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Forecasting the House Price for Ahvaz City: the Comparison of the Hedonic and Artificial Neural Network Models

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Abstract: Determination and the estimation of the house price in urban areas has a great importance for governments, individual and state investors and common people. The mentioned estimation can be used in future planning and decision making of many urban and regional policies. In this regard, due to the vital importance of the house price in recent decades powerful and effective functions have been used in order to forecast and estimate the house price. The main purpose of the current study was to present an optimal model to forecast and identify the determinants of the house price in Ahvaz metropolitan by the comparison of the Hedonic and Artificial Neural Network Models and the choice of the optimal model. The present study has a developmental-applied nature which follows a descriptive-analytical approach. The sample included 286 statistical unit in 2015 based on 27 related variables were evaluated to forecast the house price in Ahvaz city. This study used semi-log hedonic function and Neural Network Multilayer Perceptron (MLP) approaches. To compare the results of the two models in terms of predictability the criteria of R2, MSE, RMSE, MAPE, MAE and TIC coefficient were utilized. The results of the Hedonic model indicated that that among 27 variables, 18 variables were significant model and by the comparison of the results and the estimated value, it turned out that housing prices in Ahvaz is mainly influenced by the physical and structural factors. Moreover, the comparison between all criteria demonstrated that the Artificial Neural Network had a better performance than the Hedonic regression model in forecasting the house price. In order to test the difference of precision in forecasts of the house price in Ahvaz the Morgan-Granger-Newbold test was conducted as an appropriate instrument. The results of test indicated that the there was a significant difference between the predicative power of the two models which confirmed the greater performance of the ANN (%98) model in comparison with Hedonic regression model (88%).

Keywords: forecasting, house price, house, Ahvaz, Hedonic model, Artificial Neural Network (ANN) model.
JEL Classification: C45, D12, R29, A13

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1- Introduction

Forecasting the influential factors is considered as one of the main issues in economics and trade. The forecasting issues are more obvious in determining monetary policies and conducting investment analysis. Housing sector investments is one of those economic sectors that basically attracts the attentions of most capital market participants. Besides, households not only consider their residential houses as a place to live, but they also put in their portfolios as a type of their financial asset. In fact, housing constitutes up the most important part of household wealth (Case et al., 2004).

From macroeconomic perspective, housing has a special importance. The house price fluctuations could have significant consequences for the world economies. Greenwood and Herkowitz (1991) discussed that the total value of housing assets has been greater than commercial capital and typically, the value of investment in housing sector exceeds the total assets in commercial sector. Therefore, considering housing sector as a consumption commodity would be too simplistic.

The wealth effect of the housing sector is really significant and the house price reduction would lead to the decrease of consumption. Moreover, the housing market fluctuations would have a significant role in creating business cycles (Iacoviello & Neri, 2010) not only because housing investments constitutes a part of domestic demand (Bernanke & Gertler., 1995) but also because the house price fluctuations would have considerable wealth effects on consumption (IMF, 2000) and investments (Topel & Rosen., 1988). On one hand, there is extensive literature on the macroeconomic and finance which indicates that financial variables can be considered as an appropriate predictors of real economic activities and inflation. On the other hand, recent studies suggested that the asset prices would help to forecast inflation and real sector economic activities (Das et al., 2009), (Stock &Watson. 2003), (Forni et al., 2003).

Iranian economy is one of the transition economies of the world which has experienced the vast immigration from villages to towns, and from town to cities and finally from cities to metropolitans. Moreover, the structure of the nation population is formed so that a considerable percentage of the population has reached the age of marriage and has a vast and great demand for jobs. Both of these properties have led the demand for housing to become one of the main concerns of the nation's policy makers and especially in metropolitans and large cities.

Ahvaz, due to various reasons including permitting immigrations because of the large scale investments in national and economic activities and the consequences of the forced immigrations during the war is identified as one of the cities that has faced with a great house demand. However, in recent years several programs (including Mehr housing project, reconstruction of old urban areas) have been conducted to escape the lack of housing demand, due to the special issues of the mentioned projects for instance: far distance from the city and shopping centers, the lack of educational cultural and sport facilities and parks could not create an appropriate balance between the housing demand and supply especially in Ahvaz metropolitan and still housing is considered as the main concerns of the people. As any residential unit has its own properties in discussing

about the demand for housing, we have to pay attention to consumer tastes as well as their ability to the components of any residential unit.

Thus, according to the mentioned points the real activities in housing sector can be considered as a leading indicator of the real sector economy and the house price can be used to forecast the real sector activities, inflation or both and help policy makers to adopt a suitable policy and effectively use them to solve society's problems. For instance, the recent financial crisis in America began with the bursting of the bubble formed in the housing sector, and moved to the real economy and dominated the recession on US economy.

