Housing and the macroeconomy: the Italian case

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Abstract

We present an empirical analysis of the role of the housing market in the macroeconomy in Italy. We analyze the cyclical properties of house prices and residential investment 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 its influence on housing variables, monetary policy shocks are not the predominant cause of the volatility of residential investment and house prices.

Keywords: monetary policy, house price, business cycle, sign restrictions

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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 financial crisis that has burst in the past months has renewed concerns that the expected downward correction associated with the end of the latest housing market expansion might occur disorderly 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, it is useful to bear in mind that, despite a generalized convergence of credit markets spurred by greater competitions 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. According to the survey, the Italian housing finance market is ranked among the least complete[1]. 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 release 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[2]. 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

[1] See *World Economic outlook* (IMF, 2008) for similar findings.

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

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[3] by resorting to a structural VAR (SVAR) analysis. In our view such approach has several advantages. Firstly, by imposing only a minimal set of theoretical assumptions (restrictions), it allows to retain a close-to-pure statistical flavor. Secondly, this approach is firmly established in the monetary policy empirical literature both internationally and with respect to the Italian experience (see among others Christiano at al., 1999, Kim and Roubini, 2000, Gaiotti, 1999), De Arcangelis and Di Giorgio, 2001).

Our analysis relates to similar studies which try to assess the effects of several structural shocks on the housing market and the role of the latter in the propagation mechanism. Iacoviello (2005) estimates a DSGE model of the US economy which includes housing services in the utility function and housing as an investment asset but where housing supply is fixed. Iacoviello and Neri (2007), adopting a similar set-up expand the sectoral disaggregation, modeling explicitly housing supply and estimate the resulting model on US data. Among VAR studies of the effects of monetary policy on housing, the closest are Iacoviello (2000) and Giuliodori (2004); however our approach differs in the way monetary policy shocks are identified. Compared to the former, we do not exploit long run cointegrating restrictions and focus on the short to medium term. Compared to the latter, we report results both for a recursive approach and a sign restriction identification scheme. A more recent study by Musso et al. (2008) also adopts a SVAR approach to analyze the effects of several structural shocks on the housing market. However, it focuses on US and the Euro area as a whole. Considering the degree of heterogeneity across Euro area national housing markets, we believe that our work usefully complements theirs.

The paper is organized as follows: section 1 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 2 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 3 concludes.

[3] Despite the monetary regime switch occurred with the creation of the ECB, we believe that the behavioral relationships among economic agents are robust across the pre-1999 and post-1999 samples so that the analysis carries relevant insights also for the new institutional framework.

1. Cyclical analysis

In order to investigate the relationship between the housing market and the macroeconomy we articulate the analysis in two parts. In the first, we follow the classical 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. By concentrating on rises and subsequent falls in the level of the series, this approach has a very intuitive appeal. However, it should be born in mind that it does not allow to distinguish long term movements (trend), which might reflect slow moving exogenous forces (demographic factors, technological progress, land availability), from cyclical movements, which reflects medium term forces (financing conditions, opportunity costs and income). 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 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.

The "business-cycle" approach

The "business cycle" approach has a long tradition in the US, dating back to the seminal work by Burns and Mithchell (1946) at the NBER. It has led to the compilation of coincident, leading and lagging indicators, which are regularly used to assess the state of the economy and to forecast official recessions. The US experience (Leamer, 2007) shows that the housing sector is among the most important channels through which fluctuations start propagating. Indeed, statistics referring to housing starts have been consistently included among the components of the composite leading index. On the contrary, the use of coincident and leading indicators to track and forecast the Italian economy and to date its recessions and expansions is limited to a few studies. The most recent exercise is the work by Altissimo et al. (2000) where nearly 200 economic times series are accurately analyzed and a few of them selected into composite coincident and leading indicators. The authors analyze real, monetary, financial and international variables and lay down a set of stylized facts of the Italian business cycle. Among the series considered only three refer to the construction sector as a whole[4] and none to the housing sub-sector. The contrast with the US experience[5] might reflect both the less satisfactory availability (and quality) of data on the Italian housing market as well as structural differences in the propagation mechanism.

The starting point of the classical analysis is the determination of a sequence of turning points (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 to us the following business cycle dating for the housing market: 1973Q3-1980Q1; 1980Q2-1987Q3; 1987Q4-1999Q1. The latest cycle started its expansionary phase in 1999 and seems to have reached a peak in 2007Q4[6].

Since the early 1970's, real house prices[7] have experienced three complete cycles (from trough to trough; figure 1 in appendix 3): the first cycle, which started in 1973Q3, was characterized by a strong rise in its first year (the cumulated increase being 40 percent), after which several shorter cycles occurred (presumably connected to the oil shocks and their inflationary consequences). Notwithstanding the uncertainty due to the high volatility of the series in this period, in line with Zollino et al. (2008) we select 1980Q1 as the trough that sets the end of the first complete cycle[8]. The second cycle was also characterized by an immediate strong rise (40 percent over 5 quarters up to 1981Q2) after which house prices declined consistently until 1987Q3 stabilizing at almost the same level recorded at the previous trough. The third cycle occurred over the following decade ending approximately in 1999Q1, and recorded a cumulated increase during its 5 year-expansionary phase of 50 percent and a decline of nearly 20 percent in the subsequent seven years. The latest expansionary phase continued uninterrupted until 2007Q4. 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 increase is around 40 percent. Recessions tend to last longer (on average 6

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4 The series are employment in the construction sector, fixed investment in building and unit labour cost in the construction sector.

5 The Conference Board has expanded the use of Coincident and Leading indicators to several advanced economies among which France, Spain and Germany and (still in a preliminary phase) the Euro area and has included the housing start statistics among the leading component whenever available.

6 Graphical inspection suggests that real house prices have stabilized but not decreased yet. On the contrary, residential investment and employment in the construction sector have clearly peaked in the second half of 2007.

7 The nominal house price index is available on a semiannual basis but a quarterly index is obtained by interpolation based on the index of construction costs. The real house price index is obtained as ratio of the nominal index and the consumer price index.

8 Our decision is supported by the behaviour of the nominal house price index, which shows a minimum in 1980Q1. Furthermore the volatility in real house price is accompanied by persistent negative rate of growth in residential investment and employment in construction (fig.1).

years), but the cumulated real decline in prices is significantly 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 most recent upswing[9]), 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). In the first one, investment initially increased only by 2 percent between 1973 and 1974, and then declined by 15 percent over the following 4 years. The second cycle occurred over the subsequent decade. The initial expansion was followed by an abrupt decline and a further strong increase in activity between 1981 and 1983, after which a long contraction took place which ended in 1987. The third cycle occurred over the following decade. Between the trough of 1999Q1 and the latest peak in 2008Q1, which represents the latest cyclical peak, housing investment has expanded at a rapid pace[10] (30 percent cumulated over 38 quarters). 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 construction activity shows milder fluctuations: during expansions (recessions) activity posts cumulated increases (declines) of around 12 percent from the previous trough (peak) level. The close relationship between price and quantity in the housing market is also confirmed 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.

[INSERT TABLE 1 IN APPENDIX 3]

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 (column BC) we have calculated the concordance index between the respective reference cycles[11] (see Harding and Pagan, 2002).

[9] We assume that the peak in the real house price national index has occurred in 2007Q4. Indeed, the index declined during the first three quarters of 2008. In the last quarter, due to a decline in the CPI index, real house prices have increased.

[10] Residential investment includes also renovation expenditures, which have been supported by several temporary legislative interventions since 1998.

[11] The reference cycle is a binary variable that takes on the value of 1 (0) during expansionary (contractionary) phases where these are determined by the sequence of peaks and troughs. The concordance index between two reference variables i and j is computed as follows:

$$CI = \frac{1}{T}\left\{\sum_{t=1}^{T} S_{it}S_{jt} + \sum_{t=1}^{T}(1-S_{it})(1-S_{jt})\right\}$$

The index measures the relative amount of time two series spend in the same cyclical phase (either recession or expansion), taking value of 1 for perfect positive synchronization (when the two series' turning points exactly coincide) and a value of 0 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. 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 [12]. 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). A high value of synchronization is 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 considerably lower[13].

[INSERT TABLE 2 IN APPENDIX 3]

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 the variables show only few peaks and troughs when compared to interest rates, equity price indexes and inflation rates. In this section, to take into consideration such differences and to increase the robustness of synchronization measures, we focus on the cyclical comovements. The resulting (filtered) series are characterized by more cycles and therefore more turning points. The analysis is carried out by considering those fluctuations which are responsible for the behavior of a series at a specific cyclical horizon. Comparison of business cycle duration in the housing market and in GDP has shown that the former is characterized by long swings which take place over several years. 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 order to

[12] The series is 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 onwards: interest rate on main refinancing operations of the ECB. Similar results are available which refers to 3month interest rate and the overnight rate.

