

Lambertini, Luisa; Mendicino, Caterina; Punzi, Maria Teresa

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## Expectations-driven cycles in the housing market

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Luisa Lambertini – Caterina Mendicino – Maria Teresa Punzi

# Expectations-Driven Cycles in the Housing Market



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# Expectations-Driven Cycles in the Housing Market <sup>\*</sup>

Luisa Lambertini<sup>†</sup>

Caterina Mendicino<sup>‡</sup>

Maria Teresa Punzi<sup>§</sup>

## Abstract

Survey data suggests that news of changes in business conditions are significantly related to house prices and consumers' beliefs of favorable buying conditions in the housing market. This paper explores the transmission of "news shocks" as a source of boom-bust cycles in the housing market. News on shocks originated in different sectors of the economy can generate booms in the housing market in accordance with the average behavior in the data; expectations on monetary policy and inflationary shocks that are not fulfilled can also lead to the observed subsequent macroeconomic recession. Investigating the role of the credit market for house market fluctuations we find that favorable credit conditions that are expected to be reversed in the near future generate boom-bust cycle dynamics in line with the most recent episode. Further, credit conditions also affect boom-bust cycles generated by news shocks originated in other sectors of the economy. In particular, lower loan-to-value ratios reduce the severity of expectations-driven cycles and the volatility of household debt, aggregate consumption and GDP.

JEL classification: E32, E44, E52

Keywords: boom-bust cycles, credit frictions, housing market.

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<sup>†</sup>EPFL, College of Management. Email: luisa.lambertini@epfl.ch

<sup>‡</sup>Banco de Portugal, Departamento Estudos Economicos. Email: cmendicino@bportugal.pt.

<sup>§</sup>University of Nottingham. Email: punzi@bc.edu.

# 1 Introduction

Boom-bust cycles in asset prices and economic activity are a central issue in policy and academic debates. Following the recent bursting of the housing bubble and the ensuing financial crisis, particular attention has been given to the behavior of housing prices and housing investment. This paper suggests a mechanism for modeling housing-market boom-bust cycles in accordance with the empirical pattern.

Over the last three decades, housing price boom-bust cycles in the United States have been characterized on average by hump-shaped co-movement in GDP, consumption, investment, hours worked, real wages and housing investment. More precisely, these macroeconomic variables generally grow during the boom phase of housing prices and fall during the bust phase. Moreover, housing prices peaks are typically followed by macroeconomic recessions. Modeling endogenous boom-bust cycles in macroeconomics, however, is a major challenge. It is difficult to generate extended periods of sustained house price growth followed by reversals through unanticipated shocks, which generate the strongest responses in the short run and eventually die out.

An often-heard explanation of housing booms is households' optimism about future house price appreciation. In particular, Piazzesi and Schneider (2009) documented that belief of rising prices increased during the last housing boom exactly when prices reached their historical highs and that expectations of future house prices appreciation are related to optimism about economic conditions. Nofsinger (2011) argues that the emotions and psychological biases of households play an important role in the boom bust economic cycle, with increase speculative behavior late in an economic expansion and restrict economic behavior in a contraction.<sup>1</sup> Using data from the Michigan Survey of Consumers we document that news heard of recent changes in business conditions are significantly related to consumers' belief of favorable buying conditions in the housing market both when the opinion is based on the perception of the current state of the economy and when it is driven by expectations of rising house prices or tighter future credit. News heard of changes in business conditions also contain statistically significant information for house price growth. Moreover, both news on business conditions and expectations of rising house prices and future tighter credit conditions are significantly related to house price growth. These findings suggest a potential role for expectations-driven cycles in the housing market.

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<sup>1</sup>At the peak of the boom, households have bought assets at high prices, overburdened themselves with debt, and reduced their savings rate. In bust times, the household biases and fear lead to selling previously popular assets at low prices. Households then repay debt and save more, which drags on an already slow economy.

This paper shows that news on a variety of shocks can be a source of optimism about future house price appreciation. Such news shocks generates empirically plausible housing market fluctuations characterized by hump-shaped co-movement with macroeconomic variables. Our theoretical framework extends the model of the housing market developed by Iacoviello and Neri (2010) to allow for news on shocks originated in different sectors of the economy. A necessary condition for a boom to emerge is that agents expect rising house prices, which in turn fuels current housing demand and lifts housing prices immediately. Because impatient households borrow a fraction of the future expected value of their houses, the increase in housing prices is coupled with an endogenous increase in household indebtedness. If expectations are not fulfilled, a bust occurs with a dramatic drop in both quantities and prices.

Expectations of future developments in several sectors of the economy can generate housing-market boom-bust cycles characterized by co-movement in GDP, consumption, investment, hours and real wages. In particular, news on both productivity and monetary policy shocks can be a source of empirically plausible booms in house prices. However, only expectations of shocks related to the behavior of nominal variables, such as the policy rate and inflation, that are not met are also likely to cause a subsequent macroeconomic recession.

We also investigate the role of credit conditions as a source of housing market fluctuations. Survey data suggests that current favorable credit conditions as well as expected future tighter credit conditions are important reasons for consumers to judge house buying conditions as good. In our model a contemporaneous, exogenous easing of credit conditions that is expected to be reversed in the near future generates dynamics in line with the recent boom-bust cycle in the housing market.

Last, we explore the role of credit conditions for the transmission of boom-bust cycles driven by news on shocks originated in other sectors of the economy. We find that lower Loan-to-Value ratios reduce the severity of boom-bust cycles in household debt, consumption and GDP. Accordingly, solving the model under a variety of unanticipated and news shocks, we find that lower LTV ratios imply lower volatility of these variables over the business cycle. These results highlight the importance of taking into account the effect of credit standards and financial regulation for house price dynamics into the standard macroeconomic frameworks used for policy analysis.

Few other papers relate booms and busts in the housing market to expectations on future fundamentals. Tomura (2010) documents that boom-bust cycles in house prices can be generated by uncertainty about the duration of a temporary increase in income growth only if the economy is

open to international capital flows; Burnside, Eichenbaum and Rebelo (2010) generate boom and bust in the housing market relying on heterogeneous expectations about long-run fundamentals that drive house prices, as summarized by the flow of utility of holding a house. Differently from them, we explore the transmission mechanism of expectations related to different sectors of the economy and we highlight the importance of credit conditions as a source of boom-bust cycles in the housing market.

The rest of the paper is organized as follows. Section 2 characterizes the average behavior of several macroeconomic variables during four boom-bust episodes in the U.S. housing market in the last four decades and explore the relationship between consumers' survey data and house prices growth. Section 3 describes the model. Section 4 investigates the occurrence of boom-bust cycles in the housing market as a consequence of expectations regarding future macroeconomic developments driven by news shocks. Section 5 shows the effect of current and expected credit conditions for boom-bust cycles and Section 6 investigates the role of credit conditions for macroeconomic fluctuations. Section 7 concludes.

## 2 Stylized Facts about Housing Dynamics

### 2.1 Housing Boom-Bust Episodes

Over the period 1965:1 to 2009:2 real house prices in the United States display a number of boom-bust episodes, namely periods of faster-than-trend growth followed by sharp reversals. See Figure 1. We define a peak as the centered maximum in real house prices in a twenty-one-quarter window.<sup>2</sup> Using this definition we identify four boom-bust episodes that peaked in 1973:3; 1979:4; 1989:2; 2006:2.<sup>3</sup> Interestingly, real house prices peaks are always followed by macroeconomic recessions. Every housing peak as defined above has been followed by an economic downturn. Even the housing price high of 1969:4, which does not qualify as a peak according to our definition because real house

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<sup>2</sup>A more stringent definition would require the peak to be the high of a longer centered window. For example, if we require the window to be twenty-five quarters, as in Ahearne et al. (2005), the 1973:3 high in real house prices would fail to be a peak. In general, upward trending house prices make it difficult to identify peaks in long, centered windows because prices do not fall all the way to the levels they had at the beginning of the boom. On the other hand, a shorter centered window of seventeen quarters would deliver an additional peak in 1969:4.

<sup>3</sup>Our definition of peak is robust to de-trending, either with a linear trend or with an Hodrick-Prescott filter. Using the H-P filter and the twenty-one quarters definition of window would deliver two additional peaks in 1994:1 and 1999:2, the same peaks in 1973:3, 1979:4 and 1989:2, and it would put the most recent peak in 2007:1.

prices rebounded too quickly, was followed by a recession.

Figure 2 illustrates the behavior of a set of key macroeconomic variables in the most recent boom-bust episode.<sup>4</sup> Real GDP, real private consumption, real private residential and non-residential investment co-move with real house prices. Real households' loans grow during the boom phase and peak several quarters after the peak in house prices. The peak in real house prices occurs roughly at the trough of real wages in both sectors. In particular, it appears that nominal wages have not fallen at all in the construction sector and have fallen very little in the consumption-good sector since the beginning of the recession. It is worth mentioning that similar dynamics are found in all other peaks, only exception is the behavior of the real wages.<sup>5</sup> In fact, differently from the latest boom-bust episode, on average real wages rise during the booms in house prices and fall during the busts. Figure 3 shows that the average behavior of all series display significant co-movement with house prices around the four boom-busts in house prices.

Next we transform our variables in deviation from the Hodrick-Prescott filter and then calculate the average over the four housing-peak episodes. This allows us to see if housing boom-bust episodes are accompanied by below- or above-trend behavior of some variables. Figure 4 shows the data. In particular, real house prices, real GDP, private consumption and investment, both residential and non-residential, and real loans fall below trend at the end of the bust phase.

## 2.2 Survey Data and House Market Dynamics

The previous section presented unconditional, ex-post evidence that housing boom-bust episodes are characterized by bell-shaped co-movement among aggregate variables. This section provides some suggestive evidence on the importance of news for housing market dynamics. We rely on survey data from the University of Michigan Survey of Consumers, which provides assessments of consumer attitudes and expectations. We focus on two questions: a) News Heard of Recent Changes in Business Conditions; b) Buying Conditions for Houses.

