A system dynamics approach to clarify the impacts of state loans on real estate market in Iran

Yalda Amini[a], Sina Jangali Kasmaei[a], Golnoosh Sharifan[a],

Gholamreza Eslamifar[a], Ashkan Aghdaei[b]

[a]Graduate School of Management and Economics, Sharif University of Technology, Tehran, PO Box 11155-8639, Iran.

[b]Polytechnic Institute of New York University, Six MetroTech Center, Brooklyn, NY 11201, the USA.

amini@gsme.sharif.edu, s_kasmaei@gsme.sharif.edu, golnoosh_sharifan@gsme.sharif.edu, eslamifar@alum.sharif.edu, aa3502@nyu.edu

Abstract

In this paper, the effect of state loans on real estate market prices in Iran is investigated through a system dynamics approach. Although the government has given loans to the demand side for the purpose of stabilizing the housing price, the price has increased. In the proposed model, the effects of giving loans to the demand and supply sides of the market have been studied. The market includes investors as well as non-owner families and constructors in the supply and demand side. The results indicate that granting loans to the supply side for construction will be more beneficial than the demand side. In addition, the monetary policies of the government which influence the liquidity in society can influence the market behavior considerably. Thus, it is suggested that first, the government reduce the amount of liquidity in society and second, the government give state loans to the supply side of the market.

Keywords: Real estate market, loan, Iran, housing price, speculative demand

1. Introduction

In recent years, the government of Iran has taken a wide range of measures to stabilize real estate market. Although their solutions can temporarily control real estate prices, but in long term, market response to government policies might be different from those foreseen by the authorities. One example is increasing the amount of housing loans to increase people's purchasing power, which will grow the demand for real estate without growing the supply accordingly. Therefore, the prices will increase too. Furthermore, these elevated prices will attract constructors to increase the supply side but with a delay. The supply growth in high prices could result in market downturn in even higher

prices than before. In recent years this kind of behavior has been observed in the system being studied.

Another important factor that influences the real estate market in Iran is the speculative demand. Investors can play as both buyer and seller and behave in ways that maximize their profit. Providing governmental facilities will result in complex effects on the investors' entering or leaving the real estate market, which is hardly predictable.

The following examples declare the complexity and importance of real estate dynamics caused by governmental mortgages. In January 2012, central bank of Iran decided to increase the maximum amount of mortgage by 25 percent in order to stimulate the real estate market and grow the number of transactions, but in only 20 days the decision was overruled. According to the members of the real estate committee, the probability of unrealistic price increase in the market was the main reason to stop it. However some experts still believe that increasing loans will have positive effects on the market.

In 2009, the government raised the mortgage amounts to increase the purchasing power of non-owner residents. But the housing price was doubled and the purchasing power actually decreased. Therefore it is implied that changing the amount of public mortgage leads to unexpected dynamics in real estate market.

A number of researches have been done in Iran in which the behavior of the real estate market has been studied and some models have been proposed to explain the market behavior. The purpose of this paper is to focus on the consequences of loans for both demand and supply side of the housing market in Iran. In other words, it is aimed to find out whether these two categories of loans would be beneficial for the market and what the appropriate mechanism for giving loans would be. Is it better to give loans to the supply side or to the demand side?

The proposed model in this paper is created concerning the model proposed by Atefi et al. (2010) that presents the effect of mortgages on non-owner families' affordability. Atefi's model is based on a model proposed by Mashayekhi et al. (2009) which explains the relationship among the supply, the demand and the price in the real estate market.

In order to match the model results with the market behavior more precisely, some modifications have been made to the above mentioned models. First, the effect of inflation on construction costs is considered. Second, a sector related to the speculative demand is included in the model. Liquidity in the society is considered as a variable in this sector which influences the amount of investment in the housing market.

Therefore the model consists of three sectors, two of them based on the previous models and the third one created to consider the speculative demand behavior.

In the following sections, first a review on past researches is provided which briefly explains the above mentioned models. Then the proposed model is explained in three

sectors. After that the model is tested and finally some policies are suggested for granting loans.

2. Past Research

The literature regarding the real estate market is rich. The proposed model here is based on the model proposed by Atefi et al. (2010) which explains housing affordability in Iran's real estate market. This model is based on a model proposed by Mashayekhi et al. (2009) regarding the owner occupied real estate market. These two models are described briefly below.

2.1. The owner occupied market model structure (Mashayekhi et al. 2009)

This model, which is shown in Figure 1, simulates the supply-demand mechanism for the real estate market. In this model, supply represents "vacant stock" (ready-to-sell constructed houses), and demand refers only to non-owner families named "homeless families" in the model.

According to the owner occupied market model, an increase in the price will lead to new constructions, which will increase the supply with a delay. Therefore the price will decrease after the construction delay. On the other hand, price drops will lead to decline in construction, which means decreased supply after a delay. Hence the price will go up again. So it is seen that the output of this model tends to be oscillatory.

It is important to note that in this model the "total number of families" is assumed to remain constant throughout the time which is not likely in reality. In addition, the demand is determined by comparing the current price with a presumed "normal price" which again is unrealistic. Moreover, the effect of purchasing power in determination of the demand is not considered in this model.

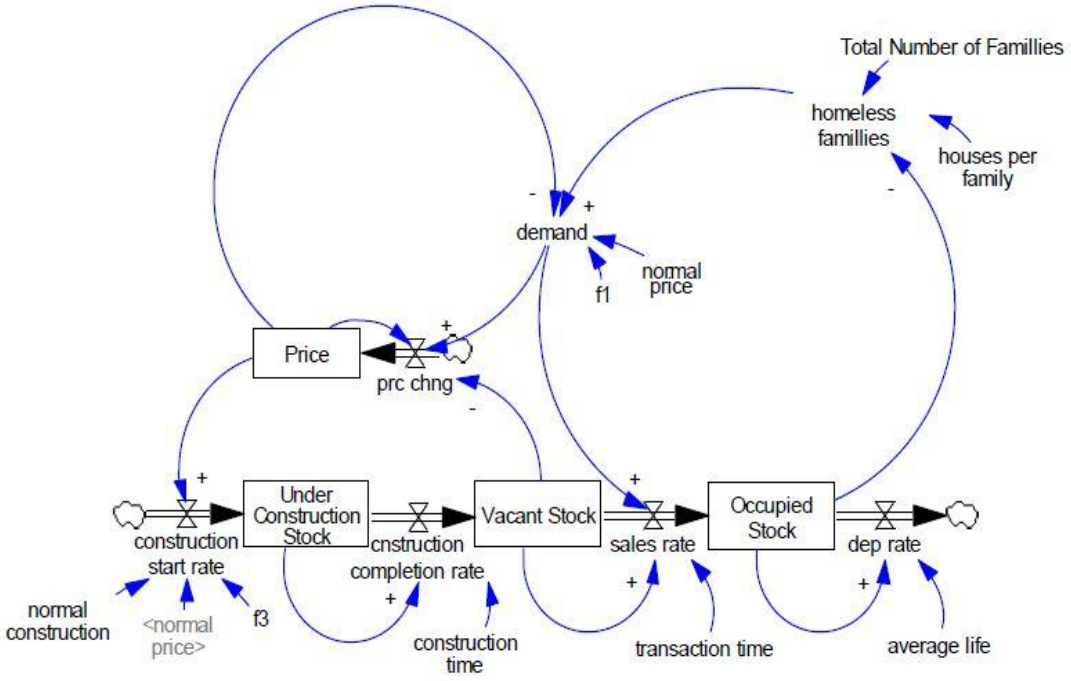

Figure 1- The owner occupied market model (Mashayekhi et al. 2009)

2.2. Iran's real estate market model (Atefi et al. 2010)

The model regarding housing affordability in Iran's real estate market is shown in Figure 2. This model which is based on Mashayekhi's model introduces the concept of "affordability" of non-owner families in housing market and aims to simulate the effect of mortgages on affordability. The model is explained in more detail in the following section.

