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2010

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Documentos de Trabajo
N.º 1033

BANCO DE ESPAÑA
Eurosistema

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(*) We are grateful for comments received from Thomas Westermann and other participants in internal seminar held at the ECB and at the XI Ecuentro de Economía Aplicada. The views expressed in this paper are those of the authors and do not necessarily reflect those of the European Central Bank, the Banco de España or the Eurosystem.

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Documentos de Trabajo. N.º 1033
2010

ISSN: 0213-2710 (print)
ISSN: 1579-8666 (on line)
Depósito legal: M. 46325-2010
Unidad de Publicaciones, Banco de España

Abstract

This paper analyses euro area 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, the own rate of return on M3 and the real capital stock of NFCs. The results indicate that NFCs money holdings adjust quickly when deviations from their long-run level are registered, and that the large increase observed recently in NFCs money holdings has been driven by changes in their fundamentals and hence they stand in line with their long-run equilibrium level. The disaggregated analysis also shows that cash holdings are linked to balance-sheet ratios (such as non-liquid short term assets, tangible assets or indebtedness) and other variables such as the firm' cash flow, its volatility or the size of the firm, which cannot be taken into account in the macro analysis. Likewise, results indicate that the main drivers of the increase in NFCs cash holdings in the last years 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 its increase contributed negatively to cash accumulation.

Keywords: money demand, coinegrated VARs, panel estimation.

JEL Classification Numbers: E41, C23, C32, D21.

Non-technical summary

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 this paper we analyse the demand for money by euro area non-financial corporations (NFCs), both from a macro and a microeconomic point of view. Non-financial corporations (NFCs) currently hold around 20% of the broad money stock M3. Although holding a smaller share than households, over the past two decades, NFC deposits have grown more quickly and fluctuate more widely than those of households, implying an increasing role in aggregate monetary dynamics.

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, the own rate of return on M3 and the real capital stock of NFC. The results indicate that NFC money holdings adjust quickly when deviations from their long-run level are registered, and that the large increase observed recently in NFCs money holdings has been driven by changes in their fundamentals and hence they stand in line with their long-run equilibrium level. In order to verify the econometric results, results on the basis of bootstrap methods are also provided. However, the results also indicate that a more comprehensive examination of the relationship between cash holdings and firms' characteristics may be needed in order to fully grasp the forces impacting on non-financial corporations money demand.

In contrast with most previous studies on cash holdings at firm-level, which have been predominantly based on datasets where large firms prevail, a panel with a large share of small and medium-sized firms, which represent the bulk of the euro area corporate sector and tend to hold more cash than large firms, has been used in this study. In the micro analysis, the implicit elasticity of cash holdings to the opportunity cost of holding cash is lower than that obtained in the macro part, something that might be due to a lower cash sensitivity to changes in the opportunity cost for smaller firms. Likewise, the firm-level analysis shows that cash holdings are linked to balance-sheet ratios (such as non-liquid short term assets, tangible assets or indebtedness) and other variables such as the firm' cash flow, its volatility or the size of the firm, which cannot be fully taken into account in the macro analysis. Similarly to the findings of the macro analysis, the micro results indicate that the main drivers of the increase in NFCs cash holdings in recent years have been cyclical factors, captured in this case by the cash-flow. Variations in the opportunity cost of holding money, have also contributed to explain money growth but more modestly than at the end of the nineties, when their increase contributed negatively to cash accumulation.

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.

Non-financial corporations (NFCs) currently hold around 20% of the broad money stock M3. Although holding a smaller share than households, over the past two decades, NFC deposits have grown more quickly and fluctuate more widely than those of households, implying an increasing role in aggregate monetary dynamics. At the same time, the modelling of NFC money demand poses a number of challenges.

First, non-financial firms devote important resources to managing their financial situation, and this degree of sophistication presumably leads to a different interaction between money, opportunity costs and income than in the case of households. NFCs money demand is determined by a wider range of relevant scale variables, such as investment, output or the wage bill, than is the case for households, and by a larger spectrum of alternative investment opportunities. Available studies at the macroeconomic level confirm that modelling non-financial corporations' money demand behaviour proves to be more challenging than households.[1]

Second, in the case of NFCs, a parsimonious macroeconomic characterisation of the main forces driving money demand suffers significantly from underlying heterogeneity. Put differently, the macroeconomic analysis of NFC money demand may benefit substantially from enhancing it with a more detailed firm level perspective. Indeed, sizeable heterogeneity in terms on money demand can be found across the euro area non-financial corporate sector, for instance when cutting across cash holdings by size, sector of activity or level of indebtedness. Such characteristics may only be treated by the analysis using firm-level data. In this sense, the macroeconomic modelling framework generally employed to investigate money demand —the cointegrated VAR— which relies on the existence of a target level for money holdings related to a set of determinants, benefits conceptually from a better understanding of the firms' management based on microeconomic evidence. Importantly, the relationship identified at the aggregate level may, in fact, result from heterogeneous adjustment behaviour of firms' cash holdings. The importance of target levels in firms' liquidity management is thus an empirical issue to be determined on the basis of micro-data in order to support the macroeconomic analysis.

Money demand at the microeconomic level reflects transactions, portfolio and precautionary considerations, with a comprehensive set of determinant variables. For instance, the transactions demand for money can be readily related to the receipt of revenues from a firm's sales, payments for wages or the cash flow. Portfolio considerations are driven by the opportunity costs of holding highly liquid assets, while foregoing higher returns from alternative investment opportunities or the need to roll-over debt. In this respect, a

1. See for instance Thomas (1997), p.7; Jain and Moon (1994), p. 197, and von Landesberger (2007), p. 20.

precautionary demand for money may also exist (that is, to cover against the risk of potential cash shortfalls), which has been the basis for some studies developed recently as a tool to analyse the existence of financing constraints [see for example Almeida, Campello and Weisbach (2004), Riddick and Whited (2009) or Han and Qiu (2007)]. The interaction between financing constraints and money holdings is more approachable at the micro- than the macro-level. Investigating non-financial corporations' money holdings from a micro perspective adds an additional dimension to the understanding of the relationship between money holdings, income and interest rates for the corporate sector.

