EXPLAINING THE MONEY DEMAND OF NON-FINANCIAL CORPORATIONS IN THE EURO AREA: A MACRO AND A MICRO VIEW[1]

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Abstract

This paper analyses non-financial corporations (NFCs) money demand, both from a macro and a microeconomic point of view. At a macro level, money holdings are modelled as a function of real gross added value, the price level, the long-term interest rate on bank lending to non-financial corporations –which is considered as the alternative return to holding money-, the own rate of return on M3 and the real capital stock of NFCs. The disaggregated analysis allows to analyse the link between cash holdings and balance-sheet ratios (such as non-liquid short term assets, tangible assets or indebtedness) and other variables such as cash flow, its volatility or the size of the firm. Results both from a macro- and micro-perspective indicate that the main drivers of this growth have been cyclical factors, captured by gross-added value and the cash-flow respectively. Variations in the opportunity cost of holding money, have also contributed to explain M3 developments but more modestly than at the end of the nineties, when their increase contributed negatively to cash accumulation. The growth of non-financial corporations' money holdings is thus, beyond the simple balance sheet relationship between loans and deposits on the MFI balance sheet, linked to developments in the external financing conditions and the activity of non-financial corporations.

Keywords: money demand, coinegrated VARs, panel estimation.

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1. Introduction

Understanding the demand for money is an important element of a detailed analysis of monetary developments, which aims to extract, in real time, signals in monetary developments that are relevant for the assessment of risks to price stability over the medium to longer term. Looking at individual sectors may allow to formulate richer explanations of the forces driving monetary developments, leading to a better understanding of monetary developments in the business cycle.

Non-financial corporations (NFCs) hold around 20% of the broad money stock M3. Although holding a smaller share than households, NFC deposits tend to grow more quickly and fluctuate more widely than those of households, implying a more important role in aggregate monetary dynamics. Furthermore, non-financial firms devote important resources to managing their financial situation. This degree of sophistication presumably leads to a different interaction between money, opportunity costs and spending than in the case of households. Available studies suggest that modelling non-financial corporations' money demand behaviour proves to be more challenging than households.[4]

From a macroeconomic perspective, non-financial corporations' motives to hold money reflect transactions, portfolio and wealth considerations. The transactions demand for money in essence thus relates to unsynchronised payments for wages or raw materials on the one hand and receipt of revenues from sales. Portfolio considerations are driven by the opportunity costs of holding highly liquid assets, while foregoing higher returns from alternative investment opportunities or paying down debt. Lastly, additional considerations may lead to a demand for money relating to the size or importance of the corporate sector for the economy.. At micro level, several studies have recently focussed on the estimation of liquidity holding equations as a tool to assess the existence of financing constraints, and evidence in favour of a positive and significant cash flow coefficient in determining firms' liquidity ratios has been considered in the empirical literature as evidence of financing constraints.. (see for example Almeida et al (2004) Oskan and Oskan (2004) or Han and Qiu (2007)).

Modern finance literature provides two alternative explanations for firms' demand behaviour for money. According to the passive adjustment view, non-financial corporations let their money balances absorb shocks to their income and spending, and only rebalance their holdings in the longer term. By contrast, the active view of money demand states that non-financial corporations try to minimise the opportunity cost of holding liquid assets (e.g. the spread between deposit interest rates and longer-term market interest rates).

The contribution of the paper is threefold: first to conduct an analysis of the demand by non-financial corporations for money both from a macroeconomic and a firm level perspective and thus cross-check whether the stylised facts derived at the aggregate level for the euro area can be found at the micro-level

[4] See for instance Thomas (1997), p.7 and Jain and Moon (1994), p. 197.

as well. Secondly, by investigating non-financial corporations' money holdings from the two perspectives allows to enrich the understanding of the interaction between money, income and interest rates in the corporate sector with cross-sectional evidence on the distribution of money holdings across firms or the importance of certain industries for money demand. In this sense, analysing aggregate data may hide different patterns in money demand on the part of firms belonging to different sectors and of different sizes. The estimation of money demand with time series data may not face a number of problems which are not present when applying panel techniques to the data. Third, differently from most previous studies n cash holdings at firm-level, a panel with a large share of small and medium-sized firms, which represent the bulk of the corporate sector and tend to hold more cash than large firms, has been used.

The paper is structured in four parts. In the first step, the paper provides a brief overview of the literature on money demand of non-financial corporations. In the second step, the data and the modelling approach used to estimate the aggregate money demand systems is presented. In a third step, the presents an analysis of cash holdings for euro area non-financial corporations on the basis of panel estimations. The last section summarises the findings of the two strands of analysis and provides some implications for monetary analysis.

2. Related studies

It seems fair to say that the theoretical foundations for holding money/cash on the part of non-financial corporations have been less at the centre of research interests than the empirical analysis of this issue. There is a fairly comprehensive body of literature that provides results for the United States, the United Kingdom and some member states of the euro area, but not representative for the entire area of the single currency. In order to provide a structured overview of the methods commonly employed and the main findings reported in the literature, these will be presented in two steps: first those based on aggregate data and then those at firm-level.

2.1 The macro economic evidence

For the US, initial empirical analysis of the non-financial corporations demand for money was undertaken by Goldfeld (1973). 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 the non-financial business sector the results for the money demand models are not satisfactory.

More recent evidence for the US using sample periods running from the early 1950s to 1990 is provided by Jain and Moon (1994) using the Johansen method, and Butkiewicz and McConnell (1995) applying the Engle-Granger approach. Based on money holdings constructed on the basis of flow-of-funds data, the former study finds a long-run relationship for a broad aggregate of business balances, but not for narrow aggregates, while the latter finds a relationship for a measure of M1 holdings. Jain and Moon (1994) explain business money holdings with a measure of business GDP and a long-term corporate bond rate. They report fairly high income elasticities for their measure of business M3 in the vicinity of 1.6 and interest rate elasticity of -0.76. Using a government bond yield to capture opportunity costs reduces the

interest elasticity, leading the authors to conclude that sector-specific interest rates are important for the analysis. They also acknowledge difficulties with the choice of an appropriate scale variable.

Butkiewicz and McConnell (1995) present evidence that non-financial business real M1 holdings are related in the long run to real GDP and the three month Treasury bill rate over their sample. However, the income effect of business balances is relatively weak, while interest rate effect found seems quite strong. This is interpreted as consistent with the hypothesis that the introduction of alternatives to demand deposits had a significant effect on the business sector's demand for money.

For the United Kingdom, empirical evidence on sectoral money holding is provided by Thomas (1997) and Brigden and Mizen (1999) using a cointegrated VAR. In the first one of these studies, industrial and commercial corporations (ICC)' holdings of real M4 are driven 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. The parameters on the scale variables investment and wealth can be restricted to the same value of 0.5. Overall the model suggests a significant interaction between the liquidity of ICCs and the return on real and financial yields, which in turn influences ICCs' investment decisions. The study by Brigden and Mizen (1999) takes a wider perspective and models the interactions between gross domestic fixed capital formation and the real M4 and credit balances of private non-financial corporations. Among the explanatory variables are included gross financial assets of the sector deflated by the price level, the return to corporate M4 balances and the cost of bank borrowing as well as explanatory variables in addition to real GDP, undistributed earnings and the Confederation of British Industry survey results. M4 deposit holdings are constrained to vary one-for-one with the sum of investment expenditure and financial wealth. Deposits also rise with the the proportion of firms reporting more than adequate stocks of finished goods, suggesting a precautionary demand for liquid assets, which matches the response of bank borrowing by firms. The implied semi-elasticity on the interest rate term is negative and significant, but is larger than the coefficient of 2.88 reported in Thomas (1997). The authors find that the equilibria in real investment, bank lending and money balances move in relation to the scale variables, measures of economic confidence and opportunity cost as economic theory would suggest.

For Germany evidence was presented by Read (1996) uses the cointegrated VAR approach. Corporate M3 holdings, which include financial corporations except insurance companies, are modelled using gross value added in the corporate sector as a scale variable. Gross financial wealth is included in the analysis but is found not to contribute to the explanation of money holdings in a meaningful way. Alternatively, a spread between the yield on public bonds and the return on corporate deposit holdings on the one hand and the a spread between the rate on loans and the return on corporate deposits on the other hand are tried as measures of opportunity costs, with the former providing better results. The study also finds that the deviations from the equilibrium level adjust to the order of 24% per period in terms of money holdings.

