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MONETARY, MACROPRUDENTIAL POLICIES AND HOUSING CYCLES: EXPLORING THE NEXUS IN TURKEY†

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Abstract

Given the pro-cyclicality of the financial cycles on the business cycles, it is of importance to analyze whether the use of the traditional monetary policy instruments along with the prudential responsibilities result in the prevention of unsustainable financial cycles e.g., housing cycles. Still, there is not enough empirical evidence regarding the exploration of the nexus between housing variables and monetary – macroprudential policy rules. Observing the developments in housing market in Turkey, that is, the simultaneous increase in both house prices and residential investments in the last decade, the nexus between housing market and macro economy deserves a further investigation.

Accordingly, a new Keynesian DSGE model is estimated with Turkish data for a period 2010-2014 using Bayesian techniques in this study. Results reveal that arguments for a monetary policy regime that produces aggregate price stability will, as a byproduct, tend to promote stability of housing markets don't fully hold in the estimation. It can also be stated that the monetary policy rules with existing prudential policy instruments may not result in prevention of further housing "bubbles". The variance-shock decomposition analyses show that demand and supply shocks dramatically determine the cycles of the real housing prices and residential investment whereas the monetary policy shocks and shocks in central bank's inflation target do not explain the volatility of the housing variables.

Keywords*: Monetary policy; Macro-prudential policy; New Keynesian economics; Housing markets; Dynamic stochastic general equilibrium models.*

JEL Classification: *C61, D58, E44, E58, E61.*

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PARA POLİTİKASI, MAKRO İHTİYATİ POLİTİKALAR VE KONUT DÖNGÜLERİ: TÜRKİYE İÇİN İLİŞKİNİN İNCELENMESİ

Özet

Finansal çevrimlerin iş çevrimleri üzerindeki aynı yönde olan etkisi göz önüne alındığında, geleneksel para politikası araçlarının, ihtiyati tedbirlerle birlikte konut dalgalanmaları gibi finansal çevrimlerin önlenmesinde kullanılıp kullanılamayacağının incelenmesi önemlidir. Ancak henüz konut değişkenleri ve para politikası-ihtiyati politikalar arasındaki bağa ilişkin yeterli ampirik bulgu bulunmamaktadır. Bu açıdan, Türkiye'deki son on yılda yaşanan konut fiyat ve yatırımlarındaki eş zamanlı artış şeklinde gözlemlenen konut piyasasına ilişkin gelişmeler, konut piyasası ve makro ekonomi arasındaki ilişkinin araştırılmasını daha değerli kılıyor.

Yukarıdaki bilgiler ışığında, bu çalışmada Bayesyen yöntemler kullanılarak, Türkiye için 2010-2014 dönemlerini kapsayan bir yeni Keynesyen DSGE modeli tahmin edilmiştir. Çalışmada toplam fiyat istikrarını sağlamak için kullanılan para politikası rejimlerinin ikincil bir sonuç olarak konut piyasalarının istikrarını sağlayacağına ilişkin görüş gözlenmemiştir. Ayrıca, halihazırdaki para politikasının ve makro ihtiyati tedbirlerin ileride oluşabilecek konut balonlarının önlemesinde yetersiz olduğu görülmüştür. Varyans ve şok dekompozisyon analizleri, reel konut fiyatları ve konut yatırımlarının döngülerini belirlemede talep ve arz şoklarının önemli bir yer tuttuğunu, buna karşın para politikası ve enflasyon hedeflemesi şoklarının konut değişkenlerindeki dalgalanmaları etkilemediğini göstermiştir.

***Anahtar Kelimeler**: Para politikası; Makro-ihtiyati politikalar; Yeni Keynesyen ekonomi; Konut piyasaları; Dinamik stokastik genel denge modelleri.*

***JEL Sınıflaması:** C61, D58, E44, E58, E61.*

1. Introduction

Financial sector has important pro-cyclical effects on real economy and the latter lays heavily hopes on the former to function properly. In furtherance of this pro-cyclicality, the global financial crisis of 2008-2009 revealed the severe macroeconomic consequences of the financial imbalances-instabilities. Since the eruption of the last global financial crisis stability of the financial sector issue has been analyzed further for its relevance with monetary policy and is still at the hearth of policy discussion among both policymakers and academicians. The debate essentially revolves around whether the policy rules in a price stability oriented monetary policy framework should be extended to deal with financial stability objectives as of provision of the stability of the asset prices. In other words, the arguments are mainly made for whether the use of monetary policy instruments results in prevention of unsustainable asset cycles e.g., housing boom-bust cycles or not.

Observing the pro-cyclicality of the housing boom-bust cycles on the real activity in the global financial crisis episode, effectiveness of the post-bust policy intervention has been intensively criticized, so that various arguments regarding the integration of prudential responsibilities within the monetary policy function for prevention of financial imbalances have been contributed. Main argument is that the central banks should use the policy rate to prevent the imbalances in the financial sector together with the provision of price stability. Furthermore, it is argued that, using the short-run policy rates, central banks can respond to asset price changes to reduce probability of occurrence of financial imbalances in the future at the expense of deviations from targeted level of inflation and output today. Contrary to this, arguments for separation of monetary and financial responsibilities suggest that financial regulatory authorities should deal with prudential issues to strengthen banking supervision and provide financial stability objectives without taking monetary authority's objectives into account. Asking for a more preventive-proactive policy framework, many countries have adopted some macro-prudential policy instruments as of loan-to-value (LTV henceforth) cap for the sake of prevention of housing bubbles. However, still there is not enough empirical evidence regarding how effective the monetary policy tools are in prevention of these unsustainable financial cycles and how much the effectiveness of those tools differs when some macro-prudential policies are accessorily considered, which is also valid for the case of Turkish economy.

Observing the developments in housing market in Turkey, that is, the simultaneous increase in both house prices and residential investments in the last decade and acknowledging the pro-cyclicality of housing market on macroeconomic fundamentals, the nexus between housing market and macro economy deserves a further investigation. Accordingly, main aim of this paper is to explore the main dynamics of housing variables and the nexus between housing market and monetary-prudential responsibilities for Turkish economy observing those developments in the housing market.

To see the main dynamics of housing variables and how effective the monetary policy tools are in prevention of these unsustainable housing cycles along with how much the effectiveness of those tools differs when some macroprudential policies are accessorily considered, dynamic stochastic general equilibrium (DSGE henceforth) model of Iacoviello and Neri[1] is estimated with Turkish data for a period 2010-2014 using Bayesian estimation techniques. This model provides a detailed description of economy where the housing market is well-defined. The model developed by Iacoviello and Neri is strictly followed in this study without considerable modifications. Accordingly, rigidities in the model economy such as the investment adjustment costs, price rigidity in consumption sector, wage rigidity in both housing and consumption sectors and imperfect competition mechanism are preserved in our study that all together enable us to better observe various business cycle facts of the economy. It is seen from the results that presumptions for a monetary policy regime that produces aggregate price stability will, as a byproduct, tend to promote stability of housing

[1] M. Iacoviello and S. Neri, "Housing market spillovers: Evidence from an estimated DSGE model", **American Economic Journal: Macroeconomics,** Vol. 2, No. 2, 2010, pp. 125-164.

markets[2] don't fully hold in our estimation. Given the inflation targeting policy framework aiming at the price stability, it can be argued that the tighter monetary policy along with the existing prudential policy instruments may not result in prevention of further housing "bubbles". From the variance decomposition analysis, it is reached that demand and supply shocks dramatically determine the cycles of the real housing prices and residential investment whereas the monetary policy shocks and shocks in central bank's inflation target do not explain the volatility of real house prices too much. Also, historical shock decomposition analysis shows that demand and inflation target shocks had played an important role in generating the variance of policy rate and shifts in the monetary authority's inflation target have contributed to volatility of nominal interest rate. Besides, sensitivity analysis reveals that tighter macro-prudential policy rules with a lower loan-to-value ratio do not significantly change the volatility of the housing variables.

