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A regime-dependent investigation of the impact of macroeconomic variables on the housing market activity in Turkey

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Abstract

This paper investigates the impact of macroeconomic variables on the housing market activity in Turkey covering the period from January 1992 to December 2012. To this aim regime-dependent impulse response and forecast error decomposition analysis are conducted based on a two-regime MS-VAR model. We find that M1 and interbank rate account considerable parts of the variation in the housing permits when the economy is in the stable regime. The results suggest that Central Bank might control the housing activity through the use of monetary policy variables.

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1. Introduction

The relationship between the housing market and macroeconomic activity has been extensively analyzed in the literature since the housing sector has crucial forward and backward linkages with important sectors of the economy. Earlier studies mainly focused on the impact of inflation on housing prices (Kearl, 1979; Follain, 1981; Schwab, 1983). Recent studies (Baffoe-Bonnie, 1998; Kholdy and Sohrabian, 1998; Lastrapes, 2002; Ewing and Wang, 2005) have attempted to measure the dynamics between monetary policy and the housing market based on VAR models. However, the nonlinearity and regime changes in the relationship have not been considered in the previous studies.

The Turkish economy presents an interesting case to analyze the nonlinear impacts of macroeconomic aggregates on the housing market. Before the financial crisis in 2001, high public debts and high real interest rates triggered instability in the financial system. Therefore, the volume of total loanable funds remained very limited for households and small enterprises. After the crisis, major reforms in monetary policy and in the banking system enhanced macroeconomic stability, which has been characterized by low inflation and high growth rates. Along with the change in the macroeconomic environment, several structural reforms have been also carried out in the Turkish housing sector. First, the mass construction of new houses has been encouraged by the Housing Development Administration (HDA) of the Turkish government. Second, the introduction of the Mortgage Law in 2007 has led to a significant decline in housing loan interest rates. According to the data released by the Banking Regulation and Supervision Agency 10-maturity mortgage loan rates have declined from 1.4% to 0.85% over the 2007-2012 period. This has created a more than twofold expansion in housing credits, i.e. from 30.823 billion TL to 75.438 billion TL. One can argue that these developments may lead to structural changes in the modeling of the housing market and macroeconomy relations.

Regarding the time series investigation of the relationship between the housing market and macroeconomic activity in Turkey, we find only two studies based on the estimation of VAR models. Sari *et al.* (2007) analyzed the housing market based on a VAR model using the annual data covering the 1961-2000 period. They found evidence for the significant impact of monetary aggregates and employment on housing market activity. Hepşen and Kalfa (2009) investigated the relationship between the housing market and the key macroeconomic variables using monthly data covering the 2002 - 2007 period. They found that macroeconomic variables, in particular national income and interest rate, account for a considerable part of the variation in the amount of housing permits.

Previous studies based on linear VAR models have not explicitly accounted for the impact of the recent economic changes in the modeling of the housing market and economic activity. This study attempts to fill this gap in the literature by examining the relationship with the estimation of a Markov Regime Switching Vector Autoregressive (MS-VAR) model for Turkey.

This paper is organized as follows. The data are introduced in the following section. The methodology and empirical results are presented in section three. Finally, the paper ends with concluding remarks.

2. Data

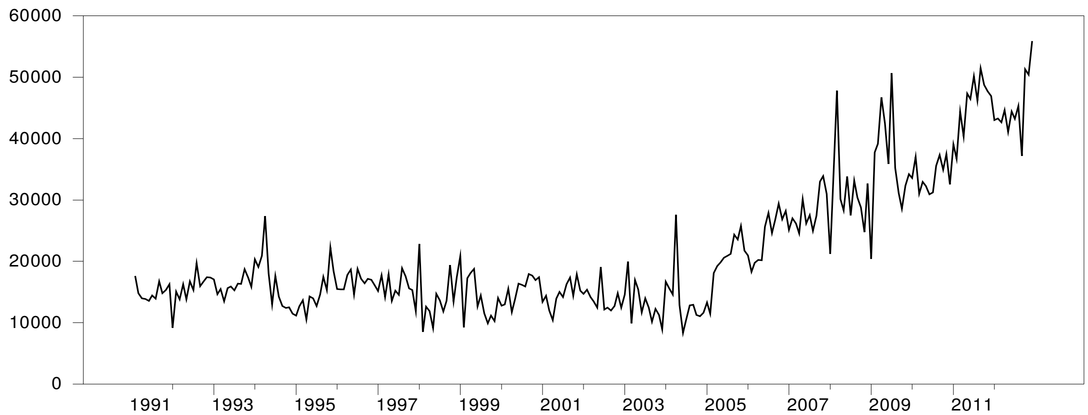
We use a five variable VAR system covering the period between January-1991 and December-2012 with monthly frequency. The variables included in the model are in line with the seminal papers, i.e. Baffoe-Bonnie (1998) and Lastrapes (2002), investigating the same relationship. The data are mainly collected from the Electronic Data Delivery System of the