In this model the governmental facilities are considered only for the demand side and not for the supply side. In addition, the effect of inflation on economic parameters such as construction costs is overlooked.

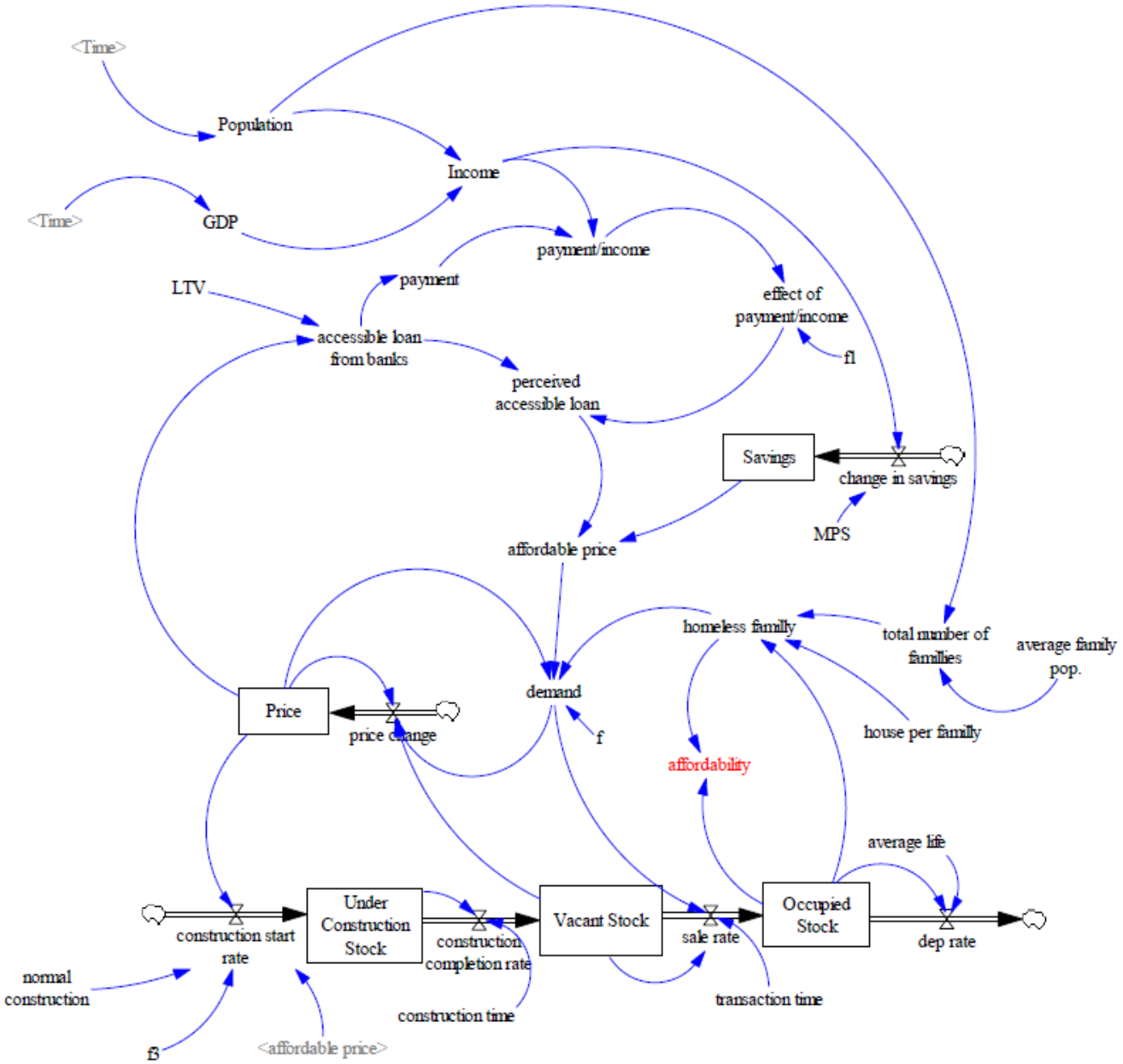

Figure 2- housing affordability in Iran real estate market (Atefi et al. 2010)

3. Structure of the proposed model

As said before, the government of Iran gives loans to house buyers in order to stabilize housing price. But the real response of the market is that the price increases. In this section a model is proposed to investigate the effect of state loans to buyers and constructors on market behavior. The proposed model here consists of three main sectors which are "Basic supply-demand model", "Consumer affordability model", and "Speculative demand model". The first two sectors are based on the previously described models with some modifications to make their output more consistent with the real market behavior. These modifications were necessary because the housing prices have always increased in Iran's real estate market, except once in 2009, but those models predict an oscillatory behavior for that. The third sector is a new model proposed to consider the influence of speculators in the market.

3.1. Sector 1- Basic supply-demand model

This sector (**Error! Reference source not found.**) is based on Mashayekhi's owner occupied market model which simulates the basic relationship of supply and demand in the real estate market and describes an oscillatory behavior in the market. In the equilibrium state, supply equals demand. If the demand rises, the price rises as well. The increase in price causes the construction to grow which leads to an increase in supply (vacant stock) after construction delay. The increase in supply can reduce the price. The price reduction could raise the demand again and the market goes through the same cycle as before.

The modifications applied to this model are regarding the demand, the construction rate, and the vacant stock supplied by investors in the market. The modifications related the demand are explained in sector 2 and sector 3.

Four main modifications are proposed for the construction rate. First, the effect of cost of construction (named "cost to constructor" in the model) on "construction start rate" is modeled. Second, the effect of inflation on the cost is considered. The constructor has to bear the cost of construction which is increasing in time due to inflation. Inflation in this model is related to the total amount of liquidity in the society. Third, the effect of construction loan is considered. The construction loan could reduce the effective cost of construction. Finally, the construction capacity is assumed to change over time due to new construction technologies.

Another modification is due to investors. The investors' purchasing behavior is described in sector 3. When the vacant houses are sold, the consumers and investors behavior will be different. It is assumed that consumers will hold on to the house after purchasing it. But the investors who have purchased the house seeking profit will sell at the appropriate time. Therefore the house would be transferred back from "house investment stock" to vacant stock.

