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Heterogeneity in money holdings across euro area countries: The role of housing

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ABSTRACT

In this paper we examine why monetary aggregates of euro area Member States have developed differently since the inception of the euro. We derive a money demand equation that incorporates housing wealth and collateral as well as substitution effects on real money holdings. Empirically, we show that cross-country differences in real balances are determined not only by income differences, a standard determinant of money demand, but also by house price developments. Higher house prices and higher user costs of housing are both associated with larger money holdings. Country-specific money holdings are also connected with structural features of the housing market.

1. Introduction

From the outset the monetary policy framework of the European Central Bank (ECB) has been based on the view that, in the long term, inflation is a monetary phenomenon, meaning that monetary growth in the medium to long term is associated with a rise in the general price level. Against this backdrop the analysis of money aggregates is an important component of the ECB's monetary policy framework. This paper contributes to the discussion on monetary aggregates and focuses on the heterogeneity of monetary dynamics across euro area countries and the possible role of housing markets therein, which may also be of importance from a financial stability point of view.

Analysing monetary aggregates and their relationship with housing markets (either in aggregate or cross-country) is of importance for a number of reasons: First, extending the analysis of monetary indicators to include a broader set of determinants than the standard ones can be useful to underpin the monetary pillar of the policy framework. Second, it has become clear in the recent financial crisis that monetary developments can be associated with financial instability. Strong increases of monetary aggregates have gone hand in hand with large increases of house prices in a number of countries and the correction of these dynamics has led to financial instability. Third, the analysis of monetary dynamics is relevant for the assessment of real and nominal divergence across euro area countries, which has been persistent and substantial, with housing markets playing a key role. Such divergence has been jeopardising intra-euro area cohesion and macro-financial stability. An investigation into the link between housing and money could help to understand the sources of that heterogeneity.

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The objective of the paper is three-pronged. First, it aims to examine the possible theoretical relationships between housing and money aggregates. This has been studied before, but not systematically in an overarching theoretical money demand framework, as will be done in this paper. Second, it provides econometric estimates of the impact of housing market developments on money aggregates across euro-area countries – and specifically the cross-country differences therein – in a panel regression framework. Third, it aims to address the question whether the creation of the single currency itself has been a factor in shaping the relationship between house prices and money growth across the euro area. This is done by re-estimating the model for the decade preceding the creation of the euro and comparing this with the baseline result.

The paper is structured as follows. Section 2 takes stock of the stylised developments in monetary aggregates and house prices across euro area Member States since the introduction of the euro and briefly reviews the empirical literature on the determinants of money demand in the euro area. Section 3 derives a money demand equation from a theoretical model incorporating housing wealth/collateral as well as housing-money substitution effects. In Section 4, our empirical specification to uncover the heterogeneity of monetary dynamics across euro area countries is developed. The empirical results are presented in Section 5. In a nutshell, housing along with differences in real-economy developments, indeed explains cross-country heterogeneity in money holdings across the euro area. Moreover this relationship has become stronger with the creation of the single currency. The final section draws some policy conclusions.

2. Facts and findings to date

The monetary pillar of the ECB's policy framework has been discussed extensively in the academic literature (Gerlach and Svensson, 2003; Gerlach, 2004; Woodford, 2008; Beck and Wieland, 2007; Fisher et al., 2008; Berger et al., 2011). On balance this literature is rather inconclusive as to the role of monetary aggregates in the policy framework. Hence the benefit of the doubt should go to those actually involved in the policymaking of the ECB and who generally do refer to monetary developments alongside price developments. Recently, some commentators have argued that monetary analysis might be justified for other reasons than monetary policymaking, in particular financial stability reasons (Galí, 2010). This view is supported by recent findings that house price bubbles may be associated with excessive money or credit growth (Alessi and Detken, 2009; Gerdesmeier, Reimers and Roffia, 2009; Agnello and Schuknecht, 2009; Eickmeier and Hofmann, 2009). An analysis of monetary aggregates therefore appears warranted for financial as well as price stability reasons.

We start from the observation that monetary aggregates have behaved very differently across euro area Member States since the introduction of the euro. This is reflected in pronounced differences in the average annual growth of the "national contributions" to M3 since 1999 — see Bosker (2004) for differences in monetary dynamics across euro area countries.[2]

For example, national contributions' annual rate of growth was 6.6% in Germany compared to 10.6% in Spain (average from 1999 to 2008).[3] Ireland recorded by far the strongest money growth with an average growth rate of more than 16% annually. To our knowledge, no recent contribution has studied the determinants of this heterogeneity.

At the same time, house price developments have been even more diverse across euro area countries. Several countries experienced strong increases in house prices, which in the cases of Ireland and Spain reached double-digit average annual growth rates.[4] The central hypothesis of this paper is therefore, that differences in real house price developments have been amongst the central factors driving the heterogeneity in monetary dynamics. This hypothesis finds some graphical evidence in Fig. 1. Countries with high growth rates for house prices, such as Spain, Ireland or Greece, also show high growth rates for national contributions to M3.[5]

Earlier studies of money demand identified stable relationships among real balances, real income and interest rates in the euro area (see e.g. Calza et al., 2001). As a result of the strong monetary dynamics after 2001, traditional money demand specifications for the euro area that model the real M3 stock as function of real GDP and an interest rate variable (for example, the difference between the three-month money market rate and the return on M3 assets), leave a major part of monetary growth since 2001 unexplained. Several explanations for the monetary overhang have been given. For a time, the heightened economic and geopolitical uncertainties in the wake of the terrorist attacks of 11 September 2001 and the dramatic decline in stock prices between 2000 and 2003 were speaking for a substitution effect on monetary growth away from relatively risky financial assets in the euro area. At that time, the response of households and enterprises included extensive portfolio shifts in favour of secure and liquid bank deposits which are part of M3 (Greiber and Lemke, 2005; Carstensen 2006).

After around mid-2004, however, such substitution effects have no longer been boosting monetary growth. Instead, the monetary expansion was driven by a marked increase in lending. At the same time, the macroeconomic development in the euro area in the 2004 to 2007 period was characterised by a very sharp increase in the price of assets, in particular house prices. The more recent literature on aggregate money demand in the euro area accounts for these developments and explains the sharp credit-driven money growth in the post-2004 period by incorporating wealth effects stemming from developments in asset

[2] National contributions to euro area M3 exclude currency in circulation as its location cannot be determined. A country's national contributions to euro area monetary aggregates are defined as liabilities of domestic monetary financial institutions (MFI) to the whole euro area non-MFI sector. As such, e.g., German households' and enterprises' short-term deposits held with branches and subsidiaries of German MFIs in Luxembourg are part of Luxembourg's contribution to euro area M3. However, the amount of deposits from and loans to euro area residents outside the domestic country is very low. As such, it can be assumed that national contributions to M3 are driven by macroeconomic developments in the individual euro area countries.

[3] Moreover, M3 dynamics have been varying substantially over time, as can be seen in Figs. A.1 and A.2 of the appendix.

[4] Figs. A.3 and A.4 in Appendix A show the heterogeneous profiles of the time series.

[5] Omitting Ireland still leaves a positive and significant relation between housing and moneyquery.

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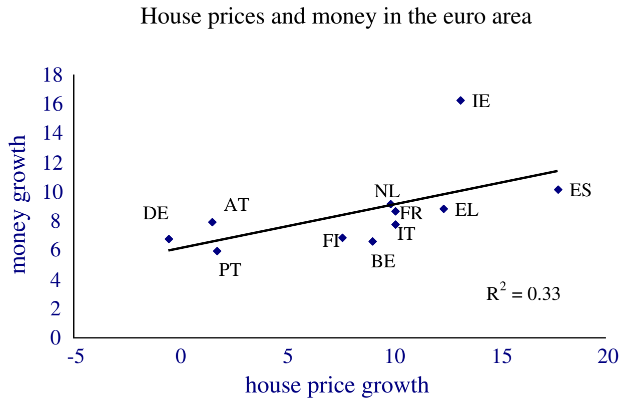

Fig. 1. House prices and money in the euro area. Note: Average annual nominal growth from 1999 to 2008 in %. Source: ECB and OECD.

markets. A number of studies extend conventional money demand functions by including housing or financial wealth variables (Boone and van den Noord, 2008; Greiber and Setzer, 2007; de Santis et al., 2008; de Bondt, 2009; Beyer, 2009). One important conclusion that can be drawn from these studies is that monetary developments at times cannot be fully explained by real income or interest rates and that wealth variables need to be included.

3. Housing in the money demand equation

Empirical approaches to money demand that incorporate housing have been subject to the criticism that they were not underpinned by a structural model. This questions the stability of the ad-hoc empirical relation on the basis of a missing theoretical foundation. In this section, we try to remedy this by deriving a money demand model that is augmented by housing market developments.