2.2 Evidence at the firm level

Initially, firm level evidence was produce in an attempt to cross-check findings on income and interest rate elasticity derived in aggregate money demand with respect to the existence of an aggregation bias. However, a sizeable literature has evolved analysing a broad set of issues linked to the impact on firms' cash holdings of financial constraints, macroeconomic uncertainty and industry and size characteristics. A comprehensive review of the literature would exceed the scope of this paper, but the evidence of some seminal contributions will be briefly reviewed.

Bover and Watson (2004) investigate the scale elasticity of money demand for US, UK and Spanish firms> They find that for US firms the scale elasticity as measured by sales is less than one (0.74), for UK firms it is equal to one. In the case of Spain, the elasticity is found to be one in the mid-1980's but to decline up to the mid-1990's (to 0.78), a period of increasing financial innovation. This result could be linked to financial innovation, which may reduce money demand by reducing the sales elasticity. Bover and Watson estimate an average interest rate elasticity of around -1/3 for the aggregate interest rate, but the empirical specification is not entirely satisfactory in the absence of time dummies. Using firm specific interest rates they find an elasticity of -0.08, with the impact of changes in aggregate interest rates on money demand found to be decreasing for financially sophisticated firms.

Adao and Mata (1999) studied a sample of Portuguese firms similar to that of Bover and Watson (2004). They estimate a basic equation whereby money is explained by the firms' size, labour cost and capital cost measures with all variables in logarithms. Fixed effects, take into account the possibility that the increase in the financial sophistication of the economy through time has led to a reduction in the utilisation of money by firms. The authors report an estimated sales elasticity of around 0.5. In no case is the hypothesis of constant returns to scale accepted.

Opler, Pinkowitz, Stulz and Williamson (1999) examine the determinants and implications of holdings of cash and marketable securities by publicly traded U.S. firms over the period 1971 to 1994. They find supportive evidence for a static trade-off model of cash holdings in which firms with strong growth opportunities and riskier cash flows hold relatively high ratios of cash to total non-cash assets. Firms that have the greater access to the capital markets, such as large firms and those with high credit ratings, tend to have lower cash ratios. According to this analysis, there is little evidence that excess cash holdings has a large short-run impact on capital expenditures, acquisition spending, and payouts to shareholders.

Almeida et al (2004), Oskan and Oskan (2004) or Han and Qiu (2007) have focussed on the estimation of liquidity holding equations as a tool to assess the existence of financing constraints. They interpret the evidence in favour of a positive and significant cash flow coefficient in explaining cash holdings (or their variation) as evidence of financing constraints.

Acharya, Almeida and Campello (2005) model the interplay between cash and debt policies in the presence of financial constraints. The evidence presented in the study suggests that financially constrained firms with high hedging needs have a strong propensity to save cash out of cash flows, while showing no propensity to reduce outstanding debt. In contrast, constrained firms with low hedging needs

systematically channel free cash flows towards debt reduction, as opposed to cash savings. The authors conclude from their evidence that cash should not be viewed as negative debt.

Bruinshoofd and Kool (2004) investigate Dutch corporate liquidity management practices between 1977 and 1997. They use a simple error correction model of corporate liquidity holdings applied to firm-level. They find evidence that long-run liquidity targets exist at firm level and find that changes in liquidity holdings are driven by short-run shocks as well as the urge to converge towards targeted liquidity levels.

3. Determinants of M3 demand: Evidence from macroeconomic data

3.1 The data

At the macroeconomic level, the empirical analysis is conducted over the sample period 1991 Q1 – 2007 Q4 on seasonally adjusted quarterly data (See Chart 1 in the annex).

Non-financial corporations' holdings of M3 ($m3_t$) are taken from the official ECB database for the period since 1999. The series is extended backwards assuming an unchanged share for money market funds, currency in circulation and debt securities holdings at the levels of 1999 Q1.[5] The non-financial corporations sector comprises small, medium and large enterprises engaged in industrial and services activity. However, the sector does not include firms and subsidiaries engaged primarily in treasury and financial activities, which belong to the non-monetary financial intermediary sector (except insurance corporations and pension funds).

The scale of non-financial corporations' transactions settled using money may be captured by different scale variables. The literature suggests the level of investment expenditures, the wage sum of the corporate sector as potential explanatory variables, or a measure capturing the level of economic activity of the business sector. The analysis is conducted using real gross added value in industry and services as a scale variable (y_t), while the deflator for gross added value in industry and services would then be the relevant measure of the price level (p_t). The long-term interest rate on bank lending to non-financial corporations is considered as the alternative return to holding money (blr_t), presuming that repaying of loans or holding money, or put differently shortening or lengthening the financial part of the balance sheet, is the main financial investment decisions facing non-financial corporations. The attractiveness of financial balance sheet expansion and thus holding more money is captured by the own rate of return on M3 (own_t). Lastly, a measure of the real capital stock of non-financial corporations is considered as an exogenous explanatory variable as well (cap_t). This can be interpreted as a measure of real corporate wealth, which was found to be an important explanatory variable by Thomas (1997) and Brigden and Mizen (1999). It can be interpreted as capturing the size of the corporate sector and is thus a natural scaling variable. A growing corporate sector, with an increasing division of labour between firms, may need higher cash balances in order to settle transactions not fully reflected in the measure of activity, which only captures the value added in production. All series are in logarithms except the interest rates.

[5] The level of money stock is the notional stock adjusted for seasonal effects with Tramo-Seats.

To establish the order of integration of the time series used, Augmented Dickey-Fuller and the Phillips Perron tests on the levels and the first differences of the series were carried out. The residuals of the test equation need to be free of autocorrelation in order for the statistic to remain efficient. The two tests take different approaches to correct for potential autocorrelation in the residuals of the test equation: While the ADF test corrects for higher order serial correlation by adding lagged differenced terms on the right-hand side, the PP test makes a nonparametric correction to the t-statistic of the coefficient to account for the serial correlation in residuals. The Newey-West correction was used to derive the heteroskedasticity and autocorrelation consistent t-statistic.

The lag length in the ADF test was selected automatically using the Akaike Information Criterion (AIC), with a maximum length of six lags, the selection of the truncation lag in the Phillips-Perron test was conducted automatically according to Newey-West. The tests indicated the null hypothesis of a unit root in the level series could not be rejected at the 5% confidence level (see Table 1 in the annex). In the ADF test, the own rate came close to rejecting the null hypothesis, a result not corroborated by the Phillips-Perron test. The tests in first differences for most series tend to reject the null hypothesis of non-stationarity at the 5% confidence level, except for the M3 and the price level series, which could also be I(2) according to the ADF test. When interpreting the results of test, caution is warranted, given the short sample period under consideration, which may weaken the power of the tests.

