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The analysis of effective factors on house with approach of systems dynamics

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Abstract

House is one of the most important components in the life of the society's people. Many elements are effective on determining the price and also house supply and demand, especially in metropolises. Definitely mere attitude on the house price behavior without considering the effective factors on it will not have any profit. Therefore, in this research with approach of systems dynamics, the effective factors on the house price in Tehran's metropolises are studied and analyzed. In this approach, by reciprocal casual loops and with considering the state and proceeding variables, the issue has been studied. Due to it, this issue can be studied comprehensively. For this purpose, after drawing the loop-form casual diagrams and state and proceeding diagrams by Vensim software, the simulation is accomplished and the house price behavior and also the effective factors on it are studied. The obtained results indicate increasing of urban facilities of other provinces of the country and also supplying the low-price house on behalf of the government and presenting facilities for construction of house lead to the balance in the house price and also reduce the price in the house market.

Key words: house price, house market, house supply and demand, systems dynamics

Introduction

House as an economic commodity has features which differentiate it from other commodities and complicate the analysis of its supply, demand and market. On one hand, house is a consuming commodity that after food and cloth it is the most important and significant need of human and it is considered as the most expensive necessary commodity of the family and on the other hand as the immovable durable commodity, it is a capital commodity in which investment is accounted as the largest part of the family asset and in addition to the family, it also has high attraction for economic firms. Especially in the inflation conditions that certainty to the investment efficiency in other economic sectors is low; purchase and construction of house are accounted as a safe investment which is more efficient than other forms of investment in long-term. In addition, lack of certainty to the future and lack of proper system of social supply converts the house to the place of family income in oldness and disablement period.

Correct analysis of the house market situation and correct recognition of the effective huge factors on it and also the effectiveness rate of each one of them can help the planners and authorities of this affair in analysis and correct prediction of the future situation and proportional with it, proper solutions can be presented (Naji Meydani, 2010).

The main purpose of this research is to make a dynamic model for analysis of the effective factors on Tehran's house market. Also the identification of the effective factors and the important loops of the system feedback control for studying and assessing the effective policies on controlling the house price are from the subsidiary purposes of this research. Therefore, in this research the systems dynamics methodology is used for achieving these purposes.

Theoretical principles

Dornbush & et al (1994) expressed that the balancing price of the house like other commodities is obtained from intersection of the curves of the market supply and demand. In the house market, we face with two supply curves: A) curve of warehouses supply that the purpose is the same inventory of constructed residential houses and existing in each moment of time, B) the proceeding supply curve which indicates the proceeding of new-constructed houses supply to the market in ant specified time period.

Historical review on the house studies as Di Pascal and Witon (1994) mentioned indicates that during the time, these studies have been inclined from studying the investment in new residential units in 1960s gradually toward studying the self-estate house, the house price effects and the financial institutes role and credit market on it. Since the early part of 1980s, new studies were done according to more explicit definition of the house possession cost by using of life period theory that for sample, the studies of Patreba (1984), Mankio and Will (1989) can be mentioned. In 1990s most of the attentions were inclined to the financial market role in the house market. Since this period onward, we witnessed the tendency to the regional studies of house and the study of the house price bubble.

A main approach in studying the house price is to consider the effective factors on the demander and supplier behavior. The main purpose in relation with the house demand is to consider the demand for house as an asset.

House demand models:

With observing the historical procedure of the house demand models, four different kinds of these models can be separated from each other. In many numbers of the house market studies, simple frame of the general models of demand which is known as Marshal demand function has been used. It can be said that in these studies implicitly the house has been considered as a commodity like other commodities. In this relation, the first approach of the study of Mankio and Will (1989), Di Pascal and Witon (1994), Goodman & Tibodio (2008) can be mentioned. The second kind of the demand models which is influenced from the primary work of Patreba (1984) and has been developed by Topel and Rosen (1988) is the demand for the house as the demand for an intended capital commodity. About the third kind or the replacement method of implicit rent, the studies that have been accomplished by Min (1990, 2002, and 2003) and Cameron & et al (2006) can be mentioned. In these studies, the house demand relation has been obtained from replacement of effective factors on implicit rent instead of it in the model.