The paper is organized as follows. Section 2 provides a literature review. Section 3 briefly introduces the benchmark model. Then, in Section 4, the data and estimation procedures are introduced. The results are given in Section 5. In Section 6, some conclusions are drawn.

2. Literature Review

Regarding the dynamics of boom-bust cycles in housing variables i.e., house prices and residential investments through their integration with monetary policy rules and macro-prudential responsibilities, it arises that the literature primarily hashes out two related challenges: of so-called "lean versus clean debate" and of how to integrate housing and asset prices into monetary policy function[3].

Arguments on these two debates revolve mainly around how aggressive monetary authorities should respond to the asset price bubbles and differ mainly in two groups as Bernanke[4] conceptualized with *lean-against-the-bubble* strategy with a more moderate policy action where central banks use monetary policy to target the economy, not asset markets and *aggressive-bubble-popping* with a more activist policy framework where central banks raises policy rates proactively to eliminate potential bubbles in asset prices. Bernanke finds proactive approach to bubbles as problematic and states that if we intend to use monetary policy as the instrument, monetary authority cannot reliably identify bubbles in asset prices and even if it could identify real estate booms, monetary policy is too blunt a tool to use effectively against them. Concerning the precrisis episode, along these lines, main policy tenet in most economies was defined as waiting for the bust and fixing distortions rather than attempt-

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2 M. Bordo and et al., "Aggregate price shocks and financial instability: an historical analysis", **NBER Working Paper**, no.7652, 2000, p.27.

3 K.J. Lansing, "Monetary policy and asset prices", **Federal Reserve Bank of San Francisco**, 2008.

4 B. Bernanke, "Asset Price Bubbles and Monetary Policy", Speech before the New York Chapter of the National Association for Business Economics, New York, 2002.

ing to prevent the bubbles. Two assumptions are made in provision of such a policy framework: the assumption that it is so difficult to identify unsustainable booms in real time and that the distortions associated with avoiding from a boom outweigh the costs of cleaning up after a bust[5]. In a similar vein, Bordo et al. state that "despite the influence of regulation and other institutional factors…a monetary policy regime that produces aggregate price stability will, as a byproduct, tend to promote stability of financial system"6.

However, observing a bust cycle of global financial crisis of 2008-2009 that triggered a deep recession episode, effectiveness of a post-bust policy intervention on prevention of emerging costs has been intensively criticized. Main argument is as stated by Otaviano and Cavallari[6] that "confidence in combining inflation-targeting-cum-flexible-exchange-rate regimes with isolated micro-prudential regulation as a way to guarantee both macroeconomic and financial stability has been shattered by the scale and synchronization of the asset price booms and busts that preceded the global financial crisis". After the great recession it is extensively believed that "if monetary policy authorities and prudential regulators are to succeed in achieving stability, there can be no complacency regarding asset price cycles"8.

In contrast to policy tenet defined above, Borio and Lowe[7] mainly argue that financial imbalances can arise in a low and stable inflation policy environment and suggest that despite to the difficulties in foreseeing of financial imbalances ex ante, historical boom-bust cycles provide some evidence in favor of useful measures to show that monetary policy can also respond to such imbalances and that cooperation between monetary and prudential authorities is essential. Blanchard et al.[8] state that the policy rate is a poor tool to deal with many financial system imbalances, such as excess leverage, excessive risk taking, or apparent deviations of asset prices from fundamentals. They argued that a higher policy rate to deal with excessively high asset price will result in cost of a larger output gap leading the central bank to face a difficult task of a trade-off within its traditional policy framework. Hence they argued that macroprudential policy as of a rule on LTV ratio can be defined to address specific financial system imbalances. Besides, Quint and Rabanal[9] stated that the conventional

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5 C. Crowe et al., "Policies for Macro financial Stability: Options to Deal with Real Estate Booms," **IMF Working Paper Series**, no.11/91, 2011, p.3. 6 Bordo et al, Ibid.

6 C. Otaviano and M. Cavallari, "Asset Prices, Macro Prudential Regulation, and Monetary Policy", **World Bank Research Paper**, no.6316, 2013, p.1. 8 Otaviano and Cavallari, Ibid.

7 C. Borio and P. Lowe, "Asset prices, financial and monetary stability: Exploring the nexus", **Bank for International Settlements Papers,** no.114, 2002.

8 O. Blanchard et al., "Rethink Macroeconomic Policy", **Journal of Money, Credit and Banking**. Vol. 42(s1), 2010, pp: 199-215.

9 D. Quint, and P. Rabanal, "Monetary and Macroprudential Policy in an Estimated DSGE Model of the Euro Area", **IMF Working Paper Series**, no.209, 2013, p.4. 12 A. Crockett, "Marrying the Micro- and Macro-prudential Dimensions of Financial Stability", **Geneva Reports on the World Economy**, 11, 2000.

monetary policy is too blunt of an instrument to address the imbalances within financial sector or overheating in one sector of the economy i.e. housing sector.

Macro-prudential policy is not a new concept in reconsideration of the financial imbalances regarding its instruments, objectives and relations with the monetary policy, but has been more emphasized in the post-crisis episode. Crockett12 marks out precisely micro- and macro-prudential dimensions of financial stability referring broadly macro-prudential objective as limiting systemic risk and micro-prudential one as limiting idiosyncratic risk of individual institutions.

In the pre-crisis episode, despite the remarks on emphasis of the macroprudential objectives as pointed out above, there was still not a literature on macro-prudential policy that is close arriving at a consensus regarding the objectives due a considerable extent to the fundamental lack of understanding of systemic risk and pro-cyclicality of financial system. The financial crisis has emphasized the need for a new macro-prudential policy framework to prevent the build-up of systemic financial risks. Accordingly, in the post-crisis episode, asking for a more preventive-proactive policy framework, macro-prudential policy tools have been reconsidered to reduce the risks-imbalances related to real estate sector. Hence forth, many countries have made provisions against financial imbalances by defining new institutional arrangements or improving the existing ones. The LTV rule as a macro-prudential instrument to fill the policy gap comes first among the policy instruments in reducing systemic risk resulted from boombust cycles in housing markets. LTV ratio that directly limits risky lending by a restriction on borrowing upon the value of the housing assets enhances resilience to risks from real estate sectors. In discussion of housing finance systems in emerging and newly industrialized economies, in IMF report[10] it is shown that LTV ratios on new loans in the name of restraining booms in mortgage credit and real estate prices or increasing resilience to occurrence of bust episode, vary widely across countries and that in the pre-crisis episode, a number of Asian (emerging) countries had used LTV caps, while implementation of LTV limits in advanced economies has been relatively rare, introduced after the onset of global financial crisis. Empirical evidence shows that many countries- both industrialized and emerging- have adopted this policy instrument in the postcrisis episode[11].

In Gelain and Lansing[12], some monetary and macro-prudential policy instruments are analyzed for exploring their contribution in reducing excess volatility of housing prices in a DSGE model. In evaluation of the policy tools, they point out that an interest rate rule of the central banks that responds to either house price booms or credit expansion provides some benefits. Additionally, under such policy tools, infla-

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10 International Monetary Fund, "Durable Financial Stability: Get-ting There from Here", in Housing Finance and Financial Stability – Back to Basics, **Global Financial Stability Report**, 2011.

11 C. Lim et al., "The Macro prudential Framework: Policy Responsiveness and Institutional Arrangements", **IMF Working Paper Series,** no.166, 2013.

12 P. Gelain and K.J. Lansing, "House prices, expectations, and time-varying fundamentals", **Journal of Empirical Finance Elsevier**, Vol. 29(C), 2014, pp: 3-25.

tion volatility improves, which is essentially very contrary to the inflation-targeting policy framework. Regarding the macroprudential policy they implement the LTV rule and state that a reduction in the LTV ratio from 0.7 to 0.5 substantially reduces the volatility of house prices, but output volatility is magnified. In a similar vein, Rubio and Carrasco-Gallego[13] consider a macro-prudential rule on the LTV rate that responds to credit expansion in reconsideration of the impact of monetary and prudential policies on the business cycles and welfare and find that the macro-prudential authority that uses a lower ratio of LTV cap can moderate the credit bubbles in the name of provision of financial stability.