[13] Table 2 reports standard confidence value for t-test on the correlation coefficient between reference cycles obtained from the following regression: $\sigma_i^{-1}\cdot\sigma_j^{-1}\cdot S_{it} = \alpha_{ij} + \rho_{ij}\cdot\sigma_i^{-1}\cdot\sigma_j^{-1}\cdot S_{ij} + \mu_t$. As the value of concordance reflects also the trending nature of the variables considered (i.e the fact that expansions last longer than recessions), the test checks if the value of concordance observed is due to the fact that expansions last longer than recession (null hypothesis) or if correcting for the latter there still is a significant synchronization between the reference cycles (see footnote 4, pag.65 of Harding and Pagan, 2006).

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[14].

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 variables[15] over the period 1970-2008.

[INSERT TABLE 3 IN APPENDIX 3]

The evidence indicates that house prices and residential investment are strongly positively correlated, with the latter leading the former by around one year. Further support for a leading role of quantity with respect to prices is found by looking at employment in the construction sector[16]. 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. 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[17] (see appendix 3 for robustness analysis). 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 Joint Research Project) and US evidence (Leamer, 2007) and 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 the latter lags residential investment but leads 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[18], suggesting that in absence of home equity release products, rising house prices have a standard negative effect on demand and therefore on

[14] The empirical literature has focused on cycles whose duration vary between 6 and 32 quarters. 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/or different time period is therefore questionable (see Everts, 2006 and Agresti and Mojon, 2001). However results obtained with the standard parameters are similar (see appendix 4).

[15] The cyclical component is obtained by using the filter developed by Baxter and King (1999).

[16] A standard explanation for such temporal ordering is that weakness in demand affects transaction volumes and housing construction activity first, as seller might have a relatively high reserve price and might prefer to wait longer before accepting to reduce the price (Leamer, 2007)

[17] The comparison among Italy, France, Spain and Germany has been conducted as part of ongoing research at the respective national central banks under the Joint Research Project (JRP) "Macroeconomics of housing markets"

[18] The stock of mortgage debt is adjusted for house price inflation. The negative correlation is robust to excluding the strong expansion of mortgage between 1998 and 2000.

mortgage applications[19]. To add robustness to our results we have also computed concordance and cross-concordance indexes with respect to the cyclical components of real house prices (table 2 column GC). 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.

2. VAR analysis

In this section we investigate the interaction of housing prices and quantities with economic activity and inflation conditional on observing a monetary policy shock. 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

[19] Musso et al. (2008) find both for the US and the Euro area excluding Germany a strong positive correlation value and suggest that it might be related to the equity refinance process which creates a positive link between house price and mortgage debt.

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.

However, both approaches have limitations: in particular, they miss nonlinearities in the economic relationships under exam; they do not account for possible structural breaks in the parameters; they rest on the assumption that the variables selected approximate well the information set of the central bank. While, the first limitation will not be dealt with in this study, we try to limit the possibility of incurring in the second one, by focusing on the relatively shorter and more homogeneous 1990-2008 sample period. Indeed, the relationship between housing and the macroeconomy might have changed due to innovation and competitive forces in housing finance and credit markets; furthermore the structural relationships might have adapted 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[20].

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 are ordered as follows: the consumer price index, GDP, the nominal house price index, housing investment, and the short term interest rate[21]. 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[22]. 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. Furthermore despite data on prices and economic activity are released with delay, the central bank can rely on accurate estimate (or "nowcast") of economic and

[20] Admittedly, more formal tests on sample (in)stability should be performed.

[21] See appendix 1 for data description and sources.

[22] Despite the inclusion of the house price index in the information set of the monetary authority could be questioned, especially for the early part of the sample, during which, presumably no reliable statistics on house price was available, including the latter in the non-policy block might better reflect the observed (downward) sluggish adjustment of prices in the housing market (and the associated lengthening of selling-time).

price developments. Indeed several studies for the US (see Romer and Romer, 2000, D'Agostino, Giannone and Surico, 2006, and D'Agostino and Whelan, 2007) suggest that much of the forecasting ability of central banks with respect to inflation and GDP is confined to the current quarter. The choice of the variables roughly follows previous VAR studies of the interaction between monetary policy and the housing market. The only difference consists in the fact that we use nominal house prices instead of real house prices. The departure is dictated by our interest about the degree of relative price stickiness in the housing market.

Among exogenous variables, the baseline specification includes a world commodity price index, and four dummy variables. The first variable accounts for external price pressures, while the dummy variables[23] mainly account for the interest rate turmoil in 1992 and 1995 and abnormal observations in the residential investment series associated with government legislative interventions[24]; furthermore we include four lags in our VAR models in line with most quarterly VARs in the empirical literature[25].

The structural decomposition of the interest rate equation residuals represents our estimated monetary policy shocks. Positive shocks signal deviations of the policy rate towards a restrictive stance compared to the level considered appropriate by the estimated policy rule (the systematic component of monetary policy). Graphical inspection of the series suggests that monetary policy matters for economic activity (figure 2): each major slowdown, represented by a negative output gap is anticipated by a tightening of monetary policy. In particular, the 1992 recession is led by a significant increase of the monetary policy rate. Also more recently, in the first years of EMU, the prolonged slow rate of growth of activity may be partly explained by the restrictive policy stance adopted by the ECB.

A more precise account of the effects of monetary policy shocks on the macroeconomy and the housing market can be obtained by analyzing impulse-response functions and the forecast error decomposition. A one standard deviation restrictive monetary policy shock (corresponding to a 50 basis point increase in the policy rate; figure 3) 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 trend reaches almost 0.2 percentage points (pp)[26]. Afterwards it slowly returns to its pre-shock level (twelve quarters after the shock the gap is no longer significant). The price level

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

[24] Legislative intervention in the field of residential construction activity includes, among others the so-called "condono edilizio" in 1994 and temporary fiscal incentives for renovation expenditures introduced in 1998 with the law 497/1997 and then prolonged several times.

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

[26] 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.

starts to decline only after two quarters[27], 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. 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 through the investment' decline 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 percentage points at their through[28]. The postponed reaction of real house price is confirmed by the conditional (to a monetary policy shock) cross-correlation functions: the cross-correlation of real house price with GDP and residential investment reaches a maximum with respectively 6 and 5 quarter time-displacements (see figure 3.1).

Table 4 (columns under identification 1) reports the share of the variance of each endogenous variable explained by monetary policy shocks at various horizons. The latter 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% at the 5-year horizon). Indeed, the historical decomposition of the variables in the VAR indicates that between 2004 and 2005 monetary policy was slightly more expansionary than economic conditions in Italy warranted, according to the estimated policy rule. However a counterfactual experiment in which the monetary policy shocks since 2002Q1 are set equal to zero suggests that, had policy been in line with the estimated feedback rule, the effect on nominal house price would have been quite small relative to the observed increases in house prices.

[INSERT TABLE 4 IN APPENDIX 3]

[27] 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.

[28] Giuliodori (2004) reports a similar reaction of real house prices. According to Iacoviello (2002) instead real house prices react more strongly and bottom out more quickly (around 4 quarters after the shock).

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. We decided therefore to change identification strategy and to exploit theory consistent information on the effects of monetary policy shocks.

This approach, pioneered by Faust (1998), Canova and De Nicolò (2002) and Uhlig (2005), consists of imposing sign restrictions on the impulse response 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 a "agnostic" approach on the response of the remaining variables. Furthermore, as several structural decompositions ("models")[29] 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 reflect not only the degree of precision with which the reduced form VAR parameters are estimated but also the uncertainty about the true underlying model.

As for the recursive approach, we focus on monetary policy shocks. Specifically, we assume that after a monetary restriction (expansion), the response of the policy rate is non-negative (non-positive), while that of real GDP, nominal house price and the consumer price index is non-positive (non-negative). 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). For instance, working with two-sector DSGE models Barsky et al. (2007) have noted that the response of the latter (which is usually assumed to be the flexible-price sector of the stylized economy) to a restrictive monetary policy shock is positive. More recently Monacelli (2008) has shown that several features of the economy can affect the response of relative prices to monetary policy shocks: among these are: (i) the role of borrowing constraint and of durables as collateral assets, (ii) consumption complementarities, (iii) production complementarities. While we will not shed light on which mechanism is at work, we still want to remain "agnostic" about the relative price stickiness in the housing market.