About fourth model, two-period model of Salou can be mentioned that general demand for self-estate house is obtained from two components. First demand is obtained on behalf of the persons that have had estate house since before but they demand more houses (additional demand) and second, demand on behalf of the persons

that at the beginning have had renting house but they have changed their decision from rent to buy (transmission effect).

House supply

These groups of the house price studies which ignore supply, abandon a fundamental part of the house market, but anyway these issues of studies related to the house supply compared with the studies of its demand are much less in terms of their number. Di Pascal (1999) has expressed that lack of standard unit for measurement of the house services and the problem of lack of information of the supply of the existing units of house are two cases of the house supply problems. Also Patreba (1984) has considered the gross investment supply for house according to the Tobin's Q theory in long-term as the positive function of the real price of house. Di Pascal and Witon (1994) used of a long-term supply model for construction of house in which supply has been the function of the house price, financial structure, land price, construction cost and the house inventory with delay. Salou (1994) has obtained the house supply from the process of maximization of the producer profit and with observing the effect of uncertainty from sale time on increase of costs and also with considering the land limitation stipulation.

Nowadays many articles study the house supply and demand together that will be introduced in the research background part.

The research background

Beltratti and Morana (2010) have studied the relation between the macroeconomics factors and house market for the countries which are the member of group 7. Their research result indicated that the global shocks on behalf of the economy supply have been an important factor in the house price fluctuations in these countries. Also the relation between the real price of house and macroeconomics factors is reciprocal, but generally, investment in comparison with consumption and production indicates stronger reaction to the house price shocks. Also Atefi & et al (2010) in an article entitled "house price: a study of the real estates in Iran" have analyzed the dynamism of the house price in the field of real estates market in Iran with approach of system dynamics. In this article, with definition of the price index with regard to the economic situation of Iran, they indicate that in the event of lack of effective financial infrastructures, this index (price) is reduced during the time. They expressed that from considered policies of the house supply sector, the movement has been toward the industrial methods of construction and increase of constructions loans volume. Also they expressed that concentration on the macroeconomic policies for reduction of economic fluctuations and investment danger in other markets is also accounted as one of the house policies in the demand sector. They indicated the results of balance between supply and demand, manner of access of Iranian families to the house by exerting these policies in their model. Also they expressed that investigation to the macroeconomic policies is a long-term solution for the price index problem. In the meantime, Xiao & et al (2014) studied and analyzed the estate policies effect on the house price of Beijing. They used of the dynamics methodology of systems. They designed a dynamic analysis model in this field by combination of estates market conditions of Beijing and then by using of Vensim software, they simulated the presented model. Their research results indicated that the land price and amount of the house supply have had much effect on the house prices. Finally, they suggested some executive policies. Like Xiao & et al , Zhang & et al (2015) also modeled the house market of China. They also used of the dynamics methodology of systems. The main purpose of their research has been the analysis of the house policies and educational problems and for these two purposes, they have done the modeling in stepwise form. In the domestic researches, Naji Meydan & et al (2010) have studied the dynamic effect of some macroeconomic variables like money volume, domestic gross production, price index of consumer and the foreign currency rate on the behavior of the price index of Iran's house by using of the error correction model. The model estimation results which had been obtained by using of seasonal data during the time period of 1990-2007 and by applying long-term convergence method of Johansen- Juselius indicated that all mentioned variables have had meaningful and positive relation with the price index of house. Also Khakpur and Samadi (2014) analyzed and assessed the effective factors on the land and house price in region 3 of Mashhad city by using of questionnaire tool and descriptive-explanatory methodology. In their research, the effectiveness of each one of the independent variables (the effective factors on the land and house price) on the dependent variable (its price) was analyzed by using of linear Regression with stepwise method that from studied factors, the variables of the economic base of residents, social base of residents and the vastness of the land pieces were known as the most important effective factors on the change of the land and house price in this urban region. In the researches domain which has been in the field of systems dynamics, Bastan et al (2012) have studied the dynamic analysis of the house price changes in Tehran that for this purpose, they used of the systems dynamics approach. After accurate explanation of the problem, they expressed the dynamic hypothesis of the model and then they identified the