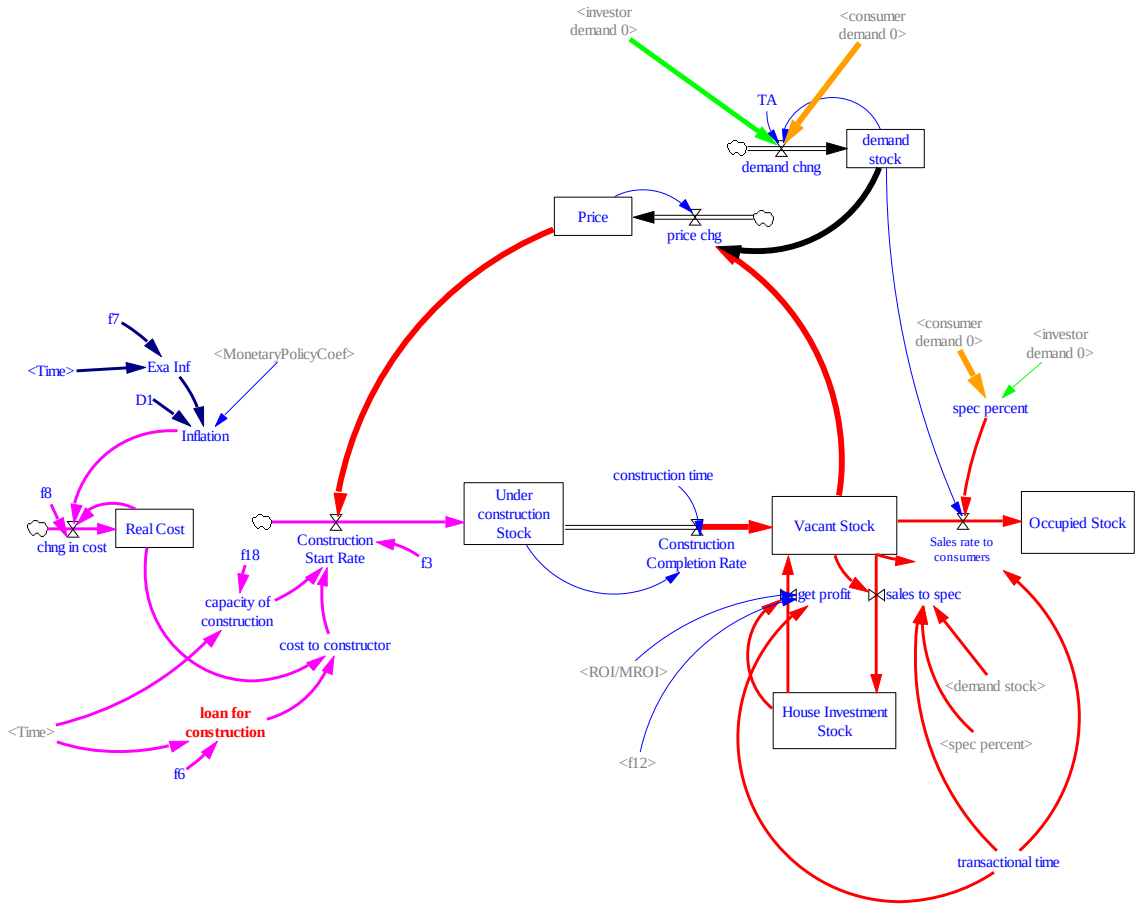

Figure 3- Sector 1

3.2. Sector 2- Consumer affordability model

This sector (Figure 4**Error! Reference source not found.**) is based on Atefi's model which describes the effect of housing loans on consumer affordability and the demand. Non-Owner families have two resources to finance real estate: one is their savings and the other is the housing loans. Therefore the affordability depends on these two factors.

Raising governmental facilities increases the perception of accessible housing loans for non-owner families. Another important factor is the family's income as they have to pay back the loan on a monthly basis. As the ratio of income to payment grows, the payback power increases. Thus the perception of accessible loans increases.

The number of non-owner families is calculated according to the overall population of the country, the average family population, the number of houses that each family needs, and the number of owner families which is represented by the number of "occupied stock".

The advantage of this model over the owner occupied market model is that the consumer demand is calculated by comparing market price with "affordable price" which is a more realistic calculation. In addition, the total number of families doesn't remain constant over time. Moreover, real data related to GNP is used for calculating

family income as opposed to Atefi's model which uses GDP. Furthermore, the "loan length" (or payment period) and "interest rate" are considered in calculating the loan payments. It should be noted that although various payment periods exist for different mortgages, here this variable is assumed to be 12 years. Finally, in this model family saving is a function of family costs which is represented by "MPC", unlike the basic model in which families are assumed to save a constant percentage of their income.

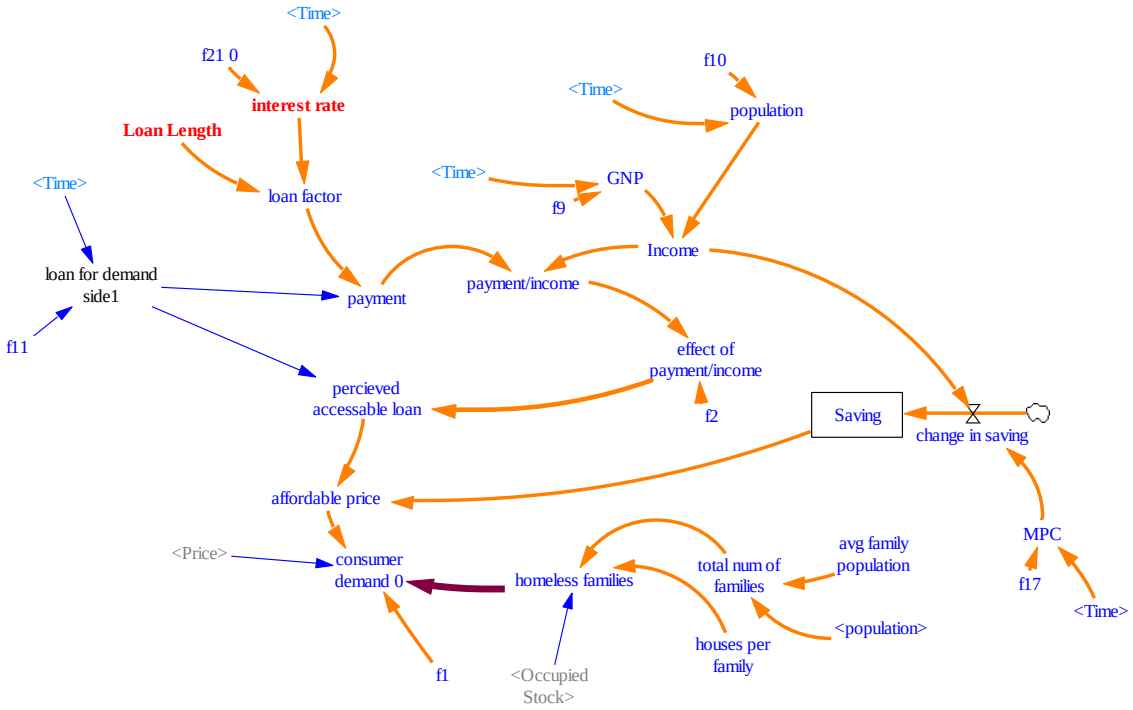

Figure 4- Sector 2

3.3. Sector 3- Speculative demand model

This sector (Figure 5) models the demand of speculators. As shown in **Error! Reference source not found.** (sector 1), "demand" stock variable consists of consumer demand (sector 2) and investor demand (sector 3). The investor demand depends on the amount of housing investments which in turn depends on two factors, the amount of liquidity (available money for investment), and the ratio of return on investment in the real estate market to the maximum available ROI in all other markets or banks (ROI/MROI).