The index of News Heard of Recent Changes in Business Conditions (News on Business Conditions henceforth) reports the fraction of respondents who heard favorable news minus the fraction of respondents who heard negative news of recent changes in business conditions. Appendix A reports the exact question wording for this variable.<sup>6</sup>

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<sup>4</sup>All variables are log-transformed, real, per capita with base in 1965:1. Appendix A describes the data in detail.

<sup>5</sup>Further differences among peak episodes are discussed in Appendix B.

<sup>6</sup>The index of News on Business Conditions is a leading indicator of GDP growth, with highest correlation one- and two-quarter ahead of real GDP growth. Let Index = News on Business Conditions; GDP = real per capita GDP,

As for Buying Conditions for Houses, the survey reports the consumers' opinion as to whether it is a good time or a bad time to buy a house and their reasons for holding a particular view. The possible reasons for opinions about good or bad buying conditions for houses can be summarized in the following categories: low house prices, higher future house prices, low current interest rates, tighter future borrowing conditions. The variable reports the fraction of respondents citing that specific reason – see Appendix A for details. We construct four variables using this data. The first variable is *Good Time to Buy-Prices Low*, which we calculate as the difference between Good time to buy (house prices are low) and Bad time to buy (house prices are high); the second variable is *Good time to Buy-Prices Rising*, which is equal to Good time to buy (house prices won't come down; are going higher); the third variable is *Good time to Buy-Future Tighter Credit*, which is equal to Good time to buy (borrow-in-advance of rising interest rates); and the last variable is *Good time to Buy-Credit Easy*, which is calculated as the difference between Good time to buy (interest rates are low; credit is easy) and Bad time to buy (interest rates are high; credit is tight).<sup>7</sup>

First, we analyze the correlation between the index of News on Business Conditions and the four variables reporting good buying conditions in the housing market. Table 1 shows that News on Business Conditions is positively and significantly correlated with Good Time to Buy because of current low interest rates or because consumers expect housing prices to increase or credit conditions to tighten in the future. During the latest boom episode these correlations become even higher. Interestingly, News on Business Conditions is negatively correlated with Good Time to Buy because housing prices are low and this correlation is very strong during the last boom episode. To assess causality, we run a Granger causality test, whose results are reported in Table 2. The index of News on Business Conditions contains statistical significant information for consumers' perception of Good Time to Buy both when the opinion is driven by perceptions on the current state of the economy related to low housing prices and easy credit and when the opinion is based on expectations of tighter future credit or of future house prices appreciation. Hence, News on Business Conditions Granger cause consumers' perception that is it is a Good Time to Buy a house.

log-transformed; and  $\Delta(\text{GDP},4) = \text{GDP} - \text{GDP}(-4)$ .

	Correlation ( $\Delta(\text{GDP},4)_{t=0}$ , $\text{Index}_{t+i}$ )								
i	-4	-3	-2	-1	0	1	2	3	4
$\text{Index}_{t+i}$	0.4715	0.6329	0.7372	0.7595	0.6777	0.4811	0.2744	0.0953	-0.0316

<sup>7</sup>Consumers appear to assess home buying conditions quite well. In fact, changes in home buying attitudes precede changes in unit sales of new and existing single family homes on average by two quarters with a correlation of 0.77.

Table 3 shows that the correlation of News on Business Conditions with house price growth is high and significant over the full sample and typically higher during house price boom episodes. Moreover, News on Business Conditions contains statistical significant information for house price growth. In fact, the hypothesis that News on Business Conditions does not Granger cause house price growth can be rejected at the one per cent significance level. On the contrary, house price growth do not contain significant information to explain the fact that consumers heard news of changes in business conditions. See Table 4.

Last, we estimate a house price growth regression using GMM.<sup>8</sup> The growth rate of house prices  $q_t$  is the log change in real house prices (QQ); the short-term real interest rate (RRQ) is the difference between the 3-month Treasury Bill Rate and the quarter-on-quarter change in the GDP deflator. We use real per capita GDP (GDP) as a proxy for economic conditions. Population (POP) is measured by Civilian Non-institutional Population. All variables are in log differences – see Appendix B for details. In addition to the standard determinants of house prices documented in the literature, we include the index of News on Business Conditions (*NEWS*). We use up to four lags of the real interest rate, real per capita GDP and population. The estimated equation is reported in Table 5. The regression also includes an intercept term. Overall, the estimates are in line with previous findings. The sensitivity of house price growth to News on Business Conditions is positive and significant, which suggests a significant impact of news on housing price dynamics. The estimate of the coefficient on the real interest rate is negative whereas the coefficient on GDP and population growth are positive. Interestingly, adding News on Business Conditions reduces the significance of both the real interest rate and GDP growth.

We also test for the importance of consumers’ optimism by adding the Index of Consumers’ Sentiment (*ICS*) to the benchmark house price equation. The index is a weighted average of survey questions on current economic conditions and expectations on both consumers’ financial situation and business and financial conditions for the country as a whole. We find that consumers’ economic optimism positively influences house price growth. Further, we estimate the significance of the alternative reasons for consumers’ to believe that it is a good time to buy a house. The estimates reported in the last four rows of Table 5 show that consumers’ opinion driven by a positive perception of the current state of the economy is either negligible, as for the perception of easy credit, or negative, as for the perception of low house prices. In contrast, consumers’ belief based on expectations of rising house prices or tighter future credit conditions are significantly and

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<sup>8</sup>For the baseline specification see among others, Del Negro and Otrok (2007) and Favara and Imbs (2010).

positively related to house price growth. Interpreting the estimated coefficients as elasticities we find a sensitivity of house price growth of about 0.1 and 0.08 per cent to consumers' beliefs of rising prices and of future tighter credit conditions, respectively.

Summarizing, both consumers' assessments of buying conditions for houses and housing prices are explained by past values of news on business conditions. Moreover, news on business conditions, expectations of future macroeconomic developments and economic optimism, are significantly related to house price growth.

### 3 The Model

Several are the papers that carry out a quantitative analysis of house market dynamics.<sup>9</sup> However, only few aim at explaining business cycle fluctuations in both house prices and investment. Among those, Davis and Heathcote (2005) use a calibrated multi-sector model that relies on technology shocks to match the co-movement between consumption, non-residential investment, residential investment and GDP; Iacoviello and Neri (2010) allowing for financing frictions, a role for monetary policy and a larger set of shocks also match the positive correlation between housing prices and investment and the wealth effect of housing prices; Int'Veld, Raciborski, Ratto and Roeger (2011) build an open-economy model of the housing market also featuring a banking sector to explore the international repercussions of housing market dynamics.

We adopt the model of the housing market developed by Iacoviello and Neri (2010) since their framework is rich enough to allow us to investigate the transmission mechanism of news related to not only to the housing market and the production sector, but also to the credit market and the conduct of monetary policy. In the following, we report the main features of the model. The model's parameters are set equal to the mean of the posterior distribution estimated by Iacoviello and Neri (2010) for the U.S. economy. See Table 6.

#### 3.1 Households

The economy is populated by two types of households: the Saver and the Borrower. They both work in the good- and housing-sector of production, consume and accumulate housing. They differ in their discount factors, ( $\beta$  and  $\beta'$ ). Borrowers (denoted by  $\iota$ ) feature a relatively lower subjective

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<sup>9</sup>See, among others, Kiyotaki, Michaelides, and Nikolov (2010), Kahn (2009), Rios-Rull and Sanchez Marcos (2006), Piazzesi, Schneider and Tuzel (2007), Silos (2007).

discount factor that in equilibrium generates an incentive to anticipate future consumption to the current period through borrowing. Hence, the ex-ante heterogeneity induces credit flows between the two types of agents. This modeling feature has been introduced in macro models by Kiyotaki and Moore (1997) and extended by Iacoviello (2005) to a business cycle framework with housing investment.

The Saver maximizes the utility function with respect to :

$$U_t = E_t \sum_{t=0}^{\infty} (\beta G_C)^t \left[ \Gamma_c \ln (c_t - \varepsilon c_{t-1}) + j_t \ln h_t - \frac{\tau}{1+\eta} (n_{c,t}^{1+\xi} + n_{h,t}^{1+\xi})^{\frac{1+\eta}{1+\xi}} \right]$$

subject to:

$$c_t + q_t \left( h_t - (1 - \delta_h) h_{t-1} \right) + \left[ \frac{k_{c,t}}{A_{k,t}} - \left( \frac{1 - \delta_k}{A_{k,t}} + R_{c,t} z_{c,t} \right) k_{ct-1} \right] + \phi_{c,t} + [k_{h,t} (1 - \delta_k + R_{h,t} z_{h,t}) k_{ht-1}] + \phi_{h,t} + k_{b,t} + p_{l,t} l_t - b_t + \frac{R_{t-1} b_{t-1}}{\pi_t} \leq \frac{w_{c,t} n_{c,t}}{X_{wc,t}} + \frac{w_{h,t} n_{h,t}}{X_{wh,t}} + p_{b,t} k_{b,t} + (p_{l,t} + R_{l,t}) l_{t-1} + D_t$$

where  $c$ ,  $h$ ,  $n_c$  and  $n_h$  are consumption, housing services, hours worked in the good-sector and in the construction-sector, respectively. The parameter  $\xi$  defines the degree of substitution between the two sectors in terms of hours worked,<sup>10</sup> while  $\eta$  is the inverse of Frisch elasticity of labor supply.  $j_t$  determines the relative weight in utility of housing services,  $R_t$  is the lending interest rate,  $\delta_c$  and  $\delta_h$  represent the depreciation rate for capital and housing stock, respectively.  $l_t$  is the land priced at  $p_{l,t}$  and  $q_t$  is the price of the houses, all relative to the CPI.  $z_{c,t}$  and  $z_{h,t}$  are the capital utilization rates of transforming potential capital into effective capital in the two sectors.  $D_t$  are lump-sum profits paid to households. The term  $A_{k,t}$  is an investment-specific technology that captures the marginal cost of producing consumption-good-sector specific capital.<sup>11</sup>  $G_C$ ,  $G_{IK_c}$  and  $G_{IK_h}$  are the trend growth rates of real consumption and capital used in the two sectors of production.  $\Gamma_c$  and  $\Gamma'_c$  represent scaling factors of the marginal utilities of consumption. Wages are set in a monopolistic way and can be adjusted subject to a Calvo scheme with probability  $1 - \theta_w$  every period.  $X_{wc,t}$

<sup>10</sup>For a value of  $\xi$  close to zero, hours worked in the two sectors are close to perfect substitutes, which means that the worker would devote most of the time to the sector that pays the highest wage. Positive values of  $\xi$  imply, instead, that hours worked are far from perfect substitutes, thus the worker is less willing to diversify her working hours across sectors even in the presence of a wage differential (see Horvath (2000) for details)

<sup>11</sup> $\phi_{c,t} = \frac{\phi_{kc}}{2G_{IK_c}} \left( \frac{k_{c,t}}{k_{c,t-1}} - G_{IK_c} \right)^2 \frac{k_{c,t-1}}{(1+\gamma_{AK})^t}$  is the good-sector capital adjustment cost, and  $\phi_{h,t} = \frac{\phi_{kh}}{2G_{IK_h}} \left( \frac{k_{h,t}}{k_{h,t-1}} - G_{IK_h} \right)^2 k_{h,t-1}$  is the housing-sector capital adjustment cost;  $\gamma_{AK}$  represents the net growth rate of technology in business capital,  $\phi_{kc}$  and  $\phi_{kh}$  indicate the coefficients for adjustment cost (i.e., the relative prices of installing the existing capital) for capital used in the consumption sector and housing sector respectively.

and  $X_{wh,t}$  are markups on the wages paid in the two sectors. Both households set wages in a monopolistic way.

