CeLEG Working Paper Series

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Working Paper No. 04
February 2011

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http://www.luiss.edu/celeg

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Leaning Against Boom-Bust Cycles in Credit and Housing Prices*

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Abstract

This paper studies the potential gains of monetary and macro-prudential policies that lean against news-driven boom-bust cycles in housing prices and credit generated by expectations of future macroeconomic developments. First, we find no trade-off between the traditional goals of monetary policy and leaning against boom-bust cycles. An interest-rate rule that completely stabilizes inflation is not optimal. In contrast, an interest-rate rule that responds to financial variables mitigates macroeconomic and financial cycles and is welfare improving relative to the estimated rule. Second, counter-cyclical Loan-to-Value rules that respond to credit growth do not increase inflation volatility and are more effective in maintaining a stable provision of financial intermediation than interest-rate rules that respond to financial variables. Heterogeneity in the welfare implications for borrowers and savers make it difficult to rank the two policy frameworks.

*We are grateful to seminar participants at the the Banco de Portugal, the Bank of International Settlements and at the BOK-BIS conference on Macroprudential Regulation and Policy for useful feedbacks on this project. We also thank Isabel Correia, Stefano Neri, Joao Sousa, Anella Murno and Enrique Mendoza for valuable comments and suggestions. The last author acknowledge the Banco de Portugal for the 2009 visiting research grant. The opinions expressed in this article are the sole responsibility of the author and do not necessarily reflect the position of the Banco de Portugal or the Eurosystem.

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1 Introduction

The recent financial crisis has demonstrated the need for a global macro-prudential approach to supervision and regulation of the financial sector. The traditional (micro) focus on the soundness of individual financial institutions proved to be insufficient in limiting volatility and the spreading of vulnerabilities from one financial institution to another. Hence, the new emphasis on the design of macro-prudential policies that lean against the financial cycle and aim at maintaining a "stable provision of financial intermediation services to the wider economy [...] to avoid the type of boom and bust cycles in the supply of credit and liquidity that has marked the recent financial crisis."[1] However, little is still known about macro-prudential policies, how they should be implemented and their potential gains. This paper contributes to the current debate on the implementation and effectiveness of macro-prudential tools by evaluating policies that make the Loan-to-Value (LTV henceforth) ratio respond to macroeconomic conditions and vary in a counter-cyclical manner. We compare the effectiveness of such policy tools against more traditional policies, such as interest rate rules that respond to financial variables.

For this analysis we rely on the model of the housing market developed by Iacoviello and Neri (2010) and extended by Lambertini, Mendicino and Punzi (2010) to incorporate expectations-driven cycles. Changes in expectations about future economic conditions are plausible sources of optimism on future house price appreciation that generate boom-bust cycles characterized by co-movement in house prices, GDP, consumption, investment, household's debt and hours worked as in the data. Expectations that lead to macroeconomic booms distort consumption and investment plans. Their sudden reversals have negative effects on economic and financial decisions that transmit across sectors and generate macroeconomic instability.

The goal of this paper is to assess alternative policies in terms of their effectiveness in mitigating boom-bust cycles and macroeconomic volatility and their impact on welfare. We first consider whether standard monetary policy, i.e. in the absence of macro-prudential goals, can contribute to making boom-bust cycles in credit and housing prices less severe. We find that strict inflation targeting delivers higher volatility of both housing prices and the loan-to-GDP ratio and is detrimental to welfare relative to an estimated rule. In fact, a strict anti-inflationary stance generates high volatility of the real interest rate that, in the presence of nominal debt contracts, implies a great deal of wealth redistribution between lenders and borrowers. Hence, a policy that completely stabilizes inflation is severely suboptimal compared to a more moderate anti-inflationary stance

[1] See Bank of England, The role of macro-prudential policy, discussion paper November 2009.

such as an estimated Taylor-type rule. We also consider an interest-rate response to expected inflation, but, we find that it yields only marginal gains in terms of stabilization relative to a Taylor-type rule that targets current inflation.

There is an ongoing debate over whether the monetary authority should react to financial variables to avoid bubbles in asset prices and large variations in credit. Our paper analyzes interest-rate rules that respond to either credit growth or housing price growth. The information content of credit aggregates is such that an interest-rate rule that responds to credit growth mitigates boom-bust cycles and macroeconomic volatility. We document that responding to credit growth reduces the amplitude of booms, avoids the occurrence of busts, and is, thus, welfare improving.

We also consider macro-prudential policies aimed at containing boom-bust cycles in credit and housing prices. We define macro-prudential policy as the use of the LTV ratio as a policy tool. We study whether counter-cyclical LTV ratio policies can be effective in providing a stable supply of financial intermediation, i.e. loans, to the household sector so as to avoid spill-over to the macro-economy. The effectiveness of alternative macro-prudential policies is measured both in terms of the volatility of the debt-to-GDP ratio and the welfare of the agents in the model. We investigate the implications of counter-cyclical LTV rules that respond to output growth, credit growth, and housing prices growth. We find that LTV rules responding to credit growth are the only policies leading to a Pareto improvement relative to the benchmark policy. Counter-cyclical LTV rules are effective in mitigating boom-bust cycles in housing prices and the debt-to-GDP ratio. Reducing LTV ratios and thereby tightening financial conditions during the boom phase while raising LTV ratios and allowing for easier access to credit during the bust phase is an effective policy to keep credit stable in response to shocks and news.

Last, we compare LTV-ratio policies and interest-rate rules that target macro-prudential goals. Compared to interest-rate rules that respond to financial variables, counter-cyclical LTV ratios are more effective in stabilizing households' debt, debt-to-GDP, and inflation. According to the welfare criterion borrowers prefer LTV rules because they benefit from the more stable supply of credit generate by active macro-prudential policy. Lenders, on the other hand, are better off under an interest-rate rule that responds directly to credit growth and more effectively stabilizes consumption. Hence, welfare heterogeneity precludes an unanimous ranking of these alternative policies.

This paper is related to two recent strands of the business cycle literature, one on asset price bubbles and monetary policy and the other on macro-prudential policy. The literature on asset-price movements and monetary policy relies mostly on models of exogenous bubbles, as in Bernanke and

Gertler (2001) and Gilchrist and Leahy (2002). In these models, the market price of an asset is the sum of its fundamentals implied by competitive equilibrium and an exogenous bubble component that stochastically emerges and disappears over time. Since the insurgence, size and burst of the bubble are exogenously determined, these models do not allow for any feedback from the conduct of monetary policy to the occurrence and the magnitude of boom-bust cycles in asset prices. Thus, unless asset prices signal changes in expected inflation, an anti-inflationary monetary policy is generally optimal in such environments.[2] Cecchetti et al. (2000) analyze rules that minimize a weighted sum of output and inflation variability to find that macroeconomic stabilization can be improved by adjusting the interest rate also in response to asset price misalignments. Christiano, Ilut, Motto and Rostagno (2008) introduce expectations on future productivity as a source of fluctuations in asset prices in a model à la Bernanke et al. (1999). When they add credit growth to the interest-rate rule, the equilibrium response of the economy to news shocks is nearly optimal. Our paper differs from these contributions in a number of ways. It analyzes optimal monetary policy in the presence of booms and busts in housing where boom-bust cycles arise in response to expectations of future changes not only about productivity but also about other shocks, such as monetary policy.[3] Lastly, we additionally consider macro-prudential policy and compare the effectiveness of interest-rate rules against LTV rules both in terms of welfare and in smoothing macroeconomic and financial cycles.[4]

A recent literature investigates the design and implementation of macro-prudential policy in models of the housing market.[5] Angelini, Neri and Panetta (2010) use ad-hoc loss functions to show that, compared to capital requirement rules, LTV rules are more effective in reducing the variability of the debt-to-GDP ratio. Kannan, Rabanal and Scott (2009) document that macroeconomic tools may be useful to mitigate the impact of financial shocks. However, they find no role for macro-prudential policy in booms generated by higher productivity. Unlike these contributions, our paper evaluates policies in response to a richer stochastic structure that allows for both current and

[2]As it is optimal in standard models with nominal stickiness like in Woodford (2003), Erceg, Henderson and Levin (2000) and Schmitt-Grohé and Uribe (2006).