3.2 Empirical results

In a first step in order to determine the appropriate lag length of the system, a VAR system in levels was estimated. The system comprised six lags of the endogenous variables vector $y_t = [m_t \; p_t \; y_t \; BRL_t \; OWN_t]'$ and the exogenous I(1) variable $x_t = [cap_t]'$, which together give $Y_t = [y_t \; x_t]$ in (1):

$$\Gamma(L) y_t = d_0 + ab' Y_t + \Psi(L) x_t + e_t \qquad (1)$$

α is (5x1) vector containing the load factors, β is the (6x1) cointegration vector, δ_0 is a (5x1) vector of constants, while Γ and Ψ are matrix polynomials capturing the data's lag structure, represented by the lag operator L. Lastly, the errors ę are assumed to be distributed NI~(0,O). On the basis of the Akaike information criterion, a lag length of three was selected for conducting the remainder of the analysis. This result is confirmed by Likelihood Ratio tests (see Table X2 in the annex). LM tests for autocorrelation in the residuals of the models revealed no remaining dynamics at the 5% confidence interval.[6]

The rank of the vector product ab' in equation 1 was determined using the trace test (see Johansen (1996)). The tests were conducted assuming the presence of a linear deterministic trend in the time series

[6] In a model with different variables, a lag length of three for the modelling of non-financial corporations' holdings of M3 was also found appropriate by von Landesberger (2007).

and a non-zero intercept in the cointegration relationship.[7] The results of the trace test are presented in Table 1 below together with bootstrapped p-values, as given the presence of an exogenous I(1) variable in the model the asymptotic distributions are not meaningful critical variables. 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.[8] 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.[9]

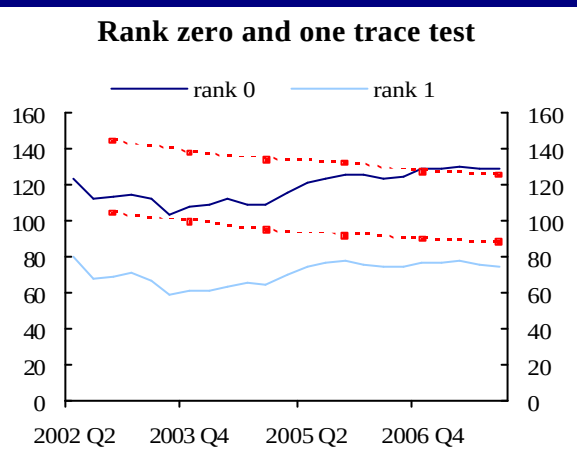
Comparing the bootstrapped critical values with the result of the trace test for model 1 indicates that the hypothesis that the rank of the $\alpha\beta'$-matrix in (1) is zero can be rejected at the 5% confidence level, while the hypotheses for a higher rank can not be rejected. In the following therefore a rank of one is assumed for modelling this system. The chart shows the recursive values of the trace statistic examining the hypothesis that the rank of the $\alpha\beta'$-matrix is zero and one. The recursive trace test results indicate that the hypothesis of rank zero can be rejected at the 5% confidence interval since 2006 Q4, while the rank of one can not be rejected at all at this significance level. However, when assessing this result it should be borne in mind that the trace test may suffer from problems of power, which may be compounded by the short sample available particularly, at the beginning of the period of recursion.

Table 1: Trace test

Sample 1991-2007

Rank	LR trace	empirical p-value
0	129.62	0.026
1	74.51	0.231
2	40.52	0.479
3	22.27	0.587
4	8.91	0.445

Chart 1: Recursive trace test



Note: The dotted line represents the 5% critical value generated by bootstrapping over the respective sample for a given model.

In order to obtain further insight into the functioning of the system both with respect to causality and to check whether a variable could be eliminated from the system, tests for stationarity of the endogenous

[7] 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. See http://www.texlips.net/svar/source.html.

[8] Juselius 2006, p. 157

[9] 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 (2005) and Chang, Park, and Song, (2002) for some recent developments regarding models with unit roots.

explanatory variables and tests for weak exogeneity were conducted. The stationarity tests did not suggest to exclude any of the endogenous variables from the long-run relationship on the grounds that a variable was stationary. Additional tests on the exclusion of the money and prices variables helped address the issue of whether real money played a role in the long-run relationship. The test rejected the exclusion of money and prices from the cointegrating vector at the 5% significance level, suggesting that indeed real money holdings did play a role. In order to examine which variables are affected by the long-run relationship, the test for weak exogeneity were conducted. The test did not reject, at conventional significance levels, setting the adjustment parameters (load factors) in the interest rate equations to zero. At the same time, the test suggests that money, prices and output will adjust to the disequilibrium.

Table 2: Tests supporing the identification of the equilibrium correction relationship

	STATIONARITY		WEAK EXOGENEITY	
	H0: variable k is stationary HA: variable k is not stationary		H0: alpha in equation k is zero HA: alpha in equation k is not zero	
Equation for	F(5, 49)	p-value	F(1,44)	p-value
m3	5.2436	0.00	9.13	0.00
p	4.9441	0.00	14.58	0.00
y	5.4477	0.00	10.66	0.00
BRL	4.9758	0.00	2.34	0.13
OWN	6.0333	0.00	0.14	0.71

At a theoretical level, the money demand generally related to an explanation of real money holdings, thus proposing to impose a parameter restriction of -1 on the long-run parameter for the price level. Such a restriction is not rejected at the 5% significance level (p-value = 0.08). Furthermore, the parameters on output and the capital stock are fairly similar with point estimates of with 1.27 and 1.39, thereby permitting to restrict the values to be identical. Together the two restrictions are not rejected by the appropriate F-test (p-value = 0.21). The long-run relationship found is

$$\begin{bmatrix} \Delta(m3)_t \\ \Delta p_t \\ \Delta y_t \\ \Delta brl_t \\ \Delta OWN_t \end{bmatrix} = \begin{bmatrix} \underset{0.0680}{-0.285} \\ \underset{0.016}{0.042} \\ \underset{0.016}{0.074} \\ 0 \\ 0 \end{bmatrix} \left[(m3 - p)_{t-1} \underset{0.048}{-1.37}\, 0y_{t-1} + \underset{0.010}{0.065}\, BRL_{t-1} - \underset{0.010}{0.116}\, OWN_{t-1} \underset{0.048}{-1.370}\, cap_{t-1} \right] + K \quad (2)$$

with standard errors shown below the parameter estimates. A joint F-test for the restrictions placed on the alpha and beta vectors in equation 2 is not reject at conventional significance levels (p-value =0.12).

The long-run relationship explains non-financial corporations' demand for money as dependent on the level of prices. Furthermore, a higher level of economic activity induces a larger demand for money reflecting needs for working capital, with the increase being more than proportional given that the elasticity is greater than one. Constraining the parameter estimate on output to one is not rejected by the data (p-value =0.13), but leads to a rise in the parameter estimate on the capital stock to 1.69, without marked deterioration in the precision of the estimate. A growing non-financial corporations sector as measured by the capital stock will require firms to hold more money as the depth of production increase

and more transactions are undertaken by firms.[10] Similarly, assuming that real money holdings move in tandem with the capital stock of the corporate sector, an assumption not rejected by the data, leads to a slightly stronger increase in the output elasticity to 1.79.

As expected, a negative relationship between bank interest rates and money holdings is found: an increase in the long-term interest rate on bank borrowing leads firms to reduce their money holdings in order to save costs. An increase in the bank lending rate by one hundred basis point reduces the level of money holdings by 6.5%, while an increase in the own rate of return on money holdings will cause firms to hold more liquid assets, to the order of 11.6%. An equality restriction on both interest rate parameters (spread restriction) can not be imposed, as such a restriction leads to a breakdown of the model.

Overall, while the model seems to explain developments in non-financial corporations' holdings of money quite well, with an R^2 of 0.48, the developments in real gross-added values are surprisingly well captured with an R^2 of 0.80. More factors seem to affect prices than is mapped in the model, as the R^2 is only 0.42.

Chart 3 shows the evolution of the error correction term reported by equation 2. It indicates that since mid-2003, non-financial corporations held (insignificantly) less monetary assets in equilibrium than would have been expected on the basis of this long-run relationship, implying ceteris paribus a supporting force for the adjustment of money holding. In order to gauge, whether the deviations from the equilibrium are meaningful, bounds are constructed on the basis of a grid-search simulation exercise for all unrestricted beta parameters.[11] The bounds indicate that considerable uncertainty is present in evaluating the error-correction term, suggesting that recent money holdings are essentially in-line with long-run demand. In order to illustrate the impact of the various explanatory variables, a decomposition of the annual growth rate of non-financial corporations M3. Chart 4 indicates that the strength of money growth until the end of 2007 Q4 can be explained on the basis of cyclical developments (as captured by the contribution of real gross added-value) and the low level of short-term interest rates. Both factors have stimulated strong growth of bank deposits by non-financial corporations. By contrast, the rise in the rate charged on bank loans has dampened broad money growth recently. Furthermore, a sizeable share of money growth can be explained by the long-run expansion and deepening of the corporate sector, as captured by the capital stock.