In addition, at a methodological level, the estimation of money demand equations with time series data may face a number of problems, which are not present when applying panel techniques to the data. As indicated for example by Bover and Watson (2005), scale elasticity measures derived using macro level can be biased due to correlation between unobservable technological innovation through time and scale variables for money demand (for example, financial development may have an impact on both money demand and output). Thus estimates for scale and interest rate elasticities and adjustment speeds at the firm level may give more meaningful indications for the magnitude of these behavioural parameters than estimates at the aggregate level.

In this context, this paper complements the study of non-financial corporations broad money demand at a macro level with a firm level analysis of cash holdings. The empirical microeconomic money demand literature uses the term "cash (and cash equivalent) holdings", when referring to a broad measure of firms' liquid assets comprising *inter alia* of holdings of notes and coins, bank deposits and short-term liquid securities. Similar monetary assets are included in the broad monetary aggregate M3. While the definitions of money in the micro- and macro-part are not completely harmonised, the overall breadth of the two measures employed should go some way to allow a comparability of the results with regard to, for instance, the demand motives and the interest rate sensitivity.

In contrast with most previous studies on cash holdings at firm-level, which have been predominantly based on datasets where large firms prevail, a panel with a large share of small and medium-sized firms (SMEs), which represent the bulk of the corporate sector and tend to hold more cash than large firms, has been used in this study. In this sense, contrasting with the analysis here presented, previous studies on NFCs cash holdings for the whole euro area are scarce [see Ferreira and Vilela (2004) and, focussing on the variation of the cash holding ratio, Pál and Ferrando (2006)] and just focussed on large corporate groups or publicly traded companies.

The paper is structured in four parts. In the first section, the paper provides a brief overview of the literature on money demand of non-financial corporations. In the second one, a money demand system for euro area NFC holdings of M3 is presented. The results of this exercise raise a number of questions which the third section, presenting an analysis of cash holdings for euro area non-financial corporations on the basis of panel estimations attempts to clarify. The last section summarises the findings of the two strands of analysis.

2 Related studies

There is a fairly comprehensive body of literature that provides results for the United States and the United Kingdom. With respect to the euro area, analysis has been conducted for some member states, but at the area-wide level evidence is only limited. 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. The results found for the non-financial business sector were unsatisfactory.

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 and GDP as well as other explanatory variables such as 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 proportion of firms reporting more than adequate stocks of finished goods, suggesting a precautionary demand for liquid assets. The implied semi-elasticity on the interest rate term is negative and significant and 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), who uses a 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 used 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 quarter in terms of money holdings.

For the euro area, in a comparative study von Landesberger (2007) using cointegrated VARs finds that NFCs'M3 holdings display a higher long-run income elasticity with respect to real GDP than households and a lower long-run elasticity of money holdings with respect to government bond yields than financial firms.

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 is briefly reviewed.

Bover and Watson (2005) 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, which may reduce money demand by reducing the sales elasticity. They 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 (2005). They estimate a basic equation whereby money is explained by the firms' size, labour cost and capital cost measures with all variables in logarithms. Annual constant 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 also control for firm-specific effects and report an estimated sales elasticity of around 0.5. In no case is the hypothesis of constant returns to scale accepted.

Bruinshoofd and Kool (2004) investigate Dutch corporate liquidity management practices, using a simple error correction model of corporate liquidity holdings. 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. They find that the rate of convergence to the target level is faster when they include firm-specific information in the target definition.

For the US, Opler, Pinkowitz, Stulz and Williamson (1999) examine the determinants and implications of holdings of cash and marketable securities by publicly traded 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 have a large short-run impact on capital expenditures, acquisition spending or payouts to shareholders.

Almeida, Campello and Weisbach (2004) and Han and Qiu (2007) have focussed on the estimation of liquidity holding equations as a tool to assess the existence of financing constraints using data for US companies. 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. However, as for the link between cash flow and cash holding accumulation, Riddick and Whited (2009) find that, after controlling for Tobin's q —and controlling for measurement errors in this variable—, cash holding accumulation and cash flow are negatively related. In the same line, Almeida, Casmpello and Weisbach 2009 find, once relaxing the assumptions in Almeida, Casmpello and Weisbach 2004, that a positive cash flow sensitivity of cash does not provide evidence in favour of the existence of financing constraints. Likewise, 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.

As has been already mentioned, the studies analysing corporate cash holdings at euro area level are scarce and focussed on large firms. Ferreira and Vilela (2004) analyse the determinants of corporate cash holdings in EMU countries for publicly traded firms, while Pál and Ferrando (2006) analyse the changes in firms' liquidity ratios from the standpoint of identifying financing constraints. In the first one of these papers, cash holdings of publicly traded firms are found to be positively linked to investment opportunities and to cash flow, and negatively linked to leverage and size. The paper by Ferrando and Pál is based on the same database than we use here, but their analysis relies on firms reporting consolidated accounts, which are usually not available for small firms, and hence, as in Ferreira and Vilela (2004), large companies and large corporate groups prevail in their sample.

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 using growth rates for money market funds, currency in circulation and debt securities holdings derived from estimates constructed according to the approach outlined in the August 2006 Monthly Bulleting box entitled "Construction of estimates of sectoral M3 aggregates".[2] For the period before 1999, the dynamics of the series are thus very close to the pattern of the series used by von Landesberger (2007), with divergences resulting from minor revisions to the deposit holdings. The non-financial corporations sector comprises companies engaged in industrial and services activity (except firms and subsidiaries engaged primarily in treasury and financial activities, which, with the exception of insurance corporations and pension funds, belong to the non-monetary financial intermediary sector).

