Modeling Housing Demand for New Residential Buildings in Urban Areas

Reza Najarzadeh[1*], Amene Shahidi[2]

Abstract

This study investigates the factors affecting the demand for new residential buildings in urban areas of Iran during 1976-2010. The demand function for new residential buildings in urban areas was estimated and then the existence of a long-run relationship among variables of this function was studied using the Bounds testing of the Autoregressive Distributed Lag Co-integration procedure. The test confirmed a long-run relationship among the variables, so the coefficients of the short-term and long-term demand for new residential buildings were estimated. The results show that the average income of urban households has the biggest impact on the long-term demand of new residential buildings and its sign is positive. In the short-term, the biggest impact on the demand for new residential buildings is the average cost of constructing a residential building, with a negative impact on the demand.

Keywords: ARDL Co-integration techniques, Bounds Test, Demand for New Residential Buildings.

JEL Classification: C51, R21

1. Introduction

Housing has long been regarded as a necessity, a human need for shelter. It is classified as an essential good along with food and clothing. Housing is usually the largest item in a household budget in most countries, normally accounting for about 20% of expenditures. Muth (1960) provided the pioneering work on housing markets, and this topic has been very important in the economics literature for many years. There is a large and rapidly developing literature on the non-essential demand for housing (Halhcioglu, 2005). One of the most important scientific contributions of this literature is the attempt to separate the total demand for housing into the demand for shelter and the demand for investment. The latter demand has been important since World War II because housing prices have had periods of sustained increases at times.

In the consumer demand for housing, securing shelter is the most

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1. Associate Professor of Economics, Tarbiat Modares University, Iran (Corresponding Author: najarzar@modares.ac.ir)
2. Ph.D. Candidate in Economics, Tarbiat Modares University, Iran (amene.shahidi@modares.ac.ir)

important factor, while the demand for investment is motivated by expected financial returns and other possible factors (Gholizade, 2009). Recognizing and separating these two demands for housing could explain a situation where the rise in housing prices causes increases in housing demand in some countries (which seems to occur in certain periods). One expects the shelter demand for housing to fall as housing prices increase, but one might expect the investment (or speculative) demand for housing to increase with higher prices. If the investment demand is strong and dominates the shelter demand, housing price increases could lead to a net increase in housing demand. Generally, the directional effect of increased housing prices depends on the relative changes in these two demand components.

The assessment of housing demand and the estimation of price and income elasticities are very important for predicting housing demand, estimating the effects of policy changes, and estimating tax revenue from real estate. One of the first empirical studies of housing demand was performed by De Leeuw (1971) using cross section data in the 1960s. Mayo (1981) and Fulpen (1988) have also done vast experimental and theoretical studies on housing demand during the 1960s, 1970s, and 1980s. Donatos (1995) and Ge and Lam (2002) have undertaken housing studies in the past two decades for developing countries. In general, developing countries need housing models more than developed countries because their rate of urbanization is significantly higher than developed countries, so the demand for housing is expanding rapidly in urban areas (Halicioglu, 2005). Malpezzi and Mayo (1987) estimate that in most developing countries the income elasticity of housing ranges between 0.5 to 1, and the average price elasticity is approximately -0.2. Goodman (2002) shows that income and rental value have significant impacts on U.S. housing prices in metropolitan areas. He estimated that conditional income elasticities are between 0.4 and 0.45.

Some housing demand studies have been conducted in Iran, too. Montazeri (1999) estimated the demand for housing in the city of Yazd during 1972-1989 by considering the number of housing units (housing stock) as the dependent variable and residential unit price, consumer price index, urban household income, the interest rate for bank loans, number of marriages, and urban population as independent variables. His results confirm that these variables describe housing demand in Yazd significantly.

