Kauko Karlo

The demand for money market mutual funds

SUOMEN PANKKI · FINLANDS BANK
EUROJÄRJESTELMÄ
EUROSYSTEMET

Bank of Finland Research
Discussion Papers
14 • 2005

Suomen Pankki
Bank of Finland
P.O.Box 160
FI-00101 HELSINKI
Finland
☎ + 358 10 8311

http://www.bof.fi

Bank of Finland Research
Discussion Papers
14 • 2005

Karlo Kauko

The demand for money market mutual funds

The views expressed are those of the author and do not necessarily reflect the views of the Bank of Finland.

* e-mail: karlo.kauko@bof.fi

http://www.bof.fi

ISBN 952-462-218-1
ISSN 0785-3572
(print)

ISBN 952-462-219-X
ISSN 1456-6184
(online)

Multiprint Oy
Helsinki 2005

The demand for money market mutual funds

Bank of Finland Research
Discussion Papers 14/2005

Karlo Kauko
Monetary Policy and Research Department

Abstract

This paper presents a model on the demand for money market funds (MMFs). These funds are a very close substitute for M1 deposits, except that MMFs do not satisfy immediate transaction requirements. The demand for MMFs strengthens when the intended volume of transactions is low. A high interest rate level makes it expensive to hold M1 deposits. High interest rate volatility, paradoxically, increases the risk of holding M1 deposits stronger than the risk of holding MMFs. The results are largely corroborated by Finnish data.

Key words: money market mutual funds, money demand

JEL classification numbers: G23, G29, E41

Rahamarkkinarahastojen kysyntä

Suomen Pankin tutkimus
Keskustelualoitteita 14/2005

Karlo Kauko
Rahapolitiikka- ja tutkimusosasto

Tiivistelmä

Tässä keskustelualoitteessa esitetään rahamarkkinarahastojen kysyntää kuvaava malli. Nämä rahastot ovat muuten erittäin läheinen käyttelytilitalletusten substituutti, mutta rahamarkkinarahastoja ei voida käyttää maksuvälineinä. Rahamarkkinarahastojen kysyntä voimistuu, jos aiottu transaktioiden määrä on vähäinen. Korkea korkotaso lisää käyttelytilitalletusten hallussapidon kustannuksia. Voimakas korkovolatiliteetti paradoksaalisesti lisää käyttelytilitalletusten riskiä enemmän kuin rahamarkkinarahastojen riskiä. Tulokset ovat suurelta osin sopusoinnussa suomalaisen aineiston kanssa.

Avainsanat: rahamarkkinarahastot, rahan kysyntä

JEL-luokittelu: G23, G29, E41

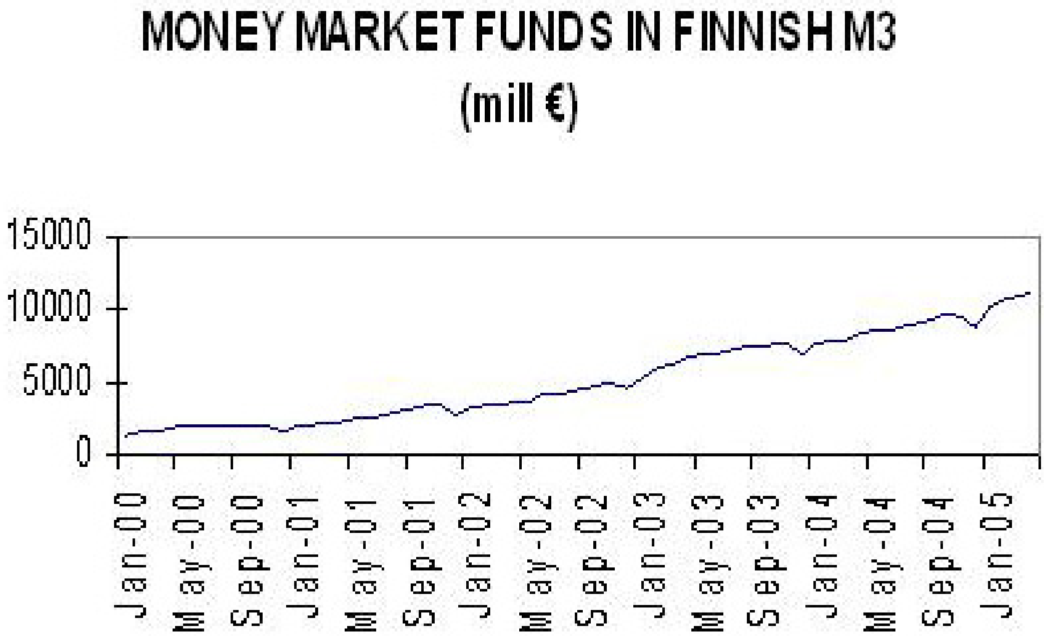
Contents

1 Introduction

1.1 The development of Money market mutual funds

Money market mutual funds (MMFs) invest in nothing but short maturity debt securities, such as treasury bills and certificates of deposit. These funds typically try to avoid default risk and prefer securities issued by low-risk debtors, such as the government. In Euro area monetary statistics these funds are classified as a component of the widest monetary aggregate M3.

Investments in Finnish MMFs have skyrocketed in the last few years. In May 2005, these funds as a component of the national contribution to Euro area M3 totalled EUR 11.3 billion, and they accounted for 12% of M3. In January 2000, the stock was just EUR 1.5 billion, about 2% of M3. The average annual growth rate has been almost 50%; it is difficult to mention any other economic variable with such an extreme and relatively persistent growth rate.



This extreme growth has been above all a Finnish phenomenon. In the whole Euro area, the stock of MMFs grew between January 2000 and January 2005 by 43% only, which implies a relatively low average annual growth rate of 7%.

From a legal point of view, MMFs can be classified in the same category with other mutual funds. However, from an economic point of view, these funds have little in common with, say, equity funds characterised by high volatility and high potential returns. Instead, MMFs are a very close substitute for transaction accounts. Both types of assets are characterised by low risk, high liquidity and low rate of return even though the return of MMFs has been higher than the rate of return on transaction accounts. MMFs are almost as liquid as M1 deposits; they can be sold any time within a couple of days, in most cases with no fees. Basically, MMFs serve all the purposes M1 deposits do, with the exception of immediate transaction needs. In Finland, MMFs cannot be used for giro payments and no checks can be drawn on them.