3. The Model

The model developed by Iacoviello and Neri17 is used in this paper as the benchmark model without a worth-mentioning modification. It is a new Keynesian dynamic stochastic general equilibrium model and it can be regarded as a medium-scale one. Because of lack of space we describe the basic structure of the model economy in this paper without giving a detailed explanation of model equations. For mathematical derivations for the equations of the model the original paper of Iacoviello and Neri[14] can be referred. Figure 3.1 shows the basic structure of the model and the channels through which the agents in the economy interact with each other.

The modeling economy features two sectors – housing and non-housing (or consumption goods) sectors-, heterogeneity in households' discount factors and collateral constraints tied to the housing prices. There are two types of households: patient ones as the lenders and impatient ones as the borrowers. Patient households consume, work and accumulate housing. They supply funds to firms and to impatient households and own the productive capital in the economy. Impatient households consume, work and accumulate housing. However, due to their relative impatience, impatient households accumulate only the required "net worth" to finance the down payment of their home. As shown in Table 3.1, both patient and impatient households supply their (homogenous) labor services to hypothetical labor unions. Assuming some monopoly power over nominal wages the labor unions transform labor unions into differentiated labor inputs and sell these labor inputs to the firms. This assumption introduces the wage rigidity into the model à la Calvo[15] to prevail in both consumption and housing sectors. Besides, financial frictions are defined in the model economy through borrowing constraint on the impatient households, which determine the maximum

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13 M. Rubio and J. Carrasco-Galllego, J, "Macroprudential and Monetary Policies: Implications for Financial Stability and Welfare", **Centre For Finance and Credit Markets**, 2013.
17 Iacoviello and Neri, Ibid.

14 M. Iacoviello and S. Neri, "Appendix E: Mathematical Derivations for the equations of housing market spillovers: Evidence from an estimated DSGE model", https://www2.bc.edu/matteo-iacoviello/research_files/NERI_APPENDIX_E.pdf, Accessed (7 july 2015).

15 G. Calvo, "Staggered prices in a utility-maximizing framework", **Journal of Monetary Economics**. Vol. 12, 1983, pp: 383–398.

amount they can borrow from the patient households. In this borrowing constraint, LTV ratio is introduced as the macro-prudential policy instrument. As stated by Gerali et al.[16] policy implication of this rule is that when the economy is exposed to an excessive credit growth, a lower LTV ratio is determined, which results in collateral constraints to become tighter. Another (microeconomic) implication of the rule is that $(1 - \text{LTV ratio})$ can be defined as the proportional cost of the collateral re-possession for the patient households who own the loans in the case of possible default of impatient one.

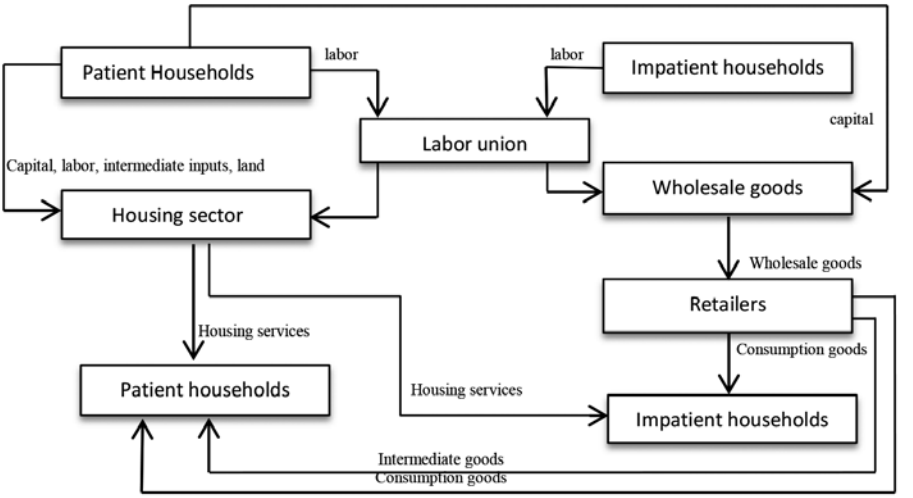
Regarding the production side of the economy there exist two sectors, that is, non-housing or consumption goods and housing sectors with two different technologies. The non-housing sector uses capital and labor to produce consumption goods and business capital. The housing sector produces housing services combining business capital, labor and land. Besides, in the modeling economy, there is the assumption of price rigidity in the consumption sector but flexible price mechanism in housing sector. As shown in Figure 3.1, price stickiness is introduced by assuming monopolistic competition at the retail level, so that retailers purchase goods from the wholesale firms in a competitive market and transformed into final goods by selling at a markup over the marginal cost.

There exists also a monetary authority in the model economy, not denoted in Figure 3.1. The modeling economy is assumed to follow an inflationtargeting policy regime in which the central bank sets the policy rate that responds to inflation and output gap. The implication is that the central bank changes the nominal interest rate in response to the deviations in inflation from its steady state level and the deviations in total output from the natural level. Besides, central bank takes previous value of nominal interest rates into consideration in determining the current nominal interest rate. It is also assumed that there are linear deterministic trends in the technologies in the consumption, residential and business investment sectors, in turn determine the growth rates of these variables as well as that of house prices.

Using a rich set of shocks to the model economy it is aimed to explicate the main dynamics of the housing sector, understand the nexus between housing variables and monetary policy for case of Turkish economy and see whether introducing a macro-prudential instrument – LTV rule in our case – makes any difference when some shocks hit to the economy.

[16] A. Gerali, et al., "Credit and Banking in a DSGE Model of the Euro Area", **Bank of Italy Working Paper Series**, no. 740, 2010, p. 14.

Figure 3.1: Basic Structure of the Model



Source: Authors' calculation

4. Data and Estimation

The model is estimated using quarterly data from the first quarter of 2010 to the last quarter of 2014 where the observable variables are real consumption, real residential investment, real non-residential investment, real house prices, inflation, nominal interest rate, worked hours and wage inflation in housing and in consumption sectors. Due to the limited availability of data for price index in housing sector for Turkey, a relatively short length of sample period for estimation is determined. However, while this sample period is obviously shorter than a desired one, observing the studies with similar sample length[17], the aforementioned sample period is considered as elucidative in estimation of the parameters.

Following the literature, some standard transformations are defined to make the data series consistent with the corresponding model variables. Corresponding data sets are taken from the database of Turkish Statistical Institute (TurkStat) and Central Bank of Turkey (CBT). The data sets for final consumption expenditures, construction production and gross fixed capital formation are expressed in per capita terms, deflated by CPI inflation and transformed into logarithmic form to have series for consumption, residential investment and business investment respectively. For real house prices, the new housing price index is used and deflated by CPI inflation. To have series for hours in housing sector and consumption sector, total employment data is divided by labor force, demeaned. For inflation data CPI inflation is chosen,

[17] H. Alp and S. Elekdağ, "The Role of Monetary Policy in Turkey during the Global Financial Crisis", **Central Bank of Turkey Working Paper Series**, no.11/10, 2011.

demeaned. For nominal short-term interest rate, the one week repo rate is chosen, demeaned. Lastly, to have wage inflation in housing and consumption sectors, data sets for quarterly changes of gross wage-salaries index in construction sector and total industry are used, demeaned respectively.

