EUROPEAN CENTRAL BANK
EUROSYSTEM

WORKING PAPER SERIES
NO 741 / MARCH 2007

SECTORAL MONEY DEMAND MODELS FOR THE EURO AREA BASED ON A COMMON SET OF DETERMINANTS

by Julian von Landesberger

EUROPEAN CENTRAL BANK

EUROSYSTEM

WORKING PAPER SERIES

NO 741 / MARCH 2007

SECTORAL MONEY DEMAND MODELS FOR THE EURO AREA BASED ON A COMMON SET OF DETERMINANTS [1]

by Julian von Landesberger [2]

In 2007 all ECB publications feature a motif taken from the €20 banknote.

This paper can be downloaded without charge from http://www.ecb.int or from the Social Science Research Network electronic library at http://ssrn.com/abstract_id=971019.

1 I am very grateful to B. Friedman, H. Pill, A. Warne, T. Westermann, B. Fischer, D. Gerdesmeier, B. Roffia, T. Tekušová and an anonymous referee for helpful comments. The views expressed in this paper are those of the author and do not necessarily reflect those of the European Central Bank.

2 European Central Bank, Directorate General Economics, 60311 Frankfurt am Main, Germany; Tel.: 069-13447027, e-mail: julian.von_landesberger@ecb.int

Address
Kaiserstrasse 29
60311 Frankfurt am Main, Germany

Postal address
Postfach 16 03 19
60066 Frankfurt am Main, Germany

Telephone
+49 69 1344 0

Internet
http://www.ecb.int

Fax
+49 69 1344 6000

Telex
411 144 ecb d

ISSN 1561-0810 (print)
ISSN 1725-2806 (online)

CONTENTS

Abstract

Empirical money demand analysis undertaken at the aggregate level may obscure behavioural differences between the financial, non-financial corporation and household sectors. Looking at the individual and more homogenous sectors may allow more clearly interpretable empirical relationships between money holding, scale variables and opportunity costs to be estimated. Two possible approaches can be taken to address this issue: aggregate and sectoral money holdings are explained either by a common set of determinant variables or by specific determinants, which may differ across sectors. In this analysis, the first approach has been chosen in order to highlight the different elasticities of the long-run money demand with respect to a common set of macroeconomic determinants and thereby to allow comparison of the model for the aggregate M3 with corresponding models for households, non-financial corporations and non-monetary financial intermediaries. This paper presents results for cointegrated VAR systems estimated over a sample of quarterly data from 1991 to 2005. A SUR system is estimated to cross-check the robustness of the findings and to analyse the importance of common shocks across sectors.

Keywords: sectoral money holdings, money demand, cointegrated VAR systems

JEL Classification Numbers: E41, C32, E59.

Non-technical summary

Understanding the factors underlying the euro area private sector's demand for money is a central element of monetary analysis. It constitutes an important part of the framework used to extract signals about the risks to price stability over the medium to longer term that stem from monetary developments. Empirical money demand analysis undertaken on aggregate data obscures possible behavioural differences between the financial, non-financial corporation and household sectors. The individual sectors may be subject to different constraints in their money holding behaviour or have different sets of alternative, non-monetary investment opportunities and thus different opportunity costs of investing in money. Looking at individual sectors may therefore allow richer explanations of the forces driving monetary developments to be formulated.

Two possible approaches can be taken to model sectoral money demand: aggregate and sectoral money holdings are explained either by a common set of determinant variables or by specific determinants, which may differ across sectors. Using a new data set of sectoral M3 aggregates for the euro area, the first approach is followed in order to compare the different elasticities of money demand with respect to a common set of macroeconomic determinants for the aggregate and sectoral M3 models. It is evident that such an identical modelling framework for all three sectoral monetary aggregates and aggregate M3 will fall short of taking into account important sectoral specificities, for instance with respect to the set of alternative investment opportunities or the appropriate sectoral scale variable. Against this background, the models constructed for each sector are not to be interpreted as a comprehensive explanation of the money demand behaviour. A refined sectoral modelling is therefore considered part of a separate future empirical investigation.

The results presented in this paper for the sample 1991 to 2005 suggest that the household, non-financial corporations and non-monetary intermediaries sectors displayed different money demand behaviour with respect to a common set of determinants, comprising real GDP, the long-term government bond yield and the dividend yield of the euro area equity market. The level of long-run income elasticity seems to differentiate households from both financial and non-financial firms. At the same time, the higher long-run elasticity of money holdings with respect to government bond yields distinguishes non-monetary financial intermediaries from the other two sectors. Lastly, the dividend yield seems to affect households money demand behaviour, while more surprisingly, it does not seem to influence non-monetary financial intermediaries M3 holdings.

1. Introduction

Monetary analysis constitutes an important part of the ECB's monetary policy strategy. Understanding the factors underlying the euro area private sector's demand for money is a central element of monetary analysis. It constitutes an important part of the framework used to extract signals about the risks to price stability over the medium to longer term that stem from monetary developments.

The main motives for holding money are its use as a medium of exchange and as a store of value. The relative importance of these motives may vary across sectors, leading to different developments in the sectoral components of money over the course of the business cycle. In general, differences in money demand behaviour across sectors could be the result of two factors.

First, the constraints surrounding the money-holding decision process can vary widely across sectors. For example, while households typically have few restrictions apart from budget constraints to take into account in their money-holding decisions, non-monetary financial intermediaries, such as investment funds, are subject to a binding regulatory framework and corporate governance rules. This could lead to different elasticities of money demand with respect to the same determinants. Similarly, the need to execute transactions will vary between economic sectors, leading to differing income elasticities of money demand.

Second, the sectors may have different sets of alternative, non-monetary investment opportunities and thus different opportunity costs of holding money, in particular when tax considerations are accounted for. Furthermore, although all the sectors hold money for transactions purposes, the level of transactions depends on different economic scale variables (e.g. for households: consumption spending; for corporations: working capital and/or production).

Looking at individual sectors may therefore allow richer explanations of the forces driving monetary developments to be formulated, leading to a better understanding of monetary developments in the business cycle.

For the euro area, the analysis of monetary developments is predominantly conducted with respect to the broad monetary aggregate M3, which comprises very different monetary instruments: currency in circulation, deposits with monetary financial institutions (MFI) and marketable securities. The spectrum of motives for holding M3 reflects the wide variety of instruments included in the aggregate.

On the basis of a new data set of sectoral M3 aggregates for the euro area, the paper presents results of estimated cointegrated VAR systems, attempting to model the money demand of households, non-financial corporations and non-monetary financial intermediaries[3], as well as aggregate M3 using the same set of regressors, in order to highlight the different elasticity of money demand behaviour to a

[3] Although the "other non-monetary financial intermediaries" sector and "insurance corporations and pension funds" sector comprise a large variety of entities with different business models, for the purpose of this note they are analysed together as "non-monetary financial intermediaries", as the entities are predominantly involved in asset management for households.

common macroeconomic environment. Similar analysis have been undertaken by Jain/Moon (1994) and Butkiewicz/McConnell (1995) for the US, finding significantly different parameter estimates for income and interest rate elasticity across individual sectors.

The paper is structured in four parts. In the first step, the paper provides a brief overview of the literature on comparative analyses of money holding behaviour across sectors and euro area aggregate money demand studies. In the second step, the data and the modelling approach used to estimate the money demand systems are discussed. Cointegrated VARs are estimated for each sector and aggregate M3 and the parameters compared. In a third step, the results are corroborated by the estimation of a SUR system. The last section summarises the findings and provides some implications for monetary analysis.

2. Related studies

Comparative studies of sectoral money demand have been conducted for the United States and for the United Kingdom, but not for the euro area. Goldfeld (1973) estimates money demand models for the US household, financial, (non-financial) business and state and local government sectors. Money demand is explained by different measures of transactions and an opportunity cost for each sector, a partial adjustment term and further sector specific variables. Goldfeld finds that money holdings by households and financial intermediaries are quite well explained, while for the government sector and non-financial business sector the results for the money demand models are not satisfactory. In particular, the findings suggest that '"income" elasticities are dramatically different across sectors'.[4]

Empirical evidence on sectoral money holding for the United Kingdom is provided by Thomas (1997a,b) and by Brigden/Mizen (1999), Chrystal and Mizen (2000) and Chrystal and Mizen (2001). The dual contribution of Thomas (1997) focuses on the personal and corporate holdings of M4, which are explained in the context of fairly similar cointegrated VAR models, while the later contributions have strongly varying specifications across sectors. The purpose of the UK analysis is to provide insights into the role of sectoral money holdings in the transmission of monetary policy, rather than strictly to explain differences in sectoral money demand behaviour. Thomas (1997a, b) therefore follows a common general structure, but the choice of variables included in the models takes account of sectoral aspects in the demand for money. More specifically, personal sector M4 holdings are explained by real consumption, real disposable income, real personal sector wealth, the three-month Treasury bill rate, an own rate of interest rate on personal sector M4 deposits, inflation and the change in unemployment. Industrial and commercial corporations' real M4 holdings are explained by real gross fixed capital formation, real GDP, a weighted own-rate on corporate sector deposits, the three-month Treasury bill rate, an equity based measure of the real cost of capital, gross financial wealth, inflation and capacity utilisation. Money demand functions are identified for both sectors, with parameter estimates that are in-line with theoretical priors. Personal sector money holdings are

[4] See Goldfeld, S. (1973): p. 628.

positively related to the scale variables income and wealth, whose parameter estimates are 0.5 each. For non-financial corporations, the parameters on the scale variables investment and wealth can be restricted to the same value. Furthermore the parameter estimate for the opportunity cost term is more negative for corporate than for the personal sector. However, given the tailor-made nature of the specification, a comparison of the sectors should be cautiously interpreted.

Jain/Moon (1994) using the Johansen approach find substantial sectoral differences in long-run money demand relationships for US sectoral money aggregates constructed on the basis of flow-of-funds data. In particular, over the sample 1960-1990, household relationships are found to be more stable than for business sector, while the demand elasticities with respect to opportunity costs is stronger for the corporate sector than for the household sector. The interest rate parameters in the long-run relationships for M1 and M2 were not significantly different from zero for the household sector, but were negative for businesses. At the same time the real scale elasticity of household money in the long-run relationship was in general lower than comparable values for the business sector.

Butkiewicz/McConnell (1995) apply Engle/Granger cointegration techniques to estimate money demand equations for the US household and business sector using M1 aggregates constructed from flow of funds data. The sample ranges from 1952 Q3 to 1990 Q1. The evidence presented indicates that while household and business real M1 holdings are related in the long run with measures of income and interest rates, such a relationship was not found for the financial and government sectors. For the household and business sector models, the scale variable and the specification of the opportunity costs differ. The authors conclude that the results indicate that tests for cointegration of aggregate M1 may suffer from an aggregation bias.[5]

Aggregate demand functions may therefore suffer from biases reflecting the fact that the aggregate parameter values are simply the weighted average of the sectoral values. Two different biases can afflict aggregate estimates: the aggregation bias, when the sectoral relationships depend on sector specific determinants (missing micro homogeneity) and the composition bias, when the sectoral composition of the aggregate changes (missing compositional stability). In the first case, the sector specific forces are only incompletely captured at the aggregate level by the macro determinants. The aggregate demand parameters may thus change, reflecting the different sectoral behaviour, although at the micro-level the behavioural relations have remained unchanged. In the second case, the composition of sectors in the economy changes through time, inducing the aggregate parameters to vary, even if the sectoral behaviour remains unchanged, but is structurally different across sectors.

A number of studies have focussed on aggregate M3 for the euro area attempting to estimate the parameters of the long-run money demand using a cointegrated VAR approach see, e.g., Brand/Cassola (2000), Calza/Gerdesmeier/Levy (2001), Coenen/Vega (2001), Kontolemis (2002),

5 See Butkiewicz/McConnell (1995), p. 241. Aggregation bias refers to the fact that under certain conditions the estimated aggregate parameter differs from the population parameter being estimated, i.e. the aggregate estimate is not equal to the aggregate of the individual parameter values.