Chart 3: Error correction term

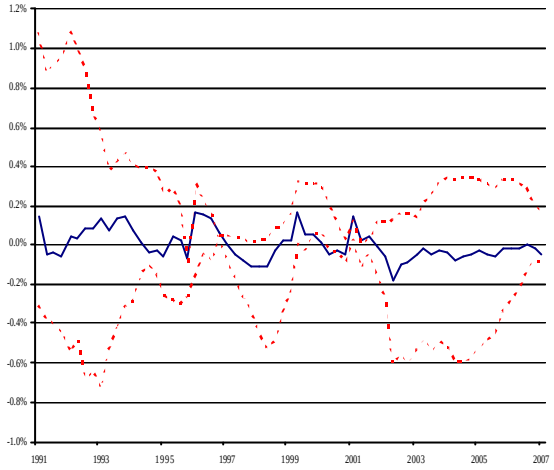
(in percent of sample mean)

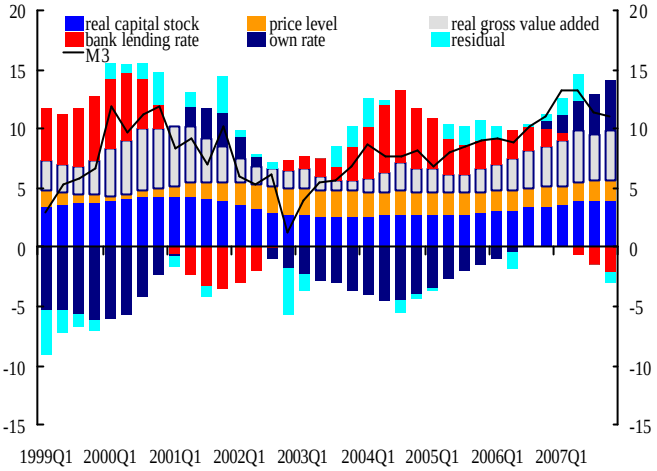
Chart 4: Decomposition of NFC M3 growt

(annual percentage changes)

[10] A similar restriction on the income and wealth parameter is imposed by Thomas (1997). In this estimation, it is not rejected at the 5% significance level. At the same time, linear homogeneity with real money may be imposed on the parameter for income, with the restriction not being rejected at this significance level either. A larger parameter estimate for the capital stock is then observed.

[11] The grid-search begins with fixing the parameter on output at -2.37, one point above the estimated parameter. The other model parameters are re-estimated and the resulting log-likelihood value compared with the log-likelihood value of the main model in an LR test. The parameter values used to construct the bounds refer to the 95% value at which the new parameters do not differ from the parameter values shown in equation 2. The search continues in increments of 0.01. The exercise is repeated for all unrestricted β parameters. The values obtained are similar to the bootstrapped parameter estimates presented below.





In order to assess the statistical properties of the model, Table 5 reports results from several standard misspecification tests on the residuals of the cointegrated VAR model. The results of the LM-test for autocorrelation at lag 1 and 4 do not point to the presence of autocorrelation. The second type of serial correlation tests calculated is the Ljung-Box Portmanteau statistic, which would suggest that some of the dynamics are not fully captured by the model. Both the multivariate test for ARCH in the residuals and the univariate test for ARCH in the M3 in residuals can not reject the null hypothesis of homoskedasticity. The normality test is clearly rejected, due to kurtosis in the residuals, which may not be unexpected given the sample analysed. Equation by equation analysis indicates that the rejection results from the bank lending rate equation, which if corrected for by dummy variables does not materially alter the estimation results.[12] The Nyblom tests conditional on the full sample estimates for the constant and the lagged endogenous parameter values do not point to instability of the long-run parameters for the estimation sample under consideration.

Table 5: Misspecification test for the cointegrated VAR

	Test statistic	p-value		Test statistic	p-value
LM-AR(1)	F(25,43) = 0.93	0.49	Univariate-M3 ARCH	F(4,44) =0.87	0.49
LM-AR(4)	F(25,40) = 1.00	0.46	Normality	F(10,47)= 3.46	0.00
Ljung-Box	151.67	0.05	Nyblom SupF	3.0769	0.8128
Multivariate ARCH	F(15,46) = 1.25	0.18	Nyblom Mean	1.1368	0.7898

Note: P-values derived from comparison with respective distribution.

3.3 Robustness check: Bootstrapping the model

In order to take into consideration, the short nature of the sample - allowing only for 49 degrees of freedom - the results presented above are complemented by parametrically bootstrapping the respective outcomes. The parametric bootstrapping procedure applied, implies drawing new innovations from a multivariate standard normal distribution. These innovations are then transformed into bootstrapped

[12] The results are available from the authors upon request.

residuals by using the estimated covariance matrix from the original estimated residuals. On the basis of the initial values and taking the estimated parameters as given, new data series are constructed and the model re-estimated on the new data set. Generally, the results reported below have been generated with 999 replications.

On the basis of a cointegration rank of one, the LR-test for the two restrictions on the beta matrix, capturing the long-run linear homogeneity between non-financial corporations' money holdings and prices and the restriction of parameter equality between output and capital stock were simulated. Using this approach, the restrictions were more clearly not rejected, with an empirical p-value = 0.35 compared to the p-value based on the asymptotic distribution of 0.21 reported above. Moving on the two restrictions on the load factors suggested by the weak exogeneity tests presented in table 2, these restrictions were also not rejected at conventional significance levels (empirical p-value = 0.13), but seem to be more constraining.

The empirical distribution at the 95% significance level for the parameter estimates of the long-run relationship is presented in equation 3:

$$(m3-p)_t = \begin{matrix}1.431\\1.208\end{matrix} y_t + \begin{matrix}-0.029\\-0.129\end{matrix} BRL_t + \begin{matrix}0.204\\0.066\end{matrix} OWN_t + \begin{matrix}1.431\\1.208\end{matrix} cap_{t-1} \qquad (3)$$

The upper (lower) bound of the empirical interval is presented as the upper (lower) number in equation 3. The outcome of the bootstrapping exercise confirms that the relationship presented in (2) fulfills the requirements for a money demand relationship. These requirements are firstly, a positive scale elasticity and secondly, a negative semi-elasticity on the opportunity costs variable – the bank lending rate. The results also suggest that the scale elasticity is greater than one. An additional important aspect in the evaluation of the relationship found as a error correcting money demand relationship is the sign and magnitude of the α-parameter estimates associated with it. In the case of the M3 equation the α values range between -0.5002 and -0.1599, clearly in negative territory, while the respective ranges for the equation on prices and output are positive, suggesting that indeed all three variables adjust to a disequlibrium in long-run money holdings.

The results of the misspecification tests presented above, evaluated against bootstrapped distributions, indicate a more ambiguous outcome for the LM test for autocorrelation, with p-values close to the 5% significance level (see Table 6). At the same time, however, the results for the Ljung-Box Portmanteau test are overturned more clearly. The presence of ARCH effects in the residuals is also rejected, suggesting that this possible misspecification should not be affecting the model. Normality of the residuals in the system is clearly rejected in the bootstrap exercise as well. Indeed, the presence of large residuals in some equations of the system may be also explain the mixed results observed for the autocorrelation tests.

Given that the stability of the parameter estimates presented in (2) could not be rejected, a more encompassing version of Nyblom Mean and Supremum tests were conducted letting all parameters be updated in the recursion. The results indicate that the null hypothesis of parameter constancy for the cointegration vector can comfortably not be rejected.

Table 6: Misspecification test for the cointegrated VAR

	Test statistic	empirical p-value		Test statistic	empirical p-value
LM-AR(1)	F(25,43) = 0.93	0.14	Univariate-M3 ARCH	F(4,44) =0.87	0.22
LM-AR(4)	F(25,40) = 1.00	0.06	Normality	F(10,47)= 3.98	0.00
Ljung-Box	151.67	0.42	Nyblom SupF	0.6568	0.83
Multivariate ARCH	F(15,46) = 1.25	0.25	Nyblom Mean Q	0.2293	0.82

Notes: Empirical p-values were generated by bootstrapping with 999 replications.

