimating the Long-Run Demand for Money from Time-Series Data," *Journal of Political Economy*, Vol. 82 (November/December 1974), pp. 1221-37. The real per capita relation implies that the per capita demand for money is homogenous of degree zero in both population and prices.

earlier, the regressions that use the narrower definition of money, M1, as the dependent variable should be the ones that show the greater improvement, when the tax factor is introduced. Third, and more generally, the regression coefficient for the rate of interest should be negative — i.e., the higher the rate, the higher the opportunity cost of holding money — and those for income should be positive.

Although the emphasis in this paper is on the demand for money, rather than on the demand for currency, it would be of some interest to test for the effects of the tax factor on the choice between holding currency and holding checking deposits. A full analysis of this "evasion effect" and of the determinants of currency holding is beyond the scope of this paper. Here, only the results of a simple test showing the impact of the tax factor are given.

If, in response to higher income taxes, individuals increase their reliance on currency transactions, the ratio of currency to checking deposits should change in some systematic way. More precisely, higher income taxes should bring about, *ceteris paribus*, higher ratios of currency to deposits. To test this hypothesis the following regression equations were estimated:

$$[4] \qquad \left(\frac{C}{D}\right)_t = a_0 + a_1 Y_t + a_2 Z_t + U_t$$

$$[5] \qquad \left(\frac{C}{D}\right)_t = a_0 + a_1 Y_t + a_2 Z_t + a_3 T_t + U_t$$

$$[6] \qquad \left(\frac{C}{D}\right)_t = a_0 + a_1 Y_t + a_2 Z_t + a_3 (MT)_t + U_t$$

In these equations C and D refer to currency and checking deposits, respectively; Y is per capita measured gross national product; Z is a trend variable; T and MT are tax variables, and U is an error term. Tax variable T is the same one that is used to correct the rates of interest that enter in the demand for money equations; the estimation of this variable is explained in the next section. MT is the statutory tax rate at which top-bracket income was taxed over the period. Neither of these variables is completely satisfactory in providing a measure of the marginal tax rates faced by the bulk of the taxpayers. But either seems preferable to the one used by Cagan and Macesich, namely, the ratio of income tax revenue to personal income, which may remain unchanged even when there are significant changes in the rate structure. Since the dependent variable is the ratio of currency to checking deposits, neither of which yields a direct (taxable) return, the rate of interest does not appear among the independent variables; there is no reason why the C/D ratio should be affected by the rate of interest. However, one would definitely want to include an income variable as well as a trend variable since income, as well as factors such as degree of urbanization and volume of travel per capita, might have an impact on that ratio.[18]

III. Description of Data

The money stocks used are centered on June 30 of each year. For the rate of interest alternatively a long-term rate and a short-term rate were used. The long-term rate is the annual yield on long-term prime corporate bonds. The short-term rate is the commercial paper rate. The long-term rate has at times been considered the better variable for use with M1 while the short-term rate has been considered preferable for M2.[19] For the income or wealth variable, use was made alternatively of (a) measured gross national product, Y1; (b) Friedman and Schwartz's estimates of "permanent" or expected net national product, Y2; (c) Darby's estimates of permanent gross domestic product, Y3; and (d) Kendrick's recent estimates of net personal stocks, W. As data were not available for the same periods, the tests with Y1 were carried out for the 1915-73 period, those with Y2 for 1900-65, those with Y3 for 1924-73, and those with W for the 1929-69 period.

To correct the interest rates for the effect of the income tax, a weighted average tax rate on interest income T_t, was calculated for each year over the 1913-73 period. The use of this average rate made it possible to estimate the net-of-tax rates of interest. These corrected rates of interest R^T_t are equal to $[R_t - R_t T_t]$. The data for the average tax rates on interest incomes, T_t, for the 1913-58 period were taken from a study by Colin Wright.[20] The series was extended beyond 1958 using his method, which can be described very briefly. Let B indicate total interest income received by individ-

18 See CAGAN, *op. cit.*, pp. 3-10.

19 However, MOHSIN S. KHAN found that the long-term rate of interest exerted a stronger effect on both M1 and M2. See "The Stability of the Demand-for-Money Function in the United States, 1901-1965," *Journal of Political Economy*, Vol. 82 (November/December 1974), pp. 1205-19.