Bruggemann/Donati/Warne (2003), Avouyi-Dovi et al. (2003), Carstensen (2006). In a recent study, Warne (2006) applies a Bayesian approach to the estimation of the model presented in Bruggemann/Donati/Warne (2003). Both studies using classical maximum likelihood techniques and such employing a Bayesian approach estimate the income elasticity of long-run money demand to exceed unity and to be closer to 1.5 than to 1. The specification of the opportunity costs and own rate terms varies across studies, however "the interest rate semi-elasticities are often imprecisely estimated in the sense that the error bands are very wide"[6].

In line with previous exercises for the euro area, long-run money demand is studied using a cointegrated VAR framework. In terms of modelling approach, this analysis is in the spirit of the investigation presented by Jain/Moon (1994).

3. The empirical approach

The aim of this analysis is to model monetary aggregates consistently across sectors using identical explanatory variables in order to be able to compare the parameters of the long-run money demand relationship. It is evident that such an identical modelling framework for all three sectoral monetary aggregates and aggregate M3 will fall short of taking into account important sectoral specificities, for instance with respect to the set of alternative investment opportunities or the appropriate sectoral scale variable. Against this background, the models constructed for each sector should not be interpreted as a comprehensive explanation of the money demand behaviour. Indeed, the level of the estimated parameters may be affected by an "omitted variables bias" resulting from the fact that a relevant variable is not included among the explanatory variables.

By construction, a general model including all potentially relevant variables and lags thereof will be free of the omitted variable bias. In order to obtain consistent long-run income and opportunity cost elasticities across sectors, the set of variables has been restricted, while in order to preserve the valid statistical representation of the data, the lag length and number of cointegration relationships is determined separately for each sector. This property is necessary in order to be able to compare the results of the model.

It is however conceivable that in the models the parameter estimates could still suffer from a bias, which in the context of a more refined sectoral specification could be reduced. However, this alternative modelling strategy oriented to finding a refined sectoral specification would cloud a comparative analysis across sectors and not provide any insights into the potential effects of an aggregation bias. It is therefore considered as part of a separate future empirical investigation.

[6] Warne, A. (2006): p. 24.

3.1 The data

The analysis covers the sample period 1991 Q1 – 2005 Q4. Throughout the analysis, the level of monetary variables consistently refers to seasonally adjusted "notional stocks".[7] The M3 series for households, non-financial corporations and non-monetary financial intermediaries were constructed according to approach outlined in the August 2006 Monthly Bulletin box entitled "Construction of Estimates of Sectoral M3 Aggregates" [8] and seasonally adjusted with Tramo-Seats. This data set has only become available in mid-2006.

The analysis focuses on estimates of sectoral M3 aggregates, as the analysis of sectoral short-term deposit holdings reported by MFIs, although providing valuable information on many aspects of the money demand behaviour, may be severely affected by substitution processes between the deposit holdings on the one hand and currency in circulation or marketable securities on the other hand. For example, in the run-up to the euro cash changeover, the pick-up in household short-term deposit growth would overstate the sector's overall money demand, as the increase reflects, to large extent, a shift between currency in circulation and overnight deposits held by the sector and vice versa after the cash change-over.

In order to obtain real money holdings, the respective M3 aggregates were deflated by the GDP deflator. The behaviour of the real money holdings is explained by a scale variable, real GDP, and two further variables, the long-term yield on euro area government bonds and the dividend yield of the euro area equity market. The own rate of return on the sectoral holdings of M3 is not zero. It is however not included in the data set as the own rate of sectoral M3 holdings would differ according to the composition of monetary instruments held by each sector. Chart 1 illustrates the heterogeneity of holdings across sectors by showing the breakdown of deposits included in M3 in 1991 and in 2005, for all three sectors analysed. The data indicates that non-financial corporations hold more overnight deposits than the other two sectors, while the households are only sector to hold significant amounts of savings deposits. Non-monetary financial intermediaries are the only sector with sizeable holdings of repurchase agreements. The level and dynamics of the own rate would therefore be different for each sector, thereby contradicting the consistent modelling approach. At the same time, the inclusion of a short-term interest rate could either capture opportunity costs considerations or approximate the own rate, therefore not being clearly identified.

---

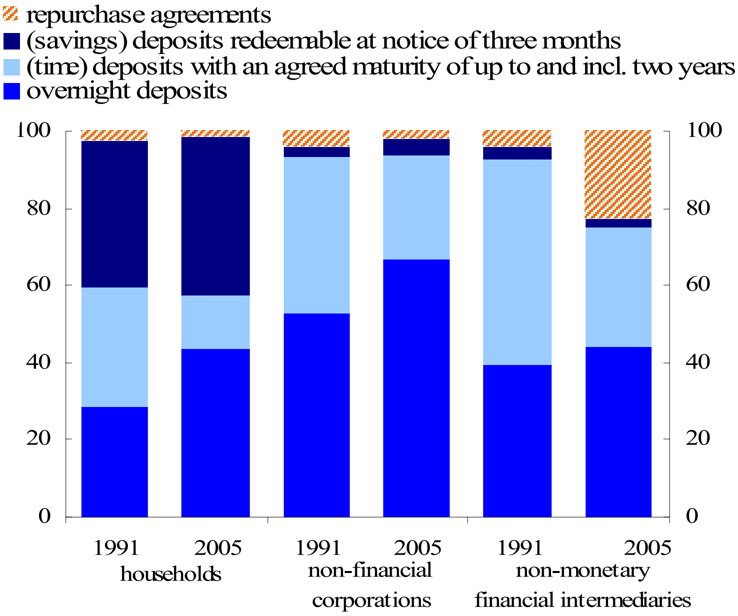
[7] The levels of monetary data (L_t) are affected by reclassifications (for example the enlargement of the euro area in January 2001 with Greece, the reunification of Germany in 1990, etc), exchange rate revaluations and other revaluations that do not reflect transactions by economic agents. Those "non-transaction-related factors" are reported by MFIs or are calculated at National Central Banks and the ECB and are used to derive monthly changes in levels (F_t) that are corrected for reclassifications and revaluations. Those changes are used to derive a chain index (I_t), called notional stocks.

$$I_t = I_{t-1}\left(1 + F_t / L_{t-1}\right)$$

Such a method also underlies the calculation of growth rates for monetary variables in the Bank of England.

[8] An M3 aggregate for the holdings of the general government excluding central government sector are not analysed given the small share of the sector in aggregate M3 (approximately 2%). Currency in circulation outside the euro area is also not included in the analysis. The implications drawn from the empirical results therefore refer in a first step to the behaviour of euro area private sector holdings in M3.

Chart 1: Breakdown of deposit holdings by component
(in percentage of the sector's M3 deposits)



Source: ECB (2006).

In order to establish the order of integration of the series used, ADF tests on the levels and the first differences of the series were carried out. The lag length in the ADF test was selected using the Akaike Information Criterion (AIC). The tests indicated the null hypothesis of a unit root in the level series could not be rejected (see Table 1 in the annex).

3.2 The modelling approach for cointegrated VARs

In a first step, VAR systems in levels comprising six lags of the log of the real money stock ($m3^j$), with j being non-financial corporations (nfc), households (hh), non-monetary financial intermediaries (fi) or aggregate money stock (agg); the log of real GDP (y), the log of the yield on long-term government bonds (rl) and the dividend yield (DIV), denoted by the vector x_t in (1).

$$x_t = \sum_{i=1}^{6} \Pi_i x_{t-i} + \Phi D_t + \varepsilon_t \tag{1}$$

The errors ε_t are assumed to be distributed NI~(0,Ω). Π_i are (4x4) matrices containing parameters of the model. D_t is a vector of constant, trend or other deterministic or exogenous variables.

Various tests were then conducted to determine the optimal lag length for the construction of the sectoral models. In general, the Likelihood Ratio test (LR) and the AIC propose the choice of slightly longer lag specification than the Schwarz (SC) and Hannan-Quinn (HQ) Criteria (see table 2 in the annex).

Depending on the test result considered, the appropriate lag length for all M3 systems ranged between one and three lags. The choice of lag-length one in level, as generally proposed by the Schwarz Criterion, was rejected on the ground that such a parsimonious choice in levels would be overly restrictive for the modelling of the (short-run) adjustment. For the modelling of the M3 holdings of non-financial corporations a lag length of three was chosen, while for the households and non-monetary financial intermediaries sector a lag length of 2 was selected. These choices were suggested by two of the four statistics computed. The choice for the lag-length specification for aggregate M3 was between two and three lags. LM tests for autocorrelation in the residuals of the models with either lag length revealed no remaining dynamics, therefore the more parsimonious specification was chosen. All money demand systems were therefore modelled with either two or three lags.

In a second step, we reformulate the estimated VAR system in ECM form and test for the rank of the matrix Π_1 using the trace test (see Johansen (1996)):

$$\Delta x_t = \Pi_1 x_{t-1} + \sum_{i=1}^{1,2} \Gamma_i \Delta x_{t-i} + \Phi D_t + \varepsilon_t \tag{2}$$

The trace tests were conducted assuming the presence of a linear deterministic trend in the time series and a non-zero intercept in the cointegration relationship.[9] The results of the trace test are presented in Table 1 below together with both the asymptotic and the bootstrapped p-values. When the sample is small, the asymptotic distributions are generally poor approximations to the true distributions. The use of bootstrapping - a method to construct artificial samples based on the estimated behaviour of the actual data - allows to account for the small-sample behaviour of the tests and to correct for size distortions.[10] While the theory on bootstrapping in a non-stationary framework, such as the cointegrated VAR, is still largely undiscovered territory, the usual theoretical properties from models with stationary variables seem to apply in this setting as well.[11] Hence, we may expect the bootstrap distributions to be more appropriate for inference than the asymptotic distributions.

The trace test statistics are evaluated at the 10% significance level rather than at the more conventional 5% level. The use of identical explanatory variables for each sector may be a particularly restrictive assumption when specifying the short-run dynamics in the VAR system in (2). In case the VAR system would take the short-run dynamics only incompletely into account, this could bias the results of the trace test toward not rejecting the null hypothesis. In order to offset such potential effects, a less restrictive significance level is chosen.

---

[9] The cointegration analysis and the results presented in the remainder of this note were computed with the Structural VAR software which was kindly provided by Anders Warne.

[10] Juselius, K. (2006): p. 157.

[11] In particular, a bootstrapped statistic can be expected to have errors in null rejection probabilities that are of a smaller order of magnitude, as the sample size goes to infinity, than its asymptotic analogue when the asymptotic distribution of the statistic is invariant to the parameters of the model. Almost all statistics that we bootstrap are invariant in this sense. See Park, J.Y. (2005), "Bootstrap Unit Root Tests", *Econometrica*, and Chang, Y., Park, J.Y., and Song, K. (2002), "Bootstrapping Cointegrating Regressions", Rice University, Department of Economics Working Paper Series No. 2002-04, for some recent developments regarding models with unit roots.