effective factors on the house price in Tehran city and drew the cause and effect model of the system. Finally, they analyzed and designed the model. Ahmadvand & et al (2014) also have analyzed the house market of Tehran province by using of the systems dynamics approach. For simulation of the considered model, they used of Vensim software. In order to study different policies in the house market, they studied the market scenario. The obtained results indicated that the increase of urban facilities of other provinces in the country and also supply of low-price houses on behalf of the government and presenting facilities for construction of house lead to the balance in the house price and also reduction of the price in the house market.

The research methodology

The system dynamics methodology was proposed for the first time on behalf of J.W. Forester. In 1961, he published the industrial dynamics book in this domain. His another important project was urban dynamics that presented a dynamic theory from the manner of effectiveness of the house construction and business development on the growth and stagnancy of urban area (Forester, 1969). Generally, it can be said that the main concept in the systems dynamics is to see how these components interact with each other. In the systems dynamics, the elements and persons in a system interact with each other through feedback loops in which one variable influences on other variables during the time and these variables influence on the first variable (Forester, 1961). For perception of these dynamic phenomena arising from reciprocal interaction of different factors, a thing more than technical tools is needed so that enables us to create mathematical models for it. The systems dynamics issue significantly is scientific and intercourse attitude and originally does the study and management of complex feedback systems like the systems existing in the domain of business, economic systems, population researches and other social systems (Sterman, 2000). The house cycle includes investment, construction, transaction and the manner of using of it. The economic system of the house market has the following unique features:

1-Systematism: the general performance of the house market is influenced from the economic, financial and population factors.

2. Dynamism: the house cycle due to face with many variables during the planning, designing, constructing, completing and finally exploiting is very dynamic. Time delay is a very common problem. With passage of time, the purpose and function of house are changed.

3. Ambiguity: many variables influence on the house supply market. Also these variables influence on each other, therefore, the fluctuations are different in time range. Consequently, the house market is very ambiguous.

4. Feedback: the house market cycle begins with house demand and then it is continued with construction, economic crisis of the market and finally destruction of it. This is a feedback system which influences on the house supply and demand.

5. Cause – effect cycle: house market is influenced from a group of variables that each one of these variables also influences on each other; for example, population influences on demand, demand influences on supply and supply also influences on demand and finally they form a cause-effect cycle.

Sensitiveness: many exogenous variables influence on the house market and this effect is expanded all around the market quickly. Since these changes will lead to the significant effects, exerting the policy has much sensitiveness (Ho & et al, 2010).

The research issue

Generally, the effective factors on the house market like other markets are divided into two parts of the supply and demand factors. In fact, supply part seeks to find the effective factors on the construction costs and determine the policies for improving the construction performance and demand part also seeks to concentrate on macroeconomics policies for reduction of economic fluctuations. These supply and demands interact with each other in the house market which is the place of house swap and cause to form the balancing price (Ahmadvand & et al, 2014).

As it was expressed, this research seeks to analyze the effective factors on the house with approach of systems dynamics. For this purpose, at first the lever and effective variables in the model are determined.

Introduction of key variables

With regard to study the previous articles in the field of current research and according to the theories of expert persons in this domain, the main variables of the model were identified as follows:

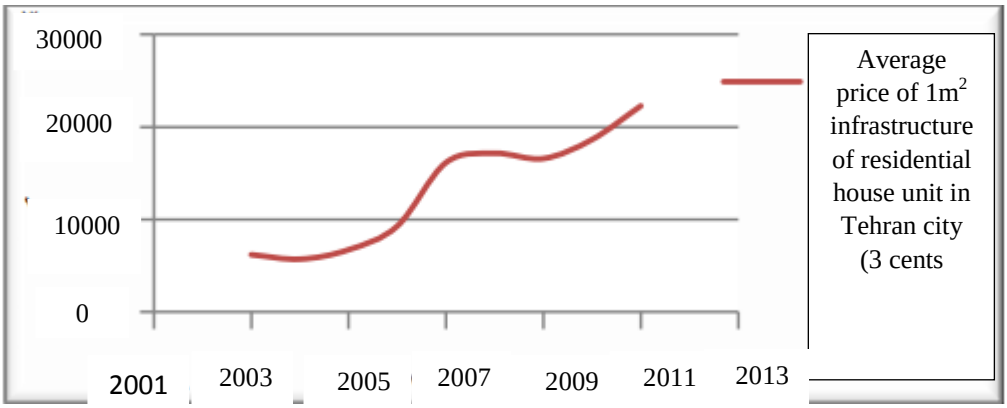
- House price (Che, 2005; Ho, Wang and Liu, 2010); land price (Che, 2010); house demand (Atefi & et al, 2010; Ho, 2003); house supply (Ho & et al, 2010; Yukian, 2003; house cost share in the families budget to the house price (Ho & et al, 2010); house purchase (Ho & et al, 2010); inflation in the house sector (Ghafelehbashi, 2009); investment of the society on the estate (Ho, 2003); per capita of domestic gross production (Ho & et al, 2010; Che, 2006; Ho, 2003; construction cost (Che, 2003); population (Ho & et al, 2010; Che, 2006; Ho, 2003; Atefi & et al, 2010; urban facilities of Tehran (Daneshpour and Hosseini, 2012); mortgage and rent cost (Daneshpour and Hosseini, 2012); banking facilities for construction (Ho & et al, 2010); investment in productive sectors; private sector investment in construction; house supply on behalf of the government.

Time horizon of modeling

With regard to this reality that in different time periods, the house market fluctuations have been different, for modeling, 15-year time range of 2008-2023 has been considered as criterion; although review of sources isn't limited to this time range. The spatial domain of this research is Tehran province. The subjective domain of this research includes dynamic modeling of the house market fluctuations in Tehran province and adoption of policies for controlling it.

Reference model of the house price

According to the census results of house price and rent in selected cities since 2009, from the management system of real estates transaction in the country, the changes procedure indicates the ascending procedure of the house price till 2011 in Tehran city in the shape 1.



Shape 1. The procedure of change of house price in Tehran city (the statistical yearbook of the country, 2012)

As it is observed in this diagram, since 2005 to 2007, improper increase of the house price has caused to appear many economic-social problems in Tehran and also it has created different conditions for providing house for new-formed or homeless families with regard to their per capita income. This price has been almost fixed till 2009 and since 2009 onward, it has taken ascending procedure to itself. In fact, this sudden increase during these periods has caused the splendour of business of many brokers and traders of house sector which are not accounted proper conditions for the society, because house isn't accounted as the primary needs of the society's people.

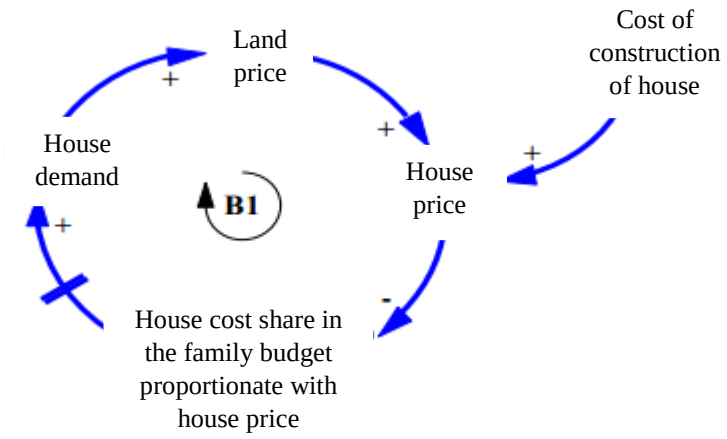
Cause-effect loops

According to the accomplished researches in the house sector, the following hypotheses and cause-effect loops can be proposed for the issue.