20 COLIN WRIGHT, "Saving and the Rate of Interest," in *The Taxation of Income from Capital*, Arnold C Harberger and Martin J. Bailey, eds., Appendix B (Washington, Brookings Institution, 1969).

uals as reported in the annual issues of the U.S. Treasury Department, Internal Revenue Service, *Statistics of Income*. Let bi indicate the amount of interest income received by the ith class. Let $Wi = \frac{bi}{B}$ be the proportion of total interest income received by the ith income class. Let πi indicate the tax rate applicable to the ith income class. Then the average tax rate applicable to interest income in that particular year is:

$$T_t = \sum_{i=1}^{n} Wi\pi i$$

IV. Empirical Results

The least-squares estimators obtained by regressing money against the variables described above are shown in Tables 1 to 4. Each of these tables contains four sets of three equations, the four sets corresponding to the four definitions of income, and wealth, used. The three equations in each set correspond to equations [1], [2], and [3] (described in the previous section). In the tables the analog to equation [1] is always identified by the letter a, to equation [2] by the letter b, and to equation [3] by the letter c. It should be recalled that equation [1] ignores the impact of taxes, [2] introduces the effect of the tax factor through a correction of the market rate, and equation [3], in addition to the correction in the rate, attempts to measure the effect on the demand for money of a change in the method of tax collection.

All the tables use per capita real values for money and income. Tables 1 and 2 use M1 as the dependent variable while Tables 3 and 4 use M2. Tables 1 and 3 use a long-term rate of interest while Tables 2 and 4 use a short-term rate. In all the tables the Cochrane-Orcutt correction has been used to correct for the autocorrelation.[21] The results are considered next. Quite apart from the issue of tax effects, the results are interesting on their own merit. However, since this paper deals with the effect of taxes, the discussion that follows will be limited mostly to that factor.

As to the first expectation — that the tax correction in the interest rate should improve the fit — Table 1, the basic table, shows

21 The R^2s reported refer to the transformed variables. The original ones were generally somewhat higher.

TABLE 1

DEMAND FOR MONEY FUNCTIONS,
WITH M1 AND LONG-TERM INTEREST RATE
(Per Capita Values)

	a_0	a_1	a_2	a_3	a_4	$\bar{R}^2$	D.W.
			With Measured Gross National Product (Y1)				
[1a]	−0.5680 (2.27)*	−0.2434 (2.66)*	+0.2626 (2.41)*	+0.0092 (0.50)		0.227	1.974
[1b]	−0.5871 (3.32)**	−0.2880 (3.97)**	+0.2788 (2.61)*	+0.0085 (1.79)		0.398	1.675
[1c]	−0.6044 (3.14)**	−0.2897 (3.86)**	+0.2834 (2.61)*	+0.0088 (1.74)	+0.0156 (0.29)	0.380	1.655
			With Friedman's Permanent Net National Product (Y2)				
[2a]	−0.3490 (1.36)	−0.4561 (4.73)**	+0.9314 (4.76)**	−0.0003 (0.05)		0.534	1.657
[2b]	−0.2578 (3.82)**	−0.5514 (15.84)**	+0.8237 (7.02)**	−0.0016 (0.79)		0.957	1.786
[2c]	−0.1644 (1.77)	−0.5240 (13.65)**	+0.6720 (4.60)**	−0.0014 (0.67)	−0.0911 (1.88)	0.949	1.758
			With Darby's Permanent Gross Domestic Product (Y3)				
[3a]	−0.3436 (0.60)	−0.2198 (2.17)*	+2.6951 (2.39)*	−0.0528 (1.77)		0.103	1.862
[3b]	−0.4870 (1.45)	−0.4045 (4.97)**	+2.2431 (3.18)**	−0.0349 (1.86)		0.392	1.651
[3c]	−0.4998 (1.36)	−0.4222 (5.02)**	−0.4222 (3.36)**	−0.0387 (1.99)	+0.0512 (1.04)	0.391	1.585
			With Kendrick's Net Personal Stocks (W)				
[4a]	−0.1097 (0.11)	−0.1640 (1.38)	−0.0879 (0.13)	+0.0079 (0.45)		0.029	1.82
[4b]	0.0344 (0.03)	−0.1852 (1.74)	−0.2681 (0.40)	+0.0135 (0.76)		0.002	1.90
[4c]	−0.1610 (0.16)	−0.1625 (1.59)	−0.1782 (0.28)	+0.0123 (0.70)	+0.0778 (1.80)	0.033	1.86