It is difficult to mention other assets characterised by such a combination of low risk and high liquidity, except notes and coins. Equities and equity funds bear a much higher market risk. Interest rate volatility affects the value of bonds and bond funds much stronger than the value of money market funds, implying a significantly higher level of interest rate risk. Time deposits are illiquid because of their fixed maturity. It may be possible to withdraw the money before the original maturity date, but not without costs, making time deposits a relatively poor substitute for M1 deposits, even though from a legal point of view all kinds of deposits are relatively similar debt contracts between licensed banks and their customers.

Because transaction accounts and MMFs are very close substitutes, it is meaningful to analyse the choice between them as a separate question.

The second section of this paper presents a model on the choice between these two monetary assets. The model is based on the idea that there are two differences between transaction accounts and MMFs; unlike M1 deposits, MMFs cannot be used for immediate transaction needs. Moreover, the return on MMFs is higher and it equals the money market rate. Paradoxically, it turns out that the overall interest rate risk of MMFs characterised by a very short maturity is lower than the interest rate risk of transaction deposits.

The third section presents some empirical analysis on the stock of these two monetary assets with Finnish monthly data. Most of the empirical predictions of the model are corroborated by the data, even though there seems to be no short-term connection between economic activity and M1 deposits. The fourth section concludes the main findings.

1.2 Previous literature on MMFs

There is surprisingly little systematic research on the demand for MMFs. The existing empirical evidence focuses almost exclusively on the U.S. market, and it was almost exclusively published in the 1990s. It is difficult to identify in this literature any established schools or research traditions; there are no standard theories or hypotheses that would have been tested with different methods and data sets. Neither are there controversies. Instead, there seems to be a relatively small number of almost non-related contributions.

A particularly detailed contribution has been presented by Farinella and Koch (1999); they analysed the impact of taxation and changes in regulations on the demand for different types of MMFs in the U.S. in 1984–1995. The demand for these funds was negatively related to the yields of government debt securities but positively related to the return on the funds themselves. The demand for MMFs does also depend on fund maturity, but the sign of this effect depends on the investor category.

Dow and Elmendorf (1998) studied the impact of stock price changes on the stock of MMFs. The results were somewhat surprising; both increases and decreases in stock prices intensified the demand for these funds, when compared to stable stock prices. The authors explain this observation by arguing that MMFs serve as a gateway between different asset classes. The argumentation may lack clarity, but the empirical results were rather clear. Goetzmann, Massa and Rouwenhorst (1999), instead, found that flows to equity funds are negatively correlated to flows to MMFs. Lam, Deb and Fomby (1989) concluded that deregulation of bank deposit rates in the U.S. in 1982 weakened the demand for MMFs because substitutes with nearly similar return properties became available.

As to the supply side, Maggs (1991) estimated how the number of different MMFs offered to the public reacted to interest rate changes. It seemed that financial interediaries' decision to launch new mutual funds reacted strongly to the highest treasury bill rate observed during the previous quarters.

There is some empirical research on the ability of money market fund managers to forecast changes in interest rates. Fund managers do not seem to be able to adjust portfolio maturities according to future changes in interest rates; in fact, portfolio maturities follow rather than anticipate interest rate changes. (Domian 1992) At least among large funds net returns to investors are driven almost exclusively by two factors, namely differences in expenses and the policy of the fund to invest or not to invest in commercial paper (Domian & Reichenstein 1997).

2 The model

2.1 Assumptions

This model analyses the demand for two different monetary assets, namely M1 deposits and their close substitute, MMFs. The model is a simple version of the money in utility function approach; holding money is costly, but agents prefer to keep a certain part of their assets as money because of the utility and services provided by monetary assets. M1 deposits provide agents with liquidity services, whereas MMFs do not. Money held for other motives, such as precautionary and speculative purposes, does also yield utility. In these other uses M1 deposits and MMFs are perfect substitutes.

All the agents incur a cost if they prefer to hold these monetary assets. The gross cost equals the money market rate (r) multiplied by the amount of assets held. The opportunity cost of holding monetary assets is the same irrespective of which kind of assets are being held. It would also be possible to assume that the cost must be somewhat higher than the mere money market rate because agents cannot borrow directly from the market, but as long as the margin between the cost and the market rate is constant, this would have basically no impact on the empirical predictions of the model.

No interest is paid on M1 deposits. The investments of MMFs, instead, earn the market rate, but there is a constant fee (f, $0 < f < 1$) charged by the mutual fund company, implying that the net cost of holding MMFs equals f times the amount of MMFs being held. This assumption is consistent with the above mentioned observations by Domian (1992) and Domian & Reichenstein (1997). To keep things simple, it is assumed that the duration of the money market fund portfolio is 0, and there are neither capital losses nor gains when interest rates change. In practice, such short-term gains and losses do take place, but because the average duration of a money market fund portfolio is very short, this factor is negligible.

The objective function of each agent is

$$U = a\mathrm{Ln}[m_1 \cdot (c - z)] + \mathrm{Ln}[m_1 + m_f] \tag{2.1}$$

where c is expenditure on consumption, m_1 is the amount of M1 deposits, m_f is the amount of money market funds and z ($0 < z < 1$) is an exogenously given minimum amount of consumption, such as the minimum level of subsistence. The parameter *a* describes agents' preference for consumption. The first part of the expression describes utility from consumption and consumption related liquidity services, the latter part describes the utility from holding monetary assets for any purpose not related to immediate transaction needs.

The sequential order is the following.

1) Agents observe the interest rate (r, $0 < r < 1$). They do also observe their preferences concerning consumption, ie. the parameter *a*.
2) Agents borrow money at the money market rate. They decide how much to borrow and how to divide these funds between M1 deposits (m_1) and money market funds (m_f).
3) Transactions are made. Utility from consumption and services provided by monetary assets is accrued.
4) Agents get their income. The income equals +1. Agents have to repay their debts and to pay their interest and fee expenditures to lenders and mutual fund companies. Agents get the interest income from their holdings.

This is a static model, and the above mentioned stages are repeated only once.