The trace test results indicate that for the system modelling aggregate M3 and non-monetary financial intermediaries M3 holdings the asymptotic critical value would suggest a cointegration rank of two. Taking the more restrictive bootstrapped critical values, a rank of zero can be rejected (see Table 1). For the system, explaining household M3 holdings, the rank of zero is rejected when using asymptotic values, but not rejected when applying the bootstrapped p-values. In the case of non-financial corporations, the trace test clearly rejects the hypothesis of rank zero, while only rejecting the hypothesis of rank one on the basis of the asymptotic p-values. This could imply the presence of a second cointegrating relationship for non-financial corporations' money holding.[12]

Table 1: Trace tests for the estimation of the number of long-run relations

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	Asymptotic p-value	Bootstrapped p-value
Aggegate M3				
None	0.3548	54.0184	0.01	0.07
At most 1	0.2443	28.6052	0.07	0.20
At most 2	0.1835	12.3562	0.14	0.27
At most 3	0.0102	0.5971	0.44	0.61
Household M3				
None	0.32951	48.85824	0.04	0.16
At most 1	0.215688	25.67293	0.14	0.33
At most 2	0.179683	11.58190	0.18	0.29
At most 3	0.001622	0.094158	0.76	0.80
Non-financial corporations M3				
None	0.468973	66.93917	0.00	0.01
At most 1	0.283136	30.86150	0.04	0.23
At most 2	0.155192	11.88796	0.16	0.41
At most 3	0.039128	2.275130	0.13	0.25
Non-monetary financial intermediaries M3				
None	0.389495	55.86116	0.00	0.04
At most 1	0.271282	27.23999	0.10	0.24
At most 2	0.136842	8.884850	0.38	0.60
At most 3	0.006011	0.349691	0.55	0.67

However, the power of the trace tests for the determination of the number of long-run relations can be low thus leading to an underestimation of the number of long-run relations. Indeed, if inference is

[12] Shortening the sample by dropping the first three observations in 1991 leads to a clear rejection of the lower rank hypotheses in both the household and non-financial corporation models.

based on the asymptotic p-values and 10% significance level, the possibility of a second long-run relationship would also be suggested for the non-monetary financial intermediary sector and the aggregate M3. To investigate the power properties of the trace test, bootstrap simulations were undertaken to determine the rank selected by the trace tests in the presence of a different number of stochastic trends. Table 2 reports how often all possible numbers of long-run relations are selected when an asymptotic size of 5% is applied. Cells with grey background color provide frequencies for correct rank determination.

Table 2: Frequencies of preferred rank in percent for a nominal asymptotic size of 5%

Model	Selected Rank	True Rank 0	1	2	3	4
Aggregate M3	0	81	16	3	1	1
	1	17	68	41	16	13
	2	2	14	46	39	37
	3	0	1	7	32	30
	4	0	1	3	13	20
Household M3	0	80	22	6	2	3
	1	18	61	48	22	20
	2	2	14	38	41	42
	3	0	2	5	28	28
	4	0	2	3	6	7
Non-financial corporations M3	0	67	3	0	0	0
	1	28	70	22	7	5
	2	4	23	59	46	30
	3	1	3	12	38	31
	4	1	1	6	9	34
Financial intermediaries M3	0	82	12	2	1	1
	1	16	73	34	16	16
	2	1	13	52	44	40
	3	0	1	8	28	26
	4	1	1	4	11	17

Note: Based on bootstrap simulation with 999 replications.
Columns may not add due to rounding.

Looking at the power of the test, Table 2 shows that for the aggregate M3 model the trace test procedure will propose the choice of rank 1 in 41% of the replications even when the true rank is 2, while only choosing the rank 2 in 46% of the cases. In the same vein, the table also shows that in the case of households M3, for the case of rank 1, only in 61% of the bootstrap replications is this rank also the result of the test. A rank of zero is the outcome of the trace test in 22% of the cases, while the selection of rank 2 would be the result in 14% of the replications. Taken together, this gives reason to believe that such tests may have a tendency to favor the choice of too few long-run relations, particularly when the nominal size of the test is 5% or a higher significance level. In order to compensate for the fact that the power of the trace test can be low for relevant alternative hypotheses in the neighbourhood of the unit circle, Juselius (2006) advices to use as much additional information as possible in the rank determination.

In particular, three approaches proposed by Juselius are followed here:

1. examine whether the t-values of the load factors of the additional cointegration vector are less than 2.6;
2. analyse recursive graphs of the trace statistic and of the cointegration relations;
3. check the economic interpretability of the results.

While the first and third approaches require the specification of the cointegrated VAR systems, the second approach - i.e. the analysis of recursive trace statistics - can be generated on the basis of the unrestricted VAR model. Chart 2a presents such recursive tests for the test of rank zero in the case of households M3. The results suggest that until mid-2002 the null hypothesis of rank zero in the VAR system was rejected at the 10% significance level. After a sharp spike in the p-values around mid-2002 the test statistic has trended towards levels consistent with conventional significance levels again.

Chart 2: Recursive trace test

Chart a: Household M3 – rank zero

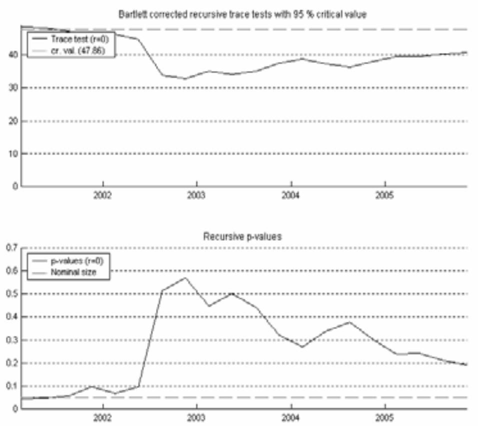
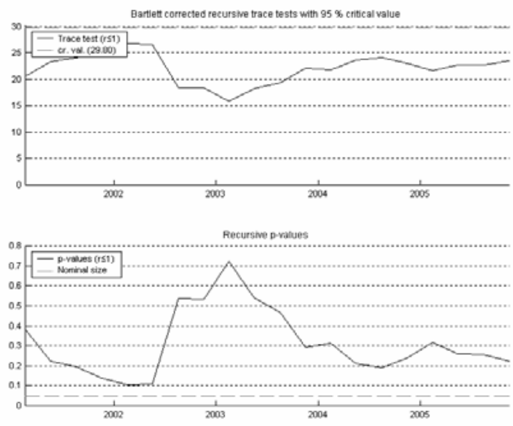


Chart b: Non-financial corporations M3 - rank one



The evidence for a second long-run relationship in the non-financial corporations M3 system is less clear (see Chart 2b). In particular, before mid-2002, the rejection of rank 1 was not as clear cut as in the case of households.

In a third step, cointegrated VAR systems were estimated on the basis of the lag-length determined above and assuming at the minimum a rank of one for the matrix Π_1. This entails the estimation of the vector of load factors α and the cointegration vector β' in (3)

$$\Delta x_t = \alpha\beta' x_{t-1} + \sum_{i=1}^{1,2} \Gamma_i \Delta x_{t-i} + \Phi D_t + \varepsilon_t \qquad (3)$$

The results of the exercise are presented in the next subsection.

3.3 The results

3.3.1 Aggregate M3 system

On the basis of the results of the trace statistic presented above, aggregate M3 was modelled in a VAR(2) with one long-run relationship. Several restrictions on the load factors parameters were imposed, allowing to consider real GDP, long-term bond yields and the dividend yield as weakly exogenous for aggregate monetary developments. The Likelihood Ratio test on these restrictions was not rejected at the 10% level of significance (F(3,47)=1.80 p-value = 0.16). Bootstrapping the LR-test on the three alpha restrictions leads to a clearer non-rejection of the weak exogeneity restrictions as the corresponding p-value is 0.355.

The long-run relationship identified has a highly significant negative load factor in the money demand equation. Standard deviations are indicated below the coefficient. The t-statistic of 4.6 is quite well above the value of 2.6 suggested by Juselius (2006) when considering the existence of additional long-run relations in the model. The estimate of 0.081 implies an adjustment over roughly 12 quarters. With 0.94, the income elasticity of aggregate M3 is lower than values found in previous estimations for the euro area around 1.3 (Calza/Gerdesmeier/Levy 2001, Bruggemann/Donati/Warne 2003). Restricting the parameter on income to 1.3 is clearly rejected at the 5% significance level on the basis of asymptotic critical values.

$$\begin{bmatrix} \Delta\left(m3^{agg} - p\right)_t \\ \Delta y_t \\ \Delta rl_t \\ \Delta DIV_t \end{bmatrix} = \begin{bmatrix} \underset{0.016}{-0.081} \\ 0 \\ 0 \\ 0 \end{bmatrix} \left[\left(m3^{agg} - p\right)_{t-1} - \underset{0.20}{0.94}\, y_{t-1} + \underset{0.06}{0.29}\, rl_{t-1} - \underset{0.01}{0.08}\, DIV_{t-1}\right] + \ldots$$

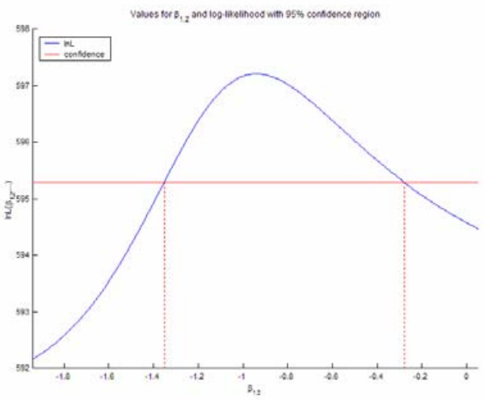
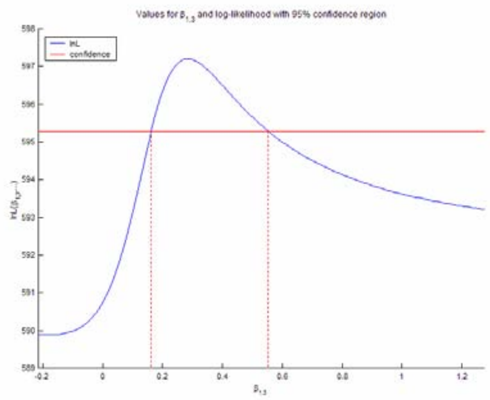
The parameter of the yield on long-term government bonds (note that the series enters in logs) is negative, while the parameter of the dividend yield has a positive parameter for the money-holding sector. Conceptually stock market developments may lead to an increase or decrease in households' money holdings. On the one hand, strong stock price rises will increase household wealth and some of the capital gains may be saved in the form of money (wealth effect).[13] Furthermore, money holdings may be complementary to equity investment as households may increase their demand for liquid assets in order to offset the higher risk in equity. On the other hand, strong stock returns may encourage substitution out of money and into the equity market (substitution effect). Indeed, the dividend yield

[13] For a theoretical foundation of the role of wealth in money demand see inter alia Friedman (1956). An empirical application can be found in Gerdesmeier (1996).

reflects both the effect of dividend payments as well as the impact of stock. The impact of stock prices seems to dominate the dividend effect on the dividend yield, as the level of dividend payments seems in general to reflect regulatory as well as fiscal consideration and to change at most annually. The dividend yield tends to be low (high), when returns on equity have been high (low). Therefore, equity investment will be attractive when the dividend yield is low and unattractive when the dividend yield is high. According to the estimate for aggregate money, the substitution effect seems to dominate the wealth effect. [14]

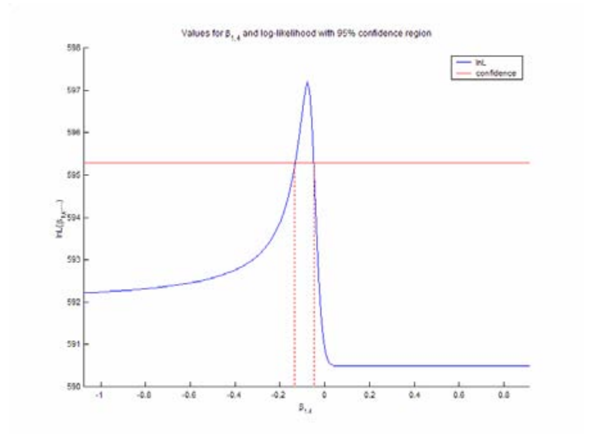
In order to determine whether the parameter estimates obtained were significant given the small available sample, empirical confidence intervals were calculated. Chart 3 (a-c) shows the 95% confidence intervals for the parameter estimates. The confidence band around the income parameter β_y indicates that a parameter estimate of 1.3 obtained in previous studies is clearly encompassed by this model (see chart 3a). However, the width of the confidence interval also suggests that the point estimate is subject to large degree of uncertainty, as the band reaches from slightly below 1.4 to below 0.2. Chart 3b supports the significantly negative impact from the level of long-term government bonds on money holdings, as the confidence band clearly does not include zero. At the same time, the confidence band on the parameter estimate of the dividend yield is also clearly positive and relatively tightly estimated between 0.05 and 0.15.