Central Bank of Republic of Turkey (CBRT) and the online database of the International Monetary Fund (IMF). The vector of endogenous variables is written as follows:

$$Y_t' = \left[lip_t \; intrate_t \; lm1_t \; lcpi_t \; lhp_t \right] \quad . \tag{1}$$

Housing market activity is measured by the number of construction permits for two and more dwelling residential buildings lhp_t (see Figure 1). As a measure of economic activity, we use industrial production index lip_t. $lcpi_t$ is the log of consumer price indices used as a proxy for the general price level. M1 narrow money $lm1_t$ and interbank rate $intrate_t$ are also included to quantify the role of monetary variables on the housing market. The variables are expressed in natural log form except for the interbank rate and they are seasonally adjusted using the Census X12 method.

Figure 1. Housing Permits in Turkey



Although all variables are found to be integrated of order one, the models are estimated in levels.[1] Fuller (1976, Theorem 8.5.1) demonstrated that differencing does not help to achieve asymptotic efficiency in the autoregressive model and results in a loss of information to the VAR framework. This issue has been also considered by a number of studies analyzing the interaction between macroeconomic variables with the VAR models (e.g. Bernanke and Blinder, 1992, Bernanke and Gertler, 1995).

3. Methodology

In the derivation of nonlinear impulse responses and forecast error decompositions, this paper uses the MSIAH (Markov Switching Intercept Autoregressive Heteroscedasticity) specification of MS-VAR model by Krolzig and Toro (2001). The MS-VAR model allowing for all parameters and residual variances, switching between m regimes is defined by the following equations,

$$Y_t = v(s_t) + A_1(s_t)Y_{t-1} + \ldots + A_p(s_t)Y_{t-p} + B(s_t)\varepsilon_t \, , \tag{2}$$

$$s_t = 1, \ldots, m, \; \varepsilon_t \sim N(0, I_K) \, . \tag{3}$$

[1] The stationary of the variables are investigated with Augmented Dickey and Fuller (1981) (ADF), Phillips and Perron (1988) (PP) unit root tests which indicate that variables are stationary at first difference at least at 5 percent significance level. We also applied Lee and Strazicich (2003) allowing for one endogenous structural break in the series. This test rejects the null hypothesis of a unit root with a break for all variables. The test results are available upon request.

Where Y_t is the previously introduced vector of endogenous variables, v is the vector of intercepts and A's are regime-dependent parameter matrices of endogenous variables with K dimension and lag order p. ε_t is the vector of disturbances assumed to be not auto-correlated. It is also assumed that the state variable s_t determining regime of the system follows an ergodic M-state first order Markov chain defined by the following transition probabilities:

$$p_{ij} = \Pr\left[s_t = j \mid s_{t-1} = i\right], \quad \sum_{i=1}^{m} p_{ij} = 1 \quad i, j = 1, ..., M \text{ .} \tag{4}$$

Where p_{ij} is the probability that event i is followed by event j, and a member of the following transition matrix:

$$P = \begin{bmatrix} p_{11} & p_{21} & . & . & . & p_{M1} \\ p_{12} & p_{22} & . & . & . & p_{M2} \\ . & . & . & . & . & . \\ p_{1M} & p_{2M} & . & . & . & P_{MM} \end{bmatrix}. \tag{5}$$

Then the regime-dependent matrix $B(s_t)$ is recovered from the variance covariance matrix of the MS-VAR model as follows:

$$\Sigma_s = E\left[B(s_t)\varepsilon_t\varepsilon_t' B(s_t)'\right] = B(s_t) I_K B(s_t)' = B(s_t)B(s_t)' \text{ .} \tag{6}$$

In order to uncover structural relationship among the variables, we use Choleski decomposition based on the recursive structure of $B(s_t)$ following Ehrmann et al. (2003). The variance decompositions and responses are nonlinear since they account for the regime changes based on regime-dependent structural shocks.