As the amount of liquidity in the society increases, more capital is invested in the real estate market. In this model, liquidity is a function of time and is controlled by the government. The ROI in the housing market (exROI) is compared to the ROI of the other markets, and when bigger, it attracts the investors. The rental payment is also included in calculation of ROI because it is assumed that the investors will continue to rent until the market price reaches their desirable value. For calculating the desirable price, the investors assume that the price changes in the next period will be the same as the recent period.

The important point is that according to this model, if the change in price is increased, the ROI will increase as well, so it will grow the demand by attracting more investors to the market. This attraction could lead to price increase and therefore the ROI of the market will grow. As a result there would be a reinforcing loop regarding the investor demand that will lead to price growth over time. The investors could also take advantage of housing mortgages and this fact is considered in calculating the investor demand as well.

The variable "Monetary Policy Coef" represents the effect of governmental restrictive or expansive policies on prices. The consequences of change in this variable are studied in the "Policy Making" section.

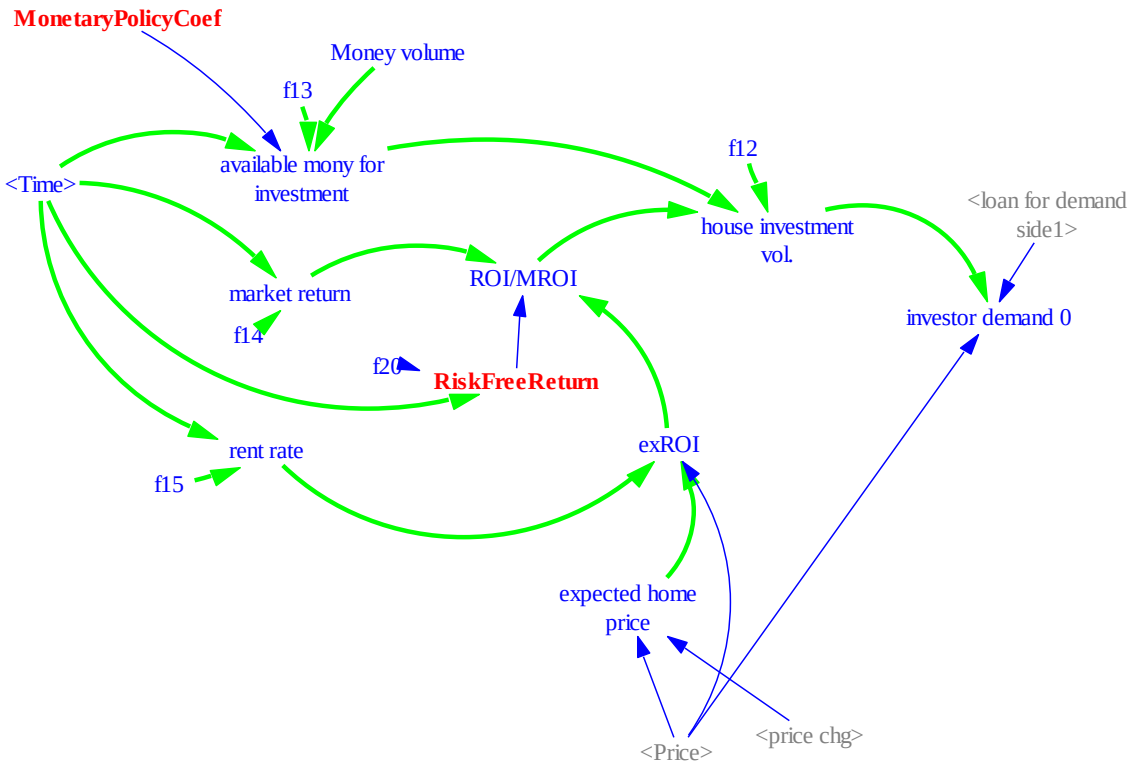

Figure 5- Sector 3

4. Simulation results

Simulation results for the supply-demand model of the market and the effect of governmental facilities on its behavior is shown below. As shown in Figure 6 exponential growth in price is observed which indicates that a reinforcing loop has dominant effect on the dynamics of the system. This behavior matches the actual trend of price in the real estate market of Iran which is exhibited in Figure 7.

Figure 6- Simulation results for price

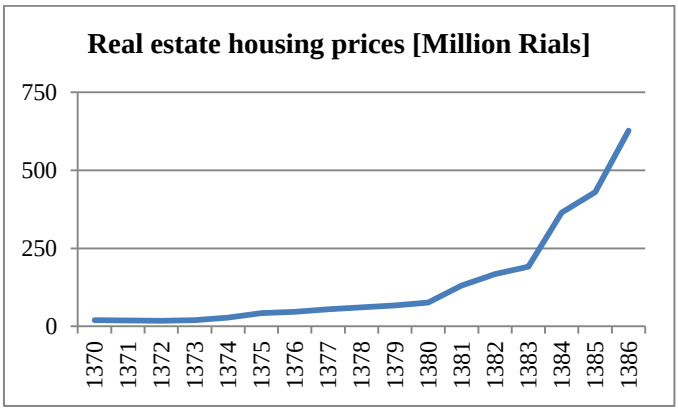

Figure 7- Real estate housing prices in Tehran (CBI 2012)

The results related to construction completion rate for the private sector in urban areas is shown below. We could see that its behavior is almost similar to the actual behavior of construction completion rate in the market.

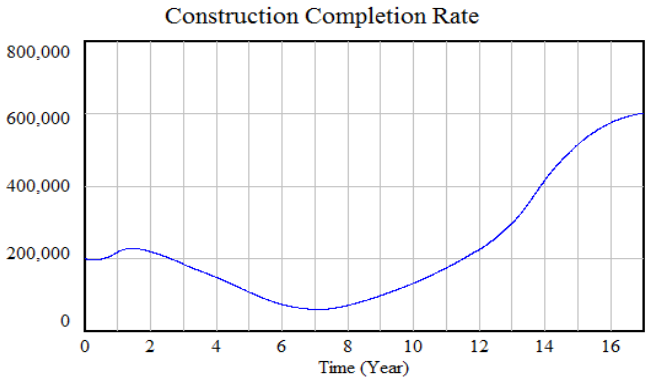

Figure 8- simulation results for construction completion rate

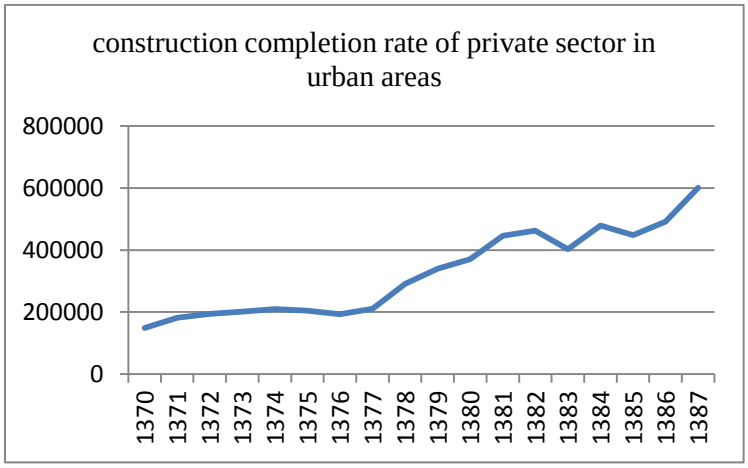

Figure 9- construction completion rate of private sector in urban areas (CBI 2012)

5. Test results

Two test types have been applied in order to test the response of the model to the research question "What is the effect of facilities on housing price?" These two types consist of comparing the simulation results with reference modes and extreme test.