Pahlevanzade (1998) estimated an Ekanem demand function for housing in urban areas of Isfahan province using explanatory variables such as residential housing prices, urban household income, mortgage rate, number of marriages, and urban population. Khoshakhlagh et al. (2008) used a hedonic pricing approach to estimate Khomeinishahr's housing demand function. They assumed that the price for a housing unit is influenced by both physical and neighborhood characteristics. They obtained their data through questionnaires and used cross-sectional analysis. Their hedonic pricing model considered location of the property and other major characteristics of the housing units. Their results show

that physical, neighborhood, and environmental characteristics of residential units affect housing prices.

Ghaderi (2003) estimated housing demand by urban households using cross-sectional data from a sample of 12,338 urban households in 2001. He estimated the demand for possessive and rental housing services. His independent variables were rent per square meter of housing, various income measures (permanent, temporary, current, and non-work income) and other household socio-economic variables. The results show that permanent, current, and temporary income variables, and also marital status, owner's age, non-salaried income, owner's literacy, and number of literate people in the household have positive impacts on the demand for possessive and rental housing. The rent per square meter, household size, and the number of people who have income in the household have a negative impact on possessive and rental housing demand. They found the income elasticity of demand for possessive and rental house is less than one, suggesting that shelter is an essential good.

Although these studies have investigated housing demand, this study uses a different approach which differentiates short-run from long-run housing demand. Furthermore, this study focuses on the demand for new housing, which is a major driver in most economies. This helps us to understand the demand for new residential buildings in more detail. Residential demand includes the sum of residential buildings completed by the private sector in urban areas and permits issued for the construction of residential buildings in urban areas. Furthermore, this study uses an auto-regressive distributed lag co-integration technique or ARDL model and the Bounds test (Pesaran et al. 2001) to provide more reliable estimates. The "cumulative residual tests"[1] and "cumulative squared residual"[2] are also used to investigate the stability of the model.

2. Materials and Methods

Ge and Lam (2002) have presented a general demand function for housing:

$$Q_d = f(G, H, D, t) \quad \text{(t= 1, 2, …, n)} \tag{1}$$

where G is a set of macroeconomic variables such as GDP, interest rates, and stock market prices; H is a set of variables specifically related to housing such as housing price, income, and unemployment; and D is a set of demographic variables such as population, number of marriage, and the birth rate. Equation (1) is specified in a double log statistic form so that:

$$LnQ_d = \alpha_0 + \alpha_1 LnG_t + \alpha_2 LnH_t + \alpha_3 LnD_t + \varepsilon_t \tag{2}$$

The variables in Equation (2) differ by country. Considering the research conducted by Mayo (1981), Fulpen (1988), Ge and Lam (2002), Halicioglu (2005), and Lu and Wang (2015), equation (2) is modified for Iran:

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1. CUMSUM
2. CUMSUMSQ

$$LnRD_t = \alpha_0 + \alpha_1 LnY_t + \alpha_2 LnRC_t + \alpha_3 LnLV_t + \alpha_4 LnNM_t + \alpha_5 R_t + \varepsilon_t \quad (3)$$

where RD is demand for new residential buildings in Iran's urban areas; Y is average real total income of urban households; RC is real average non-land cost of constructing a residential building in urban areas; LV is average real land value for a residential building in urban areas; NM is the number of marriages registered in Iran's urban areas and $R^{[1]}$ is the real long-term interest rate that is an indicator of the return to alternative assets. Expected signs for the above coefficients are:

$$\alpha_1 > 0 \qquad \alpha_2 < 0 \qquad \alpha_3 < 0 \qquad \alpha_4 > 0 \qquad \alpha_5 < 0$$

Several econometric methods have been used in past housing studies. They include univariate co-integration procedures (including techniques developed by Engle and Granger (1987), and Phillips and Hansen (1990)) which use modified ordinary least squares procedures that allow for the existence of long-run equilibrium (co-integration relationship) among variables in the model. Multivariate co-integration models developed by Johansen (1988) and Johansen and Juselius (1990) have been used when more than one dependent variable is included. Full Information Maximum Likelihood procedures by Johansson (1996) have also been widely used in empirical research. The ARDL model was originally introduced by Pesaran and Shin (1999) and was further developed by Pesaran et al. (2001). It deals with single equation co-integration models and has the following advantages over other models:

- The short-term and the long-term parameters of the model can be estimated simultaneously.
- Co-integration tests can be performed without concern over whether the model's variables are I (0) or I (1).