[3]Using simplified versions of the model of the housing market adopted in this paper that abstract from boom-bust cycles dynamics, Monacelli (2006) and Mendicino and Pescatori (2008) highlight the optimality of a certain degree of inflation volatility. These two studies analyze the Ramsey equilibrium and optimal simple rules, respectively.

[4]For some recent papers on optimal monetary policy and asset prices, see Faia and Monacelli (2006), Gilchrist and Saito (2006), and Carlstrom and Fuerst (2007).

[5]See Angeloni and Faia (2010) for macro-prudential policy in a model with credit frictions at the firm level but without housing.

expected shocks and is consistent with boom-bust dynamics in house prices. Most importantly, our paper compares policies in terms of their welfare implications.

Since Beautry and Portier (2004, 2007) and Jaimovich and Rebelo (2009), several contributions have highlighted the importance of expectations-driven cycles as a source of business cycle fluctuations. We do not review this literature, but rather focus on the contributions that are closer to our paper. Among others, Schmitt-Grohe and Uribe (2008) document that news on future neutral productivity shocks, investment-specific shocks, and government spending shocks account for a sizable fraction of aggregate fluctuations in postwar United States. Christiano et al. (2008) shows that expectations about future productivity can be a plausible mechanism to generate stock-market boom-bust cycles. Milani and Treadwell (2010) consider expectations on the policy rate and find that anticipated policy shocks play a larger role in the business cycle than unanticipated ones.

The rest of the paper is organized as follows. Section 2 briefly describes the model and section 3 describes the method used for conducting welfare analysis. Section 4 and 5 investigate interest-rate and LTV rules, respectively. Section 6 compares interest-rate rules and macro-prudential policy, as represented by LTV rules. Section 7 concludes.

2 The Model

In this section we briefly describe the model economy. We consider an economy populated by households, producers of final goods for consumption and investment purposes, a continuum of retailers, housing producers and a central bank. The framework follows Iacoviello and Neri (2010) and Lambertini, Mendicino and Punzi (2010).

Households. The economy is populated by two types of households: the Saver and the Borrower. They both work in the production of consumption goods, $n^{'}_{c,t}$, and housing, $n^{'}_{h,t}$, consume, $c^{'}_{t}$, and accumulate housing, $h^{'}_{t}$. They differ in their discount factor, (β and $\beta^{'}$). Borrowers (denoted by $'$) feature a relatively lower subjective 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 Borrower maximizes the utility function:

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

subject to the budget constraint:

$$c_t^{'} + q_t\left[h_t^{'} - (1-\delta_h)h_{t-1}^{'}\right] - b_t^{'}$$

$$\leq \frac{w_{c,t}^{'}n_{c,t}^{'}}{X_{wc,t}^{'}} + \frac{w_{h,t}^{'}n_{h,t}^{'}}{X_{wh,t}^{'}} - \frac{R_{t-1}b_{t-1}^{'}}{\pi_t}$$

We allow borrowers to collateralize the value of their homes.

$$b_t^{'} \leq mE_t\frac{q_{t+1}\pi_{t+1}h_t^{\prime}}{R_t} \ . \tag{1}$$

Except for the gross nominal interest rate, R, all the variables are expressed in real terms; π_t is gross inflation (P_t/P_{t-1}), $w_{c,t}^{'}$ and $w_{h,t}^{'}$ are the wages paid in the two sectors of production, and q_t is the price of housing in real terms. Houses depreciate at rate δ_h and j determines the relative weight in utility on housing services. Limit on borrowing is introduced through the assumption that households cannot borrow more than a fraction, m, of the next-period value of the housing stock. The borrowing constraint is consistent with standard lending criteria used in the mortgage and consumer loan markets. Households set wages in a monopolistic way. $X_{wc,t}$ and $X_{wh,t}$ are markups on the wages paid in the two sectors. Wages are adjusted subject to a Calvo scheme with a given probability every period.

The Savers choose how much to consume, to work and to invest in housing facing a similar problem. However, they also invest in capital and receive the profits of the firms. Investment-specific technology shocks, $A_{h,t}$, are assumed to affect capital investment in the goods-sector.

Firms. Final good producing firms produce non-durable goods (Y) and new houses (IH). Both sectors face Cobb-Douglas production functions. The housing sector uses capital, k_h, land, l, intermediate inputs, k_b, and labor supplied by the savers, n, and the borrowers, $n^{'}$, as inputs of production.

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

The non-housing sector produces consumption and business capital using labor and capital, k_c.

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

$A_{h,t}$ and $A_{c,t}$ are the productivity shocks to the housing- and goods-sector, respectively. Firms pay wages to households and repay rented capital to the Savers. Retailers, owned by the Savers, differentiate final goods and act in a monopolistically competitive market. Prices can be adjusted with probability $1-\theta_\pi$ every period, by following a Calvo-setting. Monopolistic competition occurs at the retail level, leading to the following forward-looking Philips curve:

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

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

Monetary Authority. We assume that the central bank follows a Taylor-type rule as estimated by Iacoviello and Neri (2009)

$$R_t = R_{t-1}^{r_R} \pi_t^{(1-r_R)r_\pi} \left(\frac{GDP_t}{GDP_{t-1}} \right)^{(1-r_R)r_Y} rr^{(1-r_R)} \frac{u_{R,t}}{A_{s,t}} \tag{2}$$

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, $A_{s,t}$. 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 at the steady state.

Shocks. Productivity in the consumption ($A_{c,t}$), investment ($A_{k,t}$), and housing sector ($A_{h,t}$) follows

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

where γ_{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 model's parameters, persistence and standard deviation of the shocks equal to the mean of the posterior distribution estimated by Iacoviello and Neri (2010). These values are summarized in Table 1.

We introduce expectations of future macroeconomic developments as in Christiano et al. (2008) and assume that the error term of the 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 $z = \{c, h, k, p, R, s\}$. 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 $u_{z,t} = 0$.

In addition to expectations on future productivity, we allow in the model for news on several other shocks as originated in the housing market, the production sector and the conduct of monetary policy. In particular, we introduce expectations on future productivity $(A_{c,t+n})$, on the supply of houses, $(A_{h,t+n})$, on the cost of transforming output into capital, $(A_{k,t+n})$, and on the policy rate, $(u_{R,t+n})$, on deviations in the central bank inflation target, $(A_{s,t})$ and on inflationary pressures, $(u_{p,t})$. As shown by Lambertini, Mendicino and Punzi (2010) these types of expectations that are not matched generates boom-bust cycles in the housing market characterized by co-movement in house prices, GDP, consumption, investment, households' debt and hours worked as in the data.

3 Welfare Analysis

Our paper studies whether interest-rate or macro-prudential policies can achieve macroeconomic stabilization and improve welfare in the presence of a rich stochastic structure that allows for both anticipated and unanticipated shocks. Since we assume that the policymaker has the same information set as private agents, the ex-ante optimal policy is independent of the realization of expectations. It is plausible to think that LTV and interest-rate rules optimized conditional only on unfulfilled expectations would be more successful in stabilizing boom-bust cycles. However, given the difficulty in identifying the source of fluctuations, we find more interesting to characterize monetary and macro-prudential policy under a mixture of shocks and news that proxies changes into both current and expected economic conditions. As in Schmitt-Grohe and Uribe (2004), we study ex-ante optimal simple rules based on the second-order approximate solution of the model.

The welfare function is given by the conditional expectations of lifetime utility as of time t:

$$V_t^i \equiv \max E_t \left[\sum_{j=0}^{\infty} \beta_i^j U(c_{t+j}^i, h_{t+j}^i, n_{c,t+j}^i, n_{h,t+j}^i) \right].$$

Thus, at the optimum

$$V_t^i = U(c_t^i, c_{t-1}^i, h_t^i, n_{c,t}^i, n_{h,t}^i) + \beta_i E_t V_{t+1}^i,$$

where $i = \{', ''\}$ denotes the welfare of the Borrowers and the Savers, respectively. We augment the set of equilibrium conditions of the model with two equations in two unknowns, $V_t^{'}$ and $V_t^{''}$.

