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CURRENCY SUBSTITUTION, FINANCIAL INNOVATIONS AND MONEY DEMAND

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ABSTRACT

This paper presents some Finnish evidence on the importance of currency substitution and financial innovations for money demand. It is also shown that conventional demand for money specifications which do not take these factors into account are clearly misspecified and produce unreasonable results. The problem is particularly acute for narrow concepts of money.

CONTENTS

1 INTRODUCTION AND THEORETICAL CONSIDERATIONS

Nowadays, most economists are very sceptical about the idea that a stable demand for money function could be derived from data which also cover the last decade (cf. e.g. Friedman (1978)). In particular, financial innovations have created serious conceptual and measurement problems. The measurement problems have many dimensions, a particularly difficult one being the lack of data for such things as credit cards and credit card transactions. It is nevertheless quite clear that it is precisely "plastic" money which is crowding out conventional means of payment, especially notes and coin.

Financial innovations have several driving forces. They include introduction of new assets, technological innovations (as with "plastic money"), deregulatory measures and such things as taxes and other price and cost terms (cf. e.g. Taylor (1987) and Hall, Henry and Willcox (1989) for further discussion and empirical results). Also the role of taxes should be emphasized in this context. In most cases capital income taxation is far from neutral in the sense that interest income is partly or totally tax-free but interest payments for loans are partly or totally tax-deductible. Thus, the after-tax interest rate wedge $r_D - (1\text{-}tax)r_L$, where r_D = the deposit rate, tax = the marginal tax rate and r_L = the bank lending rate, may well be positive, which obviously creates a strong incentive for tax arbitrage. In practice, this means simultaneous growth of tax-free assets and tax-deductible liabilities; in Finland typical examples of these tax-free assets are government bonds and time deposits. High marginal tax rates also affect money demand by increasing the incentive for tax evasion, which, in turn, may affect the structure of demand for various means of payment. In particular, the demand for notes and coin can be assumed to increase (see e.g. Klovland (1984) and Schneider (1986) for further discussion and empirical evidence of tax evasion and the "shadow economy" in terms of money demand).

Domestic financial innovations are obviously not the only factor which affect money demand functions. The lifting of various controls on capital movements and the growing importance of foreign operations have made disturbances emanating from abroad a potentially important element for the demand of domestic money balances. The specific channel of effects or hypothesis to which we refer here is the currency substitution hypothesis, which has been forcefully advocated by e.g. McKinnon (1982). The idea is that multinational firms, investment corporations and to a lesser degree households carry on productive activities at home and abroad and these activities require the maintenance of monetary balances denominated in more than one currency. By doing so, these economic agents can arbitrage interest rate differentials and fluctuations in currency rates. This implies that the demand for (real) money balances, M/P, depends on the relevant scale variable, y, a domestic interest rate, r, a foreign interest rate, r* and the expected depreciation of the exchange rate, x, i.e. M/P = m(y, r, r*, x). Basically, this is a straightforward portfolio choice problem, with the difference that the role of the foreign interest rate is somewhat problematic here. As pointed out by Cuddington (1983), this variable would mainly signal general capital mobility rather than currency substitution because an increase in r* would just raise the return on holding foreign bonds (instead of domestic and foreign cash). On the other hand, if the covered interest rate parity condition holds (and if r* is defined as the <u>covered</u> foreign interest rate, r* would just equal r and the identification of the foreign interest rate effect would be rather tedious). Thus, it seems better to test the currency substitution hypothesis with the exchange rate expectations variable only. In fact, this is the standard procedure which has been applied in empirical tests; see e.g. Marquez (1987a,b) and Fasano-Filho (1986). Without going into details we may mention here that most empirical analyses have given support to the currency substitution hypothesis, which, of course, also motivates this note.