Consumption at stage (3) equals the difference between income and the net cost of holding monetary assets. Not being able to repay debts at the stage four causes serious disutility, and it cannot be optimal to default. By definition

$$c = 1 - m_1 r - f m_f \qquad (2.2)$$

2.2 Solving the model

Substituting (2.2) for *c* in the equation (2.1), and differentiating with respect to m_1 and m_f yields the optimisation conditions $\partial U/\partial m_f = 0$ and $\partial U/\partial m_1 = 0$, and the following unique equilibrium[1]

$$m_1 = \frac{a(1-z)}{[(r-f)(2a+1)]}$$

$$m_f = \frac{(1-z)\{r - f(1+a)\}}{[(2a+1)f(r-f)]} \qquad (2.3)$$

As can be seen, it is not possible to construct examples where agents would prefer to hold no M1 deposits at all. Instead, it is entirely possible to construct examples where there is no demand for money market funds. This outcome is consistent with the real world observation that not every household and business undertaking holds shares in money market funds. Such cases are likely if market rates are low,

[1] Second order conditions
$\partial^2 U/\partial m_1^2 = -1/(m_1 + m_f)^2 - af^2/(1-fm_f - m_1 r - z)^2 < 0$
$\partial^2 U/\partial m_1^2 = -a/m_1^2 - 1/(m_1+m_f)^2 - ar^2/(1 - fm_f - m_1 r - z)^2 < 0$

which narrows the cost differential between money market funds and M1 deposits, the fees charged by mutual fund companies (f) are high and the preference for consumption is strong (a>>0). Especially the latter factor may vary between agents. In the following, the analysis is restricted to cases where the optimal holdings of MMFs are positive $\{r_m > f(1+a)\}$.

The formulae (2.3) imply that consumption expenditure equals

$$c = \frac{(a + z + az)}{(1 + 2a)} \tag{2.4}$$

With the formulae (2.3) it is possible to calculate how the optimal holdings of the two monetary assets react to changes in interest rates.

$$\frac{\partial m_1}{\partial r} = \frac{-a(1-z)}{[(2a+1)(r-f)^2]} < 0$$

$$\frac{\partial m_1}{\partial r} = \frac{a(1-z)}{[(2a+1)(r-f)^2]} > 0 \tag{2.5}$$

Unsurprisingly, the demand for money market funds increases and the demand for M1 deposits decreases when interest rates increase. The net cost of holding M1 accounts increases, whereas the cost of holding money market funds remains constant in net terms, implying that it is rational to substitute money market funds for M1 deposits. Interestingly, the formula (2.4) implies that interest rates have no impact on consumption, and the only consequence is a reallocation between the two types of monetary assets. This is probably due to the lack of long-term saving decisions in a one period model.

It is equally easy to calculate how changes in the preference parameter *a* affect the demand for the two monetary assets.

$$\frac{\partial m_1}{\partial a} = \frac{(1-z)}{[(2a+1)^2(r-f)]} > 0$$

$$\frac{\partial m_f}{\partial a} = \frac{-(1-z)(2r-f)}{[(2a+1)^2(r-f)f]} < 0 \tag{2.6}$$

This result is not particularly surprising. When agents' preferences for consumption increase, they shift monetary assets from money market funds to transaction accounts. Needless to say, such a change in preferences will also strengthen consumption.

$$\frac{\partial c}{\partial a} = \frac{(1-z)}{(1+2a)^2} > 0 \tag{2.7}$$

2.3 Interest rate volatility and the demand for monetary assets

Now, the assumptions of the model are changed in the following way. At stage 1, agents observe nothing but the expected value of future interest rates (r_e). There are two possible interest rate realisations, $r_e + v$ and $r_e - v$ ($v > 0$). These outcomes are equally likely. The actual level of interest rates is observed between stages 2 and 3; agents do not have this information when they decide how much M1 deposits and MMFs to hold, but they know how much money is left for consumption when they decide their consumption expenditure at stage 3. If the interest rate happens to be high ($r_e + v$), they have to consume less because the chosen level of M1 deposits becomes more costly to hold. If, instead, the interest rate is low ($r_e - v$), agents can afford spending more at stage 3.

Agents maximise the expected value of utility W.

When the interest rate level is observed, agents realise that the amount of consumption they can afford equals

$$c = 1 - fm_f - m_1(r_e \pm v) \tag{2.8}$$

Agents' expected utility equals

$$\begin{aligned} W = {} & Ln[m_1 + m_f] + \tfrac{1}{2}a\{Ln[m_1(1 - fm_f - m_1(r_e - v) - z)] \\ & + Ln[m_1(1 - fm_f - m_1(r_e + v) - z)]\} \end{aligned} \tag{2.9}$$

Agents' optimisation problem is[2]

$$\frac{\partial W}{\partial m_f} = 0$$
$$\frac{\partial W}{\partial m_1} = 0 \tag{2.10}$$

These conditions yield the following optimal combination

$$m_1 = \frac{a\{3(r_e - f) - \sqrt{[(r_e - f)^2 + 8v^2]}\}(1 - z)}{2(1 + 2a)\{(r_e - f)^2 - v^2\}} \tag{2.11}$$

$$m_f = \frac{[(2 + 3a)f^2 + 2(r_e^2 - v^2) + f\{a\sqrt{[(r_e - f)^2 + 8v^2]} - r_e(4 + 3a)\}](1 - z)}{2(1 + 2a)\{(r_e - f)^2 - v^2\}} \tag{2.12}$$

Unsurprisingly, if there is no interest rate uncertainty ($v = 0$), the formulae (2.11) and (2.12) reduce to the formulae (2.3).

PROPOSITION: *When interest rate uncertainty increases, agents prefer to hold more money market funds and less M1 deposits.* ($\partial m_1/\partial v < 0$; $\partial m_f/\partial v > 0$)

PROOF: Appendix 1

---

[2] The second order condition of money market funds is satisfied.