Chart 3: Parameter estimates and confidence regions for the aggregate M3 system

Chart a: Value for β_y and log-likelihood with 95% confidence region	**Chart b: Value for β_{rl} and log-likelihood with 95% confidence region**
	

---

[14] For a detailed description of the relationship between money and stock prices see, for instance, Friedman (1988) and European Central Bank (2005).

Chart c: Value for β_{DIV} and log-likelihood with 95% confidence region	
	

Testing the restriction of the income elasticity to 1.3 and using an empirical distribution does not lead to a rejection at the 5% significance level (F(1,51)=5.54, p-value = 0.125) anymore. Restricting the income parameter to 1.3 allows for the computation of confidence bands for the two other parameters. Assuming a 5% significance level places the margins for the interest rate elasticity between –0.03 and –0.44, clearly in the negative region, while the dividend elasticity ranges –0.03 and 0.4.

The inspection of the unrestricted cointegration relation suggests that it fluctuates around a mean level (see table 3 in the annex). Given, the tendency of the cointegration relation to revert to the mean, this could be seen as evidence supporting the stationarity of the relationship.

The results of the specification tests in Table 3 for the cointegrated VAR do not indicate the presence of autocorrelation or heteroskedasticity in the residuals, while evidence of non-normality can be found.[15] Nyblom tests were conducted in order to tests for the stability of the parameters in the aggregate M3 system. The tests do not provide evidence for instability of the long-run parameters in the model at the 10% confidence level.

Table 3: Specification test results for aggregate M3 model

	Test statistic	p-value		Test statistic	p-value
LM-AR(1)	F(16,47) = 1.28	0.25	Normality	F(8,50) = 2.06	0.06
LM-AR(4)	F(16,44) = 1.01	0.46	Nyblom Sup	0.98	0.22
ARCH	F(100,52) = 1.21	0.22	Nyblom Mean Q	0.34	0.26

Notes: Asymptotic p-values for all tests, except for Nyblom test. For the latter, the p-values were generated by bootstrapping.

[15] Testing for the lag length of the VAR indicates that while the null hypothesis of shortening the VAR to one lag is clearly rejected (F(16,52)=2.47,p-value=0.0073), testing the null hypothesis of a VAR(2) against the alternative of a VAR(3) model does not lead to the rejection of the VAR(2) model.

3.3.2 Household M3 system

Household M3 holdings were modelled in a VAR(2) with one long-run relationship. Similar restrictions to the aggregate M3 model were imposed on the load factors in order to identify a long-run money demand relationship. The restrictions on the load factors were just not rejected at the 5% level (F(3,52)=2.51, p-value = 0.07). The restrictions seem to constrain the model more heavily than was the case for aggregate M3. However, when judging the restrictions with an empirical distribution obtained through a bootstrapping procedure, the test-statistic of 2.51 implies a p-value of 0.23. The long-run relationship enters the money demand equation with a significant negative load factor. Similar to the aggregate M3 model, the t-statistic (4.1) is well above the value of 2.6 suggested by Juselius (2006) when considering the existence of "additional" long-run relations in the model, thereby supporting the decision to overrule the result of the trace test.

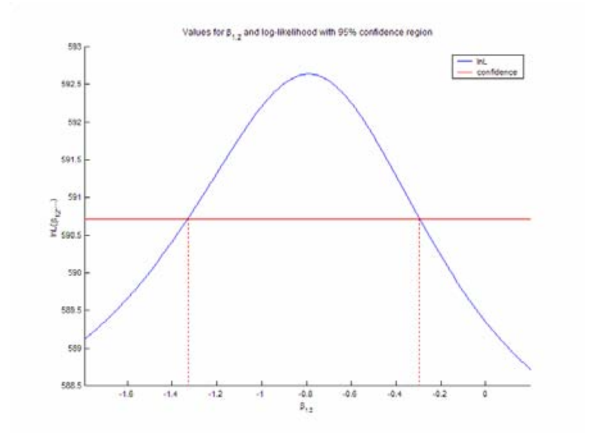
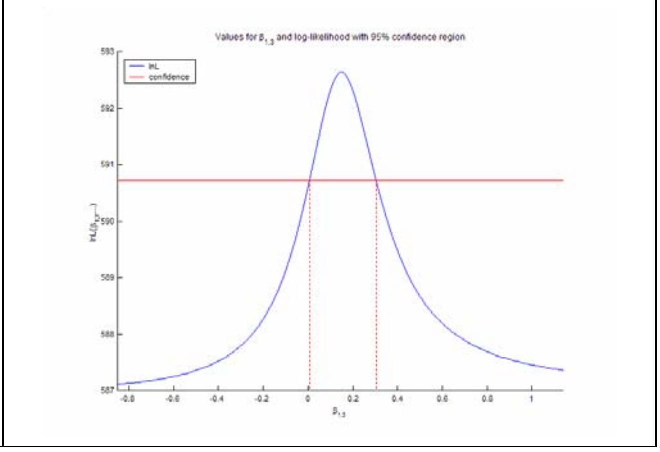
$$\begin{bmatrix} \Delta\left(m3^{hh}-p\right)_t \\ \Delta y_t \\ \Delta rl_t \\ \Delta DIV_t \end{bmatrix} = \begin{bmatrix} -\underset{0.018}{0.073} \\ 0 \\ 0 \\ 0 \end{bmatrix} \left[\left(m3^{hh}-p\right)_{t-1} - \underset{0.21}{0.79}\, y_{t-1} + \underset{0.06}{0.145}\, rl_{t-1} - \underset{0.017}{0.08}\, DIV_{t-1}\right] + \ldots$$

With 0.79, the point estimate for the income elasticity of household M3 is low, although not significantly lower than for aggregate M3. At the same time, the impact of the dividend yield on money demand is of almost identical magnitude to the corresponding coefficient in the aggregate M3 model, suggesting a quite strong effect from stock market developments on money demand. The positive parameter most likely captures the substitution between equity and money holdings, as equity returns tend to be low, when the dividend yield is high, a fact that may influence household expectations. From a long-run perspective, the dividend yield will reflect the discounting factor for dividend payments and thereby also importantly be affected by the level of risk aversion.[16] Together, these factors seem particular pertinent for household money demand behaviour.

Long-term bond yields have a negative impact on real household M3 holdings, which is weaker than for the overall money holding sector. A comparison of the point estimate for the household sector with the 95% confidence interval shown in Chart 3b for the corresponding aggregate M3 parameter suggests that it is outside the band and therefore significantly lower than the estimate for the whole economy.

[16] This view is supported by the strong negative correlation (-0.70) between consumer confidence and the dividend yield.

Chart 4: Parameter estimates and confidence regions for the household M3 system

Chart a: Value for β_y and log-likelihood with 95% confidence region	**Chart b: Value for β_{rl} and log-likelihood with 95% confidence region**
	

The inspection of the unrestricted cointegration relation for household M3 suggests that it fluctuates around a mean level (see table 3 in the annex). Given, the tendency of the cointegration relation to revert to the mean, this could be interpreted as evidence supporting the stationarity of the relationship.

The results of the specification tests for the cointegrated VAR point to the presence of autocorrelation and non-normality of the residuals, suggesting that the dynamics of the time series may not be adequately captured by the model (see Table 4). The model was therefore re-estimated, adding a further lag to the short-run dynamics of the model. The addition of a lag to the cointegrated VAR system did not alter the parameter estimates obtained for the long-run relationship. Nyblom tests were conducted in order to test for the stability of the parameters in the household M3 system of the baseline model with two lags. The tests provided no evidence indicating instability of the parameters in the restricted model for the estimation sample under consideration.

Table 4: Specification test results for household M3 model

	Test statistic	p-value		Test statistic	p-value
LM-AR(1)	F(16,47) = 1.19	0.31	Normality	F(8,50) = 2.26	0.04
LM-AR(4)	F(16,39) = 1.91	0.05	Nyblom Sup F	0.32	0.86
ARCH	F(100,52) = 1.10	0.36	Nyblom Mean Q	0.11	0.84

Notes: Asymptotic p-values for all tests, except for Nyblom test. For the latter, the p-values were generated by bootstrapping.

3.3.3 Non-financial corporations M3 system

Non-financial corporations M3 holdings could be modelled in a VAR(3) with either one or two long-run relationships depending on the interpretation of the evidence provided by the trace test in Table 1. Both alternatives were therefore examined.

Restrictions, which were not rejected at the 5% level F(2,52)= 1.87, p-value = 0.16) could be formulated on the load factors for real GDP and the government bond yield. However, restricting the load factor on the dividend yield equation invariably led to the rejection of the restriction. The dividend yield can therefore not be considered weakly exogenous in the system. According to this result, a positive monetary overhang will be adjusted both by slower real money growth (t-statistic = 2.8) and a decline in the dividend yield (t-statistic = 4.5). Looking at the individual parameter estimates, the point estimate for the income elasticity is positive, but far higher than can be considered reasonable on the basis of theoretical priors. At the same time, the point estimate for the interest rate elasticity is positive, while the point estimate on the dividend yield is negative, which could be seen as implying that for non-financial corporations the dividend yield captures a balance sheet effect on money holdings. However, the examination of the shape of the log-likelihood for parameter values surrounding the estimate turns out to be flat, thus suggesting that the parameters are very poorly estimated.

$$\begin{bmatrix} \Delta(m3^{nfc}-p)_t \\ \Delta y_t \\ \Delta rl_t \\ \Delta DIV_t \end{bmatrix} = \begin{bmatrix} \underset{0.006}{-0.017} \\ 0 \\ 0 \\ \underset{0.089}{-0.40} \end{bmatrix} \left[(m3^{nfc}-p)_{t-1} - \underset{1.46}{7.94}\, y_{t-1} - \underset{0.40}{1.04}\, rl_{t-1} + \underset{0.10}{0.34}\, DIV_{t-1} \right] + \ldots$$

The poor estimates may result from an incomplete representation of sector specific driving forces for non-financial corporations M3 demand. However, given that the error correction term seems to enter two equations, this might reflect the presence of two long-run relationships.

The first relationship explains money holding by non-financial corporations as negatively dependent on the level of interest rates and positively related to the dividend yield. The second relationship can be interpreted as explaining the equity premium (i.e. the difference between the interest rate on government bonds and the dividend yield) in terms of the level of real GDP. Restrictions can be formulated such that both relationships enter the equation explaining the non-financial corporations M3 holdings and do not affect real GDP, while interest rates and the dividend yield adjust to disequilibria in the second relationship. The four restrictions are clearly not rejected (F(4,46)=0.48, p-value = 0.75) by the data.