Standard specifications for money demand equations usually comprise a rather narrow range of explanatory variables. Money demand varies with the volume of activity or transactions and the price level in line with the quantity theory of money. In addition, money demand is assumed to decrease if the interest rate rises, because the opportunity cost of holding liquidity as opposed to bonds increases. We propose to augment the standard money demand relationship with explanatory variables that capture the possible impact of house prices on money demand.

In a seminal paper, Friedman (1988) classified the possible relationships between asset prices and money demand into wealth, substitution, and transaction effect:

- The *wealth effect* stems from the fact that money is a store of value and as such serves as an alternative to holding other assets such as housing or financial wealth. An increase in house prices leading to differences between existing and desired portfolio composition can then be associated with a rise in the portfolio demand for real balances in order to adjust the portfolio composition to the desired equilibrium.
- In contrast to the wealth effect, a *substitution effect* postulates that changes in the relative attractiveness of different assets alter the individual's portfolio structure. Specifically, an (expected) rise in house prices, *ceteris paribus*, renders this type of investment more attractive than holding money balances and causes a portfolio shift into housing and away from money.
- The *transaction effect* captures that housing sales and purchases mirrored in price and volume movements imply a rise in the need for money due to a simple transaction motive. This effect is possibly amplified by a rise in the number of transactions on the housing market during housing boom episodes (Stein, 1995).

The wealth and substitution effects are both *portfolio effects*, but carry opposite signs and are therefore partly offsetting each other. The sign of the total portfolio effect of house prices on money demand is thus ambiguous and can only be determined empirically.

A further important aspect of the relation between housing and money stems from the *collateral effect* of household's assets. Due to asymmetric information distribution on credit markets, agents' ability to borrow depends on the value of their collateral (Iacoviello, 2004, 2005). Higher collaterals reduce the influence of asymmetric information and improve lending conditions. Since housing wealth is an important balance sheet variable, it therefore determines the borrowing constraints faced by agents. Higher house prices increase the collateral values of homes and improve home owners' access to loans, fostering credit and money growth. Thus there is a direct link between housing and loan developments.

In order to illustrate how the portfolio (wealth and substitution), transaction and collateral effects could enter the money demand equation we set up a model that combines these effects. It takes the standard model for money and consumption as a starting point, and extends it with housing as an argument in the utility function. Housing is considered to be both a consumer durable that delivers utility in the form of housing services, and a (real) asset that serves as a store of wealth akin to bonds and cash balances. Following Iacoviello (2004) and others we split the household sector in 'lenders' and 'borrowers'. The lenders are assumed to finance their homes with own savings and hold bonds, whereas the borrowers are assumed to take up mortgage loans to finance their homes — hence they face a collateral constraint.

The optimisation decision faced by the *lenders* is:

$$\max_{C_t^l, \frac{M_t^l}{P_t}, H_t^l} \quad E_0\left[\sum_{t=0}^{\infty} \beta^{lt} U\left(C_t^l, \frac{M_t^l}{P_t}, H_t^l\right)\right] \tag{1}$$

subject to the flow of funds constraint:

$$C_t^l + \frac{B_t^l}{P_t} + \frac{M_t^l}{P_t} + \frac{Q_t}{P_t}\left(H_t^l - H_{t-1}^l\right) = Y_t^l + R_{t-1}\frac{B_{t-1}^l}{P_{t-1}} + \frac{P_{t-1}}{P_t}\frac{M_{t-1}^l}{P_{t-1}} \tag{2}$$

where Y_t, C_t^l, B_t^l, P_t, M_t^l, Q_t, H_t^l, R_t denote, respectively, real income, real consumption, bonds, the price level of consumption, money balances, the house price level, the volume of housing services and the real gross rate of return. The superscript l denotes that the variable refers to the lenders, E_t is the expectations operator and β^{lt} is the rate of time preference. Households derive utility from money holdings to reflect their desire to store a part of their asset portfolio in a perfectly liquid asset so as to smooth transactions. So, the money-in-utility function assumption is ultimately reflecting the transaction motive. Households obviously also derive utility from the stock of housing. However, in the flow-of-funds constraint, the change, rather than the level, of the housing stock is incorporated, as the cash flow spent on housing must equal the change in the stock (i.e. residential investment) times its current price. The real gross rate of return is defined by the Fisher parity equation:

$$1 + i_t = R_t\frac{E_t P_{t+1}}{P_t} \tag{3}$$

where i_t denotes the nominal interest rate.

The borrowers are assumed to have the same utility schedule as the lenders, the only asymmetry being that the former are assumed to be myopic, i.e. the discount factor for future utility is smaller than that of the lenders. Accordingly, the optimisation problem faced by the *borrowers* reads:

$$\max_{C_t^b, \frac{M_t^b}{P_t}, H_t^b} \quad E_0\left[\sum_{t=0}^{\infty} \beta^{bt} U\left(C_t^b, \frac{M_t^b}{P_t}, H_t^b\right)\right] \tag{4}$$

with $1 > \beta^l > \beta^b \geq 0$. For the sake of tractability we will follow Iacoviello (2004) in assuming that β^b is zero, such that β^{bt} equals 1 for t = 0 and β^{bt} equals 0 for t > 0.

The borrowers are subject to a flow of funds constraint and a collateral constraint:

$$C_t^b - \frac{B_t^b}{P_t} + \frac{M_t^b}{P_t} + \frac{Q_t}{P_t}\left(H_t^b - H_{t-1}^b\right) = Y_t^b - R_{t-1}\frac{B_{t-1}^b}{P_{t-1}} + \frac{P_{t-1}}{P_t}\frac{M_{t-1}^b}{P_{t-1}} \tag{5}$$

$$R_t\frac{B_t^b}{P_t} \leq \frac{E_t Q_{t+1}}{E_t P_{t+1}} H_t^b \tag{6}$$

where the superscript b denotes the borrowers. It is important to note that the variable B_t^b now stands for borrowing, not lending, and hence its sign turns negative in the flow of funds constraint. The collateral constraint is saying that the lenders demand a gross return on the loan that is covered at least by the expected value of the home. Iacoviello (2004) proves that this constraint will always be binding, and we will simply assume this to be the case here. The collateral constraint is essential because the discounted disutility of future sacrifices of consumption to service the mortgage debt is zero in this set-up; without the collateral constraint the amount of borrowing would be indefinite.

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From the first order conditions of these problems, and assuming log-linear utility, an aggregate money demand equation can be derived which reads (see Appendix B):

$$\log\frac{M_t}{P_t} = \delta\log\frac{b_t}{d} + \log C_t + log\frac{Q_t}{P_t} + \lambda\log\frac{H_t^b}{C_t^b}\left[1-\frac{B_t^b}{Q_tH_t^b}\right] + (1-\lambda)\left[\log\frac{H_t^l}{C_t^l}(i_t-\rho_t)-\log i_t\right] \quad (7)$$

where

$$\rho_t = \frac{E_tQ_{t+1}-Q_t}{Q_t} \quad (8)$$

denotes the expected rate of house price inflation, λ is the weight of credit-constrained households (borrowers) in aggregate money demand, b_t stands for shifts in preferences for holding money and d is the weight of housing in the (log-linear) utility function.

Eq. (7) says that aggregate money demand is a function of the autonomous trend in money preference (b), aggregate (non-housing) consumption, C, the real house price, Q/P, the net real housing wealth of credit-constrained home-owners (scaled to consumption), the real user cost per unit of housing capital (given by the nominal interest rate less the expected house price increase, again scaled to consumption).

It is important to note that the neat linear homogeneity of the equation disappears for more complex utility functions than the log-linear function, but the basic relationship would still hold. On the other hand, it needs to be stressed also that Eq. (7) is by no means intended as an all-encompassing theory but rather as an illustration as to how relatively straightforward behavioural assumptions can give rise to house prices being a determinant of money demand. Specifically, it suggests that the *level* of real house prices will be *positively* associated with the real money aggregate on the account of the wealth, collateral and transaction effects. Meanwhile, the *expected rate of change* of real house prices would be *negatively* associated with the real money aggregate on the account of the substitution effect (an expected capital gain on housing will lead to a shift in portfolios away from money into housing). The sign of the relationship between the money aggregate and the interest rate is ambiguous in this set-up. This is because there are forces acting in both directions. On the one hand, an increase in the interest rate will raise the opportunity cost of holding money and thus lead to a decline in money demand. On the other hand, a rise in the interest rate will also boost the user cost of housing which via the substitution effect raises the demand for money.

4. Empirical model and data

An important observation with respect to the empirical testing of the basic relationship between money and house prices emerging from our theoretical model is in order. At the level of the euro area it may be hard to identify a money demand equation since monetary aggregates in the euro area may be partly supply driven (Bosker, 2004), even though there is evidence that this may not have been the case in the run-up to and the early years of the monetary union (Gerlach, 2004). At lower levels of disaggregation this is less of an issue, however. In a monetary union with perfect capital mobility, money will flow wherever it is needed within the system. Hence, at sub-union levels of aggregation there is no specific money supply and variations in money aggregates (relative to the monetary union as a whole) should reflect variations in money demand rather than money supply (again relative to the area as a whole). An additional advantage from an econometric point of view is that there is less risk of reverse causality from money aggregates onto the determinants of money demand such as house prices and economic activity.

