Housing and the Macroeconomy: The Italian Case

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Abstract We present an empirical analysis of the role of the housing market and the macroeconomy in Italy. We analyze the cyclical properties of house prices and quantities and compare them with the aggregate economic cycle. We study the effects of monetary policy shocks on the housing market in a Structural VAR model with Italian data for 1990-2008. We find evidence that monetary policy strongly affects the behavior of real house prices and investment. Furthermore their response is significantly more sluggish than that of economic activity, suggesting that the housing market might contribute to the persistent propagation of the shocks hitting the economic system. Despite their influence on housing variables, monetary policy shocks are not the predominant cause of the volatility of residential investment and house prices.

JEL codes : E52, C32
Keywords : monetary policy, house price, business cycle, sign restrictions

1 Introduction

In the last decade house prices in Italy have increased by almost 40 percent in real terms. The phenomenon is not specific to the Italian economy, as several industrialized countries have experienced similar and even stronger rises. It is neither new as already in the past house prices have recorded similar strong upward movements, followed by long lasting phases of stagnation or decline. However the recent financial crisis has renewed concerns that the expected downward correction associated with the end of the latest housing market expansion might occur disorderly

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and hamper the already bleak economic outlook for much longer and more severely than anticipated.

The debate at the academic and the policy level has highlighted the role played by several factors in the run-up of house prices, among which monetary policy has attracted particular interest. The long period of historically low nominal interest rates is often cited as one of the major causes of the increase in house prices and the associated rise in residential investment. However, other factors have also been under the spotlight. Among these the effect of innovation in the lending standards of financial institutions; on this aspect, despite a generalized convergence of credit markets spurred by greater competition and financial integration, conditions in European national markets remain substantially different. For instance, according to a survey (Mercer Oliver Wyman, 2003) on European mortgage markets the degree of market completeness varies greatly. The Italian housing finance market is ranked among the least complete: for instance, the average loan-to-value ratio, one of the variables included in the completeness index, is significantly lower than the European average; the typical mortgage duration is short, usually coinciding with the borrowers' remaining working life; furthermore home equity withdrawal products are not available. Such institutional and economic arrangements coupled with cultural preferences for low indebtedness point to a rather limited role for financial acceleration effects and housing wealth effects on consumption.[1] However, considering that the majority of outstanding and new mortgages is at variable rate, monetary policy and financial shocks might affect households' consumption trough unexpected increases in the share of mortgage repayments over disposable income.

Against this background our study explores the behavior of the Italian housing market over the business cycle with particular attention to the effect of monetary policy conditions. We exploit a house price index recently compiled at the Bank of Italy (Zollino et al., 2008) to describe the comovements of house price and residential investment with a set of macroeconomic variables over the last 40 years. Furthermore, we investigate the interplay between the housing market and monetary policy by resorting to a structural VAR (SVAR) analysis. The paper is organized as follows: section 2 has a pure statistical flavor and describes the relationship between the housing market and the macroeconomy over 40 years and sets the stage for the subsequent structural analysis. It follows both the "business-cycle" approach and the "growth-cycle" approach in describing a set of comovements and stylized facts. Section 3 expands the set of stylized facts by conditioning them on observing a restrictive monetary policy shock and assess the role of the latter in explaining the observed variability of housing prices and quantities. Section 4 concludes.

[1] See Calza, Monacelli, Stracca (2007) for an analysis of the role of institutional factors on the housing channel of the transmission mechanism of shocks.

2 Cyclical analysis of the Italian housing market

In order to investigate the relationship between the housing market and the macroeconomy we articulate the analysis in two parts. In the first one, we follow the classical "business cycle" definition of the cycle as recurrent and persistent fluctuations in the level of a time series and describe its main features in terms of duration, intensity, leading-lagging behavior at turning points, and synchronization with a set of important macroeconomic time series. The second approach followed here ("growth cycle" approach) focuses instead on deviations of a series from its long term component. Although in this case the results closely depend on a artificial and ultimately subjective decomposition of a time series into trend, cycle and short term noise, they shed light on aspects of economic fluctuations that would be otherwise left unexplained, such as periods of acceleration and deceleration, which cannot be classified as expansions and recessions in a "business cycle" sense. Furthermore by identifying a larger number of shorter cycles, the growth cycle approach allows a more robust analysis of leading/lagging relationships.

2.1 The "business cycle" approach

The starting point of the classical analysis is the determination of a sequence of turning points on the level of the variables (TP, peaks and troughs), which allows to decompose a time series into a sequence of recessions and expansions. In a first stage, following a standard practice, detection of turning points is performed with the algorithm suggested by Bry and Boschan (1971). In a second stage, the sequence of selected TP is inspected in order to eliminate cyclical episodes either too short-lived or too mild to represents the medium term fluctuations that are the focus of this study. The dynamics of the real house price index suggests the following business cycle dating for the housing market: 1973Q3-1980Q1; 1980Q2-1987Q3; 1987Q4-1999Q1 (see figure 1 - where shaded areas signal periods of recessions in terms of house prices - and Appendix A for data description).