Note: The numbers in parentheses below the coefficients are t values.
* indicates significance at the 5 per cent level.
** indicates significance at the 1 per cent level.
D.W. is the Durbin-Watson statistic.

TABLE 2

DEMAND FOR MONEY FUNCTIONS,
WITH M1 AND SHORT-TERM INTEREST RATE
(Per Capita Values)

	a_0	a_1	a_2	a_3	a_4	$\bar{R}^2$	D.W.
With Measured Gross National Product (Y1)							
[5a]	−0.7935 (2.24)*	−0.0610 (2.41)*	+0.3188 (2.92)*	+0.0062 (0.75)		0.1689	1.968
[5b]	−0.806 (2.31)*	−0.0601 (2.35)*	+0.3123 (2.88)**	+0.0061 (0.75)		0.1710	1.960
[5c]	−0.866 (2.32)*	−0.0565 (2.22)*	+0.2971 (2.73)**	+0.0075 (0.88)	+0.0447 (0.96)	0.1510	1.986
With Friedman's Permanent Net National Product (Y2)							
[6a]	−0.9031 (2.07)*	−0.1179 (3.95)**	+1.1316 (5.42)**	+0.0025 (0.31)		0.4155	1.639
[6b]	−0.9763 (3.31)**	−0.1219 (4.25)**	+1.0926 (5.36)**	+0.0011 (0.18)		0.4636	1.722
[6c]	−0.7557 (3.01)**	−0.1208 (4.47)**	+0.9675 (4.81)**	−0.0028 (0.52)	−0.1246 (2.47)*	0.5453	1.76
With Darby's Permanent Gross Domestic Product (Y3)							
[7a]	−0.4068 (0.60)	−0.0357 (1.30)	+2.8016 (2.18)*	−0.0608 (1.78)		0.0402	1.851
[7b]	−0.3863 (0.57)	−0.0350 (1.28)	+2.6986 (2.17)*	−0.0590 (1.77)		0.0413	1.858
[7c]	−0.3365 (0.41)	−0.0301 (1.16)	+2.8904 (2.26)*	−0.0649 (1.79)	+0.0764 (1.93)	0.0864	1.845
With Kendrick's Net Personal Stocks (W)							
[8a]	−0.3686 (0.32)	−0.0183 (0.58)	+0.0965 (0.15)	−0.0015 (0.08)		0.0744	1.798
[8b]	−0.3421 (0.29)	−0.0168 (0.51)	+0.0874 (0.13)	−0.0019 (0.10)		0.0764	1.803
[8c]	−0.4813 (0.43)	−0.0108 (0.34)	+0.1312 (0.21)	−0.0012 (0.07)	+0.0755 (1.75)	0.0183	1.746

Note: The numbers in parentheses below the coefficients are t values.
* indicates significance at the 5 per cent level.
** indicates significance at the 1 per cent level.
D.W. is the Durbin-Watson statistic.

TABLE 3

DEMAND FOR MONEY FUNCTIONS,
WITH M2 AND LONG-TERM INTEREST RATE
(Per Capita Values)