The first test, the comparison between the simulated price behavior and actual market behavior was examined in the previous section. As seen in Figure 6 and Figure 7 the simulation results for housing price is similar to the real price trend in recent years. Also the simulation result for construction rate in urban areas in Figure 8 is consistent with its actual behavior in Figure 9. These consistencies approve the structural validity of the model.

For the extreme test, the exogenous variables of the model were set to zero value. It is expected that when the income, which is a combination of GNP and population, and liquidity in society ("Money volume" in the model) are decreased to zero, the price would decrease too. The result of this test is shown in Figure 10 which matches the expected behavior. Therefore the structure of the model is valid.

Figure 10- Extreme test result

6. Policy making

There are a number of parameters in the model that could be controlled by the government and thus could be considered in policy making for the real estate market. These parameters are related to the demand side mortgages, the supply side construction loans, the monetary policies of the government, and the risk free return on investment.

The result of change in any of these parameters is simulated and described as follows.

6.1. Demand side mortgage parameters

The parameters associated with the loan to non-owner families include the amount of loan, the loan interest rate, and the term to maturity.

First, the model is simulated with two different amounts of "loan for demand side" to study the effects of change in this variable. The results are shown in figure below, with R1-LD-P line belonging to the greater amount of loan. The exhibit shows that as the amount of mortgage increases, the price increases slightly and the number of non-owner families decreases. The effect of change in this variable seems to be insignificant. This is perhaps due to the small amount of loan with respect to the price of house.

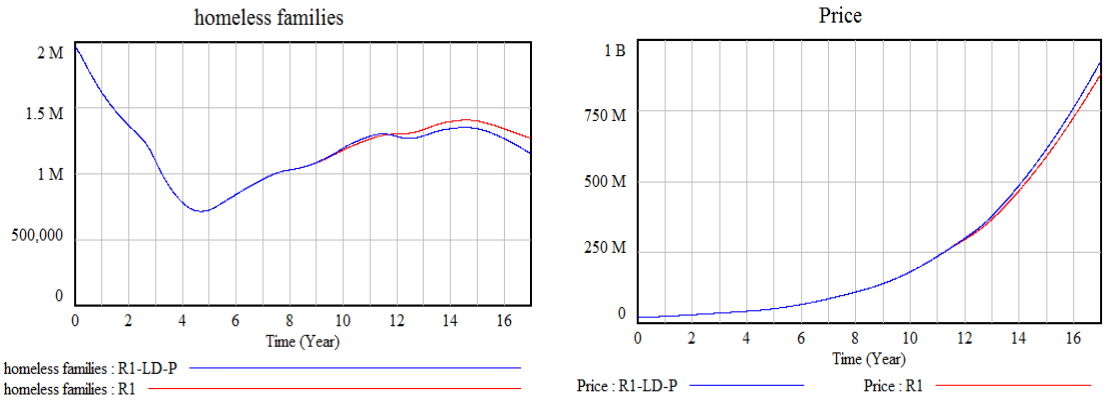

Figure 11- The effect of changing the amount of demand side loan on the number of non-owner families and price

Second, the change in the loan interest rate is simulated. The result shown in figure below indicates that if the loan interest rate increases, the housing price would experience less growth over time.

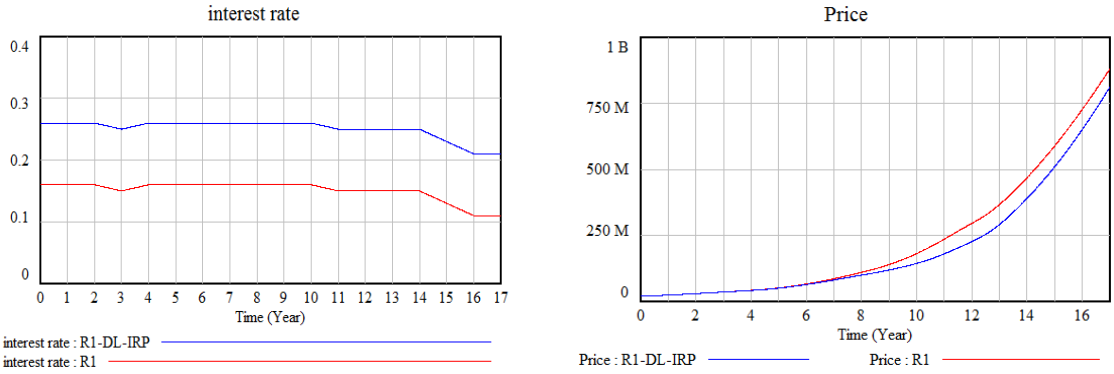

Figure 12- The effect of changing the loan interest rate on price

Third, the effect of modifying the term to maturity period is studied. As indicated in the figure below, the change will have a considerable effect when the maturity period is less than 12 years. But when it is more than 12 years, the changes will have much less effects on price. In fact if the loan conditions are tougher, the price increase will be less.

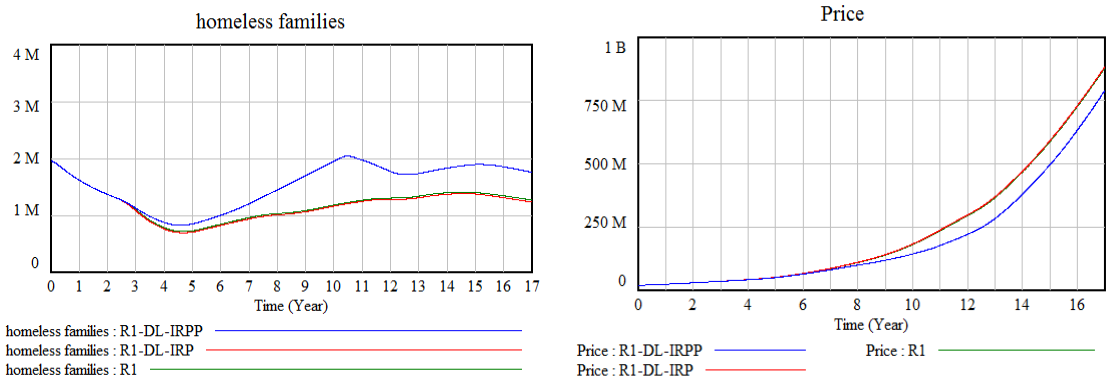

Figure 13- The effect of changing the term to maturity period on the number of non-owner families and price (R1: 12-year, R1-DL-IRP: 30-year, R1-DL-IRPP: 5-year)

6.2. Supply side construction loan parameter

The effect of change in the amount of construction loans is tested. Figure 15 shows that increasing the amount of construction loans will have desirable results for the market. As the amount of construction loans increases, the supply will grow and it would be more beneficial for constructors to enter the market. Therefore the price will have less growth over time and the number of non-owner families will have a descending behavior.