Since the rules considered in the paper do not have first-order effects, the deterministic steady state of the model is the same across the alternative regimes. Nevertheless, different policy regimes are associated with different stochastic steady states. In order not to neglect welfare effects occurring during the transition from one stochastic steady state to another, we compute the welfare implied by the different rules conditional on the initial state being the deterministic steady state. We explore the welfare performance of operational rules that determine either the interest rate or the LTV ratio as a function of observable macroeconomic variables. Alternative policy rules are compared in terms of a consumption equivalent measure, Λ^i, that would equate welfare $\tilde{V}_t^i$ under the optimized policy rule to the level of welfare under the deterministic steady state $\bar{V}^i$ where steady-state consumption is $c^i(1-\Lambda^i)$:

$$\tilde{V}_t^i = \bar{V}^i \equiv \sum_{j=0}^{\infty} \beta_i^j U((1-\Lambda^i) f(c^i, c^i), h^i, n_c^i, n_h^i),$$

where variables without time subscripts refer to the steady state.

4 Interest-rate Policy

This section analyzes interest-rate rules and their effectiveness in stabilizing the macro-economy under a rich stochastic structure that includes, among other, current and anticipated shocks to the policy rate and the central bank inflation target. A high degree of transparency in monetary policy is likely to reduce the uncertainty about future monetary policy actions and therefore reduce the occurrence of unfulfilled expectations about the future conduct of monetary policy. In the following we show that, independently of news about monetary policy, the monetary authority can affect the size and occurrence of boom-bust cycles stemming from expectations on other types of future macroeconomic developments by affecting inflationary expectations.

4.1 Anti-Inflationary Stance

Columns 1 and 2 of Table 2 compare the standard deviations of some aggregate and group-specific variables as delivered by the model under the estimated Taylor rule and a strict anti-inflationary stance. We assume that, under strict anti-inflationary stance, the monetary authority targets only inflation and credibly maintains it constant without deviating from the target. Thus, expectations on the policy rate and the central bank's target are stabilized. The estimated rule delivers much lower volatility of all variables, aggregate and individual, relative to a strict anti-inflationary stance. At the individual level, a strict anti-inflationary stance is accompanied by larger volatility of both consumption and hours. Column 1 and 2 in Table 3 report the welfare of Savers and Borrowers under the estimated rule and the strict anti-inflationary stance, respectively. Both Savers and Borrowers are strictly better off under the estimated rule.

The model we rely on differs from the standard New-Keynesian model in three dimensions: heterogeneous discount factors, nominal household debt, and news shocks. Monacelli (2006) investigates the optimal design of monetary policy in a simplified version of the model used in this paper that abstracts from news shocks. In the presence of technology shocks, the Ramsey equilibrium is characterized by some inflation volatility. Mendicino and Pescatori (2008) study ex-ante optimal interest-rate rules under a combination of shocks and show that, in the presence of nominal debt, monetary policy can avoid the welfare-reducing redistribution generated by nominal contracts by stabilizing the real interest rate, thereby allowing agents to share risk optimally. Hence, there is a trade-off between minimizing the distortions generated by nominal price rigidities and those generated by nominal debt. If the monetary authority completely stabilizes inflation, the uncertainty related to the real interest rate, namely the real rate of repayment of debt, is larger. In fact, a strong anti-inflationary stance exacerbates macroeconomic fluctuations because it makes the real rate extremely volatile. Larger volatility of the real rate means higher uncertainty about the rate of repayment of the debt and higher volatility of consumption and hours. The presence of news shocks does not alter this result. In our framework a strict anti-inflationary stance delivers higher volatility of both housing prices and the loan-to GDP ratio and lower welfare relative to the estimated rule. The rise in volatility is particularly sizable in housing investment and hours worked in the housing sector. See Table 2.

Figures 1 and 2 analyze the relationship between the standard deviation of inflation and output as a function of the central bank's responsiveness to inflation, r_π. The dashed line considers a policy response to the current inflation rate, π_t; the solid line is the response to expected future inflation. The efficient frontier in Figure 1 confirms the existence of a trade-off between the variability of output and that of inflation.[6] In other words, an inertial interest-rate rule that targets inflation and output cannot simultaneously reduce the volatility of GDP and inflation. Figure 2 displays the standard deviation of several variables with respect to the interest-rate response to inflation, r_π. A stronger response to deviations of inflation from its target reduces the volatility of inflation at the cost of increased macroeconomic volatility.

In the presence of news shocks agents face substantial uncertainty about the future development of the economy. Thus, we assess the gains of responding to expected inflation as a variable that

[6] Figures 1 and 2 display the standard deviation of some variables with respect to r_π within the range 1.5 to 4.5, while r_Y and r_R are kept constant and equal to the values estimated by Iacoviello and Neri (2010).

contains information about the future state of the economy. The efficient frontier shifts inwards when the monetary authority reacts to expected inflation, as seen in Figure 1. Keeping the standard deviation of inflation constant, the corresponding decline in the standard deviation of output is sizable. Hence, monetary policy is slightly more effective if it responds to expected rather than current inflation. Figure 2 also shows that an interest-rate rule that that responds to expected rather than current inflation yields lower volatility of GDP and financial variables. However, it delivers higher volatility of inflation. Targeting expected inflation makes R_t react by more because, during the boom-phase, movements in future inflation are larger than current inflation. Agents internalize the stronger reaction in the policy rate and respond to news shocks in a smoother way. At the same time, the stronger the policy rate reaction, the larger the effect on current inflation and the higher its standard deviation.

4.2 Targeting Financial Variables

Should the monetary authority react to asset price or credit growth movements to avoid boom-bust cycles in the financial market? In what follows we assess alternative interest-rate rules that react to either credit growth or changes in housing prices:

$$R_t = R_{t-1}^{r_R} \pi_t^{(1-r_R)r_\pi} \left(\frac{GDP_t}{GDP_{t-1}}\right)^{(1-r_R)r_Y} \left(\frac{x_t}{x_{t-1}}\right)^{(1-r_R)r_x}, \tag{3}$$

where $x_t = \{b_t, q_t\}$. We set r_R, r_y and r_π equal to the estimated values and allow for positive responses to the other target, namely $r_x \geq 0$.

To compare alternative interest-rate rules in a meaningful way, we rely on social welfare criteria. More precisely, we select the weights of the interest-rate rule on either housing price inflation or credit growth for which, starting from the estimated rule, i.e. r_Q and r_B equal to zero, both agents achieve higher welfare and none of the two agents is worse-off. The resulting interest-rate responses are equal to 0.4 and 0.9 for r_B and r_Q, respectively. These results are based on a second-order approximation.[7] Figure 3 shows that targeting financial variables is welfare improving with respect to the estimated rule. However, both Borrowers and Savers reach a higher maximum level of welfare under an interest-rate rule that responds to credit growth.

Figure 4 compares the efficient frontiers. The solid line with dots and the dotted line allow only for a response to current and expected future inflation, respectively; the solid and dashed lines

[7] We start from r_Q and r_B equal to zero and we increase the response to either targets up to the points in which both agents are better off. The other parameters are kept constant and equal to the estimated values.

allow also for an interest-rate response to variations in housing prices and credit, respectively.[8] In comparison with a rule that responds to either current or expected inflation, responding to financial variables yields significant gains in terms of output and inflation volatility. However, targeting housing prices improves the output-inflation trade-off to a lesser extent than targeting credit growth.

Figures 5 and 6 report the transmission of expectations on future productivity and the policy rate under three alternative interest-rate rules: the estimated rule (starred line); the rule responding to house price inflation, i.e. r_Q equal to 0.9, (dashed line); the rule responding to credit growth, i.e. r_B equal to 0.4, (solid line). These three rules are characterized by different length and magnitude of macroeconomic boom-bust cycles. First of all, the reaction of housing prices and household debt is dampened by adding an indicator of potential vulnerabilities in the housing market such as credit growth or housing price inflation. This also leads to a more contained response of GDP. The same result holds for other types of expectations of future macroeconomic developments (not shown in the paper). It is important to stress that boom-bust cycles generated by unfulfilled expectations are not completely offset by the monetary authority since we characterize optimal monetary under the assumption that the economy can be hit by both anticipated and unanticipated shocks and that unmatched expectations are a low probability event. Hence, we do not specifically target the smoothing of neither some particular types of shocks nor of boom-bust cycles.