Based on the issues mentioned above, various approaches can be used to forecast the house price. One of them is Artificial Neural Network. The current study attempted to present an appropriate model to forecast the house price in Ahvaz using Multi-Layer Perceptron (MLP) with propagation algorithm and the comparison between the results of Hedonic regression and Neural Network approaches. After the results of predictive models (Hedonic regression and Artificial Neural Network), using the same data, performance metrics were used to determine the accuracy of the models and their comparison. Due to the consistency of the various neural network methods with non-linear issues the lack of requirement to non-realistic assumptions like the normality of data and the re-modeling capability by including new data and variables the hedonic regression and the Artificial Neural models can be compared. As the Hedonic model has a regression nature the multi-layer neural network was chosen for conducting the analysis. Finally, the ability of the two approaches were compared in forecasting the house price in Ahvaz and the house price determinants were identified in Ahvaz as one of the major cities of Iran.

2- Literature Review

a) Foreign Researches

Peterson &.Flanagan (2009) studied a sample included 46467 transacted housing unit during the period from 1999 to 2005 in North Carolina and compared the linear hedonic and Artificial Neural Network models with each other. The results of the study indicated that the Artificial Neural Network model had lower prediction error and a higher out of sample forecasting accuracy.

Zainun et al., (2011) attempted to forecast the demand for cheap housing in Pahang, Malaysia using Artificial Neural Network model. The results of the study indicated that the best model for forecasting the cheap housing in Pahang is the one in which 0.7 of the data is used for the learning of the network and 0.3 of the data is applied for assessing the efficiency of the model. Moreover, the value of (MAPE) for the comparison of the real data and the forecasted values were obtained equal to 2.63 percent.

Diewert & Hendriks (2011) decomposed the house price index to the land and the components of the residential unit using two types of the linear and non-linear hedonic regression models. The results obtained from the two regression were compared which indicated that the non-linear regression model had a better performance than linear regression model.

Kouwenberg & Zwinkels (2014) presented an econometric model for the prediction of the price in the housing market of the United States of America.

This model is affected by two factors that their weights change dynamically over time. The results of the study indicated that there are some positive factors in the short run which convert to value in the long run.

Plakandaras et al., (2015) forecasted the housing price index for the United States and suggested that the sudden recession of the house price led the occurrence of the financial crisis of the 2007 and therefore, made the anticipation of such an imminent threat necessary. The results of the study led to the presentation of the warning system for the sudden drop in the house price of the United States.

b) Iranian Researches

Varesi & Mousavi (2010) investigated the factors affecting the house price using hedonic model for region 3 of Yazd city. The results of the study indicated that land area, floor area and number of floors are the main factors affecting the price of housing in the city of Yazd so that 1 percent increase in the land area and floor area changes the house price by 0.49 and 0.38, respectively.

Khalili Araghi & Nowbahar (2011) studied the house price for Tabriz metropolitan using hedonic and Artificial Neural Network models. The results indicated that based on all criteria, artificial neural network model had been more efficient and had less errors in predicting the hedonic housing price.

Atrian Far et al., (2011) assessed the forecasting combination methods for the prediction of the house price in Tehran and the results indicated that using the information of the various variables by the combination technique can increase the forecasting precision. Moreover, the precision of the simple combination methods was greater than the optimal weight method.

Amanpour et al., (2012) estimated the house price in Ahvaz using Artificial Neural Network models. The results indicated that the Artificial Neural Network models had a 91 percent precision in the estimation of the residential unit price in Ahvaz city. On the other hand, among the factors affecting the housing prices in the city, building area and accessibility had the largest share among the determinants of the house price.

Mombeini et al., (2015) presented a model for the prediction of the house price in Tehran using an ARIMA model. Three main hypotheses of this survey is based on the perspective that the prediction of the future house price is a function previous prices so that we can forecast the future house price having the historical data. The presented model predicted that the price increasing trend was defensive and the determination coefficient of the fitted model was equal to 99.7 % which was very appropriate for forecasting goals.

Reviewing the studies about the forecasting the house price it was observed that most of the conducted studies have focused on the house price using only one model.

Mombeini et al., (2015) presented a model based on the ARIMA model, Amanpour et al (2012), Tabales et al (2013), Zainun et al (2011) estimated the house price using artificial neural network, Varesi and Mosavi (2011), Peterson and Flangan (2009), Diewert & Hendriks (2011) investigated the determinants of house price using the hedonic regression approach.

