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INFLATION, HEDGING AND THE DEMAND FOR MONEY: SOME EMPIRICAL EVIDENCE

23.3.1984 KT 2/84

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INFLATION, HEDGING AND THE DEMAND FOR MONEY: SOME EMPIRICAL EVIDENCE***

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*** We are indebted to Timo Rajakangas for research assistance. Financial support from the Yrjö Jahnsson Foundation is gratefully acknowledged.

Abstract:

This paper examines the impact of nominal interest rate uncertainty and inflation hedging on the demand for money by using U.S. quarterly data over the period 1952.2-1982.4. It is shown that in conformity with theoretical considerations the interest rate uncertainty variable has a significant positive, while the inflation hedging variable (covariance between interest rate and inflation rate) has a significant negative effect on the demand for money. This results seems to be reasonably robust with respect to various defitions of income, interest rate, inflation rate and money variables as well as estimation methods.

1. INTRODUCTION

The question of whether the demand for money function, fitted to U.S. (and other countries') data, is "stable" has been subject to a number of studies since 1973, when Goldfeld (1973) presented evidence on systematic overprediction of real money balances by the standard money demand function. Evidence the something was wrong with the standard demand for money specification showed up in various ways, particularly in terms of parameter stability (see also Boughton (1982), Cargill and Meyer (1979)). This has lead to various lines of inquiry in the search to repair the money demand function. One line of inquiry has concentrated on financial innovation (and to a lesser extent regulatory changes) as the proximate cause of instability (see e.g. Lieberman (1979), Garcia and Pak (1979)), whereas another line of inquiry has tried to reopen the pre-1973 agenda of empirical issues. While there is some support for 'financial innovation explanation' of money demand instability, conclusive confirmation is still lacking thus motivating further investigation (for a survey these recent explanations, see Judd and Scadding (1982)).

Increased inflation during the last decade has been accompanied by increased volatility in inflation which has probably made inflation harder to predict. To the extent that e.g. nominal interest rates are not fully indexed with respect to inflation rate, a rise in future inflation rate uncertainty may give rise to an increase in "capital risk", i.e. to an increase in uncertainty about the rate of return on various assets. Since Klein (1977) presented his theoretical analysis on the effect of inflation uncertainty on the production technology of money services, the role of inflation uncertainty in the demand for money functions has been analyzed in a number of studies by using data from U.S.A and other countries (see Klein (1977), Blejer (1979), Khan (1982), Smirlock (1982)). Results have been somewhat mixed and have not given strong support to the inclusion of inflation uncertainty variables into the demand for money function. As for the "capital risk", however, the inflation uncertainty variable is not a proper one. Instead, as it is shown below, we should use the volatility of nominal interest rates as an indicator of "capital risk". Moreover, earlier analyses do no allow for the (potential) ability of economic agents to rearrange their portfolio in an effort to protect against unexpected changes in inflation and thus they may not 'correctly' capture the role of inflation uncertainty in the demand for money function. It is the purpose of this paper to shed light empirically on this very issue of whether inflation uncertainty shows up via inflation hedging by using U.S. quarterly data over the period 1952.2-1982.4. In contrast with the other related studies mentioned above the demand for money schedule to be estimated is based on a consistent and rigorous derivation of portfolio choice problem in the presence of inflation hedging motive. Moreover, the robustness of results is checked fairly carefully in terms of various interest rates, price indeces, autocorrelation properties, dynamic adjustment specifications and data samples.

In what follows theoretical considerations and specifications to be estimated are presented in section 2, while section 3 is devoted to empirical results. Finally, there is a brief concluding section.

2. INFLATION UNCERTAINTY AND HEDGING: THEORETICAL CONSIDERATIONS

A remarkable feature of Klein´s (1977) analysis mentioned above concerning the role of inflation uncertainty in the demand for money function is an implicit separability assumption with respect to the inflation rate. It is namely based, like most models of portfolio behaviour, on the maximization of the expected utility, which is defined in nominal terms. Obviously, this is a procedure, which cannot be justified in the presence of purchasing-power risk associated with future inflation rate uncertainty. As has been recently demonstrated e.g. by Boonekamp (1978), taking the purchasing-power risk into account brings the inflation hedging motive in a natural way into the analysis of the demand for money.