All aggregate variables, except inflation, are less volatile under the rule that targets credit growth relative to the one that targets growth in housing prices, as shown in Table 2. Responding to credit growth improves upon all interest-rate rules considered here not only in reducing volatility but also by raising welfare of both groups, as shown in Table 3. Responding to credit growth reduces the amplitude of the boom and avoids the occurrence of a recession at the end of the bust. Lower volatility of household debt is coupled with higher volatility of inflation. However, the welfare criterion suggest that there is no trade-off between goals of monetary policy and the smoothing of boom-bust cycles. As suggested earlier, a certain degree of (positive) inflation volatility is optimal in our model as it helps smoothing out the real effects of changes in nominal debt. To sum up, an interest-rate rule that responds to credit growth is successful in mitigating boom-bust cycles, maintaining a stable provision of financial intermediation over the cycle, and improving welfare for both Savers and Borrowers relative to the estimated interest-rate rule.

[8] The efficient frontiers are computed with respect to r_π within the range 1.5 to 4.5. The other parameters are kept constant and equal to the estimated values, in the case of r_Y and r_R, and to the welfare improving responses for r_B and r_Q.

5 LTV Ratio Policy

The recent financial crisis, which was ignited by the bursting of the housing bubble in the United States, has forced central banks to reconsider their policy framework. Should monetary policy give explicit recognition to financial stability goals? Or should financial stability goals be pursued by other instruments – such as LTV ratios? We address these questions in the remainder of the paper. In this section we explore the effectiveness of LTV ratios as macro-prudential tools aimed at financial and macroeconomic stabilization. The next section compares interest-rate and LTV ratio rules.

The international policy debate is currently focusing on the design of a macro-prudential policy whose goal is to moderate credit cycles and to reduce financial imbalances. To this respect, the Basel Committee on the Global Financial System suggests: (1) the use of instruments "effective in leaning against both the upswing and the downswing [in the financial cycle]"; (2) the implementation of "predictable and transparent" policies that are set according to "easily observable and reliable indicators"; (3) [policies that] "might apply narrowly to sectors where systemically relevant imbalances are developing".[9] The Committee identified the LTV ratio as one of the macro-prudential tools that may act as an automatic stabilizer if adjusted in a counter-cyclical manner.[10]

In the following we assess the benefits of counter-cyclical LTV ratio rules that imply tighter financial conditions during booms in the housing market but looser financial conditions during the busts. In fact, counter-cyclical LTV ratio rules limit leverage in the upswing but broaden it in the downswing. We compare rules that respond to GDP, credit, and housing price growth in moderating the credit and housing cycle and evaluate them in terms of their effectiveness in stabilizing the macro-economic and in terms of welfare. In practice, we assume

$$m_t = \nu_m m_{t-1} + (1 - \nu_m)m + (1 - \nu_m)\nu_x (x_t - x_{t-1}) \tag{4}$$

where m is the steady state value for the LTV ratio, ν_m is an autoregressive parameter that we set equal to 0.5, and ν_x is the response to alternative observable macroeconomic indicators, where $x_t = \{b_t, q_t, GDP_t\}$. $\nu_x = 0$ corresponds to the case where the LTV ratio does not respond to the variable chosen as imbalance indicator and macro-prudential policy is non-active. Negative values of ν_x make the LTV counter-cyclical because positive growth in the macroeconomic indicator reduces the LTV ratio and brings a tightening in credit conditions. We measure the effectiveness

[9]See Basel Committee on the Global Financial System. 2010. Macro-prudential Instruments and Frameworks: a Stocktaking of Issues and Experiences. CGFS Publications No 38.

[10]LTV ratio policies have been already used by Asian Central Banks after the crisis of 1997.

of alternative policy rules by looking at the volatility of the loans-to-GDP ratio and welfare. The analysis conducted in this paper does not aim at designing optimal policies conditional on some particular shocks, i.e. productivity or financial shocks, but is based on the assumption that various sources of fluctuations, both anticipated and unanticipated, can affect the economy.

Figure 7 displays the standard deviation of some key macroeconomic variables under LTV rules targeting credit, GDP, and housing price growth for values of ν_x between 0 and -7. Three results emerge. First, all three targeting rules are successful in reducing the volatility of GDP at constant prices, although the rule targeting credit growth is more effective than the others. Second, the three rules generate relatively small differences in terms of the volatility of housing prices, housing investment and inflation. Third, counter-cyclical LTV rules that respond to credit growth are effective in reducing the volatility of loans and the loan-to-GDP ratio while LTV rules targeting GDP or housing price growth fail to do so. In fact, the standard deviation of loans and the loan-to-GDP ratio increases with the responsiveness of the LTV rule to GDP and housing price growth. The intuition is as follows. LTV rules that target credit growth generate smaller deviations of the LTV ratio, m_t, from its steady state value that effectively dampen the dynamics of credit. Current shocks or news that, in the absence of counter-cyclical macro-prudential policies, would lead to a credit boom now cause a reduction of the LTV ratio that remains below steady state while the credit boom persists. As a result, loans are stabilized. This is not the case for LTV rules that target GDP or housing price growth. These rules generate stronger instantaneous responses and non-monotonic dynamics in the LTV ratio than policies that target credit growth and, thus, raise the volatility of credit. In response to current shocks and news that would generate a housing boom, these LTV rules reduce m_t so much that loans instantaneously fall. This contraction in credit curtails growth in housing prices and GDP that subsequently raise the LTV ratio, loans, and the loan-to-GDP ratio above steady state. Hence, responding to GDP or housing price growth generates larger volatility in m_t *and* in credit aggregates. Figure 8 displays the impulse response of the LTV and the loan-to-GDP ratio following a technological shock (left panel) and a monetary shock (right panel). It is clear that the large response of the LTV ratio under targeting GDP or house price growth induces large, non-monotonic deviations in credit that raise volatility in the economy.

Figure 9 shows welfare for Borrowers and Savers under the three alternative LTV rules for a range of values of ν_x between 0 and -7. LTV rules that target GDP and housing price growth bring a welfare improvement for Savers but a welfare worsening for Borrowers. Only LTV rules targeting credit growth are welfare improving for both groups of consumers. This result is a consequence of the increased volatility of loans associated with the LTV rules that target GDP and housing prices growth. Borrowers are credit-constrained and an increase in the volatility of loans implies an increase in volatility of consumption of both non-durable goods and housing and thereby a lower welfare for this group of consumers.

6 Monetary versus Macro-prudential Policy

The results presented above assess the contribution of alternative policy strategies aimed at reducing the occurrence and amplitude of boom-bust cycles in credit and housing prices. Both an interest-rate rule that directly responds to credit growth and a LTV ratio rule that responds to credit growth in a counter-cyclical manner are successful in mitigating boom-bust cycles and stabilizing the provision of credit.

Table 2 shows that, compared to the benchmark estimated economy, both policies reduce significantly the volatility of households' debt but only slightly that of housing prices. However, the lower volatility of credit and GDP induced by counter-cyclical LTV ratios are not coupled with a substantial increase in the volatility of inflation as in the case of an interest-rate response to credit growth.

Table 3 reports the stochastic mean of individual variables in deviation from the steady state. The first two rows report the stochastic mean for Savers' and Borrowers' welfare levels; the other rows report the percentage point deviation relative to the steady state, with negative numbers referring to below steady-state values. Savers' welfare is maximized under an interest-rate response to credit aggregates that implies lower volatility of consumption in both nondurable goods and housing services and hours worked, as shown in Table 2. In contrast, Borrowers are better off under the LTV rule, which leads to a higher level and lower volatility of credit. The welfare gain delivered by the LTV ratio rule for Borrowers comes from the level effect rather than the stabilization effect. Because of higher level of credit, as shown in Table 3, Borrowers experience higher levels of consumption of both nondurable and housing consumption while slightly lower levels of hours worked.

Table 4 compares the performance in terms of welfare of the interest-rate and the LTV rule that responds to credit growth. Savers' cost is the percentage point reduction in the deterministic steady-state consumption that equalizes welfare at the deterministic steady state and under the alternative policy rule. Positive numbers indicate that the consumer is better off at the deterministic steady state; negative numbers indicate that the consumer is better off under the policy rule under consideration relative to the deterministic steady state. Notice that negative numbers are possible because of the presence of credit-constrained individuals. Savers are better off under the interest-rate rule that responds to credit growth and Borrowers are better off under the LTV rule that responds to credit growth (as already seen in Table 3). Hence, agent's heterogeneity fails to provide us with a uniform ranking among the two policy frameworks. Interestingly, both policies lead to a Pareto improvement from the starting point of the benchmark policy. Notice, however, that the welfare gains for each group of agents of adopting their preferred rule relative to the other are small.