Atrian Far et al., (2013) estimated the house price using combined methods Kouwenberg and Zwinkels (2014), Plakandaras et al., (2015) presented a model to forecast the house price and only

Khalili Araghi & Nowbahar (2010) forecasted the house price and compared the house price using artificial and hedonic models in Tabriz city. Therefore, the conduction of such a study in Ahvaz can be necessary due to various reasons including permitting immigrations because of the large scale investments in national and economic activities and the consequences of the forced immigrations during the war period which causes most of cities with the demand for housing. The comparison of the various models to forecast the house price and determining a model with the least error and the highest accuracy has not been conducted in Ahvaz metropolitan. The conduction of the current study in Ahvaz causes the housing sector politicians and investors of the economic fields can use the results of the current study to choose the forecasting models with higher confidence. Moreover, in the current study 27 influencing variables were analyzed and the variables were classified based on three main and influencing components including structural factors, environmental factors and accessibility factors which they are not pointed as such in most of the studies.

3- Theoretical Framework

Hedonic Regression Models

The concept of the hedonic approach was expanded based on the ideas of Griliches and Rosen. Since the publication of the Rosen's paper, Hedonic methods have been used for the analysis of many aspects of the housing market in the west including taxes, prices of goods and public facilities, housing segregation and quality. Although, the scope of this technique has not been expanded much in the studies of Third World urban economy and the housing market and it is used only for analyzing the price effects, quality of housing and housing demand index (Akbari et al, 2005).

Hedonic models are the summarized form of the statistical models that can be raised for discussion at some point in time. Hedonic models are the locus of equilibrium prices of transactions which are defined as a function of heterogeneous real estate properties. Since the 1950s, many applications for these models have been provided. Thus, housing is considered as a multi-dimensional commodity and the price difference of the residential units is attributed to factors such as structural quality of housing, access to shopping centers, utilities and recreational facilities on the property environment.

Hedonic studies is based on the assumption that housing prices reflect the willingness to pay of its inhabitants in order to achieve the required amenities inside and outside of the housing (environment and accessibility), respectively. In other words, in this method, it is assumed that the differences in property prices can be attributed to the differences in housing characteristics. On this basis, housing prices indicates the maximum money that people are willing to pay in order to have a better quality of the environment, a certain amount of internal resources and the availability and condition of the building and the city's facilities and services (Tyrvainen, 1997).

Hedonic theory considers a variety of features for residential units. According to this theory, the utility of any individual can be expressed in terms of a function of various consumption commodities (X), a vector of welfare properties of the environment like air and noise pollution (Q), a vector constituted of structural properties of the bought building including

size of the building, number of the rooms, age and type of the building (S), and a vector of adjacent features such as quality of scientific institutions located in the neighborhood, access to sports and cultural centers, parks as well as the crime rate in that region (N) (Battalhon et al., 2002).

Each household consumes a batch of housing features and other commodities. This selection includes some level of welfare and utility to the consumer. The utility function U can be shown as follows:

$$U = U(X, Q_j, S_j, N_j) \quad (1)$$

Consumer budget constrains can be expressed:

$$Y = X + P(Z) \quad (2)$$

Where p (z) is a function of the residential properties which can be defined as a function of properties demanded by the household. This function is simply called the Hedonic price function (Arimah, 1992) and can be expressed as follows:

$$PH_i = P(Z) = P(Q_j, S_j, N_j) \quad (3)$$

Where i represents the residential unit and j refers to its corresponding features in the Hedonic price function. As consumers maximize their utility based on their budget constrain, we can write:

$$\left(\frac{\frac{\partial u}{\partial q_j}}{\frac{\partial u}{\partial x}} \right) = \frac{\partial ph_i}{\partial q_j} \quad (4)$$

Where $\frac{\partial u}{\partial q_j}$ represents the additional utility obtained from the consumption of one unit of the corresponding properties of the housing unit, $\frac{\partial u}{\partial x}$ represents the additional utility derived from the consumption of an additional unit of consumer goods and $\frac{\partial ph_i}{\partial q_j}$ shows the marginal value of the jth property. Equation (4) indicated that the necessary condition for the constrained optimization of the Hedonic function requires that the changes in Hedonic price function in response to the change in various properties of the house be equal to the changes in consumer preferences with respect to purchase house and purchase other commodities. The partial derivatives of the Hedonic function with respect to any property shows the final implicit value of that property.