[29] In the analysis we set the number of admissible decompositions ("models") to 1000. See also the appendix for more details on the identification approach.

Implementation of the sign restriction approach is based on the parameters of the reduced form VAR previously estimated. Therefore, as a starting exercise, we do not take into account the sampling uncertainty associated with the reduced form VAR coefficient estimates but focus only on "model" uncertainty[30]. Furthermore, we assume that all sign restrictions are in place for two periods after the monetary shock.

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 (figure 4). 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. 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). Afterwards, an almost steady return to equilibrium takes place. Interestingly, the response of real house prices do not change as dramatically. Real house prices fall on impact by 0.2 pp, the decline intensifies 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. Consequently, when analyzing the correlation of real house price and quantity conditional on a monetary policy shock, we find a negative correlation (-0.7 over the first 8 quarters and -0.2 over 20 quarters) (figure 4.1 panel A).

Table 5 (panel A) reports the percentage of model-responses compatible with a decline in residential investment and real house prices over several horizons: 85 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 99 percent), confirming the recursive VAR indication about the delayed reaction in the housing market. The probability of a negative response then declines to 72 percent at the 5 year horizon. Nearly all models 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. The analysis of the forecast error variance decomposition[31] (see table

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[30] Impulse response and confidence bands obtained with model and sample uncertainty are reported in figure 8 of appendix 4.

[31] Variance decomposition is calculated on one single model's response functions rather than on the median response as the latter, being obtained by averaging over the set of all admissible models, does not necessarily satisfy the requirement of orthogonality across structural shocks. By working on one specific model instead the condition of orthogonality is fulfilled and decomposition of the variance is a meaningful exercise (see Fray and Pagan, 2007). The

4; columns under identification 2) 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.

[INSERT TABLE 5 IN APPENDIX 3]

Because the impulse response functions of housing investment might be influenced by the constraint on GDP, we also calculated the median response when no restriction is imposed on the latter (figure 5). In this case, the response of GDP is no longer significantly negative (Uhlig (2005)), at the same time the response of residential investment is less strong (-0.4 pp on impact) and slightly less precisely estimated. The impact response of the real house price index does not change significantly, but its dynamics does somewhat as the return to the pre-shock level is now faster.

Overall, relaxing the constraint on GDP does not change qualitatively the results. In both cases the bulk of the effects on residential investment occurs on impact after which a return towards equilibrium takes place. While the maximal effect on house prices takes place between 2 and 3 years after the shock.

Finally, we experimented by lengthening from 2 to 4 the number of quarters during which the restrictions hold. Interestingly, the only variable to show a markedly different response is residential investment which now falls on impact by only 0.2 percentage points and then gradually declines for 2 more years (figure 6) deviating by 0.3 pp at the trough. Under such parameterization, the conditional cross-correlation between residential investment and real house price becomes again positive (0.4 over the first 8 quarters; figure 4.1 panel B) and roughly similar to the results obtained under the recursive approach.

Robustness checks

In this section we carry out some robustness analysis using the recursive VAR. Given the quarterly frequency of the data, the ordering adopted might not appropriately reflects the way monetary policy is conducted. We therefore change the ordering of the VAR by placing the house price index and housing investment after the policy rate, under the assumption that current information on the

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model selected minimizes at each horizon and over all variables the distance between the implied response of a variable and the median response of the same variable to a monetary policy shock.

housing market does not affect the systematic component of monetary policy, while house price and investment react to the latter with no delay. Under this scheme, we find a counterintuitive, although not significant, increase of nominal (and real) house price and investment on impact, followed by a gradual and significant decrease, in line with the benchmark specification. We also estimate a VAR, using directly the real house price index (instead of the nominal index) and obtain very similar results.

Furthermore we focus on the effects of including different variables. In particular, we consider different interest rate measures (the three month money market rate as well the overnight rate), different general price indexes (both the consumption deflator and the GDP deflator), without detecting any significant departure from the benchmark results. Finally we also augment the model to include in turn the exchange rate, and the M2 money stock (figure 7).

Including the exchange rate is dictated by the fact that the Italian economy is a relatively small open economy whose performance heavily depends on external demand and competitiveness. Despite the problems associated with including the exchange rate in a recursive scheme[32], we order the Italian Lira/DM nominal exchange rate before the policy rate (see Neri, 2004 and Bonci and Columba, 2006 for similar approaches). The impulse response functions to a policy shock reveal no significant change, while the response of the exchange rate has the wrong sign although it is not significant (see Chiades and Gambacorta, 2004 and De Arcangelis and Di Giorgio, 1998 for similar findings). Adding the nominal stock of money (M2) as the last variable in the VAR does not change the effect of a policy shock on the variables considered. Following a restrictive policy shock, the monetary aggregate drops on impact and remain significantly below the pre-shock level for about 4 quarters, consistently with the presence of a liquidity effect.

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.

[32] It is difficult to argue that either the exchange rate variable is not contemporaneously affected by monetary policy decisions or that the central bank does not include the exchange rate in its information set.

3. 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 comovements 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 1: 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

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 2: methodological issues

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

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

Where B(L) is a lag polynomial of order p and Y is a n x 1 vector of endogenous variables and ε are the reduced form residuals with variance-covariance matrix ∑.

The corresponding structural VAR is

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

Where A(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. Identification amounts to impose a set of restrictions (a matrix A_0) that uniquely solves – up to orthonormal transformation- the following system of equations:

$$A_0 \cdot A_0^{'} = \Sigma$$

Under a recursive scheme, 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 ($\Phi_{0;j}$) 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 effects of the j-th structural shock at any horizon k ($\Phi_{k;j}$). 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 S 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 8 we report the median and the 16^{th} and 84^{th} percentile of the distribution of the impulse response functions under sample and model uncertainty.

Appendix 3: Tables and figures

Table 1: descriptive statistics housing market cycle

1970-2008	HOUSE PRICE (1)	RES. INV.	EMPL. CONSTR.
N. cycles (trough to trough)	3 (4 ongoing)	3(4 ongoing)	2(3 ongoing)
expansion: average length (quarters)	9.3	8.5	15.8
recession: average length (quarters)	24.7	22.0	25.0
expansion: average cumulated change (%)	42.3	14.1	9.7
recessions: average cumulated change (%)	-23.4	-11.3	-12.6
average lead at peak (2)	-	0.0	-1.0
[min;max]	-	[0 ; 0]	[-4 ; 1]
average lead at trough (2)	-	-2.0	0.6
[min;max]	-	[1 ; 7]	[-3 ; 7]

(1) deflated with CPI index
(2) + (-) corresponds to lead (lag) with respect to house price turning points

Table 2: maximum cross concordance with real house price

	BC	GC
GDP	0.46 (-3)	0.68** (-7)
INFL. (2)	0.61** (-1)	0.68** (-5)
POLICY RATE	0.75*** (0)	0.67** (-1)
EMPL. CONSTR.	0.82*** (0)	0.77*** (-2)
RES. INV.	0.89*** 0	0.71*** (-3)
EQUITY PRICE (1)	0.49 (0)	0.6 (-1)
MORTGAGE DEBT (3)	0.51 (0)	0.3 (0)

* Max. cross-concordance index and lead(-) lag(+) (in parentheses) of variable in row with respect to real house price
(1) Deflated with CPI index.
(2) Y on Y change
(3) Deflated with nominal house price index
BC: Series in levels (Business Cycle approach)
GC: filtered series (Growth Cycle approach)
*;**;***: significant respectively at 10%;5% and 1%

Table 3: correlation of cyclical components*

	HOUSE PRICE (1)	RES. INV.
GDP	0.77 (-7)	0.43 (-2)
INFL. (2)	0.76 (-3)	0.57 (-1)
POLICY RATE	0.52 (-2)	0.45 (4)
EMPL. CONSTR.	0.71 (-2)	0.5 (3)
RES. INV.	0.59 (-3)	- -
HOUSE PRICE (1)	- -	0.59 (3)
EQUITY PRICE (1)	-0.39 (-8)	-0.38 (-3)
MORTGAGE DEBT (3)	-0.58 (0)	-0.57 (6)

* Max. correlation coefficient and lead(-) lag(+) (in parentheses) of variable in row with respect to variable in column
(1) Deflated with CPI index.
(2) Y o Y change
(3) Deflated with nominal house price index