The latest cycle started its expansionary phase in 1999 and seems to have reached a peak in 2007Q4.[2] Based on this dating and excluding the ongoing cycle, expansionary phases last on average around 4 years (see Table 1), during which the average cumulated real price increase is around 40 percent. Recessions tend to last longer (on average 6 years), but the cumulated real decline in prices is significantly

[2] At the time of writing the house price series was available untill the last quarter of 2008. Graphical inspection suggests that in 2008 real house prices had stabilized but not decreased yet. On the contrary, residential investment and employment in the construction sector had clearly peaked in the second half of 2007. At the end of 2009 the series of real house price has been revised and the cyclical peak estimated at the end of 2007 confirmed. Indeed, the new series shows a cyclical peak in 2008 during which the annual increase was -0.7%. In 2009 the series has further declined by 1.3 percent.

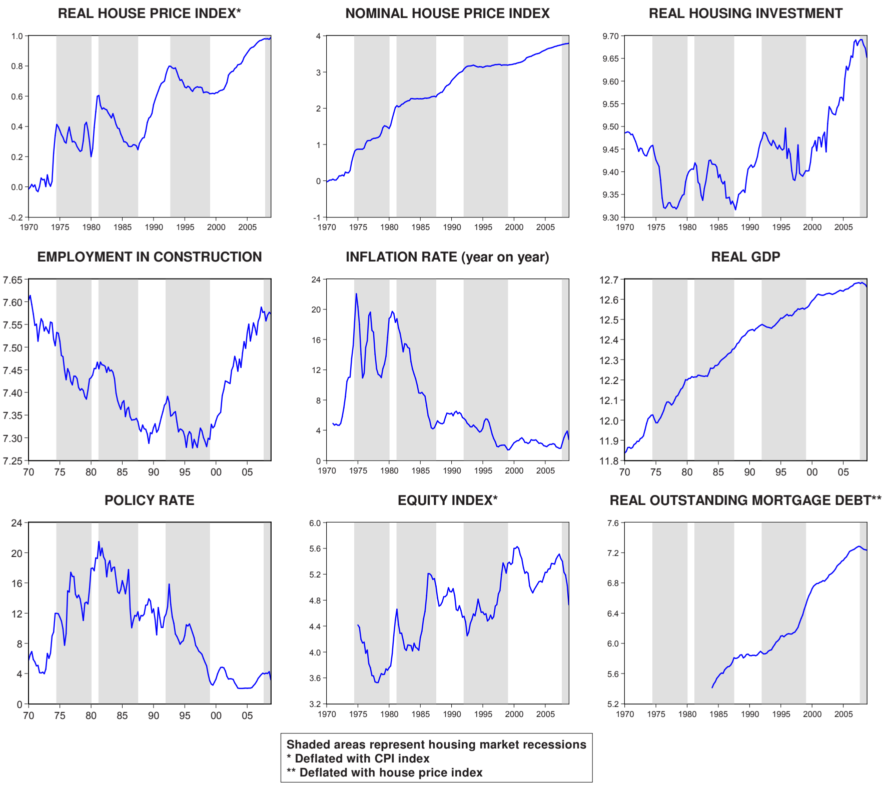

Fig. 1 Housing market variables and housing market recessions

smaller (23 percent) and is mainly accounted for by CPI inflation while nominal house prices stagnate. It is interesting to note how the duration of expansions has increased progressively since the 1970's (from 1 year in the late 1970's and early 1980's to around 8 years in the latest upswing), while that of recessions is fairly constant. The cyclical behavior of residential investment mirrors closely that of real house prices. The series has experienced three complete cycles (from trough to trough). Qualitatively, the comparison of the turning points of the series of real prices and investment suggests a high degree of synchronization (troughs in investment leads those in prices on average by 2 quarters while peaks in the two series have on average occurred at the same time). Quantitatively, residential investment shows milder fluctuations than real prices: during expansions (recessions) cumulated increases (declines) in residential investment are around 12 percent from the previous trough (peak) level, to be compared to 40% for real prices. The close relationship between price and quantity in the housing market is also confirmed visually by the cyclical behavior of employment in the construction sector. Starting from the trough of 1979Q2, the series has experienced two complete cycles, whose turning points show short leads and lags with respect to the peaks in residential activity and real house prices.

Table 1 Descriptive statistics of housing market cycle

	House Price	Res. Inv.	Empl. Constr.
Sample 1970-2008			
N. cycles (trough to trough)	3 (4 ongoing)	3 (4 ongoing)	2 (3 ongoing)
Expansions: average duration (quarters)	9.3	8.5	15.8
Recessions: average duration (quarters)	24.7	22	25
Expansions: average cumulated change (% points)	42.3	14.1	9.7
Recessions: average cumulated change (% points)	-23.4	-11.3	-12.6
Average lead at peak (quarters)[1]	-	0.0	-1
[min;max]	-	[0;0]	[-4;1]
Average lead at trough(quarters)[1]	-	-2	0.6
[min;max]	-	[1;7]	[-3;7]

Note to Table. *House price:* Real house price (deflated with CPI index). *Res. Inv:* Residential investment. *Empl. constr:* Employment in construction.; 1: + (-) corresponds to lead (lag) with respect to house price turning points.