A related issue is the question at what level of disaggregation the link between money and housing is best analysed. In principle this could be done at the country level or at sub-national levels such as the NUTSII level. We consider the country level to be the most appropriate for our purposes for a variety of reasons. First, data availability of money aggregates at the regional level is limited. Second, cross-regional variation of some of the standard determinants of money demand (e.g., interest rates) is likely to be fairly limited as well. Third, and more fundamentally, it is probably hard to determine the correct regional match between real balances and real economic variables. For example, a real transaction in one place may involve a financial operation in a different place, depending on where the relevant cash balances are recorded. This type of concern is much less relevant at the national level and is the main motivation for us to carry out our analysis at the country level.

A special feature of the empirical version of the model is that all variables are measured in deviations to the euro area average.[6] This is motivated by the considerations related to money supply highlighted above. In addition, as shown by Setzer and Wolff (2009), a central advantage of estimating the money demand function in differences to the euro area average is that it allows taking out drivers of money demand that are common to all countries. Such a procedure avoids the problem of

[6] Luxembourg was excluded from the analysis due to its importance as international financial centre which weakens the link between macroeconomic developments and monetary dynamics at the national level.

formulating precise proxies for unexplained shifts in aggregate money balances. As argued in Section 2, changes in financial and economic uncertainty, which are highly correlated across euro area countries, lead to temporary portfolio shifts and this may distort the link between money and prices (Greiber and Lemke, 2005). By taking out these global shocks, our approach permits to focus on the heterogeneity of the money-housing nexus across euro area countries. In other words, the approach does not aim to explain aggregate euro area money holdings but rather focuses on uncovering the differences in money holdings across countries. Nevertheless, as the estimated elasticities reflect the same underlying parameters as in the aggregate money demand estimation (see Setzer and Wolff, 2009), our approach is also able to provide evidence on the money-housing nexus at the aggregate level to the extent that real balances are demand-determined.

Econometrically, this approach is similar to a panel estimation which includes time fixed effects. The difference to fixed time effects estimations is that time fixed effects cater for the unweighted annual average of all variables whilst our approach takes out the weighted average developments of the variables.[7] In other words, real money holdings are measured relative to the real money holdings of the euro area and all other variables are also measured relative to the euro area values. Moreover, the model includes country fixed effects to allow for constant country-specific preferences for money holdings.[8] Specifically, we estimate the following relation:

$$\tilde{m}_{it}-\tilde{p}_{it}=f\Big(\tilde{y}_{it},\tilde{i}_{it},(\tilde{q}_{it}-\tilde{p}_{it}),\Delta(\tilde{q}_{it+1}-\tilde{p}_{it+1})\Big) \tag{9}$$

where variables are measured in deviations from the euro area average as symbolised by the tilde. The variables m, p, y and i denote nominal national contributions to M3, the GDP deflator, real GDP, and the short-term interest rate variable (three months money market rate). The variable q corresponds to the nominal residential property price index. Note that the equation includes future changes in real house prices. This variable intends to capture expectations about future house price increases (assuming rational expectations) and thus serves to assess the importance of substitution effects in line with the theoretical model. All variables except the interest rates are seasonally adjusted and they are computed in log differences to the euro area average (in case of GDP, M3 and GDP-weighted house prices) or relative to the euro area level in case of the interest rate.

The coefficients on the variables are assumed to be homogenous across countries. It is clear, however, that in a macroeconomic panel, there is usually some variation in the reaction coefficients across countries. As has been shown by Pesaran and Smith (1995), in a static case, if the coefficients differ randomly, a pooled estimation gives unbiased estimates of coefficient means. The estimated coefficients should thus be interpreted as the average cross-country reactions to the underlying variables. However, in the robustness section, we will also show that the estimated coefficients do not hinge on a small subset of countries and are fairly robust when omitting a number of countries.

Money balances were deflated with the GDP deflator.[9] For the monetary aggregates we use quarterly data for national contributions to M3.[10] The sample ranges from 1999Q1 to 2008Q4 in the baseline specification. Quarterly data for GDP and the GDP deflator are from Eurostat. Housing developments in the euro area are approximated by residential property price indices from the ECB. For some countries, data were only available on lower frequency (semi-annual or annual). Missing values were generated by linear interpolation.

Regarding the interest rate variable, it is very difficult to come up with a good measure of the opportunity cost of holding money that is specific to the individual euro area country. The more short term the interest rate, the more integrated the financial market becomes, and individual interest rates do not differ from the euro area aggregate. At the longer end of the maturity spectrum, significant differences can be found across euro area countries. However, these differences partly reflect different risk assessments of e.g. government bonds (see for example Hallerberg and Wolff, 2008). In this sense, they are ill-suited to capture opportunity costs of holding money as higher risk assessment (fuelled e.g. by economic and financial uncertainties) may lead to higher money holdings due to precautionary portfolio shifts (Greiber and Lemke, 2005). Moreover, domestic money holders can invest money in other euro area money or bond markets at little cost. Since 1999, with the removal of exchange rate risk, the opportunity costs of holding money are therefore rather similar across euro area countries. For the sake of completeness, we nevertheless include a three-month interest rate, for which small variations are observable. In addition, we use alternative opportunity cost measures such as the spread between the ten year government bond yield and the three month interest rate (see also Coenen and Vega, 2001) as well as the HICP inflation rate (see also Dreger and Wolters, 2010). As will be shown below, our central results remain unaffected by the use of these alternative opportunity cost measures.

To assess the time series properties of the data, we examine the degree of integration of the variables. The null hypothesis of the Hadri (2000) stationarity test can be clearly rejected in all cases implying that not all time series in our panel are stationary. Findings from the IPS test suggest that the null hypothesis that all time series contain a unit root cannot be rejected (Table 1). The results are not sensitive to the number of lags.

[7] For example, we use the house price index for the euro area as a whole and not an unweighted average of the house prices of all euro area countries.

[8] We do not include a deterministic trend on the assumption that exogenous shifts in money preferences are uniform across the euro area, i.e. $b_{it}-b_t=0$.

[9] As a sensitivity analysis, we deflated money balances with the HICP index without qualitative impact on the results.

[10] The national contributions are computed from the "Aggregated balance sheet of euro area monetary and financial institutions, excluding the eurosystem" published by the ECB by adding and subtracting the following items: 2.2 − 2.2.1 − 2.2.2 − 2.2.3.2.3 − 2.2.3.3.2 + 2.3 + 2.4 − 2.4.3. Obviously, this definition excludes money in circulation. However, the latter is of relatively lower importance for the monetary dynamics in a country as it accounts for less than 8% of the aggregate M3 in the euro area.

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Table 1
Panel unit root and stationarity tests.

		M3	GDP	Interest rate	House price	H_0
Hadri	Z(tau)	8.75	15.00	14.52	12.67	Stationarity
	p-value	0.00	0.00	0.00	0.00	
IPS	t-bar	−1.39	−1.06	2.58	−1.88	Unit root
	p-value	0.63	0.94	1.00	0.082	

Note: Hadri test: Null hypothesis is that all time-series in the panel are stationary processes. Controlling for serial dependence in the errors and heteroskedastic disturbances across units (lag truncation = 2). IPS is the Im-Pesaran-Shin test with the null hypothesis that all time series in the panel are realisations of a unit root process.

Table 2
Results of panel cointegration tests.

		Rho statistic	p-value
$\tilde{m}-\tilde{p}, \tilde{y}, \tilde{i}, \tilde{q}-\tilde{p}$	Group PP	−2.46	0.007
	Group ADF	−2.46	0.007

Note: Pedroni (1999) group tests for null of no cointegration amongst a multivariate vector (group rho statistic). Tests are performed with the automatic lag selection criterion by Akaike Schwarz.

We therefore test for panel co-integration. Table 2 provides the statistics of the Phillips Perron group tests and the ADF test. The test indicates that the null hypothesis of no cointegration can be rejected. Hence, we base our main estimations on a panel co-integration framework. However, it should also be taken into consideration that panel co-integration and unit root tests have notoriously low power. Moreover, from an economic point of view, it is debatable to what extent the variables, which are measured in deviation from the euro area average, can exhibit a unit root. Whilst this can locally be the case, it appears unlikely that the deviation would also exhibit a unit root in the long run.