Casual loops of the house market

In the balancing loop B1 in the shape 2, with increase of the house price, the house cost share in the family budget is reduced proportionate with the house price. If the amount of this variable is reduced, demand for the

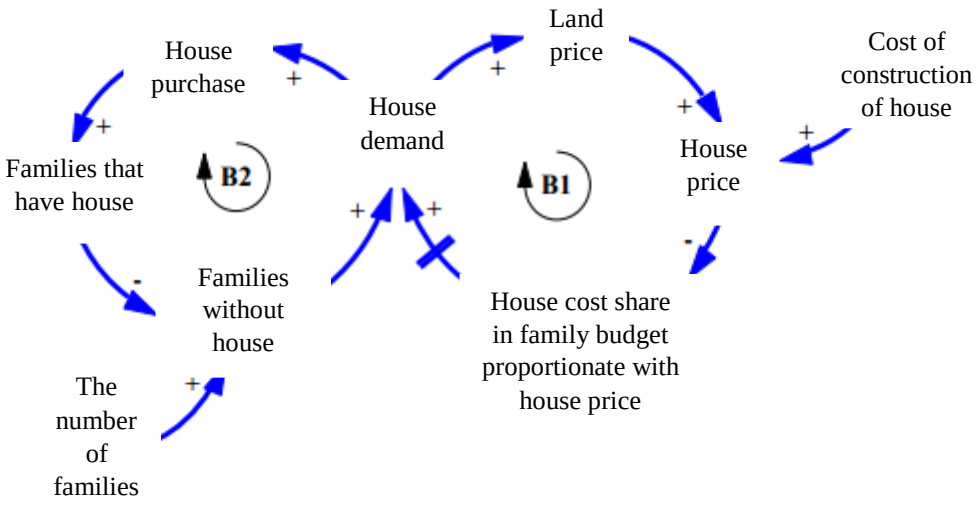
house and consequently the land price are reduced and therefore, the house price which is the sum of the construction costs and land price is also reduced.



Shape 2. The effective casual loop on house price

Casual loop on the house demand

In the balancing loop of B2 with increase of demand, the house purchase and also the number of families that own the house are increased. With increase of the number of the families that own the house, the number of families without house and also demand for house are reduced that this affair leads to balance the house demand. In the shape 3, loop B2 is added to the loop B1.