These considerations suggest that instead of estimating a standard Goldfeld (1973) -type demand for money function we should derive an augmented demand function which takes into account the determinants of financial innovations and currency substitution. Anyway, we start by writing the Goldfeld specification in the form:

(1) $$m_t = a_0 + a_1 m_{t-1} + a_2 r_t + a_3 y_t + a_4 p_t + e_t,$$

where m denotes the log of real money balances (ln(M/P)), r the nominal interest rate, y the log of real income, p the rate of inflation and e an error term. The original Goldfeld specification does not include inflation; however, it easily can be introduced by assuming, for instance, that the demand for real money balances depends on the return on real assets or, alternatively, that the partial adjustment mechanism, which is used as the theoretical point of departure in (1), is specified in terms of nominal, not real, balances (strictly speaking this assumption implies the following parameter restriction for (1) $a_1 = -a_4$). The following variables should now be included in it: s, which measures the volume of credit card transactions, x, which measures the anticipated depreciation of the respective currency, and tax, which measures the average marginal tax rate. Thus, the final estimating specification simply reads:

(2)
$$m_t = b_0 + b_1 m_{t-1} + b_2 r_t + b_3 y_t + b_4 p_t + b_5 x_t + b_6 tax_t + b_6 s_t + u_t.$$

The purpose of this note is to estimate (2) using Finnish data for the period 1973M5 - 1988M12, which is the period of floating exchange rates (although the Finnish markka has not been floating freely but has instead been pegged to a fixed exchange rate index). The data for x is derived using the forward rate with respect to U.S. dollar. As far as the other variables are concerned, m is measured in three alternative ways: M0 = notes and coin, M1 = narrow money (including saving accounts with a checqueing facility) and M2 = broad money which also includes time deposits (with 1 to 3 years to maturity). r is the yield on government bonds (with 5 years to maturity), y is measured by GDP or, alternatively, by private consumption, tax is - as mentioned above - the average marginal income tax rate and S (s = ln(S/P)) denotes purchases made by credit, charge and debit cards. Further details and a printout of the data are available upon request from the author.[1]

2 EMPIRICAL RESULTS

Equation (2) is first estimated by OLS using both monthly and quarterly data. Both data are used because the original the data for y, p, tax and s are available only on a monthly basis. When quarterly data are used, the data for m, r, and x represent monthly averages.

We now turn to the estimation results, which are reported in Table 1. The results correspond to equation (2) with the exception that the credit card transaction variable is not included in the M1 and M2 equations. This is because the role of s is in these cases theoretically ambiguous and because preliminary estimation showed that the corresponding coefficients can be estimated only very imprecisely. As can be seen, our augmented money demand equation performs strikingly well: it fits the data very well, all coefficients are of correct sign and magnitude and the equations do not suffer from obvious diagnostic problems. In particular, the tests suggest that the results do not suffer from simultaneity bias. Thus, Hausman's exogeneity tests for the interest rate (and for both the interest rate and the scale variable) do not indicate that the exogeneity assumptions are violated.[2] The results follow a clear pattern: for notes and coin the financial innovations and currency substitution variables s, tax and x are of crucial importance while for broader money aggregates their importance diminishes. By contrast, the importance of interest rate and inflation (as well as the persistence of demand) increases when monetary aggregates become broader. Needless to say, this is quite consistent with the arguments presented above (and also with the arguments presented by, for instance, Cuddington (1983) and Klovland (1984)). As far as the inflation rate variable is concerned, there is doubt about its key role in the money demand function (an analogous result for the U.S. case is obtained by Koskela and Virén (1989) and for the UK case Taylor (1987); he also finds the effects of financial innovation (operating through a nonzero opportunity cost of holding money) an important determinant of money demand).[3] If the parameter restriction $b_1 = -b_4$ is tested it turns out that this restriction can be frequently rejected. Thus, the "nominal partial adjustment story" may not be sufficient to explain the presence of the inflation rate variable in the money demand equation. Rather, a more general interpretation is needed.[4]

It is perhaps illustrative to compare these estimation results with those obtained using equation (1). In the case of monthly data the following results emerge:

	with inflation variable			without inflation variable		
	â1	â2	â3	â1	â2	â3
M0	.615	-.121	.133	.607	-.047	.154
	(12.30)	(0.77)	(5.64)	(11.70)	(0.27)	(6.29)
M1	.940	.053	.036	.960	.118	.038
	(53.19)	(0.79)	(2.09)	(42.41)	(1.38)	(1.66)
M2	.971	-.076	.044	.982	.015	.044
	(72.02)	(1.55)	(2.09)	(52.08)	(0.22)	(1.57)

Thus, if x, tax and s are not included in the estimating specification the adjustment period becomes clearly longer and the interest rate sensitivity diminishes. If, in addition, the inflation rate variable is dropped, the whole model almost collapses.[5] Thus, we can conclude that modelling both financial innovations and currency substitution in the context of money demand is currently unavoidable. And the narrower is the concept of money, the more essential is the inclusion of the corresponding variables in the demand equation.