Artificial Neural Network

Artificial Neural Network (ANN) is an approach that tries to mimic special processing abilities of human brain which is designed based on the learning process of human brain. Artificial neural networks are able to estimate the non-linear trends of various data and are considered as a flexible computational framework for modeling a wide range of nonlinear trends. One of the obvious advantages of this model compared to other nonlinear models is that artificial neural networks are a global estimators that can carry out approximations of any function with any arbitrary precision. Such networks do not require any prior assumptions about the form of the model in modeling process and they are generally data-based models (Goodarzi & Amiri, 2013).

Artificial neural networks are computational techniques to help us learn to approximate special mappings or categorize various types of data. A neural network is derived from a combination of several neurons. In a single-layer neural network instead of each input only one neuron is used and weights play the role of connecting

each neuron to the output neuron (Jalali & Sattari, 2012).

The neural network can be used to study data in parallel using massive processes. Neural network technology can also be successfully applied in commercial matters, and in most cases it has been superior to other traditional techniques and technologies (Golabi, 2011).

In general, the structure of neural networks can be classified into two general categories: Feed Forward Networks (FFN) and Return Neural Networks (RNN). Feed Forward Networks (FFNs) have a very simple structure and don not suffer from the stability problems of Return Neural Networks (RNN) (Shahnazari et al., 2015). Feed Forward Networks (FFN) also have different types notably Multilayer Perceptron (MLP) which is known as one of the common types of FFNs. Research on the Feed Forward Multilayer Networks goes back to the early works of Frank Rosenblatt on single-layer Perceptron Network and early works of Bernard Widrow and Marian Hoff (Joorabian & Hoshmand, 2003).

Housing Sector in Iran

The housing market in Iran is one of the sectors, which has experienced most of the economic fluctuations during the previous 15 years (Jafari Samimi et al., 2008). Housing is a heterogeneous, durable, immovable, capital and consumption commodity that accounts for a large share of household budgets, costs and gross national fixed investment and plays a vital role in the employment and value added created in any country (Laurice & Bhattacharya, 2005). Housing is considered as an important element in meeting the needs of biological, economic and social needs of any household. The growth of urbanizations, the increase of the cities' population, the immigrations from villages to cities, the depreciation of old buildings and their destructions, the shrinking of the size of the households etc. have led housing supply to one of the main issues in most of the cities in the third world countries (Pour Mohammadi et al., 2013).

Housing is one of the most important economic commodities. Generally, there are two types of demand for housing: demand for housing as shelter and demand for as an asset. About the first type of housing demand, it can be said that housing is one of the basic requirements of any households. As mentioned before, people are paying attention to housing as an asset in order to buy and sell the building to have investments in this sector (Chen & Patel, 1998), (Benjamin et al., 2004). Consumer housing demand is a kind of demand which is stable and predictable and lacks any substitution as well. Capital demand has been affected by several complicated factors. Therefore, it is extremely unstable and the demand for housing experiences so many fluctuations. Housing in Iran is of great importance in other aspects. Attractiveness and importance of housing in Iran cannot be overlooked as an option for investment. In years before 2010 the injection of a high volume of liquidity to the economy, the lack of appropriate performance in capital market and low economic growth led to the redirecting financial resources to the housing sector and the formation of increasing price trends of commodities. Therefore, in addition to the consumption aspect of the housing, its capital aspect should also be considered (Ghodoosi, 2010).

Because of the size and the complexity of the different aspects of housing, as well as the significance of the housing in people lives, it needs a great attention and accuracy. On the one hand, the social and

economic importance of housing puts the sector at the center of public attention. On the other hand, due to the employment and job creation of the housing sector and its close relationship with other economic sectors, it is regarded as a suitable instrument to the realization of economic policies (Azizi, 2004). In addition to the national factors, the housing market is influenced by regional factors which legitimize the analysis of the housing market in regional level (Oikarinen, 2007).

4- Research Method

This is a developmental- applied survey which is conducted by a descriptive- analytic approach. The population used in the present study was all of the residential units of the Ahvaz metropolitan.

The Method for Determining the Sample Size

In researches in which willingness to pay approach is used the common patterns for computing sample size cannot be used. Michael and Carson (1989) innovated a new method for such surveys which relies on the selection of the researcher which is based on the acceptable deviation from of the fitted values from the real values (Mitchell & Carson, 1989).

The size of the selected sample depends on the statistical precision and deviation from the real mean of the population with normal distribution (U) at a certain level of significance and the difference between the real willingness to pay and the estimated willingness to pay and can be stated as follows:

$$n = \left(\frac{u_{1-\frac{a}{2}}.V}{D}\right)^2 \qquad (6)$$

Where in the above equation n represents the sample size, V the relative standard error and $1-\frac{a}{2}$ confidence level. Also, D shows the difference between real willingness to pay and the estimated willingness to pay which can be expressed as a percentage of the willingness to pay.