$\partial^2 W/\partial m_f^2 = ½ [-2/(m_1+m_f)^2 - af^2/\{1-fm_f-m_1(r-v)-z\}^2 - af^2/\{1-fm_f-m_1(r+v)-z\}^2] < 0$

The expression for $\partial^2 W/\partial m_1^2$ is extremely complicated, but the extreme value must be a maximum of utility because $\partial W/\partial m_1$ is a continuous function with meaningful values of m_1, because the extreme value is unique and because of the following two reasons

1) $\lim_{m_1 \to 0} \partial W/\partial m_1 = \infty$;

2) When m1 approaches its theoretical maximum where nothing but the minimum sum z is spent on consumption with the high interest rate realisation (which implies infinite marginal utility of consumption)

$$\lim_{m_1 \to (1-m_f f - z)/(r+v)} W = -\infty$$

Therefore, the utility maximising value of m1 must lie between the two extremes.

This result has a simple intuition. Because agents are risk averse, ($\partial^2 W/\partial c^2 < 0$), they become unwilling to hold risk bearing assets when the uncertainty related to them increases. Paradoxically, the overall interest rate risk of M1 deposits is higher than the risk of MMFs. The gross return on MMFs is volatile whereas the return on transaction accounts is not, but, on the other hand, agents' willingness to hold different kinds of monetary assets depend on the net costs. Because there is a perfect correlation between the return on MMFs and the cost of holding them, they paradoxically turn out to be a safer investment than transaction deposits.

3 Testing the model

3.1 The data

The following analyses are based on monthly statistics on Finnish contribution to Euro area monetary aggregates. MMFs are measured with the respective component in Finnish MFIs' contribution to the Euro area M3, and transaction accounts are measured by the respective contribution to Euro area M1. All the data are from the period January 2000 – March 2005, containing 63 monthly observations.

There is one clear seasonal pattern in the money market fund data. The stock of funds decreases sharply in December but recovers in January and February. This regularity has an obvious explanation, namely the wealth tax. Individuals' wealth exceeding a certain relatively large sum was subject to a specific tax that was determined by the end of year situation. Not all the assets were taxable. Mutual fund shares were liable to taxation, but bank deposits were not. Hence, many wealthy individuals used to dispose of their mutual fund shares in December and reinvest in them in January or February. The wealth tax was abolished in 2005, but it was applicable during all the December observations of the data. The seasonal regularity can be dealt with in two different ways. Neither of them is fully satisfactory, but because of the extremely limited number of years in the data no good solution is available.

– First, the time series can be filtered with seasonal decomposition. The problem with this approach is the limited number of years in the data. One has to derive 12 scaling factors, one for each month. Each scaling factor is calculated as the average of differences of the variable from its centered moving average. This moving average cannot be calculated for the first six and the last six observations of the sample. Thus, the scaling factor is calculated as an average of very few observations.

– The second possibility is to use a specific dummy variable for December, and possibly two or three of its lagged values. On the positive side, observations for most months of the year are not affected by the unreliable estimate for the monthly factor. On the negative side, this method ignores any other potential seasonal regularity. And as to Decembers, there are only five observations in the data, implying that it is still difficult to separate random variation from seasonal regularities.

The results of preliminary estimations were fairly similar, irrespective of how the seasonal regularity of the explained variable is treated. There seemed to be more diagnostic problems, such as residual autocorrelation, when the raw data with a December dummy and its lagged values were used. Thus, the analyses to be presented in the following are based on MMF data which was deseasonalised with the additive method.[3] The highest deseasonalisation factor was 0.168 for December. All the observations were divided by the consumer price index and transformed by taking the logarithm before deseasonalisation.

Transaction account deposits held by the public are measured by M1 deposits. These data were logarithmic and transformed by dividing them with the consumer price index before taking the logarithm and deseasonalising. There does also seem to be some seasonal variation in M1 deposits. Fortunately, these data are available for a much longer period, and the deseasonalisation was done with monthly data for the period January 1990 – February 2005.

The three main explanatory variables suggested by the above model are included in the analysis.

– The Monthly Indicator of real GDP is used to measure economic activity. Even these data are real and deseasonalised. The deseasonalisation was done with logarithmic data for the period January 1990 – February 2005.
– The data set does also include data on three months Euribor rates. The observation refers to the last bank day of the month.
– The daily volatility of the three months Euribor rate during each month is used as a measure for volatility.

In addition, the difference between the six months and three months Euribor rate (YSLOP) is used as a proxy for interest rate expectations. If the yield curve is steep, the market expects interest rates to rise. Rate changes in the Euro money market seem to have been relatively predictable (Bernoth & von Hagen 2004), implying that market expectations contain relevant information and rational agents react to them. How would agents react to anticipations about rising interest

[3] Scaling factors; Jan +0.023; Feb +0.008; March +0.018; Apr -0.012; May -0.018; June -0.021; July -0.041; Aug -0.031; Sept -0.025; -Oct 0.045; Nov -0.025; Dec +0.168.

rates? There are two different possibilities. If the duration of the MMF portfolio is 0, the situation is straightforward; higher future interest rates mean nothing but higher future revenue, and it is fully rational to invest more in MMFs immediately as a reaction to the anticipated rate change. On the other hand, rising interest rates would also imply one-off capital losses because the duration of the portfolio is at least a few weeks. This latter effect, however, would be of no importance in an efficient market because there should be no anticipated market rate changes that would enable investors to benefit from abnormal capital gains; whenever a rate change becomes evident, it is reflected in the prices of all the securities that will arrive at maturity after the anticipated rate change.

The return on stock investments is used as a control variable in the equation for MMFs. As Dow and Elmendorf (1998) did in their paper on MMFs, changes in stock returns are split into two variables. The first one (HEXUP) is the percent change of the Helsinki Stock Exchange HEX portfolio return index, if the return is positive, zero otherwise. The second one (HEXDWN) is the absolute value of the percent change if the change is negative, zero otherwise.

The impact of interest rate volatility on money demand has been studied in previous research. Slovin and Sushka (1983) suggested that agents may hold less debt securities and more narrowly defined money if the return on securities is uncertain because of interest rate volatility. On the other hand, the results of Choudhry (1999) imply that interest rate volatility decreases rather than increases the demand for money. Roughly the same result was valid irrespective of whether the tests were made with short or long rate variability, even though the impact of short rate volatility on M1 demand was stronger. Hence, in the following, the long rate volatility, measured by the daily bond rate volatility during the month, is used as an additional control variable. The bond rate is the quotation of a domestic government bond with 10 years of remaining maturity.