Table 4: SVAR forecast error variance decomposition*

	CPI		GDP		HOUSE PRICE (NOMINAL)		RES. INV		POLICY RATE		HOUSE PRICE (REAL)	
*Identification**	*1*	*2*	*1*	*2*	*1*	*2*	*1*	*2*	*1*	*2*	*1*	*2*
Period												
1	0.0	38.6	0.0	17.6	0.0	7.1	0.0	6.7	90.4	9.6	0.0	4.8
2	0.2	23.6	0.2	18.8	0.0	8.0	0.0	6.9	67.0	7.6	0.0	5.3
3	0.2	19.4	0.5	20.1	0.0	8.4	0.2	9.7	60.1	7.1	0.0	5.4
4	0.4	15.4	2.4	22.4	0.4	9.2	0.7	13.9	50.9	9.2	0.3	5.7
8	2.3	17.8	16.6	24.7	0.8	10.5	8.6	19.4	40.0	21.3	0.4	5.3
12	7.8	17.0	20.0	18.9	4.3	13.6	9.8	17.2	37.9	32.3	2.4	6.9
16	13.7	14.9	19.8	15.4	9.2	14.0	9.5	16.5	33.2	39.6	5.9	7.3
20	18.1	13.8	19.2	13.9	11.7	12.7	10.2	15.9	30.8	42.3	7.7	6.6

* Percentage of forecast error variance explained by monetary policy shock
**(1): recursive; (2): sign restriction

Table 5: Probability of a negative response*

Period after shock	1	4	6	8	12	20
			Panel A: Restrictions on GDP			
RES. INV	0.85	0.99	0.99	0.99	0.78	0.72
HOUSE PRICE (REAL)	1	0.99	0.95	0.96	0.98	0.61
			Panel B: No restrictions on GDP			
RES. INV	0.71	0.63	0.78	0.68	0.3	0.25
HOUSE PRICE (REAL)	0.98	0.84	0.45	0.34	0.38	0.2

* estimated as ratio between number of models compatible with a reduction in the levels of the (housing) variables and the set of all admissable models

Fig.1: Housing market variables and selected macroeconomic variables (1)-(2)

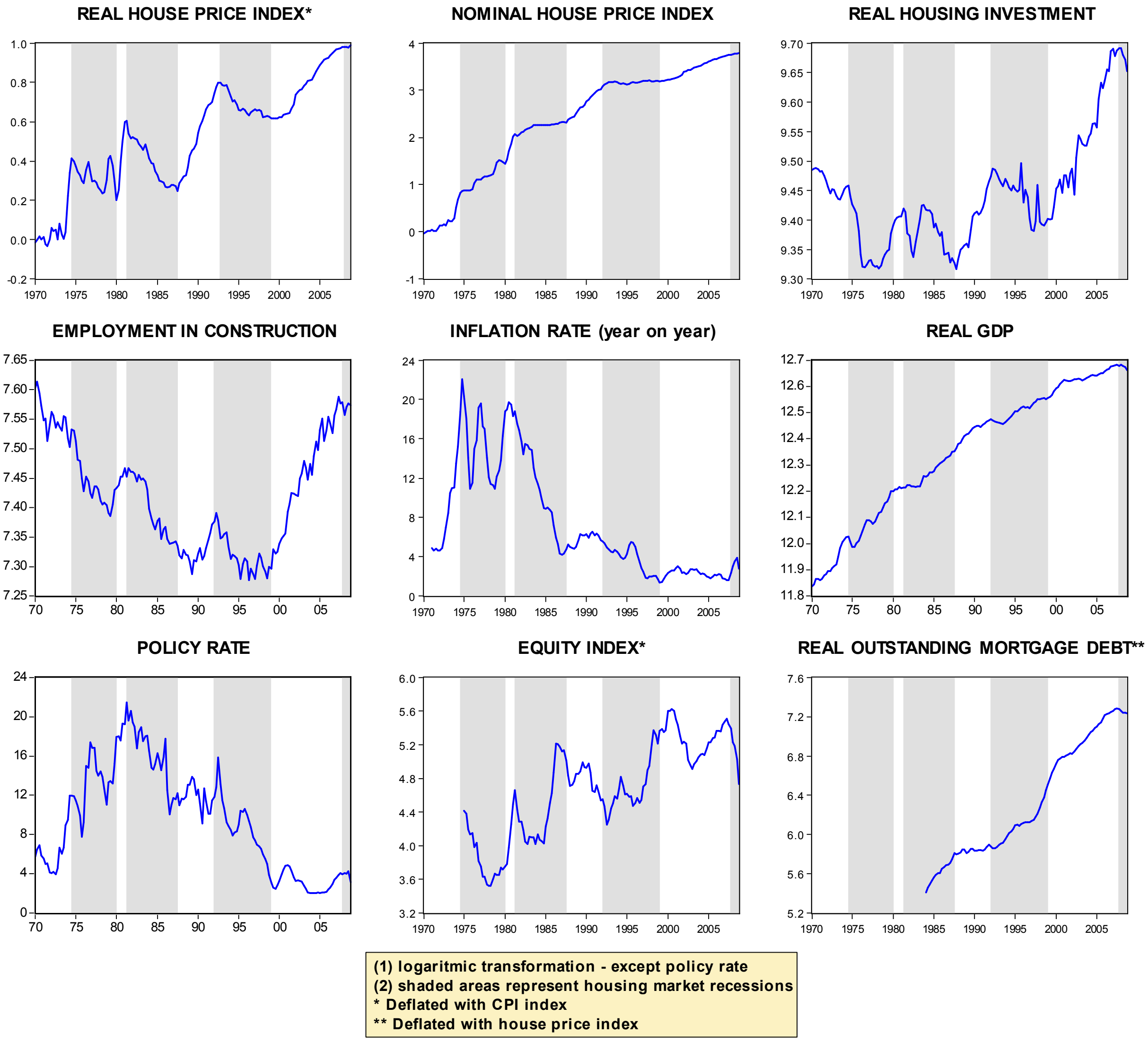
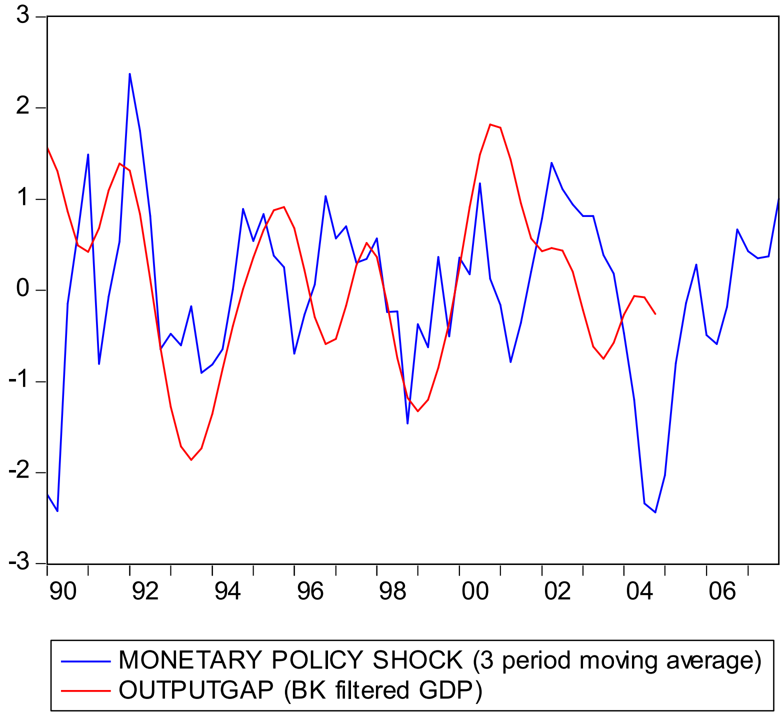


Fig.2 monetary policy shocks: recursive



In the following figures PH refers to the nominal house price index, INV refers to residential investment, P.RATE to the monetary policy rate and PHR to the real house price index, EXCH to the Italian Lira/German mark nominal exchange rate.