The model is richly parameterized where some of the parameters are calibrated, some are determined in accordance with their steady state values and the remaining is estimated. Steady state values are given in Table 4.1 and calibrated parameters are given in Table 4.2. In order to determine the structural parameters, the literature is strictly followed. Following Alp and Elekdağ[18], discount factor of patient household is determined at this rate, which gives a steady state annualized real interest rate of 3% as shown in Table 4.1. Inclusion of a different value for the discount factor of the impatient household does not create important effects on the dynamics of the model economy, but it does generate a binding borrowing constraint in equilibrium for impatient household by guaranteeing a large enough impatience motive for these agents[19].

Depreciation rate in the housing sector is taken as 0.0125 so that 5% is the annual depreciation rate of the housing stock. This parameter along with the weight on housing in the utility function gives a ratio of the residential investment to total output at around 6% given in Table 4.1. This ratio is close to share of housing in total output in data for Turkey. Similarly, the depreciation rate in the capital in the consumption sector and capital in the housing sector are set equal to 0.035 and 0.03, respectively[20]. It gives that the construction machinery has slightly longer life time (which demonstrates an annual depreciation on capital at 12 percent) than the non-residential equipment (which gives an annual depreciation rate of 14 percent). This is also supported by Yeldan and Kolsuz[21]. Considering the parameter related to macro-prudential policy tool, the LTV ratio on (mortgage loans) is set at 0.75, determined by Banking Regulation and Supervision Agency (BRSA) in Turkey in 2010. The parameters for the steady state rate of mark-up in the price and wage settings are calibrated since these parameters are difficult to estimate. Lastly, the correlationpersistence of the inflation objective shock is set at 0.95. A high value for demonstrates low-frequency movements well in inflation. Still, a slightly lower parameter compared to the one in benchmark model is determined given the historical phases of inflation in Turkish economy.

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18 Alp and Elekdağ, Ibid.

19 M. Iacoviello, "House prices, borrowing constraints, and monetary policy in the business cycle", **American Economic Review,** no.95, 2005, pp: 739-764.

20 C. Yüksel, "Role of Investment shocks in explaining Business Cycles in Turkey", **Central Bank of Turkey Working Papers**, no.1312, 2013.

21 E. Yeldan and G. Kolsuz, "1980 Sonrası Türkiye Ekonomisinde Büyümenin Kaynaklarının Ayrıştırılması", **Çalışma ve Toplum**, no.1, 2014, pp: 49-66.

Table 4.1: Steady State Ratios

Description	Values
consumption share in total output	67%
housing investment share in total output	6%
business investment share in total output	27%
annual real interest rate	3%

Table 4.2: Calibrated Parameters

Parameters	Values
discount factor of patient households	0.9928
discount factor of impatient households	0.97
parameter for the weight on housing in the utility function	0.1
capital share in the goods production function	0.30
capital share in the housing production function	0.10
land share in the housing production function	0.10
steady state share of the intermediate goods	0.10
the depreciation rate in the capital in the housing sector	0.03
the depreciation rate in the capital in the consumption sector	0.035
Depreciation rate in the housing sector	0.0125
LTV ratio	0.75
steady state price mark-up in the consumption-good sector	1.15
steady state wage mark-up in the consumption-good sector	1.15
steady state wage mark-up in the consumption-good sector	1.15
persistence of the inflation objective shock	0.95

In determination of the prior distributions, their means and standard deviations, the literature is closely followed, so that gamma distribution is assumed for positive parameters; the beta distribution is assumed for the parameters which vary between 0 and 1; inverse gamma distribution is assumed for the standard errors of shocks and normal distribution is chosen for the remaining. The values regarding the choice of prior distributions, the means, standard deviations and degrees of freedom of the estimated parameters, being consistent with previous studies, are given in Table 5.1. Specifically, regarding the monetary policy rules, the interest rate smoothing coefficient is set at 0.7 and the priors on responsiveness of the standard Taylor rule to inflation, output gap are determined at 1.4 and 0.25, respectively, following Alp and Elekdağ[22]. Since the central bank's main policy objective is the provision of price stability, a higher value for the response to inflation is determined relative to that for output gap. The prior means of both the Calvo-type price and wage parameters are set at

[22] Alp and Elekdağ, Ibid.

0.5 which are close to the estimates of Çebi[23]. Also, following Smets and Wouters[24] the prior means for the indexation parameters are set at 0.5.

In Table 5.2, the values for choice of prior distributions for the persistence parameters and standard deviations belonging to the stochastic processes are given. Accordingly, the shock persistence parameters are set with a mean of 0.80 and a standard deviation of 0.10. Also, being close to the previous studies and observation sample, the prior means for the standard deviations of shock processes are given.

In estimation of the parameters of model, Bayesian estimation techniques are applied following An and Schorfheide[25] and Schorfheide[26]. In this study we use the Metropolis algorithm. We linearize the equations of the model economy to describe the equilibrium conditions around the balanced growth path. Given the parameter values, the solution of the set of equations is defined in the form of a state-space model, so that the likelihood function is obtained. The model is solved numerically using the toolbox Dynare over MATLAB.

5. Results

In this section we discuss the results of the estimation over the posterior estimates of the model parameters, followed by the impulse response analysis, variance and shock decomposition analysis and sensitivity checks. In Table 5.1 and 5.2, the posterior means and their 95% confidence intervals for both structural parameters and shock processes are given. These tables report the posterior means of the estimated parameters where draws from the posterior distributions are obtained with the Metropolis-Hastings sampling algorithm based on a total sample of 500,000 draws.

From the posterior kernel density estimates for estimated parameters and shock processes, it is seen that the sample period is quite informative in estimation of the parameters though it is obviously shorted than desired one. Still, comparison of the parameter estimates with previous studies can be less elucidative than desired due to certain reasons. One is that the structural features of the economies studied may differ. Also, sample period and choice of time series may differ across studies. Another reason is the modeling differences in these studies i.e., use of a different monetary policy rule[27].

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23 C. Çebi, "The Interaction between Monetary and Fiscal Policies in Turkey: An Estimated New Keynesian DSGE Model", **Central Bank of Turkey Working Papers**, no.1104, 2011.

24 F. Smets and R. Wouters, "Shocks and Frictions in U.S. Business Cycles", **American Economic Review,** no.97(3), 2007, pp: 586-606.

25 S. An and F. Schorfheide, "Bayesian analysis of dsge models", **Econometric Reviews,** No.26, 2007 pp: 113–172

26 F. Schorfheide, "Estimation and Evaluation of DSGE Models: Progress and Challenges", **NBER Working Paper,** no.16781, 2011.

27 Alp and Elekdağ, Ibid.

The posterior estimate of the habit persistence in consumption for both patient and impatient agents is found around 0.5, implying a moderate degree of consumption smoothing patterns of both agents. The degree of habits in consumption is lower than the estimates of some other studies, e.g., Alp and Elekdağ[28] who find a higher degree of habit formation in consumption patterns of households in their study for the case of Turkey.

The posterior estimates of the parameters on the monetary policy rules coincide with the previous evidence. First, it is found that estimate of the interest rate smoothing parameter in Taylor-type policy rule is slightly below of 0.70. Second, the estimate of the inflation weight parameter in Taylor rule is around 1.55. Third, the estimate of the output gap parameter is around 0.25. These coefficients regarding the responsiveness of the policy rates coincide with the other findings as of Smets and Wouters[29]. Thus, given that the primary goal of the Central Bank of Turkey is the price stability within an inflation-targeting policy framework, the estimates of a higher response to inflation gap relative to output gap are in line with the empirical evidence. Also, a relatively high estimate of interest rate smoothing parameter implies that the Central Bank takes the past values of the nominal interest rates into consideration in determining the current level of nominal interest rate.

The posterior estimate for the elasticity of work effort in terms of the real wage for the patient households is around 0.65 and for impatient households is around 0.67, being close to previous studies. Thus, the inverse Frisch elasticity of labor supply gives reasonable wage elasticity for the labor supply, implying a disutility of working around 1.5. Besides, the estimated parameter for the inverse elasticity of substitution across hours in the two sectors for patient and impatient agents is found around 1 in which the former is slightly higher. As stated above, when this parameter is higher than zero, then it is allowed for some degree of sector specificity where the relative hours worked respond less to wage differentials across two sectors. Also together with the elasticity of work effort they imply less than perfect labor mobility across housing and consumption sectors.