The appropriate method to be used in testing the model depends on the time series properties of the key variables. In the following table, the unit root test results of the variables to be used in the estimations are presented. As we can see, the only variables that clearly violate the unit root hypothesis are the volatilities. Perhaps surprisingly, even the three months Euribor rate seems to have been a unit root process during the observation period.

Table 1. **Augmented Dickey-Fuller test statistics**

	Lag length (Automatic based on SIC, MAXLAG=11)	t-Statistic	Prob.*
LNRMMFS	1	-0.210	0.931
D(LNRMMFS)	0	-10.641	0.000
LNRM1S	3	0.133	0.973
D(LNRM1S)	1	-3.523	0.011
EURIB3	1	-0.897	0.784
D(EURIB3)	1	-4.744	0.000
RB	0	-1.162	0.687
D(RB)	0	-7.182	0.000
LN(VOLA)	0	-5.615	0.000
LN(BVOLA)	0	-4.350	0.001
YSLOP	0	-2.901	0.051
D(YSLOP)	0	-10.994	0.000
LNYS	2	-0.828	0.805
D(LNYS)	1	-13.204	0.000

Unit root tests of key variables and their differences; LNRMFS = Ln[(Stock of MMFs, end of month)/(consumer price index)], deseasonalised; LNR1S = Ln (M1 deposits, end of month/consumer price index), deseasonalised; EURIB3 = 3 months Euribor rate, last bank day of the month; RB = 10 years govnmnt bond yield, last bank day of the month; LN(VOLA) = Ln (standard deviation of the daily returns on a 3 month money market investment during the month); LN(BVOLA) = Ln(standard deviation during the month of the daily returns on a govnmnt bond with 10 years of remaining maturity); LNYS = Ln(Monthly series of real GDP), deseasonalised; YSLOP = the difference between the 6 and 3 months Euribor rate.
* MacKinnon one-sided p-values

There seemed to be no seasonal regularities in the volatility variables. When their logarithmic values were explained with their lagged values and dummy variables for each month, none of the monthly factors seemed to be close to statistical significance.

3.2 Results

The following two equations have been estimated with OLS. Because most of the variables are unit root processes rather than stationary variables, most of them are used as first differences in the analysis. First, all the above discussed variables were included as explanatory variables, but non-significant variables not central to the above model were dropped off. Moreover, lagged values of differences of the explained variable were also included as explanatory variables. The resulting equations are presented in the Appendix 2. As a second step all the clearly non-significant variables not central to the model described in the second section were dropped off. The resulting equations are presented in the table 2.

Table 2. **OLS results**

Estimation Method: OLS
Sample: 2000M03 2005M02
Included observations: 60

EQUATION FOR LNRM1S-LNRM1S(-1)	**Coefficient**	**t-Statistic**		**Prob.**
C	0.0675		1.2966	0.1977
LNYS(1)-LNYS	0.1687		1.1404	0.2568
LNYS-LNYS(-1)	0.0541		0.3731	0.7099
LN(VOLA)	-0.0089		-1.7958	0.0755
LN(BVOLA)	0.0168		1.8738	0.0638
EURIB3-EURIB3(-1)	-0.0387		-1.9561	0.0532
LNRM1S(-1)-LNRM1S(-2)	-0.5363		-3.8178	0.0002
LNRM1S(-2)-LNRM1S(-3)	-0.3157		-2.2301	0.0280
LNRM1S(-3)-LNRM1S(-4)	0.2103		1.6126	0.1100
R-squared	0.512264	Mean dependent var		0.00221
Adjusted R-squared	0.435757	S.D. dependent var		0.023663
S.E. of regression	0.017775	Sum squared resid		0.016113

EQUATION FOR LNRMMFS-LNRMMFS(-1)	**Coefficient**	**t-Statistic**		**Prob.**
C	0.1477		4.2470	0.0000
LNYS(1)-LNYS	-0.5200		-2.3575	0.0203
LN(VOLA)	0.0491		3.9704	0.0001
YSLOP-YSLOP(-1)	0.1539		1.2484	0.2148
HEXUP	0.4002		2.4823	0.0147
RB-RB(-1)	-0.0458		-1.6792	0.0962
EURIB3-EURIB3(-1)	0.0428		0.7303	0.4669
EURIB3(-1)-EURIB3(-2)	-0.0519		-0.9823	0.3283
LNRMMFS(-1)-LNRMMFS(-2)	-0.3019		-2.7411	0.0072
TREND	0.0010		2.6348	0.0097
R-squared	0.493294	Mean dependent var		0.029965
Adjusted R-squared	0.402086	S.D. dependent var		0.044677
S.E. of regression	0.034546	Sum squared resid		0.059673

The correlation between regression residuals of the two equations is -0.291, which is statistically significant at the 5% level. This negative correlation is probably an indicator of the mutual substitutability of these two monetary assets. Because of this correlation it is reasonable to use the SUR estimation technique instead of OLS. The results are presented in the table 3. Unsurprisingly, the results are fairly similar to the OLS results.

Table 3. **SUR results**

Estimation Method: Seemingly Unrelated Regression
Sample: 2000M03 2005M02
Included observations: 60
Total system (balanced) observations 120
Linear estimation after one-step weighting matrix

EQUATION FOR LNRM1S-LNRM1S(-1)	Coefficient		t-Statistic	Prob.
C	0.0785		1.6863	0.0948
LNYS(1)-LNYS	0.1249		0.9326	0.3533
LNYS-LNYS(-1)	0.0152		0.1176	0.9066
LN(VOLA)	-0.0096		-2.1012	0.0381
LN(BVOLA)	0.0191		2.3901	0.0187
EURIB3-EURIB3(-1)	-0.0380		-2.0929	0.0389
LNRM1S(-1)-LNRM1S(-2)	-0.5802		-4.6545	0.0000
LNRM1S(-2)-LNRM1S(-3)	-0.3304		-2.6358	0.0097
LNRM1S(-3)-LNRM1S(-4)	0.2112		1.8172	0.0722
R-squared	0.51002	Mean dependent var		0.00221
Adjusted R-squared	0.433161	S.D. dependent var		0.023663
S.E. of regression	0.017816	Sum squared resid		0.016187

