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October 1980

Graves, Philip E., *The Velocity of Money: Evidence for the U.K. 1911-1966* , Economic Inquiry, 18:4 (1980:Oct.) p.631

THE VELOCITY OF MONEY: EVIDENCE FOR THE U.K. 1911-1966

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This paper presents secular evidence on the income velocity of money, exploring the issue of the superiority of money balances. Under a variety of specifications and statistical techniques, employed on both traditional and non-traditional variables, the Friedman assertion that money is a superior good is found to lack empirical support. Indeed, income elasticities of demand for M_2 *balances of .3 to .45 are observed, elasticities much smaller than previously thought.*

A great deal of effort has been expended studying and surveying the secular evidence on the income velocity of money (see for example, Boorman (1972), Ezekiel and Adekunle (1969), Friedman (1972), Goldfeld (1973), Kaufman and Latta (1966), Laidler (1969) and Warburton (1949)). Nor has interest in the subject abated in more recent years as evidenced in work by Bordo and Jonung (1979), Graves (1976)(1978), and (1979), Jonung (1978), Schwartz (1975), and Stauffer (1978).

The present paper explores the question, for the 1911-1966 period in the U.K., of whether money is a superior good as asserted by Friedman (1959). The analysis considers, for comparative purposes, both narrowly and broadly defined money and employs a variety of specifications and statistical techniques in an effort to obtain confidence in the findings. In Section I the data are briefly described. Section II presents the regression results and is broken into two parts dealing, respectively, with traditional and non-traditional independent variables. In virtually all cases the Friedman assertion is not supported. Section III summarizes and concludes the paper.

I. THE DATA

Currency plus demand deposit data (M_1) are available for the period 1880 to 1975, while "M_2" data (M_1 plus deposits at post office savings banks, trustee savings banks, Birmingham Municipal Savings Bank as well as Building Society shares and deposits — a money definition if anything broader than M_2) are available for the period 1880 to 1966.

*University of Colorado, I wish to acknowledge Milton Friedman for encouraging me to pursue the English application of earlier U.S. work in this area. He is of course not responsible for my conclusions. Thanks are also due to M. Bordo, R. Clower, J. Dugan, R. Krumm and R. Sexton, and to members of the Kansas City Federal Reserve Bank for useful comments and to G. Schwarz for data collection and computational assistance. Remaining errors are my sole responsibility.

However, information on important independent variables (see Graves (1978)) is only available for more recent periods, with data on percent urban beginning in 1911 and data on the population age distribution (while available for 1871 and 1901) also becoming available with reasonable frequency at about that time. For the early years, prior to 1941 for age and prior to 1951 for urban population, interpolation was necessary to arrive at a complete annual data set for the period 1911 to 1966. These data, as well as traditional income and interest rate data, were obtained from Mitchell 1962 and Sheppard 1971, with the Central Statistical Office *Annual Abstract of Statistics* containing further data for recent years which was not used here in order to have comparable periods for the M_1 and "M_2" analyses.[1]

II. REGRESSION RESULTS

The presentation of results in this section does not take the usual form employed in estimations of money demand. The conventional equation (see Goldfeld (1973) p. 582) relates real money balances, M_1/P or M_2/P, to real income, lagged real money balances and various interest opportunity cost variables in a double-logarithmic specification, typically correcting for first order autocorrelation.

While the alternatives are obviously related, I have chosen to deal with dependent variables defined as ratios of cash balances, M_1 or M_2, to current dollar national income. That is, the dependent variable is the ratio of money to income or the reciprocal of velocity. This formulation simplifies the interpretation of the coefficients of the independent variables when one's interest is in velocity or money/income ratios.

A. The Traditional Variables. In Tables 1 and 2 regressions are presented, using both ordinary least squares (OLS) and the Cochran-Orcutt procedure (CORC) to correct for autocorrelation, which relate the ratio of narrowly-defined (Table 1) and broadly-defined (Table 2) money to income, the inverse of velocity, to traditional variables.

Looking first at Table 1, in all cases and very significantly, with one exception, increases in real per capita income is seen to reduce the narrowly-defined money/income ratio. This result, similar to Graves' 1976, 1978 findings for the U.S., is robust across specifications and statistical technique and is, perhaps not surprisingly, strongest in those specifications including the interest rate opportunity cost variable.