Hence, in order to be sure that our results are not an artefact of the wrong econometric procedure applied, we proceed with two different methodologies. In line with the time series evidence, we rely on a panel co-integration framework as the specification tests indicate that this is appropriate. As robustness check, we show the results of a simple fixed effects approach, which would be appropriate if the variables were stationary and not co-integrated. For the co-integration approach, we perform the estimation by dynamic ordinary least squares with one lead and one lag (DOLS(−1,1)). Dynamic OLS was originally developed by Stock and Watson (1993), and Kao and Chiang (2000)analyse its properties in a panel context.[11] Our estimation equation takes then the following form:

$$\begin{aligned}\ln\left(\tilde{M}_{it}/\tilde{P}_{it}\right) = {} & \beta_1 \ln\left(\tilde{Y}_{it}/\tilde{P}_{it}\right) + \beta_2 \tilde{i}_{it} + \beta_3 \ln\left(\tilde{Q}_{it}/\tilde{P}_{it}\right) + e_{it} \\ & + \rho_{11}\Delta\left(\ln\left(\tilde{Y}_{i,t+1}/\tilde{P}_{i,t+1}\right)\right) + \rho_{12}\Delta\left(\ln\left(\tilde{Y}_{i,t-1}/\tilde{P}_{i,t-1}\right)\right) + \rho_{21}\Delta\left(\tilde{i}_{i,t+1}\right) + \rho_{22}\Delta\left(\tilde{i}_{i,t-1}\right) \\ & + \rho_{31}\Delta\left(\ln\left(\tilde{Q}_{i,t+1}/\tilde{P}_{i,t+1}\right)\right) + \rho_{32}\Delta\left(\ln\left(\tilde{Q}_{i,t-1}/\tilde{P}_{i,t-1}\right)\right)\end{aligned} \tag{10}$$

where the tilde again symbolises deviations from the euro area average, and $e_{it} = u_i + \varepsilon_{it}$ with u_i being the country fixed effects and ε_{it} is an error term with the usual properties. The inclusion of leads and lags of the first difference of the regressors improves the efficiency in estimating the co-integration vector, which is given by $(-1, \beta_1, \beta_2, \beta_3)$. It is important to note that Kao and Chiang (2000) show that ε is by definition auto-correlated. When estimating Eq. (10), appropriate correction for the autocorrelation needs to be performed. We employ the correction of Newey and West (1994). Moreover, our standard errors are robust with respect to arbitrary heteroskedasticity. Finally, the estimation results presented constrain the short- as well as long-run dynamics to be the same across the countries. However, as a robustness check, we also allowed for different short-run dynamics for the countries and the main results were unaffected.

5. Empirical results

5.1. Baseline results

Table 3 presents the estimation of the corresponding dynamic OLS estimations. Column A displays the coefficients of a benchmark specification that includes only real income and short-term interest rates and thus the traditional explanatory variables of a money demand equation. The magnitude of the income elasticity is in line with previous research (compare, e.g., Calza et al., 2001; Carstensen, 2006; De Santis et al., 2008; Setzer and Wolff, 2009). The interest rate elasticity is positive and not significant. The non-significance is consistent with our theoretical model (viz. Eq. (7)), which predicts ambiguous effects of

[11] See also Kao et al. (1999) and Pesaran and Smith (1995).

Table 3
Dynamic OLS specification, sample 1999q1–2008q4.

	A	B	C	D	E	F	G	H	I
Real GDP	1.35***	1.15***	1.14***	1.20***	1.00***	0.96***	1.39***	1.19***	1.17***
	(7.8)	(6.61)	(6.55)	(7.14)	(5.92)	(5.87)	(8.15)	(6.93)	(6.88)
Short-term interest	1.52	1.22	3.51						
	(0.34)	(0.31)	(0.77)						
Inflation rate				−2.51	−2.93	−3.27*			
				(1.36)	(1.61)	(1.80)			
Interest rate spread							5.84*	5.68*	5.55
							(1.67)	(1.80)	(1.59)
Real house price		0.21***	0.21***		0.21***	0.22***		0.21***	0.21***
		(5.53)	(5.18)		(5.58)	(5.43)		(5.58)	(5.27)
Δ Real house price (+1)			−0.25			−0.26			−0.15
			(−0.73)			(−0.77)			(−0.41)
N	410	410	399	410	410	399	410	410	399
R^2	0.41	0.44	0.45	0.41	0.45	0.46	0.42	0.45	0.46

Note: All variables are measured in difference to the euro area average. t-Values are below the coefficient estimates in brackets. ***, **, * indicate significance at a 1, 5, 10% level, respectively. R^2 is taken from the fixed effects regression.

interest rates on money. Moreover, as described above, one should be cautious with respect to the interpretation of the interest rate semi-elasticity as there has been a high co-movement in interest rates across euro area countries after 1999. This results in a low cross-country variation of the time series in our sample period.

Column B displays the augmented money demand model, with real house prices included. The coefficient of the house price variable is highly significant indicating that higher house prices lead to larger holdings of real balances. This suggests that the wealth and collateral effects are important determinants of money holdings. This view is further supported by the fact that the income elasticity falls when house prices are included in the estimation. This confirms the notion that the income elasticity in traditional money demand specifications (i.e. those that exclude wealth variables) also captures some of the wealth and collateral effects.

The absolute value of the house price coefficient is relatively small, but non-negligible. A one percentage point increase in real house prices (compared to the euro area average) leads, ceteris paribus, to a rise above-euro area average in real money holdings of 0.21 percentage points. This value has to be interpreted against the background of the heterogeneous house price developments in the individual euro area countries which considerably exceed differences in monetary dynamics. As such, even a relatively small house price elasticity may provide a sizeable explanatory factor in explaining monetary heterogeneity.

Assuming constancy of the remaining variables, Table 4 displays – in a somewhat simplified way – the share of the deviation in money growth that is explained by house price and income developments for each euro area country (last column). In half of the countries in our sample, national house price developments explain at least a third of the deviation in money growth from the euro area average. For France, Austria and Spain in particular, the wealth and collateral effects of housing seem to have been important as there has been a close housing-money nexus. By contrast, house prices do not provide any explanation for below-average

Table 4
Deviation from euro area money growth explained by house price and income elasticity.

Country	M3 growth		House price growth		Deviation from EA money growth explained by house price elasticity	GDP growth		Deviation from EA money growth explained by income elasticity
	Average annual % change 1999–2008	Deviation of EA average (percentage points)	Average annual % change 1999–2008	Deviation of EA average (percentage points)		Average annual % change 1999–2008	Deviation of EA average (percentage points)	
EA	*8.4*		*6.2*			*4.4*		
AT	7.9	−0.5	1.5	−4.6	193%	4.0	−0.4	92%
BE	6.6	−1.8	9.0	2.9	−34%	4.1	0.1	−6%
DE	6.8	−1.6	−0.5	−6.7	88%	2.4	−2.0	144%
ES	10.1	1.7	17.7	11.6	143%	7.3	2.9	196%
FI	6.9	−1.5	7.6	1.5	−21%	4.7	0.3	−23%
FR	8.6	0.2	10.1	4.0	420%	3.9	−0.5	−288%
IE	16.3	7.9	13.1	7.0	19%	8.8	4.4	64%
IT	7.7	−0.7	10.1	4.0	−120%	3.7	−0.7	115%
NL	9.2	0.8	9.9	3.7	97%	5.1	0.7	101%
PT	5.9	−2.5	1.7	−4.4	37%	4.6	0.2	−9%

Note: The deviation of EA money growth which is explained by house price and income developments is calculated under ceteris paribus assumption by multiplying the country-specific average annual deviation of house price growth from the euro area average with the estimated house price elasticity of 0.21 and the income elasticity of 1.15 (see Table 3) and dividing it by the average annual deviation of the country-specific M3 growth from the euro area average. M3 growth does not include currency in circulation.

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money growth in Belgium, Finland and Italy, suggesting that other factors (including the above described substitution effects between money and housing) are more important drivers of the monetary dynamics in these countries (Table 4).

Column C in Table 3 further extends the model to include future changes in real house prices. This variable intends to capture expectations about future house price increases (assuming rational expectations) and thus serves as a variable to assess the importance of substitution effects. The variable is negative (as predicted by the theoretical model) but not significant, suggesting that substitution effects between money and housing have played a comparatively minor role. This finding may be explained by the different degrees of liquidity of both assets.

The remaining columns corroborate these results using alternative opportunity cost measures. Specifications D to F replace short-term rates by inflation as this variable may be a measure of the return on holding goods (see also Dreger and Wolters, 2010). Models G to I use the difference between the long-term and the short-term interest rates as opportunity cost measure. The long-term rate is defined as the yield on the ten-year government bond. The positive effects stemming from the wealth and collateral channel remain to be reflected in a highly significant positive house price elasticity, whilst the negative substitution effect remains insignificant. The results regarding opportunity cost measures are somewhat less robust, documenting the difficulty of capturing differences in opportunity cost of money holdings across euro area countries.

Institutional aspects of housing markets may also be important determinants of the housing–money relationship. Recent studies have found important heterogeneity in the transmission of monetary policy on house prices depending on the structural and institutional features of the mortgage market (Maclennan et al., 1998; Calza et al., 2007; Muellbauer and Murphy, 2008). However, one problem with accounting for institutional differences is the nature of the available data. Institutional characteristics change little over time, if available in the form of time series at all, so that time series analysis with such data is precluded.