In consideration of the nominal rigidities - the Calvo-type parameters in price and wage settings, it is found that the estimate of the Calvo parameter for price settings is around 0.60, which implies that the prices are adjusted for every 2.5 quarter on the average. Thus, in terms of the price rigidity, it is relatively low. It coincides with the empirical study of Özmen and Sevinç[30] (2011) who explore the price rigidity in Turkey using a micro-level data. Their results suggest that in terms of price stickiness, it is low in Turkey. Additionally, they argued that there exists a mixed pricing strategy which is a combination of state and time dependent pricing and there is great heterogeneity across groups in Turkey, Thus, a reliable comparison of the results for

28 Alp and Elekdağ, Ibid.

29 Smets and Wouters, Ibid.

30 M.U. Özmen and O. Sevinç, "Price Rigidity in Turkey: Evidence from Micro Data", **Central Bank of Turkey Working Paper Series**, no.11/25, 2011.

this parameter with the other studies in literature is difficult. Also, the estimates of the Calvo-type parameter in wage settings in consumption goods sector and housing sector are 0.56 and 0.35, respectively, implying that the wages in consumption goods sector are adjusted for every 2 quarters and the wages in housing sector are adjusted for every 1.5 quarters on the average. Thus, for the wages, it is found that the stickiness in the housing sector is less than the consumption sector. It is also found that the elasticity of indexation to previous period's inflation is more than 0.5. The parameters regarding the degree of indexation of wages to previous period in goods and housing sectors are around 0.4 and 0.50, respectively, which implies a higher degree of indexation in housing sector. This set of parameters implies that the - both wage and new Keynesian – Phillips curves have backward looking components at a significant rate. Regarding the history of high inflation periods in Turkey, the backward looking behavior of wage and price inflation is meaningful[31].

In consideration of the technological progress for different sectors, it is found from posteriors that there is a high rate of technological progress in the production of business investment goods, followed by the technological progress in housing goods, which is slightly higher than those in consumption goods, which together determine the long-run features of the economy. Accordingly, there is a slow rate of productivity increase in consumption and housing sectors compared to business investment sector.

Table 5.1: Prior and Posterior Distribution of the Structural Parameters

Parameters	Distributions	Prior Distr.		Posterior Distr.		
		mean	Std. dev.	mean	2.5%	97.5%
Habit persistence parameter in consumption of patient Households-HH	Beta	0.5	0.01	0.4959	0.4744	0.5134
Habit persistence parameter in consumption of impatient HH	Beta	0.5	0.01	0.5003	0.4852	0.5111
Interest rate smoothing parameter in Taylor rule	Beta	0.7	0.10	0.6869	0.6072	0.7528
Inflation weight parameter in Taylor rule	Normal	1.4	0.10	1.5683	1.4427	1.7026
Output gap parameter in Taylor rule	Normal	0.25	0.10	0.2719	0.1732	0.3806
Disutility of labor supply for patient households	Gamma	0.66	0.10	0.6576	0.5100	0.8065
Disutility of labor supply for impatient households	Gamma	0.66	0.10	0.6775	0.5363	0.8566
the inverse elasticity of substitution across hours for patient households	Normal	1	0.10	1.0130	0.8700	1.1391
the inverse elasticity of substitution across hours for impatient households	Normal	1	0.10	1.0017	0.8471	1.1312
Calvo-type parameter in price settings	Beta	0.5	0.10	0.6116	0.4779	0.7090
Calvo-type parameter in wage settings in consumption goods sector	Beta	0.5	0.10	0.5688	0.4892	0.6477
Calvo-type parameter in wage settings in housing sector	Beta	0.5	0.10	0.3504	0.2275	0.4803

[31] Yüksel, Ibid.

the elasticity of indexation to previous period inflation rate	Beta	0.5	0.20	0.5385	0.2542	0.8590
the elasticity of indexation of wage to previous inflation rate in goods sector	Beta	0.5	0.20	0.4168	0.1147	0.7114
the elasticity of indexation of wage to previous inflation rate in housing sector	Beta	0.5	0.20	0.4730	0.1951	0.7705
Technological progress in consumption goods	Normal	0.005	0.01	0.0015	-0.0005	0.0034
Technological progress in housing investment goods	Normal	0.005	0.01	0.0016	-0.0008	0.0044
Technological progress in business investment goods	Normal	0.005	0.01	0.0034	0.0009	0.0060
Labor income share of constrained households	Beta	0.65	0.10	0.6537	0.5380	0.8099

In Table 5.2, the posterior means for the persistence parameters and standard deviations of shock processes are given. It is seen from the estimated parameters that all shocks are quite persistent that lie within a range of 0.82 for the shock to labor supply and 0.94 for the shocks to technological progress in goods sector. Observing the estimates of the standard deviations of the shocks it is seen that the volatility of the shocks are quite small in general except for the case of the housing demand shock and for the case of the innovations in stochastic processes in inflation targeting regime. The latter estimate is actually in line with the empirical evidence for Turkey given the frequent changes in the inflation target of the Central Bank for the observation period of 2010-2014. In discussion of the housing sector dynamics, the persistence parameter for the shock to housing preference is 0.90 together with a quite high standard deviation of 0.07. Also, shocks to technological progress in housing sector are also persistent but less volatile. Lastly, it is estimated that the standard deviation of the measurement error for the hours and wage inflation in the housing sector is high for the case of labor supply and low for the case of wage income.

Table 5.2: Prior and Posterior Distribution of the Shock Processes

Parameters	**Distributions**	**Prior Distr.**		**Posterior Distr.**		
		mean	**Std. dev.**	**mean**	**2.5%**	**97.5%**
persistence parameter in shocks to intertemporal preferences	Beta	0.80	0.10	0.8869	0.7748	0.9558
persistence parameter in shocks to labor supply	Beta	0.80	0.10	0.8278	0.7339	0.9273
persistence parameter in shocks to housing preference	Beta	0.80	0.10	0.9036	0.8487	0.9808
persistence parameter in shocks to technological process in goods sector	Beta	0.80	0.10	0.9333	0.8902	0.9671
persistence parameter in shocks to technological process in housing sector	Beta	0.80	0.10	0.8478	0.7214	0.9905
persistence parameter in shocks to technology in non-residential sector	Beta	0.80	0.10	0.8442	0.7290	0.9749
Standard deviation of the innovations in consumption goods sector	Inverse gamma	0.01	0.01	0.0117	0.0082	0.0149
Standard deviation of the innovations in housing sector	Inverse gamma	0.03	0.01	0.0184	0.0142	0.0225

Standard deviation of the innovations in non-residential sector	Inverse gamma	0.01	0.01	0.0086	0.0036	0.0130
Standard deviation of the innovations in intertemporal preferences	Inverse gamma	0.03	0.01	0.0244	0.0184	0.0304
Standard deviation of the innovations in labor supply	Inverse gamma	0.01	0.01	0.0159	0.0112	0.0213
Standard deviation of the innovations in housing demand	Inverse gamma	0.01	0.01	0.0787	0.0258	0.1183
Standard deviation of the innovations in monetary policy rule	Inverse gamma	0.001	0.01	0.0011	0.0008	0.0014
Standard deviation of the cost shocks in consumption sector Phillips curve	Inverse gamma	0.01	0.01	0.0064	0.0043	0.0085
Standard deviation of the stochastic processes in inflation targeting regime	Inverse gamma	0.10	0.01	0.0367	0.0255	0.0492

Regarding the exploration of the nexus between the housing cycles and monetary and macro-prudential policy rules, an analysis over the impulse response functions is carried out. First, an inverse policy shock raising the nominal interest rates is given to economy. Second, a housing preference shock is given to the economy, which may enable us to see how it creates housing collateral effects on the business cycles. Third, technology shocks on housing sector are given to economy. Beside to these shocks, an inflation target shock is considered. In the baseline model, the macro-prudential policy rule of LTV ratio is set at 0.75. Figures below denote the responses of real consumption (data_CC), real business investment (data_IK), real residential investment (data_IH), real GDP (zata_GDP), real house prices (data_QQ) and the nominal interest rate (data_RR) to abovementioned shocks. The term (zata_GDP) denotes domestic demand excluding government purchases and it is not among the observable variables and determined as a function of the components of the aggregate demand i.e., consumption, business and residential investments.