The Borrower maximizes the utility function:

$$U_t = E_t \sum_{t=0}^{\infty} (\beta' G_C)^t \left[ \Gamma'_c \ln (c'_t - \varepsilon' c'_{t-1}) + j_t \ln h'_t - \frac{\tau}{1 + \eta'} ((n'_{c,t})^{1+\xi'} + (n'_{h,t})^{1+\xi'})^{\frac{1+\eta'}{1+\xi'}} \right]$$

subject to:

$$c'_t + q_t \left[ h'_t - (1 - \delta_h) h'_{t-1} \right] - b'_t \leq \frac{w'_{c,t} n'_{c,t}}{X'_{wc,t}} + \frac{w'_{h,t} n'_{h,t}}{X'_{wh,t}} + D'_t - \frac{R_{t-1} b'_{t-1}}{\pi_t}$$

and

$$b'_t \leq m_t E_t \left( \frac{q_{t+1} h'_t \pi_{t+1}}{R_t} \right)$$

$\beta' \in (0, \beta)$  captures the Borrower's relative impatience.

Limits on borrowing are introduced through the assumption that households cannot borrow more than a fraction of the next-period value of the housing stock. The fraction  $m$ , referred to as the equity requirement or loan-to-value ratio, should not exceed one and is treated as exogenous to the model. It can be interpreted as the creditor's overall judicial costs in case of debtor default and represents the degree of credit frictions in the economy. The borrowing constraint is consistent with standard lending criteria used in the mortgage and consumer loan markets. We explore the effects of temporary deviations from the established degree of credit market access by assuming that  $m_t$  is stochastic. We refer to this as a loan-to-value ratio shock.

### 3.2 Firms

Firms producing non-durable goods (Y) and new houses (IH) face Cobb-Douglas production functions. The non-housing sector produces consumption goods using capital,  $k_c$ , and labor supplied by the Savers,  $n$ , and the Borrowers,  $n'$ ,

$$Y_t = \left( A_{c,t} \left( n_{c,t}^\alpha n'^{1-\alpha}_{c,t} \right) \right)^{1-\mu_c} (z_{c,t} k_{c,t-1})^{\mu_c}.$$

The housing sector also uses an intermediate input,  $k_b$ , and land,  $l$ , as inputs of production

$$IH_t = \left( A_{h,t} \left( n_{h,t}^\alpha + n'^{1-\alpha}_{h,t} \right) \right)^{1-\mu_h-\mu_b-\mu_l} (z_{h,t} k_{h,t-1})^{\mu_h} k_b^{\mu_b} l^{\mu_l}.$$

$A_{h,t}$  and  $A_{c,t}$  are the productivity shocks to the housing- and good-sector, respectively. Firms pay the wages to households and repay back the rented capital to the Savers.

The investment-specific technology is specified in the following way

$$IK_t = \frac{1}{A_{k,t}} (k_{c,t} - (1 - \delta_{k_c}) k_{c,t-1}),$$

where  $A_{k,t}$  is an investment-specific shock.

Retailers operate in a monopolistically competitive market and are owned by the Savers. Prices can be adjusted by each producer with probability  $1 - \theta_\pi$  every period, following a Calvo-setting. Monopolistic competition occurs at the retail level, leading to the following forward-looking Philips curve:

$$\ln \pi_t - \iota_\pi \ln \pi_{t-1} = \beta G_C \left( E_t \ln \pi_{t+1} - \iota_\pi \ln \pi_t \right) - \epsilon_\pi \ln(X_t/X) + u_{p,t}$$

where  $\epsilon_\pi = \frac{(1-\theta_\pi)(1-\beta\theta_\pi)}{\theta_\pi}$ ,  $X_t$  represents the price markup and  $u_{p,t}$  is a cost-push shock. In contrast, housing prices are assumed to be flexible.

### 3.3 Monetary Policy Rule

We assume that the central bank follows a Taylor-type rule as estimated by Iacoviello and Neri (2010):

$$R_t = R_{t-1}^{rr} \pi_t^{(1-rr)r_\pi} \left( \frac{GDP_t}{G_C GDP_{t-1}} \right)^{(1-rr)r_Y} rr^{(1-rr)} \frac{u_{R,t}}{A_{s,t}}, \quad (1)$$

where  $rr$  is the steady-state real interest rate and  $u_{R,t}$  is a monetary policy shock. The central bank's target is assumed to be time varying and subject to a persistent shock,  $s_t$ , as in Smets and Wouters (2003). Following Iacoviello and Neri (2010), GDP is defined as the sum of consumption and investment at constant prices. Thus

$$GDP_t = C_t + IK_t + qIH_t,$$

where  $q$  is real housing prices along the balanced growth path.

### 3.4 News Shocks

The model assumes heterogeneous deterministic trends in productivity in the consumption ( $A_{c,t}$ ), investment ( $A_{k,t}$ ), and housing sector ( $A_{h,t}$ ), such that

$$\ln(A_{z,t}) = t \ln(1 + \gamma_{Az}) + \ln(Z_{z,t}),$$

where  $\gamma_{Az}$  are the net growth rates of technology in each sector,

$$\ln(Z_{z,t}) = \rho_{Az} \ln(Z_{z,t-1}) + u_{z,t}.$$

$u_{z,t}$  is the innovation and  $z = \{c, k, h\}$ . The inflation target ( $A_{s,t}$ ) and loan-to-value ratio ( $m$ ) shocks are assumed to follow an  $AR(1)$  process. The cost-push shock ( $u_{p,t}$ ) and the shock to the policy rule ( $u_{R,t}$ ) are assumed to be *i.i.d.* We set the persistence and standard deviation of the shocks as in Iacoviello and Neri (2010). To introduce expectations of future macroeconomic developments, we follow Christiano et al. (2008) in assuming that the error term of each shock consists of an unanticipated component,  $\varepsilon_{z,t}$ , and an anticipated change  $n$  quarters in advance,  $\varepsilon_{z,t-n}$ ,

$$u_{z,t} = \varepsilon_{z,t} + \varepsilon_{z,t-n},$$

where  $\varepsilon_{z,t}$  is *i.i.d.* and  $z = \{h, c, R, s, p, j, k, m\}$ . Thus, at time  $t$  agents receive a signal about future macroeconomic conditions at time  $t + n$ . If the expected movement doesn't occur, then  $\varepsilon_{z,t} = -\varepsilon_{z,t-n}$  and  $u_{z,t} = 0$ .

## 4 News Shocks and Boom-Bust Dynamics

In this section we identify which types of news shocks can generate empirically plausible boom-bust cycles. Section 2.2 documented that survey data on news heard of recent changes in business conditions are significantly related to both house prices and consumers' opinion of favorable house market buying conditions. Further, news on business conditions, along with consumers' expectations of rising house prices and economic optimism, affects house price growth. Agents endogenous expectations could be related to both current or expected macroeconomic developments. Thus, unanticipated and news shocks are both potential sources of agents expectations on economic conditions and house prices. However, business cycle models that feature only standard unanticipated shocks as sources of fluctuations, cannot reproduce the hump-shaped dynamics shown in the data during periods of boom-bust in the housing market. In fact, standard unanticipated shocks generate the strongest responses in the short run and eventually die away. Moreover, in the current framework, macroeconomic developments lead by unanticipated shocks also fail in generating the observed co-movement of housing prices with hours worked, investment and GDP. See Appendix C.

### 4.1 News on Productivity

Changes in agents' expectations about future technological growth seems to be an important source of business cycle fluctuations. Beaudry and Portier (2006) show that business cycle fluctuations

in the data are primarily driven by changes in agents' expectations about future technological growth. In fact, they first documented that stock prices movements anticipate future growth in total factor productivity and that such dynamics are accompanied by a macroeconomic boom. Since Beaudry and Portier (2006) several authors have highlighted the importance of expectations-driven cycles as a source of business cycle fluctuations.<sup>12</sup> According to Christiano, Ilut, Motto, and Rostagno (2008), stock-market boom-bust cycles can be generated by changes in expectations of future productivity shocks. In particular, they show that a standard one-sector real business cycle model with habit persistence and costs of adjusting the flow of investment generates a boom-bust pattern in output, consumption, investment and hours in response to news on productivity shocks that do not materialize. The price of capital, however, is negatively correlated with all other aggregate variables and therefore it falls and then increases. The introduction of an inflation targeting central bank and sticky nominal wages make the price of capital co-move with the other aggregate variables and boom-bust dynamics emerge.<sup>13</sup>

We show that news on future productivity shocks generate macroeconomic booms also in a model of the housing market that features collateralized household debt, standard preferences and production functions, and nominal rigidities. Figure 5 reports the effect of an anticipated increase in productivity, namely a four-period ahead expected shock to  $A_{c,t}$  (starred line). It also illustrates the case in which news of a future shock to  $A_{c,t}$  turn out to be wrong and at time  $t = 4$  there is no change in productivity (solid line). The anticipation of future higher productivity leads households to increase their current consumption expenditure. Demand pressures rise current

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<sup>12</sup>The empirical literature on news shocks is growing rapidly. Among others, Schmitt-Grohe and Uribe (2008) show that innovations in expectations of future neutral productivity shocks, investment-specific shocks, and government spending shocks account for more than two thirds of predicted aggregate fluctuations in postwar United States; Kurmann and Otrok (2010) document that new shocks about future productivity significantly contribute to explain swings in the slope of the term structure; Milani and Treadwell (2010) looking at expectations on the policy rate, shows that anticipated policy shocks play a larger role in the business cycle than unanticipated shocks.