More specifically, Boonekamp (1978) derives the consequences of price uncertainty for the allocation of wealth between two monetary assets, one of which is money in the framework, where money is a safe asset in nominal terms, but not in real terms, while bonds are risky in both nominal and real terms. Solving this portfolio model, defined in terms of real value of wealth, yields (in the case of 'small price risks') the following demand for money equation

$$(1) \qquad M = W\{1 - \frac{1}{RRA}\frac{E(r)}{v(r)} - (1 - \frac{1}{RRA})(\frac{Cov(r,p)}{v(r)})\}$$

where W = the stock of wealth, E(r) = the expected nominal rate of return on bonds, v(r) = the variance of the nominal bond return (the nominal risk of return on bonds), Cov(r,p) = the covariance between the nominal rate of return on bonds and the rate of inflation and RRA = the Arrow-Pratt measure of relative risk aversion. Several features of the equation (1) merit note: First, the demand for money can be separated into speculative demand due to bond rate of return uncertainty (the term $-(RRA)^{-1}E(r)/v(r)$) and into the hedging demand which indicates of the extent to which bonds are as a hedge against the depreciation in the value of money (the term $-(1-(RRA)^{-1})Cov(r,p)/v(r)$). Second, the hedging effect vanishes not only in the case of price certainty, but also if either bonds are not used as a hedge against inflation ($Cov(r,p) = 0$) or the relative risk aversion is unity. Third, assuming the the relative risk aversion exceeds unity (which lies in conformity with some empirical evidence, see Friend and Blume (1975)), it is to be seen that both the expected nominal rate of return and its covariance with the inflation rate affect the demand for money negatively, while the assumption that bonds are a positive hedge against inflation is a sufficient, but not a necessary condition for the positive relationship between the variance of the nominal rate of return and the demand for money (for other details, see Boonekamp (1978)).

In what follows we assume that the relative risk aversion is constant (Friend and Blume (1975) present empirical evidence in favour of this assumption). The demand for money equation (1) provides a framework to look at the significance of inflation hedging, or more generally at the question of whether changes in nominal yield risks and the covariances of nominal yields with the inflation rate can contribute to explaining the observed changes in the demand for money.

By proxying W with an income variable (Y), deflating M and P by a relevant price term P, by linearising the multiplicative terms in (1), by taking the natural logs of (M/P) and (Y/P) and finally, by applying the standard "partial adjustment" mechanism with respect to (M/P) we end up with the following demand for money specification

$$(2) \qquad \log(M/P)_t = a_0 + a_1\log(Y/P)_t + a_2r_t + a_3v(r)_t + a_4Cov(r,p)_t + a_5\log(M/P)_{t-1} + u_t$$

where r is the interest rate and u is the error term. The equation (2) is the basic specification in our empirical analyses. By applying the "partial adjustment" mechanism to M, we obtain the the 'nominal adjustment' demand for money specification, where the lagged dependent term is (M_{t-1}/P_t) and the equation is otherwise similar to (2). As it is well-known, (2) can be justified also in terms of 'permanent' or expected values for Y/P, r, v(r) and cov(r,p) by assuming that the permanent values are revised according to the adaptive expectations scheme $x^e_t - x^e_{t-1} = (1-c)(x_t - x^e_{t-1})$, $0 \leqq c \leqq 1$, where $x_t = (Y/P)_t, r_t, v(r)_t, Cov(r,p)_t$. If we assume that the 'permanent' specification applies only to $(Y/P)_t$ so that the terms $r_t, v(r)_t$ and $cov(r,p)_t$ have only short-term effects, then we end up with the following demand for money specification

$$(3) \qquad \log(M/P)_t = b_0 + b_1 \log(Y/P)_t + b_2 r_t + b_3 r_{t-1} + b_4 v(r)_t + b_5 v(r)_{t-1} + b_6 Cov(r,p)_t + b_7 Cov(r,p)_{t-1} + b_8 \log(M/P)_{t-1} + e_t$$

where e is the error term and the coefficients of the lagged terms should be related to the unlagged ones according to the Koyck lag structure (see e.g. Kmenta (1971), p. 475). The equation (3) was also estimated in order to evaluate the appropriateness of the dynamic specification underlying (2).