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).* Thus, the relevant measure of the price level *(p_t)* is then deflator for gross added value in industry and services. For the period before 1999, nominal and real gross value added are constructed from series in national legacy currencies and aggregated using the conversion rates to euro fixed at the end of 1998. This approach mirrors the approach taken for monetary aggregates and thus ensures that exchange rate effects do not influence the relative dynamics of the series.

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 [see 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.

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

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

were carried out. 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, but the Phillips-Perron test clearly rejects the null hypothesis. We hence consider the series as I(1).

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 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):

$$\Gamma(L)y_t = \delta_0 + \alpha\beta' Y_t + \Psi(L)x_t + \varepsilon_t \tag{1}$$

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 ε_t are assumed to be normally distributed. 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 2 in the annex). LM tests for autocorrelation in the residuals of the models revealed no remaining dynamics at the 5% confidence interval.

The rank of the vector product $\alpha\beta'$ 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 and a non-zero intercept in the cointegration relationship.[3] The results of the trace test are presented in Table 1 below together with bootstrapped p-values.[4] They indicate 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. Therefore, in the following a rank of one is assumed for modelling this system.[5]

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3. 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.

4. 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 [see Juselius (2006), p. 157]. The use of bootstrapped values is also required by the inclusion of an exogenous I(1) variable in the model (the asymptotic distributions are not meaningful critical variables in this situation).

5. 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 particularly at the beginning of the period of recursion the trace test may suffer from problems of power, given the short sample available.

Table 1: Trace-test

Rank	LR trace	bootstrapped 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

Tests on the stationarity of the cointegrating variables confirm the assessment made on the order of integration, since they do not suggest that variables can be excluded from the long-run relationship on the grounds of stationarity. 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 weak exogeneity were conducted, to examine which variables are affected by deviations in NFCs' cash holdings from the long-run relationship (see Table 2). 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 were found to adjust to the disequilibrium in money holdings with respect to their long-run level. In the model, the long-run forcing variables for money, prices and output are thus the two interest rates and the capital stock.

Table 2: Tests supporting 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

In order to assess whether real money played a significant role in the equilibrium relationship or whether, the relationship was in fact an investment equation only linking interest rates, production and the capital stock, tests on the exclusion of the money and prices variables were conducted. The test rejected the exclusion of money and prices from the cointegrating vector at the 5% significance level.

At a theoretical level, the money demand is 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. The implied price deflator for real gross value added may however be an imperfect measure of firms' price considerations. Deviations from strict parity could therefore result from a measurement error. However, the neutrality restriction is not rejected at the 5% significance level (p-value = 0.08), with small deviations from neutrality proving to be less constraining for the model. 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 (p-value = 0.19). Introducing only the restriction on the parameters of output and capital stock would lead to a point estimate on the price level of 0.98, very close to unity. Together the two restrictions are clearly not rejected by the appropriate F-test (p-value = 0.21). The long-run relationship found is

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

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 = 0.13).

The long-run relationship explains non-financial corporations' demand for money as positively 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 = 0.14), 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.[6] 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, in line with the results in Brigden and Mizen (1999) for the UK: an increase in the long-term interest rate on bank borrowing leads firms to reduce their money holdings in order to save financing 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.

An important aspect of the analysis of cointegration is to provide some estimates of the speed with which the economy or the markets under consideration return to their equilibrium states, once shocked. The estimated parameters indicate that the return to the equilibrium when money holdings depart from their long-run level is achieved not only through an adjustment in this variable but also through changes in prices and gross value added. More specifically, these two variables adjust upwards when M3 is above its long-run level.

As discussed by Pesaran and Shin (1996), the most obvious method to examine the speed of adjustment would be to apply the impulse response approach to estimate the time profile of the effect of 'particular' shocks on the cointegrating relations. This method raises the issue of the orthogonalisation of the shocks, which can be influenced by the ordering

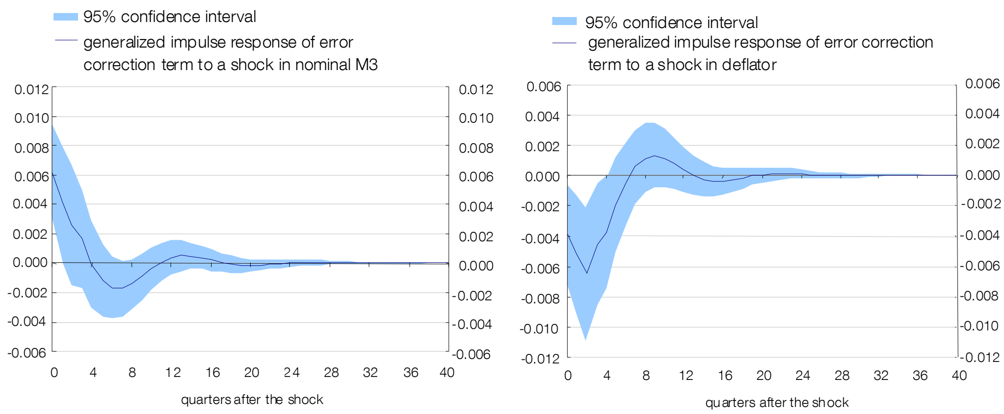
6. A similar restriction on the income and wealth parameter is imposed by Thomas (1997). In this estimation, it is not rejected at the 5% significance level. At the same time, linear homogeneity with real money may be imposed on the parameter for income, with the restriction not being rejected at this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

of the variables in the case of Cholesky decomposition. As proposed by Warne (2008), the generalized impulse response provides a tool to measure how quickly the long-run relation converges to its steady state values after a shock, without the need to identify structural shocks. The speed of adjustment implied by the estimated parameters is quite large, suggesting that NFCs adjust their money holdings relatively quickly to approach their optimal level.