Figure 5.1 denotes an adverse i.i.d. shock to monetary policy rule where the y-axis measures the percent deviation from the steady state values and the solid line is the mean impulse response whereas the thinner lines are the 10% and 90% posterior intervals – as for the other figures. It is seen from Figure that the real house prices do not much drop and remain below its baseline for about 4 quarters as a result of an adverse monetary policy shock.

The Figure also reveals that all components in the aggregate demand side are adversely affected by the shock where the consumption substantially responds to the shock followed by the real business and residential investments. The former drops around 9 percent and remains below its baseline level for about 6 quarters whereas the responses of real business and residential investments are less persistent. The reason for the aforementioned high response of consumption to the monetary policy shocks can be attributed to the existence of nominal rigidities and collateral effects on constrained households that are generated through the financial frictions - relatively tighter LTV ratio. Besides, since the model does not take the collateral constraints and financial frictions into account on the side of the firms, there exists a marginal response of both the real business and residential investments to the adverse monetary

shocks that prompt the nominal rate of interest. As stated by Iacoviello and Neri[32], the collateral effects slightly reduce the sensitivity of investment to these monetary shocks, because unconstrained households shift loanable funds from the constrained households towards firms – as unconstrained agents - in order to smooth their consumption. Additionally, since it is found from the posterior estimates that the wage rigidity in the housing sector is lower than non-residential sector, it can be expected to have less interest rate sensitivity of the residential investment compared to real business investment.

Eventually, from the impulse response analysis over the monetary policy shocks, it is seen that presumptions for a monetary policy regime that produces aggregate price stability will, as a byproduct, tend to promote stability of housing markets and the financial system e.g., Bordo et al.[33], don't fully hold in our estimation. Given the inflation targeting policy framework aiming at the price stability as in the case of Turkey, it can be argued that the tighter monetary policy along with the some prudential policy instruments may not result in prevention of a housing "bubble".

Figure 5.2 denotes the effects of a positive housing demand shock. As seen from the Figure, by creating new demands towards housing, a positive preference shock substantially raises the real house prices which remain above its baseline level for long periods. The estimated autocorrelation of 0.90 for the housing preference parameter contributes the long-lasting increase in house prices. The increase in the demand for the new houses in turn causes residential investment to increase as well. Since a LTV ratio is introduced in the credit constraint, fluctuations in the prices in housing market affect the borrowing capacity of households. Accordingly, a positive housing preference shock increases the value of the housing assets as the collateral of the constrained agents, which increase the borrowing capacity of those agents. As observed from the Figure, this increases borrowing and consumption of the agents in total.

In consideration of the response of residential investments, it is observed that though the housing demand shock results in an increase in real house prices of more than 10 percent, the real residential investments rise at a much lower rate. As stated before, in the model economy, it is assumed that there are flexible prices in the housing sector and that wage rigidity in the housing sector is low, which in together can be the explanatory instruments for response of the construction of new homes being less sensitive the housing demand shock. Overall, there exist significant effects on the real output where the housing preference shock contributes a significant and long-lasting increase in real GDP.

Figure 5.3 plots the responses to positive technology shocks in the housing sector which result in a rise in the real residential investments. Housing technology shock also leads the real house prices to drop and remain below its baseline persistently, which can be attributed to the fall in the unit cost of production of construction

32 Iacoviello and Neri, Ibid.

33 Bordo et al., Ibid.

services. Besides, as a response to positive technology shock, the hours worked in the construction industry rise and the hours in the goods market do not shift– not given in the Figure.

In the monetary policy rule, a stochastic process introduced to implicitly model deviations of inflation from its targeted level which may arise due to shifts in the monetary authority's inflation target. Accordingly, Figure 5.4 shows impulse responses to a shock to the central bank's inflation target that increase the inflation objective there exists a persistent rise in the nominal interest rate and inflation – not given in the Figure. Also, all components of aggregate demand – real consumption, real residential and business investments – increase. However, those effects vanish after around 5 quarters once the nominal rigidities are compensated. Regarding the effects of the positive inflation objective shocks on the real house prices, it is seen that deviations of inflation from its targeted level when the central bank shift its inflation target cause the housing prices to rise and remain above its baseline level for around one year.

Figure 5.1: Impulse Responses: An i.i.d. Monetary Policy Shock

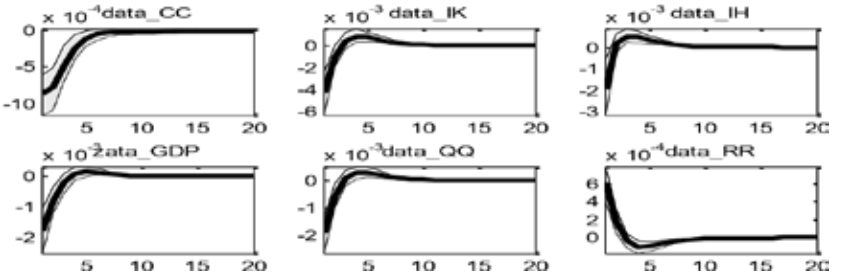


Figure 5.2: Impulse Responses: A Housing Preference Shock

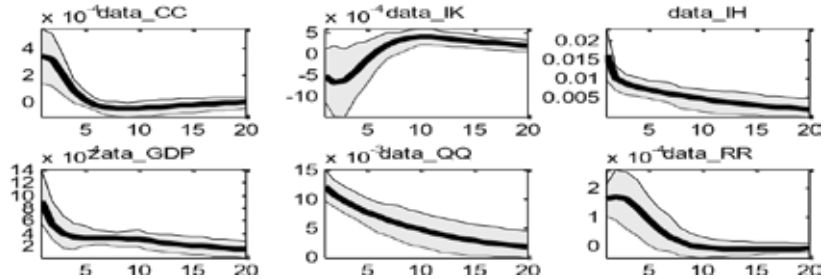


Figure 5.3: Impulse Responses: A Housing Technology Shock

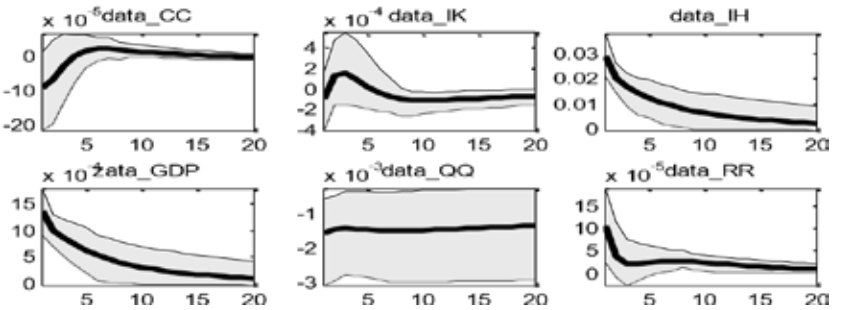
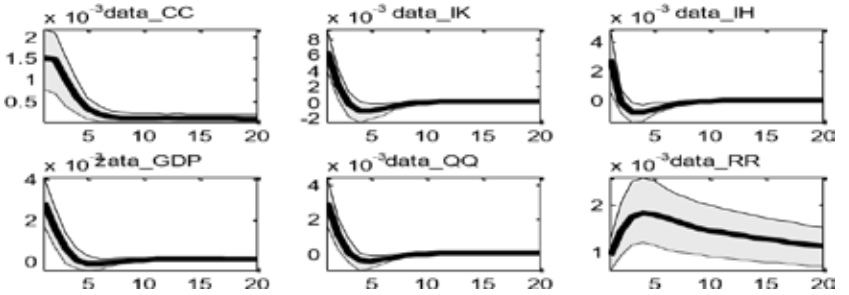