Fig.3 effects of monetary policy shocks: recursive

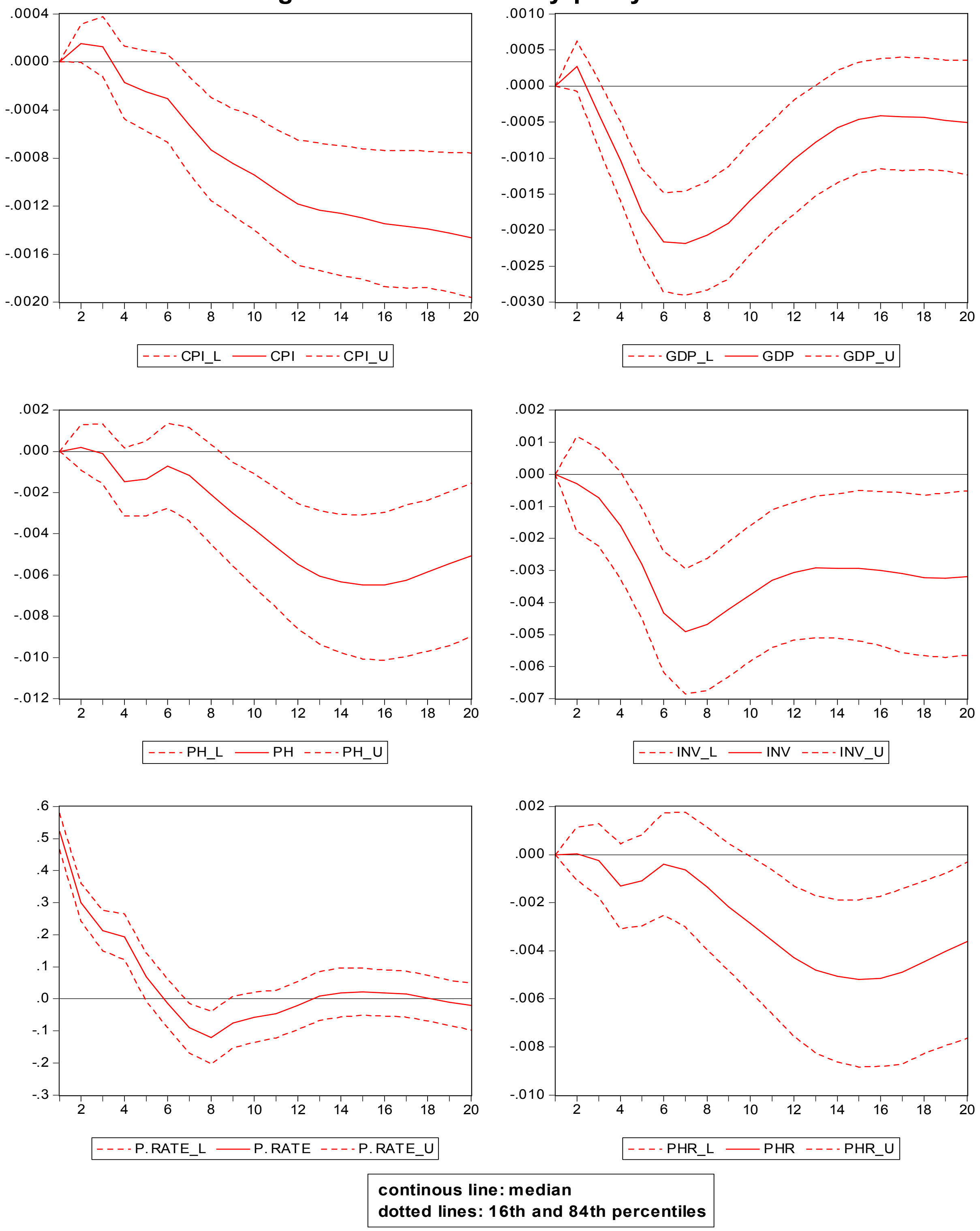


Fig.3.1: Effects of monetary policy shock (recursive)

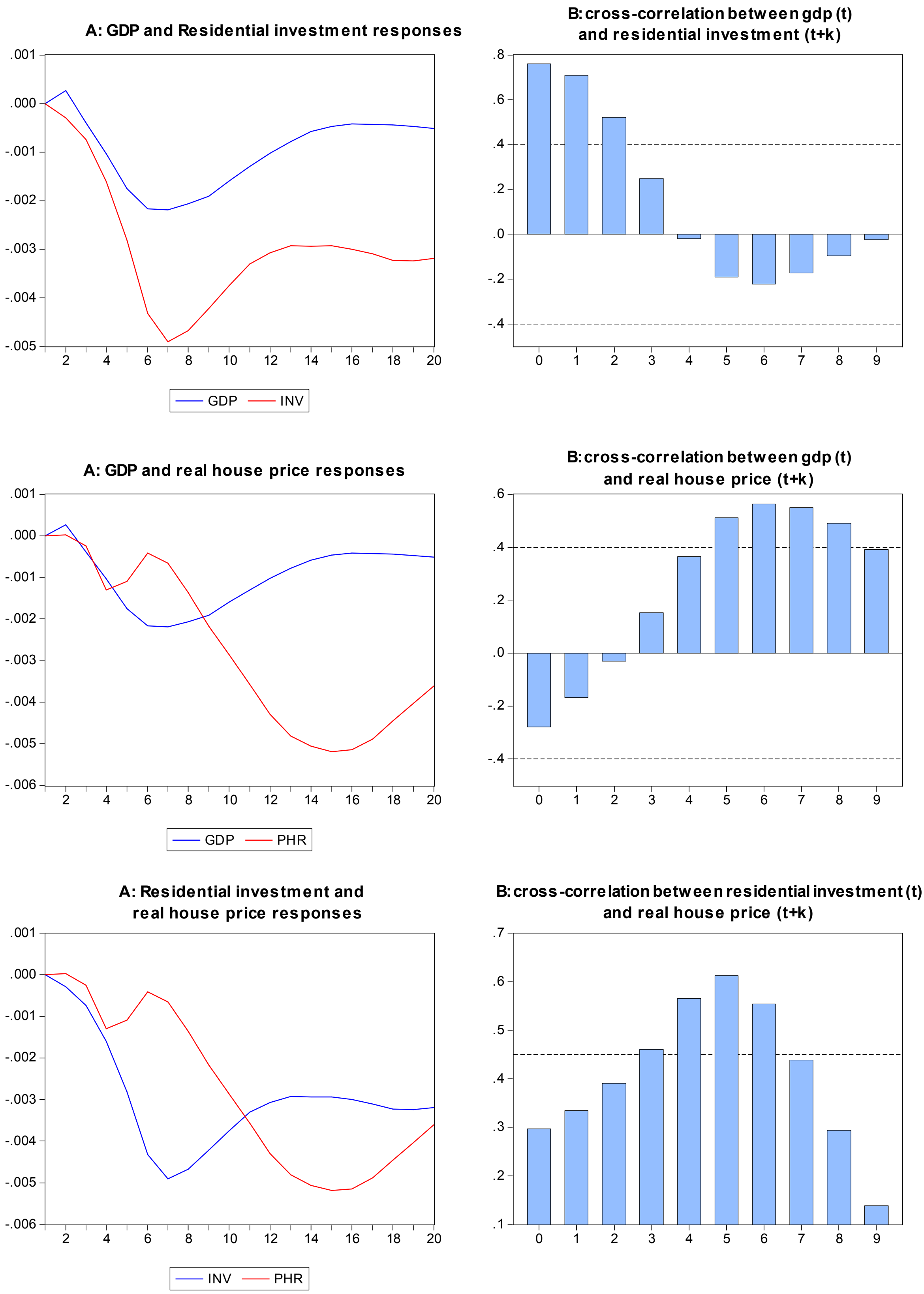
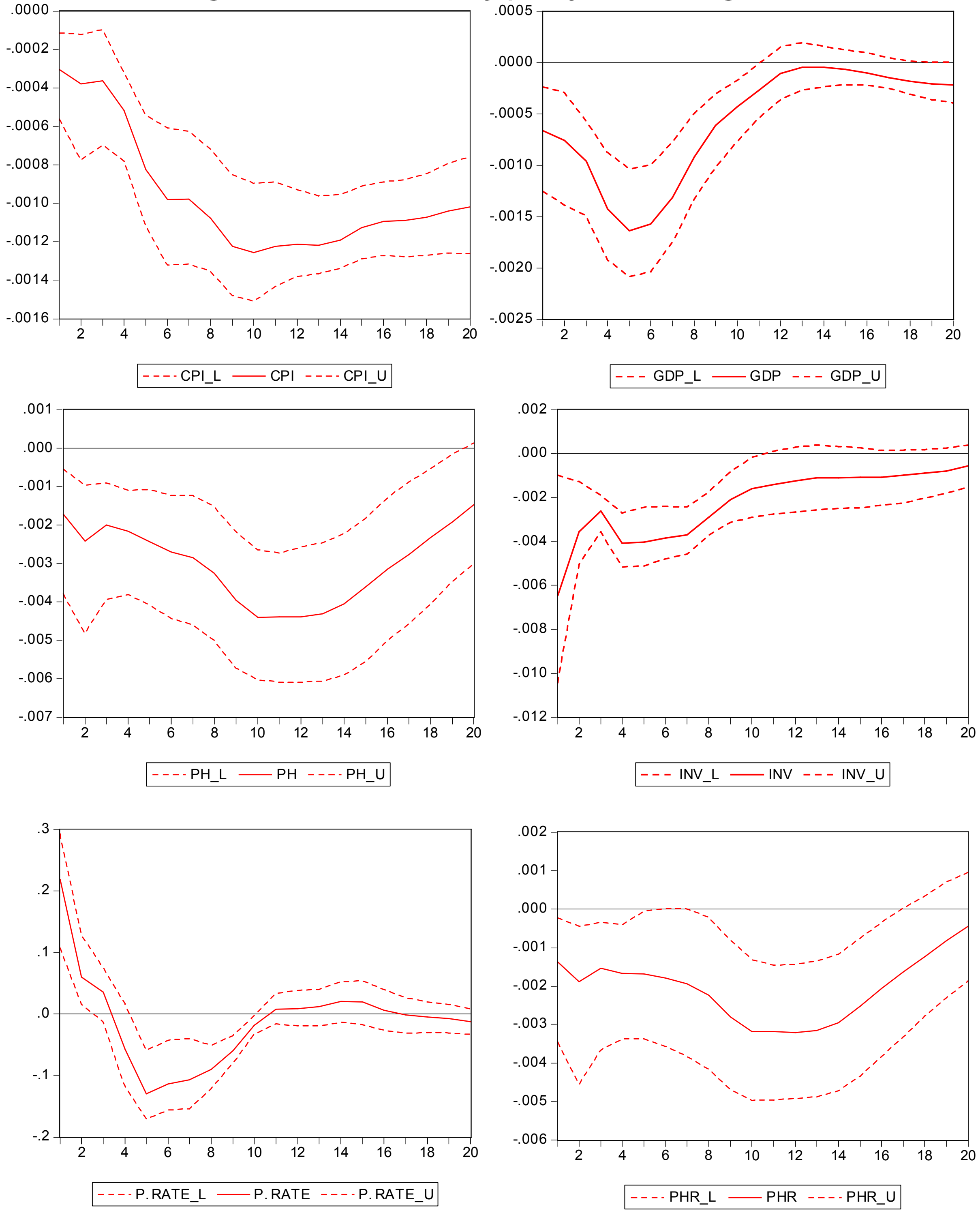
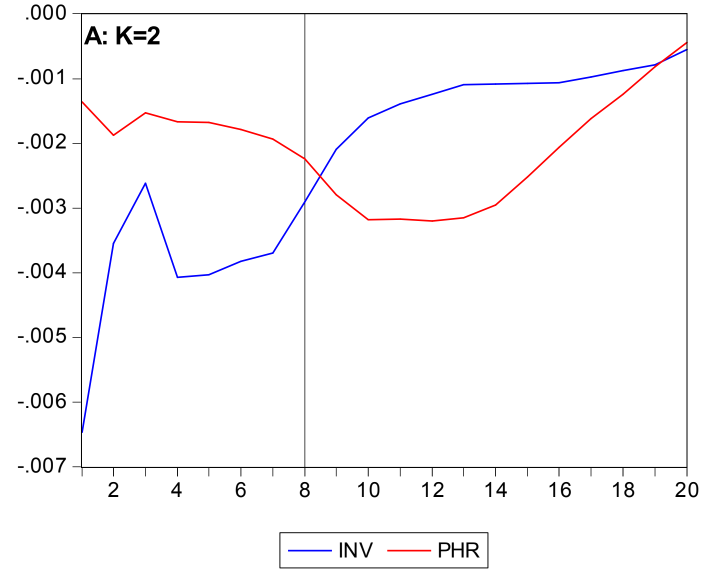