Due to these advantages, the ARDL model is applied for investigating the presence or absence of a co-integration relationship among the variables. Equation (3) is specified in ARDL form as:

$$(4)$$

$$\Delta LnRD_t = \alpha_0 + \sum_{i=1}^{m} \alpha_{1i} \Delta LnRD_{t-i} + \sum_{i=0}^{m} \alpha_{2i} \Delta LnY_{t-i} + \sum_{i=0}^{m} \alpha_{3i} \Delta LnRC_{t-i}$$

$$+ \sum_{i=0}^{m} \alpha_{4i} \Delta LnLV_{t-i} + \sum_{i=0}^{m} \alpha_{5i} \Delta LnNM_{t-i} + \sum_{i=0}^{m} \alpha_{6i} \Delta R_{t-i} + \alpha_7 LnRD_{t-1}$$

$$+ \alpha_8 LnY_{t-1} + \alpha_9 LnRC_{t-1} + \alpha_{10} LnLV_{t-1} + \alpha_{11} LnNM_{t-1} + \alpha_{12} R_{t-1} + \varepsilon_t$$

The Bounds test is used in the ARDL approach to investigate the long-run relationship or co-integration between the variables of Equation (3). This test procedure is based on the F or Wald statistic and it is the first step in the ARDL co-integration method. The Bounds test is a joint test for no co-

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1. Because of the negative value of the real interest rate in some years, it enters the model in a non-logarithmic form.

integration ($H_0: \alpha_7 = \alpha_8 = \alpha_9 = \alpha_{10} = \alpha_{11} = \alpha_{12} = 0$). The F-test for this method has a non-standard distribution, so Pesaran et al. (2001) have calculated two sets of critical values for a given level of significance. One set (the lower value) assumes that all the variables in the model are I (0). The other set (the higher value) assumes that all variables are I (1). If the calculated F statistic is higher than the upper critical bound value, the hypothesis is rejected (implying that there is co-integration). If the calculated F statistic is between the upper and lower critical values, the result is uncertain. If the calculated F statistic is less than the lower critical bound value, the hypothesis cannot be rejected (implying that there is no co-integration).

If the results confirm the existence of a long-run relation among the variables, we proceed with the long-run estimations and error correction ARDL model. The long-run model is obtained by estimating Equation (4) in the context of the ARDL model. In order to obtain the speed of the adjustment and the short term coefficients, it is necessary to estimate the following dynamic error-correction model:

$$(5)$$

$$\Delta LnRD_t = \alpha_0 + \sum_{i=1}^{m}\alpha_{1i}\Delta LnRD_{t-i} + \sum_{i=0}^{m}\alpha_{2i}\Delta LnY_{t-i} + \sum_{i=0}^{m}\alpha_{3i}\Delta LnRC_{t-i}$$
$$+ \sum_{i=0}^{m}\alpha_{4i}\Delta LnLV_{t-i} + \sum_{i=0}^{m}\alpha_{5i}\Delta LnNM_{t-i} + \sum_{i=0}^{m}\alpha_{6i}\Delta R_{t-i} + EC_{t-1} + u_t$$

In Equation (5), λ measures the speed of the adjustment and shows how the deviation from long-run equilibrium leads to changes in the dependent variable in order to move towards long-run equilibrium. EC_{t-1} is the lagged long term estimated error. After estimating the model's coefficients, we can test the stability of these coefficients for selected ARDL regressions.

3. Data
All of the time series data used in this study come from Iran's Statistics Center website and Iran's Central Bank. The time period is from 1976 to 2010. The RC variable is a weighted average of construction costs for completed residential buildings and construction costs for residential buildings under construction by the private sector in urban areas divided by the number of units. It should be noted that this cost does not include the land value of a building. The LV variable is a weighted average of the land value of completed residential buildings and the land value of residential buildings under construction divided by the number units. The real interest rate is obtained by subtracting the inflation rate from the nominal interest rate, and the profit rate of five-year investment deposits has been considered as long-term interest rate.