Chart 1 shows the adjustment of the long-run relation in response to (generalized) shocks to nominal M3 holdings and price deflator. While the path of the adjustment differs for the two variables —one is initially positive and the other negative—, the chart indicates that after around 20 quarters any divergence from the baseline has disappeared. Taking a 95% confidence interval into account, the divergence is not significantly different from zero between 2 and 4 quarters after the shock, suggesting a rapid adjustment, also in comparison with other studies based on macroeconomic data.[7]

Chart 1: Adjustment to long-run equilibrium quantified by generalized impulse responses

(deviation from baseline in percent)



In line with the view that the disequilibria dissipate rapidly, the error correction term, shown in Chart 2, has stood at very low levels over the sample period, indicating that money holdings have been broadly in line with the value implied by their fundamentals during this period. 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[8] the bounds suggest that recent money holdings developments are essentially in-line with their long-run determinants, although considerable uncertainty is present in evaluating the error-correction term.

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7. The impulse responses for the other variables included in the model do not paint a different adjustment pattern and are not shown for conciseness. The results are available upon request.

8. 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.

The dynamic model seems to explain changes in non-financial corporations' level of activity and money holdings of money quite well. More specifically, Chart 3 shows the quarterly growth rate of euro area real gross value added in industry and services and the ones that would be derived from the model. The fluctuations in real gross-added values appear to be well captured with an adjusted R^2 of 0.80. No protracted deviations between the two series are discernable. Tests for Granger-causality strongly reject the hypothesis that non-financial corporations' money holdings do not contribute to the explanation of economic activity, with a sizeable share of the fluctuations explained by the error correction term, Taken together, this supports the view that non-financial corporations' broad money holdings comprise significant cyclical information.

Chart 2: Error correction term

(in percent of sample mean)

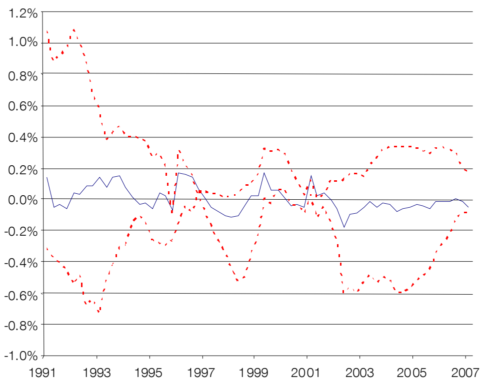


Chart 3: Actual & fitted for gross value added

(quarterly growth rate in percentage points)

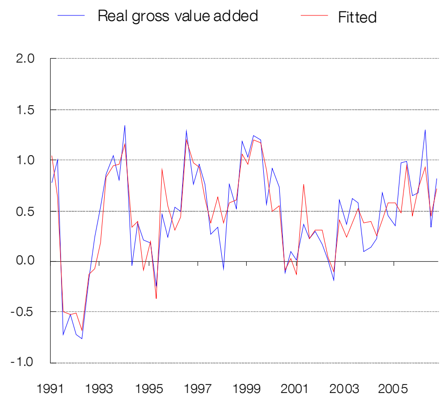
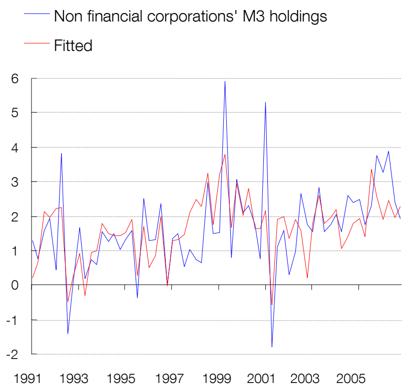


Chart 4 illustrates the developments in M3 holdings of non-financial corporations as well as the ones that would be derived from the cointegrated VAR model. The adjusted R^2 is lower than for economic activity with 0.48. Overall the main fluctuations are captured by the equation, even several large outliers can be identified, which however reverse rapidly. In order to illustrate the impact of the various explanatory variables, Chart 5 shows a decomposition of the annual growth rate of non-financial corporations M3 following the methodology outlined in Fischer et al. (2008).[9] It 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 impact from the own rate on M3 holdings. 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 in the most recent quarters. 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.

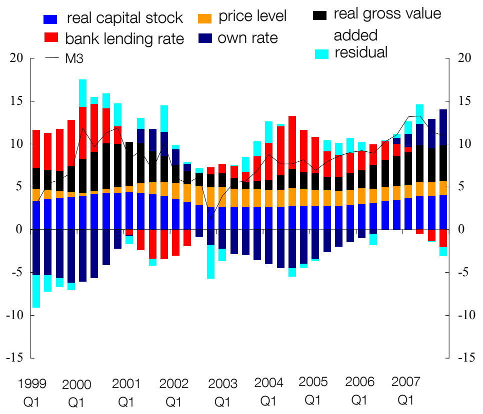
9. For a detailed description of the methodology see Appendix C of Fischer, B. et al. (2008), p. 169.

Chart 4: Actual and fitted M3 holdings **Chart 5: Decomposition of NCF M3 growth**

(quarterly growth rate in percentage points)



(annual percentage changes)



In order to assess the statistical properties of the model, Table 3 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 is at the margin of significance and hence would suggest that some of the dynamics might 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. Equation by equation analysis indicates that the rejection results from the bank lending rate equation which if corrected for by a dummy variable for an additive outlier in 1996 Q3/Q4 and in 2003 Q1[10] does not materially alter the estimation results.[11] While the introduction of dummy variables does allow to recover the normality in the residuals, it also complicates the appropriate modelling of trends in the data, which is core to the modelling of the long-run relationship. Had the non-normality of the residuals resulted from the presence of outliers in the M3, prices or output equation of the VAR, then the non-normality would need to be considered more concerning and possibly warrant a different approach. 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.