Fig.4 effects of monetary policy shocks: sign restrictions



continous line: median
dotted lines: 16th and 84th percentile

Fig. 4.1: effects of monetary policy shock: sign restriction (K=2 and K=4)
Comparison of residential investment and real house price responses



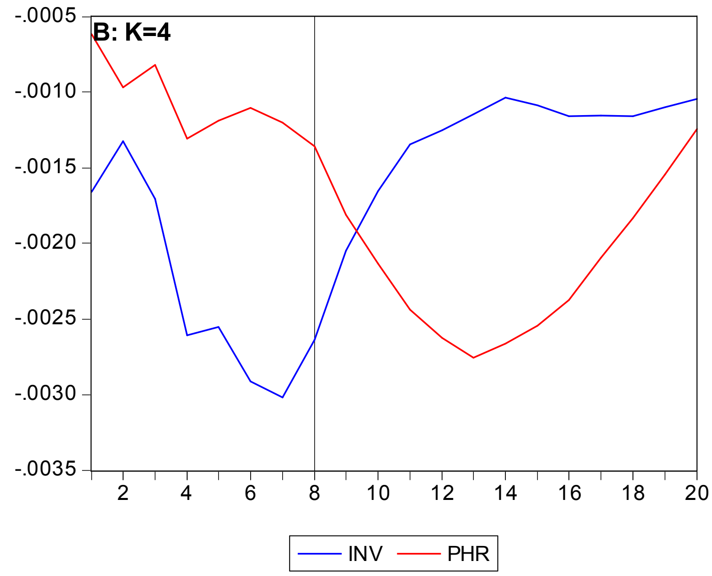
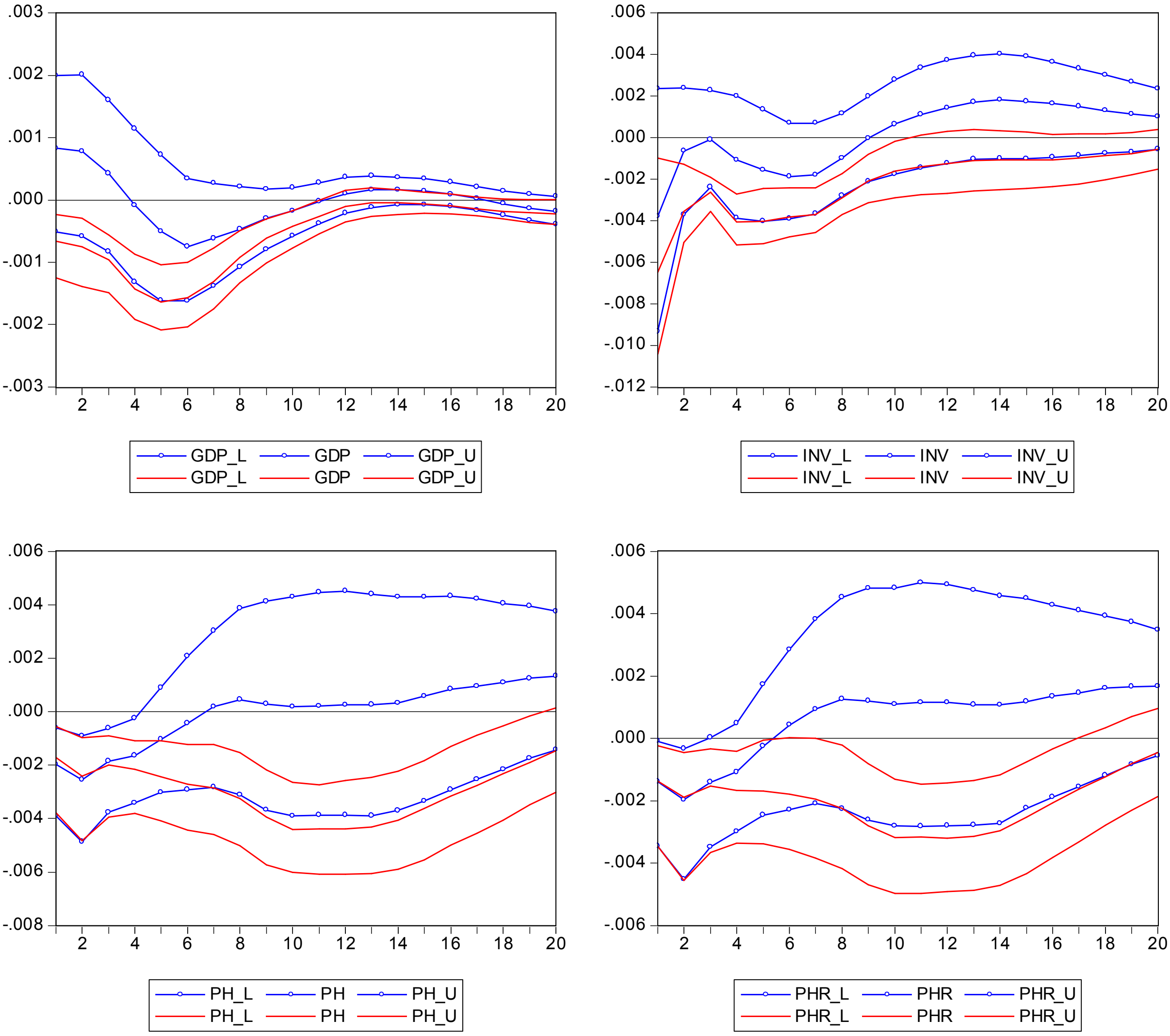