3. ESTIMATION RESULTS

Equations were estimated by using U.S. quarterly data over the period 1952.2.-1982.4. The data is seasonally adjusted and obtained from (various issues of) Business Conditions Digest. We used both narrow (M_1) and broad (M_2) money, proxied the income variable alternatively by GDP and households´ disposable income. With GDP the GDP deflator (obtained by dividing the seasonally adjusted GDP in current prices by the seasonally adjusted GDP in constant prices) and with households´ disposable income the seasonally adjusted consumer price index (CPI) were used respectively as the price indeces. As an alternative to CPI we also experimented with the implicit price deflator of (nondurable) private consumption expenditure. As for the interest rates, which were seasonally unadjusted, we were experimented with the three alternatives, namely with the Treasury bill rate, r_T, with the bank rate on short-term business loans (35 cities), r_L, and with the yield on long-term Treasury bonds, r_B.

As pointed out earlier, we were interested in the question of whether changes in nominal yield uncertainty and the covariances of nominal yields with the inflation rate can contribute to explaining the observed changes in the demand for money in addition to variables conventionally used. For this purpose we computed for each interest rates the twelve-term moving variance from the twelve-term moving mean and used this value as a proxy for v(r). Analogously, the covariance terms were computed from the nominal interest rates and the quarterly percentage rates of change in the price indeces (for an analogous procedure, see e.g. Klein (1977) and Smirlock (1982)).[1)]

Results from estimating the demand for money specification (2) are presented in Tables 1a-1c. Estimations were carried out both by OLS and by Hatanaka two-step estimation procedure (H2S); in the latter case the data were filtered by various kinds of AR-filters (see the parameters

Table 1a. Estimation Results with Quarterly U.S. Data, 1952.2-1982.4

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Constant	.183	.143	.080	.173	.093	.087	-.190	-.262	-.265	-.119	-.176	-:178
	(1.83)	(1.41)	(1.02)	(2.44)	(1.12)	(0.83)	(5.59)	(8.01)	(6.33)	(4.65)	(7.80)	(5.22)
r	-.009	-.010	-.009	-.013	-.013	-.013	-.014	-.201	-.019	-.015	-.023	-.020
	(5.35)	(4.51)	(5.27)	(6.64)	(5.91)	(5.53)	(7.21)	(9.28)	(7.44)	(8.53)	(11.18)	(8.81)
y	.026	.035	.035	.029	.032	.036	.109	.110	.146	.106	.068	.215
	(4.50)	(6.16)	(7.41)	(4.50)	(5.23)	(4.74)	(3.23)	(3.68)	(3.67)	(3.79)	(2.76)	(5.47)
m_{-1}	.937	.934	.946	.937	.948	.946	.919	.930	.893	.918	.965	.822
	(42.34)	(42.91)	(56.34)	(52.99)	(47.56)	(37.00)	(29.04)	(33.12)	(23.69)	(34.78)	(40.81)	(21.55)
$v(r_T)$	.	-.016	-.005	.	.150	.134	.	.317	.183	.	.597	.121
		(0.19)	(0.07)		(1.25)	(0.99)		(4.10)	(1.97)		(6.18)	(0.94)
$Cov(r_T,p)$	.	-.376	-.453	.	-.270	-.294	.	-.465	-.399	.	-.371	-.158
		(4.37)	(6.31)		(4.42)	(3.61)		(5.44)	(3.57)		(6.98)	(1.68)
R^2	.9760	.9806	.9999	.9844	.9870	.9856	.9993	.9995	.9988	.9992	.9995	.9923
LM(4)	15.00	14.86	.	24.89	11.89	.	45.21	19.95	.	67.38	35.07	.
Chow	8.975	3.933	.	11.633	6.333	.	12.254	3.793	.	26.636	22.865	.
Glejser	.78	.04	.	.90	3.08	.	2.25	1.48	.	2.95	1.93	.
$\hat{a}_1$	.172	-.075	.	.287	.156	.144	.496	.357	.383	.600	.458	.510
	(1.77)	(0.75)		(2.99)	(1.53)	(1.44)	(5.34)	(3.75)	(4.41)	(6.80)	(4.97)	(5.66)
$\hat{a}_2$	.086	-.165	.	.151	.026	.020	.054	.006	.	.109	.053	.092
	(0.91)	(1.68)		(1.57)	(0.25)	(0.21)	(0.53)	(0.05)		(1.07)	(0.52)	(0.96)
$\hat{a}_3$	.302	.056	.	.291	.181	.174	.236	.193	.	.237	.260	.280
	(3.16)	(0.57)		(3.03)	(1.74)	(1.77)	(2.32)	(1.89)		(2.32)	(2.56)	(2.98)
$\hat{a}_4$	-.137	-.351	-.330	-.131	-.262	-.273	-.069	-.028	.	-.125	-.056	-.106
	(1.32)	(3.50)	(3.51)	(1.26)	(2.39)	(2.70)	(0.70)	(0.27)		(1.31)	(0.55)	(1.19)
definition of variables	(M_1,P_y)	(M_1,P_y)	(M_1,P_y)	(M_1,P_c)	(M_1,P_c)	(M_1,P_c)	(M_2,P_y)	(M_2,P_y)	(M_2,P_y)	(M_2,P_c)	(M_2,P_c)	(M_2,P_c)
method	OLS	OLS	H2S	OLS	OLS	H2S	OLS	OLS	H2S	OLS	OLS	H2S

