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Abstract

This paper examines the relation between money and housing variables in the euro area and in the US. Our empirical model is based on a standard money demand relation which is augmented by housing market variables. In doing so, co-integrated money demand relationships can be established for both the euro area and the US. Furthermore, we find evidence for asset inflation channels, that is, liquidity fuels housing market developments.

JEL-Classifikation: E41, E52

Keywords: Money demand, asset inflation, housing, wealth

Money and Housing – Evidence for the Euro Area and the US

1 Introduction

Money and credit growth have been extraordinarily strong in both the euro area and in the US in recent years. However, contrary to conventional wisdom, monetary growth has not coincided with a concurrent increase in consumer price (CPI) inflation. At the same time, several euro area countries and the US have experienced strong increases in house prices which significantly outpaced CPI inflation. The upswing in house prices was accompanied by an expansion of construction activities. Both developments add to the boost in housing wealth. This raises the question about a possible causal relationship between money and housing. Has the recent boom on real estate markets been influenced by increased liquidity? Or does strong monetary growth rather mirrors the surge in house prices over the last years?

In principle, multiple interdependencies between monetary dynamics and housing variables might exist. For example, a surge in house prices may trigger a rise in the demand for money due to an increase in net household wealth or due to a higher transaction volume on housing and construction markets (Friedman 1988). On the other hand, causality could also run from monetary developments to the housing market if an expansionary monetary policy provides ample liquidity and thereby causes asset inflation (see e.g. Adalid and Detken 2007). In addition, developments in the housing market have important implications for the lending behaviour of banks. Higher house prices increase the collateral values of homes and improve home owners' access to loans, fostering credit and money growth. Since the latter may fuel further house price increases, the causality between house prices and monetary development runs here in both directions, leading to possible accelerator effects. The question about the causality between monetary developments and house prices has important monetary policy

implications. If money demand is found to be significantly affected by swings in real estate markets, an assessment of the current monetary conditions should take developments in the housing sector into account. Conversely, if excess liquidity flows into property markets, resulting in higher house price inflation, a stronger case can be made for the role of monetary analysis in general and the indicator properties of money in particular.

Considering the current debate on the role of monetary aggregates for monetary policy, an empirical relationship between house prices and money may explain signs of instability in standard money demand functions. While earlier studies of money demand identified stable relationships between real balances, real income and interest rates in the euro area (see e.g. Calza, Gerdesmeier and Levy 2001), the evidence in favour of the existence of a cointegration relationship between these three variables has become weaker in the post-2001 period. Though several explanations for this phenomenon have been found (Carstensen 2003, Greiber and Lemke 2005, Dreger and Wolters 2006), it has become increasingly difficult to explain the episode of strong money growth, particularly since 2004. Similar evidence was found for the US where signs of instability in standard money demand functions occurred already in the second half of the 1990s (Carlson, Hoffmann, Keen and Rasche 2000, Greiber and Lemke 2005).

To further investigate the relative importance of these potential relationships, this study tries to establish an empirical link between money and housing developments. By explicitly taking liquidity considerations into account, we add to the recent literature which emphasises the role of housing for economic activity (Goodhart and Hofmann 2007) and the transmission of monetary policy (Guliodori 2005, Iacoviello 2005, Del Negro and Otrok 2007), but largely ignores the relation with monetary developments. Furthermore, we enrich the small empirical branch of the literature which studies the relationship between house prices and monetary aggregates, but does not use a money demand approach (Gouteron and Szpiro 2005) or disregards interdependencies between the variables of interest (Boone and van den Noord 2007).

The following main findings emerge from this study: Firstly, housing markets play a vital role for the demand for real balances both in the euro area and the US. While the inclusion of housing variables in a money demand framework was less

important when housing wealth was sufficiently closely related to economic activity (as it was the case in the 1980s and 1990s), the recent strong rise in housing prices and wealth asks for an explicit consideration of these variables. Secondly, not only do house prices influence monetary developments but the reversed relationship is relevant as well. Specifically, we identify strong links from liquidity to the housing sector.

The remainder of this study is organised as follows. Chapter 2 describes the theoretical relationship between money and housing. Chapter 3 provides estimates for the euro area and the US concerning the role of house prices and wealth in the determination of the money stock. Furthermore, we address the interaction between housing and monetary policy using vector autoregressive models and derive the impulse responses of our key macroeconomic variables. Chapter 4 provides some robustness checks by augmenting our benchmark model with additional variables. Chapter 5 concludes.

2 Housing and money

The relation between housing variables and monetary aggregates can be rationalised in different ways. The various channels which provide a link between the two variables can be grouped into three not mutually exclusive categories: The first group comprises classical money demand motives ("money demand channel"). The second category addresses mechanisms describing the particular role of liquidity with respect to the financing of housing which we label as "asset inflation channel". Finally, due to the collateral value of real estate property there is a relation between lending and money ("credit channel").

(a) Money demand channel

Following Friedman (1988) the relationship between house prices and money demand can be classified into wealth, substitution, and transaction effect.[1] According to the wealth effect money is a store of value and as such it serves as an alternative to

[1] Friedman (1988) analyses the relationship between money and *stock prices*; however, his arguments are transferable to other asset prices such as house prices. See Boyle (1990) for a similar approach.

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" which captures that a change in the level of wealth alters the demand for all asset classes including money, the "substitution effect" postulates that changes in the relative attractiveness of different assets change 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.

While these two previous effects relate to portfolio aspects, the "transactions 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 the fact that the number of transactions on the housing market is generally higher during housing boom episodes (Stein 1995). Since home owners want to avoid capital losses they tend to delay sales when house prices stagnate. They perceive declining house prices as temporary phenomenon which leads to a breakdown in the turn-over of real estate trading. Only with house prices rising, they re-enter property markets.

(b) Asset inflation channel

While the previous considerations identify a causal link from the housing market to money, there are also potential effects from monetary policy and monetary aggregates to the housing market ("asset inflation channel"). Optimal portfolio allocation considerations suggest that an expansive monetary policy providing the markets with ample liquidity may trigger a rebalancing of assets and thus cause house price increases. In particular, an increase in real house prices, i.e. a stronger rise of house prices compared to consumer goods, may result because of differing price elasticities of supply. With a view to recent developments the emergence of low-cost producers in emerging markets and developing countries may have prevented firms from increasing consumer prices in response to a liquidity shock while supply in

housing markets was restricted. As a result, house prices were more sensitive to an increase in aggregate demand caused by monetary expansion than consumer prices.

Moreover, monetary policy could improve financing conditions which increases demand and borrowing for housing. A special case for this effect can be made if agents are subject to "money illusion" (Brunnermeier and Julliard 2006). In particular, in times of decreasing inflation people will underestimate future real payments related to their loans because the decrease in nominal interest rates is wrongly attributed to a decline in real interest rates and not to the reduction in inflation.

(c) Credit channel

A third important aspect of the relation between housing and money stems from the collateral value of household's assets. Due to asymmetric information distribution on credit markets, agent's ability to borrow depends on the value of their collaterals. Iacoviello (2005) highlights the role of housing as collateral in the transmission mechanism. Since housing wealth is an important balance sheet variable it determines the borrowing constraints faced by agents. Higher collaterals reduce the influence of asymmetric information and improve lending conditions. Thus there is a direct link between housing and loan developments. Moreover, in the spirit of Kiyotaki and Moore (1997) housing property may act as a catalyst which amplifies the effects of monetary policy and thus provides a house price channel.