4. Model Estimation
4.1. Unit root test
It is necessary to perform unit root tests on all variables of the model to ensure that they are either I(0) or I(1). The variables cannot be I(2) or greater because the calculated F statistic cannot be trusted since the F-test is based on the assumption that all the variables are either I(0) or I(1) (Ouattara, 2004). We used the Augmented Dickey-Fuller test (ADF) to test if the variables are stationary. The Schwarz-Bayesian criterion (SBC) was used to choose the number of lags. The results are presented in Table 1. According to the table, LnLV, LnNM, and R are I(0) and LnRD, LnY, and LnRC are I(1). Since none of the variables are integrated higher than one, we can use the Bounds testing for evaluating the long-run relationship among variables.

Table 1. Augmented Dickey-Fuller Test with an Intercept and Trend

Variable	lag	Test-statistic at 5% significance level	Critical value at 5% significant level	Stationary status
LnRD	0	-2.5746	-3.5514	Non-stationary
First difference of LnRD	0	-5.0630	-3.5562	stationary
LnY	1	-2.3610	-3.5562	Non-stationary
First difference of LnY	0	-3.6771	-3.5562	stationary
LnRC	1	-2.4168	-3.5562	Non-stationary
First difference of LnRC	1	-4.1787	-3.9586	stationary
LnLV	1	-4.1647	-3.5562	stationary
LnNM	0	-3.8699	-3.5514	stationary
R	1	-4.4248	-3.5615	stationary

4.2. Co-integration test
To determine the presence or absence of a long-run relationship among variables, we use the Bounds test for Equation (4). The null hypothesis is that there is no co-integration among the variables. The results are summarized in Table 2.

Table 2. Bounds Test for Co-Integration

F-statistic	22.3256
Upper critical value	3.805
Lower critical value	2.649

Table 2 shows that the calculated F-statistic is higher than upper critical bound value. Thus, the null hypothesis that there is no co-integration among the variables in the model is rejected. A long-run relationship exists among the variables and it is possible to estimate short-term and long-term coefficients for variables in the second stage of the ARDL.

4.3. Estimation of the Long-Run and Short-Run Coefficients
Equation (4) was estimated by using ARDL to determine the long-term

coefficients or elasticities. The results are given in Table 3. The optimum number of lags for the estimation is chosen based on the SBC.

Table 3. Estimation of Long-run Coefficients for Housing Demand

Independent Variables	Coefficient	Standard Error	t-statistics	Probability
LnY	0.418	0.253	1.651	0.112
LnRC	0.409	0.264	1.552	0.134
LnLV	-0.218	0.154	-1.421	0.169
LnNM	0.411	0.105	3.898	0.001
R	0.003	0.006	0.451	0.656
Intercept	-3.800	3.224	-1.179	0.251

It has been seen that among the examined variables, the coefficients related to the average income of urban households and the average cost of constructing a residential building at 10% level and the number of marriages at 1% level are significant in the long term and all three variables have a positive impact on the demand for new residential buildings. In other words, a rise in the average income of urban households, the average cost of constructing a residential building, and the number of marriages increase the demand for new residential buildings in urban areas. Although the coefficients of all three variables are very close to each other, the highest coefficient in the long term belongs to the average income of urban households which is 0.42.

Short-term dynamic adjustment coefficients of Equation (5) using the ARDL model are presented in Table 4. The results of the diagnostic tests are given in Table 5.