V, a, and D were relative error, level of confidence and the deviation of the forecasted values from the actual value, respectively. In the current study the values of v=1.5, a=0.10 and D=0.15 respectively and the size of the sample was equal to 286. The volume of the sample at a given level of confidence ensures that the estimated willingness to pay in 90 percent of the will be between 15% of the willingness to pay. In order to increase the accuracy we can increase the size of the sample, but as in the current study data collection was costly and time consuming the model was estimated using the mentioned size of the sample (Askari, 2001).

Data Collection Method

In order to remove the effect of time in this study, only the cross-sectional data for the year 2016 was used. The data used for this research was collected through direct reference to real estate agents and filling up questionnaires. Notably, it should be said that 85 percent of data was used for neural network learning and determination of the Hedonic regression equation and the evaluation of the effectiveness of two models was done using 15% of the remaining data.

Table1. Explanatory variables of the model

Name of the variables	Definition	Expected sign
Structural and physical variables		
Price2	Price per square meter of land as an independent variable	Positive
Area1	The floor area under the building housing units per square meter as independent variable	Positive
Area2	The area of land which is built on residential units as independent variable	Positive
Age2	Dummy variable for building age (over 10 years: 1, otherwise 0)	Negative
Room2	Dummy variable for the number of rooms (3 rooms and more: 1 Otherwise: 0)	Positive
Building facade2	Dummy variable for the exteriors of buildings (luxury view: 1, otherwise 0)	Positive
Parking	Dummy variable for parking (existence: 1, Non-existence: 0)	Positive
Elevator	Dummy variable for elevators (there: 1, No: 0)	Positive
Decoration2	Dummy variable for indoor decorative (Deluxe: 1, otherwise 0)	Positive
Coldness	Dummy variable for cooling systems (Air conditioner: 1, otherwise 0)	Positive
Balkony	Dummy variable for having balcony (existence: 1, Non-existence: 0)	Positive
Accessibility and environmental variables		
Medical	Dummy variable for access to health centers (existence: 1, non-existence: 0)	Positive
Religion	Dummy variable for Accessibility religious centers (Yes: 1, No: 0)	Positive
Training	Dummy variable for accessibility and educational center (very close: 1, otherwise 0)	Positive
Center	Dummy variable for accessibility to downtown and shopping center (Yes: 1, No: 0)	Positive
Place1	Dummy variable for the location of the building (the street: 1, otherwise 0)	Positive
Place2	Dummy variable for building location (alley, cul: 1, otherwise 0)	Positive
Width	Dummy variable for the width of alley or the street (more than 10 meters: 1, otherwise 0)	Positive

5- Research Findings

Choosing the Functional form of the Hedonic Model and Model Estimation

To determine the determinants of the housing prices the Hedonic price function was used. For commodities which price is a function of the good's property the Hedonic function is applied to estimate the price. In the current study due to the easy access to information the vectors of the physical characteristics of housing have been used. In order to estimate the Hedonic price function the semi logarithmic function was used which can be expressed as follows (Shihomi, 2007):

$$Lnp = a_0 + \sum \beta_i X_i \qquad (7)$$

The results of the estimation of the Hedonic function for the residential units of the Ahvaz city using Ordinary Least Square (OLS) approach and Eviews 6 software were provided in the following Table:

Table2. The results of the estimation of the Hedonic function

Prob	t-statistics	Variable	Prob	t-statistics	Variable
0.000	17.67	Price2	0.070	1.815	Elevator
0.021	2.21	Area1	0.398	0.846	Decoration1
0.033	2.45	Area2	0.000	4.26	Decoration2
0.752	0.316	Age1	0.010	2.57	Coldness
0.046	-1.96	Age1	0.000	3.49	Balkony
0.070	1.815	Elevator	0.004	2.85	Medical
0.398	0.846	Decoration1	0.000	-3.96	Religion
0.000	4.26	Decoration2	0.094	1.67	Training
0.010	2.57	Coldness	0.004	2.86	Center
0.070	1.815	Elevator	0.001	3.22	Place1
0.398	0.846	Decoration1	0.000	3.58	Place2
0.000	4.26	Decoration2	0.019	2.35	Width
0.010	2.57	Coldness	R^2=0.88	Prob (F-statistic)=000	1.85=DW
0.557	-0.55	Heat	-	-	-