We therefore relate unexplained country-specific preferences for holding money to institutional features of the housing market. The country-specific preference for holding money is captured by the country-specific fixed effects. Specifically, we therefore relate our country-specific fixed effects to the loan to value ratios (LTVs) to first time buyers and to the home ownership rate. A high LTV ratio is akin to a lower collateral constraint. As less equity is required for a house purchase, a higher share of the property can be financed by loan. The creation of a new loan is likely to go along with the creation of new deposits, suggesting that the effects of house prices on money are likely to be marked in economies with high LTV ratios.

Fig. 2 indeed provides some evidence for this hypothesis as we find a positive relation between the LTV and the fixed effect. Hence, ceteris paribus, a country where the LTV ratio is high tends to have larger real balances as households can relatively easily obtain financing to purchase property. France and Finland could be seen as outliers. In France, the LTV ratio for all homeowners is on average comparatively low. The LTV on new home purchases shown in Fig. 2 is probably not representative for the marginal lender. Abstracting from France and Finland increases the R^2 to 45%. Fixed effects for Finland are probably capturing the aftermath of its housing bust in the 1990s.

As regards home ownership, we also find a positive relationship as higher home ownership is associated with a higher fixed effect (Fig. 3). Hence, all other things equal, money holdings are higher in countries with high home ownership ratios. This may be explained by the transaction motive of money demand which is likely to be stronger if home ownership is higher, but it is also consistent with theoretical considerations according to which the wealth effect of housing should increase with a higher share of home ownership. Italy and (again) Finland are clear outsiders in this case, in the case of Italy possibly related to cultural forces as dwellings are often a parental gift and thus housing transactions are not necessarily associated with the raising of housing loans (ECB, 2009). Removing these two countries from the table increases the R^2 to 31%.

5.2. Robustness checks

In this section we corroborate our analysis by extensive robustness checks with respect to changes in the estimation procedure, the specification of the dependent variable, alternative opportunity cost measures and changes in sample size.

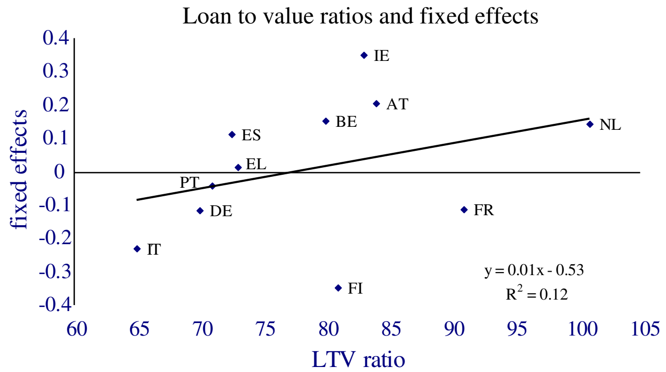

Fig. 2. Loan to value ratios and fixed effects. Note: Fixed effects are taken from the regression B in Table 3 (with all fixed effects highly significant). Loan to value ratios are taken from ECB (2009).

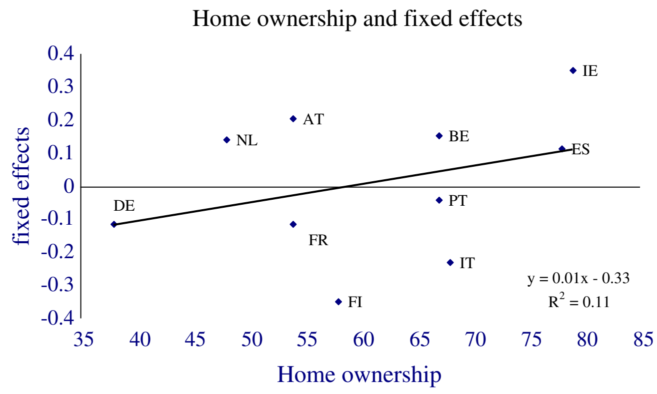

Fig. 3. Home ownership and fixed effects. Note: Fixed effects are taken from the regression B in Table 3 (with all fixed effects highly significant). In order to avoid reverse causality, home ownership rates refer to the pre-estimation period (year 1990). They are taken from Hilbers et al. (2008). No data for Greece available.

First, we estimate our specification with standard fixed effects. The estimation of that model yields very similar results, with the coefficients of our main variable of interest hardly changing. Again, there is strong evidence for the existence of wealth and collateral effects, whilst we find no significant substitution effects between money and housing (Table 5).

In a second robustness check we try to correct for the potential bias that may arise from the fact that some of the M3 components are tradable instruments, and thus can migrate from one euro area Member State to another Member State. The euro area monetary data is constructed in such a way that all MFI sector's liabilities to the non-MFI sector in a country are attributed to domestic residents although some of the M3 components are held by non-domestic euro area residents. For our panel

Table 5
Country fixed effects specification, sample 1999q1–2008q4.

	A	B	C
Real GDP	1.26***	1.07***	1.06***
	(16.14)	(13.64)	(13.59)
Short-term interest	0.90	0.61	0.55
	(0.27)	(0.20)	(0.18)
Real house price		0.22***	0.21***
		(7.10)	(6.88)
Δ Real house price (+1)			−0.16
			(−0.94)
N	410	410	410
R^2 (within)	0.41	0.48	0.48

Note: All variables are measured in difference to the euro area average. t-Values are below the coefficient estimates in brackets. ***, **, * indicate significance at a 1, 5, 10% level, respectively. Estimation method is fixed effects.

Table 6
Dynamic OLS specification, narrow monetary aggregates, sample 1999q1–2008q4.

	A	B	C	D	E	F	G	H	I
Real GDP	0.78***	0.64***	0.62***	0.73***	0.58***	0.55***	0.81***	0.67***	0.64***
	(6.74)	(5.76)	(5.54)	(6.67)	(5.63)	(5.36)	(6.92)	(5.95)	(5.72)
Short-term interest	2.98	2.71	4.12						
	(0.8)	(0.83)	(1.12)						
Inflation rate				−0.79	−1.12	−1.42			
				(−0.57)	(−0.83)	(1.09)			
Interest rate spread							1.90	1.86	1.83
							(0.63)	(0.68)	(0.63)
Real house price		0.16***	0.15***		0.16***	0.15***		0.16***	0.15***
		(4.87)	(4.57)		(5.01)	(4.84)		(4.88)	(4.56)
Δ Real house price (+1)			−0.23			−0.24			−0.18
			(−0.81)			(−0.86)			(−0.62)
N	410	410	399	410	410	399	410	410	399
R^2	0.27	0.34	0.34	0.27	0.34	0.34	0.27	0.34	0.34

Note: All variables are measured in difference to the euro area average. t-Values are below the coefficient estimates in brackets. ***, **, * indicate significance at a 1, 5, 10% level, respectively. R^2 is taken from the fixed effects regression.

investigations, with the emphasis on the country dimension, however, a high share of money holdings by non-residents may have repercussions on the results obtained. We therefore constructed a more narrow monetary aggregate by excluding all debt securities and money market shares from the analysis. Our adjusted monetary aggregate is then only defined in terms of deposits for which the share of euro area cross-border holdings is minor.[12] All our previous empirical findings remain valid when using the adjusted monetary measure as dependent variable (Table 6). This suggests that our results do not depend on the composition of the bank's liabilities. Apparently, the monetary implications of house price booms are not only visible in strong security issuance but also in high amounts of deposits.

In view of the heterogeneity of euro area countries, our results could be sensitive to changes in the cross-section or time dimension of our sample. Table 7 presents robustness tests with regard to the exclusion of individual countries. In columns A–C, we exclude the largest EMU country, Germany, as it might unduly influence the estimates because of its size. Moreover, in further sub-sample tests we exclude the three countries with the highest real money growth between 1999 and 2008, namely Ireland, Spain and France (columns D to F) as well as the two countries with the lowest monetary growth rates since the introduction of the euro, namely Portugal and Belgium (columns G to I).

Again, this robustness check reveals a considerable degree of sub-sample stability. The income elasticity does hardly change compared to our baseline scenario and consistently falls when house price developments are taken into account. Also the wealth, collateral and transaction effects remain significant. They are, however, less significant in the group excluding the low money growth group, especially when the user cost of housing is included. By contrast, the evidence for substitution effects is very strong for this country group. Overall, the robustness check therefore supports our hypothesis of the importance of housing market developments. Economic growth and house prices explain a significant part of the cross-country heterogeneity of real balances since 1999. These findings are not driven by a small subset of countries but reflect a rather constant pattern of determinants of cross-country differences in money holdings. In other words, cross-country differences in money holdings can be explained by a number of observable variables and the empirical relations appear to be rather stable across the countries.

5.3. Comparison with the pre-EMU period

A potentially interesting issue is whether the creation of the single currency itself has been a factor in shaping the relationship between house prices and money demand. Our hypothesis is that when countries still maintained their own currencies, capital flow constraints were more binding and therefore housing needed to be financed largely domestically, whereas after the creation of the single currency cross-border capital flows were unhampered by exchange rate risk. As a result, before monetary union money growth would reflect predominantly national monetary policy setting whereas in monetary union cross-country differences in money growth could also reflect capital flows associated with different investment opportunities in real estate and their financing.