Beyond potential accelerator effects, these balance sheet effects also stress that lending related to the financing of property is closely linked to the money supply. In a rather mechanical sense the creation of a new loan is likely to go along with the creation of new deposits. In particular, this effect is quite likely if the central bank does not restrict money growth. Moreover, these balance sheet mechanisms should be independent of whether existing or newly build property is transferred.[2]

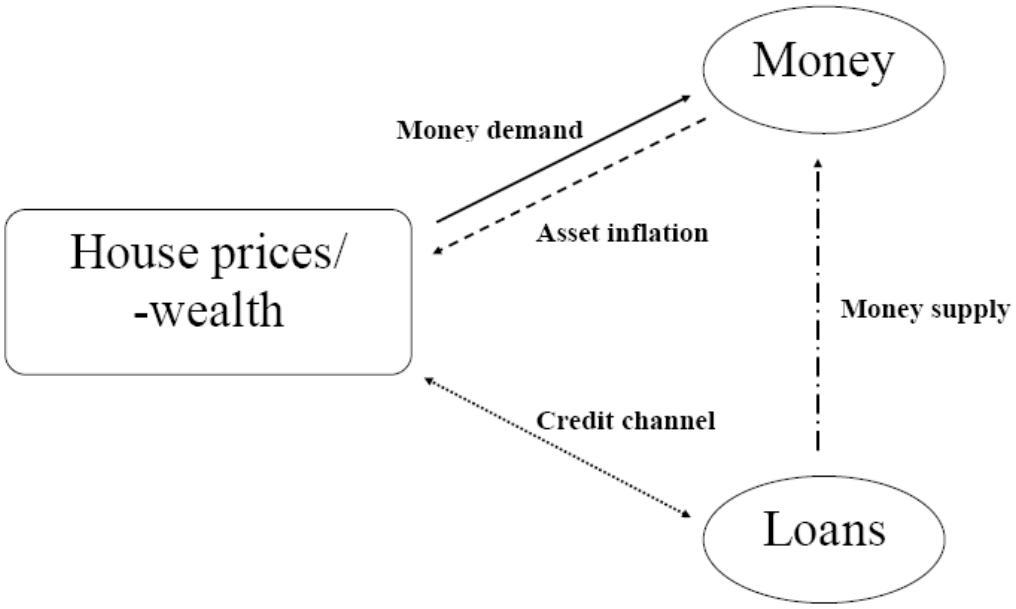
With respect to the empirical identification of the credit channel, the well known identification problems arise in this context (see e.g. Oliner 1995). Despite the relevance

[2] This may also explain why using GDP or its subcomponent construction which contains only newly build housing is likely to be a bad proxy for housing transactions and the corresponding demand for money.

of these effects it is hard to discriminate or separate them from other channels. Thus, in the following the strategy is not to formally test for effects associated with this channel. Rather these are considered by including additional credit variables in our model in order to detect potential differences due to these effects.

Graph 1 portraits the channels discussed. Money is directly linked to house prices and wealth via the money demand and the asset inflation channel. The credit channel captures that housing developments influence household's borrowing capacity which in turn determines loans and thus money supply. The arrow connecting house prices and loans runs in both directions indicating that higher house prices and loans may reinforce each other: Rising house prices increase household's borrowing capacity and at the same time augment the supply of credit which leads to a further rise in house prices.

Graph 1: Relations between money and housing



Beyond money, monetary policy and financial developments housing markets are certainly also influenced by other factors, such as taxes, demographics and other developments determining the demand for housing. Among these a very important mechanism is that the trend behaviour of real house prices is determined by supply effects, e.g. technological progress. In particular, real house prices are likely to follow an upwards trend over time (Poterba 1984). This is because housing supply adjusts

slower to demand shocks, e.g. because some of the input factors – for example land – are likely to be scarcer or less re-produceable than those used for the production of other goods. Thus, in case of an increasing aggregate demand the price of property is likely to increase stronger than that of products where input factors are less restricted. Moreover, partially due to the constrained supply of input factors technological progress is possibly lower in the construction sector as compared to others. This may finally lead to an upward trend in real house prices since the lower marginal productivity in combination with strong wage competition from other sectors has to be offset by higher factor compensation in the construction sector.

Another important factor influencing the money-housing interaction is the process of financial liberalisation which creates liquidity by improving the provision of financial services related to housing. For example, mortgage-backed-security (MBS) transactions have become increasingly popular. In the US in particular, new ways of structuring MBS deals have also improved the lending possibilities of big state mortgage agencies, such as Fanny Mae and Freddie Mac. Additionally, real estate investment trusts are growing in number and volume. As a result of these structural and institutional changes, it has become increasingly easier for households to lend on the increasing value of their housing assets (Belke and Wiedmann 2006).

In sum, these channels hypothesise significant links between money and housing. However, the discussion also implies some identification problems. The above considerations provide potential relations between money and house prices as well as between money and housing wealth but it remains unclear a priori which of the two housing variables is the more relevant one. However, a precise discrimination between the two indicators is not crucial given that property prices are an empirical proxy for property wealth and vice versa.[3] Thus, in the following empirical analysis we employ both variables.

[3] In this case, one should expect a cointegrated relation between house prices and housing wealth.. However, as further data analysis suggests, such a relationship does neither seem to exist for the US nor for the euro area. Thus the long-run development of real house prices contains information differing from the one in housing wealth.

3 Empirical issues

3.1 Data and methodological issues

To empirically test for the link between money and housing variables we start by applying a cointegration approach. This firstly allows to assess whether such a relation exists in the long-run and secondly to test for the money demand and the asset inflation channel. Within a vector-error correction model the former can be done by establishing cointegrated relationships considering money and housing while the latter refers to the significance of the respective error correction mechanisms or loadings.

In order to estimate a long-run relation we augment a standard money demand specification with housing variables:

$$(1)\quad (m-p)_t = \alpha_0 + \alpha_1 \cdot gdp_t + \alpha_2 \cdot ir_t + \alpha_3 \cdot prop_t + \varepsilon_t,$$

where *m*, *p*, *gdp* and *ir* denote nominal M3, the GDP deflator, real GDP, and an interest rate variable (which is specified below). The variable $prop_t$ corresponds to the real residential property price index (*p_price*) or the housing wealth indicator (*p_wealth*), alternatively. All variables except the interest rates are transformed to logarithms. For the monetary aggregates we use seasonally adjusted quarterly data for real M3 (for the euro area) and real M2M (for the US). Note that we use different observation periods for the two regions. The sample for the euro area (EA) ranges from 1981Q1 to 2006Q4. In contrast, the sample start for the US was set to 1986Q1. This is due to the fact that the possible inclusion of prior data introduced serious specification problems such as serial correlation. This reflects that the employed monetary aggregate M2M is not the appropriate monetary measure in the US for the first half of the eighties since the alleged shifts out of small time deposits into mutual funds rather occurred in the second half of that decade.[4]

Real money balances were computed by using the GDP deflator. Considering the choice of the interest rate variable we use the ten-year government bond yield for the euro area (*irl)* and the spread between the three month treasury bill and the own rate of M2M for the US (*irs)*. The use of different specifications is motivated by differences

between the European and the US inflation path over the sample period. Specifically, the euro area is characterised by relatively high inflation rates in the first period of the sample with a subsequent disinflation process. This entailed higher inflation risk premia in mortgage contracts which are probably better captured by long-term rates. By contrast, inflation rates in the US underwent a much smoother path during the observation period resulting in no need to control for inflation expectations.[5] [6]

Data used for the euro area are obtained from an updated version of the data base in Fagan, Henry, and Mestre (2001) (Area Wide Model) and official ECB statistics. For the US data from the FRED data base by the Federal Reserve Bank of St. Louis are used. Housing developments in the euro area are approximated by a) the residential property price index (all dwellings) from the macroeconomic database of the BIS and b) ECB estimates for households' housing wealth, which cover the value of all dwellings, including the value of land on which the buildings are built (ECB 2006). Both indices are only available on an annual respectively semi-annual (the property price index from 1996 on) basis. Missing values were generated by linear interpolation. US house prices are also taken from the BIS data bank, while real estate property observations of households are based on the Flow of Funds data from the Board of Governors of the Federal Reserve System.