<sup>13</sup>As already shown by Beaudry and Portier (2004, 2007), a standard one-sector optimal growth model is unable to generate boom-bust cycles in response to news. To generate co-movement, Jaimovich and Rebelo (2009) introduce three elements in an otherwise standard neoclassical growth model: Variable capital utilization; adjustment costs to investment; and a weak short-run wealth elasticity of labor supply. Other papers have focused on different mechanisms. Den Haan and Kaltenbrunner (2007) consider a labor market matching mechanism; Floden (2007) incorporates variable capital utilization and vintage capital; Kobayashi, Nakajima and Inaba (2007) and Walentin (2009) show that expectations-driven cycles can arise in models with credit constraints on firms; Nutahara (2010) prove that internal habits can help to generate co-movement in response to news on future productivity.

inflation. Expected future higher productivity also creates endogenous expectations of rising house price that further induce Borrowers to increase their current demand for housing and thus credit. Due to limits to credit, Borrowers increase their labor supply in order to raise internal funds for housing investments. Savers' position in the housing market depends only on housing prices: when housing prices are above equilibrium, Savers housing demand declines.

Given the adjustment costs of capital, firms in the consumption sector start adjusting the stock of capital already at the time in which news about a future increase in productivity spread. This way, when the increase in productivity occurs, capital is already in place. For the increase in investment to be coupled with an increase in hours, wages rise in both sectors. The increase in business and housing investment makes GDP rise. In the case of an anticipated shock that realizes, aggregate variables boom and then slowly decline (starred line). The peak response in output corresponds to the time in which expectations realize. In contrast, if expectations do not realize there is a dramatic drop in both quantities and prices. See Appendix D for robustness analysis to different parameter values and Appendix E for the contribution of the different modeling choices.<sup>14</sup>

## 4.2 Other News Shocks

Since boom-bust cycles in the housing market can be plausibly related to expectations of future developments in different sectors of the economy we introduce changes in expectations on several other shocks.<sup>15</sup> In particular, we explore the role of news on housing market shocks, investment-

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<sup>14</sup>As in Christiano, Ilut, Motto, and Rostagno (2008) we show that price and wage stickiness have an important role for expectations on future productivity to generate co-movement between house prices and consumption, investment and hours worked. However, contrary to them, we obtain boom-bust dynamics in all aggregate variables and real wages. In our model house prices co-move with the other aggregate variables independently of whether wages are stickier than prices or vice versa. Intuitively, the increase in housing demand and therefore housing prices in response to news allows for an increase in both real wages and hours in the housing sector that spills over the consumption sector. The empirical evidence in Figure 4 seems to suggest that real wages are *not* below trend before a peak in house prices and that they increase throughout the boom phase. Notice also that the asset-price peak in the first quarter of the year 2000-2001 to which Christiano et al. (2008) refer to was preceded by a rapid increase in real wages both in the consumption-good and in the housing sector – see Figure 11 in the Appendix. In their model, the increase in hours is possible because the real wage falls, hence producers are willing to raise labor demand. Since nominal wages are sticky, a decrease in real wages occurs because prices fall faster than wages. The inflation-targeting central bank responds to this fall in inflation by cutting the nominal interest rate, which in turn raises investment and the price of capital.

<sup>15</sup>Duca, Muelbauer and Murphy (2010) highlights that large swings in housing construction have had major macroeconomic effects in Ireland, Spain, and the US. Bjørnland and Jacobsen (2010) found that unexpected changes in in-

specific shocks, inflationary and monetary policy shocks. See Figure 6. We find that expectations of future housing demand shocks cannot generate the right co-movement between business and housing investment. Due to an expected shift in preference for housing relative to consumption, firms in the consumption sector reduce their stock of capital. As a result, business investment falls. Because of the reduction in business investment during the boom phase, housing demand news shocks fail to generate boom-bust dynamics consistent with the data. See Figure 6 (starred line). In the data business investment starts increasing on average six periods before the peak in housing prices. Expectations related to future housing demand make business investment decline throughout the boom phase. The behavior of business investment is independent of the time horizon of the expected increase in housing demand. Anticipated increase in housing demand at longer time horizons only postpone the occurrence of the peak. The decline in business investment is also robust to different parametrization of key model's parameters. See Appendix F. In contrast, investment-specific news shocks and news on productivity shocks in the housing sector can generate boom-bust cycles characterized by co-movement in GDP, consumption, investment, hours and wages. See Figures 6 left panel.

Expectations of future expansionary monetary policy shocks that are not met are likely to cause an housing market boom and also a subsequent macroeconomic recession. See Figure 6 right panel (dashed line). It takes about ten quarters for GDP to go back to the initial level. Thus, good communication on monetary policy is essential for reducing the occurrence of expectations-driven cycles and recessions.<sup>16</sup> Qualitatively similar is the transmission of news on the central bank's inflation target and the cost push shock. However, compared to the case of expectations of future expansionary monetary policy shocks, expectations of a temporary upward shift in the inflation target generate a less sizable boom but a more pronounced bust. In contrast, inflationary news shocks lead to a more sizable boom but a milder bust. See Appendix F for further details.

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terest rates have an immediate effect on house prices in most countries. They found that monetary policy contributes significantly to house price fluctuations, and that house price innovations are, in turn, important for variability in macro variables.

<sup>16</sup>If agents expect the policy rate to remain low for several periods the effect on housing prices and on all other aggregate variables are stronger and the initial boom and the subsequent recession are more pronounced relative to the case where the expected reduction in the policy rate is only for one period.

## 5 Expected Credit Conditions and Housing Booms

An often-heard explanation for the last housing boom is the easing in credit conditions. Among others, Liebovitz (2011) finds that the most important factor related to foreclosures in the United States is the extent of negative equity in a home, which is directly related to low down payments. Indeed, in the years before the housing boom, mortgage credit in the US became more easily available to new home buyers. Piazzesi and Schneider (2009) looking at survey data, report that good credit conditions was the main driver of the last boom in its initial phase. Survey data reported in the previous section also show that expectations of future tighter credit are an important reason for consumers to believe that is a good time to buy a house and are significantly related to house price growth.

In the following we analyze the effect of favorable conditions in the credit market that are expected to be reversed in the near future. We consider a one percentage point increase to the established loan-to-value ratio,  $m$ , coupled with expectations of future restrictions in the access to credit.<sup>17</sup> Figure 7 displays the case in which agents expect  $m$  to return to its original value after four quarters. For simplicity we analyze only the case in which expectations of a reversal in credit conditions are matched. Unmatched expectations would generate a more sizable bust.

Due to an exogenous rise in  $m$ , borrower's debt and therefore consumption and housing demand increase. This leads to a rise in aggregate consumption, investment and GDP. Demand pressures make housing prices rise. Lower expected access to credit in the future induce Borrowers to increase their current demand for loans and housing further more. Borrowers also substitute consumption for housing and supply more labor to take advantage of temporarily better access to credit. In contrast, Savers' consumption and business investment increase because of higher interest income and expected future lower real interest rates. Hours worked increase substantially in both sectors and real wages fall slightly. Interestingly, the dynamics of real wages is consistent with the empirical evidence on the housing peak of 2006:2.

It is important to notice that, in the absence of expectations of future reversal in credit conditions, the model's responses would not display the hump-shaped dynamics that typically emerge in boom-bust cycles. A current increase in  $m$  would lead to an initial increase in house prices, investment, consumption and GDP and a slow monotone decline towards the initial level.<sup>18</sup> In

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<sup>17</sup>To illustrate the effect of changes in the access to credit, we assume that  $m$  follows an AR(1) process with persistence equal to 0.994, as estimated by Iacoviello and Neri (2010) Appendix D.

<sup>18</sup>See Appendix F.

contrast, a current increase in  $m$  coupled with expectations of future restrictions in the access to credit generates more pronounced and hump-shaped dynamics.

## 6 Boom-Bust Cycles and the LTV Ratio

The previous section showed that an easing of credit conditions coupled with expectations of future tightening in credit conditions can *per se* drive housing booms. Here we investigate the role of the LTV ratio for the transmission of expectations-driven cycles in our model generated by news on shocks originated in other sectors of the economy.

Although LTV ratios for new mortgages vary significantly across OECD countries, they have risen in the last decade.<sup>19</sup> The average LTV ratio for U.S. conventional single-family fixed-rate mortgages increased from 70 percentage points in March 2004 to 80 percentage points in December 2007. In fact mortgages with LTV ratios of 0.7 or less went from 25 to 19 percent of the total while mortgages with LTV ratios above 0.9 increased from 15 to 30 percent of the total over the period 2004 to 2007. The estimated LTV ratios of new mortgages increased by 6 percentage points in the Euro area and 26 percentage points in the United Kingdom over the period 2004 to 2007.<sup>20</sup> Duca, Muellbauer and Murphy (2010) argue that the distinctive feature of the recent US mortgage lending and housing bubble was an unsustainable weakening of credit standards. By presenting some cross-country evidence they show that financial innovation further amplified the consumption effect of the bubble by altering the collateral role of housing.