10. The dummy in 2003 Q1 captures the level shift resulting from the change-over to the MFI interest rate statistics (MIR) and the ensuing necessary linking with the previously available retail interest rate statistics (RIR) used to construct the series before 2003.

11. The full set of results is available from the authors upon request. Correcting for the additive outlier in 1996 Q3 and Q4 and 2003 Q1, the statistic of Doornik-Hansen test for normality is F (10,45) = 1.0110, with a p-value = 0.4492. The dummy variables are highly significant in the equation for the bank lending rate (t-statistic -4.2709 and 7.6465 respectively).

Table 3: 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 —which allows 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 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. 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:

$$(m3-p)_t = {}^{1.431}_{1.208} y_t + {}^{-0.029}_{-0.129} BRL_t + {}^{0.204}_{0.066} OWN_t + {}^{1.431}_{1.208} cap_{t-1} \tag{3}$$

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 that the results for the Ljung-Box Portmanteau test are overturned more clearly (see Table 4). The presence of ARCH effects in the residuals is also rejected. Nyblom Mean and Supremum tests indicate that the null hypothesis of parameter constancy for the cointegration vector can comfortably not be rejected.

Table 4: 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.

3.4 Main findings

Several findings can thus be reported: At the macroeconomic level, euro area broad money holdings for the non-financial corporate sector can be explained by developments in real gross added value as found for Germany by Read (1996). A strong cyclical element characterises the dynamics of non-financial corporations M3 holdings. The real capital stock of non-financial corporations, which can be interpreted as a measure of real corporate wealth [see Thomas (1997) and Brigden and Mizen (1999)] or also as a variable capturing the size of the corporate sector and thus as a natural scaling variable, enters as additional scale variable into the model. The role of firm size for firms' cash holdings may be investigated more deeply at the firm-level, and will be addressed in the next Section. Furthermore, the role of the capital stock for money demand may be linked to its use as collateral in borrowing. Hence, examining the role of tangible assets for firms' cash holdings could provide additional insights into the interpretation of the capital stock.

The interdependence between firms' decisions to borrow funds and to hold money is also supported by the negative impact of the long-term interest rate on bank lending to non-financial corporations, considered in the analysis as the alternative return to holding money. A more comprehensive examination of the relationship between cash holdings, borrowing and a firm's characteristics, such as size and sector of activity, can thus improve the understanding of firm's money demand.

4 Determinants of cash holdings: evidence from firm-level data

In this section we present an analysis of cash holding determinants based on 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. Thus, since many small-and medium-sized (SMEs) firms provide only unconsolidated accounts, we are able to include in our sample a large number of SMEs,[12] which would have been excluded otherwise. Hence, differently from previous studies on cash holdings determinants at micro level, which have used databases where large companies prevail, our sample includes large share of SMEs, which are those those expected to be more affected by financing constraints and generally hold larger cash holdings.

Table 5 presents some basic features of the dataset. As can be seen, cash holding distribution appears to be positively skewed, the median value being around 7%. Firms in manufacturing sector account for roughly one third of the sample, and also those in trade and repair activities, while firms in the services and construction sectors also account for a significant share of the sample.

Table 5: Micro data descriptive statistics

			mean	median	standard deviation
Liq	liquidity		0.125	0.071	0.15
CF	cash flow		0.088	0.072	0.10
CFV	cash flow volatility		1.039	0.418	2.64
TA	tangible assets over total assets		0.208	0.149	0.19
spread	spread		0.025	0.025	0.008
NWC	net working capital		0.406	0.400	0.255
L	indebtedness		0.696	0.716	0.236
Sample composition					
	% of observations in sector:	Construction			9.51
		Manufacturing			32.6
		Services			16.66
		Trade and Repair			35.01
		Others			6.23
	% of SMEs		95.1		
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.

12. Size class definition is based on the classification adopted by the European Commission, which relies on the number of employees and a joint condition on either total assets or turnover. More specifically, SMEs are firms that satisfy two out of the following three conditions: maximum number of 250 employees, maximum turnover of 50 million Euro and maximum balance sheet total of 43 million Euro.

4.1 Descriptive evidence

This section presents a descriptive graphical analysis on the relationship between firms' liquidity ratio and its potential determinants, that is, those variables linked to either the opportunity cost of holding cash or its benefits.

The costs of holding cash are associated to the lower return offered by this type of assets in comparison to alternative investment opportunities. 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 (associated to the lack of synchronisation between firms' payments and revenues) and the precautionary motive (linked to the existing uncertainty regarding future cash inflows and outflows and the subsequent probability of being short of cash if liquidity holdings are low). 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, other things equal, lower cash holdings.

Regarding the second advantage of holding cash, firms might decide to hold cash to hedge future investment against possible income shortfalls, in the context of credit market imperfections. As pointed out in Han and Qiu (2007), if a firm has unrestricted access to external funds, it has no need to safeguard against future investment needs and hence its cash policies should not depend on cash flow variability. In contrast, firms anticipating financing constraints in the future might decide to hoard cash today when they have more volatile cash flows.[13] Similarly, 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 degree of financing constraints they face. Chart 6 presents the relationship between cash holding levels and several variables that can 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, 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 reflects a negative relationship between net working capital (defined as short-term assets minus cash and cash equivalents —net of trade credit—