Therefore, based on the results of the final estimation of the Hedonic price function which were presented in Table (2), the estimated coefficient for all the variables in the final estimation were significant at 90, 95 and 99 level of confidence. The determination coefficient indicated that 88 percent of the changes in the dependent variable could be explained by the explanatory variables of the model. In other words, the explanatory power of the variables in the model was equal to 88 percent. The remaining change in the dependent variable can be explained by the variables which were not included in the model. Table (2) provided the most important determinants of the housing price in Ahvaz city. As it can be seen in the Table (2) 9 variables of 26 did not have a significant effect on the independent variable and 18 remaining variables which were used in the final estimation of the linear semi-logarithmic function as a structural model for the estimation of the housing Hedonic price in Ahvaz city had a significant effect on house price in Ahvaz. Based on the Table (2) the most important determinants of the house price in Ahvaz included the price of land, land area, area of the building, the age of the building, number of rooms, Frontage, elevators, parking and interior decoration which are considered as physical or structural factors affecting house prices. On the other hand, the environmental and accessibility determinants of the house price were accessibility to health centers, educational, and shopping centers. Thus, the investigations indicated that the physical and structural factors have a greater effect on the house price in Ahvaz than environmental factors. Therefore, it is recommended that in the planning of the construction of residential units, a greater attention to be paid to the physical factors than other determinants of the house price.

Checking of the Efficiency of the Model

After the estimation of the Hedonic regression model, in order to determine the efficiency of the model using 46 real data, we forecasted the prices and compared the obtained results with the real values. Therefore, in order to obtain a model which has both accuracy and simplicity, the efficiency of both models will be

tested. As it can be seen in the following figure, for the Hedonic model, it can be said that the Hedonic model presents an acceptable prediction for the house price in Ahvaz, therefore, the model can be used to forecast the house price in this city. In the following, we can find the most efficient model by comparing the obtained results from Hedonic and Artificial Neural Network. The comparison of the real prices and the results of the forecasted values can be done using Figure (1).

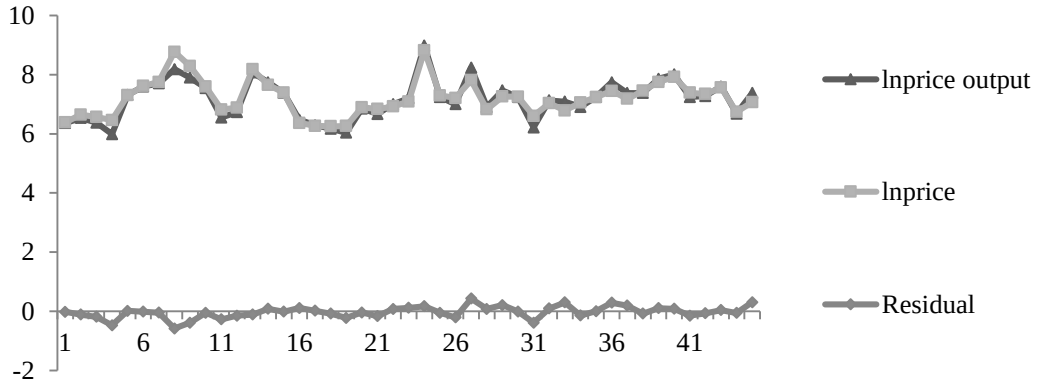

Fig1. The comparison of the Hedonic prices with real prices

Table3. The analysis of the Hedonic model efficiency

Hedonic Coefficient	Error criterion
0.88	R^2
0.0411	MSE
0.2027	RMSE
2.1221	MAPE
0.1513	MAE
0.014	TIC coefficient

Forecasting the House Price Using Artificial Neural Network

In designinig the structure and architecture of the neural network, the number of vector input elements from the problem is specified and not chosen by the designer. However, it is necessary to determine the number of hidden layers, the number of neurons, the type of communication between the neurons, the type of activation function, the number of repetitions, and so on to the designer's choice (Vellido et al., 1999).

This study used a neural network Multilayer Perceptron (MLP) with propagation algorithm to predict the price of housing for the city of Ahvaz. To choose model parameters and optimal network design 8-stage process by Kastera & Boyd (1996) was utilized.