In the aftermath of the recent financial crisis, several countries have considered reductions in LTV ratios for mortgages to avoid the recurrence of house price and household debt cycles and mitigate potential vulnerabilities in the financial system. The U.S. Federal Housing Finance Agency is considering to increase down payment requirements for all mortgages. The Swedish Financial Supervisory Authority has recently introduced a maximum permitted LTV ratio of 0.85; tighter LTV ratios have also been implemented in Central and Eastern European economies, namely Latvia and Romania.<sup>21</sup>

Do lower LTV ratios reduce the severity of cycles in the housing market? Figures 8 and 9 show

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<sup>19</sup>According to the ECB report on “Housing Finance in the Euro Area,” the typical LTV ratio for a first-time house buyer was around 80 percentage points in the Euro area in 2007, ranging between 63 and 101 percentage points. Similar ratios have been reported by Calza et al.(2010) and Cardarelli et al. (2009).

<sup>20</sup>See Prudential Real Estate Investors (2009).

<sup>21</sup>For further details see the ECB report on “Housing Finance in Euro Area,” 2009. For a discussion of alternative policy tools, see the BIS report on “Macprudential Policy Tools and Frameworks”, 2011.

the cumulated booms and busts for several macroeconomic variables generated by unrealized news on monetary policy and productivity shocks as the LTV ratio varies from zero to one. Lower LTV ratios reduce the severity of both booms and busts in household debt, consumption and GDP. On the other hand, lower LTV ratios slightly amplify the cumulated fluctuations in housing prices, housing and business investment.

In order to understand the effect of the LTV ratio on the aggregate economy, we compare the responses of Borrowers' and Savers' consumption and housing demand to news on monetary policy and productivity shock (not realized) for the benchmark value of the LTV ratio ( $m=0.85$ ), a lower ( $m=0.75$ ) and a higher ( $m=0.95$ ) value. See Figure 10. The LTV ratio plays an important role at the individual level. Higher LTV ratios lead to a more sizable increase in debt, which in turn leads to a more pronounced increase in Borrowers' consumption and above all housing demand, as this allows for a further increase in borrowing. Consider the case of an anticipated expansionary monetary policy shock. Because lower interest rates make borrowing cheaper and relax the credit constraint, Borrowers raise their debt and expand consumption and housing demand. Higher LTV ratios amplify these responses and generate larger cumulated booms for these variables. Moreover, since Borrowers are more leveraged, the fall in Borrowers' consumption and housing expenditure is more sizable when expectations do not materialize. Hence, higher LTV ratios are accompanied by deeper troughs and larger busts in Borrowers' debt, consumption and housing demand. Savers, on the other hand, are consumption smotherers. In response to future lower interest rates they expand current lending and, due to habit persistence, current non-durable consumption. However, Savers' optimal consumption is largely unaffected by alternative LTV ratios. Thus, the higher sensitivity of aggregate consumption and GDP to news shocks for higher values of  $m$  is mainly driven by the Borrowers' optimal consumption and debt decisions. Given the asymmetric response of Borrowers' and Savers' housing decisions to news shocks, the effect of the LTV ratio on the individual responses almost cancels out in aggregate terms. As a result, house prices react by slightly less to news shocks under higher LTV ratios, which in turn generates lower sensitivity of housing investment and business investment (driven in part by the demand for capital in the residential sector). Hence, the heterogeneity in housing demand reduces the impact of the LTV ratio on the transmission of news shocks to house prices and investment. A similar mechanism is at work for the case of a favorable change in expectations about future productivity in the non-durable sector.

In the following we explore the role of lower LTV ratios for macroeconomic volatility. We rely on

the estimated model by Iacoviello and Neri (2010) augmented by a set of news shocks that generate the co-movement seen in the data during periods of housing booms. Table 7 reports the theoretical standard deviation of some key macroeconomic variables in our model for the benchmark value of the LTV ratio ( $m = 0.85$ ) a lower ( $m=0.75$ ) and a higher ( $m=0.95$ ) value. For this exercise we keep the LTV ratio constant at the specified value and set the standard deviation of news shocks equal to the estimated standard deviation of the contemporaneous shocks. A lower LTV ratio significantly reduces the volatility of households' debt, consumption and GDP. The effect is particularly strong for households' debt. Compared to the benchmark LTV ratio of 0.85, its standard deviation is reduced by 30 per cent under a LTV ratio of 0.75. However, the stabilization effect of a lower LTV ratio on these variables is not accompanied by a reduction in the volatility of house prices and investment. These results are robust to considering unanticipated shocks only, news shocks only, or by reducing the standard deviation of news shocks to half the estimated standard deviation of contemporaneous shocks. It is worth mentioning that adding news shocks to the model dampens the reduction in the volatility of consumption, GDP and household debt and further increases the volatility of house prices and investment.

A few papers have investigated the role of collateral requirements for the transmission of unanticipated shocks and macroeconomic volatility. Campbell and Hercowitz (2004) show that lower LTV increase the amplification of productivity shocks and thus imply higher volatility of output, consumption, and hours worked. According to their findings, the U.S. mortgage market liberalization of the early 1990s, proxied by an increase in the LTV ratio, played a role in explaining the great moderation. In contrast, Calza, Monacelli and Stracca (2010) show that the transmission of monetary policy shocks to consumption, investment and house prices is dampened by lower LTV ratio.<sup>22</sup> Using a model with a richer stochastic structure that includes several types of unanticipated and news shocks, we find that overall, lower LTV ratios sizably reduce the volatility of household debt, and also dampen variations in consumption and GDP, however, without mitigating fluctuations in house prices and investment.

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<sup>22</sup>Walentin and Sellin (2010) quantify the effects of higher LTV ratios in an estimated model of the Swedish economy and report an increase of 8.3 and 24 per cent in GDP and aggregate consumption, respectively, for an increase in  $m$  from 0.85 to 0.95.

## 7 Conclusions

We explore the transmission mechanism of news on business conditions as a source of optimism about the housing market and rising house prices. In our model expectations on a variety of shocks can generate housing-market booms in accordance with the empirical findings. However, only expectations monetary policy and inflationary shocks that are not fulfilled can generate macroeconomic recessions.

Regarding the credit market, easier credit conditions that are expected to be reversed in the near future can generate boom-bust dynamics in line with the recent housing market cycle. Moreover, lower LTV ratios reduce the severity of booms and busts in GDP, consumption and households' debt.

A quantitative assessment of the relative importance of each shock in generating boom-bust cycles through estimation requires separate consideration. The role of monetary policy, as well as the analysis of the optimal conduct of monetary policy, is also left to future research.

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Table 1: Correlation between News on Business Conditions and Good Time to Buy

Variables	Full Sample	Boom 2006
Good Time to Buy, Prices Low	-0.2160*** [0.0036]	-0.7649*** [0.0000]
Good Time to Buy, Prices Rising	0.2686*** [0.0003]	0.5830*** [0.0055]
Good Time to Buy, Future Tighter Credit	0.2847*** [0.0001]	0.6298*** [0.0022]
Good Time to Buy, Credit Easy	0.1454** [0.0514]	0.7008*** [0.0004]

\*\*\* 1%, \*\* 5%, \* 10% significance. Full sample: 1965:1 to 2009:4. P-values in parentheses.

Table 2: Granger Causality Tests between News on Business Conditions and Good Time to Buy

Null Hypothesis	F-statistic
News on Business Conditions does not Granger Cause GTB, Prices Low	10.9246*** [0.0000]
GTB, Prices Low does not Granger Cause News on Business Conditions	0.6911 [0.5024]
News on Business Conditions does not Granger Cause GTB, Prices Rising	3.7857*** [0.0246]
GTB, Prices Rising does not Granger Cause News on Business Conditions	0.8791 [0.417]
News on Business Conditions does not Granger Cause GTB, Future Tigher Credit	5.3644*** [0.0055]
GTB, Future Tigher Credit does not Granger Cause News on Business Conditions	0.6210 [0.5386]
News on Business Conditions does not Granger Cause GTB, Credit Easy	4.0961*** [0.0183]
GTB, Credit Easy does not Granger Cause News on Business Conditions	5.5639 [0.0046]

\*\*\* 1%, \*\* 5%, \* 10% significance; 2 lags; sample: 1965:1 to 2009:4. GTB: Good Time to Buy.

Table 3: Correlation between House Price Growth and News on Business Conditions

Full Sample	Boom 1973	Boom 1979	Boom 1989	Boom 2006
0.6857 ***	0.7451 ***	0.6854 ***	0.7268 ***	0.7389 ***
[0.0000]	[0.0001]	[0.0006]	[0.0002]	[0.0001]

\*\*\* 1%, \*\* 5%, \* 10% significance; sample: 1965:1 to 2009:4; P-values in parentheses.

Table 4: Granger Causality Tests between Housing Price and News on Business Conditions

Null Hypothesis	F-statistic
News on Business Conditions does not Granger Cause House Price Growth	19.0776 *** [0.0000]
House Price Growth does not Granger Cause News on Business Conditions	2.66938*** [0.0722]

\*\*\* 1%, \*\* 5%, \* 10% significance; 2 lags; sample: 1965:1 to 2009:4.

Table 5: Housing Price Equation

Regressor	Dependent Variable: $q_t$						
	Coeff.	Coeff.	Coeff.	Coeff.	Coeff.	Coeff.	Coeff.
$GDP_t$	1.32***	0.49**	0.60***	1.15***	0.79***	0.73***	1.22***
	[0.202]	[0.214]	[0.226]	[0.177]	[0.229]	[0.201]	[0.212]
$RRQ_t$	-1.12***	-0.23***	-0.34	-1.06***	-0.81**	0.02	-1.11***
	[0.285]	[0.270]	[0.251]	[0.306]	[0.422]	[0.342]	[0.281]
$POP_t$	-0.06	0.30	2.13***	-3.59**	-5.44**	2.00***	0.90
	[0.643]	[0.620]	[0.759]	[1.816]	[1.770]	[0.575]	[1.510]
$NEWS_t$		0.01***					
		[0.004]					
$ICS_t$			0.03***				
			[0.009]				
Good Time to Buy:							
Prices Low				-0.02**			
				[0.010]			
Prices Rising					0.10***		
					[0.026]		
Future Tigher Credit						0.08**	
						[0.036]	
Credit Easy							0.003
							[0.005]

\*\*\* 1%, \*\* 5%, \* 10% significance. Standard errors in parentheses.