Table 4. Estimation of Short-Run Coefficients

Variables	Coefficient	Standard Error	t-Statistics	Probability
$\Delta \ln RD_{t-1}$	0.268	0.124	2.162	0.040
$\Delta \ln Y_t$	0.271	0.168	1.607	0.121
$\Delta \ln RC_t$	-1.027	0.353	-2.907	0.008
$\Delta \ln LV_t$	0.200	0.150	1.334	0/194
$\Delta \ln NM_t$	0.266	0.088	3.034	0.006
ΔR	0.002	0.004	0.473	0.640
INPT	-2.458	2.143	-1.147	0.262
ecm_{t-1}	-0.647	0.123	-5.247	0.000
R^2	0.78			

All coefficients are significantly different from zero at the 10% level except the average land value of residential buildings and the real interest rate, so an increase in average urban household income and the number of
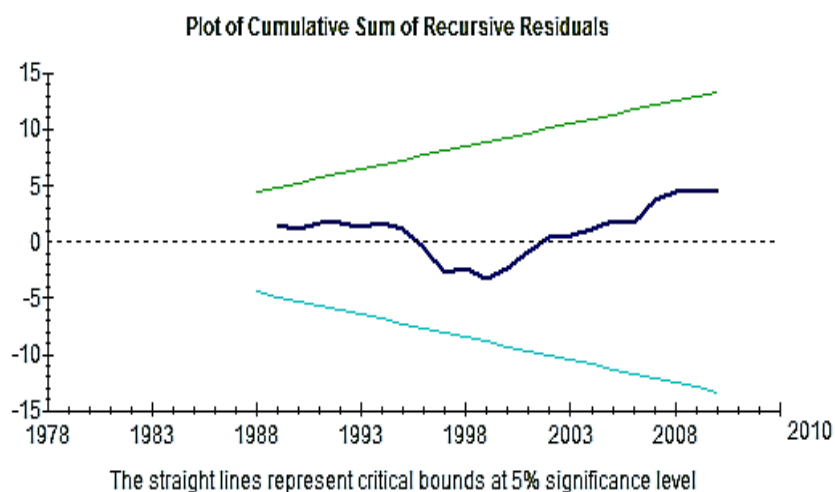
marriages increase residential housing demand in the short-run. An increase in average costs of constructing residential housing reduces demand. The coefficient measuring the speed of adjustment, -0.65, is also significant and has the correct sign. The error correction term suggests a high speed of adjustment from short-term to long-run equilibrium in urban areas. Any imbalance in the demand for new residential construction is adjusted by about 65% in the next period.

The diagnostic tests indicate that the model has no problem with serial correlation of residuals (P=0.22), incorrect functional form (P=0.14), or heteroskedasticity (P=0.81). We cannot reject the hypothesis that the error term has a normal distribution (P=0.13).

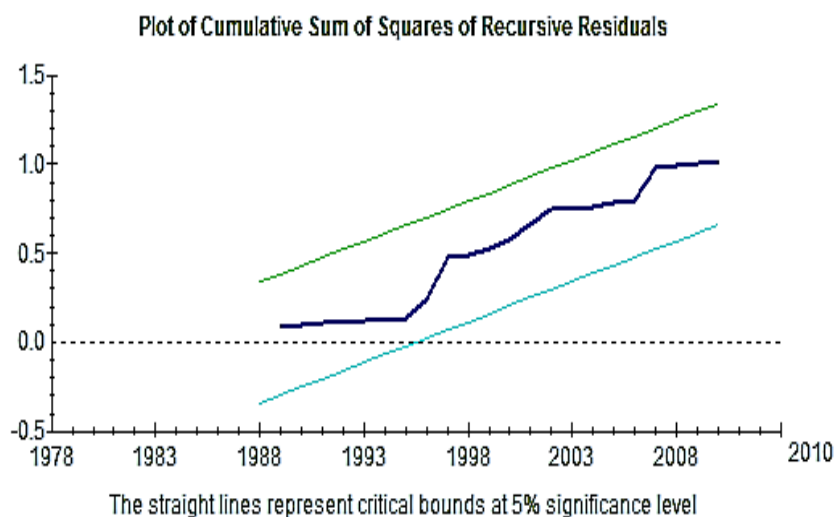**Table 5. Diagnostic Tests with Probability of Statistical Problems**

$$\chi^2_{SC}(1) = 1.493[0.222]$$

$$\chi^2_{FF}(1) = 2.216[0.137]$$

$$\chi^2_{N}(2) = 0.419[0.811]$$

$$\chi^2_{H}(1) = 2.323[0.127]$$

Figures 1 and 2 show the results of the CUSUM and CUSUMSQ stability tests, respectively. They show that the coefficients of the error correction model are stable; therefore, we can say that the demand function of estimated new residential buildings in the urban areas is stable.