Results in Table 2, for very broadly-defined money, are not as clear-cut upon first perusal. In two of the five equations having signficant income effects the effect of income is to increase cash balances as a frac-

1. A brief variable description and means for the raw data used in this study as well as a complete variable list is available from the author.

TABLE 1

OLS and CORC specifications of the effect of traditional money demand variables on M_1/Y, the fraction of income held as narrowly defined money balances. All variables logarithmic; 56 observations covering the period 1911-1966; t-values in parentheses.

Equation	Constant	$(M_1/Y)^a_{-1}$	*RPCY*[b]	*BLRATE*[c]	Rho	R^2	D–W
			Ordinary Least Squares				
(1)	−.042		−.1026	−.1833		.04	.11
	(.14)		(1.44)				
(2)	.136		−.1097	−.1833		.72	.38
	(.83)		(2.81)	(11.23)			
(3)	.213	.9590	−.0565			.90	1.48
	(2.18)	(21.38)	(2.42)				
(4)	.211	.8265	−.0642	−.0341		.91	1.36
	(2.21)	(10.31)	(2.79)	(1.97)			
			Cochran-Orcutt Iterative Procedure				
(5)	1.996		−.5545		.949	.91	1.44
	(2.83)		(3.69)				
(6)	2.138		−.5721	−.0966	.944	.94	1.69
	(4.04)		(4.94)	(5.55)			
(7)	.263	.8987	−.0750		.333	.91	2.03
	(1.88)	(14.49)	(2.23)				
(8)	2.345	.1575	.5986	−.0845	.949	.95	1.96
	(4.28)	(1.45)	(5.11)	(4.43)			

[a] Lagged dependent variable, narrowly-defined money/income.
[b] Real per capita income.
[c] Interest rates on 3-month bank bills (average of the minimum and maximum over the year).

tion of income. Hence velocity appears to fall with rising income in keeping with Friedman's view that money balances represent security which is a superior good.

However, Durbin-Watson statistics of .12 and .58 for the preceding two cases suggest high autocorrelation, an indication of probable model misspecification. Upon correcting for autocorrelation with the Cochran-Orcutt procedure, the effect of income on cash balances as a percentage of income is seen to be negative. Particularly noteworthy in this regard are Equations 6 and 8 in Table 3 which properly control for the effects of interest rates on the demand for money. In both the lagged dependent variable case (Equation 8) and the unlagged specification (Equation 6) a

TABLE 2

OLS and CORC specifications of the effect of traditional money demand variables on "M_2"/Y, the fraction of income held as broadly-defined money balances. All variables logarithmic; 56 observations covering the period 1911-1966; t-values in parentheses.

Equation	Constant	("M_2"/Y)$_{-1}$[a]	*RPCY*[b]	*BLRATE*[c]	Rho	R^2	D – W
			Ordinary Least Squares				
(1)	−.9948		.2039			.12	.12
	(3.12)		(2.68)				
(2)	−.7973		.1960	−.2032		.79	.58
	(5.04)		(5.21)	(12.99)			
(3)	.1506	.9735	−.0366			.92	1.32
	(1.36)	(22.67)	(1.42)				
(4)	.0202	.8324	−.0032	−.0366		.92	1.24
	(.16)	(9.46)	(0.10)	(1.82)			
			Cochran-Orcutt Iterative Procedure				
(5)	2.192		−.4914		.964	.93	1.28
	(3.00)		(3.22)				
(6)	2.646		−.5527	−.0935	.970	.95	1.55
	(4.25)		(4.39)	(5.29)			
(7)	.1679	.9145	−.0424		.401	.93	2.01
	(1.01)	(14.44)	(1.09)				
(8)	2.832	.2434	−.5923	−.0761	.971	.96	1.92
	(4.67)	(2.22)	(4.83)	(4.06)			

[a] Lagged dependent variable, broadly-defined money/income.

[b] Real per capita income.

[c] Interest rates on 3-month bank bills (average of the minimum and maximum over the year).

very significant negative effect of income on cash balances as a fraction of income is observed. These negative effects are more than twice as large as the apparent positive effects seen in Equations 1 and 2 and Durbin-Watson statistics of 1.55 and 1.92 suggest more appropriate model specification.