Table 1 OLS Estimation Results of Equation (2)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
const.	.547	.214	-.153	-.840	.595	-.661	-1.704	.308	-1.079
	(1.03)	(2.60)	(1.35)	(1.28)	(2.22)	(2.08)	(1.72)	(0.92)	(2.04)
	[1.12]	[3.11]	[1.54]	[1.05]	[3.06]	[2.14]	[1.75]	[1.12]	[2.16]
Y_{-1}	.400	.923	.969	.427	.775	.893	.365	.637	.875
	(7.23)	(50.63)	(68.01)	(5.57)	(16.48)	(27.40)	(3.45)	(11.96)	(19.58)
	[7.12]	[37.38]	[75.92]	[4.04]	[11.28]	[28.22]	[2.47]	[8.20]	[20.73]
r	-.188	.051	-.109	-.173	.043	-.095	-.283	.044	-.087
	(0.97)	(0.68)	(1.84)	(2.46)	(0.68)	(2.79)	(3.84)	(0.72)	(2.45)
	[0.98]	[0.65]	[2.56]	[2.73]	[0.84]	[3.40]	[4.61]	[0.68]	[2.78]
y	.248	.030	.038	.341	.077	.133	.396	.176	.184
	(4.39)	(1.60)	(1.71)	(4.51)	(1.50)	(2.61)	(3.23)	(2.93)	(2.30)
	[4.34]	[1.55]	[1.90]	[3.33]	[1.38]	[2.68]	[2.89]	[2.80]	[2.49]
p	-1.061	-1.172	-1.014	-.783	-1.199	-1.001	-.305	-1.649	-.917
	(4.59)	(11.27)	(13.41)	(5.92)	(8.90)	(14.57)	(0.93)	(7.21)	(6.85)
	[4.98]	[9.83]	[4.29]	[6.22]	[6.16]	[17.27]	[1.13]	[6.23]	[6.41]
x	-.269	-.057	-.013	-.069	-.065	-.010	-.073	-.078	-.013
	(5.13)	(2.98)	(1.01)	(3.42)	(4.23)	(1.29)	(3.59)	(5.74)	(1.66)
	[5.76]	[2.86]	[1.49]	[3.51]	[3.27]	[1.64]	[3.82]	[3.84]	[2.36]
tax	.191	.167	.091	.105	.189	.059	.162	.186	.045
	(1.03)	(2.02)	(1.47)	(1.59)	(2.75)	(1.66)	(2.08)	(2.83)	(1.17)
	[0.97]	[1.88]	[1.74]	[1.31]	[2.11]	[1.68]	[1.60]	[2.23]	[1.38]
s	-.015			-.037			-.040		
	(1.90)			(3.65)			(3.11)		
	[1.90]			[2.88]			[2.90]		
R2	.862	.994	.999	.956	.990	.999	.936	.991	.999
SEE	.025	.012	.008	.014	.015	.008	.016	.013	.008
DW	2.44	2.09	2.06	1.59	1.87	1.40	1.67	1.61	1.37
LM1	4.20*	0.64	3.44*	1.33	0.43	1.69*	0.84	1.40	1.92*
CHOW	3.36*	0.74	0.85	2.93*	1.24	1.97	3.50*	1.35	2.76*
F	15.47*	4.81*	1.22	14.23*	9.51*	1.67	10.28*	17.01*	1.56
RESET	2.84	0.90	2.43	0.75	1.48	3.59*	0.12	6.77*	2.22
RBOW	1.10	4.38*	1.66*	2.00*	7.68*	1.73	4.57*	4.83*	0.70
H(r)	0.10	2.64	0.00	0.39	1.85	0.59	0.01	0.37	2.78
H(r,y)	4.09	4.38	1.16	0.39	1.85	3.03	4.99	2.59	6.62
DATA	M0.M	M1.M	M2.M	M0.Q	M1.Q	M2.Q	M0.Q	M1.Q	M2.Q