In order to demonstrate the evolution of housing variables Graphs 2a and 2b depict real house prices and wealth for the euro area and the US respectively. As can be seen for the euro area, there is a relative high synchronisation between house prices and housing wealth. Both time series are characterised by relatively long cycles around an upward trend. Periods of low growth (or even declines in the case of property prices) in the first halves of the 1980s and the mid-1990s have been followed by extensive booms in the second half of the 1980s, the early 1990s and the last seven years. In the US the

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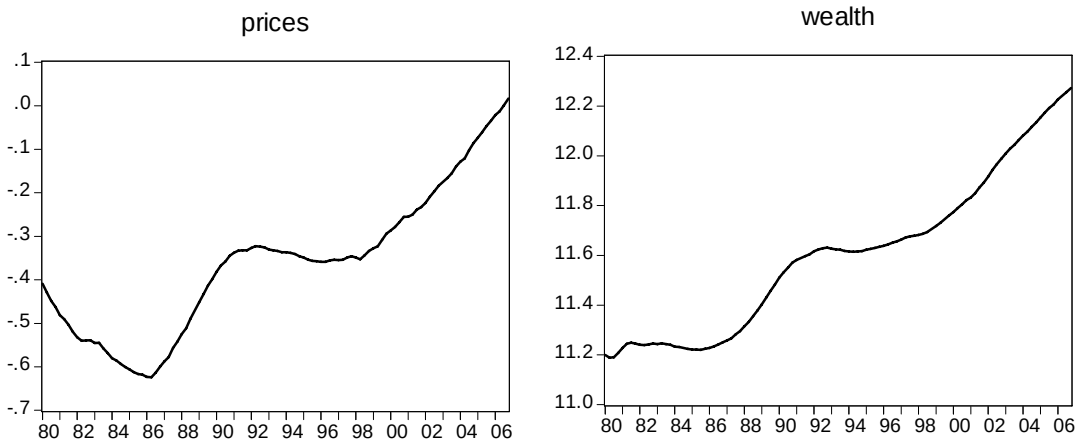
[4] More specifically, applying the Johansen method led to severe non-normality and serial correlation of the errors when the sample was extended backwards. Although this did not affect point estimates, significance levels of the estimators should be biased.

[5] Another difference between the two currency areas is that, though both European countries and the US rather use fixed mortgage rates (Tsatsaronis and Zhu 2004, p. 69), the typical US mortgage contract contains a feeless prepayment facility. Thus, US borrowers can switch to a less costly new contract in the case of falling interest rates. As a consequence, the impact of short term rates on house prices could be expected to be comparably stronger for the US in comparison to the euro area.

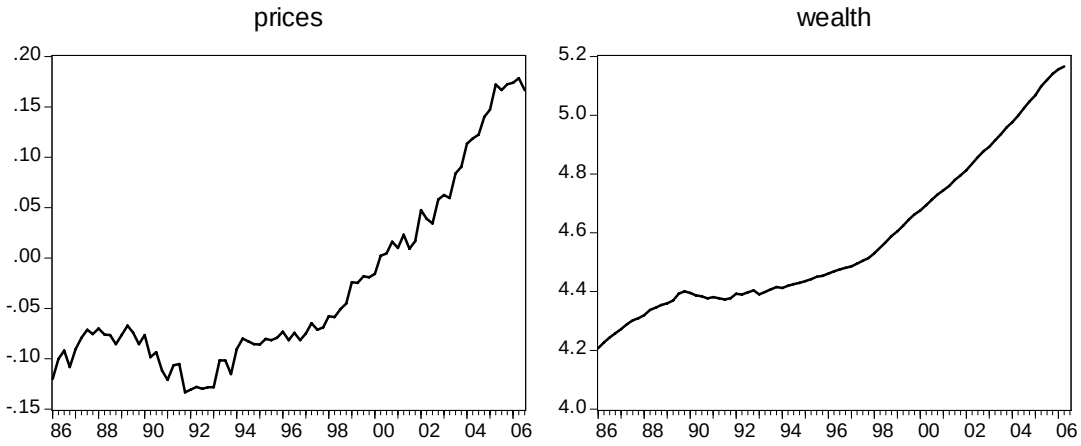
[6] Empirical evidence (not shown) supports this view. Using short-term rates for the euro area and long-term rates for the US instead did not yield stable relations of the kind shown later.

development is similar considering recent years. However, the surge in real property prices started a bit earlier.

Graph 2a: Real house prices and housing wealth – Euro area



Graph 2b: Real house prices and housing wealth – US



Finally, to assess the time series properties of the data, we examine the degree of integration of the variables. Findings from Philips-Perron and Augmented-Dickey-Fuller (ADF) tests reveal that series have to be differenced (at least) once to become stationary (Table 1). Some ambiguities remain with respect to the property variables of the euro area, however. While the Philips-Perron test suggest that housing prices and housing wealth are both I(1), the ADF test can reject the null hypothesis of non stationarity only at the 10 percent level. Therefore, the Kwiatkowski-Philips-Schmidt-Shin (KPSS) test is utilized as a complement to check for stationarity. The null

hypothesis of stationarity cannot be rejected implying that the series are stationary. Based on the test statistics with a unit root null (Philips-Perron, ADF test) and a stationarity null (KPSS), there is thus reasonable evidence that all series are I(1). Moreover, this is consistent with our theoretical considerations, given that it is the level (and not the first difference) of house prices and housing wealth which should be relevant for the money demand and credit channel (Friedman 1988, Boyle 1990).

Table 1: Unit Root and Stationarity Tests

	PP level	PP difference	ADF level	ADF difference	KPSS level	KPSS difference
Critical value	-2.90	-2.90	-2.90	-2.90	0.46	0.46
Euro Area						
$(m\text{-}p)_t$	1.71	-5.82*	2.16	-5.59*	1.14*	0.43
gdp_t	-0.52	-7.58*	-0.28	-7.79*	1.13*	0.08
irl_t	-1.90	-5.93*	-1.36	-5.69*	1.15*	0.06
p_prop_t	1.02	-3.04*	0.03	-2.61	1.00*	0.39
p_wealth_t	1.16	-2.96*	1.61	-2.60	1.08*	0.35
USA						
$(m\text{-}p)_t$	0.54	-4.03*	-0.51	-3.53*	1.07*	0.10
gdp_t	-0.07	-7.41*	-0.08	-4.00*	1.15*	0.07
irs_t	-2.30	-5.06*	-2.83	-5.05*	0.49*	0.08
p_prop_t	1.56	-10.34*	0.82	-3.07*	1.08*	0.32
p_wealth_t	2.53	-2.90*	2.01	-2.97*	1.18*	0.39

Notes: PP – Philips-Perron test (H_o: series ha s a unit root), ADF – Augmented-Dickey-Fuller test (H_o: series has a unit root), KPSS – Kwiatkowski-Philips-Schmidt-Shin test (H_o: series is stationary). * denotes rejection of the null hypothesis at the 0.05 level. Constant included in all tests.

3.2 VECM estimates

To estimate the augmented long-run equation (1), it is embedded into a vector error correction model (VECM) which is estimated by the Johansen procedure. In a first step the cointegration rank is determined by applying the trace test based on Johansen (1991). Table 2 reports the estimated trace statistics and the corresponding critical values due to MacKinnon, Haug and Michelis (1999). Lag lengths were chosen to avoid serial correlation of the errors.

Both for the US and the euro area, these tests advocate the existence of one cointegrating relationship, which relates real balances to GDP, interest rates and housing developments.[7] This holds true for housing wealth as well as house prices.

Table 2: Johansen cointegration rank tests (trace statistics)

Employed variables $(m-p)_t$, gdp_t , ir_t , $prop_t$

Number of cointegrating relationships	0	1	2	3
Critical value	47.86	29.80	15.49	3.84
sample 1981Q1-2006Q4		Euro area		
prices (lags = 2)	49.80*	24.34	6.87	1.19
wealth (lags = 2)	61.64*	20.32	7.56	012
sample 1986Q1-2006Q3		USA		
prices (lags = 3)	55.64*	26.48	8.00	1.71
wealth (lags = 1)	60.08*	22.65	9.15	2.58

* denotes rejection of the null hypothesis at the 0.05 level; critical values due to MacKinnon, Haug and Michelis (1999).