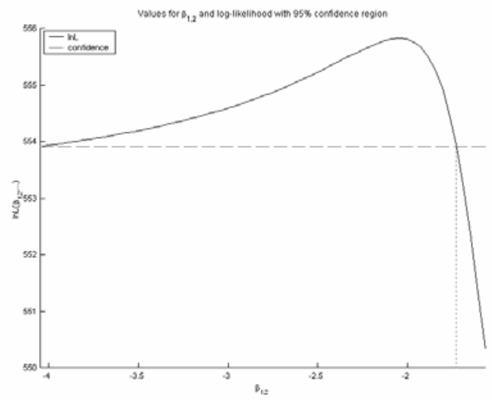
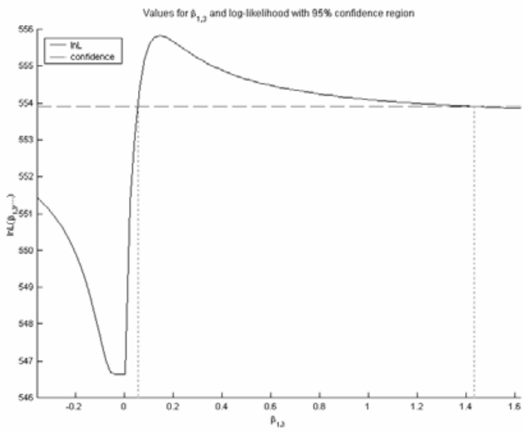
$$\begin{bmatrix} \Delta(m3^{nfc}-p)_t \\ \Delta y_t \\ \Delta rl_t \\ \Delta DIV_t \end{bmatrix} = \begin{bmatrix} \underset{0.026}{-0.129} & \underset{0.063}{0.266} \\ 0 & 0 \\ 0 & \underset{0.224}{-0.637} \\ 0 & \underset{0.674}{3.385} \end{bmatrix} \begin{bmatrix} (m3^{nfc}-p)_{t-1} & + \underset{0.061}{0.65}\, rl_{t-1} - \underset{0.042}{0.14}\, DIV_{t-1} \\ & y_{t-1} + \underset{0.018}{0.25}\, rl_{t-1} - \underset{0.013}{0.05}\, DIV_{t-1} \end{bmatrix} + \ldots$$

However, the system does not identify the money demand relationship as different linear combinations of the first and second cointegration vector can be conceived. In order to solve the identification issue a theoretically based restriction on the load factor needs to be applied. For example, if the equity premium is considered to be determined independent of monetary developments, then a zero-restriction can be applied to the second load factor in the non-financial corporations M3 holdings equation. The first load factor is then significant (t-statistic of -4.4). The relationships can be rewritten in order to highlight money demand and equity premium relationships more clearly as

$$\begin{bmatrix} \Delta(m3^{nfc}-p)_t \\ \Delta y_t \\ \Delta rl_t \\ \Delta DIV_t \end{bmatrix} = \begin{bmatrix} \underset{0.029}{-0.129} & 0 \\ 0 & 0 \\ 0 & \underset{0.249}{-0.637} \\ 0 & \underset{0.750}{3.385} \end{bmatrix} \begin{bmatrix} (m3^{nfc}-p)_{t-1} - 2.06y_{t-1} + 0.15rl_{t-1} - 0.04DIV_{t-1} \\ y_{t-1} + 0.24rl_{t-1} - 0.05DIV_{t-1} \end{bmatrix} + \dots$$

The implied parameter indicates a much stronger reaction of non-financial corporations M3 holdings to real GDP (see Chart 5a) than was the case for households M3 or aggregate M3 as it clearly lies outside the 95% confidence interval shown in Chart 3b. The point estimate of the reaction of non-financial corporations M3 holdings to long-term government bond yields is not significantly different than that of household sector, while it lies just outside the lower bound of the estimates obtained for aggregate M3.

Chart 5: Parameter estimates and confidence regions for the non-financial corporations M3 system

Chart a: Value for β_y and log-likelihood with 95% confidence region	**Chart b: Value for β_{rl} and log-likelihood with 95% confidence region**
	

Alternatively, one could restrict the load factors for the two long-run relationships to be identical. In this case different long-run parameter values would ensue for the money demand relationship.

The results of the specification tests for the cointegrated VAR do not point to the presence of autocorrelation, heteroskedasticity or non-normality of the residuals (see Table 5). The model can therefore be deemed as an adequate representation of the data. In order to tests for the stability of the parameters in the non-financial corporations M3 system, Nyblom tests were conducted. The tests provided no evidence of instability for the parameters in the restricted model.

Table 5: Specification test results for non-financial corporations M3 model

	Test statistic	p-value		Test statistic	p-value
LM-AR(1)	F(16,41) = 0.41	0.97	Normality	F(8,44) = 1.54	0.17
LM-AR(4)	F(16,38) = 1.15	0.35	Nyblom Sup Q	0.49	0.85
ARCH	F(100,46) = 1.22	0.22	Nyblom Mean Q	0.27	0.69

Notes: Asymptotic p-values for all tests, except for Nyblom test. For the latter, the p-values were generated by bootstrapping.

3.3.4 Non-monetary financial intermediaries M3 system

Non-monetary financial intermediaries M3 holdings were modelled in a VAR(2) with one long-run relationship. The relationship explains real money holdings by non-monetary financial intermediaries as positively related to real GDP and the dividend yield, while being negatively dependent on the level of interest rates. The impact of the long-run relationship can be relatively easily restricted not to affect the determination of the government bond yield and the dividend yield.[17] A constraint on the impact of the long-run relationship on the dynamics of real GDP would barely not be rejected at the 5% significance level (F(3,52)=2.56, p-value = 0.06). However, in conjunction with an exclusion restriction on the long run parameter of the dividend yield, the evidence for rejecting the joint restriction on all three load factors is then stronger (F(3,52)=3.35, p-value = 0.03), implying that real GDP should not be considered weakly exogenous in the system. In turn, this implies that disequilibria in the long-run demand for money by non-monetary financial intermediaries may have informational content for future real GDP developments. The load factor in the money demand equation is highly significant (t-statistic = 5.3). With -0.25, it is also fairly high, supporting the assessment that real money holdings of non-monetary financial intermediaries adjust relative strongly to disequilibria, while the corresponding load factor in the equation for real GDP albeit being much smaller, does not support error correction.[18]

$$\begin{bmatrix} \Delta\left(m3^{fi}-p\right)_t \\ \Delta y_t \\ \Delta rl_t \\ \Delta DIV_t \end{bmatrix} = \begin{bmatrix} \underset{0.048}{-0.254} \\ \underset{0.008}{-0.022} \\ 0 \\ 0 \end{bmatrix} \left[\left(m3^{fi}-p\right)_{t-1} - \underset{0.33}{2.02}\, y_{t-1} + \underset{0.10}{0.62}\, rl_{t-1} - \underset{0.02}{0.01}\, DIV_{t-1}\right] + \ldots$$

Turning to the interpretation of the cointegration parameter estimates, the point estimate for the dividend yield is just positive but not significantly different from zero (F(1,51)=0.36, p-value = 0.55). Restricting the dividend yield to zero in the long-run relationship leaves the parameter estimates broadly unchanged.

$$\begin{bmatrix} \Delta\left(m3^{fi}-p\right)_t \\ \Delta y_t \\ \Delta rl_t \\ \Delta DIV_t \end{bmatrix} = \begin{bmatrix} \underset{0.045}{-0.231} \\ \underset{0.001}{-0.023} \\ 0 \\ 0 \end{bmatrix} \left[\left(m3^{fi}-p\right)_{t-1} - \underset{0.33}{1.98}\, y_{t-1} + \underset{0.09}{0.63}\, rl_{t-1}\right] + \ldots$$

[17] The F-test statistic for the restrictions on the load factors only is 1.93 (p-value = 0.15), while the F-test statistic for the joint restriction on the dividend yield and the load factors was 1.35 (p-value = 0.27).

[18] A bootstrap simulation indicates that the 95% confidence band for the load factors range between -0.53 and -0.074 for the real money equation and -0.05 and 0.01 for real GDP, suggesting that the main adjustment channel of monetary disequilibria in this sector is through a dampening of money demand.

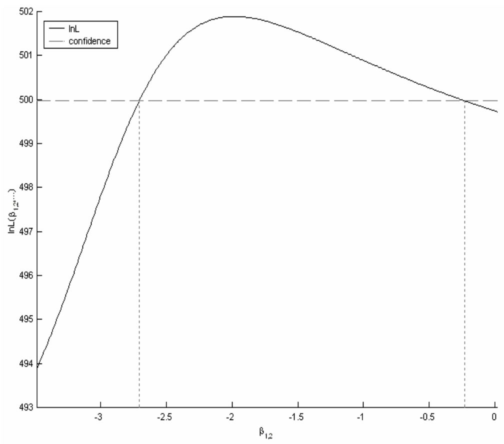
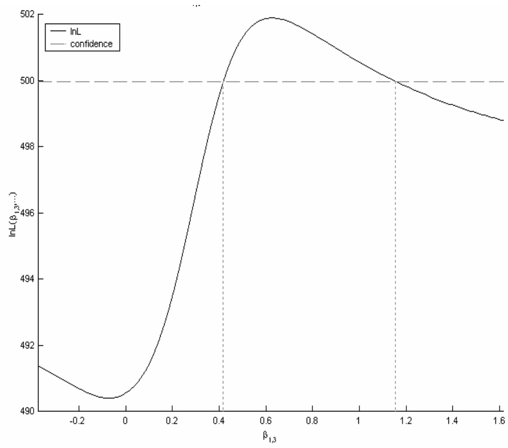
The dividend yield does not seem to impact on the level of real money holding by financial intermediaries.. Two interpretations are possible: First, non-monetary financial intermediaries M3 holdings are not affected by the wealth or substitution effect from the equity market in a clearly determined manner. This is worth highlighting given that non-monetary financial intermediaries are mainly asset managers for households. At the same time, the finding may be linked to the fact that euro area non-monetary financial intermediaries are more invested in loans and securities other than shares rather than in equities.[19] Second, at a gross level the substitution effect from the stock market developments does impact on the money holding, similarly to the household sector, but this is offset by the fact that asset managers keep a fairly constant share of liquid asset in their portfolios. More specifically, in times of rising stock prices (lower dividend yield), asset managers face strong inflows into their portfolios, while the opposite is true in times of declining stock prices. Overall, the dividend yield may not be a good proxy for the opportunity costs of holding money for asset managers. Only a more refined modelling of the return and wealth position of this sector would permit a better understanding of the forces at work.

The point estimate for the income elasticity of 1.98 is surrounded by large uncertainty as indicated by the 95% confidence bands (see Chart 6). It is clear from a comparison between the interval for the aggregate M3 and that for the non-monetary financial intermediaries M3 that the income elasticity of aggregate M3 is significantly lower than the parameter estimate for financial intermediaries. However, it cannot be excluded that the income elasticity of financial intermediaries is the same as for aggregate M3 owing to the large range of the 95% confidence interval.

The lower bound of the 95% confidence interval for interest rate parameter estimate is above the point estimate obtained for all three other sectors. This suggests that financial intermediaries are more reactive to government bond yields than the other sectors. A comparison of the 95% confidence bands indicates that it encompasses only values greater than the respective upper bounds obtained for the household M3 system.

[19] The ratio of equity holdings to the sum of securities and loans held by euro area non-monetary financial intermediaries was between 1999 and 2005 on average around two fifths.

Chart 6: Parameter estimates and confidence regions for the non-monetary financial intermediaries M3 system

Chart a: Value for β_y and log-likelihood with 95% confidence region	Chart b: Value for β_{rl} and log-likelihood with 95% confidence region
	

The inspection of the unrestricted cointegration relation suggests that it fluctuates around a mean level (see table 3 in the annex). Given the exhibited tendency for mean reversion this could be interpreted as evidence supporting the stationarity of the cointegration relationship.

Table 6 reports the results of the specification tests for the cointegrated VAR. They do not point to the presence of autocorrelation, heteroskedasticity or non-normality in the residuals. The model can therefore be deemed as an adequate representation of the data. In order to tests for the stability of the parameters in the non-monetary financial intermediaries M3 system, Nyblom tests were also conducted. The tests provided no evidence pointing to instability of the long-run parameters (see Table 6).

Table 6: Specification test results for non-monetary financial intermediaries M3 model

	Test statistic	p-value		Test statistic	p-value
LM-AR(1)	F(16,47) = 1.22	0.29	Normality	F(8,50) = 1.58	0.15
LM-AR(4)	F(16,44) = 1.02	0.45	Nyblom Sup Q	0.35	0.64
ARCH	F(100,52) = 1.21	0.23	Nyblom Mean Q	0.12	0.58

Notes: Asymptotic p-values for all tests, except for Nyblom test. For the latter, the p-values were generated by bootstrapping.