4. Empirical Results

In order to estimate the MS-VAR model in Eq. (2) and (3), this paper employs a maximum likelihood estimation method based on the implementation of the Expectation Maximization (EM) algorithm by Hamilton (1990).[2] Transition probabilities computed through the algorithm are used in the identification of the regimes.[3]

Table I. Testing the nonlinearity and lag length in MS-VAR Model

No. of Lags	**1**		**2**		**3**	
	MS-VAR	**Linear VAR**	**MS-VAR**	**Linear VAR**	**MS-VAR**	**Linear VAR**
Log-likelihood	1549.649	1327.110	1903.170	1469.300	1886.591	1440.439
AIC criterion	-11.127	-9.787	-13.369	-10.501	-13.163	-10.572
HQ criterion	-10.624	-9.541	-12.589	-10.117	-12.106	-10.049
SC criterion	-9.874	-9.174	-11.429	-9.545	-10.533	-9.271
LR linearity test	445.077	(0.000)	892.3056	(0.000)	867.7384	(0.000)

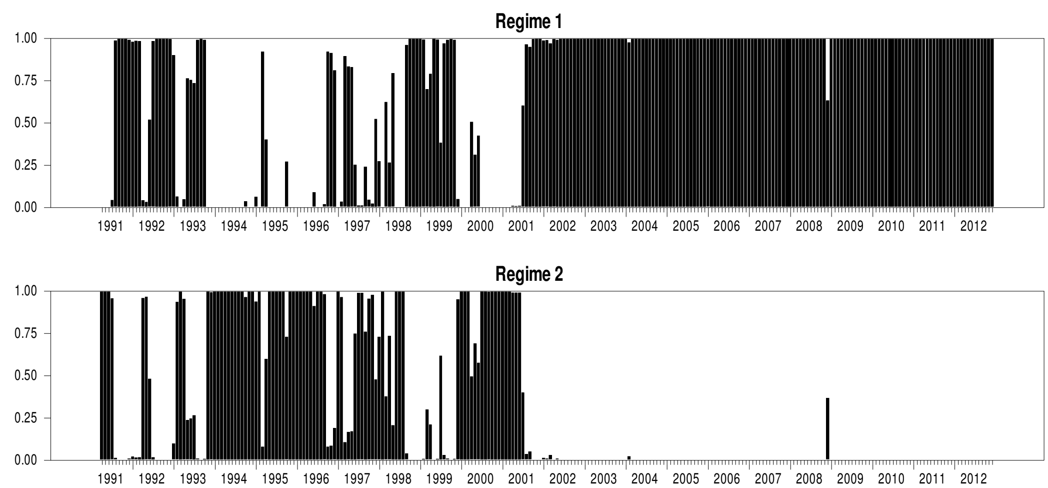
Notes: The probability of Likelihood Ratio (LR) linearity test are given in parentheses. The LR linearity test tests the null hypothesis that the true model is a linear against the alternative of MSIAH and is distributed as $\chi^2(q)$ where q isequal to the number of restrictions under which the two models are identical.

[2]The estimation of the model is based on two steps. First, the initial values of the parameters are determined, and then based on the initial values, transition probabilities are computed. Second, using the transition probabilities, the parameters are estimated with maximum likelihood. These steps are repeated until the convergence of the parameters.

[3]In the determination of the number of regimes (M), the log-likelihood of the two and three regime models are compared following Krolzig (1997) and the number of regimes is determined as M=2.