Table 6: Calibrated Parameters

Parameter	Value	Parameter	Value	Parameter	Value
$\beta$	0.9925	$\xi$	0.66	$\rho_s$	0.975
$\beta'$	0.97	$\xi'$	0.97	$\rho_{AC}$	0.95
$j$	0.12	$\phi_{k,c}$	14.25	$\rho_{AH}$	0.997
$\mu_c$	0.35	$\phi_{k,h}$	10.90	$\rho_{AK}$	0.992
$\mu_h$	0.10	$\alpha$	0.79	$\rho_j$	0.96
$\mu_l$	0.10	$r_R$	0.59	$\rho_z$	0.96
$\mu_b$	0.10	$r_\pi$	1.44	$\rho_\tau$	0.92
$\delta_h$	0.01	$r_Y$	0.52	$\sigma_{AC}$	0.0100
$\delta_{kc}$	0.025	$\theta_\pi$	0.83	$\sigma_{AH}$	0.0193
$\delta_{kh}$	0.03	$\iota_\pi$	0.69	$\sigma_{AK}$	0.0104
$X$	1.15	$\theta_{w,c}$	0.79	$\sigma_j$	0.0416
$X_{wc}$	1.15	$\iota_{w,c}$	0.08	$\sigma_R$	0.0034
$X_{wh}$	1.15	$\theta_{w,h}$	0.91	$\sigma_z$	0.0178
$m$	0.85	$\iota_{w,h}$	0.40	$\sigma_\tau$	0.0254
$\varepsilon$	0.32	$\zeta$	0.69	$\sigma_p$	0.0046
$\varepsilon'$	0.58	$\gamma_{AC}$	0.0032	$\sigma_s$	0.0004
$\eta$	0.52	$\gamma_{AH}$	0.0008	$\sigma_{w,c}$	0.1218
$\eta'$	0.51	$\gamma_{AK}$	0.0027	$\sigma_{w,h}$	0.0071

Table 7: Macroeconomic Volatility and LTV ratios

	$m = 0.95$	$m = 0.85$	$m = 0.75$	% Difference (0.95-0.85)	% Difference (0.85-0.75)
Unanticipated Shocks					
Household Debt	0.2447	0.1218	0.0838	-50.238	-31.135
Consumption	0.0182	0.0162	0.0156	-10.945	-3.717
Business Investment	0.0416	0.0418	0.0420	0.427	0.633
Housing Investment	0.0837	0.0845	0.0850	0.897	0.665
GDP	0.0240	0.0227	0.0223	-5.642	-1.569
Housing Prices	0.0218	0.0218	0.0219	0.003	0.537
Unanticipated+News Shocks					
Household Debt	0.2919	0.1614	0.1205	-44.695	-25.369
Consumption	0.0314	0.0289	0.0278	-8.193	-3.594
Business Investment	0.0697	0.0705	0.0713	1.159	1.075
Housing Investment	0.1362	0.1378	0.1388	1.149	0.754
GDP	0.0424	0.0408	0.0403	-3.747	-1.167
Housing Prices	0.0311	0.0315	0.0318	1.160	1.040

Standard Deviations for HP-filtered series.

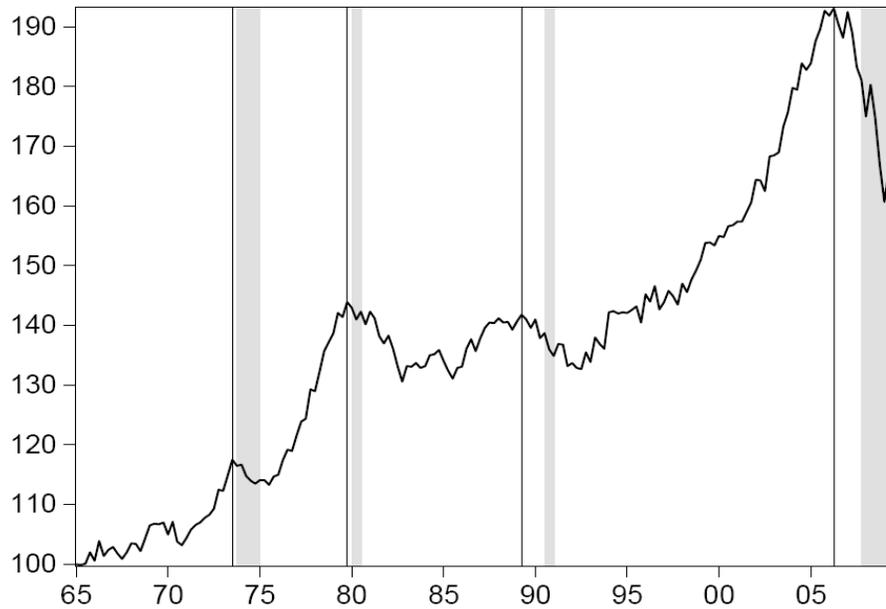


Figure 1: Real House Prices in the United States 1965:1- 2009:2; The gray shaded areas indicate recession dates according to the National Bureau of Economic Research; The vertical line indicates the peaks in real house prices.

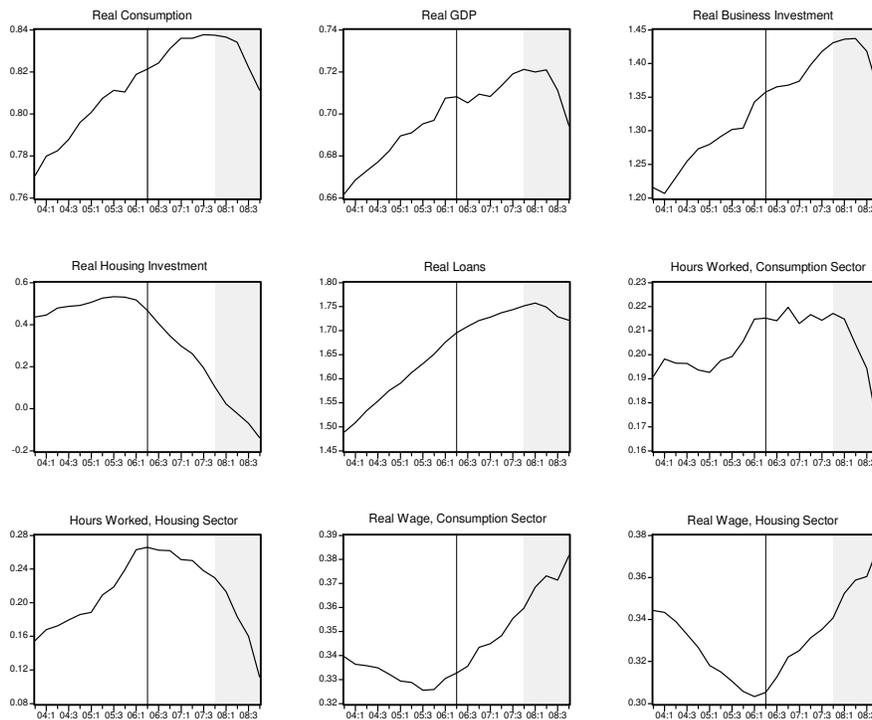


Figure 2: The vertical line indicates the 2006:2 peak in real house prices. The peak is defined as the centered maximum in real house prices in a twenty-one-quarters window, excluding end points.

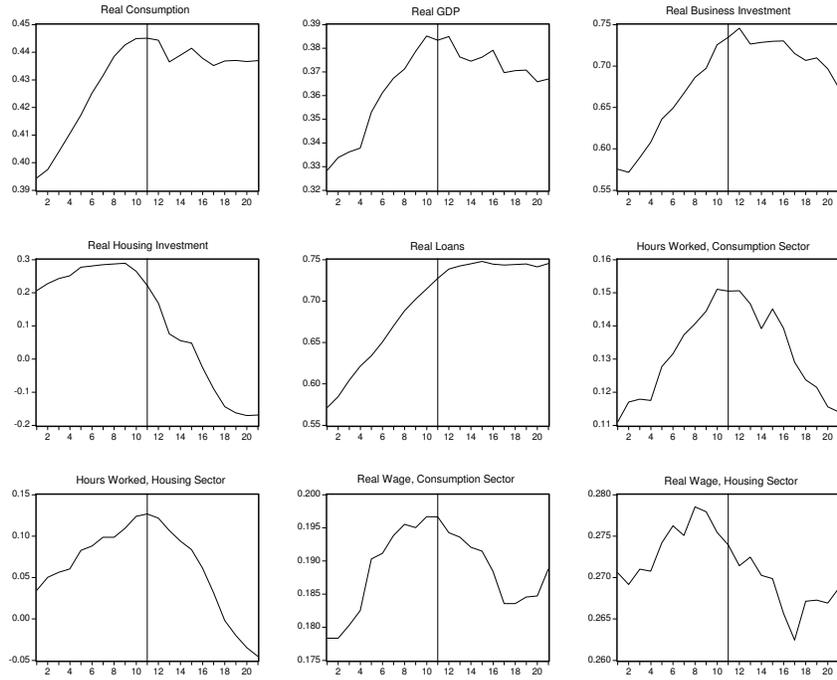


Figure 3: Macroeconomic variables average behaviour during house-price Boom-Bust. The vertical line indicates the peaks in real house prices.

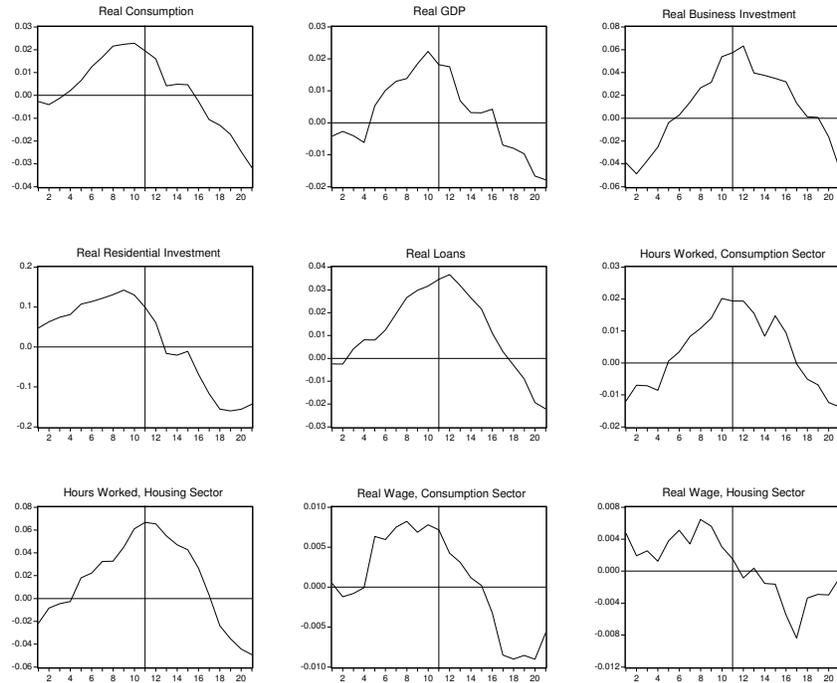


Figure 4: H-P-filtered macroeconomic variables around the house price peaks: average over all boom-bust cycles; The vertical line indicates the peaks in real house prices.