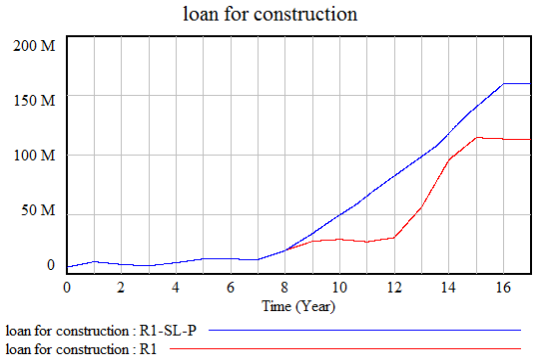

Figure 14- Changing the amount of loan for construction in two scenarios

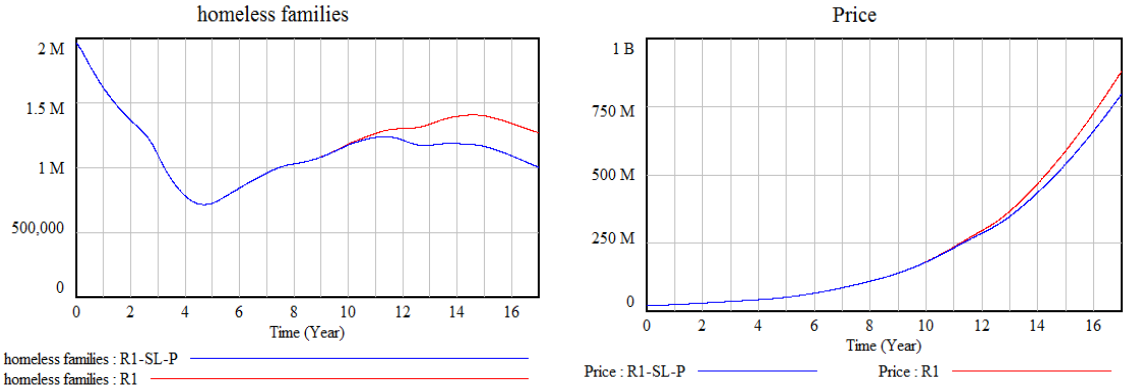

Figure 15- The effect of changing the amount of loan for construction on the number of non-owner families and price

6.3. The monetary policies of the government

The result of decreasing the liquidity in society by government is tested. Figure 16, Figure 17, and Figure 18 show the results according to a 20 percent decrease in the amount of liquidity. It is seen that the reduction of liquidity will have a really favorable effect on price and the number of non-owner families.

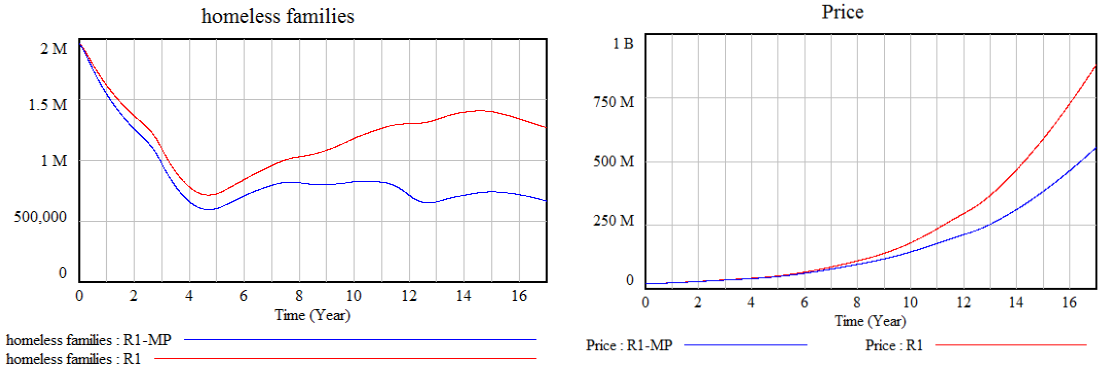

Figure 16- The effect of the monetary policies of the government on the number of non-owner families and price

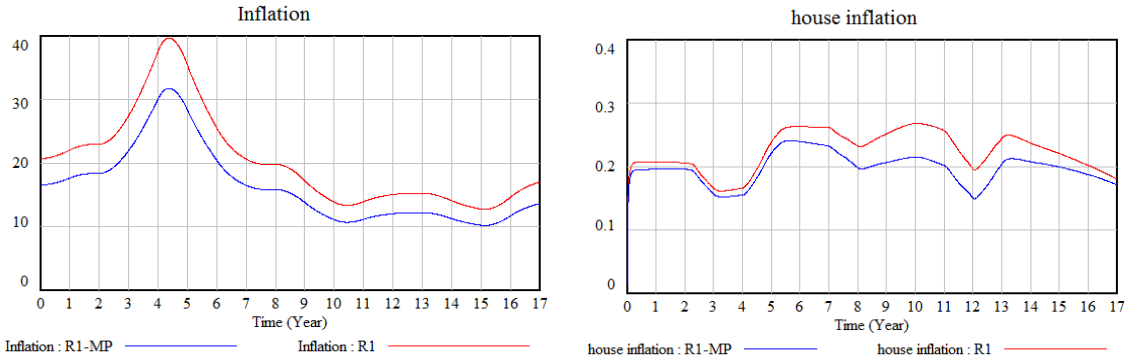

Figure 17- The effect of the monetary policies of the government on inflation and house inflation

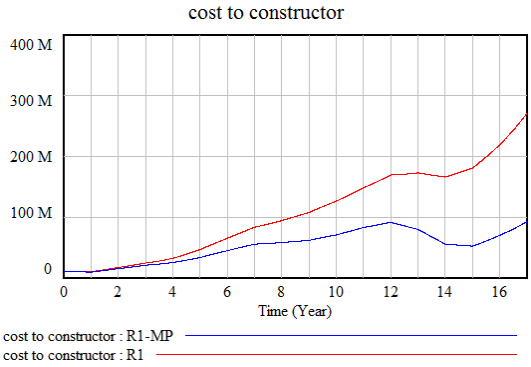

Figure 18- The effect of the monetary policies of the government on the cost to constructor

6.4. Risk free return on investment

Here the effect of changes in the risk free ROI (ROI of bank investment) is studied. The simulation results are shown in figures below. The effect of raising the risk free ROI would improve the conditions of market due to decreasing the speculative demand for purchasing houses. It is important to note that since the amount of risk free ROI is much less than the ROI of the real estate market, the changes in this parameter will have minor effect on the market behavior. As it is seen in Figure 20, the two fold increase of the risk free ROI will have little effect on price.