3.4 A closer examination of the relationship between the income and interest rate parameter estimates

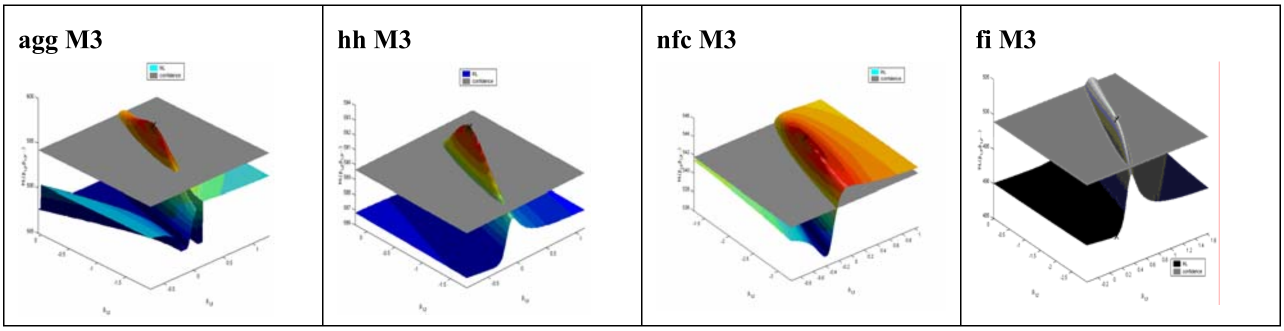
The previous analysis of the money demand models for the sectors focussed on a comparison of the estimated parameters for a partial perspective. Money demand theory provides two identification restrictions for parameters of the long-run relationship in models including money: The money holdings should be positively related to income and negatively related to the opportunity cost variables included in the long-run relationship. Table 7 provides an overview of the results obtained from the sectoral money demand models using the cointegrated VAR framework. The level of long-run income elasticity seems to differentiate the behaviour of households from both financial and non-financial firms. At the same time, the higher long-run elasticity of money holdings with respect to government bond yields distinguishes non-monetary financial intermediaries from the other two sectors. Lastly, the effect captured by the dividend yield seems to affect households' money demand behaviour, while it does not seem to influence non-monetary financial intermediaries M3 holdings.

Table 7: Long-run money demand parameter estimates in the cointegrated VAR systems

Parameter values for	hh M3	nfc M3	fi M3
y	0.79	2.06	1.98
rl	-0.15	-0.15	-0.63
DIV	0.08	0.04	-

In order to deepen this analysis, it may be worthwhile to analyse simultaneously the confidence regions for two parameters crucial for the identification of money demand. For aggregate M3 and the three sectoral aggregates, chart 7 presents contour plots showing the log-likelihood value obtained with different combinations of income and interest rate parameters in estimations undertaken with the model specifications presented above over the sample 1991 Q1-2005 Q4. Likelihood values below the grey surface indicate parameter estimates that are not significant at the 95% confidence interval, while the estimates above are in a region of significance. As the significance increases, the colour moves become increasingly towards red. The point estimates presented above are indicated by the cross. Several findings may be noted. First, the variation at the 95% significance level of the income parameter is rather large in all models (in line with the results obtained for the individual parameter analysis, even when the interest rate is allowed to vary). Second, the variation at the 95% significance level of the interest rate parameter is rather small, particularly when compared to the range of the income parameter, except in the case of non-financial corporations. This is reflected by the thin shape of the "iceberg" tip illustrating the significance region. Third, with higher parameter values for income, the interest rate parameter declines in absolute value in order to remain significant. However, the relative change of the parameters varies across sectors, suggesting that different money holding behaviours are being observed across sectors.

Chart 7: Parameter estimates for β_y and β_{rl} and log-likelihood with 95% confidence region



Looking at the breakdown of M3 by holding sector indicates that households (including non-profit organisations serving households) constitute the largest holders of M3, holding approximately two-thirds of the stock. Non-financial corporations hold slightly less than a fifth of M3 and non-monetary financial intermediaries hold roughly 10%.[20] Over the course of the sample, the relative importance of households as holders of M3 seems to have declined, while the non-monetary financial intermediaries have increased their share of money holdings. The share of non-financial corporations has remained broadly unchanged.

4. A SUR system for sectoral money demand

The analysis presented in section 3 was undertaken in a broadly similar framework across sectors with the same set of explanatory variables for the money demand. This approach did not permit to examine whether interdependence between the developments in sectoral money growth had an influence on the estimated parameters. In order to assess whether common monetary shocks across sectors (e.g. due to cyclical influences or financial market events) have affected the estimation results, a SUR system was estimated along the lines of the specification already implemented in the cointegrated VAR framework.

The central modelling elements taken over from the cointegrated VAR systems are the number of cointegrating relationships and the weak exogeneity restrictions (i.e. the exclusion restrictions on the load factors for the long-run relationships). The system consists of six equations: a block of three equations explaining the quarterly growth of M3 holdings by sector, an equation for the growth rate of real GDP, for change in the log of the government bond yield and one for the change in the dividend yield.

$$\begin{array}{c} \Delta\left(m3^{hh}-p\right)_t \\ \Delta\left(m3^{nfc}-p\right)_t \\ \Delta\left(m3^{fi}-p\right)_t \\ \Delta y_t \\ \Delta\log(rl_t) \\ \Delta DIV_t \end{array} = \begin{array}{r} f\left[\left(m3^{hh}-p\right)_{t-1}, y_{t-1}, \log(rl_{t-1}), DIV_{t-1}, \Delta\left(m3^{hh}-p\right)_t, \Delta y_{t-i}, \Delta\log(rl_{t-i}), \Delta DIV_{t-i}\right] + \varepsilon_{1t} \\ f\left[\left(m3^{nfc}-p\right)_{t-1}, y_{t-1}, \log(rl_{t-1}), DIV_{t-1}, \Delta\left(m3^{nfc}-p\right)_t, \Delta y_{t-i}, \Delta\log(rl_{t-i}), \Delta DIV_{t-i}\right] + \varepsilon_{2t} \\ f\left[\left(m3^{fi}-p\right)_{t-1}, y_{t-1}, \log(rl_{t-1}), DIV_{t-1}, \Delta\left(m3^{fi}-p\right)_t, \Delta y_{t-i}, \Delta\log(rl_{t-i}), \Delta DIV_{t-i}\right] + \varepsilon_{3t} \\ f\left[y_{t-1}, \log(rl_{t-1}), DIV_{t-1},, \Delta\left(m3^{fi}-p\right)_{t-i}, \Delta\left(m3^{hhi}-p\right)_{t-i}, \Delta\left(m3^{nfc}-p\right)_{t-i}, \Delta y_{t-i}, \Delta\log(rl_{t-i}), \Delta DIV_{t-i}\right] + \varepsilon_{4t} \\ f\left[y_{t-1}, \log(rl_{t-1}), DIV_{t-1}, \Delta\left(m3^{fi}-p\right)_{t-i}, \Delta\left(m3^{hhi}-p\right)_{t-i}, \Delta\left(m3^{nfc}-p\right)_{t-i}, \Delta y_{t-i}, \Delta\log(rl_{t-i}), \Delta DIV_{t-i}\right] + \varepsilon_{5t} \\ f\left[y_{t-1}, \log(rl_{t-1}), DIV_{t-1}, \left(m3^{fi}-p\right)_{t-1}, \Delta\left(m3^{fi}-p\right)_{t-i}, \Delta\left(m3^{hhi}-p\right)_{t-i}, \Delta\left(m3^{nfc}-p\right)_{t-i}, \Delta y_{t-i}, \Delta\log(rl_{t-i}), \Delta DIV_{t-i}\right] + \varepsilon_{6t} \end{array}$$

[20] European Central Bank (2006): p. 63.

with lag length i = 1,…, 3. Wald-tests were conducted to determine the optimal lag length between one and three lags. The reduction of three to two lags in the system is not rejected at the 10% significance level ($\chi^2(30)$ = 38.9, p-value 0.13), while the reduction from two to one lag is clearly rejected ($\chi^2(30)$ = 63.8, p-value 0.00). The negative parameter estimates on lagged money terms in the three sectoral money equations are clearly significant: in the case of households and non-monetary financial intermediaries the t-statistic is above 3, while the t-statistic for the non-financial corporations is 2.3. A test for the joint hypothesis of insignificance of the lagged money terms is clearly rejected, thus supporting the assessment that within the context of this model long-run money demand relationships exist.

Table 8: Long-run money demand parameter estimates

Estimation method	**SURE**			**OLS**
Parameter values for	hh M3	nfc M3	fi M3	agg M3
y	1.18	2.08	2.14	1.29
rl	-0.05	-0.12	-0.58	-0.18
DIV	0.08	0.03	0.04	0.08
Adjusted R-squared	0.44	0.25	0.20	0.49
S.E. of regression	0.004	0.01	0.02	0.003

Most long-run money demand parameter values obtained with the SUR estimation are close to the values reported for the cointegrated VAR approach, with the exception of the income and interest rate elasticity of household M3 holdings (see Table 8).

A Wald test for the equality of coefficients across all three money-holding sectors is clearly rejected at the 1% significance level. Given the similarity of the parameter estimates shown in Table 8, it could be assumed that non-financial corporations and non-monetary financial intermediaries are homogenous in their money-holding behaviour. However, this hypothesis is also clearly rejected by the Wald test at the 1% significance level, given the difference in the interest rate parameter.

The table also reports the long-run parameters from a single equation estimation for aggregate M3 holdings on the basis of the specification described in 3.3.1. All three parameter estimates are insignificantly different from those obtained in the cointegrated VAR.

According to the results of the estimation, the quarterly growth rate of household M3 holdings is rather well explained by the determinants, as the adjusted R^2 is quite high (0.44), whereas the growth rates of non-financial corporations and non-monetary financial intermediaries M3 holdings only exhibit an adjusted R^2 of 0.25 and 0.20, respectively. The performance in terms of explanatory power could be related to missing variables or modelling errors. Taken at face value, the results indicate that household money holdings may be more easily explained by fundamental determinants of money demand and less affected by exceptional developments. Interestingly, the adjusted R^2 for aggregate

M3 is higher than for any of the respective sectors. This finding suggests, on the one hand, that there may be a benefit to aggregation across sectors, while on the other hand, it could be that offsetting sector specific variables are important at the sectoral level, but less relevant for the aggregate dynamics.

In this respect, table 4 in the annex is of interest. It displays the residuals of the estimated equations, which, by visual inspection, do not reject white noise properties. The residuals of the household equation have a smaller standard error than those of the other two money-holding sector equations. Statistical tests on the equality of the variance of the residual series strongly reject equality.[21] More recently, the impact of the switch from inter-bank activity to electronic trading platforms operated by OFIs that influenced monetary development in 2005 are clearly discernible in the non-monetary financial intermediaries M3 residual chart.[22] At the same time, the strong dynamics in money holdings of non-financial corporations in the more recent quarters is also well visible.

Table 9: Correlation between equation residuals

	$M3^{hh}$	$M3^{fi}$	$M3^{nfc}$	y	DIV	rl
$M3^{hh}$	-	0.15	0.09	-0.14	0.18	-0.04
$M3^{fi}$	0.15	-	0.06	0.06	-0.03	-0.32
$M3^{nfc}$	0.09	0.06	-	-0.002	-0.34	-0.04
y	-0.14	0.06	-0.002	-	-0.20	0.14
DIV	0.18	-0.03	-0.34	-0.20	-	0.19
rl	-0.04	-0.32	-0.04	0.14	0.19	-

Table 9 indicates that the correlation between the residuals of the individual equations is fairly low. This is particularly the case for correlations between the residuals of the sectoral money equations (shaded in grey). This suggests that the results on the basis of the individual sectoral cointegrated VAR systems could be reliable. Two correlations in are slightly more elevated: First, the residual of non-financial corporations M3 holdings and the dividend yield are correlated with a coefficient of -0.34 and second, the residual of non-monetary financial intermediaries M3 holdings and the government bond yield are also negatively linked with -0.32. This could be interpreted as implying that a downward surprise in bond yields entails an upward surprise in the level of non-monetary financial intermediaries M3 holdings. At the same time, it may be that the interaction between the respective variables is not fully captured by the model, in particular given the primitive description of the bond and dividend yield equations.