4. Determinants of cash holdings: evidence based on firm-level data

In this section we present various regression results on cash holding determinants using micro data. The data used are derived from AMADEUS of the Bureau van Dijk, containing profit and loss account and balance sheet data on private and publicly owned firms across eleven euro area countries in the period 1990-2005. For the purpose of the analysis we considered euro area private listed and unlisted non-financial enterprises. We excluded the first two years because of the poor coverage across countries and lose some additional years for the construction of the variables for the econometric analysis. The size of our final sample is around 100,000 firms with about 600,000 observations and covers the period 1998-2005. Whenever available, we use the consolidated annual accounts as these are considered to be most suitable for providing information about the financial situation of a company with subsidiaries. When consolidated data are not available, unconsolidated data are used. Differently from previous studies on cash holdings determinants at micro level, which have used databases mainly focussed in large companies (and often just on quoted firms -see for example Oskan and Oskan (2004), Almeida et al (2004) or Han and Qiu (2007)-), the sample includes a large number of SMEs. This is a positive characteristic of this database, since smaller firms are those expected to be more affected by financing constraints and generally hold larger cash holdings.

Table 7 presents some basic features of the dataset across countries. As can be seen, cash holding distribution appears to be positively skewed, the median value being around 7%. The coverage of the AMADEUS database is especially large in France, Spain in Italy an as a result companies in these countries represent the bulk of the sample (around 95%). The sample includes also companies from Austria, Belgium, Germany, the Netherlands and Portugal. Firms in manufacturing sector account for roughly one third of the sample, and also those in trade and repair activities, while firms in service and in construction sectors also account for a significant share of the sample.

Table 7: Micro data descriptive estatistics

		mean	median	standard deviation
L/A	liquidity	0.125	0.071	0.15
CF	cash flow	0.088	0.072	0.10
CV	cash flow volatility	1.039	0.418	2.64
TA	tangible assets over total assets	0.208	0.149	0.19
SP	spread1	0.025	0.025	0.0001
NWC	net working capital	0.406	0.400	0.255
L	indebtedness	0.696	0.716	0.236
Sample composition: sectoral and country distribution (percentage of observations)				
	% observations in sector:		% observations in country:	
	Construction	9.51	Belgium	2.89
	Manufacturing	32.6	France	37.61
	Services	16.66	Italy	22.4
	Trade and Repair	35.01	Spain	36.3
	Others	6.23	Others	0.8
Number of firms		97420		
Number of observations		605784		
Sample period:		1998-2005		
Note: sectors under the heading "Others" include gas, electricity, water supply, transport, storage and communications. Countries under the heading "others"are Austria, Germany, the Netherlands and Portugal				

4.1 Descriptive evidence

Cash holding levels will depend on both the costs and benefits of holding liquid assets. As indicated in the previous section, the costs are associated to the lower return offered by this type of assets in comparison to alternative investment opportunities. The benefits are derived from the need for working capital, given the lack of synchronisation between firms' payments and revenues, and the lower probability of being short of cash if liquidity holdings are high.

As in the macro analysis, the opportunity cost of holding cash is measured by means of the spread between the return of investment in liquid assets and long-term bank rates for loans to non-financial corporations, hence presuming, that repaying loans or holding money, is the main financial investment decisions facing non-financial corporations. In this sense, the opportunity cost of holding cash is likely to be higher for more leveraged firms and hence the liquidity ratio is likely to present a negative relationship with indebtedness (see Baskin, 1987).

As for the benefits of holding cash, the literature on corporate cash holdings emphasises two main motives for holding cash: the transaction costs motive and the precautionary motive. The first one is related to the fact that firms can save transaction costs by using cash to make payments without having to liquidate assets. As it is reasonable to assume that the cost of converting non-cash liquid (or short-term) assets into cash is much lower as compared with other assets, firms with higher levels of short-term assets other than cash are expected to present lower cash holdings. Regarding the second advantage of holding cash, firms might decide to hold cash out of their current cash flow to hedge for the risk of future cash shortfalls, something that might result in foregone investment opportunities. Hence, firms with more profitable investment opportunities might decide to hold more cash to avoid suffering liquidity shortages that might result in foregone good investment opportunities. It has to be noted that this link is the result of capital market imperfections: as pointed out in the literature (see for example Almeida et al, 2004), if firms are financially unconstrained they do not need to safeguard against future investment needs and

corporate liquidity becomes irrelevant and cash holdings would do not depend neither on current cash flows nor on future investment opportunities. In contrast, if firms anticipate financing constraints in the future might respond by hoarding cash today.

We also consider the potential role that cash flow variability can have in determining liquidity holdings: firms with more uncertain revenues might invest comparatively more in liquid assets in order to avoid liquidity shortages; hence, cash flow variability might be positively linked to cash holdings. In the same line, firms with more volatile asset value might decide to hold more cash, something that would imply a negative relationship between the proportion of tangible assets in total assets ratio and cash holdings. Finally, the incentives to hold cash can be different for firms of different sizes due, for example, to differences in the financing constraints they face.

Chart 3 presents the relationship between cash holding levels and several variables that according to the existing theoretical and empirical evidence affect firms' liquidity holdings. The chart presents the median level of cash over assets for firms which show high levels of a given variable (above the 90th percentile), median levels (between the 45th and the 55th percentile) and low levels (below the 10th percentile).

As can be seen in the first panel of the chart, it seems to be a clear relationship between the firms' cash holdings and their cash flow. Firms with higher values of the latter hold higher cash holdings, the difference being specially accused for firms with very high cash flows. Likewise, it is observed that firms with very high levels of tangible assets show substantially lower cash holding levels than firms which present medium and low levels of these assets in their balance sheets, while these later two groups show similar liquidity ratios.

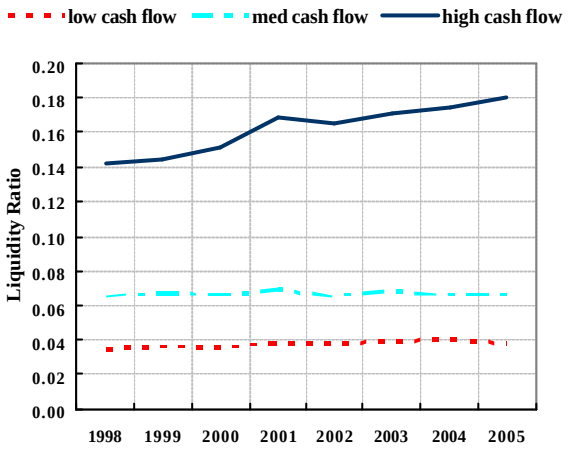
The third panel in the chart also reflects a negative relationship between net working capital (defined as short-term assets minus cash and cash equivalents –net of trade credit- over total assets) and cash holdings, in line with their role as substitutes. Also, as expected, a negative relationship is observed between cash holdings and indebtedness levels, as the cost of holding cash are higher for more leveraged firms.

The relationship between the cash flow variability and liquidity holdings does not seem positive according to this descriptive analysis: firms for which their cash flow volatility is low hold similar cash holding levels that firms with medium levels of volatility, and in fact, and opposite to what would be expected, firms with high levels of volatility seem to hold less cash according to this descriptive evidence. This descriptive analysis does not take into account sectoral or country differences, for example, which might be behind these counter-intuitive results. Finally, the Chart illustrates that firms of different size[13] differ substantially in their liquidity ratios

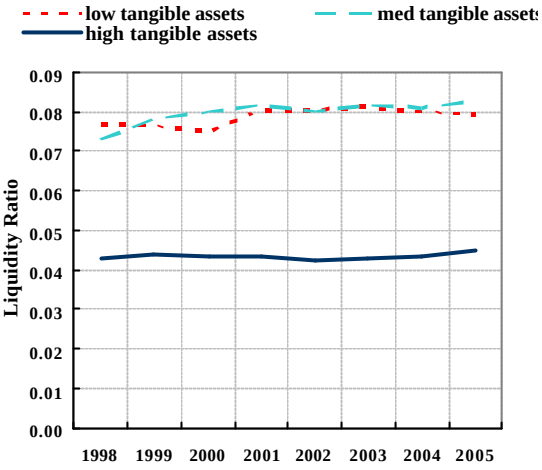
Chart 8: Relationship between cash holdings and some of their theoretical determinants

[13] SMEs are firms that satisfy two out of the following three conditions: maximum number of 250 employees, maximum turnover of 50 mio. Euro and maximum balance sheet total of 43 mio. euro.