Table 3 presents the estimation of the corresponding VEC systems for the euro area and the US assuming one cointegrating relationship, respectively. The residual diagnostics reveal no signs of misspecification like serial correlation or non-normality (see bottom part of the table). Furthermore, the Nyblom test supports stability of the parameters. Using the asymptotic critical values for a 5 percent test from Hansen (1992), we cannot reject the null hypothesis that the parameters in the cointegrating relationship are constant.[8]

Turning to the parameter estimates of the long-run relations the results for the euro area in columns 1 and 2 show the expected signs with respect to GDP and opportunity costs. According to the clearly positive signs on the property price and wealth variables the expected positive effect stemming from the wealth, credit and transaction channels dominate the adverse substitution channel. It is also interesting to see that the GDP and housing wealth elasticities add up to about one and are thus much

[7] Extending this analysis to different periods and using more robust single-equation based cointegration tests (Engle and Granger 1987) confirmed these findings.

[8] The Nyblom test values were calculated using the SVAR programme by Anders Warne.

lower than those obtained by standard money demand specifications for the euro area where the scale variable elasticity is typically higher than unity.[9]

Table 3: Johansen cointegration analysis

Long-run: $(m-p)_t = \alpha_0 + \alpha_1 \cdot gdp_t + \alpha_2 \cdot ir_t + \alpha_3 \cdot prop_t + \varepsilon_t$

	(1) EA – prices	(2) EA – wealth	(3) US – prices	(4) US – wealth
	Long-run relationship			
gdp_t	0.32* (0.12)	0.59* (0.08)	0.87* (0.03)	0.73* (0.07)
irl_t	-2.55* (0.39)	-0.48* (0.17)		
irs_t			-4.86* (0.45)	-4.87* (0.52)
p_price_t	0.84* (0.08)		0.77* (0.07)	
p_wealth_t		0.48* (0.03)		0.28* (0.05)
constant	-2.18	-10.21	-4.26	-4.33
	Error correction terms			
$\Delta(m\text{-}p)_{t-1}$	-0.06* (0.02)	-0.07* (0.03)	-0.11* (0.045)	-0.08* (0.03)
Δgdp_{t-1}	0.06 (0.03)	0.16* (0.03)	-0.04 (0.03)	-0.03 (0.02)
Δirl_{t-1}	-0.07* (0.02)	-0.01 (0.02)		
Δirs_{t-1}			0.01 (0.02)	0.001 (0.14)
Δp_price_{t-1}	-0.01 (0.03)	0.05* (0.02)		
Δp_wealth_{t-1}			0.30* (0.07)	0.10* (0.03)
	Diagnostics			
lags	2	2	3	1
log likelihood	1667.7	1730.4	1318.6	1326.2
LM(1)	0.96	0.20	0.20	0.20
LM(4)	0.11	0.16	0.28	0.07
normality	0.27	0.34	0.08	0.70
Nyblom	0.44	0.36	0.37	0.43

Standard errors in parenthesis; * significant at the 0.05 level; Δx_{t-1} – error correction term in the respective difference equation; lags – lag length of VECM; LM(j) - test for no autocorrelation up to order *j* (p-value); normality – Jarque-Bera-test for normality (p-value); Nyblom – Nyblom test for parameter constancy of cointegrating vector (p-value), samples: 1981Q1-2006Q4 (Euro area), 1986Q1-2006Q3 (US).

Considering the short-run dynamics of the money demand system, the coefficients of the error correction term in the equation for money growth are statistically significant and have the correct sign, indicating that excess liquidity lowers money growth. The

[9] An income elasticity higher than one is often interpreted as an indication of the relevance of wealth effects for money demand (Calza, Gerdesmeier and Levy 2001).

magnitude of the coefficients (-0.06 and -0.07) is in line with previous research (compare Calza, Gerdesmeier and Levy 2001, Carstensen 2006, Boone and van den Noord 2007). The sign of the error correction term in the property equation is statistically significant and positive for the housing wealth model, but not the price model. One possible explanation for this result is that when excess liquidity stimulates demand for housing this implies a volume and a price effect. Thus, from the econometric point of view the housing surge signal might be stronger when looking at housing wealth which contains both. Furthermore, this observation could also be related to the fact that house price developments were quite heterogeneous among EMU countries. Consequently, the asset inflation channel for the euro area can only be measured if this stronger signal is considered.

For the US (columns 3 and 4) both specifications also deliver income elasticities below one. The elasticities with respect to prices and wealth differ somewhat, the former being 0.77, the latter 0.28. Interestingly, the interest rate elasticities appear even higher than for the euro area. This may reflect the alternative specification based on short-term interest rates. Still, they are in line with other estimates in the literature (see e.g. Carlson, Hoffman, Keen and Rasche 2000). The respective error correction terms for the property variables in both cases indicate that the monetary overhang significantly raises property prices/wealth. This result states that a robust asset inflation channel exists, i.e. liquidity "flows" into the housing market. At the same time, the error correction term in the money equation also has the expected negative sign and is statistically significant. The adjustment coefficient of the monetary overhang is similar in magnitude as for the euro area.

Finally, turning back to the discussion of wealth, transaction and substitution effects within the money demand framework, the clear and positive correlation between house prices and money gives rise to the view that the substitution effect is of minor importance. This result is not surprising for a number of reasons: Firstly, given the importance of housing wealth in total household's wealth, one might expect wealth effects to be significant, particularly if house price movements are perceived as permanent. Secondly, the magnitude of the substitution effect should be relatively low, given that housing property has a lower degree of liquidity than financial assets. Moreover, collateral or credit channel effects which also imply a positive correlation

between money and housing should be significant. This is in line with empirical estimates suggesting that house price fluctuations are a major determinant of credit cycles (ECB 2003).[10]

3.3 Impulse response analysis

To obtain further insights into the relationship between housing and money, an impulse response analysis based on the VECM from the previous section is conducted in the following. Therein, in particular the reaction of the property variables to money shocks and vice versa is investigated.

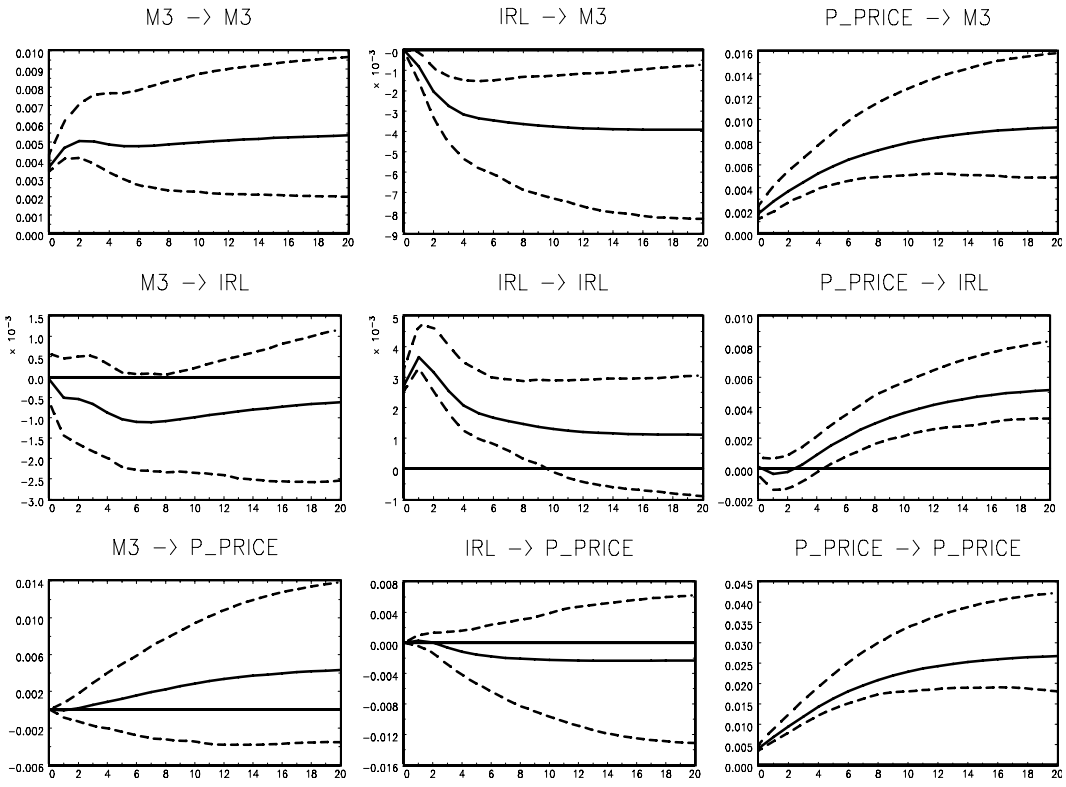
For the identification of shocks we generally employ a Choleski factorisation of the estimated variance-covariance matrix supposing that interest rates and money react contemporaneously to the real indicators, income and the property variables. Thus, block endogeneity of the policy and financial market variables (interest rates, money) is assumed. Moreover, within the two blocks we restrict the output shock to have no immediate effect on property prices/wealth, and impose the restriction that money has no immediate effect on interest rates.[11] Accordingly, the ordering of the VECM is specified as $(prop_t, gdp_t, (m-p)_t, ir_t)$.[12]