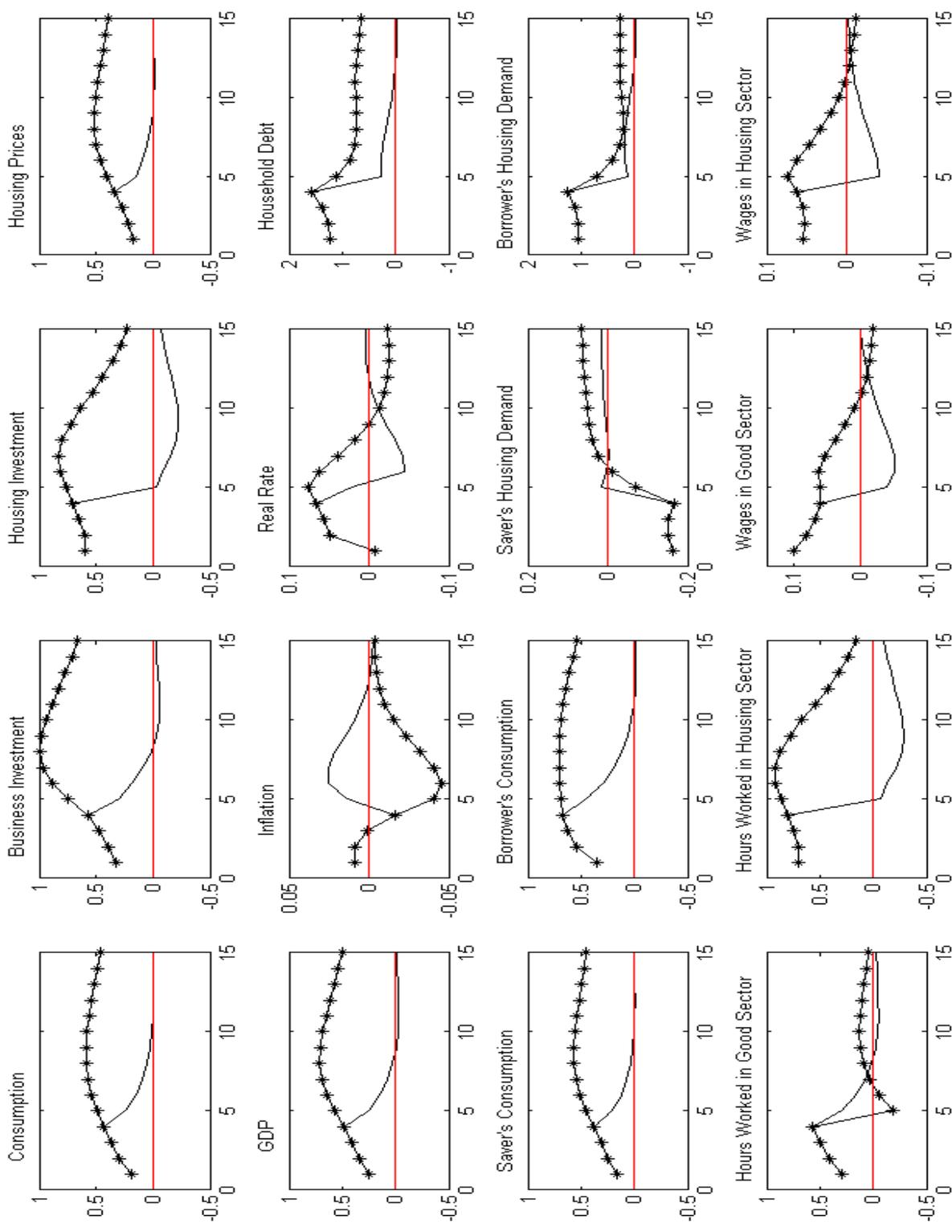


Figure 5: News on Technology Shock: Anticipated Shock (starred line) and Not Realized Shock (solid line)