B. Other Money Demand Shifters. As was the case for the U.S. (see Graves (1978)), these income and interest rate changes were not occurring in a *ceteris paribus* world over the period 1911 to 1966 in the U.K. In particular, as indicated in earlier work, the percentage of the population of retirement age and residing in urban areas was changing throughout this period. Both variables would be expected to shift the demand for

money balances, as discussed in Graves (1976) (1978). Failure to control for these variables will lead to omitted variable bias in the income coefficient which will then capture effects associated with movements in excluded variables which are correlated with income.

In Tables 3 and 4 are equations comparable to those presented earlier except that the percentage of population over 65 years old and the percent of population living in urban areas are explicitly considered.

For narrowly-defined money (Table 3) increasing income is seen to always lead to significant reductions in the M_1/income proportion, the t-values ranging from 3.57 to 6.69. This result is robust to alternative specifications as well as to statistical technique. The strong similarity is particularly noteworthy in the income coefficients which range from −.7047 to −.7540 throughout the CORC specifications, implying an income elasticity of demand of .3 to .25.

The age and urban effects on money balances as a percentage of income are consistent throughout Tables 3 and 4: increasing the percentage of old people in the population increases the M_i/income ratio while increasing the percentage of the population residing in urban areas reduces the ratio. The age effect is as expected from previous work and *a priori* theorizing, with retirees "cashing out." The direction of the urban effect is *a priori* ambiguous and the results presented here for the U.K. are not consistent with earlier evidence. As Graves (1978) indicates:

> Urbanization is expected to exert several effects with the net impact being *a priori* ambiguous. For example, trading in larger cities where one is not known, greater precautionary balances due to unexpected shopping opportunities, and the probably greater amount of cash balances for transactions involving intermediate goods would be expected to increase the demand for money, while the greater accessibility to non-bank earning asset markets in urban areas would lead to reduced cash holdings since lower transactions costs would facilitate the holding of proportionally less cash. Empirically, both within and across countries, the former types of motivations are seen to dominate with greater urbanization being associated with lower velocity. (p. 54).

Which of the two effects dominates may well depend on the stage or rapidity of development for the country or countries under investigation. England, throughout the 1911-1966 period, was highly developed with little rapid changes occurring. In such cases, the portfolio argument of greater access to non-money earning assets implying lower M_i/income ratios appears to plausibly dominate the other motivations.

Interest rates throughout all the tables are seen to significantly affect the demand for money in the usual way, requiring little in the way of additional comment.

TABLE 3

OLS and CORC specifications of the effect of non-traditional money demand variables on M_1/Y, the fraction of income held as narrowly defined money balances. All variables logarithmic; 56 observations covering the period 1911-1966; t-values in parentheses.

Equation	Constant	$(M_1/Y)_{-1}$	*RPCY*	*BLRATE*	*OLD*[a]	*URB*[b]	Rho	R^2	D − W
			Ordinary Least Squares						
(1)	10.54		−1.545		2.017	−1.626		.60	.35
	(6.45)		(6.61)		(5.53)	(1.45)			
(2)	6.963		−1.058	−.1351	1.396	−2.089		.84	.48
	(6.26)		(6.69)	(8.84)	(5.57)	(2.94)			
(3)	3.152	.8510	−.4755		.6271	−1.199		.92	1.19
	(3.40)	(13.83)	(3.57)		(3.19)	(2.31)			
(4)	3.569	.6662	−.5461	−.0448	.7227	−1.445		.93	1.02
	(4.05)	(7.68)	(4.30)	(2.85)	(3.86)	(2.93)			
			Cochran-Orcutt Iterative Procedure						
(5)	4.681		−.7047		.9354	−.0323	.947	.92	1.53
	(2.36)		(4.00)		(1.33)	(0.04)			
(6)	4.536		−.7229	−.1004	.8325	−.5440	.874	.95	1.75
	(3.74)		(5.12)	(5.72)	(2.72)	(0.99)			
(7)	5.094	.6465	−.7540		.9998	−1.359	.602	.93	2.19
	(4.79)	(6.94)	(5.17)		(4.65)	(2.17)			
(8)	4.772	.3220	−.7327		.9292	−1.264	.722	.95	2.05
	(4.83)	(3.05)	(5.61)	(4.35)	(4.56)	(2.25)			

[a] "*OLD*" is defined as the ratio of those over 65 years old to the total population.