[10] The clearly positive correlation between housing assets and money stands in contrast to the sometimes found negative relationship between financial assets and money in the literature (see e.g. Kontolemis 2002). In the case of stocks, e.g., the negative substitution effect plays an important role since in periods of relatively high risk perception economic agents tend to substitute money for stocks. Moreover, in contrast to housing the collateral channel is likely to be negligible since stocks are not considered to be valid collateral for lending activities.

[11] In general, the results were quite robust using alternative identification schemes. Neither the ordering within the two blocks nor the assumption of which block (financial/real) reacts quicker were crucial.

[12] Confidence bands were calculated by the bootstrap procedure in JMulti. Displayed are the 95% Hall percentiles.

Graph 3a: Impulse responses – Euro area, benchmark VECM, property prices

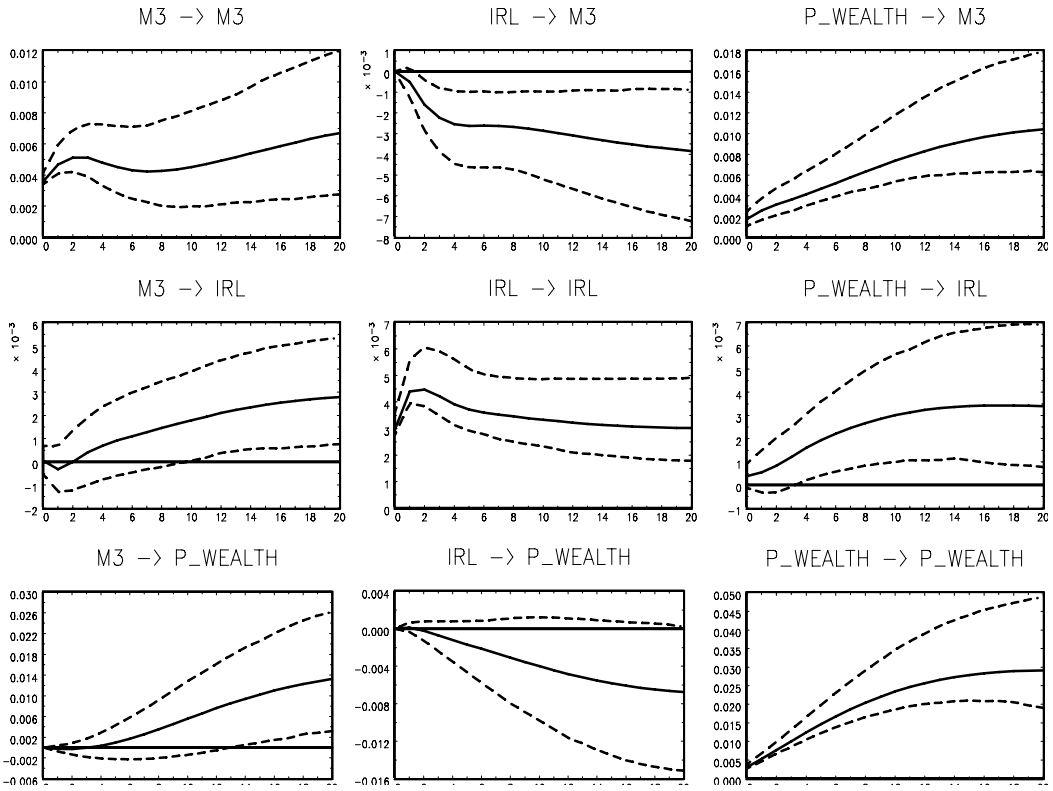


Graphs display impulses responses with bootstrapped 95% confidence intervals containing variables in the following order: real property prices (P_PRICE), real gross domestic product (GDP), real M3 (M3), long-term interest rate (IRL).

With regard to the euro area results, the response of money to a house price shock is positive and significant (Graph 3a).[13] In addition, money is also affected by innovations to the long-term interest rate. By contrast, property prices do not react significantly to a money shock. Rather, they are largely explained by their own shocks. A slightly different picture emerges if wealth is employed as the housing variable (Graph 3b). Again, money reacts positively to a property shock and negatively to interest rate news. However, in contrast to the price specification, housing wealth appears not only to be driven by its own shocks but – at least in the long-run – also by money shocks. This result plainly confirms the finding of the VECM where an asset inflation channel was also identified for the wealth specification but not for the price model.

[13] In order to save space and since we are primarily interested in the monetary variables of our model, we display only a selection of the impulse responses. However, the unreported results are in line with economic theory.

Graph 3b: Impulse response – Euro area, benchmark VECM, property wealth



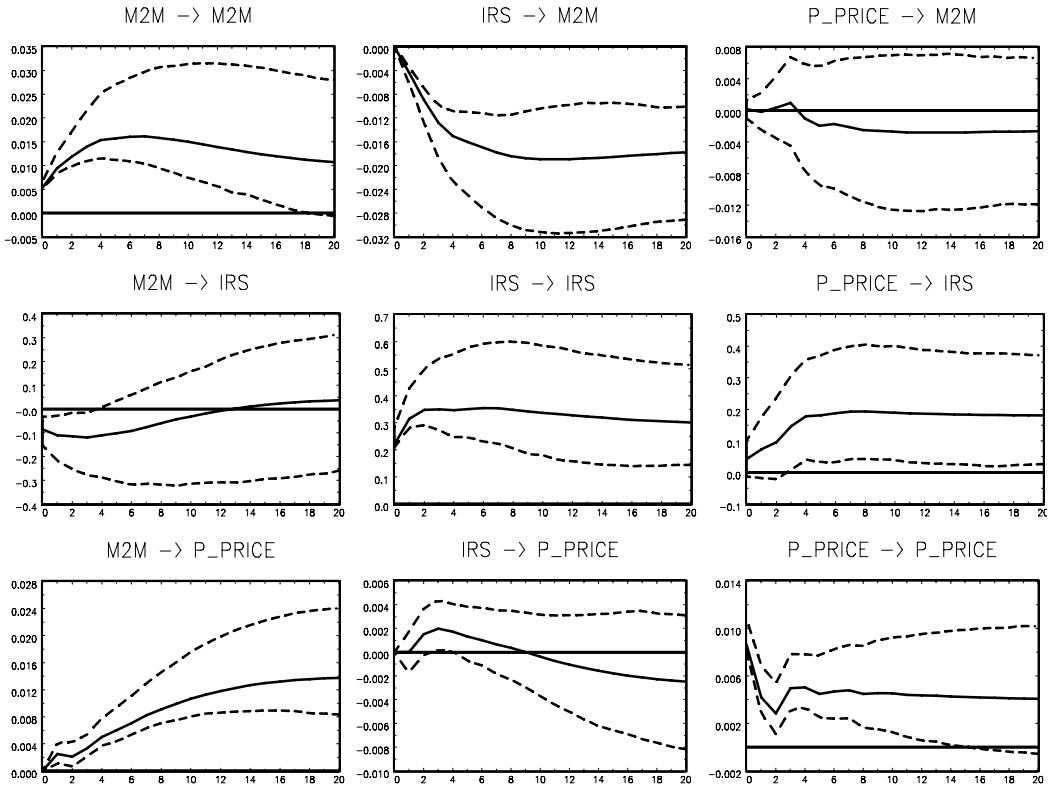
Graphs display impulses responses with bootstrapped 95% confidence intervals containing variables in the following order: real property wealth (P_PRICE), real gross domestic product (GDP), real M3 (M3), long-term interest rate (IRL).