7 Conclusions

We analyze the monetary policy implications of expectations-driven cycles. An interest-rate policy that completely stabilizes inflation fails to mitigate boom-bust cycles. In contrast, an interest-rate response to credit growth improves macroeconomic and financial stability and welfare. Hence, there is no trade-off between the goals of monetary policy and the smoothing of boom-bust cycles.

We also investigate the effectiveness of counter-cyclical macro-prudential rules in leaning against boom-bust cycles. Counter-cyclical LTV rules that respond to credit growth are more effective in stabilizing credit over the cycle than interest-rate rules that respond to credit growth because they directly tighten financial conditions during the boom phase and allow easier access to credit during the bust phase. However, heterogeneity in terms of welfare prevent a clear ranking of the two policy frameworks.

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Parameters' Value					
Technology		ι_π	0.69	m	0.85
μ_c	0.35	$\theta_{w,c}$	0.79	Shocks	
μ_h	0.10	$\iota_{w,c}$	0.08	ρ_{AS}	0.975
μ_l	0.10	$\theta_{w,h}$	0.91	ρ_{AC}	0.95
μ_b	0.10	$\iota_{w,h}$	0.40	ρ_{AH}	0.997
α	0.79	Preferences		ρ_{AK}	0.992
$\phi_{k,c}$	14.25	ξ	0.66	ρ_j	0.96
$\phi_{k,h}$	10.90	$\xi^{'}$	0.97	ρ_z	0.96
δ_h	0.01	β	0.9925	ρ_τ	0.92
δ_{kc}	0.025	$\beta^{'}$	0.97	σ_{AC}	0.0100
δ_{kh}	0.03	j	0.12	σ_{AH}	0.0193
X	1.15	ε	0.32	σ_{AK}	0.0104
X_{wc}	1.15	$\varepsilon^{'}$	0.58	σ_j	0.0416
X_{wh}	1.15	η	0.52	σ_R	0.0034
γ_{AC}	0.0032	$\eta^{'}$	0.51	σ_z	0.0178
γ_{AH}	0.0008	Policy		σ_τ	0.0254
γ_{AK}	0.0027	r_R	0.59	σ_p	0.0046
Stickiness		r_π	1.44	σ_{As}	0.0004
θ_π	0.83	r_Y	0.52		

Table 1: Parameter Values Estimated by Iacoviello and Neri (2009)

	Estimated rule	Strict anti-inflationary stance	Interest-rate Rule responding to housing inflation $\alpha_q = 0.9$	Interest-rate Rule responding to credit growth $\alpha_b = 0.4$	LTV rule responding to credit growth $v_b = -10$
Consumption	0.0526	0.2358	0.0470	0.0419	0.0504
Business Investment	0.1128	1.1269	0.1044	0.0942	0.1129
Housing Investment	0.3299	2.6095	0.3300	0.3151	0.3294
Housing Prices	0.2369	0.5946	0.2363	0.2354	0.2368
GDP	0.0695	0.6071	0.0633	0.0539	0.0678
Inflation	0.0147	-	0.0163	0.0174	0.0148
Household Debt	0.2192	3.595	0.1546	0.1207	0.0865
Debt-to-GDP	0.1811	3.2938	0.1250	0.1007	0.0935
Real Rate	0.0104	0.7846	0.0091	0.0080	0.0106
Hours housing sector	0.1705	3.124	0.1623	0.1343	0.1692
Hours consumption sec.	0.0573	0.6514	0.0514	0.0349	0.0547
Saver's Consumption	0.0459	0.2339	0.0417	0.0385	0.045
Borrower's Consumption	0.0957	0.6299	0.0832	0.0674	0.0894
Saver's Hours in C	0.0625	0.6577	0.0561	0.0385	0.0589
Borrower's Hours in C	0.0401	0.6681	0.0356	0.0231	0.0445
Saver's Hours in H	0.1731	3.1250	0.1654	0.1364	0.1713
Borrower's Hours in H	0.1611	3.1216	0.1514	0.1269	0.1621
Saver's Housing Demand	0.2521	0.5599	0.2548	0.2507	0.2515
Borrower's Housing Demand	0.3061	3.3780	0.2836	0.2554	0.2559

Standard deviation in percentage terms. All shocks, Second Order Approximation.

Table 2: Stabilization Effect: Standard Deviations

	Estimated rule	Strict anti inflationary stance	Rule responding to housing inflation $\alpha_q = 0.9$	Rule responding to credit growth $\alpha_b = 0.4$	LTV rule responding to credit growth $v_b = -10$
Savers' welfare	-0.1165	-0.3264	-0.1163	-0.1154	-0.1163
Borrowers' welfare	-2.4526	-4.2577	-2.4513	-2.4507	-2.4506
Saver's Consumption	0.4132	0.50238	0.4128	0.4124	0.4132
Borrower's Consumption	-1.2117	-1.3927	-1.2123	-1.2127	-1.2114
Saver's Hours in C	-0.2612	-0.32386	-0.2615	-0.2616	-0.2611
Borrower's Hours in C	-0.0720	-0.13215	-0.0718	-0.0719	-0.0719
Saver's Hours in H	-1.7640	-3.8191	-1.7633	-1.7617	-1.7642
Borrower's Hours in H	-1.3592	-3.1258	-1.3582	-1.3567	-1.3592
Saver's Housing Demand	2.6737	4.5104	2.6732	2.6714	2.6736
Borrower's Housing Demand	0.8360	-5.6417	0.8461	0.8442	0.8494
Household's debt	0.5415	-7.4428	0.5518	0.5509	0.5547

Stochastic means of log-transformed variables. All shocks, Second Order Approximation.

Table 3: Level Effect: Stochastic Means

	Estimated rule	Rule responding to credit growth $\alpha_b = 0.4$	LTV rule responding to credit growth $v_b = -10$
Savers' cost	0.0661	-0.0140	0.04604
Borrowers' cost	-1.5931	-1.7979	-1.8087

All shocks, Second-order Approximation.

Welfare costs are expressed in steady-state consumption-equivalent terms.

Positive figures are costs; negative figures are gains.