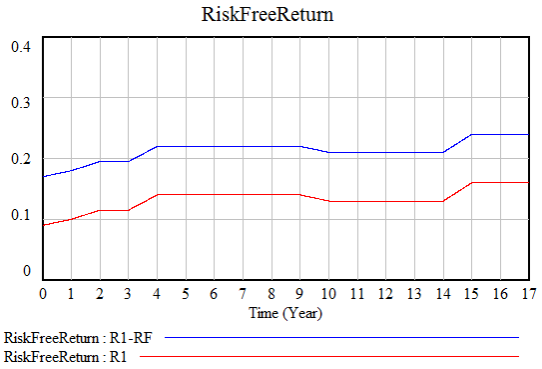

Figure 19- Changing the risk free return on investment in two different scenarios

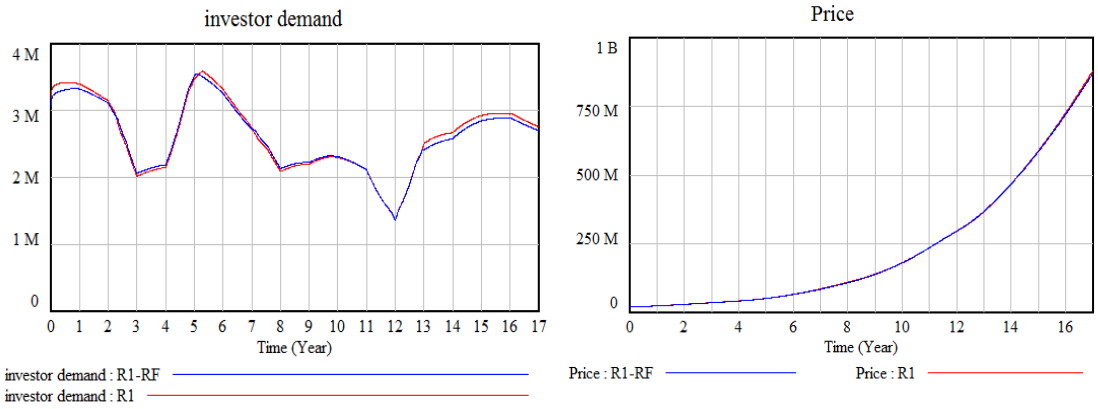

Figure 20- The effect of changing the risk free ROI on the investor demand and price

6.5. Suggested policies

As the results of changing different parameters indicated, increasing the amount of construction loans will have more desirable effects than increasing the amount of the purchasing loans. Thus in response to the answer of the research question regarding the mechanism of granting loans, it is suggested that all the facilities should be dedicated to the supply side for construction.

Another policy which is suggested according to the simulation results in previous section is to decrease the liquidity in society through governmental monetary policies.

These two suggested policies could cause the price to be controlled and the number of non-owner families to be reduced.

7. Conclusion

The proposed model in this paper simulates the real estate market behavior in Iran. The purpose of the model is to study the consequences of governmental loans to the both supply and demand side of the market.

The model consists of three interconnected sectors. The first one is based on Mashayekhi's owner occupied market model with some modifications on housing construction rate and sources of vacant stock. The second one is based on Atefi's model for housing affordability in Iran which is modified slightly. The modifications are made to make the model simulation results more consistent with real market behavior. The third sector models the speculative demand of the market.

The model test results confirm the validity of the model and its consistency with real data. Some policies have been tested in order to find out the best way of giving state loans to the market demand and supply side. The policies concern the modification of

some exogenous parameters that could be controlled by the government. These parameters include the demand side mortgage parameters, the supply side construction loan parameters, the monetary policies coefficient of the government, and the risk free return on investment.

The results of testing the policies indicate that the amount of construction loans and the monetary policies of the government have more considerable effects than other parameters on market price. Therefore controlling them can have more desirable influences. Finally it is suggested that if all of the state loans be dedicated to the supply side of the market and the government reduce the amount of liquidity in the society by its monetary policies, the number of non-owner families will decrease and the price will stabilize over time.

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Appendix: Equations of the model

(01) affordable price= Saving+percieved accessable loan
(02) available mony for investment= (Money volume(Time)*f13(Time)*1e+010)*MonetaryPolicyCoef Units: Miliard rial
(03) avg family population= 4
(04) capacity of construction= f18(Time)
(05) change in saving= (1-MPC)*Income
(06) chng in cost= f8*(Real Cost*Inflation*0.9
(07) Construction Completion Rate= Under construction Stock/construction time
(08) Construction Start Rate= f3(Price/cost to constructor)*capacity of construction
(09) construction time= 1
(10) consumer demand= homeless families*f1(Price/(affordable price))
(11) cost to constructor= Real Cost-loan for construction ** It is the cost to build a typical 100-square meter house
(12) D1= 1

(13) demand chng= ((consumer demand+investor demand)-demand stock)/TA
(14) demand stock= INTEG (demand chng, 240000)
(15) DSR1= demand stock/Vacant Stock
(16) "effect of payment/income"= f2("payment/income")
(17) Exa Inf= f7(Time)
(18) expected home price= Price+price chg
(19) exROI= (expected home price+rent rate)/Price
(20) f1([(0,0)-(8,1)],(0,1),(2.05505,0.960526),(3.1315,0.894737),(4.11009,0.811404),(4.99083,0.72807),(5.60245,0.578947),(6.16514,0.403509),(6.72783,0.223684),(7.02141,0.118421),(7.53517,0.0307018),(7.95107,0.0175439))
(21) f10((0 , 5.5837e+007), (1 , 5.6657e+007), (2 , 5.7488e+007), (3 , 5.8331e+007), (4 , 5.9188e+007), (5 , 6.0055e+007), (6 , 6.107e+007),
(22) f11((0, 9.2777), (1, 11.3604), (2, 11.362), (3, 7.55273), (4, 12.2308), (5, 13.3476), (6, 18.1214), (7, 16.9687), (8, 22.8218), (9, 26.4017), (10, 31.5808), (11, 29.9643), (12, 29.0435), (13, 43.3194), (14, 60.5391), (15, 79.7976), (16, 88.1541))
(23) f12([(0,0)-(4,1)],(0.0856269,0.0131579),(0.220183,0.0394737),(0.366972,0.100877),(0.464832,0.166667),(0.574924,0.232456),(0.697248,0.298246),(0.807339,0.355263),(0.880734,0.434211),(0.941896,0.460526),(0.990826,0.5),(1.18654,0.574561),(1.38226,0.649123),(1.55352,0.70614),(1.78593,0.741228),(2.00612,0.785088),(2.17737,0.824561),(2.44648,0.877193),(2.80122,0.916667),(2.96024,0.934211),(3.0948,0.951754),(3.26606,0.969298),(3.41284,0.97807),(3.53517,0.986842),(3.65749,0.995614),(3.76758,0.995614),(3.86544,1))
(24) f13([(0,0)-(17,0.4)],(0.103976,0.15),(17,0.15)) ** It is the persentage of money volume used in any investment
(25) f14((0, 0), (1, -0.0783732), (2, -0.072627), (3, 0.720942), (4, 1.23128), (5, 0.25), (6, -0.146477), (7, 0.15657), (8, 0.708407), (9, 0.598567), (10, 0.436791), (11, 0.512389), (12, 1.38631), (13, 0.136184), (14, -0.127176), (15, 0.146618), (16, 0.175616), (17, -0.112613))
(26) f15((0, 700), (1, 844), (2, 978), (3, 1089), (4, 1372), (5, 1783), (6, 2122), (7, 2550), (8, 3288), (9, 3892), (10, 4820), (11, 7222), (12, 10631), (13, 10545), (14, 17162), (15, 17127), (16, 21830))
(27) f17((0 , 0.741), (1 , 0.764), (2 , 0.683), (3 , 0.757), (4 , 0.729), (5 , 0.713), (6 , 0.738), (7 , 0.763), (8 , 0.745), (9 , 0.725), (10 , 0.727), (11 , 0.718), (12 , 0.703), (13 , 0.688), (14 , 0.705), (15 , 0.675), (16 , 0.661))
(28) f18([(0,0)-(20,1e+006)],(0,298246),(6.97248,429825),(15.9021,635965)) (29) f2([(0,0)-(1,1)],(0,1),(0.0978593,0.973684),(0.146789,0.97807),(0.168196,0.964912),(0.217125,0.973684),(0.330275,0.951754),(0.394495,0.916667),(0.415902,0.916667),(0.48318,0.916667),(0.574924,0.864035),(0.685015,0.789474),(0.743119,0.697368),(0.813456,0.565789),(0.847095,0.47807),(0.874618,0.390351),(0.926606,0.22807),(0.948012,0.149123),(0.966361,0.114035),(1.00306,0.0921053))
(30) f20((0, 0.09), (1, 0.1), (2, 0.115), (3, 0.115), (4, 0.14), (5, 0.14), (6, 0.14), (7, 0.14), (8, 0.14), (9, 0.14), (10, 0.13), (11, 0.13), (12, 0.13), (13, 0.13), (14, 0.13), (15, 0.16), (16, 0.16), (17, 0.16))
(31) f21((0, 0.16), (1, 0.16), (2, 0.16), (3, 0.15), (4, 0.16), (5, 0.16), (6, 0.16), (7, 0.16), (8, 0.16), (9, 0.16), (10, 0.16), (11, 0.15), (12, 0.15), (13, 0.15), (14, 0.15), (15, 0.13), (16, 0.11), (17, 0.11))
(32) f3([(0,0)-