Before the variance decomposition and impulse response analysis, linearity of the model is checked. To this aim, two-regime MS-VAR and linear VAR models are estimated up to 3 lags and the log-likelihood, Akaike information Criterion (AIC), Schwarz Bayesian Criterion (SBC) and Hannan Quinn Criterion (HQC) are reported in Table 1. The model selection criterions support the superiority of the MS-VAR against the linear model and also indicate that the best fit is obtained when MS-VAR is estimated with 2 lags. Likelihood Ratio (*LR*) linearity tests based on the difference between the log-likelihood of MS-VAR and Linear VAR reject the null hypothesis of the Linear VAR model against the alternative of MSIAH specification. Therefore, they also corroborate the use of nonlinear specification in the modeling.

Figure 2. Regime probabilities for MSVAR Model



The probabilities illustrated in Figure 2 show that regimes are properly identified by high transition probabilities. Regime 1 can be labeled as a stable regime since it mostly covers the periods of Turkey during which time the economy was characterized by relatively high growth and low inflation rates. It also represents the period when important structural changes occurred in the Turkish economy.[4] The monetary policy regime based on a fixed exchange rate system changed after the failure of the IMF stabilization in 2001. An inflation targeting strategy with a floating exchange rate regime was adopted within the price stability objective of the CBRT. These reforms were successful, as inflation declined to a single digit by the end of 2004. On the other hand, regime 2 can be labeled as the unstable regime, as it represents a highly volatile and unstable phase of the economy. During this period, the Turkish economy experienced the 1994 and 2001 economic crises, which were triggered by banking sector fragility and the accumulation of current account deficits (see Alper, 2001 and Akyurek, 2006).

The properties and transition probabilities of the regimes are reported in Table 2. Regime 1 had a longer duration, with 14.7 months and contains 70.3% of the total number of observations. Regime 2 has fewer observations with a lower transition probability. Diagonals of the transition matrix (p_{11} and p_{22}) illustrate that the probability of the system remaining in

[4] The period starting from the second half of the 1998 up to the beginning of 2000 is also belong to stable regime as indicated by high transition probabilities. This can be attributed to the successful implementation of a staff-monitored agreement with IMF during that period. Despite the negative impact of Russian crisis, the program based on tight fiscal policies had led to relatively more stable macroeconomy as evidenced by the considerable decline in the interest rates and inflation.

the current regime are more than 80% for each regime. Therefore, when the system is exposed to an exogenous shock, it will most likely move towards the same regime.

Table II. Transition probabilities and regime properties

Transition Probabilities			
	Regime 1	Regime 2	
Regime 1	0.932	0.068	
Regime 2	0.154	0.846	
Regime Properties			
	N	Prob.	Duration
Regime 1	185	0.703	14.706
Regime 2	78	0.297	6.494

Having estimated regime switching model, we compute regime-dependent impulse-response functions and forecast error decompositions based on equation (6) to measure the impact of macroeconomic variables on the housing market activities in a nonlinear framework.[5] The linear VAR model results are also presented with MS-VAR in order to make comparisons.

Table III. Linear and regime-dependent variance decompostion of housing permits

	Linear VAR					
Step	Std Error	lip_t	$intrate_t$	$lm1_t$	$lcpi_t$	lhp_t
1	0.394	8.179	0.228	0.088	0.015	91.490
3	0.457	8.311	0.244	1.495	0.411	89.540
6	0.483	7.618	0.437	4.616	0.564	86.765
12	0.521	6.594	0.643	15.079	2.418	75.266
24	0.588	5.365	1.347	28.301	5.442	59.544
36	0.634	4.853	1.861	34.785	6.823	51.678
	Regime 1					
	Std Error	lip_t	$intrate_t$	$lm1_t$	$lcpi_t$	lhp_t
1	0.227	5.871	0.465	2.364	0.018	91.282
3	0.236	5.931	0.456	13.008	0.296	80.309
6	0.240	5.533	0.553	22.444	0.632	70.838
12	0.244	4.853	3.268	29.194	1.023	61.661
24	0.245	4.055	17.313	26.488	1.084	51.060
36	0.245	3.725	26.977	24.882	0.987	43.428
	Regime 2					
	Std Error	lip_t	$intrate_t$	$lm1_t$	$lcpi_t$	lhp_t
1	0.181	13.571	1.213	0.199	0.964	84.052
3	0.211	10.329	1.098	5.117	1.910	81.546
6	0.234	9.599	1.267	10.816	2.609	75.708
12	0.252	9.173	1.614	14.421	3.005	71.787
24	0.261	9.072	1.761	15.215	3.091	70.861
36	0.263	9.069	1.767	15.242	3.095	70.827

Ordering: lip_t, $intrate_t$, $lm1_t$, $lcpi_t$, lhp_t.