Graph 4a shows the impulse responses of real M2M, property prices and the opportunity costs of M2M for the benchmark identification scheme in the case of the US. Considering the responses of money it is significantly driven by its own shocks and the interest rate spread but not by house prices. Real property prices are positively influenced by own shocks and shocks to the money supply. Short-term interest rates are driven down by positive M2M shocks which represents a standard liquidity effect. The reaction to its own shocks own appears relatively persistent.

The impulse responses in Graph 4b based on wealth instead of prices largely mirror the above finding. In contrast to the price-VECM, however, an increase in the housing (wealth) variable now increases money demand. Thus, money shocks play an important role for property markets in the US. Moreover, not only money demand motives but also the asset inflation channels running from monetary dynamics to house prices are relevant for the US. In fact, the latter effect seems to be even stronger for the

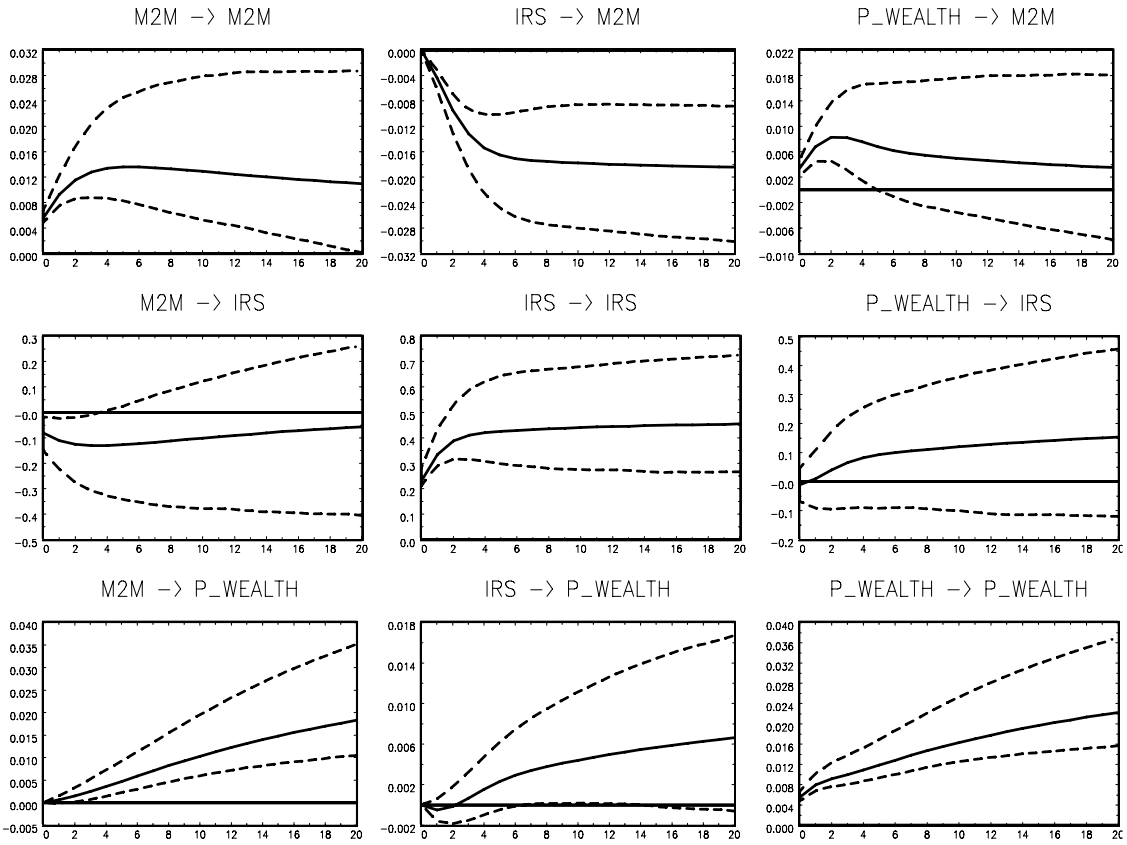
US than for the euro area. However, the reaction of housing wealth to a contractionary interest rate move appears somewhat puzzling for the US—an issue that will be addressed in the next section.

Graph 4a: Impulse response – US, benchmark VECM, property prices



Note: Graphs display impulses responses with bootstrapped 95% confidence intervals containing variables in the following order: real property prices (P_PRICE), real gross domestic product (GDP), M2M real (M3), spread between the three month treasury bill and the own rate of M2M (IRS).

Graph 4b: Impulse response – US, benchmark VECM, housing wealth



Graphs display impulses responses with bootstrapped 95% confidence intervals containing variables in the following order: real property wealth (P_WEALTH), real gross domestic product, M2M real (M2M), spread between three month treasury bill and own rate of M2M (IRS).

4. Robustness analysis

In sum, the findings of the VEC-models suggest a very close relationship between money and housing both for the euro area and the US. However, the 4-variable-approach can only portrait a rather limited picture of the relevant channels in particular with a view to the influence of monetary policy. By omitting potentially relevant variables one might miss important channels concerning the relationship between housing and money. For example, given the close link between loans and housing, it is of particular interest to see whether the relationship between money and housing is still existent if one controls for the role of lending. Similarly, it should be tested whether the inclusion of both short- and long-term interest rates affects the results of our benchmark model.

Thus, in order to refine the analysis and to assess the robustness of the previous results in this section our basis model is augmented by variables representing financing conditions. Since it is hard to identify with any degree of accuracy the underlying structural parameters of a VECM which includes a large number of variables, for practical reasons we follow Sims, Stock and Watson (1990) who show that valid impulse-response can also be obtained from a VAR in levels instead of a VECM given that long-run relations are present. In the following analysis we therefore derive impulse responses from a VAR in levels, which due to its simplicity seems to be a more appropriate technique.