The correlations in Table 9 indicate that over the whole sample under consideration, the residuals from the sectoral equations are only weakly correlated with each other. However, a comparison of the

[21] Equality of the variance of residuals for households and non-monetary financial intermediaries, the F-test is (56,56) = 5.86; p-value =0.00; for the equality of the variance of residuals for households and non-financial corporations, the F-test is (56,56) = 3.91; p-value =0.00.

[22] Deutsche Bundesbank (2005), p. 23.

aggregated sectoral residuals with the residuals obtained from the OLS estimation (presented in Table 8) suggests that the individual sectors are at times strongly affected by idiosyncratic shocks, visible in the significantly larger amplitude of the fluctuations in the aggregated sectoral M3 residual in Chart 8. Evidently, these shocks are offset in the aggregate, thus providing a benefit to aggregation.

Chart 8: Comparison of aggregate M3 residuals and aggregated sectoral M3 residuals *(in % of M3)*

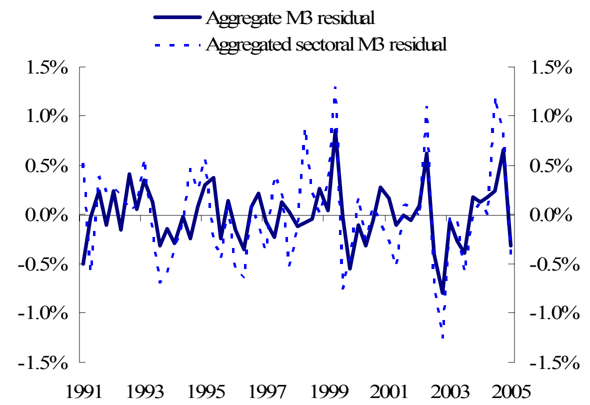
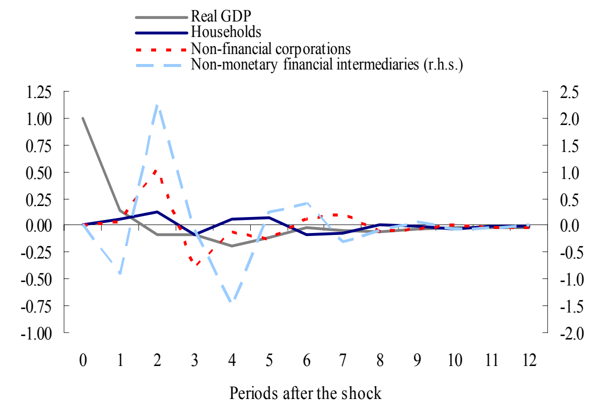


Chart 9: Impulse response of real M3 holdings to a 1 percentage point shock to real GDP in one quarter *(Deviation from baseline in %)*



In order to exemplify the dynamic behaviour of the sectoral M3 holdings, Chart 9 presents the response to a 1 percentage point shock in one quarter to real GDP growth within the SUR system. The chart clearly shows that the response of non-monetary financial intermediaries M3 holdings is more volatile than that of the non-financial sectors. Its fluctuation is more than twice as large as the response of the non-financial sectors. Furthermore the initial response differs: while the money holdings of the non-financial sectors tend to increase after the shock, the holdings of the financial sector declines due to the strong negative impact from higher bond yields. The chart also shows that all series display a peak in M3 holdings two quarters after the shock. After 3 quarters, it seems that the non-financial sector leads the holdings of financial intermediaries as the rebalancing of the sectoral money holdings become more similar.

5. Conclusion

The results presented in this analysis suggest that estimated money demand systems over the sample 1991 Q1 to 2005 Q4, for the euro area household, non-financial corporations and non-monetary intermediaries sectors display different long-run behaviour with respect to a common set of determinants. This result is in line with the findings presented for the US by Jain/Moon (1994) and Butkiewicz/McConnell (1995). The development in aggregate M3 over the business cycle may therefore reflect a varying sectoral composition.

The findings suggest that the long-run income elasticity seems to differentiate households and firms, both financial and non-financial, a result which is also reported, for example by Jain/Moon (1994) for the US. A higher elasticity of money holdings with respect to government bond yields distinguishes non-monetary financial intermediaries from the non-financial sector. The higher elasticities of non-monetary financial intermediaries M3 holdings with respect to the government bond yield would in part explain why this sector's M3 holdings would display a higher volatility than the other sectors, given identical underlying growth dynamics. However, given the higher long-run elasticity of firms' money holding with respect to real GDP, the underlying monetary dynamics will be higher in the corporate than in the household sector, thus helping explain a decline in trend velocity. A growing importance of the corporate sector for monetary developments would imply a stronger decline in aggregate velocity. Indeed over the sample, the importance of the corporate sector for M3 developments has increased.

Lastly, the dividend yield affects mainly households' money demand behaviour, thereby capturing a substitution effect, between equity and money holdings, as equity returns tend to be low when the dividend yield is high. The dividend yield does not seem to affect non-monetary financial intermediaries' M3 holding, which requires a more refined modelling. Overall, these findings are robust across estimation methods.

In general, caution should be applied when interpreting these findings, given the short period covered by the sample. Furthermore, the models do not represent a "best economic explanation" of the money demand behaviour, but are statistical representations under the restriction of a common set of explanatory variables. More specifically, the parameter estimates should be interpreted in the light of the fact that, within this limited set of determinants, differences in the parameter estimates could reflect the impact of omitted sector-specific variables.

6. Annex

Table 1: Results of ADF test in levels

Variable		t-Statistic	p-value*
Aggregate M3 ($m3^{agg}$)	(C,8)	3.36611	0.9999
Household M3 ($m3^{hh}$)	(C,4)	0.99870	0.9960
Non-financial corporations M3 ($m3^{nfc}$)	(C,0)	2.32686	0.9999
Non-monetary financial intermediaries M3 ($m3^{fi}$)	(C,3)	0.44001	0.9829
Real GDP (y)	(C,1)	-0.3169	0.9154
Dividend yield (DIV)	(C,1)	-1.7585	0.3970
Long-term government bond yield (rl)	(C,4)	-1.3562	0.5969

*MacKinnon (1996) one-sided p-values. Note: (C, X) estimated with a constant, X = lag length

Table 2: Lag-length determination

Aggregate M3

Lag	LogL	LR	AIC	SC	HQ
0	176.2579	NA	-6.263924	-6.117936	-6.207469
1	574.9003	724.8043	-20.17819	-19.44825*	-19.89592*
2	**592.0189**	**28.63477***	**-20.21887**	**-18.90498**	**-19.71078**
3	608.8111	25.64633	-20.24768*	-18.34984	-19.51377
4	619.6151	14.92910	-20.05873	-17.57694	-19.09900
5	630.2548	13.15462	-19.86381	-16.79807	-18.67826

Household M3

Lag	LogL	LR	AIC	SC	HQ
0	176.2616	NA	-6.264059	-6.118072	-6.207605
1	569.1882	714.4119	-19.97048	-19.24054*	-19.68820*
2	**589.9357**	**34.70504***	**-20.14312***	**-18.82923**	**-19.63503**
3	604.3407	22.00032	-20.08512	-18.18727	-19.35121
4	611.9554	10.52218	-19.78020	-17.29840	-18.82047
5	630.8836	23.40213	-19.88668	-16.82093	-18.70113

Non-financial corporations M3

Lag	LogL	LR	AIC	SC	HQ
0	167.9800	NA	-5.962908	-5.816920	-5.906454
1	507.4428	617.2052	-17.72519	-16.99525*	-17.44292
2	530.2320	38.12012	-17.97207	-16.65818	-17.46398*
3	**549.6636**	**29.67739***	**-18.09686***	**-16.19902**	**-17.36295**
4	558.1151	11.67831	-17.82237	-15.34057	-16.86264
5	574.0354	19.68329	-17.81947	-14.75372	-16.63392

Non-monetary financial intermediaries M3

Lag	LogL	LR	AIC	SC	HQ
0	147.8301	NA	-5.230185	-5.084198	-5.173731
1	479.1739	602.4433	-16.69723	-15.96729*	-16.41496*
2	**499.0722**	**33.28447***	**-16.83899***	**-15.52510**	**-16.33090**
3	514.3456	23.32664	-16.81257	-14.91473	-16.07866
4	529.5195	20.96747	-16.78253	-14.30073	-15.82280
5	543.1794	16.88859	-16.69743	-13.63169	-15.51188

Notes: LR refers to the Likelihood Ratio test, AIC to the Akaike Information Criterium, SC to the Schwarz Criterium and HQ to the Hannan-Quinn Criterium, respectively.

Table 3: Cointegrating relationships

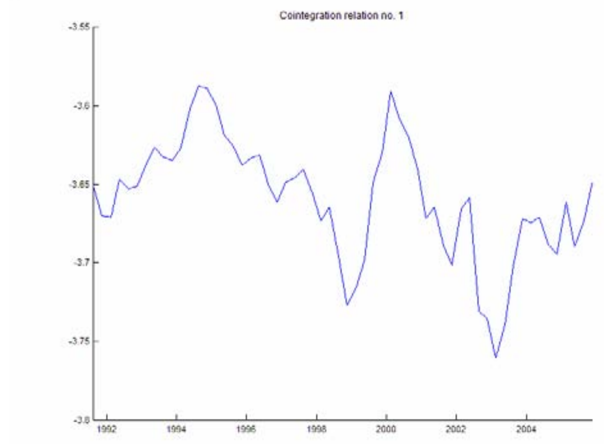
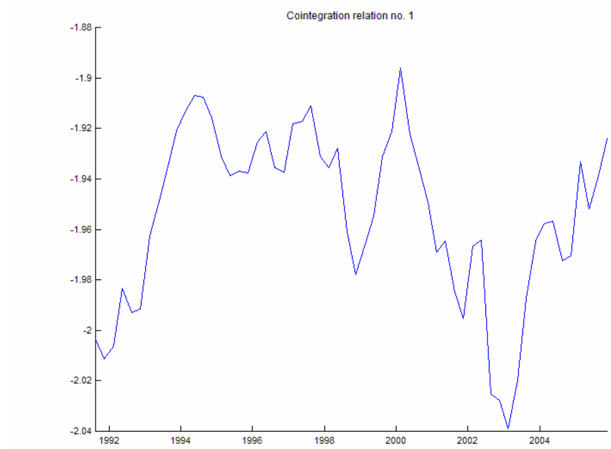
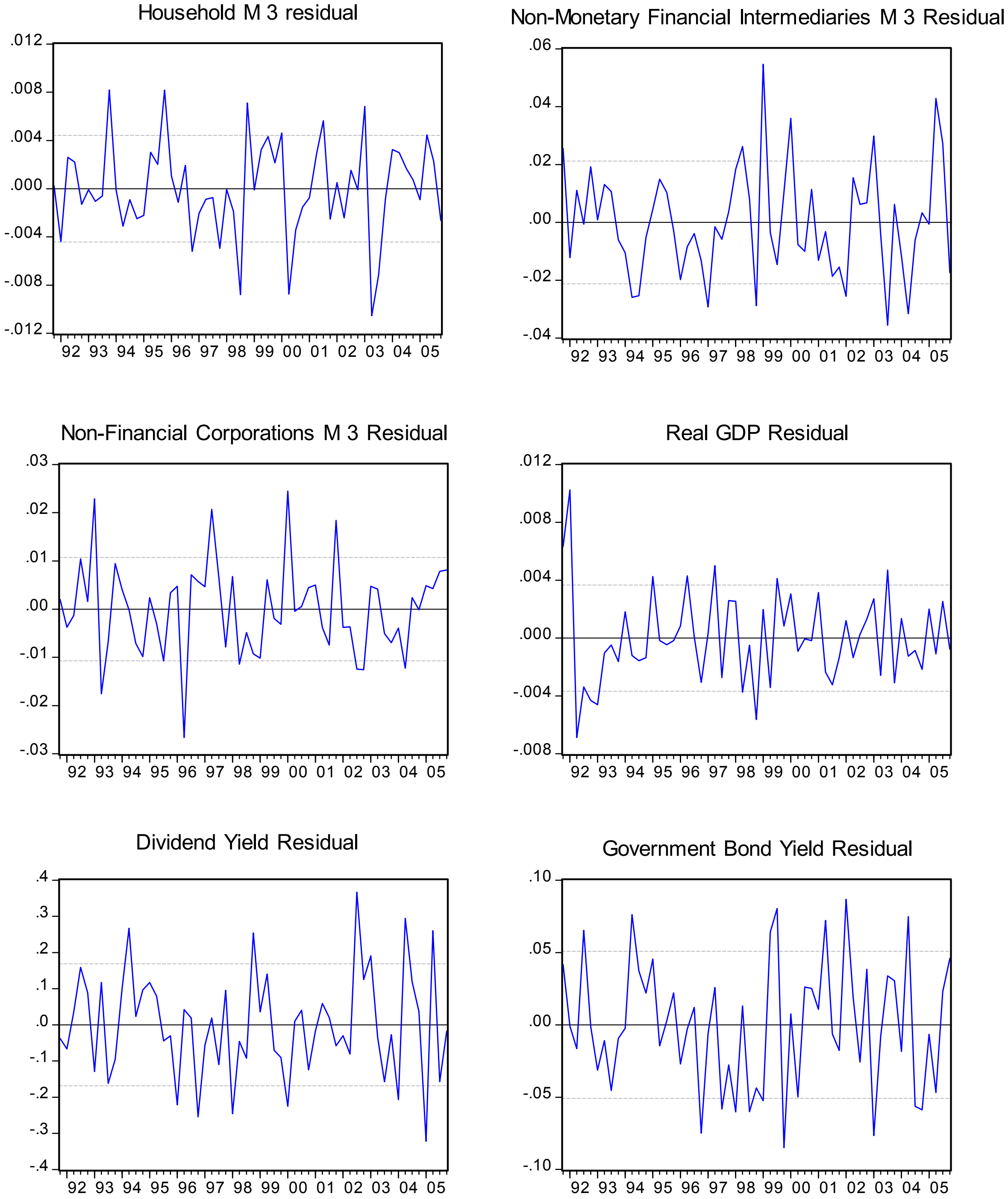
Aggregate M3	*Household M3*
	