Kastera & Boyd (1996) in their paper stated that the neural network with a hidden layer have greater capabilities than two layer neural networks. In practice neural networks with one or even two hidden layer are widely applied and have an appropriate performance. Therefore, it

was recommended that all neural networks begin their work with one or two hidden layers. The theory and most of the empirical studies suggested that the application of neural networks with more than 4 layers (more than 2 hidden layers) will not create any improvement in the results. Moreover, unlike the great importance of the number of hidden layer neurons in the efficiency of the neural networks, there is no precise formula for determining the optimal number of the neurons. Although, some rules have been proposed to determine the number of hidden layer neurons. One of these rules is to use $M = \sqrt{K \times L}$ formula which can be applied for a three-layer network where M represents the number of hidden layer neurons, K the number of input layer and L the number of output layers, respectively. The real number of hidden layer neurons (M^*) depends on the level of the problem complexity which M^*can fall in the $\frac{1}{2}M \langle M^* \langle M$ interval. More complicated the relationship between the variables more the number of the hidden layer. However, it should be mentioned that regardless of the methods used for the determination of the interval of the number of hidden layers in the test, we always should choose the model which had the best performance in the test set (Kaastra and Boyd, 1996 cited from Araghi and Nobahar, 2012).

In the current study the value of K=28 and L=1 and therefore, $M = (28)^{0.5} = 5.3$ and thus we have: $2.15 < M^* < 10.6$. Therefore, the network was created by 1 and 2 hidden layers with 3 to 10 neurons in the hidden layer and the results of the two model were compared to each other. The results indicated that the usage of one hidden layer will have a better performance and a higher efficiency. Also, the activation function used in this study was hyperbolic tangent function and the max training period for the software was equal to 1000. The software used for the analysis was neurosolution5. For this purpose, 15 percent of the data was used for testing the model and 85 percent were assessed for training the network.

The Figure (2) shows the procedure of house price forecasting for Ahvaz city using neurosolution5 software.

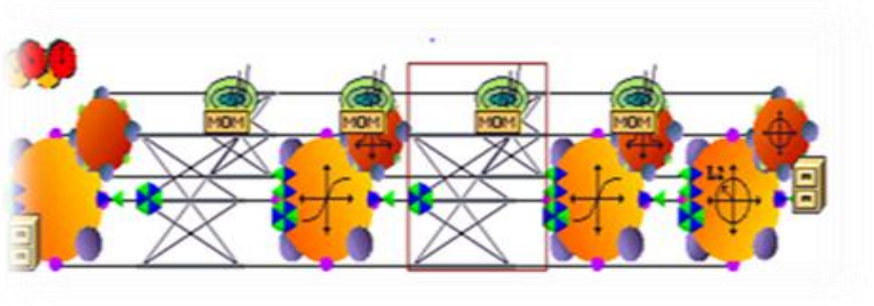

Fig2. The forecasting procedure using artificial neural network model

The comparison of the real prices and the results of the price forecasting for data using artificial neural network model were presented in figure (3).

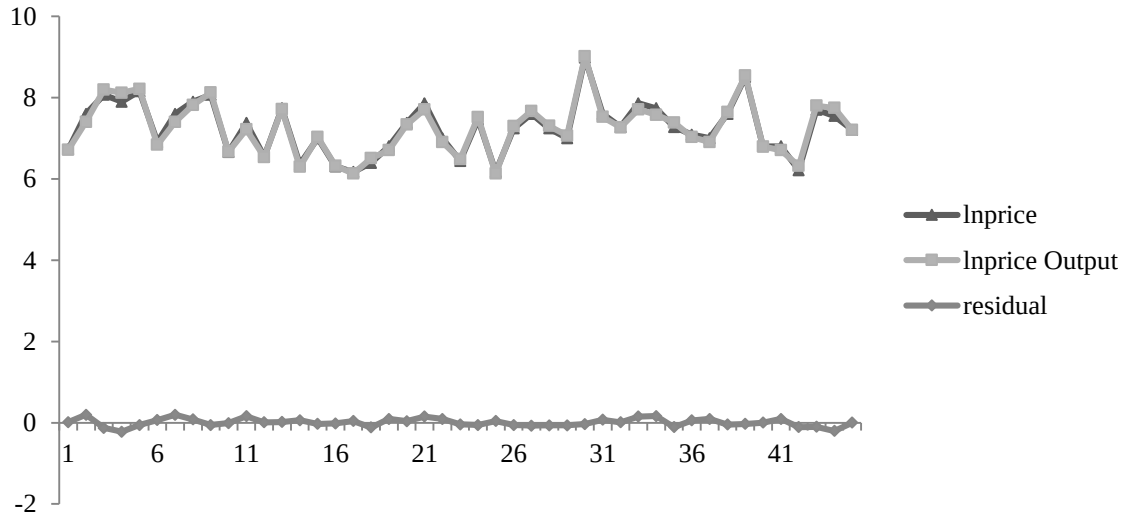

Fig3. The comparison of the real price and the forecasted house price

In the following the efficiency of the model was determined using the results of the artificial neural network model. Then, using 46 real data the prices were forecasted and the obtained results were compared to real values that the assessment criterions were provided in the Table (4).