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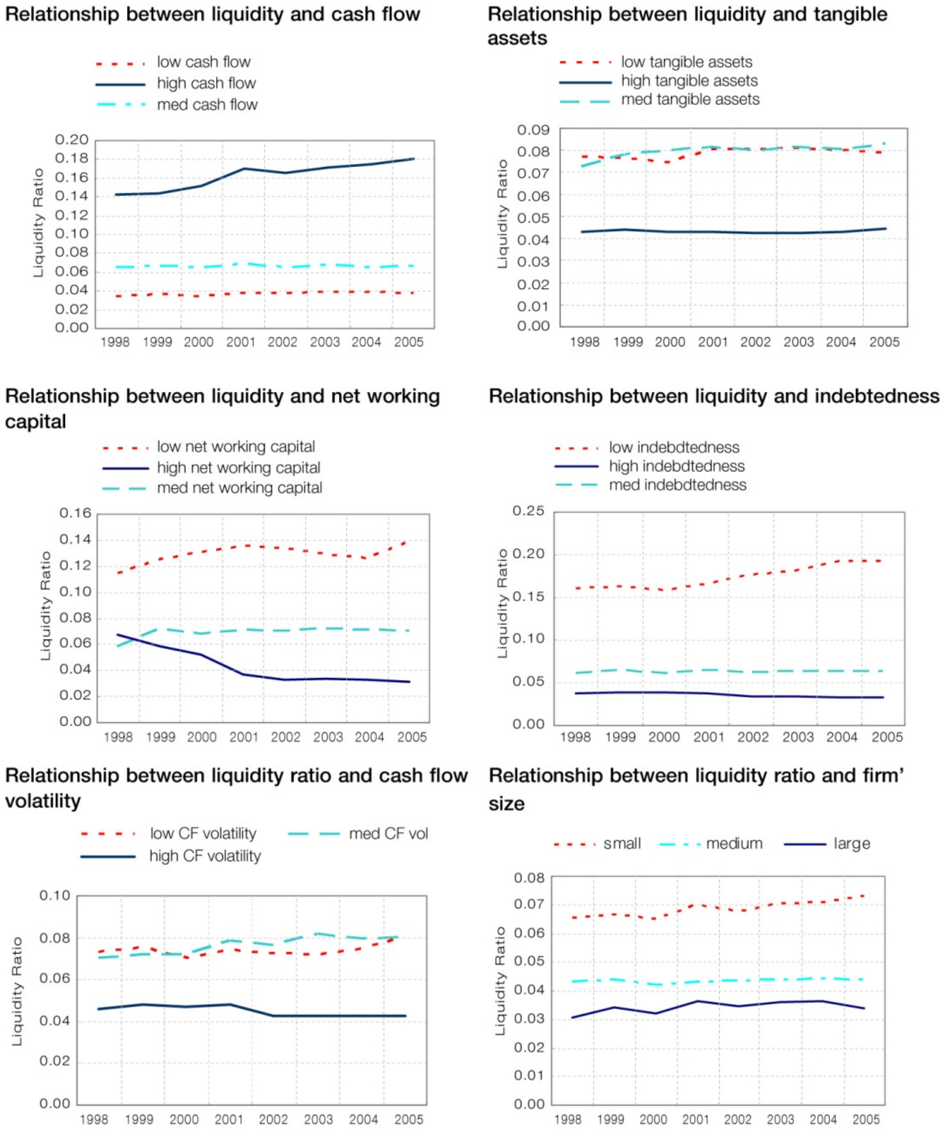
13. The analysis of cash policies as a tool to identify financing constraints has also been used in Almeida, Campello and Weisbach (2004). They linked the existence of financing constraints to a positive sensitivity of cash holdings to cash flow; however, the same authors conclude later that that a positive sensitivity of cash holdings to cash flow is not necessarily a sign of financing constraints (see Almeida, Campello and Weisbach, 2009).

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 differ substantially in their liquidity ratios, being the largest firms the ones that show the lowest median values for this ratio.

Chart 6: Relationship between firms' cash holdings and their determinants



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 55^{th} 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 is the ratio of short-term assets different from cash and cash equivalent over assets, 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

We analyse empirically which are the determinants of cash holdings by estimating the following equation:

$$\begin{aligned} Liq_{it} &= \beta_1 Liq_{it-q} + \beta_2 Liquidity_{it-2} + \beta_3 spread_t + \beta_4 CF_{it} + \beta_5 CFV_{it-1} + \\ &+ \beta_6 NWC_{it-1} + \beta_7 TA_{it-1} + \beta_8 L_{it-1} + \beta_9 Dmed_{it} + \beta_{10} Dl\arg e_{it} + \alpha_i + \theta_t + S_i + \varepsilon_{it} \end{aligned} \quad (4)$$

where i indexes 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 (short term assets minus cash and its equivalents over total assets), *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 0 otherwise, while *Dlarge* takes value 1 for large firms and 0 otherwise). α_i are company-specific fixed effects, θ_t, are time effects that control for macroeconomic influences on cash holdings common across companies and S_i control for sectoral effects constant over time. ε is a serially-uncorrelated, but possibly heteroskedastic error.

According to the discussion presented in section 4.1, a positive coefficient is expected for 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, in line with the analysis presented in the previous section), net working capital, the ratio of tangible assets over total assets and leverage. Likewise, if different patterns in cash holdings across firm sizes exists, non-zero coefficients for, size dummies will be obtained. Two lags of the endogenous variable are also included to control for potential persistence in cash holdings.

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.[16] Apart from the biases that would arise if fixed effects were not controlled for, it is also necessary to take into account that most current firm-specific variables are endogenous (it is likely that shocks affecting firm liquidity holdings affect also other firm-specific characteristics such as its cash flow). In order to avoid the bias associated with this endogeneity problem, we use a GMM estimator taking lags of the dependent and explanatory variables as instruments. Likewise, 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 requires the absence of second order serial correlation in the first differenced residuals for which the test of Arellano and Bond (1991) is presented (labeled 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.

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14. The coefficient of correlation between a weighted mean of this measure (using as weights cash holdings) 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.

16. 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.