Fig.5 effects of monetary policy shocks: sign restrictions on GDP



continous lines: sign restrictions on GDP (16th 50th and 84th percentiles)
circled lines: no sign restrictions on GDP (16th 50th and 84th percentiles)

Fig.6 effects of monetary policy shock : sign restrictions (K=2 and K=4)

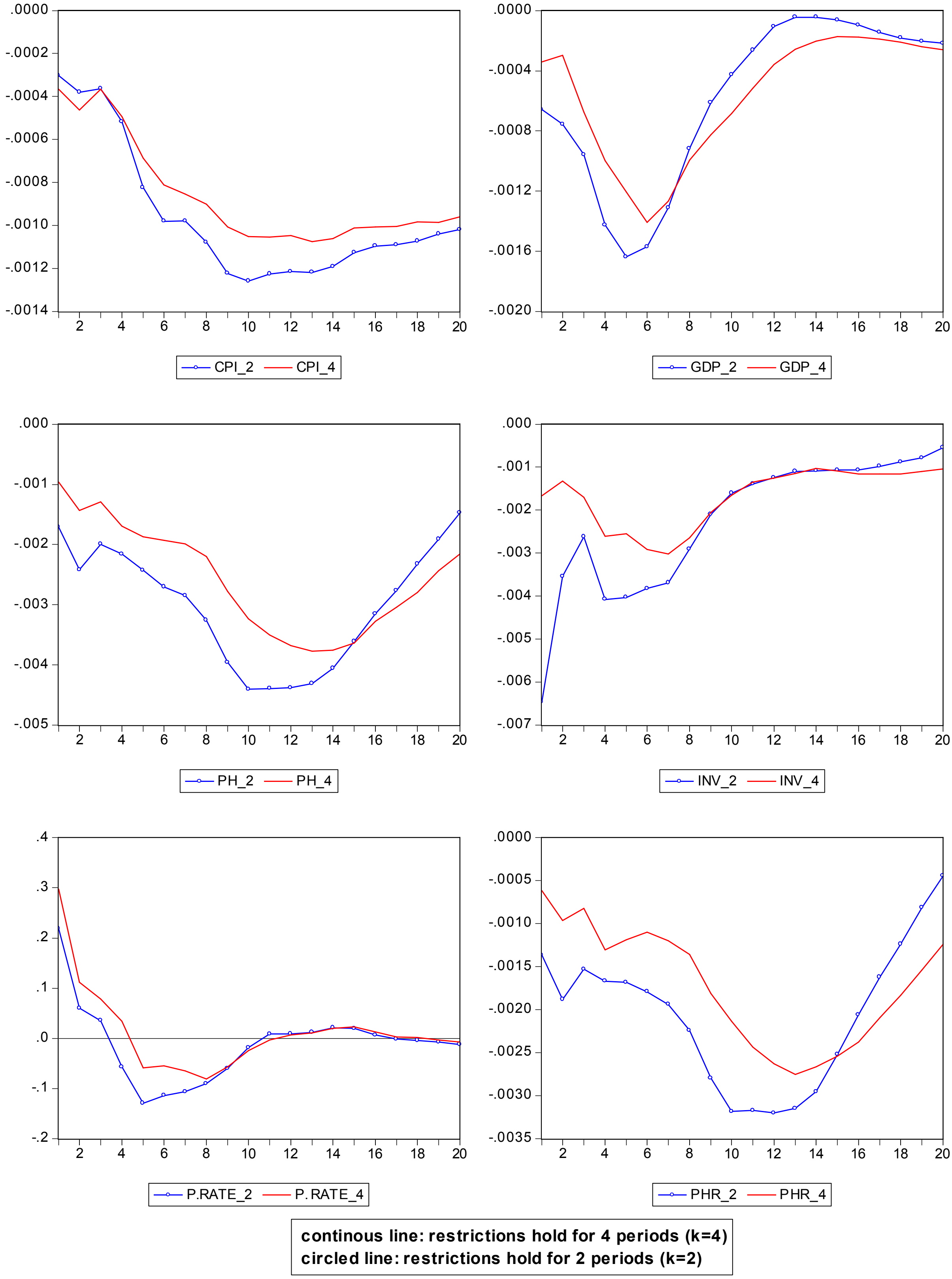


Fig.7: effects of monetary policy shocks: recursive (robustness)

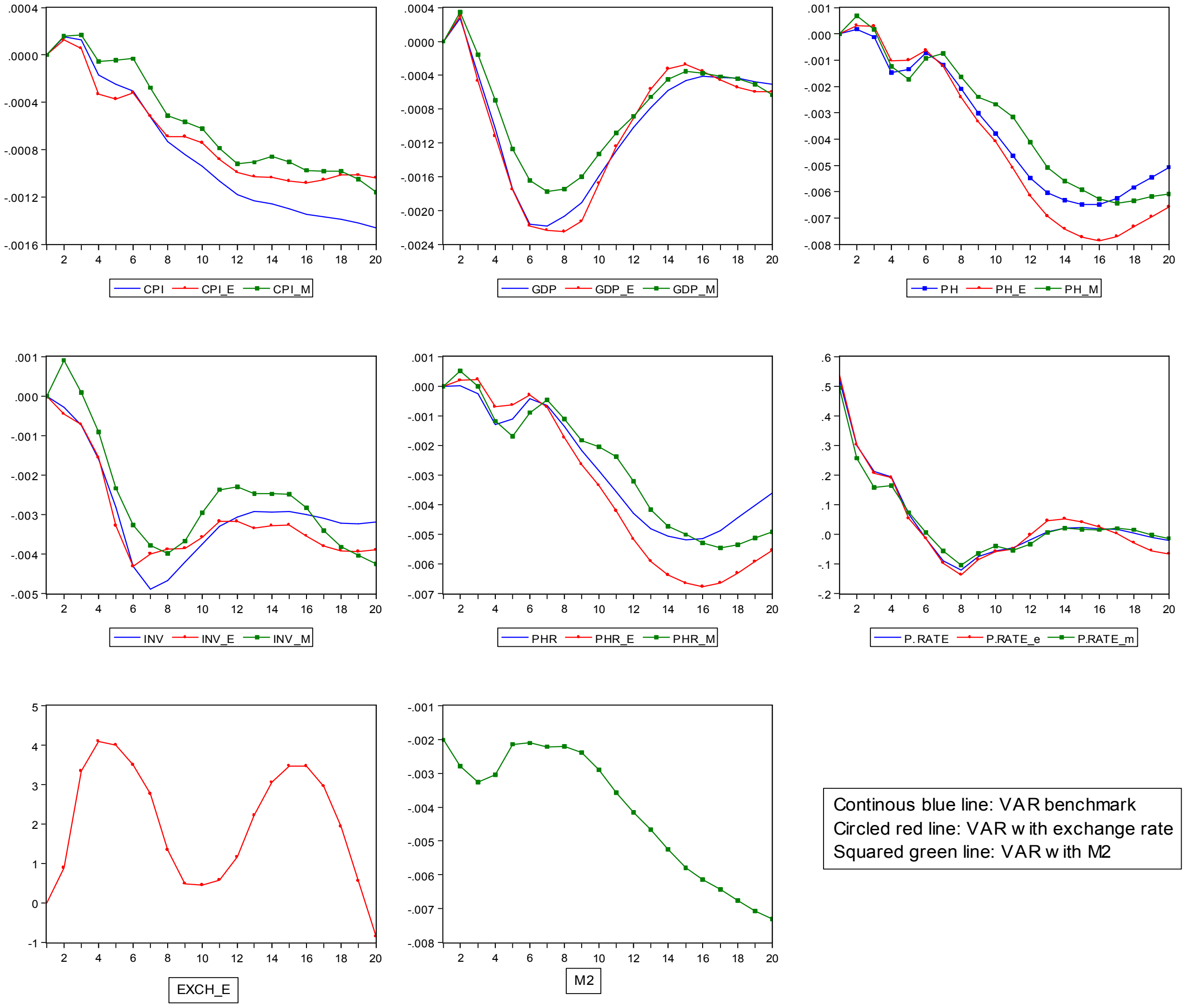
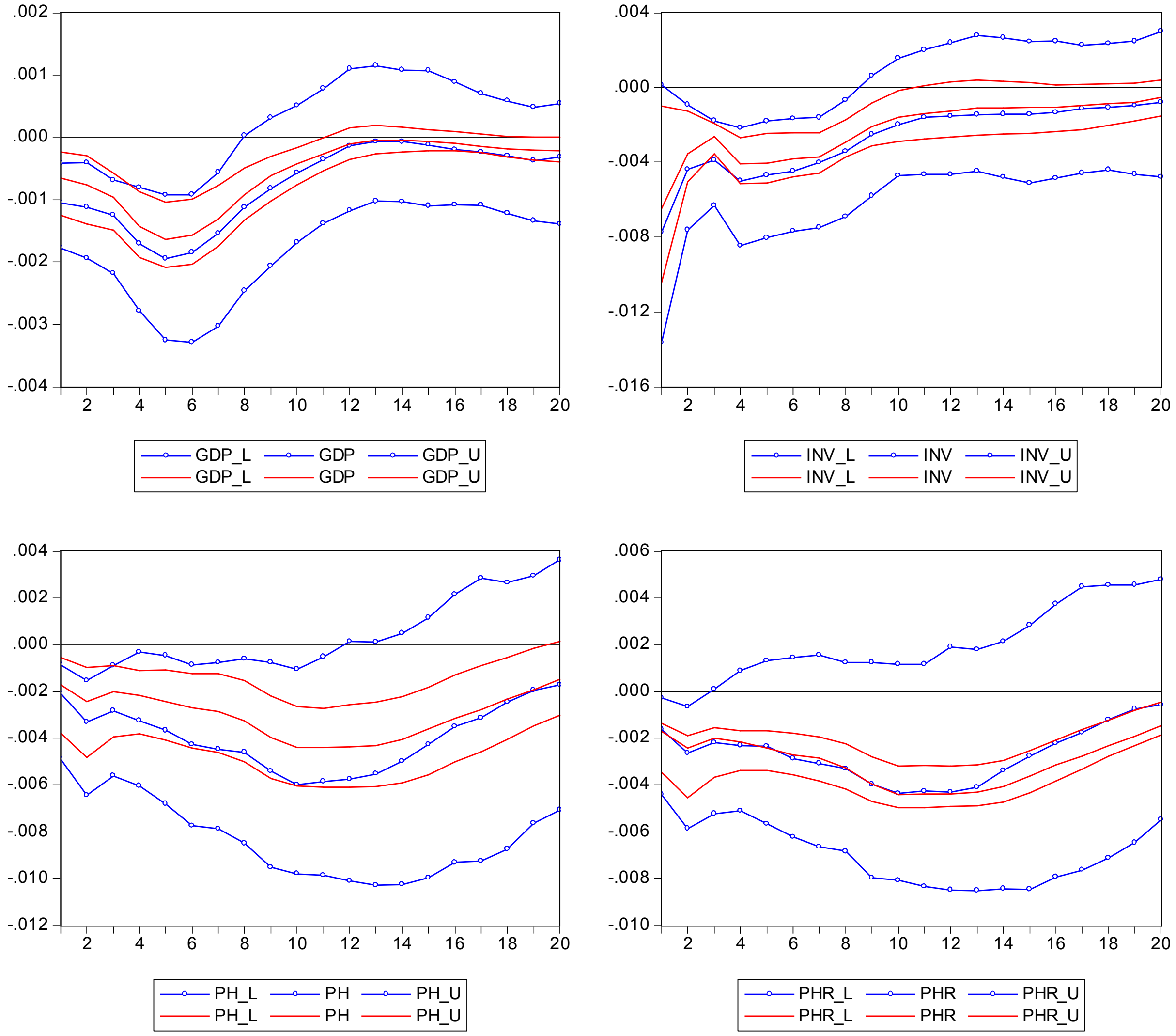