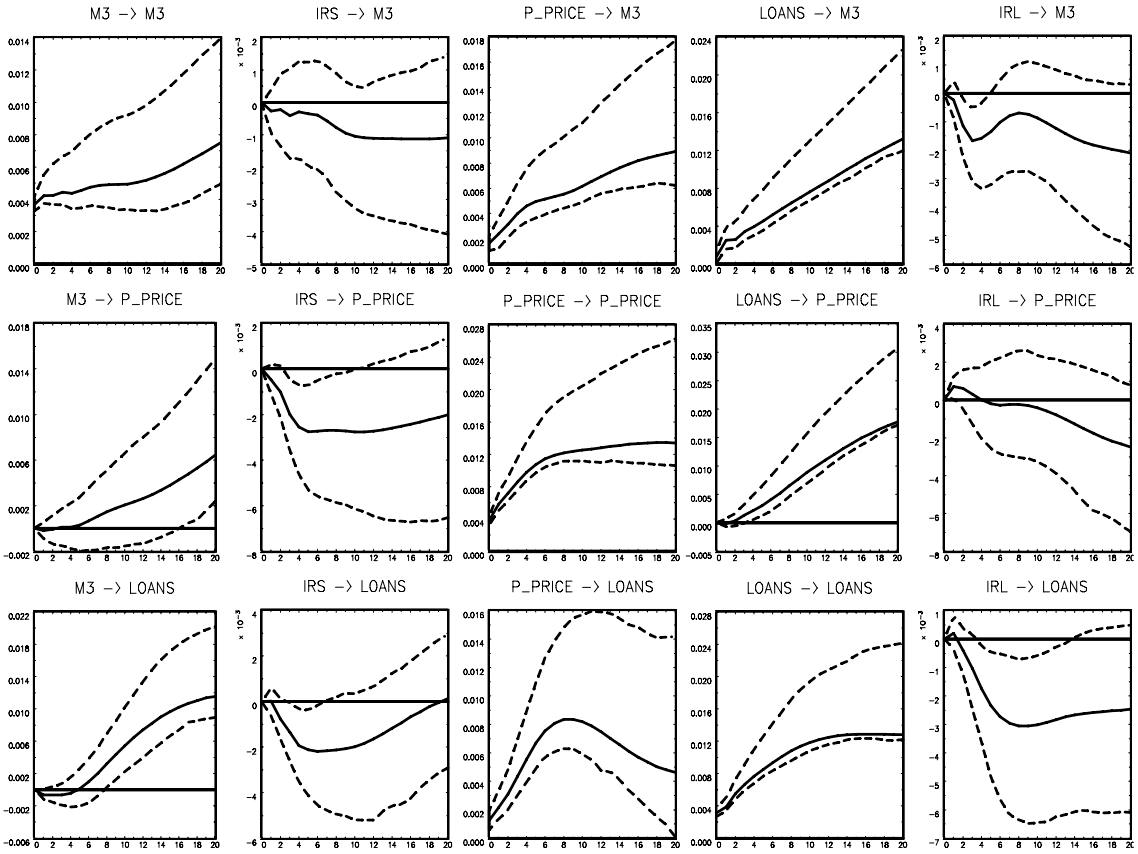
In order to enrich the description of the transmission mechanism, we augment the euro area benchmark specification by loans to the private sector (in logs and deflated by GDP deflator) ($loans_t$) and the difference between the three-month interest rate and the own rate on M3 (irs_t). By including loans, it can be analysed whether in the above impulse-responses M3 shocks only reflect movements in loans or whether liquidity developments are an independent driving factor for housing markets. Finally, the inclusion of short term interest rates is supposed to capture the influence of monetary policy rate shocks on the money-housing relationship. As above the ordering of the variables in the Choleski decomposition *($prop_t$, gdp_t, $loans_t$, $(m\text{-}p)_t$, irl_t, irs_t)* was chosen to reflect the timing of reaction of the respective variables to shocks.[14] In particular, it was assumed that interest rates react more promptly to shocks than monetary variables, while the latter themselves display a quicker reaction than real indicators. Lag length was chosen based on the Schwarz information criterion.

In general, the analysis of the augmented VAR analysis largely confirms the picture of the VECM. Again, property price and wealth shocks exert a significant impact on money which mirrors the money demand channel in the euro area (Graph 5a and b). However, in contrast to the benchmark model, the extended model yields more evidence for the relevance of monetary developments for house prices as can be seen from the responses of the housing variables to a shock in M3. In particular the quick and significant response of housing wealth supports the notion of a significant asset inflation

[14] Again the results appeared quite robust with respect to the ordering of the variables within the VAR, i.e. the Choleski decomposition. Specifically, a re-ordering of short and long term interest rates or a change in the order of loans and money did not affect the basic results.

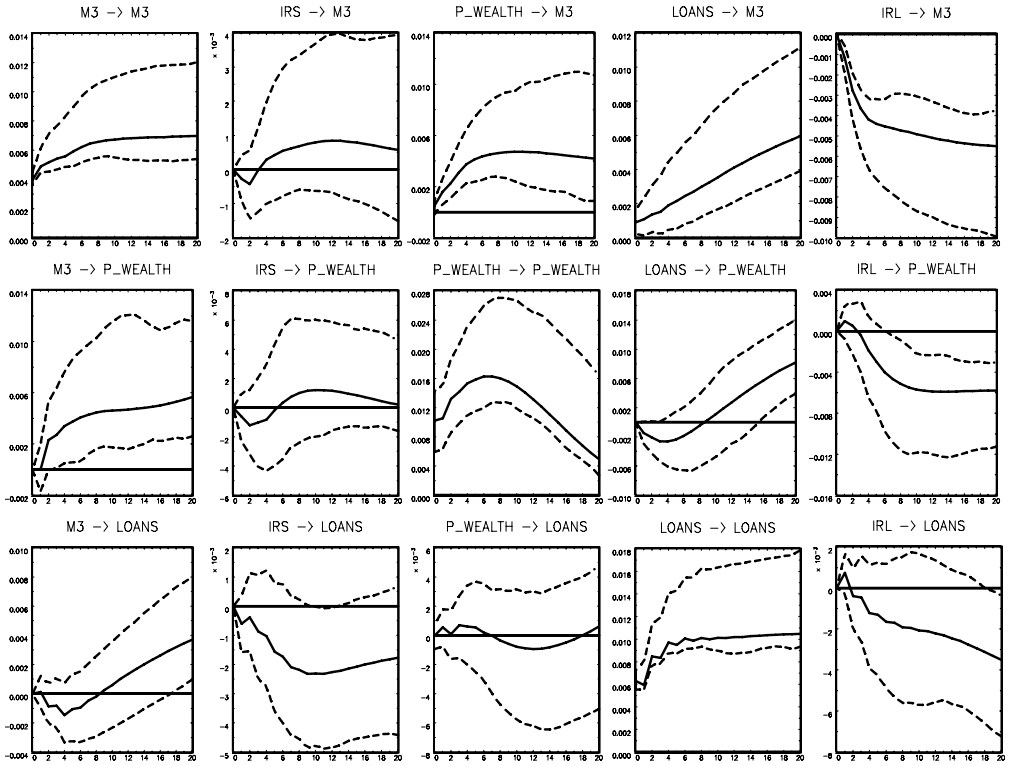
channel. Furthermore, expansionary shocks in loans also imply a highly significant rise in housing variables. This could point at the importance of collateral effects. The only difference between the two specifications based on prices and wealth is the importance of short- and long-term interest rates. While property prices display a significant negative reaction to a positive monetary policy shock, a significant reaction of housing wealth occurs only to innovations in the long-term interest rate. Again, this refers to the sensitive reaction of the volume effect (as only captured by the housing wealth variable) to long-term rates. The remaining responses are also in line with economic theory. Specifically, money, property prices and loans all react negatively to positive (short- or long-term) interest rate shocks. As such, these results are consistent with the evidence in the literature emphasising the significant role of monetary policy for housing markets.

Graph 5a: Impulse Response – Euro area, property prices, augmented VAR



Graphs display impulses responses with bootstrapped 95% confidence intervals containing variables in the following order: P_PRICE, GDP, LOANS, M3, IRL, IRS.

Graph 5b: Impulse Response – Euro area, property wealth, augmented VAR



Graphs display impulses responses with bootstrapped 95% confidence intervals containing variables in the following order: P_WEALTH, GDP, LOANS, M3, IRL, IRS.