EQUATION FOR LNRMMFS-LNRMMFS(-1)	Coefficient		t-Statistic	Prob.
C	0.1494		4.7531	0.0000
LNYS(1)-LNYS	-0.5022		-2.5114	0.0136
LN(VOLA)	0.0520		4.7008	0.0000
YSLOP-YSLOP(-1)	0.1218		1.1180	0.2662
HEXUP	0.4342		3.0803	0.0027
RB-RB(-1)	-0.0382		-1.5922	0.1145
EURIB3-EURIB3(-1)	0.0597		1.1428	0.2558
EURIB3(-1)-EURIB3(-2)	-0.0690		-1.4865	0.1403
LNRMMFS(-1)-LNRMMFS(-2)	-0.2873		-2.9670	0.0038
TREND	0.0011		3.5158	0.0007
R-squared	0.488052	Mean dependent var		0.029965
Adjusted R-squared	0.395901	S.D. dependent var		0.044677
S.E. of regression	0.034725	Sum squared resid		0.06029
Determinant residual covariance			2.40E-07	

As can be seen in the appendix 3, there is no sign of obvious diagnostic problems in the estimations, such as residual autocorrelation, heteroscedasticity or non-normality.

Most empirical predictions of the model are consistent with estimation results.

1) Short rate volatility increases the demand for MMFs but decreases the demand for M1 deposits. The effect is surprisingly strong in the case of MMFs.
2) The demand for MMFs depends negatively on economic activity of the near future. Past volume of economic activity is less relevant than future activity, which is consistent with the idea that liquidity is invested in MMFs when it is not intended to be used for transaction purposes in the near future.
3) High money market rates decrease the demand for M1 deposits and anticipations of high future interest rates strengthen the demand for MMFs, which is consistent with the model.

When agents decide about their investments in MMFs, their decisions seem to be forward looking. They react to planned or expected volumes of activity and to interest rate expectations rather than past developments. In the case of M1 deposits, instead, the past seems to be at least as relevant as the future. This may reflect differences in the composition of agents who invest in these assets. The relative share of unsophisticated agents, such as poorly informed households, is probably larger among depositors than among MMF investors.

Perhaps surprisingly, the only empirical prediction of the model that finds no support in these results is the positive relationship between M1 deposits and the economic activity. However, there is previous empirical evidence in favour of the positive relationship between these two variables (see Ripatti 1998 for analysis with Finnish data), and it is possible that the lack of evidence is simply due to the limited number of observations and the strong focus on very short-term developments.

One surprising finding related to money demand is the very strong negative impact of past changes in the stock of M1 deposits; it seems that almost 70% of any short-term change in the stock of M1 deposits is eliminated within three months. There is a similar yet much weaker negative autocorrelation in the changes of the MMF stock.

The very strong statistical evidence of the trend variable in the MMF equation indicates that, if anything, the growth rate of MMFs has been accelerating during the observation period, and there is no evidence that the stock of MMFs would already be stabilising at an equilibrium level.

Because most key variables of the model are unit root processes, it might be interesting to analyse the existence of co-integrating relationships between them. However, in the light of preliminary experiments, it does not seem to be possible to find such relationships, at least not if the trend variable is omitted. If the trend variable is included, the Johansen procedure finds a relationship between the 3 months Euribor rate and the stock of MMFs, but there is little or no evidence on the relationship between MMFs and other interesting variables, such as the GDP series and the stock of M1 deposits. This may not be surprising because the extreme growth rate of MMFs probably indicates that this variable is still converging towards an equilibrium level to be found in the future.

4 Conclusions

This paper presents a simple model to analyse the demand for M1 deposits and MMFs. MMFs are a close substitute for M1 deposits because they are highly liquid and bear a very low risk. However, MMFs cannot be used for immediate transaction needs as a payment medium. Instead, the return on MMFs is somewhat higher. Agents prefer to hold more MMFs instead of transaction deposits if the intended volume of transactions is low and if the cost of holding monetary assets, ie the money market rate, is high and volatile. Perhaps surprisingly, MMFs with variable rate of return bear a lower overall risk than fixed rate deposits. This paradoxical result is valid if the cost of holding monetary assets equals the money market rate, which is also the rate of return on the investments of the typical MMF.

Most of the empirical predictions of the model find support in both OLS and SUR analysis with first differences of the key variables. Interestingly, anticipations about future money market rates seem to affect the demand for MMFs, but there is little evidence that past changes would have much effect. This finding is consistent with the statement that changes in the short market rate have been predictable and agents have often reacted to changes in interest rates before they have taken place. Short rate volatility and slowing economic activity intensify the demand for MMFs. The results of Dow and Elmendorf (1998) were partly corroborated; strongly positive stock returns strengthen the demand for MMFs. On the other hand, there seems to be no evidence of the impact of negative returns.

Perhaps surprisingly, previous results on the impact of economic activity on the demand for M1 deposits are not corroborated by the analysis. At least as to reactions to interest rates, agents seem to be more forward looking in their choice of holding MMFs. The empirical results are strong, but they are based on a relatively short sample from one country. Therefore, it would be interesting to test whether the results can be reproduced with data from other parts of the world.

References

Bernoth, K – von Hagen, J (2004) **The Euribor Futures Market: Efficiency and the Impact of ECB Policy Announcements.** International Finance 7, 1–24.

Choudhry, T (1999) **Does Interest Rate Volatility Affect the US M1 Demand Function? Evidence from Cointegration.** The Manchester School 67, 621–648.

Domian, D L (1992) **Money Market Mutual Fund Maturity and Interest Rates.** Journal of Money, Credit, and Banking Vol. 24, 519–527.

Domian, D L – Reichenstein, W (1997) **Perforance and persistence in money market fund returns.** Financial Services Review, Vol. 6, 169–183.

Dow, J P – Elmendorf, D W (1998) **The Effect of Stock Prices on the Demand for Money Market Mutual Funds.** Finance and Economics Discussion Series from Board of Governors of the Federal Reserve System (U.S.), No 1998-24.

Farinella, J A – Koch, T W (1999) **The Demand for Taxable and Tax-Exempt Money Market Mutual Funds.** Journal of Macroeconomics 21, 335–353.