Figure 5.4: Impulse Responses: A Shock in Central Bank's Inflation Target



To consider the dynamic features of the model further, variance, shock decomposition and sensitivity analyses are made. Accordingly, the asymptotic variances of housing and non-housing variables at the business cycles frequencies are computed which enable us to see the role of each shock, in particular to the housing preference, housing investment and monetary policy rules in producing fluctuations in abovementioned variables. In the Tables below nine shocks to the economy are defined in the model where eps_c shows the technology shocks in consumption goods sector, eps_h shows the technology shocks in housing sector, eps_k shows the technology shocks in business investment sector, eps_j shows the housing demand shock, eps_e shows the monetary policy shock, eps_p shows the cost shock, eps_s shows the inflation target shock, eps_t shows the labor supply shock and eps_z shows the shocks to intertemporal preferences. In Table 5.3, the variance decomposition analysis is given considering a relatively *tighter* macro-prudential policy rule where the parameter for LTV ratio is set at 0.75 whereas in Table 5.4, the variance composition analysis is made for a relatively *loose* macro-prudential policy rule i.e., the LTV ratio is set at 0.90. Besides, in Figures 5.5 and 5.6, the shock decompositions of real house prices and real residential investment are given where LTV ratio is set at 0.75 observing the implementation of this rule in practice by financial regulators (BRSA) in Turkey. From both Tables 5.3 and 5.4 some important results are reached such that under both tight and loose mac-

roprudential policy rules, variance of the real house prices are determined by (productivity) shocks in housing sector to a considerable extent and affected by productivity shocks in consumption sector to some extent. Besides, housing preference shocks and shocks to intertemporal preferences are important for the boom-bust cycles of the real house prices. However, a worthy result is that monetary policy shock and shocks in central bank's inflation target do not explain the volatility of real house prices. They appear to explain around 2 percent of the variance of real house prices. Also, use of a different weight for parameter of the macro-prudential policy rule, i.e., LTV ratio is raised from 0.75 to 0.90, does not change the volatility of the real house prices.

Table 5.3: Variance Decomposition (in percent) - A Tight Prudential Policy Rule

Variables	eps_c	eps_e	eps_h	eps_j	eps_k	eps_p	eps_s	eps_t	eps_z
consumption	61.24	0.22	0.02	0.00	5.75	0.68	0.49	0.43	31.16
business investment	10.69	0.17	0.04	0.00	14.51	0.48	0.27	0.08	73.75
residential investment	0.15	0.05	88.29	0.54	0.01	0.02	0.06	0.03	10.85
house prices	11.26	0.11	61.62	20.41	0.11	0.04	0.02	0.00	6.41
GDP	35.65	0.30	7.73	0.05	11.27	0.77	0.51	0.30	43.42
interest rate	2.58	0.46	0.03	0.01	0.71	1.12	46.14	0.02	48.92
inflation	3.70	0.85	0.06	0.01	0.29	4.89	59.99	0.02	30.19

We can conclude that demand shocks represented by housing preference and supply shocks represented by the changes in housing technology and in consumption technology in the housing market determine the boom-bust cycles of the real housing prices. In a similar vein, it is found from the Tables 5.3 and 5.4 that variance of the real residential investment is considerably determined by housing (productivity) shocks and by intertemporal preference shocks to some extent. Also, shocks to monetary policy rules do not explain the volatility of the housing investments.

Table 5.4: Variance Decomposition (in percent) - A Loose Prudential Policy Rule

Variables	eps_c	eps_e	eps_h	eps_j	eps_k	eps_p	eps_s	eps_t	eps_z
consumption	61.54	0.41	0.25	0.04	5.72	0.88	0.87	0.43	29.86
business investment	10.60	0.13	0.09	0.02	14.66	0.42	0.18	0.08	73.82
residential investment	0.10	0.02	88.74	0.47	0.01	0.00	0.02	0.03	10.60
house prices	11.25	0.10	61.63	20.40	0.11	0.03	0.02	0.00	6.45
GDP	35.47	0.31	8.09	0.06	11.21	0.77	0.52	0.30	43.27
interest rate	2.35	0.32	0.17	0.08	0.75	0.91	47.13	0.02	48.28
inflation	2.92	1.24	0.46	0.09	0.31	4.41	61.33	0.02	29.24

Figures 5.5 and 5.6 depict the historical shock decompositions of real house prices and real residential investment during the estimated period of 20102014. Figure 5.5 depicts the historical shock decomposition of real house prices. Meanwhile, we should note that since the paper is colorless printed the figures 5.5 and 5.6 belonging to shock decomposition analysis are not clearly distinguished hence the original paper is available upon request.

As shown in Figure 5.5, consumption productivity shocks have mattered for the volatility of real house prices for the sample period by positively affecting the latter. In addition to this, until the mid of 2011 – shown between 0 and 6 in the Figure - cost-push shocks had played an important role in generating the variance of the real house prices with an adverse effect whereas in the subsequent periods, these type of shocks positively affect the variance of real house prices. Also, as given in the variance decomposition analysis, the housing technology shock has significant effects on real house prices, which can be interpreted such that positive housing technology shocks result in cost of producing housing services in the construction industry to decrease, which is in turn expected to pull down the real house prices.

Figure 5.5 reveals that intertemporal preference shocks appear to generate effects on cycles of real house prices. These shocks have contributed to variance of real house prices by adversely affecting the latter particularly with the early periods of 2011. An interpretation is that the intertemporal preference shocks, e.g. discount shock, result in an increase in consumption on the one side and a fall in the business and residential investments on the other. Accordingly, as shown in the Figure, real house prices was affected adversely, which can be attributed to transition of the preferences from the durable goods to non-durables that in turn reduces the housing demand.

In consideration of the shock decomposition of real residential investments shown in Figure 5.6, it is observed that housing (productivity) shocks was the leading source for the volatility of real residential investments for all the sample period. Besides, intertemporal preference shocks generated adverse effects on cycles of housing investments. As Stated before that the intertemporal preference shocks as of a discount shock result in an increase in consumption and a fall in the business and residential investments which can make a transition of the preferences from the durable goods to non-durables that in turn reduces the housing demand and thus housing investment. From the Figure it is understood that the shocks to monetary policy rules had minor effects on the cycles of housing investment during the estimated period.