	a_0	a_1	a_2	a_3	a_4	$\bar{R}^2$	D.W.
With Measured Gross National Product (Y1)							
[9a]	−0.4029 (2.88)**	−0.1799 (1.98)	+0.3872 (2.37)*	+0.0117 (2.84)**		0.6201	1.984
[9b]	−0.4549 (4.11)**	−0.1539 (2.19)*	+0.3533 (2.16)*	+0.0115 (2.88)**		0.6441	1.981
[9c]	−0.4771 (3.34)**	−0.1630 (2.07)*	+0.3681 (2.11)*	+0.0118 (2.78)**	+0.0252 (0.25)	0.6400	1.981
With Friedman's Permanent Net National Product (Y2)							
[10a]	−0.3357 (2.39)*	−0.3092 (3.46)**	+0.9581 (4.65)**	+0.0035 (1.05)		0.8210	2.050
[10b]	−0.4520 (3.95)**	−0.2281 (3.30)**	+0.8520 (4.02)**	+0.0036 (1.07)		0.8245	2.040
[10c]	−0.4183 (4.69)**	−0.2810 (4.88)**	+0.9244 (4.62)**	+0.0026 (0.85)	+0.0620 (1.68)	0.8993	2.010
With Darby's Permanent Gross Domestic Product (Y3)							
[11a]	−0.6182 (3.72)**	−0.3740 (4.23)**	+2.9406 (3.93)**	−0.0339 (2.29)*		0.5204	1.820
[11b]	−0.6478 (4.72)**	−0.3094 (4.97)**	+2.4045 (3.87)**	−0.0255 (2.12)*		0.6458	1.844
[11c]	−0.7761 (5.11)**	−0.3404 (5.22)**	+2.6764 (4.17)**	−0.0280 (2.21)*	+0.0942 (2.41)*	0.6112	1.848
With Kendrick's Net Personal Stocks (W)							
[12a]	0.1317 (0.15)	−0.2190 (2.16)*	−0.2826 (0.50)	+0.0245 (2.18)*		0.3268	1.760
[12b]	0.1859 (0.22)	−0.2142 (2.69)*	−0.3601 (0.55)	+0.0254 (2.41)*		0.4361	1.820
[12c]	0.1639 (0.20)	−0.2259 (2.83)**	−0.4129 (0.79)	+0.0290 (2.77)**	+0.0881 (2.15)*	0.413	1.810

Note: The numbers in parentheses below the coefficients are t values.
* indicates significance at the 5 per cent level.
** indicates significance at the 1 per cent level.
D.W. is the Durbin-Watson statistic.

TABLE 4

DEMAND FOR MONEY FUNCTIONS,
WITH M2 AND SHORT-TERM INTEREST RATE

(Per Capita Values)

	a_0	a_1	a_2	a_3	a_4	$\bar{R}^2$	D.W.
With Measured Gross National Product (Y1)							
[13a]	−0.6013 (7.53)**	−0.0656 (1.93)	+0.4677 (2.83)**	+0.0099 (2.44)*		0.6201	1.983
[13b]	−0.6083 (8.29)**	−0.0680 (2.20)*	+0.4596 (2.85)**	+0.0097 (2.48)*		0.6541	1.981
[13c]	−0.5671 (4.20)**	−0.0681 (2.20)*	+0.4450 (2.53)*	+0.0092 (2.32)*	−0.0318 (0.35)	0.6743	1.976
With Friedman's Permanent Net National Product (Y2)							
[14a]	−0.5426 (10.52)**	−0.1277 (6.44)**	+1.3556 (8.22)**	−0.0036 (1.30)		0.9256	2.000
[14b]	−0.5639 (11.12)**	−0.1163 (6.19)**	+1.2571 (7.67)**	−0.0029 (1.03)		0.9220	2.000
[14c]	−0.5640 (10.40)**	−0.1163 (6.13)**	+1.2576 (6.81)**	−0.0029 (0.97)	+0.0002 (0.01)	0.9207	2.000
With Darby's Permanent Gross Domestic Product (Y3)							
[15a]	−0.8486 (2.61)*	−0.0704 (2.68)*	+3.5856 (3.70)**	−0.0562 (2.50)*		0.2801	1.815
[15b]	−0.9140 (3.22)**	−0.0712 (2.72)**	+3.3660 (3.64)**	−0.0500 (2.40)*		0.3018	1.825
[15c]	−0.9340 (2.66)*	−0.0662 (2.69)*	+3.6583 (3.75)**	−0.0567 (2.46)*	+0.0827 (2.15)*	0.3064	1.841
With Kendrick's Net Personal Stocks (W)							
[16a]	0.1253 (0.12)	−0.0413 (1.34)	−0.2149 (0.36)	+0.0219 (1.77)		0.1978	1.741
[16b]	0.2421 (0.22)	−0.0429 (1.35)	−0.2867 (0.48)	+0.0232 (1.89)		0.2226	1.762
[16c]	−0.0594 (0.06)	−0.0330 (1.11)	−0.1469 (0.26)	+0.0217 (1.73)	+0.0792 (1.90)	0.1837	1.713