Goetzmann, W N – Massa, M – Rouwenhorst, K G (xxxx) **Behavioral Factors in Mutual Fund Flows.** Yale ICF Working Paper No 00-14.

Lam, C H – Rajat, D – Fomby, T (1989) **Deregulation and the Demand for Money Market Mutual Funds.** Journal of Macroeconomics 11, 297–308.

Maggs, G E (1991) **Depository Disinterediation and the Equilibrium Quantity of Money Market Mutual Funds.** Journal of Economics and Business 43, 253–263.

Ripatti, A (1998) **Demand for Money in Inflation-Targeting Monetary Policy.** Bank of Finland studies E:13.

Appendix 1

Proof of the proposition

When m_f is determined according to (2.12)

$$\frac{\partial m_f}{\partial v} = \frac{av\{5(r_e - f)^2 + 4v^2 - 3(r_e - f)\sqrt{[(r_e - f)^2 + 8v^2]}\}(1 - z)}{(1 + 2a)[(r_e - f)^2 - v^2]^2} \quad \text{(A1.1)}$$

(A1.1) is positive iff

$$\begin{aligned} &\{5(r_e - f)^2 + 4v^2 - 3(r_e - f)\sqrt{[(r_e - f)^2 + 8v^2]}\} > 0 \\ &\Leftrightarrow 25(r_e - f)^4 + 40v^2(r_e - f)^2 + 16v^4 > 9(r_e - f)^4 + 72(r_e - f)^2 v^2 \\ &\Leftrightarrow 16(r_e - f)^4 + 16v^4 - 32(r_e - f)^2 v^2 > 0 \end{aligned} \quad \text{(A1.2)}$$

If $v = (r_e - f)$, the left hand side of (A1.2) equals 0.

When the expression on the left side of the inequality sign of (A1.2) is differentiated with respect to v, one gets $64v^3 - 64(r_e\text{-}f)^2v$. Iff $v < (r_e\text{-}f)$, as assumed, this derivative is negative, implying that the left hand side of (A1.2) is positive and $\partial m_f/\partial v > 0$ whenever $v < (r_e\text{-}f)$.[4]

When m_l is determined according to (2.12), the impact of v on m_l is

$$\frac{\partial m_l}{\partial v} = -\frac{av[-3(r_e - f) + \frac{4[(r_e - f)^2 - v^2]}{\sqrt{[(r_e - f)^2 + 8v^2]}} + \sqrt{[(r_e - f)^2 + 8v^2]}](1 - z)}{(1 + 2a)[(r_e - f)^2 - v^2]^2} \quad \text{(A1.3)}$$

If $v = (r_e\text{-}f)$, the expression (A1.3) equals 0.

The expression (A1.3) is negative iff

$$-3(r_e - f) + \frac{4[(r_e - f)^2 - v^2]}{\sqrt{[(r_e - f)^2 + 8v^2]}} + \sqrt{[(r_e - f)^2 + 8v^2]} > 0 \quad \text{(A1.4)}$$

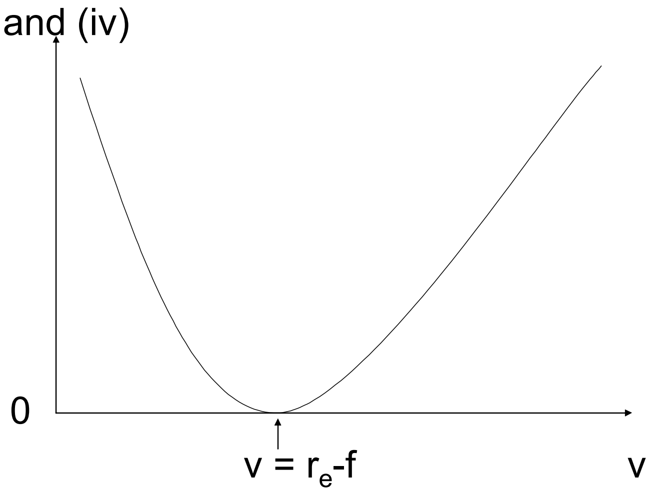
If $v = (r_e\text{-}f)$, the left hand side of (A1.4) equals 0.

[4] In fact, the inequality (A1.2) would hold even when $v > r_e\text{-}f$ because beyond the point where $v = r_e\text{-}f$ the left hand side of (A1.2) is an increasing function of v. When $v = r_e\text{-}f$, the left had side of (A1.2) reaches its extreme (minimum) value because the derivative with respect to v equals zero.

When the left hand side of (A1.4) is differentiated with respect to v, one gets

$$-\frac{32v[(r_e - f)^2 - v^2]}{[(r_e - f)^2 + 8v^2]^{(3/2)}} \tag{A1.5}$$

This is negative because by assumption $v < r_e\text{-}f$, implying that (A1.4) is a declining function of the parameter v and the inequality (A1.4) is satisfied always when $v < r_e\text{-}f$. If follows that (A1.3) is negative.[5]



[5] In fact, the inequality (A1.4) would hold even when $v > r_e\text{-}f$ because beyond the point where $v = r_e\text{-}f$ the left hand side of (A1.4) is an increasing function of v. When $v = r_e\text{-}f$, the left had side of (A1.4) reaches its minimum value because the derivative with respect to v equals zero.