Further support for a close relationship between price and quantity in the housing market is obtained by calculating their degree of synchronization. In table 2 we have calculated the cross-concordance index between the respective reference cycles (see Harding and Pagan, 2002). The index measures the relative amount of time two series spend in the same cyclical phase, after controlling for any lead/lag relationship, taking value of 1 at lead/lag zero for perfect positive synchronization (when the two series' turning points exactly coincide) and a value of 0 at lead/lag zero for perfect negative synchronization (when two series' turning point are always in opposition). According to this measure, real house prices are indeed strongly synchronized with residential activity, both measured as investment in residential construction as well as employment in the sector. In order to put such figures in the general economic context, the same analysis is repeated for GDP, inflation, a monetary policy interest rate, the real stock of mortgage debt and the real stock price index. These series have been found to be among the most important drivers of house price dynamics in several studies, reflecting the interaction between income, the opportunity cost of housing investments, credit availability and the role of housing as hedge against inflation (see for instance Sutton, 2002, Borio and McGuire, 2004, Tsatsaronis and Zhu, 2004). Significant values of synchronization are found only for the short term interest rate and inflation while in the case of GDP, the real equity price index and real stock of mortgage debt the coefficient is not significantly different from zero. The inflation cycle appears to be slightly ahead of the house price cycle.

Table 2 Synchronization of cycles: cross-concordance index

	Real House Price with:
Sample 1970-2008	
Res. Inv.	0.9***
	(0)
Empl. Constr.	0.8***
	(0)
GDP	0.5
	(-3)
Inflation[1]	0.6**
	(-1)
Policy rate	0.75***
	(0)
Equity price index[2]	0.5
	(0)
Stock of mortgage debt[3]	0.5
	(0)

Note to Table. The table reports the maximum value of the concordance index between real house price and the variable in rows along with the quarterly lead(-)/lag(+) of the corresponding series with respect to real house prices. *Res. Inv:* Residential investment. *Empl. constr:* Employment in construction.; 1: year on year change of CPI index. 2: Deflated with CPI index. 3: Deflated with nominal house price index.** and *** significant at 5% and 1%.

2.2 The "growth cycle" approach

The business cycle approach to comovements analysis is affected by the diverse frequency at which turning points occur in different series. Indeed, housing market variables show only few peaks and troughs when compared to macro variables. For instance, duration of house price cycles (from trough to trough) has varied between a minimum of 26 quarters and a maximum of 46 quarters compared to a minimum of 9 quarters and a maximum of 46 for GDP. In this section, to take into consideration such differences and to increase the robustness of synchronization measures, we focus on the cyclical comovements.[3] The analysis is carried out by considering those fluctuations which are responsible for the behavior of a series at a specific cyclical horizon. In order to strike a balance between the observed durations of housing market cycles and of fluctuations in economic activity, inflation and interest rate, we focus on that component associated with fluctuations lasting between 3 and 10 years.[4] Table 3 reports the maximal correlation coefficient (and the lead/lag at which it occurs) between the cyclical components of real house prices and of the other

[3] The resulting (filtered) series are characterized by more cycles and therefore more turning points.

[4] The empirical literature has focused on cycles whose duration varies between 1.5 and 8 years. These values have been proposed for the US economy by Baxter and King (1999) who indirectly refer to the empirical work by Burns and Mitchell (1946). The application of these values to other economies and different time periods is therefore questionable (see Everts, 2006 and Agresti and Mojon, 2001). However results obtained with the standard parameters are similar and available from the author upon request.

variables over the period 1970-2008.[5] The evidence indicates that house prices and residential investment are strongly positively correlated, with the latter leading the former by around one year.[6] Further support for a leading role of quantity with respect to prices is found by looking at employment in the construction sector. The correlation between house price and GDP is not significant at lag 0, but increases at longer lags suggesting that cyclical fluctuations in real house prices follow the economic cycle with a two year delay. Further evidence is found by looking at GDP components, with households' consumption (of durable as well as non durable) and non residential investment strongly leading house price by 1.5-2 years.

Table 3 Synchronization of cycles: correlation between cyclical components

	Real House Price	Residential investment
Sample 1970-2008		
Real house price	-	0.6
	-	(3)
Res. Inv.	0.6	-
	(-3)	-
Empl. Constr.	0.7	0.5
	(-2)	(3)
GDP	0.8	0.4
	(-7)	(-2)
Inflation[1]	0.8	0.6
	(-3)	(-1)
Policy rate	0.5	0.45
	(-2)	(4)
Equity price index[2]	-0.4	-0.4
	(-8)	(-3)
Stock of mortgage debt[3]	-0.6	-0.6
	(0)	(6)

Note to Table. The table reports the maximum value of the correlation coefficient between variable in column and variables in rows along with the quarterly lead(-)/lag(+) at which it occurs. *Res. Inv:* Residential investment. *Empl. constr:* Employment in construction.; 1: year on year change of CPI index. 2: Deflated with CPI index. 3: Deflated with nominal house price index.

This result is at odds with the evidence available for the Euro area (Musso et al., 2008), France, Spain and Germany, where house prices are found to be coincident or slightly leading with respect to economic activity.[7] Residential investment are pro-cyclical and slightly lagging GDP, consumption and non residential investment (by 2 quarters). The result stands out when compared to the available international evidence for the Euro area (Musso et al., 2008) and US evidence (Leamer, 2007) and

[5] The cyclical component is extracted with the filter proposed by Baxter and King (1999).