Against this backdrop, we apply our specification to the pre-EMU period (Table 8). The estimation results for the period 1990q1 to 1998q4 document a clear robustness regarding the income elasticity. Thus, we find no evidence for a structural change regarding the link between income and money holdings after 1999. However, in the earlier sample, we find an insignificant house price elasticity. House price developments have only become an important parameter of money holdings with the introduction of the common currency. This finding is corroborated in an estimation covering the entire sample, which is documented in the last column of Table 8. There we find that only after 1999, house price developments have become a significant determinant of money as suggested by the significant interaction parameter between house prices and the dummy variable "EMU" which is denoted one for the period after 1999q1 and zero otherwise.

This finding is consistent with our above hypothesis but also with previous studies analysing the link between interest rates, consumer prices and housing wealth in the euro area (Weber et al., 2009), who find similar effects for the entire EMU period. Importantly, our result does not stem from lower variation in house prices in the pre-EMU period. In fact, the heterogeneity in house prices across euro area countries has been high also in the pre-EMU period. However, one additional possible explanation for the fact that housing emerges as a relevant variable determining money only with EMU is related to the process of financial liberalisation and innovation. This process has generally eased the access of credit to borrowers. For instance, innovations in credit markets have facilitated the access to standardised credit for lower-income borrowers and reduced financial constraints for homebuyers. Moreover, as a result of the property price boom and a rise in homeownership rates, households were increasingly able to withdraw equity in the post-1999 period (ECB, 2009). This boosts consumption spending and aggregate demand, and might support the link between house prices and money after 1999.

6. Conclusions

Monetary analysis remains an essential ingredient of the economic analysis on which monetary policy decisions in the euro area are based, so it is important to establish a stable relationship between real-economy developments and money aggregates.

[12] More specifically, we add and subtract the following items from the ECB "Aggregated balance sheet of euro area monetary and financial institutions, excluding the eurosystem": 2.2 − 2.2.1 − 2.2.2 − 2.2.3.2.3.

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Table 7
Results sensitivity analysis, dynamic OLS, sample 1999q1–2008q4.

	A	B	C	D	E	F	G	H	I
Real GDP	1.37***	1.11***	1.10***	0.43**	0.37*	0.36*	1.42***	1.37***	1.35***
	(7.81)	(6.43)	(6.40)	(2.09)	(1.85)	(1.77)	(9.66)	(9.23)	(9.45)
Short-term interest	−2.92	4.01	6.93	6.57	2.07	4.17	2.35	1.67	3.03
	(−0.51)	(0.17)	(1.14)	(1.09)	(0.38)	(0.52)	(0.66)	(0.54)	(0.86)
Real house price		0.29***	0.29***		0.27***	0.27***		0.05**	0.04*
		(5.27)	(5.08)		(6.00)	(5.93)		(1.98)	(1.81)
Δ Real house price (+1)			−0.10			−0.21			−0.89***
			(−0.28)			(−0.60)			(−2.49)
N	372	372	362	296	296	288	304	304	296
R^2	0.41	0.48	0.48	0.04	0.22	0.23	0.65	0.66	0.67
Removed	DE	DE	DE	IE, ES, FR	IE, ES, FR	IE, ES, FR	PT, BE	PT, BE	PT, BE

Note: All variables are measured in difference to the euro area average. t-Values are below the coefficient estimates in brackets. ***, **, * indicate significance at a 1, 5, 10% level, respectively. R^2 is taken from the fixed effects regression.

We find it striking that both money and real-economy developments have been rather diverse across the member countries of the euro area — a challenging situation for economic policy making.

Against this background, this study presents a theoretical and empirical analysis of the determinants of money holdings across euro area countries. Specifically, we derive a money demand specification that includes apart from the usual determinants of money demand (real income, interest rates and inflation) developments in the housing sector. The empirical specification is based on an innovative model featuring housing wealth, collateral and substitution effects. Housing wealth and collateral effects imply a positive relationship between money demand and house prices, whilst the substitution effect implies a negative relationship between the expected increase in house prices and money demand.

The empirical specification allows us to analyse the determinants of the strong differences in monetary dynamics of euro area Member States. It resorts to an idea originally proposed by Setzer and Wolff (2009), in which all variables are measured in deviation from the euro area average. In this way, we can control for unobserved common shocks to money demand that affect all countries. Differences in the monetary dynamics across euro area Member States are related to differences in the economic fundamentals determining money demand.

Our empirical findings provide support for our model. By estimating euro area money demand in national deviations from the area average, we show that cross-country differences in monetary dynamics can be explained to a large extent by asymmetries in house price developments on top of different income developments. We find robust evidence that housing wealth as captured by house prices has been a significant determinant of money holdings since 1999. Sensitivity analyses suggest that these results are stable and do not depend on the money-housing nexus in some individual euro area countries only.

Interestingly, our results provide less evidence for a role of housing prior to the adoption of the single currency in 1999. In that period there may have been a closer relationship between local income and house price developments, with the role of cross border capital flows more limited. Since the launch of the single currency, fairly large cross-country differences in price

Table 8
Results sensitivity analysis, dynamic OLS, pre-EMU sample (1990q1–1998q4, column A–F) and full sample (1990q1–2008q4, column G).

	A	B	C	D	E	F	G
Real GDP	1.39***	1.41***	1.35***	1.37***	1.38***	1.40***	1.25***
	(19.90)	(18.16)	(18.30)	(17.02)	(18.39)	(17.53)	(15.77)
Short-term interest	0.72***	0.71***					2.395***
	(2.11)	(2.07)					(4.58)
Interest rate spread			−0.55*	−0.53			
			(−1.66)	(−1.59)			
Inflation rate					−2.05***	−2.06***	
					(−3.64)	(−3.79)	
Real house price	−0.05	−0.05*	−0.01	−0.02	−0.01	−0.02	0.05
	(−1.59)	(−1.90)	(−0.49)	(−0.76)	(−0.32)	(−0.40)	(−1.52)
Real house prices*EMU							0.10*
							(1.72)
Δ real house price (+1)		−0.23		−0.23		−0.23	
		(−1.09)		(−1.12)		(−1.12)	
N	362	362	362	362	361	361	772
R^2	0.73	0.74	0.72	0.73	0.73	0.74	0.72

Note: All variables are measured in difference to the euro area average. t-Values are below the coefficient estimates in brackets. ***, **, * indicate significance at a 1, 5, 10% level, respectively. R^2*is taken from the fixed effects regression.*

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fluctuations of assets occurred despite a single monetary policy, reflecting the impact of large capital flows. A simple analysis of the money–price relationship which does not take explicit account of such a development in asset markets then misses an important determinant of cross-country monetary and credit dynamics.

Our findings point to a potentially promising new line of research which at some point may have implications for the interpretation of the monetary policy framework in the euro area. No explicit consideration of cross-country differences in house prices is needed in a monetary context as long as these broadly move in concert with income, as was the case before 1999. However, after 1999 high money growth in several euro area countries has been a reflection of excessive house price developments. These developments were less apparent at the aggregate level, and yet could eventually have systemic and financial stability risks for the euro area as a whole.

7. Acknowledgements

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Appendix A

Figs. A.1–A.4 display real money and nominal house price growth in the euro area from 1999 to 2008. They show that there is substantial variation of the variables not only across countries but also within each individual country in time.

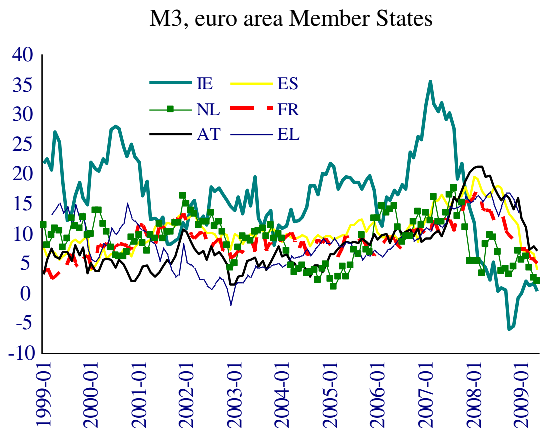

Fig. A.1. M3, euro area Member States. Note: Real growth rates, year-on-year in %.
Source: ECB.

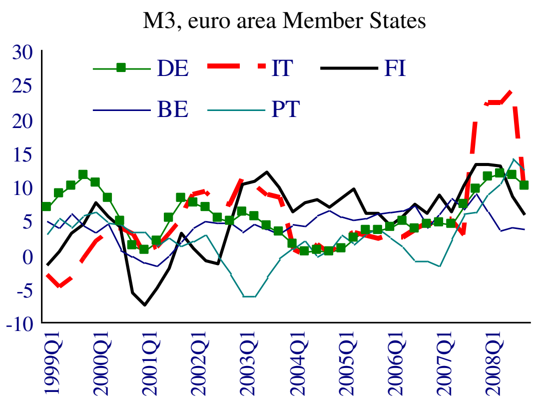

Fig. A.2. M3, euro area Member States. Note: Real growth rates, year-on-year in %.
Source: ECB.