Fig.8 effects of monetary policy shocks: sample and model uncertainty



continous lines: only model uncertainty (16th 50th and 84th percentiles)
circled lines: sample and model uncertainty (16th 50th and 84th percentiles)

Appendix 4: robustness analysis for cyclical correlations

In this appendix the cyclical relationship between the housing market (residential investment and real house price) and GDP is analysed. Starting from the results reported in the main text, we propose several robustness checks. More specifically, as the results in the main text are obtained by extracting the cyclical component of each series by applying the Baxter and King filter to the level of the series and by defining the cyclical component as those fluctuations with cyclical duration longer than 3 years and shorter then 10 years, our choice contrasts with the definition usually adopted in empirical applications which focus on cyclical fluctuations with period ranging between 1.5 and 8 years. Furthermore, several filters are available to separate the cyclical component from the trend and the short-term components. The robustness of our findings is therefore assessed by using the standard 1.5-8 year window and by using the HP band-pass filter (see Artis et al. 2003). Finally results are tested over different sample periods to check if relationships have changed in more recent years.

Using the standard cyclical window

The use of the standard cyclical window to extract the cyclical component leads to slightly more volatile cycles. This is not surprising as shorter cycles (between 1.5 and 3 years) are now included in the cyclical component and longer cycles (those between 8 and 10 years) are removed. However, for the three variables considered the correlation between the two cyclical components is always maximal at the 0 lag and ranges between 0.8 and 0.9.

Table A1 shows the pair-wise cross-correlations between the cyclical components of residential investment, real house price and GDP, over different sample periods. The first group of correlations refers to the whole sample. In the first row, the B-K filter is used along with a cyclical window of 3-10 years. In the third row the more standard window (1.5-8 years) is used. Although the latter leads to a reduction in the correlation coefficient, the lead/lag relationship confirms that housing market variables lag economic activity by several quarters.

Using the HP band pass filter

The original HP filter may be considered as a high-pass filter that damps long term fluctuations and leaves short-run movements untouched. Artis at al. (2003) suggest using a band pass filter as the difference between two H-P filters, the first working on short run fluctuations, the second on long run movements. For given cyclical window and for each variable, the correlation coefficients between the B-K cyclical component and the H-P-band one are very high (around 0.9) and occurs at the lag 0. Furthermore the contemporaneous correlation between B-K cyclical component with the 3-10 years window and H-P-band cyclical component with the 1.5-8 year window ranges between 0.77 and 0.86. Comparing the first row with the second and the fourth row, the effect of using a different filter and a different cyclical window can be gauged. The strength of the relationship is more strongly affected by the choice of the cyclical window than by that of the filter. Overall, the lagging behaviour of housing market variables with respect to GDP is robust to changes in the filter and its parameters.

Using different sample periods

The final robustness test consists in analysing the stability of previous results to changes in the sample period. This check is particularly needed as both the economy as well as the financial sector and consequently the housing market have gone trough substantial changes.

Comparison of the results for three sample period (1970-2007, 1980-2007 and 1990-2007) indicates firstly that the lagging behaviour of real house price with respect to GDP is quite robust. Secondly that excluding the 1970's, the relationship between residential investment and GDP becomes less strong and slightly more coincident (especially over the 1980-2007 period).

Table A1: Correlation coefficent between cyclical components

		variable 1 RES. INV	variable 2 GDP	variable 1 HOUSE PRICE (REAL)	variable 2 GDP	variable 1 RES. INV	variable 2 HOUSE PRICE (REAL)
filter[(1)]	window[(2)]	max. corr[(3)]	lead/lag[(4)]	max. corr[(3)]	lead/lag[(4)]	max. corr[(3)]	lead/lag[(4)]
1970-2007							
BK	3-10	0.43	(+2)	0.77	(+7)	0.59	(-3)
HP	3-10	0.39	(+2)	0.68	(+6)	0.56	(-3)
BK	1.5-8	0.41	(+2)	0.37	(+4)	0.37	(-2)
HP	1.5-8	0.45	(+2)	0.43	(+4)	0.36	(-3)
1980-2007							
BK	3-10	0.28	(+0)	0.73	(+7)	0.46	(-3)
HP	3-10	0.2	(+0)	0.71	(+7)	0.45	(-1)
BK	1.5-8	0.38	(+0)	0.5	(+5)	0.35	(-2)
HP	1.5-8	0.47	(+0)	0.46	(+5)	0.26	(-3)
1990-2007							
BK	3-10	0.29	(+2)	0.68	(+7)	0.61	(-3)
HP	3-10	0.25	(+1)	0.69	(+7)	0.48	(+0)
BK	1.5-8	0.42	(+1)	0.6	(+7)	0.43	(-4)
HP	1.5-8	0.47	(+0)	0.64	(+7)	0.16	(-3)

(1) BK: Baxter and King filter; HP: Hodrick-Prescott
(2) minimum and maximum length of cyclical fluctuations
(3) maximum correlation coefficient
(4) lead(-)/lag(+) of fvariable 1 wrt variable 2

Cyclical components of selected series