[6] A standard explanation for such temporal ordering is that weakness in demand affects transaction volumes and housing construction activity first, as sellers might prefer to wait before accepting to reduce their reserve price (Leamer, 2007)

[7] See contributions in this volume.

might partly be due the distorting effect of several fiscal incentives implemented in the last decade. Real house prices and to a lesser degree residential investment are positively correlated also with inflation and the policy interest rate. The lead-lag structure suggests that interest rates lag residential investment but lead house prices by few quarters. Real house prices are mildly negatively correlated with the real stock price index one year later. Finally, the cyclical component of real house prices is negatively correlated with that of the real stock of mortgage debt, suggesting that in absence of home equity withdrawal products, rising house prices have a standard negative effect on demand and therefore on mortgage applications.

To add robustness to our results in Table 3 we have also computed the cross-correlation with respect to the cyclical components of real house prices. The results bring further evidence to the lead/lag relationship uncovered so far: real house price tend to lag housing volume measures (residential investment and employment in construction) as well as aggregate economic activity. The relation with the policy rate and inflation is somewhat less strong but again there is evidence of house price lagging these variables.

To summarize, the statistical evidence indicates that cycles in the housing market tend to last longer than the cycles observed in economic activity and other macroeconomic variables. Prices and quantities moves in synchronization, although prices are significantly more volatile. Expansions are usually shorter (although since the 1970's, their duration has progressively increased) but more intense than recessions and the cumulated increases in real prices observed during the expansionary phases are only partially reabsorbed during the following recessions. Housing prices and quantities are strongly procyclical and lag economic activity by around one year. They are also positively correlated with inflation and the monetary policy interest rate. On the contrary, they are strongly negatively correlated with real mortgage debt.

3 A SVAR analysis of monetary policy and the housing market

Having documented a set of stylized facts about the interaction between housing and macro variables, in this section we investigate the role of monetary policy (more specifically of its unpredictable component)in shaping the unconditional moments of the housing variables. We focus specifically on monetary policy shocks for two reasons. Firstly, the theoretical literature has studied extensively the conditions under which such shocks can be correctly identified and abundant empirical evidence is available as benchmark. Secondly, the recent debate has focused on the role that an over-expansionary monetary stance might have played in fuelling housing prices. We present two sets of results. A first set is derived from a recursive identification scheme, where the ordering of the variables critically reflects the identifying assumptions. A second set of results is proposed where a structural non-recursive interpretation is given by imposing sign restrictions on the response of (some) variables to a monetary policy shock. While recursive VARs have been extensively used to make structural inference (see Christiano et al., 1999), they implicitly make strong assumptions on the temporal relationships among structural shocks. Identification of monetary policy shocks trough sign restrictions follows from acknowledging that a widespread agreement seems to have been reached among economists on the effects of monetary policy on several macroeconomic aggregates. According to Christiano et al. (1999) "*The nature of this agreement is as follows: after a contractionary monetary policy shock, short term interest rates rise, aggregate output, employment, profits and various monetary aggregates fall, the aggregate price level responds very slowly [. . .]*". Compared to a recursive scheme, a sign restriction approach seems to us more flexible as it can accommodate several models and different assumptions regarding the temporal relationships among variables. in both cases the analysis focus on the more homogeneous sample period 1990-2008. Monetary policy in Italy since the 1990's can be well approximated by the stance of the short term interest rate, furthermore the structural relationships might have evolved from the high inflation and high volatility environment that characterized the 1970's and the early 1980's to the low inflation environment experienced afterward.

3.1 Housing in a monetary VAR: the recursive approach

We start with a baseline model that includes a minimal set of variables necessary to analyze the interaction of monetary policy and the housing sector. In the baseline specification these variables are ordered as follows: the consumer price index (CPI), GDP, the nominal house price index (HP), residential investment (RI), and the short term interest rate (P.RATE). All variables enter in log-levels (except the policy rate; figure 1). We adopt a recursive approach to identify the structural shocks, so that the ordering of variables reflects our assumption on monetary policy and its transmission mechanism to the economy. Specifically, the non-policy block is ordered first, reflecting the view that the monetary authority sets the interest rate knowing the contemporaneous values of the price level, output, the house price level and of housing investment. It is further assumed that these variables react to interest rate changes only with a lag. Several studies adopt this ordering, claiming that output and prices are sluggish and react to policy decisions only with lags. The choice of the variables follows previous VAR studies of the interaction between monetary policy and the housing market (see for instance Giuliodori, 2004 and Vargas-Silva, 2008). The only difference consists in the fact that we use nominal house prices (HP) instead of real house prices (RHP), which however are recovered by construction from the behavior of nominal house price (HP) and that of the price level (CPI). The departure is dictated by our interest about the sign of the responses of both house prices and the general price level. Among exogenous variables, the baseline specification includes a world commodity price index, and four dummy variables.[8] The first variable accounts for external price pressures, while the dummy variables mainly account for the interest rate turmoil in 1992 and 1995 and abnormal observations in the residential investment series associated with government legislative interventions; furthermore we include four lags in our VAR models in line with most quarterly VARs in the empirical literature.[9]

The effects of monetary policy shocks on the macroeconomy and the housing market can be analyzed through impulse-response functions and the forecast error decomposition. From the former, a one standard deviation restrictive monetary policy shock (corresponding to a 50 basis point increase in the policy rate; see figure 2) significantly affects GDP: output starts to contract significantly after three quarters and continues to decline up to six quarters after the shock, when its deviation from the baseline reaches almost 0.2 percentage points (pp).[10]