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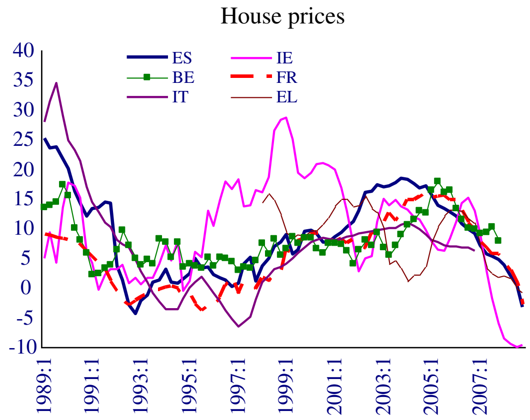

Fig. A.3. House prices. Note: Nominal growth rates, year-on-year in %. Source: ECB and OECD.

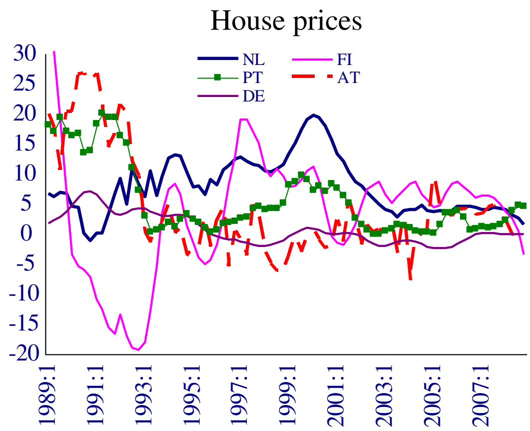

Fig. A.4. House prices. Note: Nominal growth rates, year-on-year in %. Source: ECB and OECD.

Appendix B

In this Appendix we derive the first order conditions for the theoretical model proposed in Eqs. (1)–(8) in the main text and subsequently derive an aggregate money demand equation from these conditions.

Deriving the first order conditions for the lenders

To derive the first order conditions from the problem described in Eqs. (1)–(3) for the lenders we need to compute the Bellman equations for the problem. The household inherits from the past $\frac{B_{t-1}^l}{P_{t-1}}, \frac{M_{t-1}^l}{P_{t-1}}$ and H_{t-1}^l, i.e., bonds, money and the home. We define the state variable ω_{t-1}as:

$$\omega_{t-1} = \frac{Q_t}{P_t} H_{t-1}^l + R_{t-1} \frac{B_{t-1}^l}{P_{t-1}} + \frac{P_{t-1}}{P_t} \frac{M_{t-1}^l}{P_{t-1}}. \tag{B.1}$$

This implies that the budget constraint can be rewritten as:

$$\frac{B_t^l}{P_t} + \frac{M_t^l}{P_t} + \frac{Q_t}{P_t} H_t^l = \omega_{t-1} + Y_t^l - C_t^l. \tag{B.2}$$

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The transition equation for the new state variable is:

$$\begin{aligned}\omega_t &= \frac{E_t Q_{t+1}}{E_t P_{t+1}} H_t^l + R_t \frac{B_t^l}{P_t} + \frac{P_t}{E_t P_{t+1}} \frac{M_t^l}{P_t} \\ &= \frac{E_t Q_{t+1}}{E_t P_{t+1}} H_t^l + \frac{P_t}{E_t P_{t+1}} \frac{M_t^l}{P_t} + R_t \left[-\frac{M_t^l}{P_t} - \frac{Q_t}{P_t} H_t^l + \omega_{t-1} + Y_t^l - C_t^l \right].\end{aligned} \tag{B.3}$$

After some re-arranging this yields:

$$\omega_t = R_t \left[\omega_{t-1} + Y_t^l - C_t^l \right] - \left[R_t \frac{Q_t}{P_t} - \frac{E_t Q_{t+1}}{E_t P_{t+1}} \right] H_t^l - \left[R_t - \frac{P_t}{E_t P_{t+1}} \right] \frac{M_t^l}{P_t}. \tag{B.4}$$

The Bellman equation for the problem then reads:

$$V_t(\omega_{t-1}) = \max_{C_t^l, \frac{M_t^l}{P_t}, H_t^l} E_0 \left[U\left(C_t^l, \frac{M_t^l}{P_t}, H_t^l \right) + \beta V_{t+1}(\omega_t) \right]. \tag{B.5}$$

The first order conditions with respect to consumption, real money and housing read:

$$\frac{\partial U}{\partial C^l} + \beta V'(\omega_t) \frac{\partial \omega}{\partial C^l} = 0 \Rightarrow \frac{\partial U}{\partial C^l} = \beta R_t V'(\omega_t) \tag{B.6}$$

$$\frac{\partial U}{\partial (M^l/P)} + \beta V'(\omega_t) \frac{\partial \omega}{\partial (M^l/P)} = 0 \Rightarrow \frac{\partial U}{\partial (M^l/P)} = \beta \left[R_t - \frac{P_t}{E_t P_{t+1}} \right] V'(\omega_t) \tag{B.7}$$

$$\frac{\partial U}{\partial H^l} + \beta V'(\omega_t) \frac{\partial \omega}{\partial H^l} = 0 \Rightarrow \frac{\partial U}{\partial H^l} = \beta \left[R_t \frac{Q_t}{P_t} - \frac{E_t Q_{t+1}}{E_t P_{t+1}} \right] V'(\omega_t). \tag{B.8}$$

Putting the results for real money and consumption together yields:

$$\frac{\frac{\partial U}{\partial (M^l/P)}}{\frac{\partial U}{\partial C^l}} = \frac{R_t - \frac{P_t}{E_t P_{t+1}}}{R_t} \Rightarrow \frac{\frac{\partial U}{\partial (M^l/P)}}{\frac{\partial U}{\partial C^l}} = \frac{i_t}{1 + i_t}. \tag{B.9}$$

This is the standard result that would also be obtained by including only money and consumption in the utility function, and therefore it is not very interesting for our purposes. However, putting the results for real money and housing together does yield an interesting relationship:

$$\frac{\frac{\partial U}{\partial (M^l/P)}}{\frac{\partial U}{\partial H^l}} = \frac{R_t - \frac{P_t}{E_t P_{t+1}}}{R_t \frac{Q_t}{P_t} - \frac{E_t Q_{t+1}}{E_t P_{t+1}}} \Rightarrow \frac{\frac{\partial U}{\partial (M^l/P)}}{\frac{\partial U}{\partial H^l}} = \frac{i_t}{\frac{Q_t}{P_t} \left[1 + i_t - \frac{E_t Q_{t+1}}{Q_t} \right]}. \tag{B.10}$$

This equation says that the marginal utility of money relative to that of housing will increase if the real price increases and if the expected increase in the house price (the expected capital gain) falls. In fact, the term in the denominator represents the user cost of housing capital. Hence, if the user cost of housing capital increases, the marginal utility of money decreases relative to that of housing, i.e. the amount of real cash balances held by the household will increase relative to the amount of housing services.

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Deriving the first order conditions for the borrowers

Substituting the collateral constraint (6) in the flow of funds constraint (5) and rearranging yields:

$$\begin{aligned} & C_t^b + \frac{Q_t}{P_t}\left(H_t^b - H_{t-1}^b\right) + R_{t-1}\frac{B_{t-1}^b}{P_{t-1}} + \frac{M_t^b}{P_t} - Y_t^b \\ & -\frac{E_t Q_{t+1} H_t^b}{R_t P_t} - \frac{P_{t-1}}{P_t}\frac{M_{t-1}^b}{P_{t-1}} = 0. \end{aligned} \tag{B.11}$$

If ϕ_t is the Lagrange multiplier, the first order conditions read:

$$\frac{\partial U}{\partial C^b} = \frac{\partial U}{\partial (M^b/P)} = \phi_t \tag{B.12}$$

$$\frac{\partial U}{\partial H^b} = \phi_t \frac{Q_t}{P_t}\left[1 - \frac{E_t Q_{t+1}}{R_t Q_t}\frac{P_t}{E_t P_{t+1}}\right]. \tag{B.13}$$

This implies that:

$$\frac{\frac{\partial U}{\partial (M^b/P)}}{\frac{\partial U}{\partial H^b}} = \frac{1}{\frac{Q_t}{P_t}\left[1 - \frac{E_t Q_{t+1}}{R_t Q_t}\frac{P_t}{E_t P_{t+1}}\right]}. \tag{B.14}$$

Or, after substituting the collateral constraint (6) in this result:

$$\frac{\frac{\partial U}{\partial (M^b/P)}}{\frac{\partial U}{\partial H^b}} = \frac{1}{\frac{Q_t}{P_t}\left[1 - \frac{B_t^b}{Q_t H_t^b}\right]}. \tag{B.15}$$

This equation effectively says that the relative utility of money (compared to housing) will decrease if the net wealth position of households increases. The net wealth, in turn, is a positive function of the real house price.