[5] RATS econometric software codes written by Doan (2010) are modified to estimate regime dependent impulse responses and variance decompositions. The dataset and estimation codes are available upon request from the corresponding author.

The estimated variance decompositions of the housing permits lhp_t in Table 3 indicates the clear difference between regimes and also suggests that the linear model may lead to misleading inferences regarding the impact of macroeconomic variables on the housing market. Although most of the forecast error variance of the housing permits is explained by its own shock in both specifications, the importance of other shocks varies significantly across regimes.

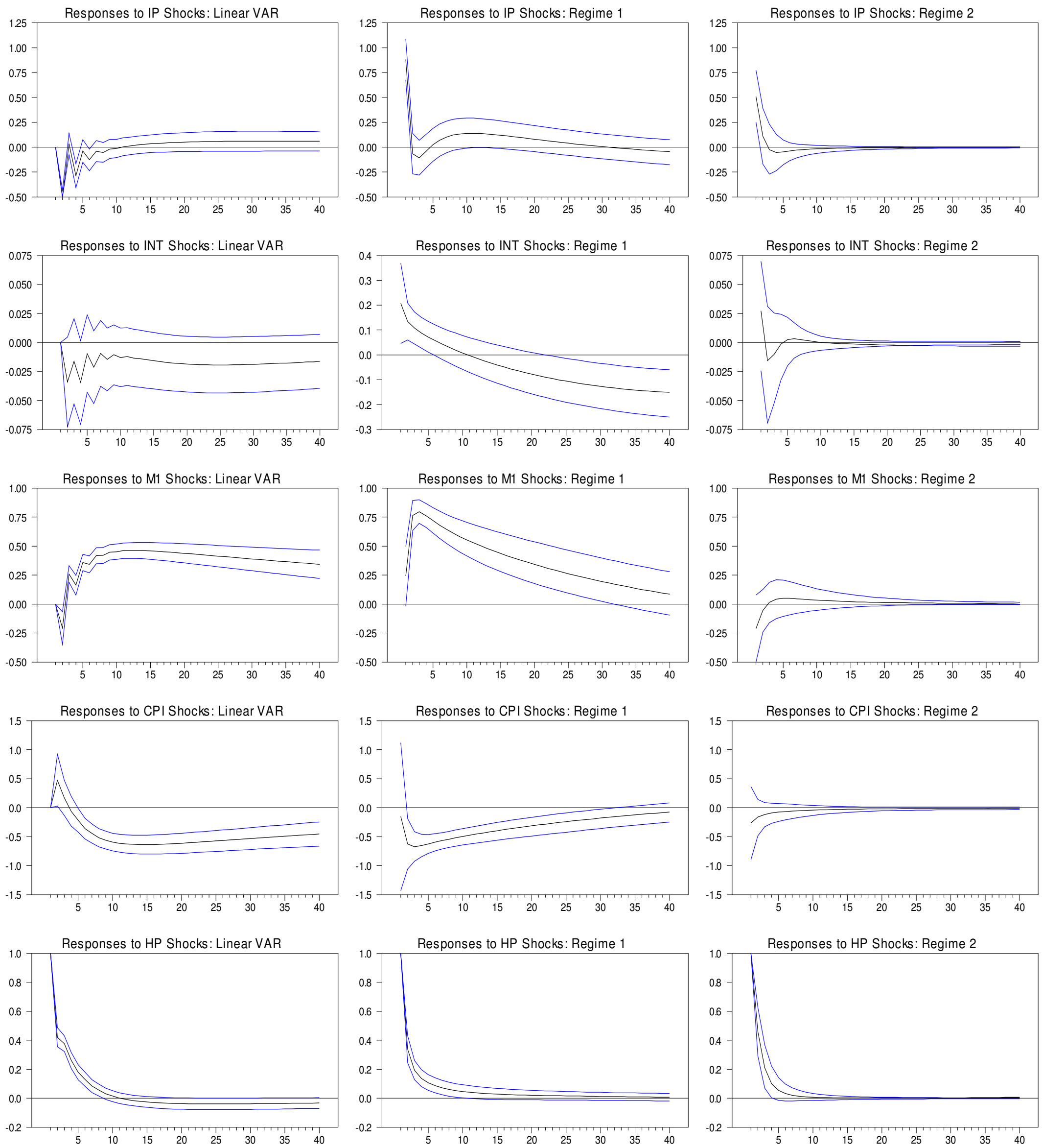
In the linear model M1, shocks are the major contributor of housing permits with 34.785% at the 36 month horizon after its own shock. However, when the MS-VAR estimates are considered, the explanatory power of the variable declines significantly (24.882% in regime 1, 15.242% in regime 2). The results also indicate that at the 36th month horizon, interbank rate accounts for 26.337% of the variation of housing permits in regime 1. This is larger than the proportion explained by the other monetary shock $lm1_t$ (24.882%). As the economy moves to regime 2, the explanatory power of interbank rate has declined significantly to 1.767; however, $lm1_t$ still explains a considerable part of the housing permits forecast error variance with 15.242%. Industrial production lip_t and consumer prices $lcpi_t$ shocks do not play a significant role in the explanation of housing permit shocks, but it is also observed that their explanatory power are more pronounced in the unstable regime (regime 2).