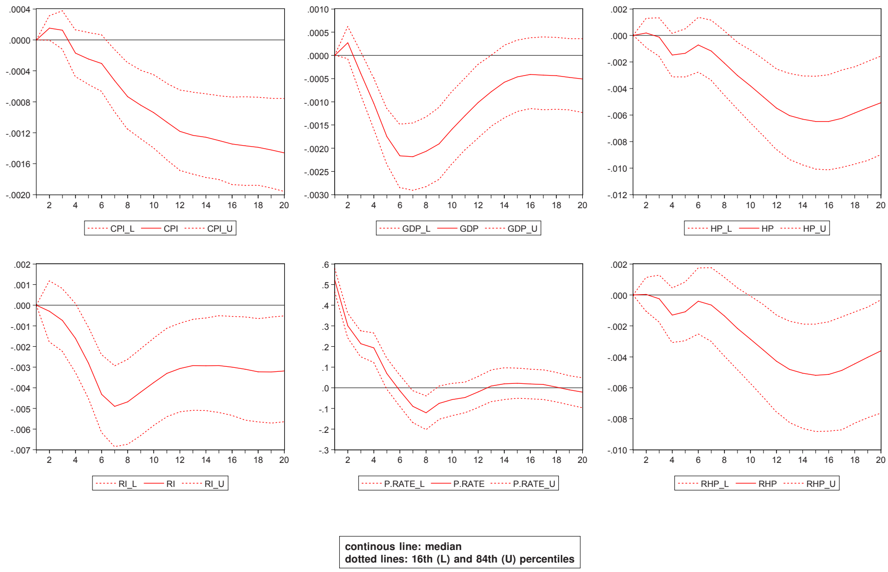

Fig. 2 Impulse-response functions: recursive approach

[8] Dummy variables have been used for the following quarters:1992Q3, 1995Q2, 1995Q4, 1997Q4 and 1998Q1.

[9] Lag-length criteria give discordant results so that the choice strikes a balance between non auto-correlated and normally distributed residuals and the precision of the estimated coefficients. Results not reported but available from the author.

[10] The magnitude of the response is in line with results by Giuliodori (2004), Bonci and Columba (2006) and De Aracangelis and Di Giorgio (1998), after adjusting for the different size of the shocks.

Afterwards it slowly returns to its pre-shock level (twelve quarters after the shock the gap is no longer significant). The price level starts to decline only after two quarters, although it significantly deviates from its pre-shock level only after 6 quarters and, in line with previous studies for Italy (see Gaiotti, 1999), its response is less intense and more spread-out than output.[11] Quantity and prices in the housing market react with different timing. Housing investment leads house prices by several quarters. The former start to significantly decline after 4 quarters, and the contraction is strong during the first 1.5-2 years, reaching a maximal deviation of 0.5 pp, after which it very gradually recovers. The reaction of nominal house prices is not significant during the first 8 quarters. The bulk of the effect shows up only in the third and fourth year after the shock, with a maximal deviation of 0.7 pp after 16 quarters. Overall, both quantity and prices in the housing market react more strongly to monetary policy than economic activity (at its trough the decline in investment is twice as big as that in GDP) and their return to pre-shock levels is significantly slower (it takes around 5 years for their response to be no longer significant, compared to 3 years for GDP). Given the limited reaction of the CPI index, the real house price mimics quite closely the behavior of nominal prices, declining consistently only after two years and deviating by 0.5 pp at their trough.

Table 4 reports the share of the variance of each endogenous variable explained by monetary policy shocks at various horizons. They account for around 20 percent of output volatility at the 3 year horizon, while their contribution to price volatility is non-negligible only at longer horizons. With respect to price and quantities in the housing market, the analysis indicates that in the short run monetary policy shocks play a small role. Their contribution tends to increase at longer horizons (around 10 percent at the 5-year horizon).

3.2 Housing in a monetary VAR: a sign restriction approach

The recursive VAR analysis suggests that monetary policy shocks have significant effects on the housing market in the medium term (3 to 4 years). However, their short run effects are not precisely estimated. Furthermore the reaction of the CPI index during the first three quarters, although insignificant, is wrong-signed. In order to check the robustness of previous results, we decided therefore to change identification strategy and to exploit theory-consistent information on the effects of monetary policy shocks.[12] This approach, pioneered by Faust (1998), Canova and De Nicol' (2002) and Uhlig (2005), consists of imposing sign restrictions on the impulse re-

[11] In the first two quarters after the shock, the CPI index slightly increases, however the (16-84 percent) standard error bands show that the so called ”price-puzzle” is not significant.

[12] Within the recursive approach the results obtained are robust to changes in the order of the variables in the VAR, to the use of different measures of interest rate (3months money market rate) and of the price level (GDP deflator) and to the inclusion of the bilateral exchange rate Lira/Deutsche Mark and of a real monetary aggregate (the real stock of M2).