Note: The numbers in parentheses below the coefficients are t values.
* indicates significance at the 5 per cent level.
** indicates significance at the 1 per cent level.
D.W. is the Durbin-Watson statistic.

a remarkable improvement when the market rate of interest is replaced by the tax corrected rate. Whether one uses measured gross national product, Y1, or Friedman's permanent net national product, Y2, or Darby's permanent gross domestic product, Y3, the effect of the tax correction on the t values of the interest rate variable is considerable. Kendrick's W does not perform well whether or not the tax factor is introduced. As far as Table 1 is concerned the full improvement is brought about by the correction in the yield; the addition of the dummy, to account for the change in the method of payment, does not help. This is also in line with our expectations as it was argued in section II that the method of payment ought to be more important for M2 than for M1. When Table 3 is considered (which uses M2 rather than M1), the dummy becomes significant in connection with Y3 (Darby's) and W (Kendrick's).

The second expectation — that the improvement in the fit should occur especially when the dependent variable is M1 rather than M2 — is also fully satisfied. This is seen most clearly by comparing Table 1 with Table 3. Both tables use a long-term rate of interest, but while Table 1 uses M1 as the dependent variable Table 3 uses M2. In Table 3 the t values for the interest-rate variable are generally high and remain high even when Kendrick's net personal stocks variable is used instead of income. However, no improvement is brought about when taxes are taken into account. Tables 2 and 4 also use alternatively M1 (Table 2) and M2 (Table 4) as the dependent variable, but a short-term rate of interest is used instead of a long-term rate. The use of a short-term rate performs better with equations using M2 as the dependent variable: the results in Table 4 are superior to those in Table 2. However, if the basic issue is the improvement in the fit brought about by the tax correction neither of these tables performs very well: the correction for taxes has a marginal effect on the statistical fit.

As expected, the coefficients for the rate of interest — i.e., the interest elasticities of the demand for money — are negative and for the most part highly significant. The t values for these coefficients increase significantly when the market rate of interest, Rt, is replaced by the tax corrected rate R^T_t in the regression equations. However, these improvements are limited to the use of M1 with a long-term rate of interest. The interest elasticities of the demand for money are much higher when a long-term rate is used, especially in connection with M1, and they increase significantly when the tax

TABLE 5

REGRESSIONS RELATED TO RATIO OF CURRENCY TO DEPOSITS

[17a]	$\left(\frac{C}{D}\right)_t$	$= 0.2004$ $(6.93)^{**}$	$- 0.0068Y_t$ (0.27)	$+ 0.0021Z_t$ (1.55)		$\bar{R}^2 = 0.1015$ D.W. $= 1.859$
[17b]	$\left(\frac{C}{D}\right)_t$	$= 0.1782$ $(8.61)^{**}$	$- 0.0216Y_t$ (1.11)	$+ 0.0015Z_t$ (1.52)	$+ 0.0029T_t$ $(4.93)^{**}$	$\bar{R}^2 = 0.4456$ D.W. $= 1.846$
[17c]	$\left(\frac{C}{D}\right)_t$	$= 0.1326$ $(4.41)^{**}$	$+ 0.0083Y_t$ (0.37)	$+ 0.0008Z_t$ (0.64)	$+ 0.0010(MT)_t$ $(3.90)^{**}$	$\bar{R}^2 = 0.3060$ D.W. $= 1.966$

Note: The numbers in parentheses below the coefficients are t values.
** indicates significance at the 1 per cent level.
D.W. is the Durbin-Watson statistic.

correction is made (see Table 1).[22] Also as expected, the coefficients for the income variable were positive and generally highly significant. Finally, the trend variable was not helpful.