Figure 5.5: Shock Decomposition of Real House Prices

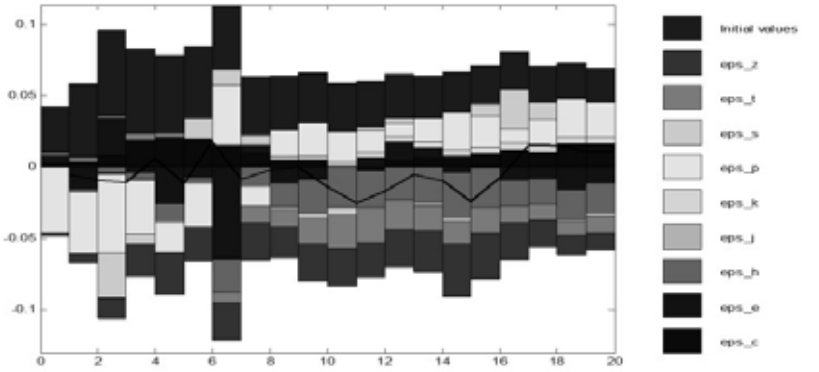
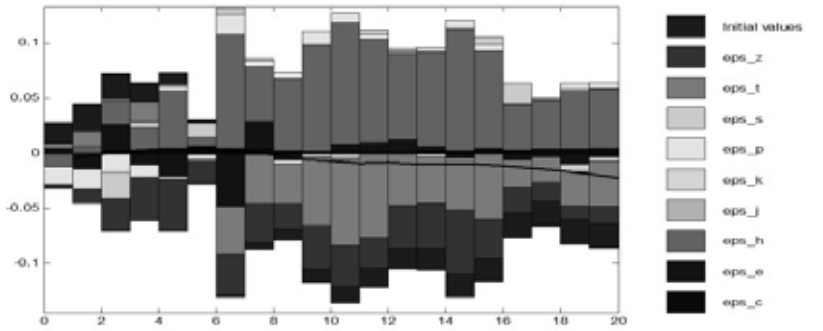


Figure 5.6: Shock Decomposition of Real Residential Investment



In order to understand how important the macro-prudential policy rules are in determining the boom-bust cycles of the housing variables considered accessorily with the monetary policy, a sensitivity analysis is made through

Figures 5.7 and 5.8. Figure 5.7 depicts impulse response functions to a monetary policy shock with two specifications of the macro-prudential policy rule: one is the tight policy rule where LTV ratio is calibrated to value 0.75 and the other is the loose policy rule where the LTV ratio is set at 0.90.

Main argument is that loan-to-value rules can create financial frictions in the credit and housing markets due to possibility of liquidity constraints for potential borrowers and thus of potential trade-offs between financial stability benefits and economic activity[34]. Accordingly, a LTV rule can reduce the volatility of the house prices but in return for deterioration of the economic activity.

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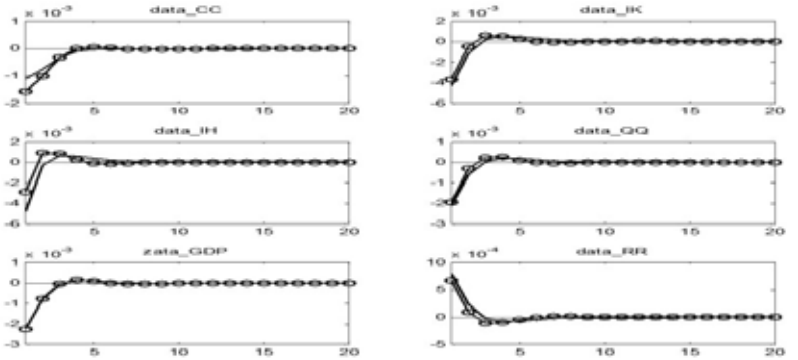
34 Bank of England, "Instruments of Macroprudential Policy", **Bank of England Financial Services Authority staff Discussion Paper**, no.20, 2011, <http://www.bankofengland.co.uk/publications/Documents/other/financialstability/discussionpaper111220.p df> accessed (2 july 2015).

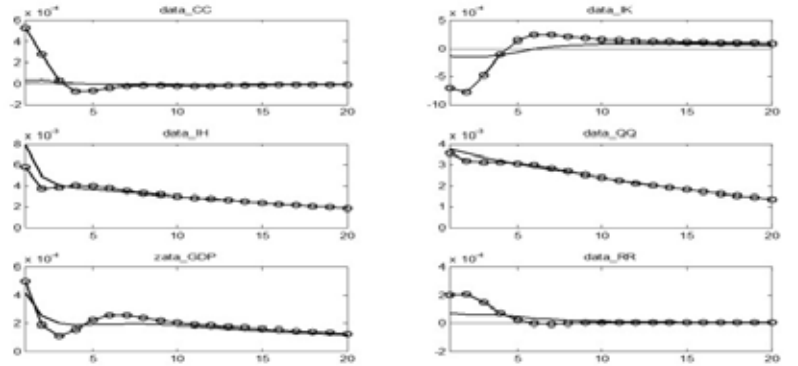
In Figure 5.7, it is examined whether a decrease in the LTV ratio (from a value of 0.90 to 0.75) reduce the volatility of house prices and increase the economic activity. As shown in Figure 5.7, the response of the model variables for different values of LTV ratio is qualitatively the same but there is some difference in magnitude of these responses, particularly for those of consumption and residential investment. However, considering a monetary policy shock, it is clear that two specifications of the LTV ratio do not have a substantial effect on the real house prices. Similarly, in Figure 5.8, impulse responses to a housing demand shock are defined with two specifications of the macro-prudential policy rule, which give similar results with the case of a monetary policy shock. Accordingly, considering the housing preference shock, two specifications of the LTV ratio do not have an important effect on the real house prices but give smoother responses for consumption - with a tighter LTV ratio.

Figure 5.7: Impulse Responses to a Monetary Policy Shock: Sensitivity Analysis



Note: the solid line denotes tight macro-prudential policy rule and dotted line denotes the loose policy rule.

Figure 5.8: Impulse Responses to a Housing Demand Shock: Sensitivity Analysis



Note: the solid line denotes tight macro-prudential policy rule and dotted line denotes the loose policy rule.

6. Conclusion

The pro-cyclical behavior of the financial sector on real economy was well-demonstrated by the global financial crisis of 2008-2009 revealing the severe macroeconomic consequences of the financial imbalances-instabilities which denoted itself through a combination of the excessive credit growth and boom episodes in housing variables on the one hand and the loose monetary and weak regulatory policies on the other. Given such a pro-cyclicality of housing markets on macroeconomic fundamentals, still there is not enough empirical evidence regarding the exploration of the nexus between cycles of housing variables and monetary and prudential policy responsibilities, which is also valid for the case of Turkish economy. Accordingly, it is important to analyze how effective the monetary policy tools are in prevention of these cycles of housing variables and how much the effectiveness of those tools differs when some macro-prudential policies are accessorily considered.

Observing the developments in housing market in Turkey, that is, the simultaneous increase in both house prices and residential investments in the last decade and recognizing that the shocks to the economy may result in unsustainable boom-bust cycles in house prices and residential investments that in turn can create unfavorable effects on Turkish economy through e.g., deteriorations in consumption and credit mechanisms, the nexus between housing market and macroeconomy deserves a further investigation. Accordingly, in this paper we examine the existence of a nexus between cycles of housing variables and monetary and prudential policy responsibilities. Besides, in this paper, the main dynamics and driving forces of the housing variables as well as of some macroeconomic indicators are examined.

A Bayesian estimation of a medium-scale closed economy DSGE model with housing sector is made for the Turkish economy for period 2010-2014. In general terms, it is seen that the sample period is quite informative in estimation of the parameters and that business cycle features of the model show a good data fit though it is obviously shorted than desired one. The results show that under a moderate lean-against-the-bubble strategy, presumption that "aggregate price stability will, as a byproduct, tend to promote stability of financial markets"[35] don't fully hold in our estimation. Given the inflation targeting policy framework aiming at the price stability, it can be argued that the tighter monetary policy along with the some prudential policy instruments may not result in prevention of a housing "bubbles". Also, the variance decomposition analysis reveals that demand and supply shocks dramatically determine the cycles of the real housing prices and residential investment whereas the monetary policy shocks and shocks in central bank's inflation target do not explain the volatility of real house prices too much. From historical shock decomposition analysis, it is seen that demand and inflation target shocks had played an important role in generating

[35] Bordo et al., Ibid.

the variance of policy rate and shifts in the monetary authority's inflation target have positively contributed to volatility of nominal interest rate with the early periods of 2014 though there had been an opposite relation between these two in the previous periods. Besides, sensitivity analysis reveals that tighter macroprudential policy rules with lower loan-to-value ratio do not significantly change the volatility of the housing variables.

For the future research, it would be interesting to consider the capital flows within an open-economy framework in the model economy, so that dynamics of the financial markets and nexus between housing sector and monetary policy rules can be better understood. Besides, some alternative macroprudential policy instruments can be examined.

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