Table 4 Recursive VAR: forecast error variance decomposition

Period	CPI	GDP	HP	RI	P.RATE	RHP
1	0.0	0.0	0.0	0.0	90.4	0.0
2	0.2	0.2	0.0	0.0	67.0	0.0
3	0.2	0.5	0.0	0.2	60.1	0.0
4	0.4	2.4	0.4	0.7	50.9	0.3
8	2.3	16.6	0.8	8.6	40.0	0.4
12	7.8	20.0	4.3	9.8	37.9	2.4
16	13.7	19.8	9.2	9.5	33.2	5.9
20	18.1	19.2	11.7	10.2	30.8	7.7

Note to Table. The table reports for each variable in column the share of its forecast error variance accounted for by monetary policy shocks, at several forecast horizons. *CPI:* Consumer Price index. *GDP:* Output. *HP:* House price index. *RI:* Residential investment. *P.RATE:* Policy rate. *RHP:* Real house price index.

sponse functions of some variables with respect to a set of structural shocks. By restricting the dynamic behavior of only a subset of variables, such identification scheme allows the researcher to take an "agnostic" approach on the response of the remaining variables. Furthermore, as several structural decompositions ("models") are compatible with a given set of restrictions, it allows to quantify the uncertainty about possible outcomes, following a monetary policy shock. In other words, unlike the recursive scheme, confidence bands around the estimated impulse responses reflects the uncertainty about the true underlying model.[13] We assume that after a monetary restriction, the response of the policy rate is non-negative, while that of real GDP, nominal house price and the consumer price index is non-positive. All restrictions are in place for two quarters. No restriction is placed on the response of housing investment. Such scheme leaves unrestricted the two variables of interest in the housing market: housing investment and real house prices. Indeed, recent theoretical work does not univocally pin down the effect of a monetary policy shock on the relative prices of durable goods (like housing).

Following a restrictive monetary policy shock, the policy rate increases above the "optimal" level for three quarters before moving into expansionary territory for the next six quarters (see Figure 3).

[13] The analysis does not take into consideration prameter uncertainty around OLS point estimates. Taking the latter into consideration would lead to wider confidence bands than those reported here (see figure 5 in appendix B).

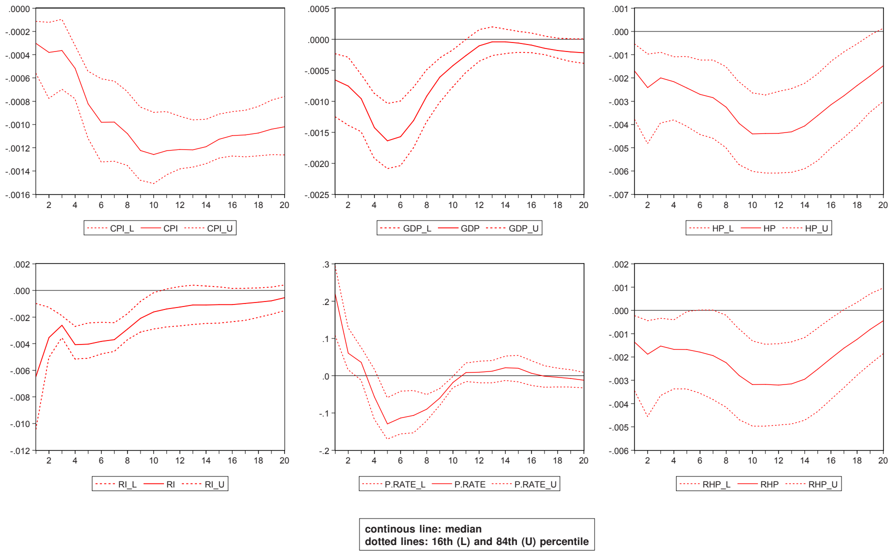

Fig. 3 Impulse-response functions: sign restriction approach

Nominal house prices decrease on impact by 0.2 pp and continue to fall up to 3 years after the initial shock, so confirming the highly inertial response obtained under the recursive scheme. Quantitatively the maximum deviation is 0.4 pp compared to 0.7 pp under the recursive scheme. Significantly different is the response of residential investment in the two identification methods considered here - namely recursive or with sign restrictions - (see Figure 4, which compares the IRFs displayed in Figures 2 and 3). Now the bulk of the response shows up on impact when investment declines by 0.6 pp (under the recursive scheme, a similar drop occurs only six quarters after the shock and coincides with the through, see figure 4).[14]

Afterwards, an almost steady return to equilibrium takes place. Interestingly, the response of real house prices does not change as dramatically. Real house prices fall on impact by 0.2 pp, the decline intensifying in the following 3 years, deviating by 0.3 pp at the trough (compared to a decline of 0.5 pp obtained under the recursive scheme) and then return towards their pre-shock level. Table 5 reports the percentage of model-responses compatible with a decline in residential investment and real house prices over several horizons: 80 percent of the models signal a reduction of residential investment one quarter after the policy shock. At the 4 and 8 quarter horizons, such percentage increases (to 90 percent), confirming the recursive VAR indication about the delayed reaction in the housing market. The probability of a negative response then declines to 70 percent at the 5 year horizon. Nearly all models

[14] The response of residential investment is more similar to that obtained under the recursive scheme, if we impose the sign restrictions to hold for 4 quarters (results available upon request from the author).