Plot of Cumulative Sum of Recursive Residuals

The straight lines represent critical bounds at 5% significance level

Fig.1. Cumulative Sum of Recursive Residuals (CUSUM)

Plot of Cumulative Sum of Squares of Recursive Residuals

The straight lines represent critical bounds at 5% significance level

Fig. 2. Cumulative Sum of Squares of Recursive Residuals (CUSUMSQ)

5. Conclusions

The present study uses the Bounds test for the ARDL approach in order to investigate a long-run relationship between new residential buildings demand, the average income of urban households, the average cost of constructing a residential building, the average land value of a residential building, the number of marriages in urban areas, and the real interest rate. We found a long-run relationship among the variables. The results show a positive, significant, and low elasticity effect of urban households' average income on the demand for new residential buildings in urban areas of Iran in the long-run. Based on the results, a doubling of the average income of urban households increases the demand for new residential buildings in urban areas by about 42 percent.

An increase in the cost of constructing new residential buildings in the long-term increases the demand for new residential buildings. Although theoretically we expect that an increase in construction costs to cause an increase in price and therefore a reduction in demand, instead people see increasing construction costs and rising prices as reflecting a housing boom. These events increase the speculative demand for housing. It seems that the increase in speculative demand is greater than the decrease in consumer demand so that a doubling of the average cost of a residential building will increase the long-term demand by about 41 percent even though the rising cost decreases demand in the short run. With regard to the average land value of a residential building, it seems that through the accretion of raw land value and subsequently the price rise of residential buildings, the increase in speculative demand cannot overcome the decreasing consumer demand and vice versa. Therefore, the effect of this variable on demand for new residential buildings

in the long and short term is insignificant. It can be argued that the cost of the accretion of raw land increases the speculative demand for residential buildings less than the rising of construction costs. This is because the accretion of raw land gives incentives to people who invest in the housing sector for a profit to buy and sell raw lands instead of residential buildings.

These results seem to be consistent with the realities of Iranian society because it has been found that in some cases, despite rising prices in the housing market, buying and selling in the market is also booming.

The number of marriages in urban areas has a significant impact on the demand for urban residential buildings in the short-term and long-term. A doubling of marriages increases the demand by about 27 percent in the short-term and about 41 percent in the long-term.

Although theoretically we expect that the impact of interest rate variable —a representative for returns on alternative assets— on demand for new residential buildings to be negative, this study shows that this variable has no impact on demand either in the short run or in the long run. Whereas the interest rate variable is the real interest rate, and in many years during the period of study, the inflation rate was larger than the nominal interest rate, this variable has a negative value in those years. Therefore, it should not be expected that improving this variable necessarily decreases the demand for housing. In fact, although the improvement of long-term interest rate on the one hand can incline people to prefer maintaining those assets which have higher returns rather than housing maintenance and it decreases the community's demand for residential buildings, on the other hand the inflation rates which are higher than the nominal interest rates make it irrational to maintain cash and it may lead to the entrance of some part of cash into the housing sector and subsequently increase the demand for new residential buildings. The outcome of these two effects leads to an insignificant result for the real interest rate variable. We should explain that although it has not been shown in the current study, the investigation of the authors shows that if instead of the real interest rate, the nominal interest rate is used, the impact of interest rate on demand for new residential buildings will be negative and significant.

Finally, the CUSUM and CUSUMSQ tests show that the estimated demand function for new residential buildings in urban areas of Iran is a stable demand function. Hence, we can conclude that this function can be used as a policy tool in housing planning at a macro-level in the country.

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