Table 4: Welfare Cost

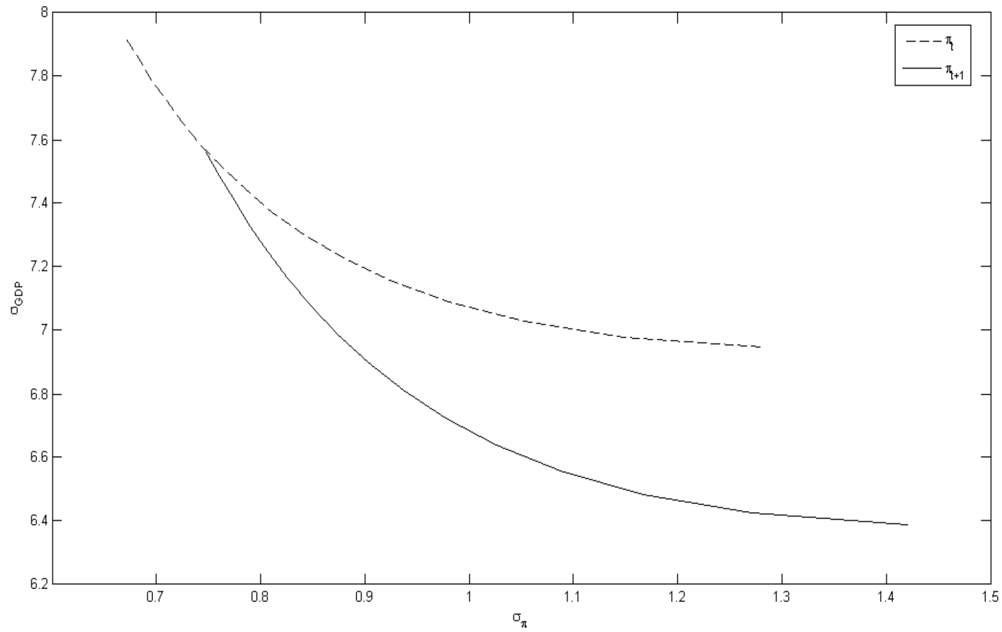

Figure 1: GDP-Inflation Trade-Off

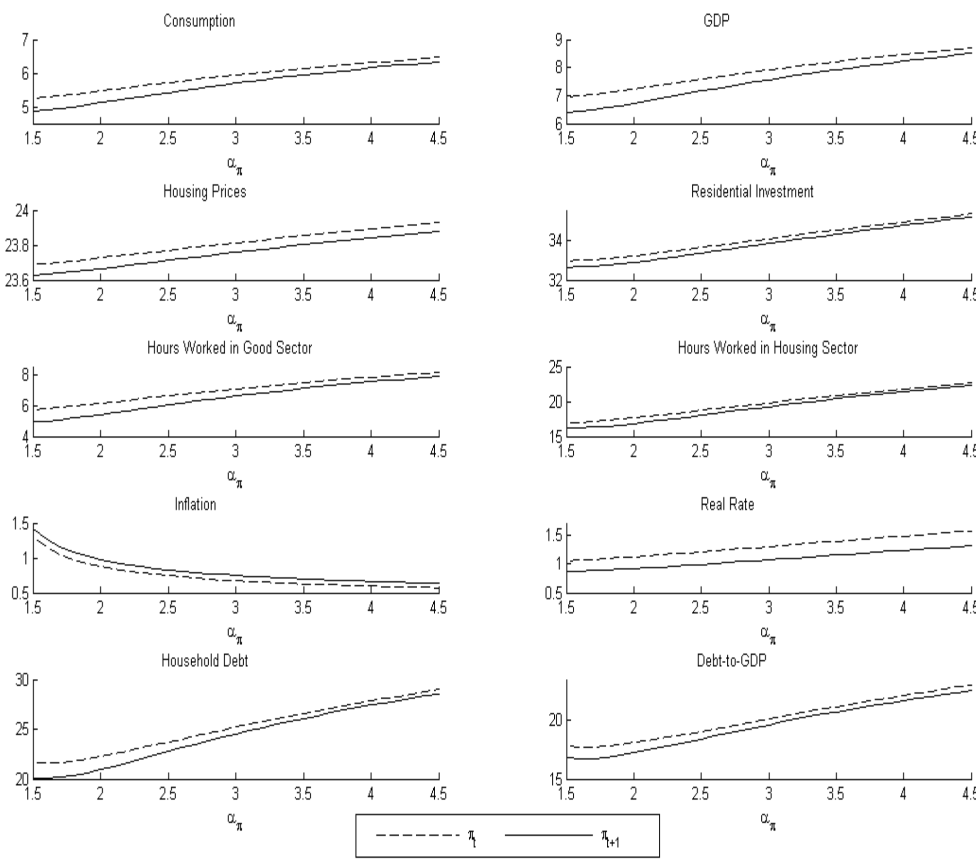

Figure 2: Standard Deviation w.r.t. the Interest rate response to Inflation

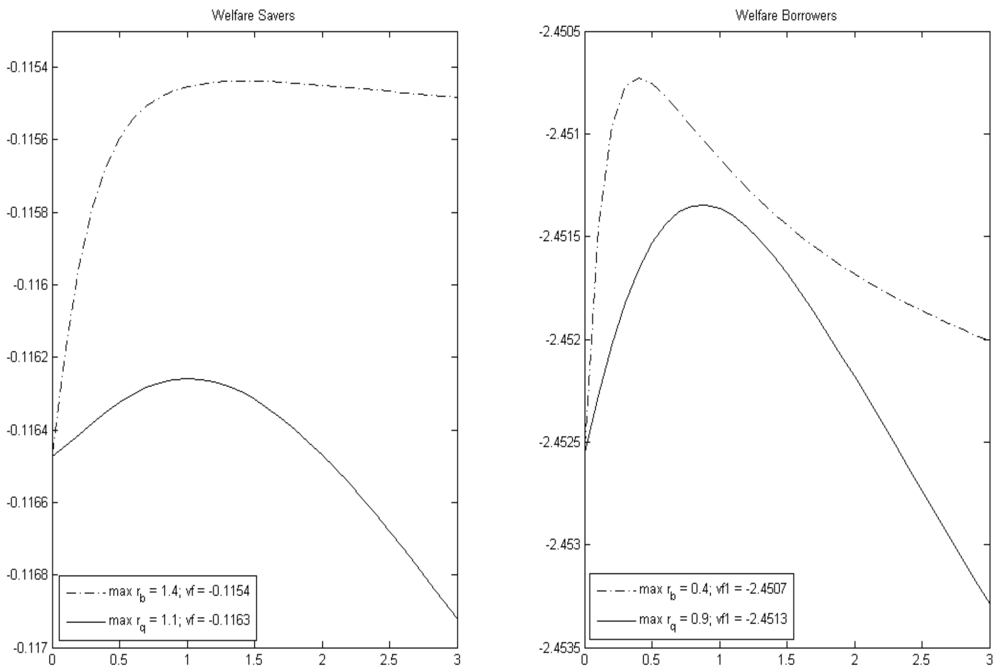

Figure 3: GDP-Inflation Trade-Off

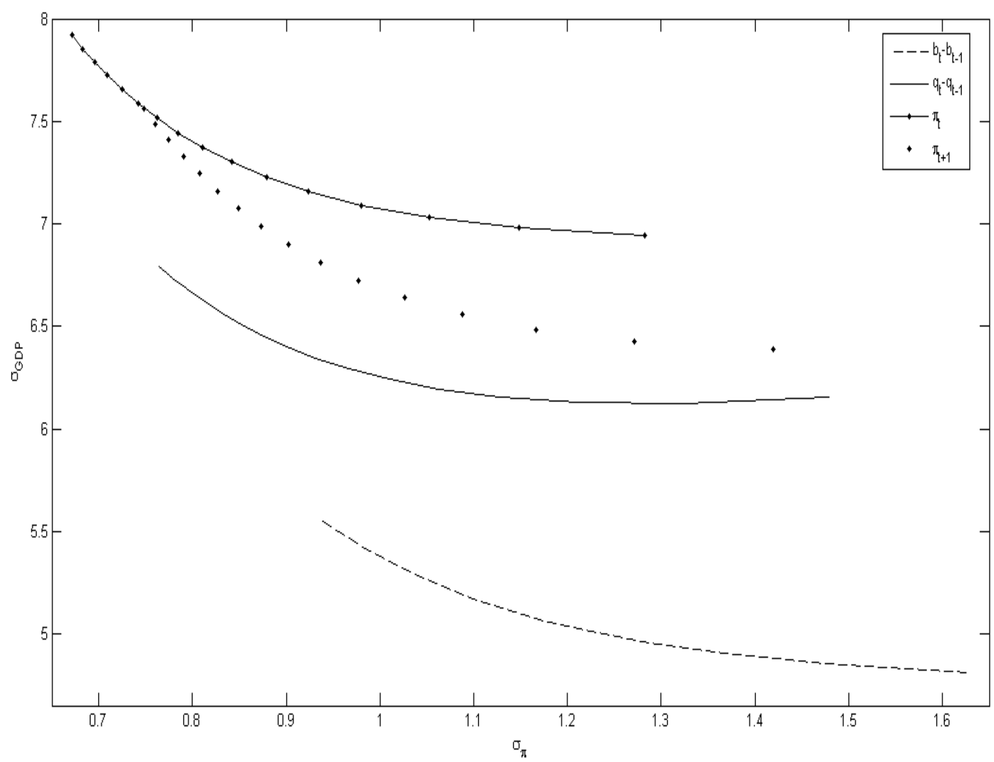