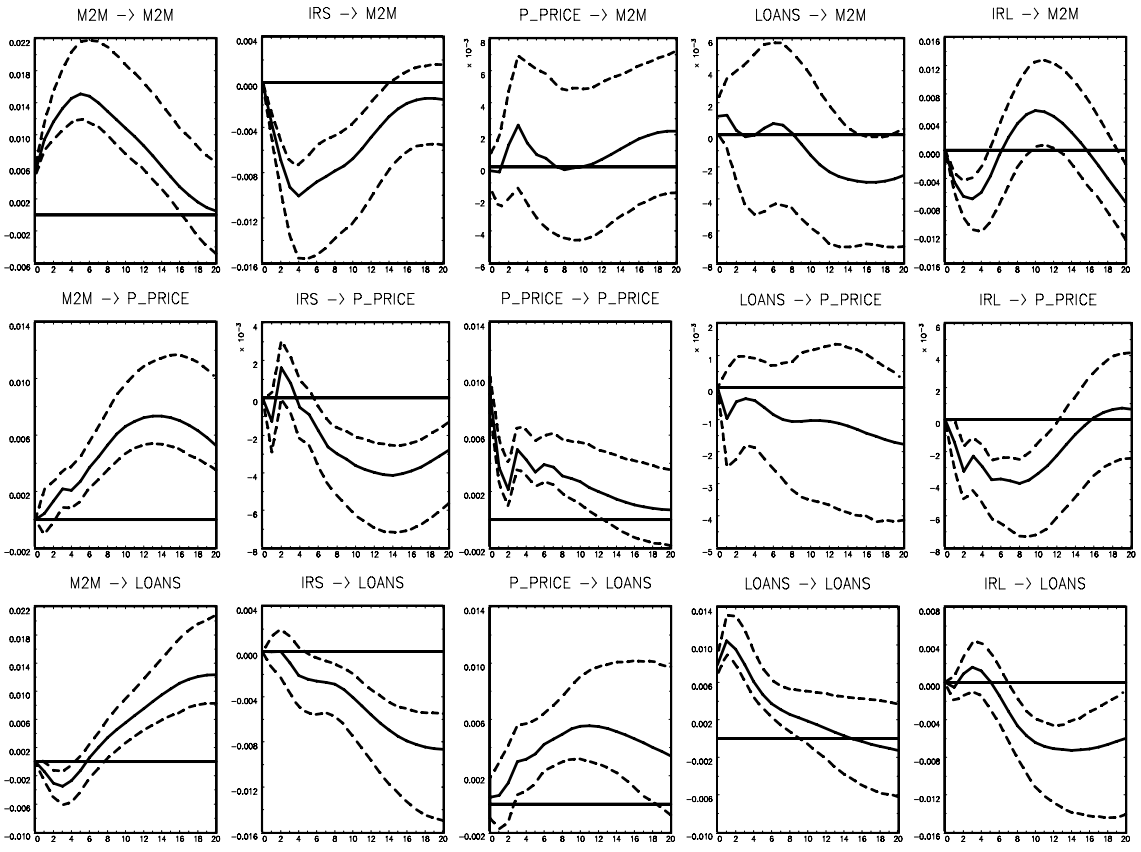
In the same manner the US model is augmented by a loan series and a long-run interest rate. For the latter the mortgage rate was chosen which is supposed to capture lending conditions better than long-run government bond yields.[15] Furthermore, loans for house purchases are available and thus used instead of household loans as for the euro area.

For the US strong asset inflation channels can be detected again. Positive money innovations significantly drive up housing variables. Money demand effects are also visible but only for the wealth specification where M2M reacts significantly to a positive wealth impulse. In comparison to the euro area the interplay of the monetary aggregates is interesting (Graph 6a and 6b). While shocks in real M2M significantly drive up real loans, the reverse response is statistically indifferent from zero for both specifications. At the same time money bears an impact on property prices while loan shocks do not seem to exert an influence. This corroborates the above finding for the

[15] For the euro area, no corresponding data are available for longer time periods.

benchmark VECM. Thus, money does not only seem to mirror loan developments but play an independent and very important role for housing. It may, however, be the case that true sale securitisation of loans explain this pattern to some extent. Assuming that this type of loan securitisation is a common practise in the US this implies that a significant portion of loans disappears from banks' assets. Thus an impulse stemming from credit demand may not materialise in an increased volume of loans in the banking statistics. However, its impact on M2M via the implied money creation process stays visible. As a consequence, it may be the case that the observed asset inflation pattern partly still captures effects emanating from credit market innovations.

Graph 6a: Impulse Response – US, property prices, augmented VAR

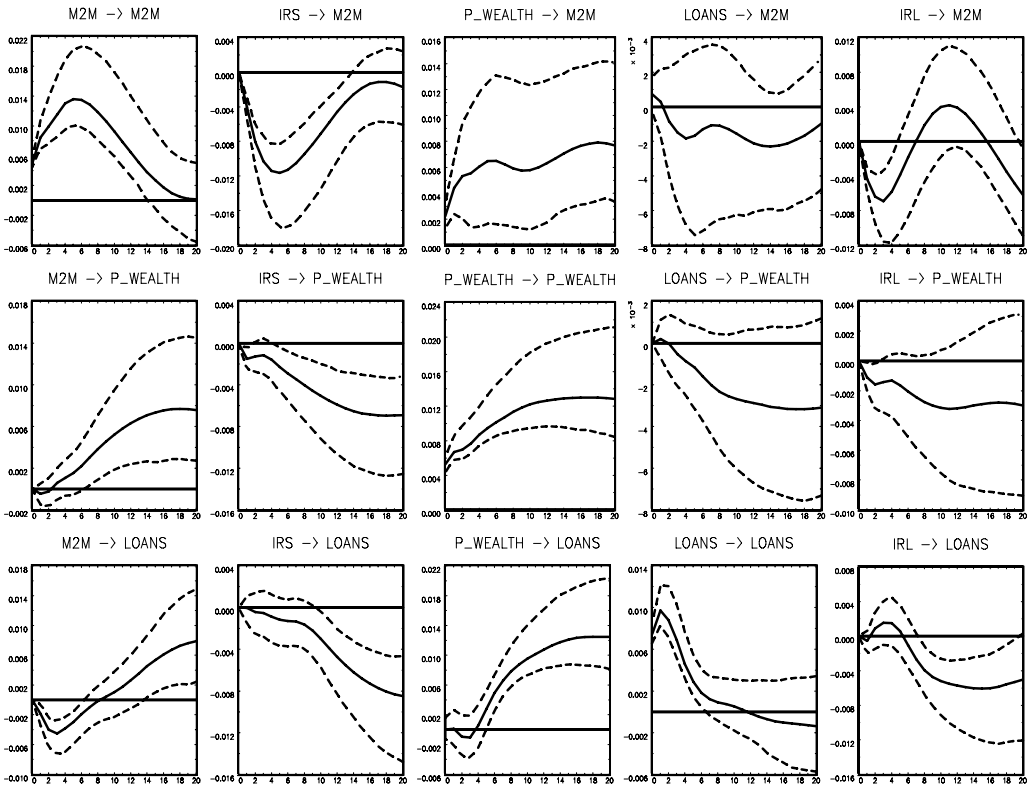


Graphs display impulses responses with bootstrapped 95% confidence intervals containing variables in the following order: P_PRICE, GDP, LOANS, M2M, IRL, IRS.

Another interesting feature of the augmented impulse response is the role of short term rates. In contrast to the benchmark, positive innovations in the opportunity cost measure now show a significant and negative impact on house prices and wealth.

Similarly, monetary aggregates decrease in response to a positive interest rate shock. Thus, this variable is likely to reflect monetary policy shocks. As for the euro area monetary policy seems to have a significant role for housing market developments. Finally, the inclusion of mortgage rates does not seem to change the role of money. Innovations in long-term mortgage rates are significant for house prices and loans.

Graph 6b: Impulse Response – US, property wealth, augmented VAR



Graphs display impulses responses with bootstrapped 95**%** confidence intervals containing variables in the following order: P_WEALTH, GDP, LOANS, M2M, IRL, IRS.

In sum, the evidence corroborates but also refines the findings based on the benchmark VECMs. In general, the inclusion of loans shows that liquidity does not only mirror credit volumes but play an independent role for housing market developments. Of particular interest with respect to potential policy conclusions is the strengthened evidence in favour of an asset inflation channel for the euro area. Furthermore, taking into account both short- and long-term interest rates representing monetary policy stance and long-term financing prices enriches the analysis but does not change the role of money.

4 Concluding remarks

This study supports the assessment that the recent surge in house prices and the loose monetary conditions are related phenomena. Both for the euro area and the US significant bidirectional links between money and housing can be identified. On the one hand, the inclusion of variables representing developments on the housing sector helps to establish stable money demand functions for both areas. On the other hand, there is also evidence that monetary policy influences housing market developments. These are partly transmitted through interest rates, but also through liquidity. Our results are corroborated if we augment the benchmark model with variables representing general financing conditions, which demonstrates the robustness of the approach.

For the US the asset inflation channel even seems to be more pronounced, i.e. liquidity plays a very important role in explaining developments of property prices and wealth. This finding may suggest a link with the institutional characteristics of the financial system. 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 (Debelle 2004, Calza, Monacelli and Stracca 2006). This implies that the strength of the asset inflation channel could differ significantly across countries of the euro area and may explain why the role of monetary policy for house prices is (at least in some specifications) less visible in the euro area aggregate, though it may be significant at the level of individual countries.

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