Table 6: Panel data econometric results

	Coefficient	Std Error	Coefficient	Std Error	Coefficient	Std Error	Coefficient	Std Error
Liquidity $_{t-1}$	0.78	0.083	0.77	0.082	0.787	0.082	0.766	0.083
Liquidity $_{t-2}$	0.04	0.069	0.04	0.067	0.048	0.068	0.057	0.069
CF	0.17	0.042	0.17	0.042	0.207	0.039	0.213	0.040
Spread	-0.39	0.151	-0.75	0.302	-0.455	0.147	-0.358	0.154
CFV	0.003	0.001	0.00	0.001	0.004	0.001	0.004	0.001
NWC	-0.026	0.009	-0.03	0.010	-0.016	0.013	-0.023	0.010
TA	-0.041	0.013	-0.04	0.013	-0.022	0.014	-0.030	0.014
L	-0.016	0.007	-0.02	0.007				
Dmed	-0.016	0.004	-0.02	0.004	-0.013	0.003	-0.014	0.004
Dlarge	-0.021	0.005	0.00	0.007	-0.017	0.005	-0.019	0.005
Spread*D_{SME}			0.44	0.30				
Short-term debt/Assets					0.001	0.009		
Long-term debt/Assets					-0.018	0.010	-0.018	0.009
Tests (p-values):								
M_1	0.00		0.00		0.00		0.00	
M_2	0.16		0.18		0.21		0.27	
Sargan	0.03		0.01		0.03		0.02	
n. firms	97420		97420		97420		97420	
n. observations	605784		605784		605784		605784	

Notes: Estimation by GMM-SYSTEM estimator using the robust one-step method [Blundell and Bond (1998); Arellano and Bond, (1998)]. Sargan is a Sargan Test of over-identifying restrictions (p-value reported). Mj is a test of jth-order serial correlation in the first-differenced residuals (p-values reported). Instruments: in first-differences equations of regressors dated as follows: Liquidity (t-4), spread (t-3), NWC (t-4), TA (t-5), BK (t-3), Spread * D_{SME} (t-3) Short-term debt/assets (t-3), long-term debt/assets (t-3).

First column in Table 6 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 M_2 statistic indicates the key condition for the validity of this method. The Sargan test typically returns a value somewhat above of the standard critical value, but, as Blundell et al. (2000) show, 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, and the results here presented remain valid when alternative instruments are used.[17]

As can be seen from column (1) in the table, the first lag of the endogenous variable is found to be clearly significant, indicating persistence in firms' liquidity holdings. In fact, this persistence appears to be quite large, higher than that derived from the macroeconomic analysis presented in previous section.[18] The implied speed of adjustment obtained in this analysis is below that reported for other studies based on micro data for publicly traded firms for the US or the UK [see Han and Qiu (2007) and Oskan and Oskan (2004)]. This might be indicating that these firms adjust relatively quickly their cash holding ratios to their optimal level in comparison to smaller firms, which might be less active in managing their cash holdings and prevail in the sample here used; in any case, the data does not point clearly in this direction[19] and other factors might also be playing a role in explaining this difference with respect to the results obtained in previous studies. Persistence is also higher than that

17. Results available upon request.

18. Under the assumption of a first-order partial adjustment mechanism, the speed of adjustment of cash holdings towards the desired level is around 20% per year (it is computed as $1-\beta_1$.The coefficient for the second lag of the endogenous variable has not been taken into account, as it was close to zero and non-significant. See, for example, Ozkan and Ozkan (2004) for a derivation of the formula).

19. We tested whether the speed of adjustment is slower for SMEs and for large firms, by allowing a differential degree of persistence for SMEs. The coefficient obtained for this differential degree of persistence was indeed positive, but it was estimated very imprecisely and, as a result, was clearly non-significant (p-value = 0.66).

reported in the macro analysis, although they are not strictly comparable since in the micro analysis we normalise cash and its equivalents by total assets.

The results for the rest of the regressors are also in line with the expectations. The opportunity cost of holding cash and cash flow are found to be those variables exerting a higher impact on firms' liquidity ratios, a result in line with Bruinshoofd and Kool (2004), who analyse corporate liquidity management for a sample of Dutch firms. The short-run implicit elasticity of cash holdings (not normalised by total assets) to the cash flow ratio is 1,4, and hence, similar to the elasticity of cash holdings to the level of activity derived from the macro analysis (1,38),[20] while the long-run impact would be larger than the one derived from the macro analysis. As for the opportunity cost of holding cash, the implicit long-run semi-elasticity of cash holdings to the opportunity cost of holding cash is somewhat above that obtained in the macro part. When allowing different sensitivity to changes in the opportunity cost for large and small and medium-sized firms, the sensitivity seems to be lower for smaller companies: as can be seen in column 2 in the table, the estimated coefficient for the interaction term between the opportunity cost and a dummy for SMEs is positive (although the significance is somewhat limited -p-value = 0,14), indicating that cash holdings for these companies might be less sensitive to variations in the opportunity cost of holding cash than for large firms.

Liquidity ratios are also found to depend negatively on leverage, in line with the evidence found in Ferreira and Vilela (2004) for a sample of publicly traded companies, in line with the higher opportunity costs of holding cash for more indebted firms, and on the ratio of (less volatile) 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. In addition, and consistently with the results reported in Han and Qiu (2007), 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% (7% of the mean 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; likewise, differences in the weight of smaller firms across sectors might also be behind this difference, since sector dummies indicate that firms in the construction and services tend to show higher cash holding ratios, while the differences between the other sectors are lower (and sometimes not significantly different from zero).

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20. This elasticity is derived combining the estimated elasticity of liquidity ratios to cash flow (0.17) and the mean value of the liquidity ratio (12.5%). The two measures are not, however, strictly comparable since the measure for the level of activity is different in the macro and micro analysis.

Results presented in first column in Table 6 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 (debt with maturity up to one year) in their balance sheet. Second column in Table 6, where indebtedness breakdown has been included (between short and long-term debt) indicates that indeed a different relationship between short-term and long-term debt and cash holdings exists, and only for long-term assets a relationship with liquid assets is found. For short-term debt, the estimated coefficient is non-significant and close to zero. 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 omitted they appear to be significant again (see third column in Table 6).