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t-ratios are in parentheses. The values of v(r) and Cov(r,v) have been multiplied by 100. LM(4) indicates the Breusch (1978 autocorrelation statistic for 4 lags, Chow the Chow F-statistic for parameter stability the break in data being 1973/1974, Glejser the heterogeneity test statistic of Glejser (1969) which is here computed by regressing $|\hat{u}_t|$ against the respective dependent variable; the values presented in Tables 1a-1c are the corresponding t-ratios. On the one hand, a_i's indicate, the estimates of of the autoregressive parameters computed in the context of Breusch LM(4) statistic, and, on the other hand, they are autoregressive parameters used in filtering the data in the Hatanaka two-step estimation procedure. P_y indicates the GDP deflator and P_c the CPI, $y = \log(Y/P)$ and $m = \log(M/P)$. With P_y the scale variable is GDP and with P_c households' real disposable income. r_T is the Treasury bill rate, r_L is the bank rate on short-term business loans and r_B the yield on long-term Treasury bonds. $F_{.05,4,100} = 2.46$, $F_{.01,4,100} = 3.51$, $F_{.05,6,100} = 2.19$, $F_{.01,6,100} = 2.99$.

Table 1b. Estimation Results with Quarterly U.S. Data, 1952.2-1982.4

	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24)
Constant	.312 (3.88)	.157 (1.64)	.131 (1.66)	.345 (4.88)	.131 (1.65)	.190 (1.77)	-.133 (4.21)	-.190 (6.43)	-.178 (4.22)	-.080 (3.27)	-.118 (5.92)	-.107 (3.06)
r	-.009 (7.08)	-.014 (8.53)	-.013 (9.06)	-.013 (8.89)	-.016 (10.03)	-.017 (9.74)	-.009 (5.95)	-.019 (9.78)	-.016 (8.18)	-.011 (7.37)	-.021 (12.61)	-.017 (10.69)
y	.033 (5.94)	.039 (7.38)	.039 (8.31)	.041 (6.55)	.035 (5.71)	.043 (5.40)	.077 (2.24)	.089 (3.06)	.132 (3.17)	.102 (3.39)	.065 (2.75)	.191 (4.65)
m_{-1}	.908 (41.66)	.929 (44.29)	.933 (53.34)	.893 (49.11)	.940 (47.02)	.920 (33.65)	.944 (29.00)	.942 (33.74)	.895 (21.97)	.917 (32.24)	.961 (42.71)	.835 (20.97)
$v(r_L)$	.	.184 (3.92)	.172 (4.19)	.	.241 (4.21)	.224 (3.19)	.	.337 (6.84)	.227 (3.79)	.	.428 (8.87)	.192 (2.85)
$Cov(r_L,p)$	.	-.254 (5.05)	-.271 (6.31)	.	-.182 (5.13)	-.188 (3.64)	.	-.195 (3.46)	-.090 (1.07)	.	-.181 (5.17)	-.062 (1.02)
R^2	.9799	.9840	.9899	.9871	.9899	.9843	.9992	.9994	.9978	.9991	.9995	.9883
LM(4)	19.84	12.40	.	34.86	17.96	.	54.96	35.14	.	75.67	50.47	.
Chow	9.130	1.229	.	10.718	2.519	.	8.527	2.341	.	20.044	4.702	.
Glejser	.01	1.17	.	1.41	3.99	.	2.01	.22	.	2.27	.83	.
$\hat{a}_1$	.245 (2.84)	.107 (1.06)	.	.431 (4.52)	.344 (3.40)	.350 (3.47)	.649 (7.00)	.566 (5.97)	.566 (6.80)	.791 (8.82)	.663 (7.19)	.774 (8.53)
$\hat{a}_2$	.054 (0.57)	-.213 (2.18)	.	.065 (0.65)	-.068 (0.65)	-.078 (0.78)	-.056 (0.51)	-.111 (1.01)	.	-.102 (0.89)	-.117 (1.03)	-.151 (1.43)
$\hat{a}_3$	.321 (3.38)	.116 (1.19)	.	.301 (3.02)	.214 (2.00)	.214 (2.09)	.231 (2.11)	.139 (1.27)	.	.286 (2.51)	.245 (2.19)	.287 (2.69)
$\hat{a}_4$	-.108 (1.05)	-.274 (2.77)	-.233 (2.47)	-.141 (1.35)	-.230 (2.06)	.244 (2.40)	-.101 (1.04)	.061 (0.62)	.	-.168 (1.75)	-.021 (0.21)	-.076 (0.81)
definition of variables	(M_1,P_y)	(M_1,P_y)	(M_1,P_y)	(M_1,P_c)	(M_1,P_c)	(M_1,P_c)	(M_2,P_y)	(M_2,P_y)	(M_2,P_y)	(M_2,P_c)	(M_2,P_c)	(M_2,P_c)
method	OLS	OLS	H2S	OLS	OLS	H2S	OLS	OLS	H2S	OLS	OLS	H2S