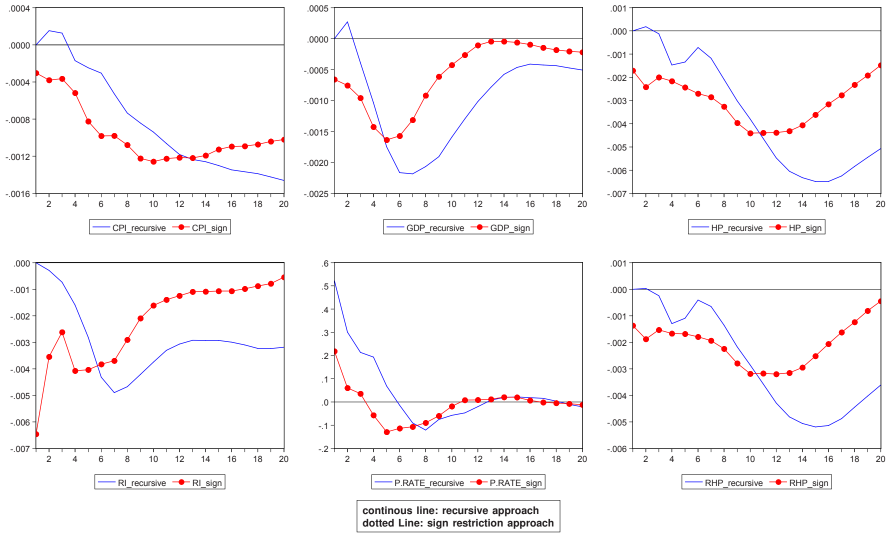

Fig. 4 Comparison of impulse-response functions between recursive and sign restriction approaches

are compatible with a reduction in the relative price of houses between 1 and 12 quarters after the shock. After 5 years still 60 percent of models are compatible with real house price below the pre-shock level. Overall, model uncertainty is very limited both at short and medium horizons and suggests that residential investment and relative house prices significantly react to unexpected changes in the monetary policy stance for several years after the initial shock.

Table 5 Sign restricted VAR: model uncertainty

Period after shock	1	4	6	8	12	20
RI	0.8	0.9	0.9	0.9	0.8	0.7
RHP	1	0.9	0.9	0.9	0.9	0.6

Note to Table. The table reports the share of admissable models that are compatible with a reduction in residential investment and in real house prices at several horizons. *RI:* Residential investment. *RHP:* Real house price index.

The analysis of the forecast error variance decomposition (see table 6) indicates that monetary shocks account for around 20 percent of residential investment volatility at the 3-year-horizon and slightly less at longer horizons. They play a smaller role in the variance of the nominal house price index (between 7 and 14 percent) and a negligible role in explaining the volatility of real house prices (between 4 and 6 percent). While the sign restriction approach leads to a slightly bigger role of monetary policy shocks in explaining housing market variability, the results are broadly in line with those obtained under a recursive scheme in suggesting a marginal role for monetary policy innovations, especially with respect to real house prices.

Table 6 Sign restricted VAR: forecast error variance decomposition

Period	CPI	GDP	HP	RI	P.RATE	RHP
1	38.6	17.6	7.1	6.7	9.6	4.8
2	23.6	18.8	8.0	6.9	7.6	5.3
3	19.4	20.1	8.4	9.7	7.1	5.4
4	15.4	22.4	9.2	13.9	9.2	5.7
8	17.8	24.7	10.5	19.4	21.3	5.3
12	17.0	18.9	13.6	17.2	32.3	6.9
16	14.9	15.4	14.0	16.5	39.6	7.3
20	13.8	13.9	12.7	15.9	42.3	6.6

Note to Table. The table reports for each variable in column the share of its forecast error variance accounted for by monetary policy shocks, at several forecast horizons. *CPI:* Consumer Price index. *GDP:* Output. *HP:* House price index. *RI:* Residential investment. *P.RATE:* Policy rate. *RHP:* Real house price index.

To summarize, the VAR analysis supports the view that monetary policy shocks have significant and long-lasting effects on housing variables. Despite a greater degree of uncertainty on the quantitative size of the latter in the short term, we have found robust evidence that over the medium term horizon (3-5 years), housing investment and prices react strongly to changes in financing conditions. Furthermore the analysis also suggests that house prices react faster and more strongly than the general price level and that the return to equilibrium in the housing market is significantly slower than in the rest of the economy. Finally, variance decomposition indicates monetary policy shocks play a minor role in the observed variability of real house prices. This result does not imply that the historically low interest rates observed in Italy in the last decade have not contributed to the long expansionary phase in house prices. It points to the role of the systematic component of monetary policy (i.e. the estimated feedback rule) rather than to the deviations from it.

4 Conclusions

The study extends the recent empirical literature on the role of housing markets in macroeconomic fluctuations, by providing new evidence on the Italian experience. Our results suggest that the housing market is characterized by long cycles whose duration is significantly longer than that observed for economic activity, interest rates and inflation. However, focusing on medium term fluctuations significant co-movements emerge, which indicate that the housing market lags the economic cycle. The VAR-based evidence indicates that monetary policy strongly affects the behavior of real house prices and investment, furthermore their response is significantly more sluggish than that of GDP and its components, suggesting that the housing market as a whole might contribute to the persistent propagation of the shocks hitting the economic system. Despite its influence on housing variables, monetary policy shocks are not the predominant cause of the volatility of residential investment and house prices.