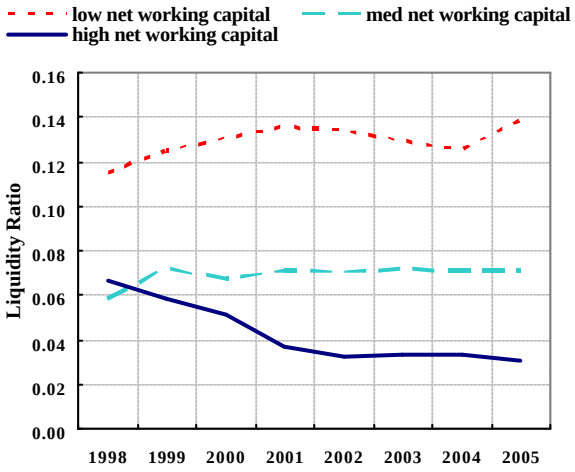
Relationship between firms' liquidity ratio and their cash flow (over total assets)



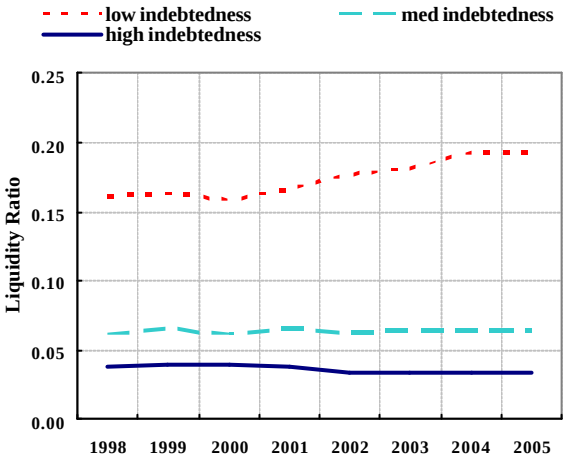
Relationship between firms' liquidity ratio and their tangible assets (over total assets)



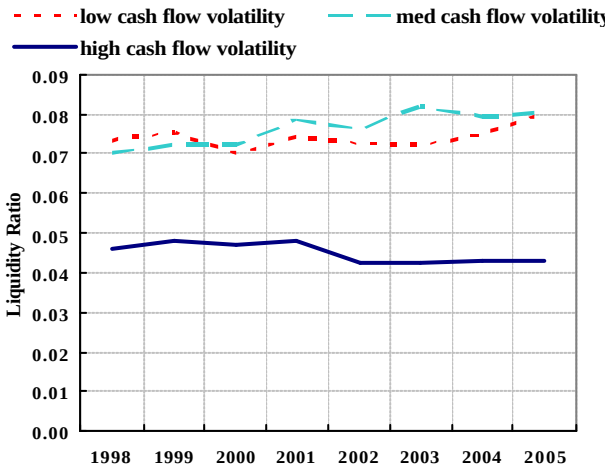
Relationship between firms' liquidity ratio and their net working capital



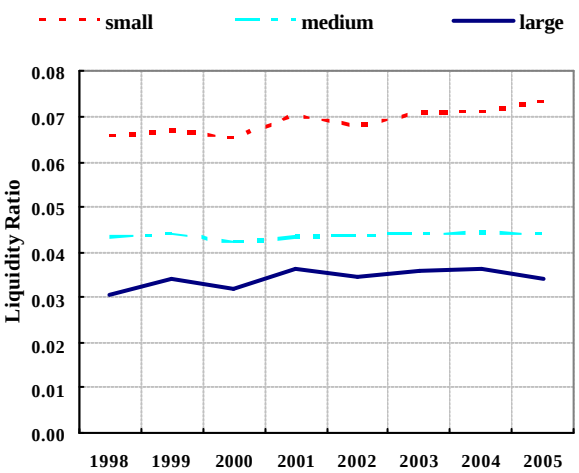
Relationship between firms' liquidity ratio and their indebtedness



Relationship between firms' liquidity ratio and the volatility of their cash flow



Relationship between firms' liquidity ratio and size



Source: Amadeus, Bureau van Dijk and own calculations.

Note: The different panels present the median liquidity ratio for firms with high level of a given variable (above the 90th percentile -cash flow, tangible assets over total assets, net working capital, indebtedness, cash flow volatility or size, depending on the panel-), medium level of that variable (firms for which this ratio stands between the 45th and the 55th percentile) and low level of the variable (lower decile). The liquidity ratio is defined as the ratio of cash and cash equivalents over assets.Net working capital includes short-term assets different from cash and cash equivalents, indebtedness is the ratio of debt over assets, cash flow variability is measured by means of the coefficient of variation of this variable and size is defined as a function of assets, employees and turnover.

4.2 Micro-data based econometric evidence

According with the discussion in section 2.1, cash holdings determinants are analysed empirically by estimating the following equation:

$$Liq_{it} = b_1 Liq_{it-q} + b_2 Liquidity_{it-2} + b_3 spread_t + b_4 CF_{it} + b_5 CV_{it-1} + \\ + b_6 NWC_{it-1} + b_7 TA_{it-1} + b_8 L_{it-1} + b_9 Dmed_{it} + b_{10} Dl\arg e_{it} + a_i + q_t + S_i + e_{it} \quad (4)$$

where i ?ndexes companies *i=1,2..N*?and t indexes year *t=1,2..T.* The liquidity ratio is constructed as the ratio of cash and cash equivalent over total assets, *CF* is the cash flow to total assets ratio[14], *spread* is the difference between long-term interest rate on bank lending to non-financial corporations and M3 rate, *CV* is the cash flow volatility, defined as the coefficient of variation of firms' cash flow over the past five years[15], *NWC* is the net working capital, defined as… *TA* is the ratio of tangible assets to total assets, L_{it} is the leverage ratio (debt over assets) and *Dmed, Dlarge* are size dummies (Dmed takes value 1 for medium-sized firms and) otherwise, while *Dlarge* takes value 1 for large firms and 0 otherwise). a_i are company-specific fixed effects, *? ?*??are time effects that control for macroeconomic influences on fixed investment common across companies and S_i?control for sectoral effects constant over time. e is a serially-uncorrelated, but possibly heteroskedastic error.

Ideally both the cash flow and a measure of growth opportunities, such as the usual Tobin's Q measure, would have been included in the specification, but the database does not include information on the latter and hence it could not be included. In any case, in the absence of financial constraints, no systematic changes in cash holdings are expected as a response to changes in either current cash flows or future investment opportunities.

According to the discussion presented in section 4.1, a positive coefficient is expected for cash flow and cash flow variability, while negative ones are expected for the spread between long-term interest rate on bank lending to non-financial corporations and M3 rate (which is used as a proxy for the opportunity cost of holding cash), net working capital, the ratio of tangible assets over total assets and leverage. Also, if smaller firms are more affected by financing constraints, a negative sign might be obtained for the size dummies taking value 1 when the firm has a medium or large size. Two lags of the endogenous variable are also included to control for potential persistence in cash holdings.

[14] The coefficient of correlation between a weighted mean of this measure (using as weights cash holdings, in line with the analysis that will be presented later) and gross value added in the previous section normalised by the capital stock is 0.54.

[15] That is, the standard deviation divided by the mean (in absolute value) of cash flow in the last five years.

We take into account the potential existence of endogeneity in order to analyse cash holdings determinants. First, it is likely that shocks affecting firm liquidity holdings affect also other firm-specific characteristics such as leverage or the ratio of tangible assets over total assets. The GMM estimation procedure allows controlling for this problem. Second, it is possible that the observed relationship between liquidity ratios and other firms' balance sheet characteristics reflect the effects of cash on the latter or vice versa; to reduce this endogeneity problem, we include all balance sheet right hand side variables lagged one period.