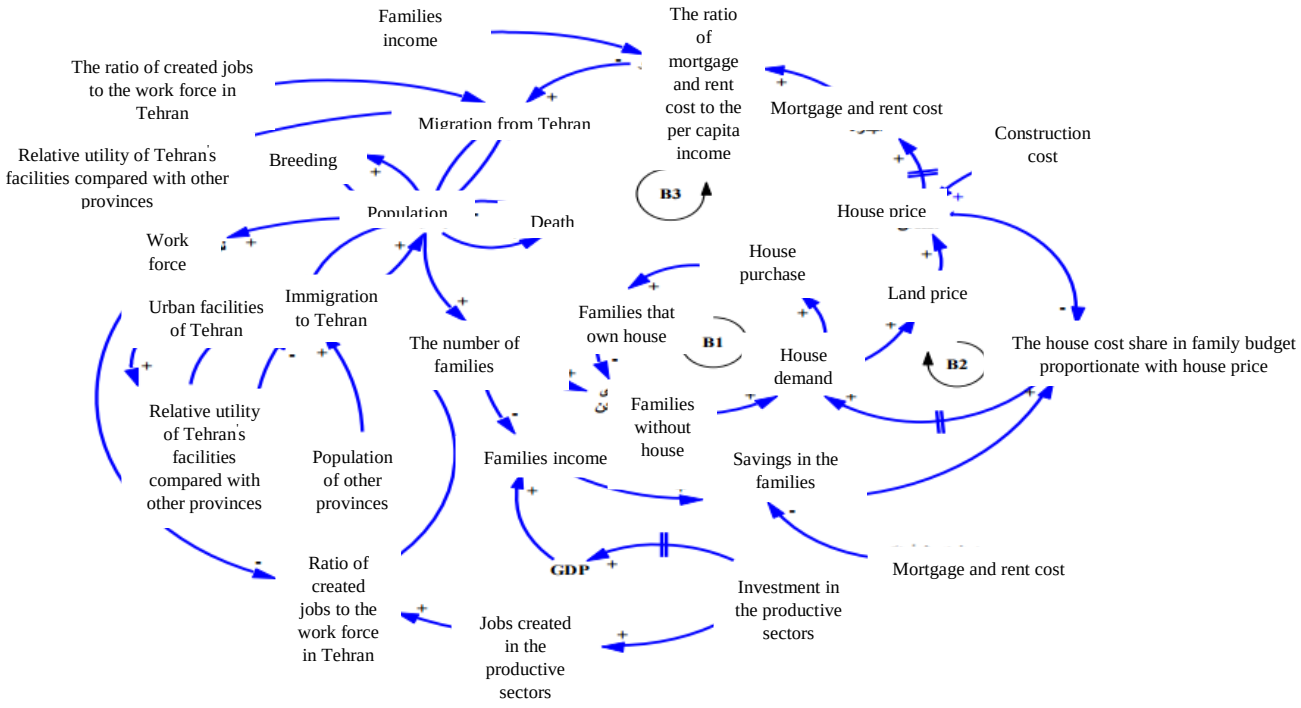


Shape 3. Combination of the house price loop B1 and house demand B2

Casual loop of population and house

Tehran's population is changed for four main reasons. Immigration to Tehran and breeding cause to increase the population and migration from Tehran and death reduce the population. The variable of Tehran's facilities difference with other provinces causes to increase the immigration to Tehran and reduce the migration from this city. In the balancing loop of B3, with increase of population, the number of families is increased and since the need to the shelter after food and cloth is from the significant needs of each family, the number of families without house is increased and this issue leads to increase the house demand and finally the house price. Consequently, the variable of mortgage and rent costs- which is influenced from the house price- is increased and consequently, the ratio of mortgage and rent cost to the per capita income of families is also increased. Also due to the creation of improper economic conditions for living, migration from Tehran becomes more and

population is reduced gradually. In the shape 4, Loop 3 has been added to the previous loops and the effective casual variables on population and other variables have been indicated.



Shape 4. Combination of population loop of B3, house price loop of B1 and house demand of B

Casual loop of the house supply

Supply sector includes all variables which lead to produce house; therefore, with regard to the facilities and limitations of access to the land, planning for construction begins. The purpose of construction planning is the number of houses that every year the construction of them begins.

When the construction of a house begins, this house after the necessary time for construction is added to the completed houses. Then the variable of new houses supply is increased and influences on the house price. This affair leads to form the incremental loop of R1. In the shape 5, combination of loop R1 with previous loops indicates the cause-effect structure of this research model.

Proceeding diagram

According to the manner of mentioned loops effectiveness on the model and the interaction of variables with each other, the variables kind (state, proceeding and auxiliary) is expressed. In fact, the following cases are accounted from the most important variables of state: the price of per m^2 of land, residential houses number, the number of houses without residents, population, families saving, total of houses existing in Tehran and houses which are being constructed. The most important variables of the model rate include the following cases:

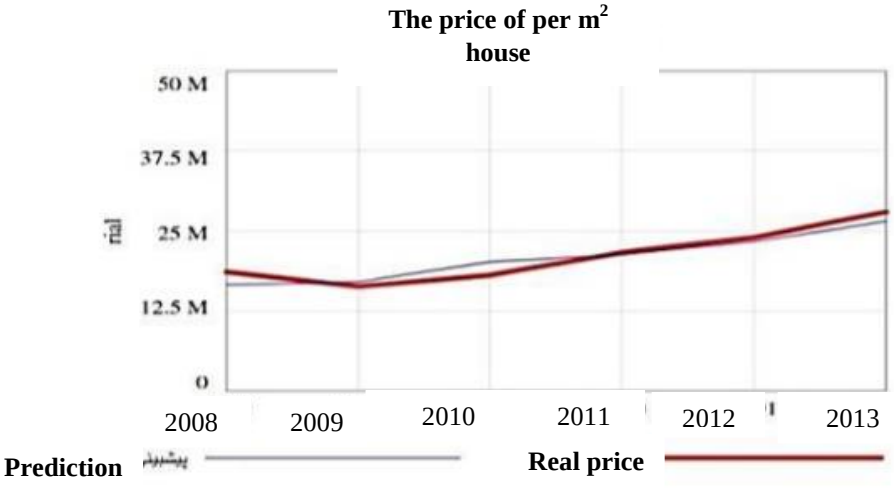
Sale, supply and purchase of house, families income and costs, the houses that construction of them has been started, the rate of completion and outwear of houses; also the variables of effective rate on population include death, breeding, immigration to Tehran and migration from Tehran. Other variables which are accounted auxiliary have been mentioned in the shape 6. According to the main variables, the effective factors in the model have been identified and logical and Regression relations between them have been extracted by using of SPSS software. Also some of the data related to the fixed variables in the model have been obtained from statistical center of Iran. After formulizing the model and drawing the proceeding diagram in Vensim software environment, simulation has been accomplished. Of course, here due to the issue brevity, we avoid from expressing more details and confine our discussion to indicate the proceeding diagram in the shape 6 and software outputs.

Validation of the model

The validation of the proceeding model is an important part of the research process that gives validity to the researcher findings. In this research, the created model has been validated with two methods that in the continuation, the results obtained from each one are expressed.

1. Reference behavior reconstruction

For validation of the created model, the price of per m^2 house that has been predicted for time span of 2008-2013 by model, has been compared with the real amount of house price in this same span. The diagram of shape 7 indicates the amount of predicted price and real amount.



Shape 7.the results obtained from references behavior reconstruction

As it is observed, they have similar behavior, the error amount of these two amounts in predicted amount and real amount has become equal to 0.060 averagely that indicates high accuracy of the model in prediction of the reference behavior.

2. Simulation of boundary behavior (boundary conditions test)

This test confirms the validity of the proceeding model, for example if the construction of low-price houses on behalf of the government is increased 1000 times , we expect due to the delay after two years due to the increase of supply, house price not to have much change that shape 8 confirms this issue. It is worth noting that the reason of this increase is also the increase of building materials price.

Conclusion:

With regard to this issue that the house price is one of the necessary commodities in Iranian families basket and also with regard to this issue that the price of per m^2 of it in Iran is more than the other countries, Study and analyses of the effective factors on the house price especially in metropolises have special importance. Also one of the most important issues in this field is to study the issue during the time and with considering the tile delays of variables that in this research with regard to this issue that the used methodology has been the systems dynamics; this research can cover this issue. With regard to the casual loop model and also state and proceeding model of this research, the intended issue was simulated in Vensim software. The time considered in this simulation is monthly and for 8 years (since 2012 to 2019). The results obtained from simulation indicated the ascending procedure of price for house. Of course, this price has been affected by fluctuation during the time, but generally it has ascending procedure. In this research, at first the cause-effect model has been presented for studying the dynamism of Tehran's house market and then for simulation of the cause-effect model, the proceeding model has been extracted. A much as much as possible, for determining the relation between the variables, real data have been used. For validation of created model, the changeable behavior of the price reference of per m^2 of house has been compared with its real amount, low error of this comparison indicates conformity of created model with that thing which occurs in reality. Of course the correctness of created model was confirmed by sensitiveness test and boundary behavior test. The results obtained from the model indicate

the increase of the house price in the form of exponential growth model in time span of 2013 to 2023 that the reason of this event can be searched in the house demand sector. Population which is the main variable of the house demand has been increased in time span of 10 years and naturally the demand for house is also increased that this affair is the main reason of increase of the land and house price. With regard to the results of this research, if the government in the population sector of Tehran as the demand origin uses of policies that approximate the facilities of other provinces to Tehran (for example, attempt for increasing the scientific level of other universities or attention to the urban beauty of other provinces like Tehran), Tehran's population will be balanced more and consequently, demand for house and the rate of increase of house price are reduced.

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