Non-financial corporations M3	
	
Non-monetary financial intermediaries M3	
	

Table 4: Residual from SURE system



7. References

Avouyi-Dovi, S., Diop, A., Fonteny, E.-C., Gervais, E. Jacquinot, P., Mesonnier, J.-S., Sahuc, J.-G. (2003): Estimation of a Money Demand Function for the Euro Area: A Summary of the Results, Banque de France Bulletin, No. 113, May.

Brand, C., Cassola, N. (2000): A Money Demand System for the Euro Area, ECB Working Paper No. 39.

Bruggeman, A., Donati, P., Warne, A. (2003): Is the Demand for Euro Area M3 Stable?, ECB Working Paper Series No. 255.

Brigden, A., Mizen, P. (1999): Money, credit and investment in the UK corporate sector, Bank of England Working Paper 100.

Butkiewicz, J., McConnell, M. (1995): The Stability of the Demand for Money and M1 Velocity: Evidence from the Sectoral Data, in: Quarterly Review of Economics and Finance, Vol. 35, No. 3, pp. 233-243.

Calza, A., Gerdesmeier, D., Levy, J. (2001): Euro Area Money Demand: Measuring the Opportunity Costs Appropriately, IMF Working Paper No. 01/179.

Carstensen, K. (2006): Stock Market Downswing and the Stability of European Monetary Union Money Demand, in: Journal of Business and Economic Statistics, Vol. 25, pp. 395-402.

Chang, Y., Park, J.Y., and Song, K. (2002): Bootstrapping Cointegrating Regressions, Rice University, Department of Economics Working Paper Series No. 2002-04.

Coenen, G., Vega, J. L. (2001): The Demand for M3 in the Euro Area, in: Journal of Applied Econometrics, Vol. 16, pp. 727–748.

Chrystal, A., Mizen, P. (2000): Consumption, money and lending: a joint model for the UK household sector, Bank of England Working Paper 134.

Chrystal, A., Mizen, P. (2001): Other Financial Corporations: Cinderella or Ugly Sister of Empirical Monetary Economics?, Bank of England Working Paper 151.

Deutsche Bundesbank (2005): Monthly Report, November.

European Central Bank (2005): Money Demand and Uncertainty, ECB Monthly Bulletin, October.

European Central Bank (2006): Sectoral Money Holdings: Determinants and Recent Developments, ECB Monthly Bulletin, August.

Friedman, M. (1956): Studies in the Quantity Theory of Money, University of Chicago Press, Chicago.

Friedman, M. (1988): Money and the stock market, The Journal of Political Economy, Vol. 96, No. 2, pp. 221-245.

Gerdesmeier, D. (1996): Die Rolle des Vermögens in der Geldnachfrage, Diskussionspapier 5\96, Volkswirtschaftliche Forschungsgruppe der Deutschen Bundesbank, May.

Goldfeld, S. (1973): The Demand for Money Revisited, Brookings Papers on Economic Activity, Vol. 1973, No. 3, pp. 577-646.

Jain, P., Moon, C.-G. (1994): Sectoral money demand: A cointegration approach, Review of Economics and Statistics, Vol. 76, No. 1, pp. 196-201.

Johansen, S. (1996): Likelihood-Based Inference in Cointegrated Vector Autoregressive Models (2nd ed.),

Oxford University Press, Oxford.

Juselius, K. (2006): The Cointegrated VAR Model: Methodology and Applications Oxford University Press, Oxford.

Kontolemis, Z. G. (2002): Money Demand in the Euro Area: Where Do We Stand (Today)?, IMF Working Paper No. 02/185, November 2002.

MacKinnon, James. G. (1996): Numerical distribution functions for unit root and cointegration tests, in: Journal of Applied Econometrics 11, 601-618.

Park, J.Y. (2003), Bootstrap Unit Root Tests, Econometrica, Vol 71, No. 6, pp. 1845-1895.

Thomas, Ryland (1997a). “The Demand for M4: A Sectoral Analysis Part 1 - The Personal Sector.” Bank of England Working Paper 61, Bank of England.

Thomas, Ryland (1997b). “The Demand for M4: A Sectoral Analysis Part 2 - The Corporate Sector.” Bank of England Working Paper 62, Bank of England.

Warne, A. (2006): Bayesian Inference in Cointegrated VAR Models with Applications to the Demand for Euro Area M3, ECB Working Paper Series No. 692.

European Central Bank Working Paper Series

For a complete list of Working Papers published by the ECB, please visit the ECB's website (http://www.ecb.int)

699 "The behaviour of producer prices: some evidence from the French PPI micro data" by E. Gautier, December 2006.

700 "Forecasting using a large number of predictors: is Bayesian regression a valid alternative to principal components?" by C. De Mol, D. Giannone and L. Reichlin, December 2006.

701 "Is there a single frontier in a single European banking market?" by J.W. B. Bos and H. Schmiedel, December 2006.

702 "Comparing financial systems: a structural analysis" by S. Champonnois, December 2006.

703 "Comovements in volatility in the euro money market" by N. Cassola and C. Morana, December 2006.

704 "Are money and consumption additively separable in the euro area? A non-parametric approach" by B. E. Jones and L. Stracca, December 2006.

705 "What does a technology shock do? A VAR analysis with model-based sign restrictions" by L. Dedola and S. Neri, December 2006.

706 "What drives investors' behaviour in different FX market segments? A VAR-based return decomposition analysis" by O. Castrén, C. Osbat and M. Sydow, December 2006.

707 "Ramsey monetary policy with labour market frictions" by E. Faia, January 2007.

708 "Regional housing market spillovers in the US: lessons from regional divergences in a common monetary policy setting" by I. Vansteenkiste, January 2007.

709 "Quantifying and sustaining welfare gains from monetary commitment" by P. Levine, P. McAdam and J. Pearlman, January 2007.

710 "Pricing of settlement link services and mergers of central securities depositories" by J. Tapking, January 2007.

711 "What "hides" behind sovereign debt ratings?" by A. Afonso, P. Gomes and P. Rother, January 2007.

712 "Opening the black box: structural factor models with large cross-sections" by M. Forni, D. Giannone, M. Lippi and L. Reichlin, January 2007.

713 "Balance of payment crises in emerging markets: how early were the "early" warning signals?" by M. Bussière, January 2007.

714 "The dynamics of bank spreads and financial structure" by R. Gropp, C. Kok Sørensen and J.-D. Lichtenberger, January 2007.

715 "Emerging Asia's growth and integration: how autonomous are business cycles?" by R. Rüffer, M. Sánchez and J.-G. Shen, January 2007.

716 "Adjusting to the euro" by G. Fagan and V. Gaspar, January 2007.

717 "Discretion rather than rules? When is discretionary policy-making better than the timeless perspective?" by S. Sauer, January 2007.

718 "Drift and breaks in labor productivity" by L. Benati, January 2007.

719 "US imbalances: the role of technology and policy" by R. Bems, L. Dedola and F. Smets, January 2007.

720 "Real price wage rigidities in a model with matching frictions" by K. Kuester, February 2007.

721 "Are survey-based inflation expectations in the euro area informative?" by R. Mestre, February 2007.

722 "Shocks and frictions in US business cycles: a Bayesian DSGE approach" by F. Smets and R. Wouters, February 2007.

723 "Asset allocation by penalized least squares" by S. Manganelli, February 2007.

724 "The transmission of emerging market shocks to global equity markets" by L. Cuadro Sáez, M. Fratzscher and C. Thimann, February 2007.

725 "Inflation forecasts, monetary policy and unemployment dynamics: evidence from the US and the euro area" by C. Altavilla and M. Ciccarelli, February 2007.

726 "Using intraday data to gauge financial market responses to Fed and ECB monetary policy decisions" by M. Andersson, February 2007.

727 "Price setting in the euro area: some stylised facts from individual producer price data" by P. Vermeulen, D. Dias, M. Dossche, E. Gautier, I. Hernando, R. Sabbatini and H. Stahl, February 2007.

728 "Price changes in Finland: some evidence from micro CPI data" by S. Kurri, February 2007.

729 "Fast micro and slow macro: can aggregation explain the persistence of inflation?" by F. Altissimo, B. Mojon and P. Zaffaroni, February 2007.

730 "What drives business cycles and international trade in emerging market economies?" by M. Sánchez, February 2007.

731 "International trade, technological shocks and spillovers in the labour market: a GVAR analysis of the US manufacturing sector" by P. Hiebert and I. Vansteenkiste, February 2007.

732 "Liquidity shocks and asset price boom/bust cycles" by R. Adalid and C. Detken, February 2007.

733 "Mortgage interest rate dispersion in the euro area" by C. Kok Sørensen and J.-D. Lichtenberger, February 2007.

734 "Inflation risk premia in the term structure of interest rates" by P. Hördahl and O. Tristani, February 2007.

735 "Market based compensation, price informativeness and short-term trading" by R. Calcagno and F. Heider, February 2007.

736 "Transaction costs and informational cascades in financial markets: theory and experimental evidence" by M. Cipriani and A. Guarino, February 2007.

737 "Structural balances and revenue windfalls: the role of asset prices revisited" by R. Morris and L. Schuknecht, March 2007.

738 "Commodity prices, money and inflation" by F. Browne and D. Cronin, March 2007.

739 "Exchange rate pass-through in emerging markets" by M. Ca' Zorzi, E. Hahn and M. Sánchez, March 2007.

740 "Transition economy convergence in a two-country model: implications for monetary integration" by J. Brůha and J. Podpiera, March 2007.

741 "Sectoral money demand models for the euro area based on a common set of determinants" by J. von Landesberger, March 2007.

ISSN 1561081-0
9 771561 081005