The estimation method consists of the GMM-System estimator proposed by Arellano and Bover (1995) and examined in detail in Blundell and Bond (1998). These models control for unobservable firm-specific fixed effects with the estimator being an extension of the GMM estimator of Arellano and Bond (1991) and estimates equations not only in first differences but also in levels. The use of GMM-System estimator is especially justified in the case of autoregressive models with high persistence in the data such that the lagged levels of a variable are not highly correlated with the first difference, something that results in finite sample biases associated with weak instruments in the first-difference estimator (see Blundell and Bond, 1998). Blundell and Bond (1998) show that in these circumstances also including the levels equations in the system estimator offers significant gains, countering the bias. They also show that in autoregressive-distributed lag models, first-differences of the variables can be used as instruments in the levels equations provided that they are mean stationary. The high levels of serial correlation displayed by several variables included in the models and the fact that they can be regarded as mean stationary favour the use of a GMM-System estimator rather than the first-difference estimator. Lagged levels of the explanatory variables are used as instruments.

The estimation method requires the absence of second order serial correlation in the first differenced residuals for which the test of Arellano and Bond (1991) is presented (labelled M_2). If the underlying models residuals are indeed white noise then first-order serial correlation should be expected in the first-differenced residuals for which we also present the test of Arellano and Bond (1991), labelled M_1. We also report the results of the Sargan test of overidentifying restrictions as test for instrument validity in the GMM-System equations.

First column in Table 8 shows the results obtained. We find the expected first-order serial correlation in our first-differenced residuals while there is no evidence of second order serial correlation, the key requirement for validity of our instrumentation strategy. The Sargan test typically returns a value somewhat above of the standard critical value, but the M2 statistic indicates the key condition for the validity of this method. Blundell et al (2000) report Monte-Carlo evidence showing that the Sargan test tends to over-reject, especially when the data are persistent and the number of time-series observations large. In any case, we have used conservative instruments to help counter the possibility of invalid instruments and checked the sensitivity of the results to changes in the instruments used.

Table 8: Panel data econometric results

	(1)		(2)		(3)	
	Coefficient	p-value	Coefficient	p-value	Coeffic	p-value
$Liquidity_{t-1}$	0.78	0.00	0.79	0.00	0.77	0.00
$Liquidity_{t-2}$	0.04	0.59	0.05	0.48	0.06	0.40
CF	0.17	0.00	0.21	0.00	0.21	0.00
spread	-0.39	0.01	-0.45	0.00	-0.36	0.02
CFV	0.003	0.00	0.004	0.00	0.004	0.00
NWC	-0.03	0.01	-0.02	0.19	-0.02	0.02
TA	-0.04	0.00	-0.02	0.12	-0.03	0.03
BK	-0.02	0.02				
Dsize(medium)	-0.02	0.00	-0.02	0.00	0.00	0.00
Dsize(large)	-0.02	0.00	-0.01	0.00	-0.02	0.00
Short-term debt/Assets			0.00	0.95		
Long-term debt/Assets			-0.02	0.08	-0.02	0.04
Tests (p-values):						
m1	0.00		0.00		0.00	
m2	0.16		0.21		0.27	
sargan	0.03		0.03		0.02	
n. firms	97420		97420		97420	
n. observations	605784		605784		605784	

As can be seen, the first lag of the endogenous variable is found to be clearly significant, indicating persistence in firms' liquidity holdings. The signs expected for the rest of the regressors are also in line with the expectations: the liquidity ratio depends negatively on the opportunity cost of holding cash, as well as on leverage and on the ratio of tangible assets over total assets. Likewise, firms holding higher level of assets that can be considered as cash substitutes (higher net working capital) hold less cash. Results also indicate that cash flow drive cash savings. Likewise, we find evidence that cash flow volatility affect positively liquidity holdings, in line with the precautionary motive for holding cash; more specifically, the estimated coefficient for this variable imply that for an increase of one standard deviation of cash flow volatility, the liquidity ratio increases by 0.8% (11.2% of the median liquidity ratio in the sample).

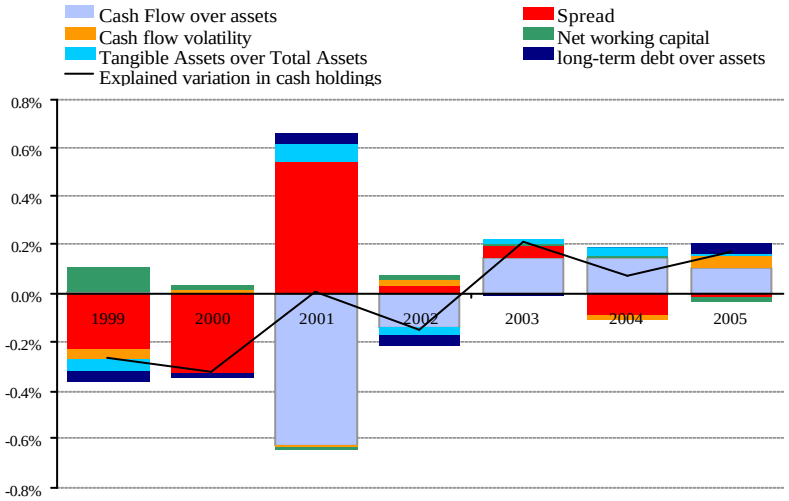
The size dummies are also significant, indicating that firms with different size tend to show differences in their cash holdings: larger firms hold less assets in the form of cash. More specifically, medium and large firms hold, ceteris paribus, liquidity ratios that are 1,6 and 2,1 pp, respectively, lower than those for smaller firms, a difference that seems quite important given the levels observed for this ratio (the median cash holding levels over the sample period is 7%). These differences are however lower than those revealed just comparing median cash holding levels for smaller and larger firms, indicating that differences in some characteristics relevant for determining cash holdings are playing a role in explaining difference in cash holding levels across firm sizes (for example, smaller firms present higher cash flow volatility and lower proportion of tangible assets in their balance sheet, two variables that according to the analysis presented are linked to cash holdings).

Results presented in first column in Table 8 seem indicate that indebtedness and cash holdings are negatively related, in line with the higher opportunity cost of holding cash that more leveraged firms might have. However, there might also be some cost associated to holding little cash when indebtedness is higher, associated to the higher probability of experiencing financial distress. Hence, highly leveraged

firms might decide to hold more cash to reduce this probability, especially those which present higher percentage of short-term debt in their balance sheet. Second column in Table 8, where indebtedness breakdown has been included (between short and long-term debt) indicates that indeed short-term indebtedness is not positively linked to cash holdings, while for long- term liabilities the relationship remains negative. Net working capital and the ratio of tangible assets over total assets appear to be non-significant in this alternative specification but once the short-term indebtedness term is deleted they appear to be significant again (see third column in Table 8).

The econometric results shown in Table 8 indicate that the spread and, to a lesser extent, cash flow seem to be the main drivers of cash holding changes. Chart 9 depicts the relative contribution that the explanatory variables considered above have had in explaining cash holding variations in the last years, using the coefficients presented in Table 2. As can be seen, changes in the spread largely drove cash holdings movements at the end of the 1990s-early 2000s, while in the more recent period they have played a more limited role: from 2002 onwards the variations observed in the spread has been much more limited across countries, and hence also their contributions to liquidity ratio movements. In this period, positive cash flow developments have replaced opportunity cost variations as the main factor contributing to cash holding accumulation. Likewise, in line with the accumulation observed recently in financial assets, the reduction in the proportion of tangible assets in firms' balance sheets seems to have also contributed to cash holdings accumulation, but more modestly.

Chart 9: Factors behind recent changes in liquidity ratio.



5. Conclusion

Understanding the demand for money is an important element of monetary developments analysis, and hence for the assessment of risks to price stability over the medium to longer term. This paper analyses which are the determinants of NFCs cash holdings, both from a macro and a micro perspective.

At a macro level, money holdings are modelled as a function of real gross added value, the price level, the

long-term interest rate on bank lending to non-financial corporations –which is considered as the alternative return to holding money-, the own rate of return on M3 and the real capital stock of non-financial corporations. The disaggregated analysis shows that cash holdings are linked to balance-sheet ratios such as non-liquid short term assets, tangible assets or debt over assets and also to other variables such as cash flow over assets, cash flow volatility or the size of the firm.