Table 1c. Estimation Results with Quarterly U.S. Data, 1952.2-1982.4

	(25)	(26)	(27)	(28)	(29)	(30)	(31)	(32)	(33)	(34)	(35)	(36)
Constant	.292	.168	.103	.308	.163	.267	-.059	-.272	-.242	-.046	-.224	-.262
	(2.49)	(1.51)	(1.11)	(3.12)	(1.77)	(1.99)	(1.32)	(4.37)	(3.04)	(1.32)	(5.03)	(4.50)
r	-.010	-.019	-.020	-.018	-.036	-.041	-.006	-.028	-.024	-.010	-.036	-.039
	(3.54)	(3.17)	(3.69)	(4.24)	(5.25)	(5.67)	(2.05)	(4.09)	(3.08)	(3.25)	(5.83)	(6.51)
y	.029	.044	.044	.040	.063	.078	.007	.098	.145	.055	.084	.315
	(3.35)	(4.26)	(4.83)	(3.38)	(4.97)	(5.17)	(0.16)	(2.48)	(2.54)	(1.46)	(2.59)	(6.34)
m_{-1}	.916	.921	.933	.901	.905	.869	1.004	.946	.892	.957	.961	.741
	(32.83)	(35.97)	(42.69)	(31.16)	(34.68)	(23.55)	(27.26)	(26.97)	(17.29)	(27.88)	(31.82)	(15.75)
$v(r_B)$	.	.509	.577	.	1.097	1.068	.	1.076	.709	.	1.592	.986
		(1.66)	(2.11)		(3.12)	(2.91)		(3.04)	(1.85)		(4.11)	(2.75)
$Cov(r_B,P)$		-.723	-.775	.	-.221	-.198	.	-.703	-.482	.	-.213	-.148
		(3.64)	(4.17)		(2.31)	(1.76)		(3.00)	(1.60)		(2.03)	(1.09)
R^2	.9741	.9788	.9873	.9814	.9855	.9700	.9990	.9992	.9971	.9988	.9991	.9861
LM(4)	19.36	9.69	.	33.86	16.94	.	51.84	39.71	.	69.70	55.87	.
Chow	9.134	3.971	.	10.713	3.852	.	2.611	2.538	.	4.957	3.791	.
Glejser	.90	.56	.	.12	1.92	.	3.15	1.14	.	4.45	1.92	.
$\hat{a}_1$	.235	.002	.	.366	.201	.202	.585	.447	.552	.699	.518	.625
	(2.46)	(0.01)		(3.88)	(2.05)	(2.03)	(6.31)	(4.82)	(6.56)	(7.82)	(5.73)	(7.28)
$\hat{a}_2$	.126	-.050	.	.201	.172	.171	.040	.119	.	.049	.185	.212
	(1.30)	(0.49)		(2.06)	(1.75)	(1.78)	(0.37)	(1.20)		(0.44)	(1.81)	(2.26)
$\hat{a}_3$	.298	.152	.	.256	.234	.209	.214	.238	.	.195	.194	.163
	(3.07)	(1.48)		(2.61)	(2.32)	(2.21)	(1.99)	(2.30)		(1.78)	(1.84)	(1.70)
$\hat{a}_4$	-.154	-.251	.256	-.123	-.225	-.244	-.135	-.097	.	-.115	-.129	-.182
	(1.47)	(2.44)	(2.64)	(1.17)	(2.14)	(2.49)	(1.39)	(0.98)		(1.19)	(1.30)	(2.13)
definition of variables	(M_1,P_y)	(M_1,P_y)	(M_1,P_y)	(M_1,P_c)	(M_1,P_c)	(M_1,P_c)	(M_2,P_y)	(M_2,P_y)	(M_2,P_y)	(M_2,P_c)	(M_2,P_c)	(M_2,P_c)
method	OLS	OLS	H2S	OLS	OLS	H2S	OLS	OLS	H2S	OLS	OLS	H2S

a_i in Tables 1a-1c). Choice of filters was based on extensive study of autocorrelation patterns of residuals. It turned out among others that the usual Cochrane-Orcutt AR(1) filtering was not in general appropriate.