The scale variable is GDP in equations (1) - (6) and private consumption in equations (7) - (9). Hence, the corresponding implicit price deflator is used for P. Y_{-1} denotes the lagged dependent variable. t-ratios are in parentheses (immediately below them are White's heteroskedasticity adjusted t-ratios). LM1 denotes Godfrey's LM test statistic for first-order autocorrelation in the presence of a lagged dependent variable, Chow's stability test statistic is computed with repect to the period 1980.1, RESET denotes Ramsay's Reset test with respect to the 2nd and 3rd powers of fitted values, RBOW denotes Utts' Rainbow test for lack of fit, and, finally H(r) (H(r,y)) denote Hausman's exogeneity test for r (r and y); the discount rate, public sector real debt, the three month Euro-dollar rate, r_{-1} and y_{-1} are used as instruments. F denotes a test statistic for the hypothesis $b_5 = b_6$ $(= b_7) = 0$. The estimation period is 1973M5 - 1988M12 with monthly data and 1973Q3 - 1988Q4 with quarterly data. In the case of column (1) LM1, CHOW, F, RBOW, H(r) and H(r,y) follow N(0,1), F(8,172), F(3,180), F(2,178), F(94,86), Chi-square (1) and Chi-square (2) distributions. The starred statistics exceed the 5 per cent critical value.

FOOTNOTES

1) The data for different concepts of money, interest rates and exchange rates are derived from the Bank of Finland's data bank. In the case of monthly data the observations represent end-of-period values. The data for gross domestic product and private consumption are from the Finnish quarterly national accounts. The monthly series of GDP is constructed using industrial production as the reference series. Hence, the consumer price index is used to derive the monthly variation in the implicit price deflator. The monthly values of S and tax are obtained simply by mechanical interpolation. The data are seasonally adjusted. The values of s are lagged by one period.

2) In the same context we also checked the robustness of results using robust estimators. This was because the Jarque-Bera tests for residual normality suggested that the normality assumption was not valid and because this was apparently due to some outlier observations. Using Huber's (1981) M-estimator with monthly data produced the following estimates:

	$\hat{b}0$	$\hat{b}1$	$\hat{b}2$	$\hat{b}3$	$\hat{b}4$	$\hat{b}5$	$\hat{b}6$	$\hat{b}7$
m_0	.605	.392	-.181	.243	-1.058	-.279	.242	-.016
	(1.21)	(6.98)	(0.93)	(4.25)	(4.52)	(5.25)	(1.29)	(1.92)
	R2 = .862, DC = .996, SEE = .025, DW = 2.42, F = 15.37							
m_1	.218	.950	-.013	.011	-1.102	-.036	.121	
	(4.09)	(80.57)	(0.27)	(0.95)	(16.39)	(2.96)	(2.25)	
	R2 = .994, DC = .999, SEE = .011, DW = 2.07, F = 3.04							
m_2	-.167	.963	-.109	.044	-1.051	-.012	.086	
	(2.42)	(110.08)	(2.98)	(3.27)	(22.65)	(1.41)	(2.27)	
	R2 = .999, DC = .999, SEE = .008, DW = 2.04, F = 0.52,							

where the symbols are the same as in Table 1. DC is, however, the least absolute deviations analogon to R2. The tuning constant 1.345 is used for all of these equations. Clearly, these results, in the same way as the results with quarterly data, are well in accordance with those reported in Table 1, and they again suggest that our augmented variables x, tax and s are essential ingredients of the money demand function.

3) We may also mention here that all exercises were also carried out for two additional concepts of money, M1b (which only includes notes, coin and cheque and postal giro accounts) and M3 (which also includes savings accounts in co-operative business). The results were so close to those obtained with the M1 and M2 concepts defined above that in order to save space these results are not reported here. Divisia monetary indices were not used in this study; some earlier analyses by Söderlund (1988) suggest, however, that our M1 concept of money mimics such an index for Finland rather well.

4) Apart from opportunity costs of real assets, obvious candidates for explanations are inflation uncertainty and hedging effects (see e.g. Koskela and Virén (1987)).

5) Although the parameter estimates of the currency equation still make sense, it fails in most diagnostic tests. Thus, for instance, Chow's stability test statistics for 1980M1 go up to 10.94 and 11.21 for these two set of estimated equations.

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