Results both from a macro- and micro- perspective indicate that the main drivers of this growth have been cyclical factors, captured by gross-added value and the cash-flow respectively. Variations in the opportunity cost of holding money, measured by the spread between the cost of bank loans and the return on monetary assets, have also contributed to explain M3 developments but more modestly than at the end of the nineties, when their increase contributed negatively to cash accumulation. The growth of non-financial corporations' money holdings is thus, beyond the simple balance sheet relationship between loans and deposits on the MFI balance sheet, linked to developments in the external financing conditions and the activity of non-financial corporations. At macro level, results suggest that the contribution of the build-up of the capital stock to money holdings growth has been recently quite stable. At micro level, results indicate that NFCs asset restructuring (lower tangible asset to total asset ratio, in line with financial asset accumulation observed in the recent period) has contributed positively to recent increase in cash holdings, although more modestly than cash flow developments.

6. Annex

Table X1: Results of unit root tests

Variables	ADF			Phillips Perron		
		t-Statistic	p-value*		t-Statistic	p-value*
m3	(CT,3)	-0.66	0.97	(CT,5)	-0.43	0.98
y	(CT,1)	-2.89	0.17	(CT,4)	-2.64	0.26
p	(CT,0)	-2.97	0.15	(CT,5)	-3.15	0.10
BLR	(C,2)	-1.76	0.40	(C,3)	-1.76	0.40
OWN	(C,5)	-2.78	0.07	(C,4)	-1.64	0.46
cap	(CT,6)	-2.54	0.31	(CT,6)	-3.03	0.13
1st difference						
m3	(C,2)	-2.09	0.25	(C,2)	-28.23	0.00
y	(C,4)	-4.07	0.01	(C,2)	-4.41	0.00
p	(C,2)	-2.69	0.08	(C,4)	-6.03	0.00
BLR	(N,1)	-3.36	0.00	(N,2)	-4.98	0.00
OWN	(N,2)	-3.53	0.01	(N,1)	-3.40	0.00
cap	(C,4)	-4.42	0.00	(C,5)	-2.89	0.05

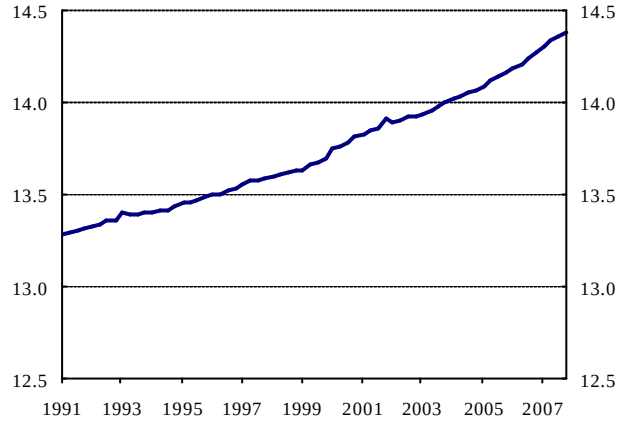
*MacKinnon (1996) one-sided p-values. Note: (C,X) C indicates estimated with a constant or constant and trend or no intercept, X = lag length.

Table X2: Lag length determination

Lag	Likelihood Ratio Test	Akaike Information Criterion
0	NA	-18.31015
1	1262.849	-39.71817
2	119.9661	-40.97464
3	57.24698*	-41.13285*
4	37.42066	-40.97474
5	40.85697	-41.10867

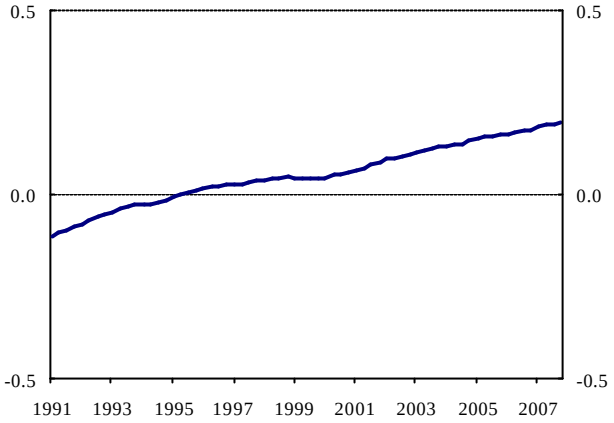
Charts 1-6: Macroeconomic time series

Chart 1: Log of M3



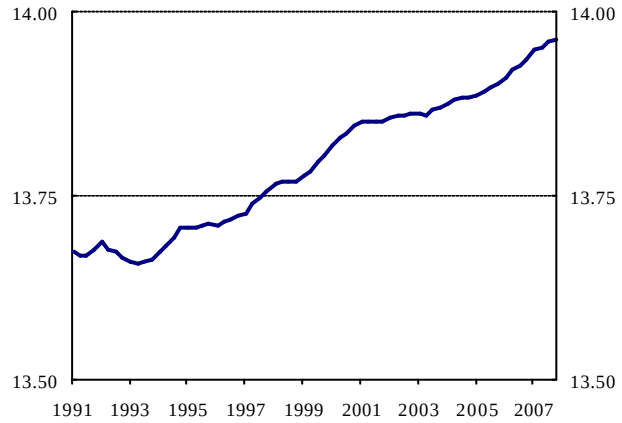
Source: ECB calculations

Chart 2: Log of gross value added deflator



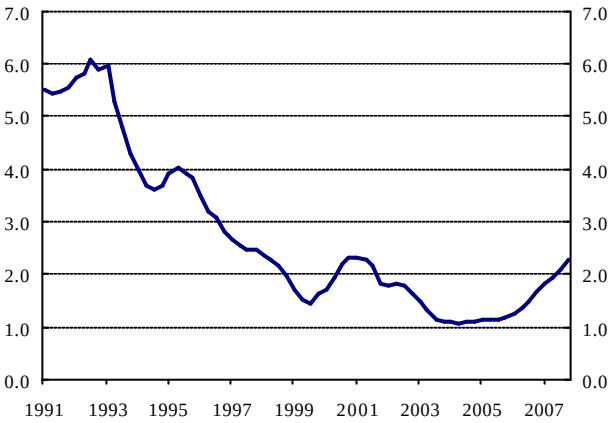
Source: ECB calculations

Chart 3: Log of real gross value added



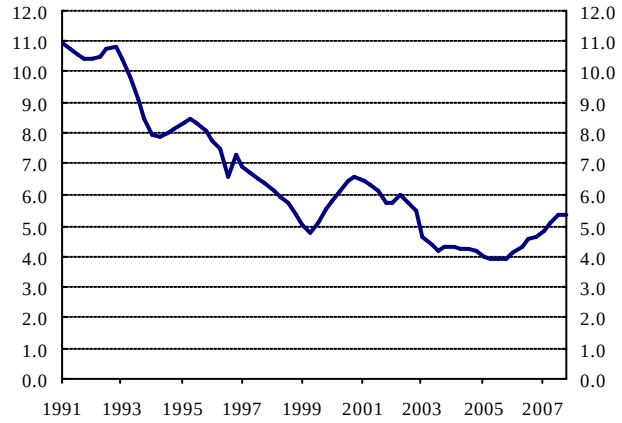
Source: ECB calculations

Chart 4: Own rate of return on M3



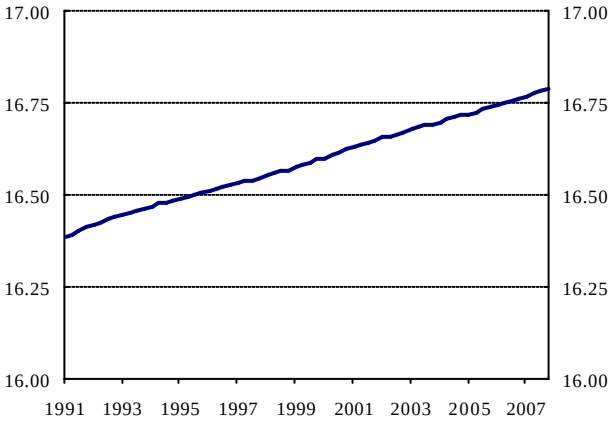
Source: ECB calculations

Chart 5: Long-term nominal bank lending rate



Source: ECB calculations

Chart 6: Log of capital stock



Source: ECB calculations

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