Table 5 shows the regression equations corresponding to equations [4], [5], and [6] in section II. As it will be recalled, the aim of these equations was to provide a simple test for the effect of changes in income taxes on the composition of M1, namely, on the ratio of currency to checking deposits. The table shows that the explanatory power of the equation is very low when the tax variable is not included (see equation [17a]). However, the inclusion of the tax variable leads to a dramatic improvement in the fit. More importantly, the tax variable is significant at the 1 per cent level and has the right (i.e., positive) sign. Equations [17b] and [17c] indicate that an increase in income taxes is accompanied by an increase in the ratio of currency to checking deposits. Equation [17b] which uses the weighted average tax rate performs better than the one using the top-bracket statutory tax rate. This result also conforms to expectations as the top-bracket statutory rates are relevant for only a few individuals and are not always an indication of the marginal tax rates of the majority of taxpayers.

Before closing this section, a report should be made on some attempts that did not give satisfactory results. First, the analysis related to the demand for money was performed by lagging the independent variables in different ways. None of these alternative

22 On the other hand, these elasticities decrease when M2 is used with a long-term interest rate and the tax correction is made.

formulations gave results preferable to those obtained with unlagged variables. Second, various stock adjustment processes were also tried without success. Third, on the assumption that children do not hold money, per capita series were obtained by using as a denominator only the population over 14 years of age. This attempt was aimed at capturing some potential economies of scale in money holding that might have occurred because of the increase in the average-sized family after World War II. The results were once again disappointing.

V. Concluding Remarks

This paper has dealt with one of the most researched areas in economics, the demand for money. However, in spite of the literally hundreds of empirical studies on the determinants of the demand for money, none has taken into account the possible impact of income taxes on that demand by introducing a wedge between the market rates of interest and the (net-of-tax) yields that individuals receive. Using traditional demand for money functions, and standard statistical techniques, it has been shown that the tax factor is important and establishes a new link between monetary and fiscal policy. The significance of the tax factor was supported by various statistical tests using alternative income concepts.

The basic conclusion is that the introduction of income taxes, or changes in the rates of existing taxes, does affect the demand for money and thus has monetary implications that have been ignored by both monetary economists and monetary authorities. These tax-induced effects are different from the more traditional Keynesian ones — which are associated with variations in disposable income following tax changes. Rather, they exist even when the increases in income taxes were completely compensated by, say, decreases in sale taxes. The size of these effects depends on the interest elasticity of the demand for money and may become important when substantial tax reforms are introduced in countries where the demand for money is particularly interest elastic. In these situations the monetary authorities might have to adjust the money supply to match the tax-induced change in the demand for money.

Finally, it has been shown that the ratio of currency to checking deposits — a ratio completely determined by individual choice —

is partly determined by the level of income taxes. As a change in this ratio, given the reserve requirements, affects the commercial banks' ability to expand their deposit liabilities, this result is also important for monetary policy.

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APPENDIX

DATA SOURCES

Y1 = measured gross national product: UNITED STATES DEPARTMENT OF COMMERCE, BUREAU OF ECONOMIC ANALYSIS, *Long Term Economic Growth, 1860-1970* (Washington, D.C., 1973); and *Economic Report of the President Transmitted to the Congress January 1977* (Washington, 1977).

Y2 = permanent net national product estimated by Milton Friedman and Anna Schwartz: National Bureau of Economic Research.

Y3 = permanent gross domestic product estimated by Michael R. Darby: M. R. DARBY.

W = net personal stocks estimated by John W. Kendrick: see JOHN W. KENDRICK (assisted by Yvonne Lethem and Jennifer Rowley), *The Formation and Stocks of Total Capital* (National Bureau of Economic Research, New York, 1976).

R_l = long-term rate of interest (annual yields on long-term prime corporate bonds, Moody's Aaa): MOODY.

R_s = short-term rate: commercial paper rate (4-to-6 month commercial loans). FEDERAL RESERVE.

M1, M2, currency, and checking deposits: DIVISION OF RESEARCH AND STATISTICS, FEDERAL RESERVE.

T_t = weighted average tax rate: see text.

MT = statutory top-bracket rate: JOSEPH A. PECHMAN, *Federal Tax Policy*, rev. ed. (W. W. Norton and Company, New York, 1971), p. 255.