Figure 4: Standard Deviation w.r.t. the Interest rate response to Inflation

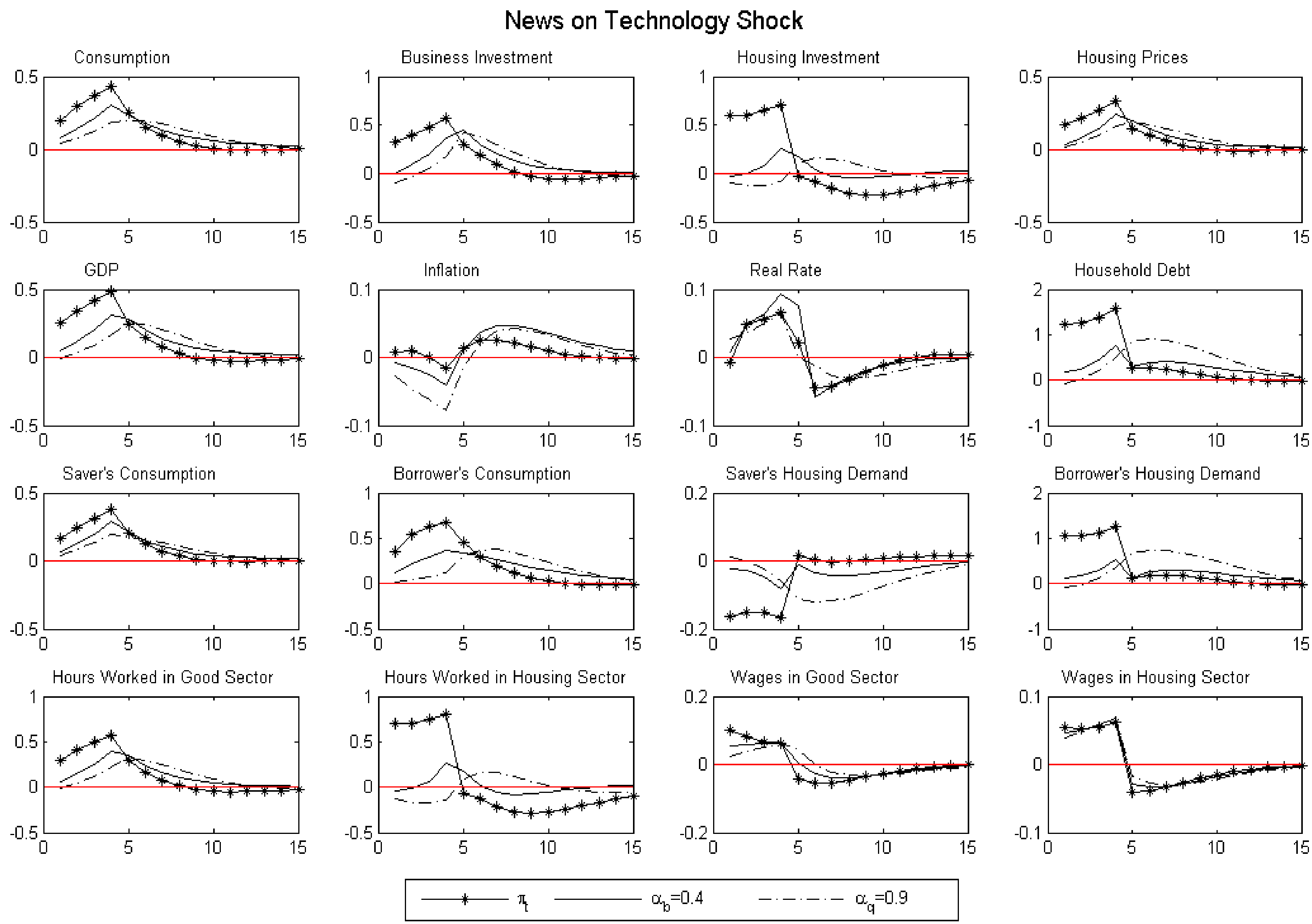

Figure 5: Technology Shock: Estimated Rule vs $\alpha_b = 0.4$ and $\alpha_q = 0.9$

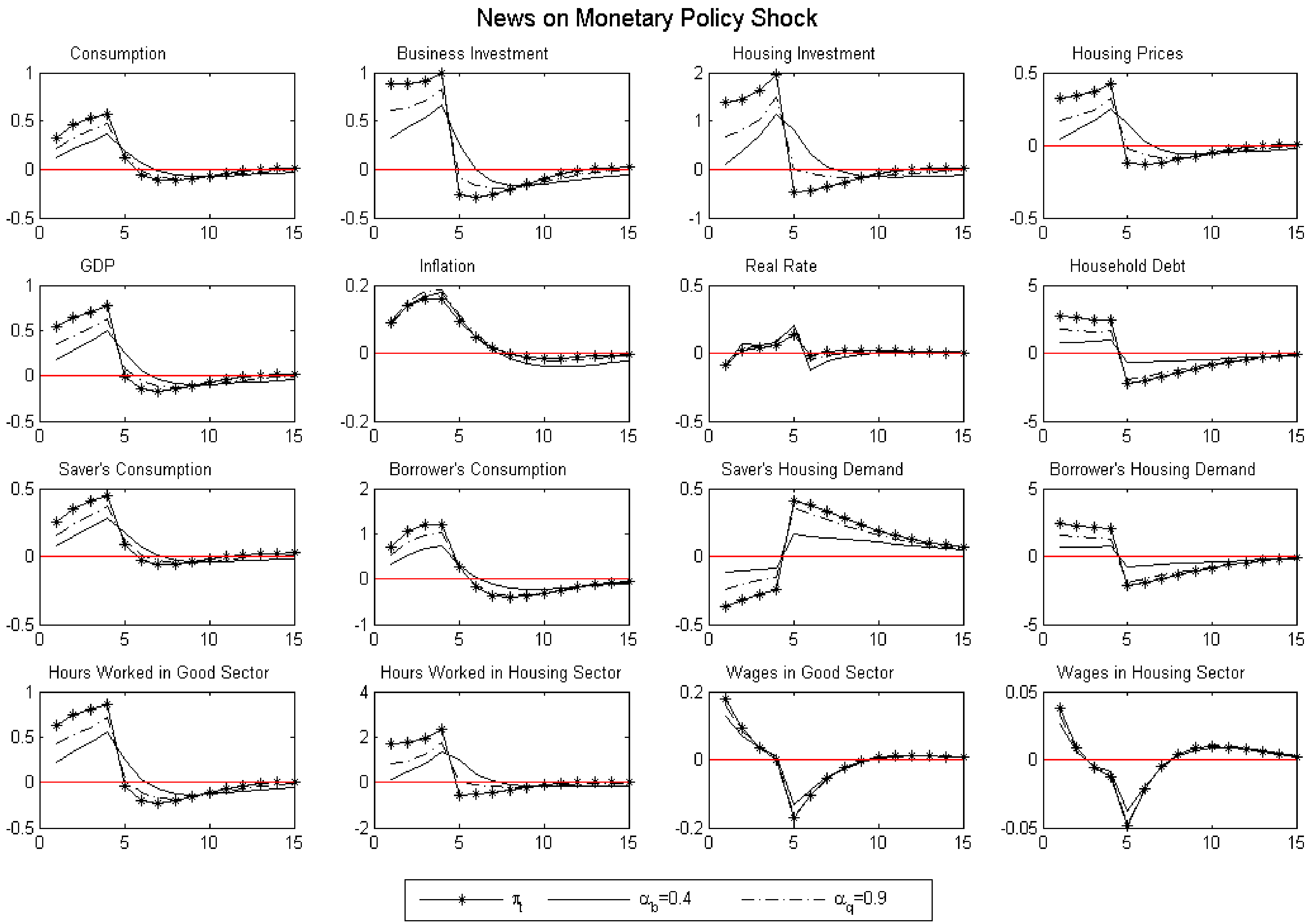

Figure 6: Monetary Policy Shock: Estimated Rule vs $\alpha_b = 0.4$ and $\alpha_q = 0.9$