Appendix 2

All the explanatory variables included

Estimation Method: Least Squares
Sample: 2000M03 2005M02
Included observations: 60
Total system (unbalanced) observations 120
Explained variable: LNRM1S-LNRM1S(-1)

	Coefficient	t-Statistic	Prob.
C	0.0198	0.3203	0.7494
LNYS(1)-LNYS	0.1711	1.1338	0.2598
LNYS-LNYS(-1)	0.1265	0.8288	0.4094
LOG(VOLA)	-0.0053	-0.8210	0.4138
LOG(BVOLA)	0.0087	0.8270	0.4104
EURIB3-EURIB3(-1)	-0.0454	-1.8530	0.0671
LNRM1S(-1)-LNRM1S(-2)	-0.5814	-3.7537	0.0003
LNRM1S(-2)-LNRM1S(-3)	-0.3405	-2.2775	0.0251
LNRM1S(-3)-LNRM1S(-4)	0.1439	1.0303	0.3055
LNRMMFS(-1)-LNRMMFS(-2)	0.0466	0.7431	0.4593
HEXUP	0.0418	0.4460	0.6566
HEXDWN	-0.0342	-0.4299	0.6683
RB-RB(-1)	0.0223	1.5216	0.1315
TREND	0.0003	1.5412	0.1267
R-squared	0.567339	Mean dependent var	0.00221
Adjusted R-squared	0.445066	S.D. dependent var	0.023663
S.E. of regression	0.017628	Sum squared resid	0.014294

Explained variable: LNRMMF1S-LNRMMFS(-1)

	Coefficient	t-Statistic	Prob.
C	0.291541	2.499857	0.0142
(LNYS(1)-LNYS)	-0.776719	-2.806767	0.0061
(LNYS-LNYS(-1))	-0.264143	-0.978362	0.3305
LOG(VOLA)	0.04992	3.976311	0.0001
LOG(BVOLA)	0.025899	1.313046	0.1924
(YSLOP-YSLOP(-1))	0.127509	2.007006	0.0477
HEXUP	0.538145	3.011615	0.0034
HEXDWN	0.0386	0.240808	0.8102
RB-RB(-1)	-0.081241	-2.501961	0.0141
EURIB3-EURIB3(-1)	0.095862	1.544957	0.1258
EURIB3(-1)-EURIB3(-2)	-0.072557	-1.313968	0.1921
LNRMMFS(-1)-LNRMMFS(-2)	-0.415018	-3.510427	0.0007
TREND	0.001092	3.029493	0.0032
LNRM1S(-1)-LNRM1S(-2)	-0.309393	-1.261561	0.2103
R-squared	0.558811	Mean dependent var	0.029965
Adjusted R-squared	0.434127	S.D. dependent var	0.044677
S.E. of regression	0.033608	Sum squared resid	0.051957

Appendix 3

Residual tests

OLS estimation, basic diagnostic statistics		M1 residuals	Money Market Fund residuals
Heteroscedasticity	ARCH Test; Squared residual regressed on four lagged squared residuals; R2*Nr of observations	5.908	6.189
	Prob, based on chi squared	0.206	0.185
Autocorrelation	Breusch-Godfrey Serial Correlation LM Test: Residual regressed on four lagged residuals and explanatory variables of original regression; R2*Nr of observations	5.880	3.831
	Prob, based on chi squared	0.208	0.429
Residual normality	Jarque-Bera	1.132	0.496
	Prob	0.568	0.781

SUR estimation, basic diagnostic statistics		M1 residuals	Money Market Fund residuals
Heteroscedasticity	ARCH Test; Squared residual regressed on four lagged squared residuals; R2*Nr of observations	3.294	6.367
	Prob, based on chi squared	0.510	0.173
Autocorrelation	Breusch-Godfrey Serial Correlation LM Test: Residual regressed on four lagged residuals and explanatory variables of original regression; R2*Nr of observations	4.313	8.535
	Prob, based on chi squared	0.365	0.074
Residual normality	Jarque-Bera	1.016	0.053
	Prob	0.602	0.974

BANK OF FINLAND RESEARCH
DISCUSSION PAPERS

ISSN 0785-3572, print; ISSN 1456-6184, online

1/2005 Patrick M. Crowley **An intuitive guide to wavelets for economists.** 2005. 68 p. ISBN 952-462-188-6, print; ISBN 952-462-189-4, online.

2/2005 Tuomas Saarenheimo **Ageing, interest rates, and financial flows.** 2005. 30 p. ISBN 952-462-190-8, print; ISBN 952-462-191-6, online.

3/2005 Timo Vesala **Relationship lending and competition: Higher switching cost does not necessarily imply greater relationship benefits.** 2005. 27 p. ISBN 952-462-192-4, print; ISBN 952-462-193-2, online.

4/2005 Johanna Sinkkonen **Labour productivity growth and industry structure. The impact of industry structure on productivity growth, export prices and labour compensation.** 2005. 88 p. ISBN 952-462-196-7, print; ISBN 952-462-197-5, online.

5/2005 Matti Virén **Why do capital intensive companies pay higher wages?** 2005. 23 p. ISBN 952-462-198-3, print; ISBN 952-462-199-1, online.

6/2005 Maritta Paloviita – Matti Virén **The role of expectations in the inflation process in the euro area.** 2005. 33 p. ISBN 952-462-200-9, print; ISBN 952-462-201-7, online.

7/2005 Marketta Henriksson **Productivity differentials and external balance in ERM II.** 2005. 32 p. ISBN 952-462-202-5, print; ISBN 952-462-203-3, online.

8/2005 Matti Virén **Government size and output volatility: is there a relationship?** 2005. 24 p. ISBN 952-462-204-1, print; ISBN 952-462-205-X, online.

9/2005 Karlo Kauko **Bank interest rates in a small European economy: Some exploratory macro level analyses using Finnish data.** 2005. 44 p. ISBN 952-462-206-8, print; ISBN 952-462-207-6, online.

10/2005 Essi Eerola – Niku Määttänen **The optimal tax treatment of housing capital in the neoclassical growth model.** 2005. 30 p. ISBN 952-462-210-6, print; ISBN 952-462-211-4, online.

11/2005 Karlo Kauko **The mixed oligopoly of cross-border payment systems.** 2005. 31 p. ISBN 952-462-212-2, print; ISBN 952-462-213-0, online.

12/2005 Patrick M. Crowley – Jim Lee **Decomposing the co-movement of the business cycle: a time-frequency analysis of growth cycles in the euro area.** 2005. 67 p. ISBN 952-462-214-9, print; ISBN 952-462-215-7, online.

13/2005 Jarmo Pesola **Banking fragility and distress: An econometric study of macroeconomic determinants.** 2005. 95 p. ISBN 952-462-216-5, print; ISBN 952-462-217-3, online.

14/2005 Karlo Kauko **The demand for money market mutual funds.** 2005. 29 s. ISBN 952-462-218-1, print; ISBN 952-462-219-X, online.

Suomen Pankki
Bank of Finland
P.O.Box 160
FI-00101 HELSINKI
Finland

. 2343