Deriving the aggregate money demand equation

In order to derive money demand equations for the two groups of households (which together determine aggregate money demand), we need to specify the utility function. For the sake of convenience we assume a log-linear utility function, noting that more complex utility functions would not lead to a fundamentally different relationship in terms of its signs. So, the utility function reads:

$$U\left(C_t^j, \frac{M_t^j}{P_t}, H_t^j\right) = \log C_t^j + b_t^\delta \log \frac{M_t^j}{P_t} + d \log H_t^j, j = l, b \tag{B.16}$$

where b_t stands for shifts in preferences for holding money. Aggregate money demand M is determined as:

$$\log M_t = (1-\lambda)\log M_t^l + \lambda \log M_t^b \tag{B.17}$$

where λ denotes the weight of money demand of credit-constrained households (borrowers) in total money demand.

Combining Eqs. (B.10) and (B.16) yields the following money demand equation for the *lenders*:

$$\frac{M_t^l}{P_t} = \frac{b_t^\delta}{d} C_t^l \frac{Q_t}{P_t}\frac{H_t^l}{C_t^l}\frac{(i_t - \rho_t)}{i_t} \tag{B.18}$$

where

$$\rho_t = \frac{E_t Q_{t+1} - Q_t}{Q_t}$$

denotes the expected rate of house price inflation.

Combining Eqs. (B.15) and (B.16) yields for the *borrowers*:

$$\frac{M_t^b}{P_t} = \frac{b_t^\delta}{d} C_t^b \frac{Q_t}{P_t} \frac{H_t^b}{C_t^b}\left[1 - \frac{B_t^b}{Q_t H_t^b}\right]. \tag{B.19}$$

Converting Eqs. (B.18) and (B.19) in logs, combining them with the aggregation identity (B.17) and assuming that λ can be used to approximate the weight of credit constrained households in aggregate consumption then yield the aggregate money demand Eq. (7) in the main text.

References

Agnello, L., Schuknecht, L., 2009. Booms and busts in housing markets: identification, determinants and implications. ECB Working Paper 1071. European Central Bank, Frankfurt.

Alessi, L., Detken, C., 2009. Real-time early warning indicators of costly asset price boom/bust cycles: a role for global liquidity. ECB Working Paper 1039. European Central Bank, Frankfurt.

Beck, G.W., Wieland, V., 2007. Money in monetary policy design: a formal characterization of ECB-style cross-checking. Journal of the European Economic Association 5, 524–533.

Berger, H., de Haan, J., Sturm, J.-E., 2011. Does money matter in the ECB strategy? New evidence based on the ECB communication. International Journal of Finance and Economics 16, 16–31.

Beyer, A., 2009. A stable model for euro area money demand: revisiting the role of wealth, ECB Working Paper 1111, Frankfurt. European Central Bank, Frankfurt.

Boone, L., van den Noord, P., 2008. Wealth effects on money demand in the euro area. Empirical Economics 38, 525–536.

Bosker, M., 2004. Eurozone money demand — evidence from a non-stationary dynamic panel data analysis. DNB staff report no. 126. De Nederlandsche Bank, Amsterdam.

Calza, A., Gerdesmeier, D., Levy, J., 2001. Euro area money demand: measuring the opportunity costs appropriately. IMF Working Paper 11/179. International Monetary Fund, Washington.

Calza, A., Monacelli, T., Stracca, L., 2007. Mortgage markets, collateral constraints, and monetary policy: do institutional factors matter? CFS Working Paper 10/2007. Center for Financial Studies, Frankfurt.

Carstensen, K., 2006. Stock market downswing and the stability of European monetary union money demand. Journal of Business and Economic Statistics 25, 395–402.

Coenen, G., Vega, J.-L., 2001. The demand for M3 in the euro area,. Journal of Applied Econometrics 16, 727–748.

De Bondt, G., 2009. Euro area money demand: empirical evidence on the role of equity and labour markets. ECB Working Paper 1086. European Central Bank, Frankfurt.

De Santis, R.A., Favero, C.A., Roffia, B., 2008. Euro area money demand and international portfolio allocation. ECB Working Paper 926. European Central Bank, Frankfurt.

Dreger, C., Wolters, J., 2010. Investigating M3 money demand in the euro area — new evidence based on standard models. Journal of International Money and Finance 29, 111–122.

ECB, 2009. Housing finance in the euro area. ECB Occasional Paper 101. European Central Bank, Frankfurt.

Eickmeier, S., Hofmann, B., 2009. Monetary policy, housing booms and financial (im)balances. ECB Working Paper 1178. European Central Bank, Frankfurt.

Fisher, B., Lenza, M., Pill, H., Reichlin, L., 2008. Money and monetary policy: The ECB experience 1999–2006. ECB, Conference Volume of the 4th ECB Central Bank Conference on “The Role of Money: Money and Monetary Policy in the Twenty-First Century”. European Central Bank, Frankfurt, pp. 102–175.

Friedman, M., 1988. Money and the stock market. Journal of Political Economy 96, 221–245.

Galí, J., 2010. The monetary pillar and the great financial crisis. Paper prepared for the ECB colloquium on “The Great Financial Crisis: Lessons for Financial Stability and Monetary Policy”, Frankfurt, May 20–21.

Gerdesmeier, D., Reimers, H.-E., Roffia, B., 2009. Asset price misalignments and the role of money and credit. ECB Working Paper 1068. European Central Bank, Frankfurt.

Gerlach, S., 2004. The two pillars of the European Central Bank. Economic Policy 44, 389–439 October.

Gerlach, S., Svensson, L.E.O., 2003. Money and inflation in the euro area: a case for monetary indicators? Journal of Monetary Economics 50, 1649–1672.

Greiber, C., Lemke, W., 2005. Money demand and macroeconomic uncertainty. Deutsche Bundesbank Discussion Paper 26/05. Deutsche Bundesbank, Frankfurt.

Greiber, C., Setzer, R., 2007. Money and housing: evidence for the euro area and the US. Deutsche Bundesbank Discussion Paper 12/07. Deutsche Bundesbank, Frankfurt.

Hadri, K., 2000. Testing for stationarity in heterogeneous panel data. Econometrics Journal 3, 148–161.

Hallerberg, M., Wolff, G.B., 2008. Fiscal institutions, fiscal policy and sovereign risk premia in EMU. Public Choice 136, 379–396.

Hilbers, P., Hoffmaister, A., Banerji, A., Shi, H., 2008. House Price Developments in Europe: A Comparison, IMF Working Paper 211. International Monetary Fund, Washington.

Iacoviello, M., 2004. Consumption, house prices, and collateral constraints: a structural econometric analysis. Journal of Housing Economics 13, 304–320.

Iacoviello, M., 2005. House prices, borrowing constraints, and monetary policy in the business cycle. The American Economic Review 95, 739–764.

Kao, C., Chiang, M.-H., 2000. On the estimation and inference of a cointegrated regression in panel data. In: Baltagi, B. (Ed.), Nonstationary Panels, Panel Cointegration, and Dynamic Panels'. : Advances in Econometrics, 15. JAI Press, Amsterdam, pp. 179–222.

Kao, C., Chiang, M.-H., Chen, B., 1999. International R&D spillovers: an application of estimation and inference in panel cointegration. Oxford Bulletin of Economics and Statistics 61, 693–711.

Maclennan, D., Muellbauer, J., Stephens, M., 1998. Asymmetries in housing and financial market institutions and EMU. CEPR Discussion Paper 2062. Centre for Economic Policy Research, London.

Muellbauer, J., Murphy, A., 2008. Housing markets and the economy: the assessment. Oxford Review of Economic Policy 24, 1–33.

Newey, W.K., West, K.D., 1994. Automatic lag selection in covariance matrix estimation. Review of Economic Studies 61, 631–653.

Pedroni, P., 1999. Critical values for cointegration tests in heterogenous panels with multiple regressors. Oxford Bulletin of Economics and Statistics 61, 653–670.

Pesaran, M.H., Smith, R., 1995. Estimating long-run relationships from dynamic heterogeneous panels. Journal of Econometrics 68, 79–113.

Setzer, R., Wolff, G.B., 2009. Money demand in the euro area: new insights from disaggregated data. DG ECFIN Economic Papers 373. European Commission, Brussels.

Stein, J.C., 1995. Price and trading volume in the housing market: a model with down-payment effects. Quarterly Journal of Economics 110, 379–406.

Stock, J., Watson, M.W., 1993. A simple estimator of cointegrating vectors in higher order integrated systems. Econometrica 61, 783–820.

Weber, A.A., Gerke, R., Worms, A., 2009. Has the monetary transmission process in the euro area changed? Evidence based on VAR estimates. BIS Working Paper 276. Bank for International Settlements, Basel.

Woodford, M., 2008. How important is money in the conduct of monetary policy? Journal of Money, Credit and Banking 40, 1561–1598.