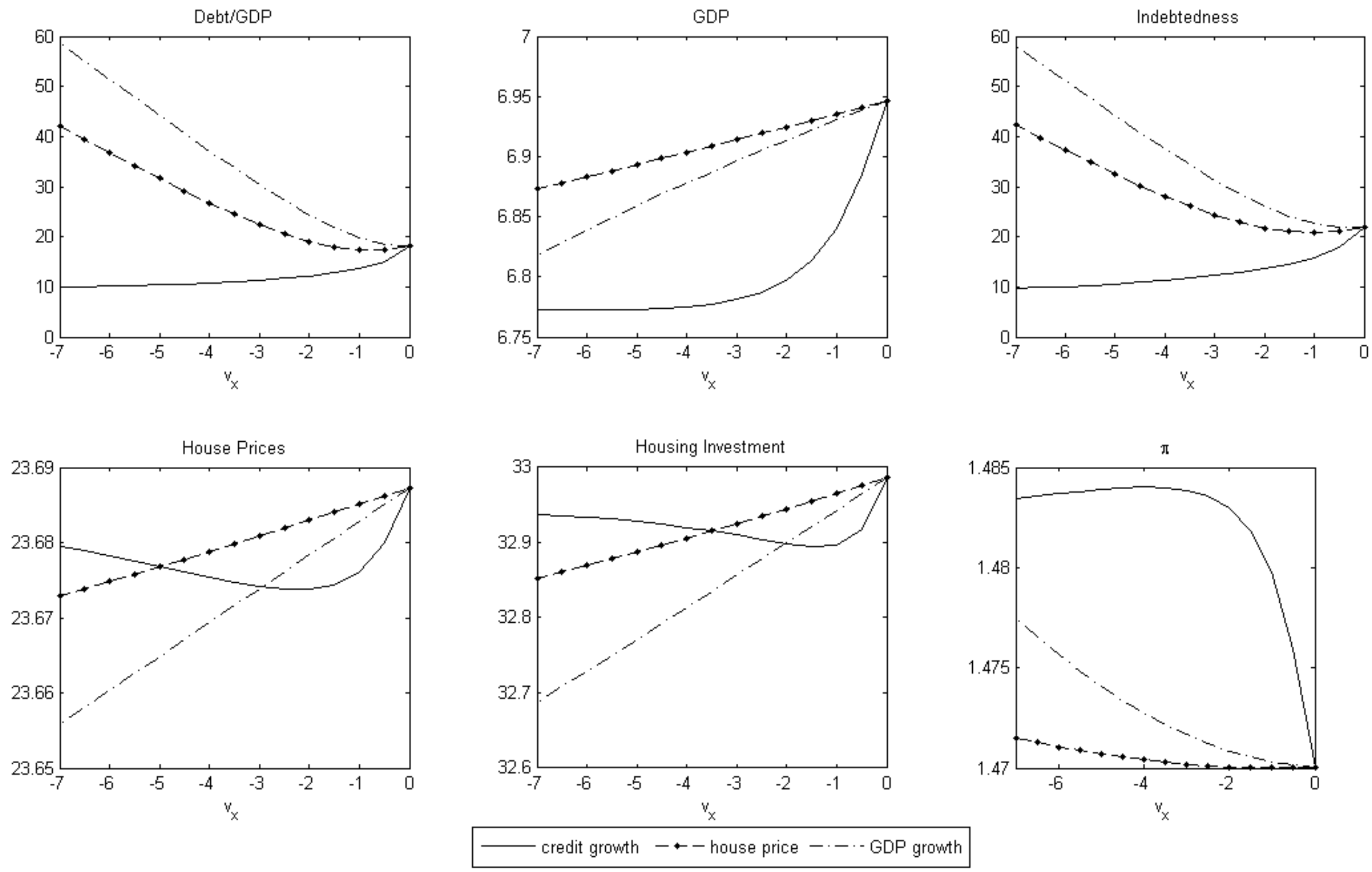

Figure 7: Standard Deviation (%) w.r.t. Macro-prudential Response to Credit, GDP, or House Price Growth

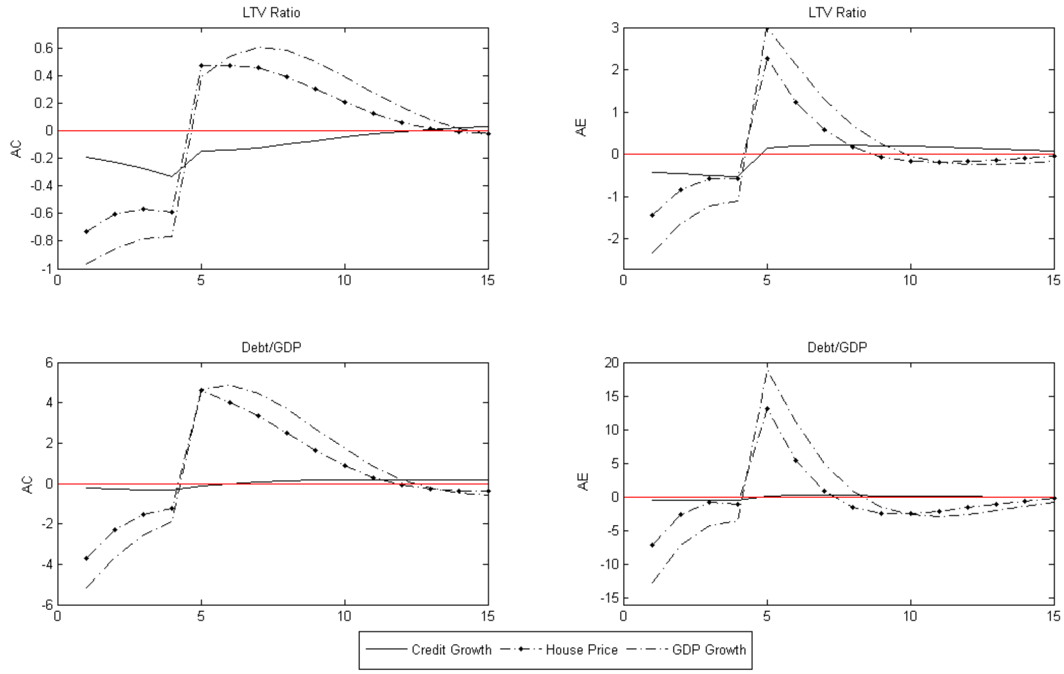

Figure 8: LTV ratio and Debt/GDP responses to alternative LTV ratio rules, $\nu_x = -10$

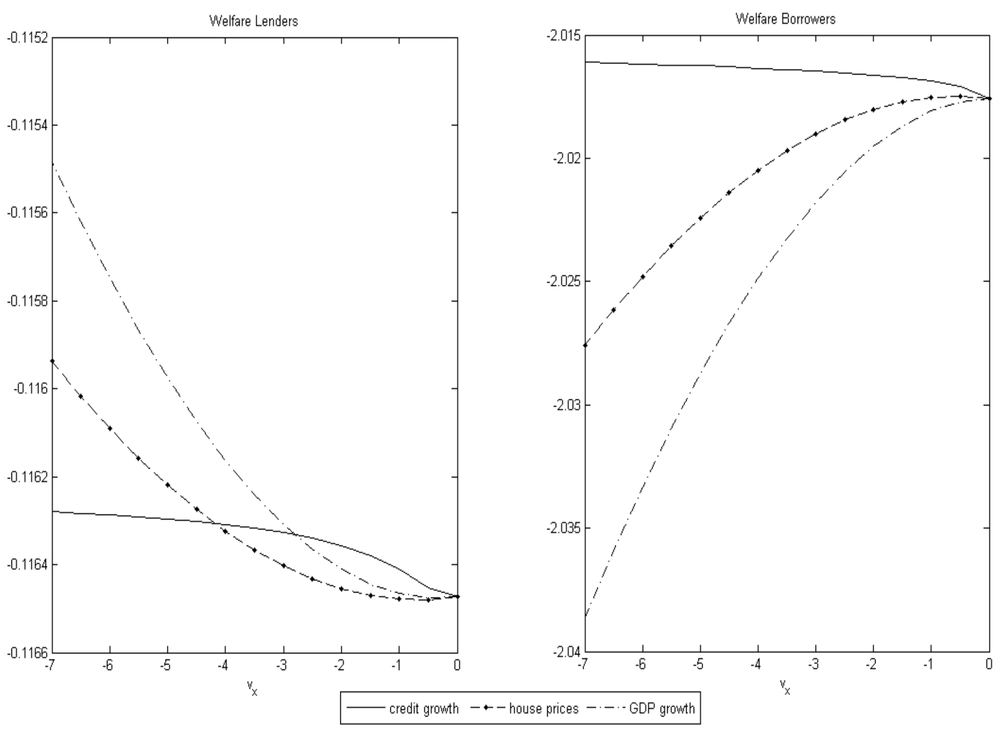

Figure 9: Welfare w.r.t. a macroprudential rule response to either credit growth, GDP growth or house price inflation