Overall, these results indicate that variables which are such as firm size, non-liquid short term assets or firm' cash flow variability, which cannot be controlled for with macro data, are relevant to explain NFC liquidity ratios. Similarly to the findings of the macro analysis, a contribution analysis based on these results would indicate that the main drivers of the increase in NFCs cash holdings in recent years have been cyclical factors, captured in this case by the cash flow. Variations in the opportunity cost of holding money, have also contributed to explain money growth but more modestly than at the end of the nineties, when its increase contributed negatively to cash accumulation.

5 Conclusion

Understanding the demand for money is an important element of monetary analysis, and hence for the assessment of risks to price stability over the medium to longer term. This paper analyses the determinants of NFCs cash holdings, both from a macro and a micro perspective. With respect to the latter one, the analysis is carried out with a sample where small and medium-sized firms, which represent the bulk of the corporate sector and tend to hold more cash than large firms, prevail, contrasting with previous (and scarce) studies on NFCs cash holdings for the whole euro area.

At a macro level, results indicate that recent increase in M3 of non-financial corporations is in line with movements in its determinants, and hence its level stays in line with its long-run level. Money holdings are found to be linked to 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 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 economic activity of non-financial corporations. While these determinants permit to explain the developments in M3 of non-financial corporations, the interpretation of the mechanism underlying the long-run relationship is not clear cut as it seems to also reflect the ability of firms' to borrow.

The estimations conducted at micro level confirm that cash holdings are linked to the opportunity cost of holding cash (proxied by means of the spread between bank rates and the own rate returns of liquid assets). This variable is, together with the cash flow indicator, the one found to have a largest impact on cash holdings variations. Likewise, the significance of firm' characteristics such as its ratio of tangible assets over total assets, the volatility of its cash flow or the size of the firm suggests that firms' cash holdings are closely linked to their borrowing ability. Finally, also other variables such as non-liquid short-term assets, which are the closest substitutes for cash, or indebtedness, linked to the opportunity cost of holding cash, are also found to be linked to the weight of liquid assets in the firms´ balance sheet.

Annex

Table 1: Results of unit root tests

Variables	ADF			Phillips Perron		
		t-Stadistic	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.

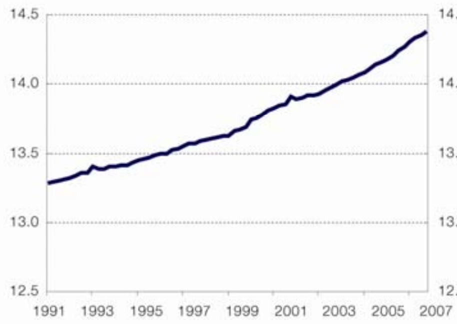
Table 2: Lag length determination

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

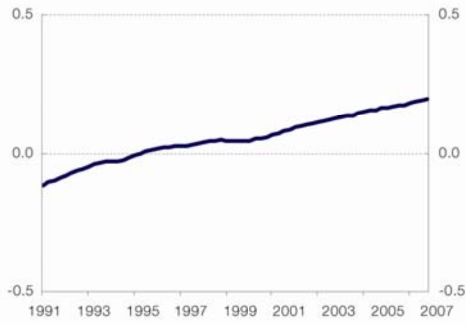
Charts 1-6: Macroeconomic time series

Chart 1: Log of M3



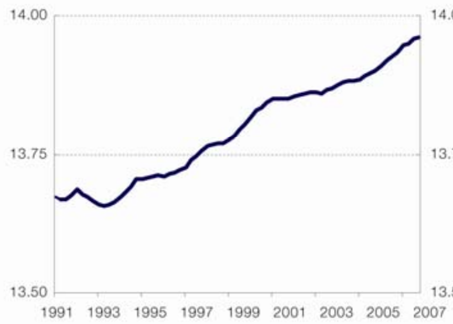
Source: ECB calculations

Chart 2: Log of gross value added deflator



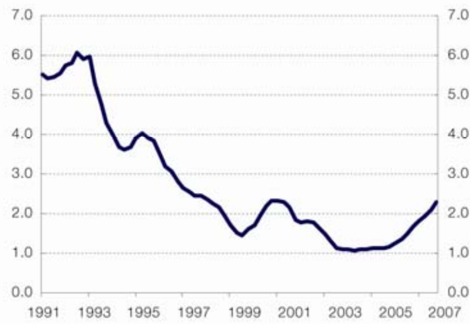
Source: ECB calculations

Chart 3: Log of real gross value added



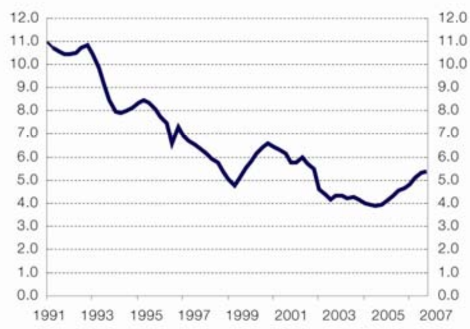
Source: ECB calculations

Chart 4: Own rate of return on M3



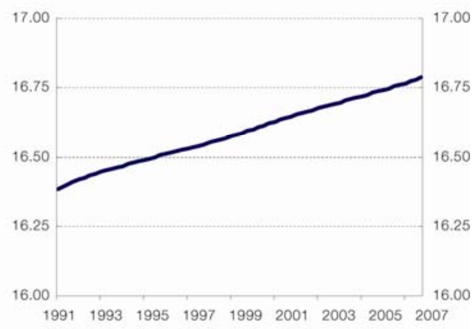
Source: ECB calculations

Chart 5: Long-term nominal bank lending rate



Source: ECB calculations

Chart 6: Log of capital stock



Source: ECB calculations

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