(4,1)],(0,0),(0.746177,0.0263158),(0.941896,0.0789474),(1.34557,0.328947
),(1.68807,0.561404),(2.32416,0.859649),(2.51988,0.899123),(3,0.969298),(4
,1),(100,1))
(33) f6((0, 5.59297), (1, 10.2279), (2, 7.93128), (3, 6.73815), (4, 9.41376), (5,
12.6126), (6, 12.5328), (7, 11.9252), (8, 19.7006), (9, 27.5129), (10, 29.0111), (11,
26.9816), (12, 30.5121), (13, 56.4215), (14, 96.0845), (15, 114.652), (16, 113.54))
Units: **undefined**
(34) f7((0, 20.7), (1, 24.4), (2, 22.9), (3, 35.2), (4, 49.4), (5, 23.2), (6, 17.3), (7, 18.1),
(8, 20.1), (9, 12.6), (10, 11.4), (11, 15.8), (12, 15.6), (13, 15.2), (14, 12.1), (15, 11.9),
(16, 18.4))
(35) f8= {PULSE TRAIN(1, 0.012 , 1 , 100)}0.01 Units: Year
(36) f9((0, 41261), (1, 54850), (2, 84616), (3, 108941), (4, 156964), (5, 206950), (6,
244857), (7, 276522), (8, 368587), (9, 496884), (10, 578692), (11, 784543), (12,
971716), (13, 1.27474e+006), (14, 1.654e+006), (15, 2.02919e+006), (16,
2.58365e+006), (17, 3.06155e+006))
(37) FINAL TIME = 17
Units: Year The final time for the simulation.
(38) get profit= House Investment Stock*(1-f12("ROI/MROI"))/transactional time
(39) GNP= f9(Time)*1e+009
(40) homeless families= total num of families-Occupied Stock/houses per family
(41) house inflation= price chg/Price
(42) House Investment Stock= INTEG (sales to spec-get profit,
2e+006)
(43) "house investment vol."= f12("ROI/MROI")*available mony for investment
(44) houses per family= 1
(45) Income= (GNP/population)
(46) Inflation= {DELAY1(((0.3*price chg/Price)+(0.7*Exa Inf)), D1
)}{DELAY1(((0*price chg/Price)+(1*Exa Inf)), DELAY1(Exa Inf,
D1)*MonetaryPolicyCoef
(47) INITIAL TIME = 0 Units: Year The initial time for the simulation.
(48) interest rate= {0.14}f21(Time)
(49) investor demand= "house investment vol."/(Price-loan for demand side)
(50) loan factor= {0.1}(1/(1+interest rate))*(1-(1/(1+interest rate))^Loan
Length)/(interest rate /(1+interest rate)){*0+0.1}
(51) loan for construction= 1e+006*(f6(Time)+0)
(52) loan for demand side= (f11(Time)+0)*1e+006
(53) Loan Length= 12
(54) market return= f14(Time)
(55) MonetaryPolicyCoef= 1
(56) Money volume((0, 28628.4), (1, 35866), (2, 48135), (3, 61843.9), (4, 85072.2), (5,
116553), (6, 134286), (7, 160402), (8, 192689), (9, 249111), (10, 320957), (11,
417524), (12, 526596), (13, 685867), (14, 921019), (15, 1.2842e+006), (16,
1.64029e+006), (17, 1.90137e+006))
(57) MPC= f17(Time)
(58) Occupied Stock= INTEG (Sales rate to consumers,
1.2e+007) ** we assume that 50% of families are home owners
(59) PAPR1= Price/affordable price
(60) payment= loan for demand side/loan factor ** yearly payment

(61) "payment/income"= payment/Income
(62) PCR= Price/cost to constructor
(63) percieved accessable loan= {loan for demand side*"effect of payment/income"}loan for demand side*("effect of payment/income" *1)
(64) population= f10(Time)
(65) Price= INTEG (price chg, 1.96e+007) Units: **undefined** This is a price of a typical 100 square meteres house
(66) price chg= 0.08*Price*LN((0.001+ demand stock)/(0.001+Vacant Stock)) ** 0.2-0.1
(67) Real Cost= INTEG (chng in cost, 1.7e+007)
(68) rent rate= f15(Time)*100*12 ** yearly rent for a 100-square meter house
(69) RiskFreeReturn= f20(Time)
(70) "ROI/MROI"= {(MAX(exROI , 0)+0.001)/(MAX(market ROI , 0)+0.001)}{exROI/market ROI} (MAX(exROI , 0)+1)/(MAX(market return , RiskFreeReturn)+1)
(71) Sales rate to consumers= (1-spec percent)*MIN(Vacant Stock, demand stock)/transactional time
(72) sales to spec= spec percent*MIN(Vacant Stock, demand stock)/transactional time
(73) SAVEPER = TIME STEP Units: Year [0,?] The frequency with which output is stored.
(74) Saving= INTEG (change in saving,
5e+006)
(75) spec percent= investor demand/(consumer demand+investor demand)
(76) TA= 0.1
(77) TIME STEP = 0.0078125 Units: Year [0,?] The time step for the simulation.
(78) total num of families= population/avg family population
(79) transactional time= 0.2 ** Time spent to sell a house to a buyer
(80) Under construction Stock= INTEG (Construction Start Rate-Construction Completion Rate,
200000)
(81) Vacant Stock= INTEG (Construction Completion Rate+get profit-Sales rate to consumers-sales to spec , 200000)