The linear and MS-VAR responses of housing permits support the general findings of the variance decompositions (see Fig. 2). The responses are plotted with their upper and lower one-standard-error bands in order to evaluate their significance. [6] MS-VAR results suggest that except for the industrial production lip_t, shocks to macroeconomic variables do not have any significant impact on housing market activity in regime 2. However, when the economy switches to regime 1 (stable regime), the responses of housing permits to all macroeconomic variables become significant. It is also observed that the linear VAR model wrongly estimates the impact of industrial production through its conclusion that one unit positive shock to lip_t leads to decline in the housing permits in the linear VAR model. However, MS-VAR results suggest a positive and significant impact of industrial production on housing permits. Responses to $lm1_t$ shocks are found to be larger and significant in regime 1 and also in the linear VAR but not in regime 2.

Responses of housing permits lhp_t to interbank rate $intrate_t$ are even more interesting than responses to $lm1_t$ shocks. MS-VAR estimates do not show any significant responses of housing permits to one-unit interbank rate shocks in regime 2 (unstable regime). However, when the economy switches to regime 1, the interbank rate $intrate_t$ shocks become larger and more persistent. This suggests that interbank rate can be used as an effective monetary policy tool in terms of its effects on housing market activity in regime 1 (stable regime).

[6] The standard error bands are generated from 1000 draws by Monte Carlo Integration based on Sims and Zha (1999).

Figure 2. Responses of housing permits



Note: The one-standard error bands of the responses are generated from 1000 draws by Monte Carlo Integration based on Sims and Zha (1999).

5. Conclusions

In this paper, we analyze the impact of macroeconomic variables on the housing market under possible regime changes in Turkey covering the period from January 1991 to December 2012. For this purpose, we use a two-regime MS-VAR model including the variables for industrial production, M1, interbank rate, consumer prices and housing permits and evaluate the impacts of those variables on the housing market with the application of regime-dependent impulse response and variance decomposition analysis.

Our results suggest that the significance of the responses of housing permits to monetary variables depends on the regime prevailed in the economy. We find that the impact of macroeconomic variables has become more apparent and significant in recent years with the application of sound macroeconomic policies in Turkey. In particular the impact of M1shocks on the housing permit is found to be stronger and more persistent than interbank rate. We also report that monetary policy variables M1 and interbank rate account more than half of the variation in the housing permits in the stable regime. Moreover, the variance decomposition of M1 seems support a stronger relationship between M1 and housing permits than exists between the interbank rate and housing permits. This suggests that the Central Bank might be able to affect the housing market activity through the use of those monetary policy variables.

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