The estimation results can be summarized as follows: First, the conventional specifications, which do not include the v(r) and Cov(r,p)-terms, even though they seem to fit data rather well, display typically highly autocorrelated and heteroscedastic residuals. Moreover, the Chow-test statistics indicate that the parameters are not constant over time; in particular, this concerns the break in 1973/1974 which have been extensively studied elsewhere (see e.g. Hafer and Hein (1982)). Second, introducing the "nominal interest rate uncertainty"- and "inflation hedging"(covariance)-terms has the effect of making the performance of the demand for money equation significantly better in several respects: (i) the goodness-of-fit is increased, and neither autocorrelation nor heteroscedasticity of residuals do not any more seem to be crucial problems,[2)] (ii) with the sole exception of equations (2) and (3) in Table 1a the the "nominal interest rate uncertainty"- and "inflation hedging"-terms are highly significant and typically of 'right' sign (provided that assets alternative to money do not serve as 'strong' negative hedges against the depreciation in the value of money).[3,4)] Third, even though the results concerning the significance of "nominal interest rate uncertainty"- and "inflation hedging"-terms seem rather favourable for the specification (2), there are some caveats to be noticed.

When the data is filtered by AR(4)-process in the Hatanaka two-step estimation procedure, the performance of the "nominal interest rate uncertainty"- and "inflation hedging"-terms diminish considerably even though their signs to not change. Particularly, this happens in the case of broad (M_2) money equations.[5] Thus one can doubt in the light of this that the conventional demand for money specification suffers only from some dynamic misspecification so that "nominal interest rate uncertainty"- and "inflation hedging"-terms represent in fact only some lagged terms of (Y/P) and r_t. We were unable, however, to find out clear evidence in favour of this interpretation. More specifically, estimating the "permanent income" version of the demand for money equation suggested that it could not outperform the standard specification. Moreover, including the "nominal interest rate uncertainty"- and "inflation hedging"-terms i.e. estimating the equation (3), made no great changes either. Their coefficients were generally of right sign and magnitude, but unprecisely estimated (obviously due to strong multicollinearity).[6]