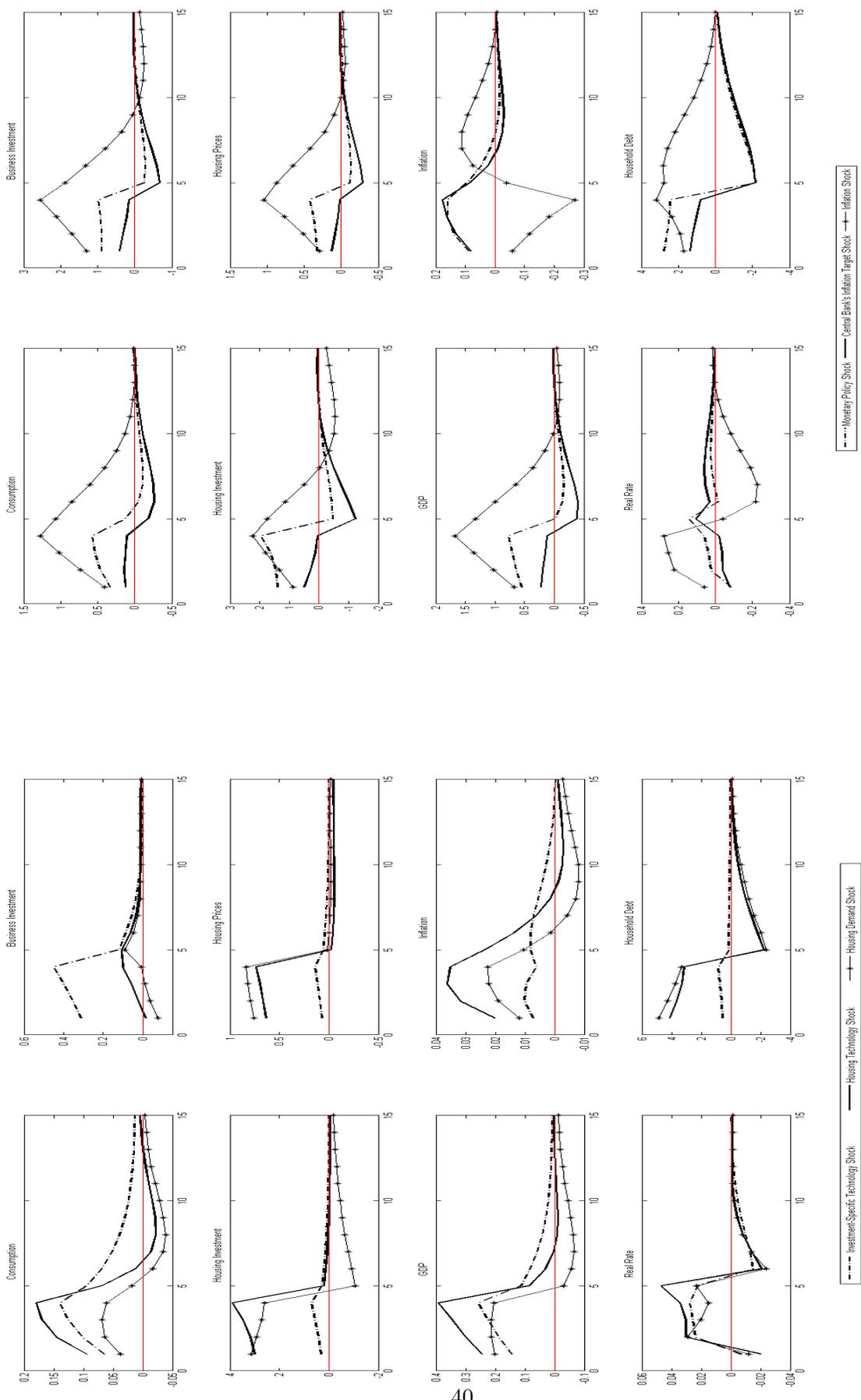


Figure 6: Unrealized News Shocks

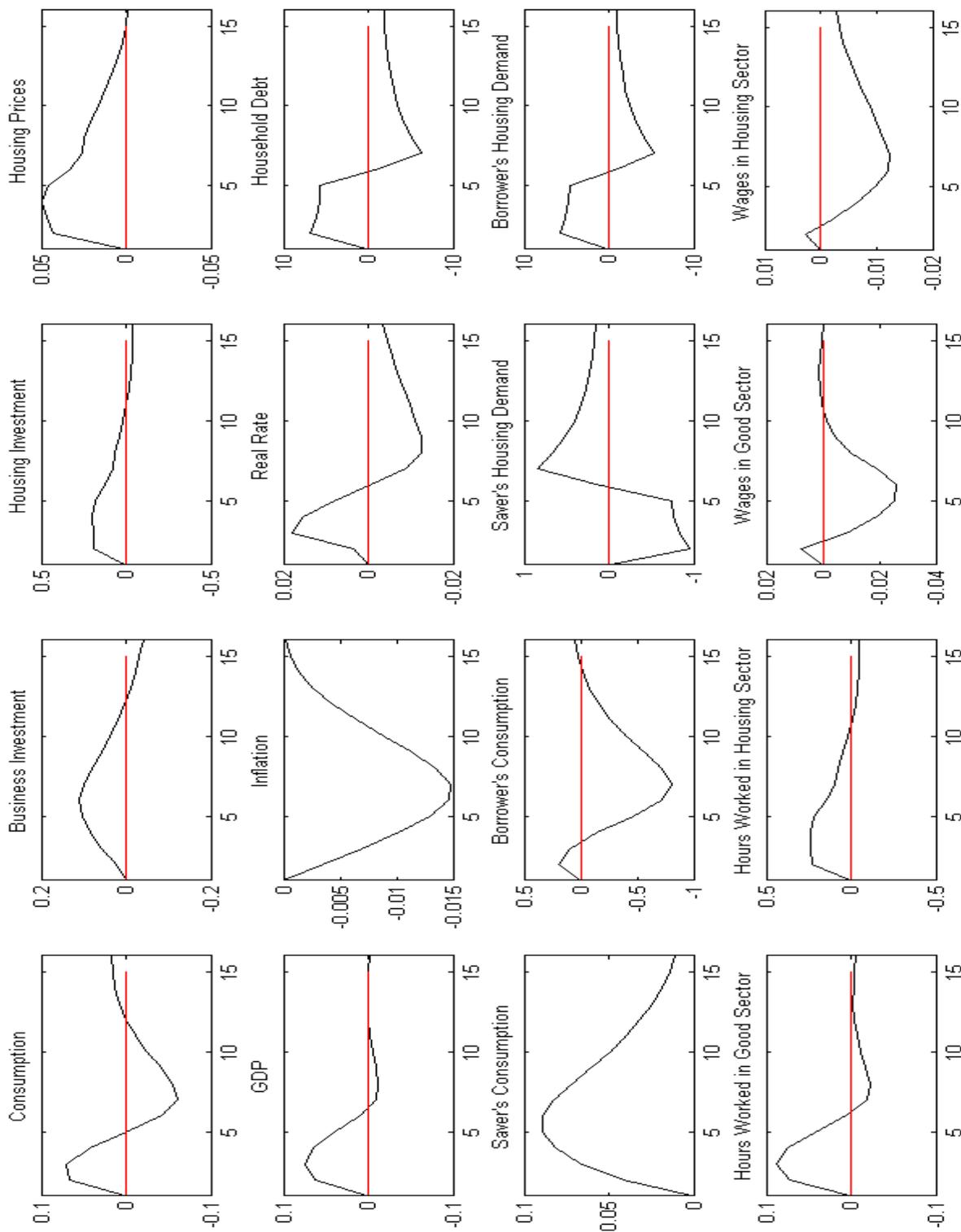


Figure 7: A Temporary Increase in the LTV Ratio combined with Expected Future Credit Tightening

Figure 8: News on Monetary Policy Shock and the LTV Ratio

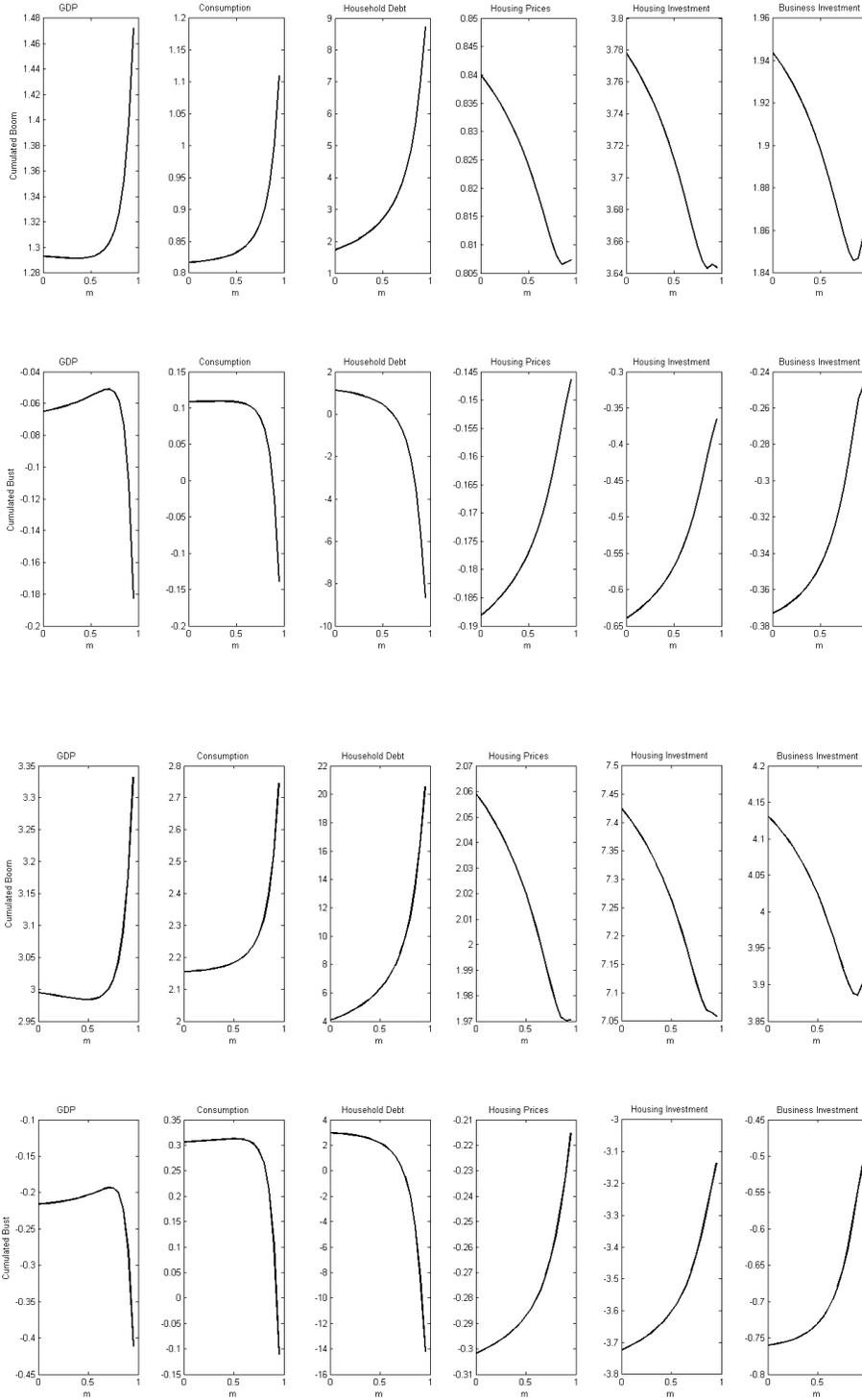


Figure 9: News on Technology Shock and the LTV Ratio

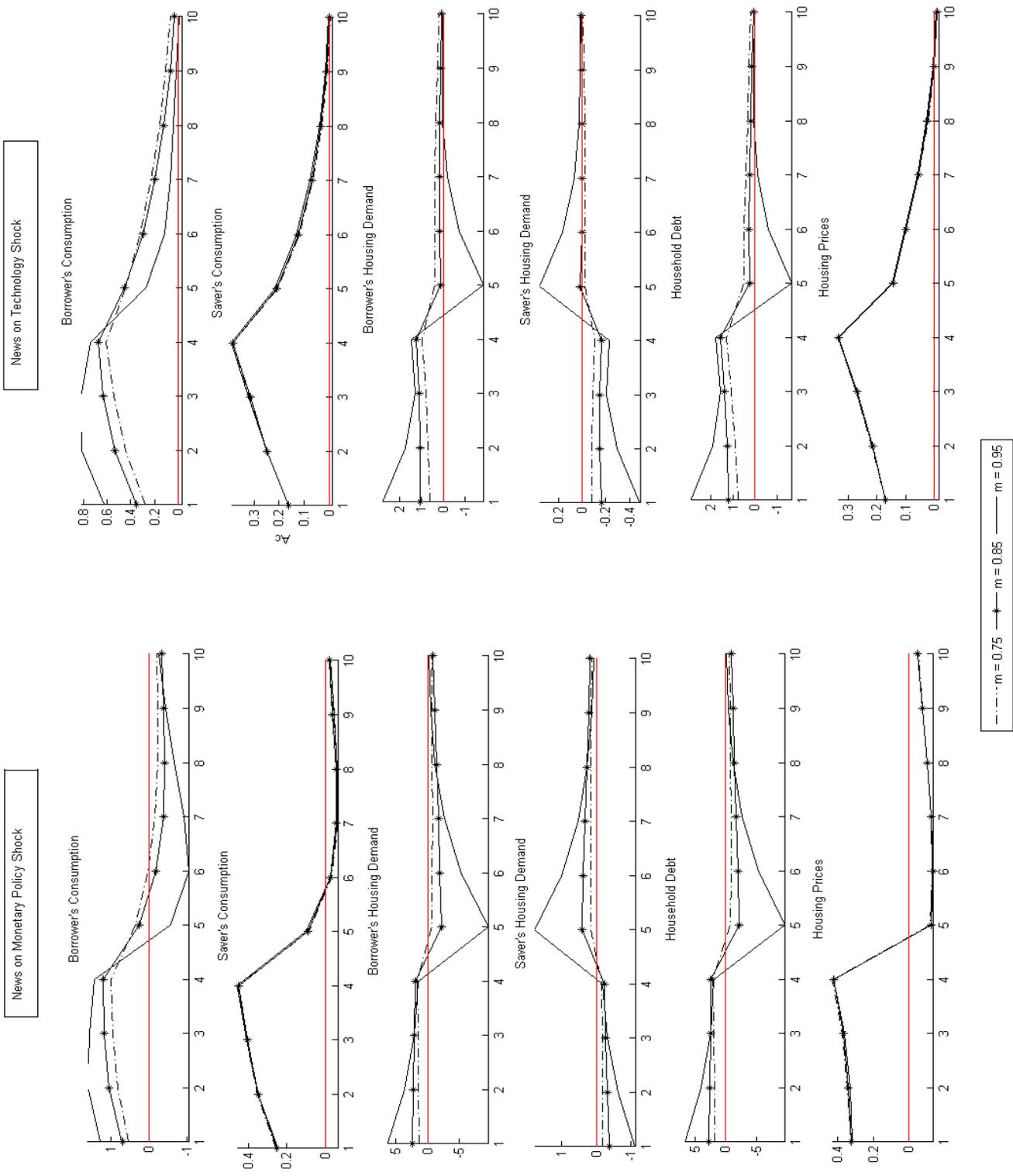


Figure 10: Individual Responses and the LTV Ratio

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