Table4. The efficiency of the artificial neural network

Coefficient of the artificial neural network	Error criterions
0.98	R^2
0.0098	MSE
0.096	RMSE
1.063	MAPE
0.0781	MAE
0.0066	TIC coefficient

In order to compare the forecasting power of the Hedonic regression model and artificial neural network the determination coefficient (R^2), Mean Square Error (MSE), Root Mean Square Error (RMSE), Mean Absolute Percentage Error (MAPE) and Mean Absolute Deviation (MAE) and TIC coefficient were used. The relationship between the indicators is so that the explanatory power of the model by the variables is higher when the R^2 is closer to 1 and other parameters are closer to zero and the model would have a better performance.

The Comparison of the Performance of Hedonic and ANN Models

According to the obtained results from the both models the performance of the Hedonic and ANN models in forecasting the house price for Ahvaz city were compared.

Table 5.The comparison of the Hedonic and Artificial Neural Network in forecasting Ahvaz house price

Error criterion	Artificial network coefficient	Hedonic coefficient
R^2	0.98	0.88
MSE	0.0094	0.0411
RMSE	0.096	0.2027
MAPE	1.063	2.1221
MAE	0.0781	0.1513
TIC coefficient	0.0066	0.014

As it can be seen in Table (5), the R^2, MSE, RMSE, MAPE, MAE and TIC coefficient were estimated for both the models.

The provided criteria indicated that the Artificial Neural Network had a better performance in comparison with Hedonic regression Model. As it was observed, the Artificial Neural Network had less error and therefore higher performance in forecasting the house price in Ahvaz.

In order to see whether the difference in forecasting of the two models were significant from the statistical perspective the Morgan-Granger-Newbold test was used to compare the forecasted house prices in Ahvaz. The results of the test were provided in Table (6).

Table6. The results of the Morgan-Granger-Newbold test for the difference in forecasting

Prob	The value of the test statistic
0.000	5.27

The results of the hypothesis testing indicated that the null hypothesis of the test which referred to the lack of forecasting power of the two models and the capability of the models in forecasting the accurate house price was not rejected and therefore, the difference between the forecasting power of the two models was statistically significant which confirmed the better performance of the Artificial Neural Network in comparison with Hedonic regression model in forecasting the house price of Ahvaz city.

6- Conclusion and Discussion

In the economic literature, housing is always considered as a commodity with dual properties. In addition to consumption value from the economic perspective, it is interpreted as an assets which attracts the attention of the capital owners. Therefore, the accurate forecasting of the house price for owners, investors, governments and active corporations in the field of construction and other participants in the asset market is of great importance. Nowadays, the effect and the importance of housing and its considerable role in the economy is not hidden to anyone. Therefore, the existence of a model for forecasting the accurate and efficient house price fills up the information vacuum and decreases the uncertainty created from the lack of enough information and therefore, leads

to the improvement of the efficiency of market asset.

The current paper attempted to forecast the house price in Ahvaz using 27 variables from two Hedonic and artificial neural network models. First of all the Hedonic model was considered and then the variables of the model were introduced. The classic assumptions were tested for the regression model and the results indicated that the classic assumptions hold. Then, the determinants of the house price were analyzed using Hedonic regression model. Based on the results of the study, the explanatory variables could explain most of the changes in the dependent variable. The forecasting process was conducted using Artificial Neural Network model. In this model the assessment criteria including MSE, RMSE, MAE and MAP were proposed which can be used to compare the efficiency of the two models. The results of the Hedonic model indicated that among 28 variables in model 18 variables were significant and the comparison of the estimated values indicated that the house price in Ahvaz is mainly influenced by the physical and structural factors. Finally, using Morgan-Granger- Newbold test the performance of the two models were compared using the assessment criteria. The final results indicated the better performance of the artificial neural network (98%) in comparison with Hedonic regression Model (88%). On the other hand, in comparison with similar research conducted by Khalili Araghi and Nowbahar in Tabriza city the forecasting power of the house price in Ahvaz using artificial neural network was 17% greater. The appropriate performance of the artificial neural network model in comparison with Hedonic regression model confirm the existence of nonlinear relationships between variables from a degree that the application of artificial neural network model will improve the predictions. The results of the study were similar to the results of the studies conducted by Khalili Araghi and Nowbahar (2010), Amanpour et al., (2012), Tabales et al (2013), Zainun et al (2011) and indicated that the artificial neural network model has the capability to provide better and more accurate prediction with respect to econometric methods. This property may be attributed to the existence of properties like parallel processing and flexibility in artificial neural network models.

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