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Appendix A - Data description

House price index: Aggregate index for Italy based on Zollino et al. (2008). *Source:* Il Consulente Immobiliare survey. The survey is conducted every six months and reports the average price of sales made in a set of cities that currently includes all the provincial capitals and approximately 1400 other municipalities. Prices refer to three type of dwellings, according to their location (centre; semi-centre; outskirt). Prices are further divided in relation to the property's state of repair (new houses; recently built houses). Aggregation to a national price index is obtained on the basis of the distribution of the population and of the housing stocks. Homogeneity in the time series is obtained by imputing missing observations and correcting anomalous ones at the micro-level (see Zollino et al. 2008 for further information). The quarterly series is obtained by interpolating semi-annual data on the basis of the deflator for residential investment.

Residential investments: Quarterly National Accounts chain index value of investments in residential construction. *Source:* ISTAT.

Employment in construction sector: Number of employed people. *Source:* ISTAT.

GDP: QNA chain index value of gross domestic product. *Source:* ISTAT.

CPI: consumer price index. *Source:* ISTAT.

Policy rate: short-term interest rate. From 1980 to 1981: average interest rate on fixed term advances. From 1982 to 1998: auction rate on repurchase agreements between the Bank of Italy and credit institutions. From 1999: interest rate on main refinancing operations of the ECB. *Source:* Bank of Italy.

Equity share price index: MIBTEL index (Quarterly average). *Source:* Datastream.

Stock of mortgage debt: outstanding stock of mortgage debt. *Source:* Bank of Italy.

Exchange rate: Lira/Deutsche mark. *Source:* Datastream.

Commodity Price Index: commodity price index. *Source:* IMF.

Appendix B - VAR identification

We assume that the model can be estimated through a VAR in reduced form:

$$y_t = B(L)y_{t-1} + \varepsilon_t \tag{1}$$

where $B(L)$ is a lag polynomial of order p and y is a n x 1 vector of endogenous variables and ε the vector of reduced form residuals with variance-covariance matrix Σ. The corresponding structural VAR is

$$A_0 y_t = A(L)y_{t-1} + u_t \tag{2}$$

where $A(L) = A_0 B(L)$ is a lag polynomial of order p and the matrix, A_0 is the matrix that describes the contemporaneous relationship among the endogenous variables and $u_t = A_0 \varepsilon_t$ is the vector of structural shocks. Identification amounts to impose a set of restrictions to the matrix A_0 that uniquely solves - up to orthonormal transformation- the following system of equations:

$$A_0 A_0' = \Sigma \tag{3}$$

Under a recursive scheme, the identification amounts to assume that the matrix A_0 is lower triangular. This corresponds to imposing n x (n-1)/2 restrictions on the contemporaneous relationships among structural disturbances that allow to exactly identify the model. Each (n x 1) column vector a_j of the matrix A_0 contains the impact effects of the j-th structural shock on the n endogenous variables. By multiplying the vector a_j by the lag polynomial B(L) it is possible to recover the vector of effects of responses to the j-th structural shock at any horizon k after the shock. Under a sign restriction approach a set of restrictions is imposed on the effect of the j-th structural shock on a subset of endogenous variables for K periods.

For a given set of restrictions there exist a set of (n x n) matrices S_0 which satisfy them. Given a matrix $S_{0,i}$ belonging to S, any other identification matrix can be obtained as the product of $S_{0,i}$ by an orthonormal matrix H. In other words, the sign restriction approach does not identify one single model but a set of admissible "models". As a consequence, for a given set of restrictions, a set of admissible impulse response functions is identified whose distribution reflects the range of compatible "models". When, as in the main text, the estimated coefficients of the B(L) polynomial are kept fixed, such conditional distribution can be probabilistically interpreted as "model"-uncertainty. To take into account uncertainty around OLS estimates ("sample" uncertainty), it is assumed that the posterior density for the reduced form VAR under sign restrictions is proportional to a Normal-Wishart. In figure A1 we report the median and the $16th$ and $84th$ percentile of the distribution of the impulse response functions under sample and model uncertainty.

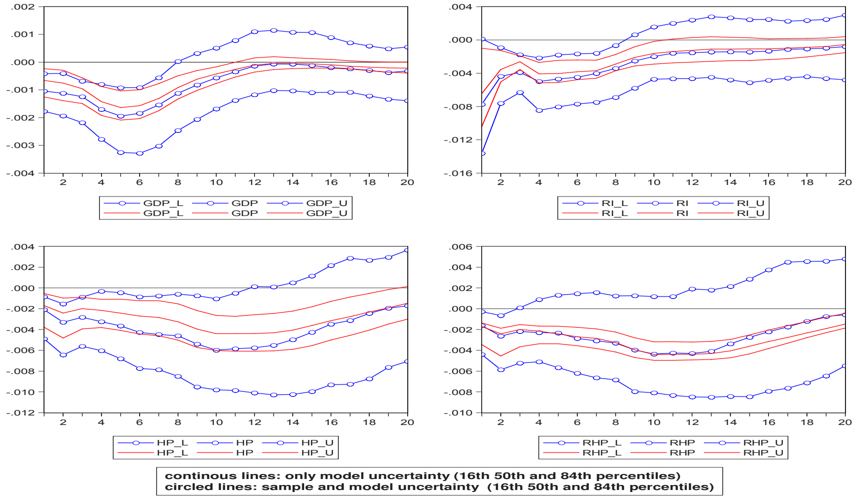

Fig. 5 Impulse-response functions: sample and model uncertainty

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