[b] "*URB*" is defined as the ratio of urban population to the total population.

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TABLE 4

OLS and CORC specifications of the effect of non-traditional money demand variables on M_2/Y, the fraction of income held as narrowly defined money balances. All variables logarithmic; 56 observations covering the period 1911-1966; t-values in parentheses.

Equation	Constant	$(M_2/Y)_{-1}$	*RPCY*	*BLRATE*	*OLD*[a]	*URB*[b]	Rho	R^2	D – W
			Ordinary Least Squares						
(1)	10.32		−1.339		2.157	−1.729		.64	.27
	(5.94)		(5.39)		(5.56)	(1.45)			
(2)	6.212		−.7789	−.1554	1.442	−2.261		.89	.55
	(6.10)		(5.38)	(11.12)	(6.52)	(3.47)			
(3)	3.150	.8602	−.4445		.6551	−1.181		.93	1.05
	(3.50)	(14.85)	(3.57)		(3.31)	(2.26)			
(4)	3.664	.6164	−.4910	−.0574	.8167	−1.533		.94	.88
	(4.33)	(6.59)	(4.25)	(3.17)	(4.32)	(3.11)			
			Cochran-Orcutt Iterative Procedure						
(5)	6.163		−.6986		1.474	−.5619	.929	.93	1.38
	(3.48)		(4.01)		(2.62)	(0.78)			
(6)	6.079		−.7255	−.0999	1.377	−1.029	.841	.96	1.66
	(5.36)		(5.25)	(5.82)	(5.21)	(1.91)			
(7)	5.450	.6206	−.7278		1.151	−1.435	.679	.95	2.13
	(4.97)	(6.30)	(5.12)		(5.07)	(2.39)			
(8)	5.394	.3515	−.6909		1.193	−1.564	.711	.96	1.96
	(5.60)	(3.36)	(5.56)	(4.30)	(5.94)	(3.00)			

[a] "*OLD*" is defined as the ratio of those over 65 years old to the total population.

[b] "*URB*" is defined as the ratio of urban population to the total population.

In Table 4 a strong denial of the Friedman notion that broadly-defined money is a superior good is evident. With t-values ranging from 3.57 to 5.56, increasing income is seen to lead to significant reductions in the M_2/income ratios. Moreover, the magnitude of the effect is substantially robust to both inclusion or exclusion of interest rates and lagged dependent variables and alternative estimation techniques. The coefficient on real per capita income averages quite close to −.7. This corresponds to an income elasticity of demand for cash balances on the order of .3, far below the 1.3 or so commonly inferred from U.S. time series data. As may be seen in comparing Tables 4 and 2 this large difference is due in part to the fact that age and urbanization are not controlled in the traditional demand for money studies.

III. SUMMARY AND CONCLUSION

This paper has focused on the United Kingdom monetary experience considering the implications of incorporating important money demand shifters which are ignored in the usual money demand study. Specific conclusions are:

- *The income elasticity of demand for either M_1 or M_2 money is less than unity even in the traditional specification.
- *Controlling for age and urbanization of the population reveals that the income elasticity of demand for money (however defined) is smaller than had been thought from specifications employing only the traditional variables.
- *Increases in the percent of the population over 65 years old leads to increases in the economy-wide ratio of M_i to income.
- *For the U.K., increases in the percent of the population residing in urban areas leads to a decrease in the economy-wide ratio of M_i to income.

The discussion particularly focused on the effect of income on money demand, concluding that Friedman's assertion that money is a superior good is denied as was found in earlier work for the U.S. and in cross-country comparisons. Two implications of this finding should be stressed; Arrow's "increasing relative risk aversion hypothesis" becomes more suspect, based as it was empirically on the time series finding of the superiority of money (see Graves (1979)), and the amount of inflation resulting from any given percentage increase in the money supply over time will be larger than would be the case if velocity were falling with rising real income.

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