4. CONCLUDING REMARKS

This paper has examined the impact of "nominal interest rate uncertainty" and "inflation hedging" on the demand for money by using U.S. quarterly data over the period 1952.2.-1982.4. The major departure from other related studies has been to take account of the possibility that inflation uncertainty creates incentives for economic agents to rearrange their portfolios towards assets that are better inflation hedges, which in turn typically shows up in the demand for money equations in such a way that the covariance between the nominal interest rates and the inflation rate affects the demand for money negatively.

It has been shown that "nominal interest rate uncertainty" and "inflation hedging" (covariance between nominal interest rate and the inflation rate) have significant positive and negative effects respectively on the demand for money. This result seems to be reasonably robust with respect to various definitions of income, interest rate, inflation rate and money variables as well as with respect to estimation methods.

But some open questions remain. The fact that future expectations both on interest rates and on inflation rates have not been explicitly modelled might be a serious shortcoming. Furthermore, and related to this there is no guarantee; that e.g. the period over which the "nominal interest rate uncertainty" and "inflation hedging"-variables have been computed is just 12 quarters as it has been supposed and stays constant over time. Clearly, modelling the impact of various uncertainties on the demand for money still deserves further attention.

FOOTNOTES

1) Obviously, this is a rather rough procedure. Alternatively, one might experiment with explicit models of formation of interest rate expectations by estimating the time-series process of interest rates using Box-Jenkins methods and by producing then forecast error variances as alternative proxies for nominal interest rate uncertainty and analogously for "inflation hedging"-term (for this kind of approach in another context, see Ibrahim and Williams (1978) and Klein (1981)).

2) In some cases slight heteroscedasticity of residuals still showed up according to Glejser-type test statistics so that e.g. the Chow-statistics should be considered with due care. In order to check the seriousness of heterogeneity problem, we also computed some heterogeneity test statistics proposed recently by White (1980). The respective values of test statistics were significant suggesting that the heterogeneity problem might after all be more serious than what the Glejser tests seem to indicate.

3) The results with the implicit price deflator of (nondurable) private consumption expenditure were similar to those reported in Tables 1a-1c. In order to give some flavour of these results we present here only the coefficient estimates of v(r) and Cov(r,p):

Definition of variables	v(r)	Cov(r,p)	F-test statistic for the parameter restriction $a_3=a_4=0$
M_1,r_T	.053 (0.55)	-.223 (6.30)	20.39
M_1,r_L	.156 (2.80)	-.150 (5.50)	20.90
M_1,r_B	.436 (1.00)	-.368 (3.50)	19.59
M_2,r_T	.395 (4.21)	-.229 (6.15)	22.17
M_2,r_L	.350 (6.50)	-.117 (3.88)	30.02
M_2,r_B	.568 (1.15)	-.415 (3.43)	20.79

4) Slovin and Sushka (1983) have introduced both nominal interest rate and inflation rate uncertainty variables - measured by the logarithm of the standard deviation of the respective variables over the previous eight quarters - into the standard demand for money equation. According to their estimation results with U.S. quarterly data over the period 1954-1974.4 given the volatility of interest rates (affecting positively) the volatility of inflation has no significant positive effect on the demand for money. But to the extent that economic agents are able to protect against the depreciation in the value of money, the inflation uncertainty variable is not the appropriate explanatory variable in the demand for money equation.

5) In this context it should, however, be pointed out that M_2 already includes assets which do at least partly provide hedging against inflation. To the extent that this is true, there are some measurement errors associated with covariance, which may explain these estimation problems (see also Kantor (1983)).

6) As far as other checks of robustness are concerned we also estimated the standard demand for money equation both (1) in nominal adjustment form and (2) with various lag-lead specifications of variance and covariance terms. The results were qualitatively similar to those reported in Tables 1a-1c. Hence, they are no reported. A complete set of results is available from the authors upon request.

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