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USING SYSTEM DYNAMICS IN STUDYING THE EFFECT OF GOVERNMENTAL HOUSING POLICIES ON THE REAL ESTATE MARKET IN EGYPT

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Abstract: The real estate market in Egypt plays an important role in the construction industry, constitutes a large fraction of the total wealth in the economy and strongly affects the job market. This perceived growth witnessed in recent years has centered on the high end segment which represents a very thin layer of the market. However, supply for low and middle end segments has been declining. In Egypt, there is a large stock of vacant housing units that could be brought back to the market if an appropriate regulatory framework could be implemented. Therefore, the urban crisis in Egypt is not a quantitative/scarcity problem, rather, mismatch between supply and demand due to the accumulation of ill-conceived policies over time. This research utilizes system dynamics in studying the effect of governmental housing policies on the real estate market in Egypt. First, a quantitative causal loop diagram encompassing the key variables and their interrelationships was developed. Next, this mental model was translated to a quantitative stock and flow diagram using Anylogic® software package. In this quantitative model, real market values for stocks, flows and parameters were utilized. This paper focuses on simulating and representing the effect of implementing a house tax policy on the key variables in the market. This research will help in better understanding the housing market in Egypt and assist decision-makers in quantifying indirect consequences of their policy actions.

1 Introduction

The housing market is one of the major problems facing the Egyptian government over the past years. In Egypt, there is a large stock of formal and informal housing units that are vacant. These units could be brought back to the market if an appropriate regulatory framework and incentives to owners/developers could be effectively implemented (World bank 2007). Therefore, it was found that the urban crisis in Egypt is not a scarcity problem, rather, distortions in the market caused by the accumulation of ill-conceived and inadequate policies. The aforementioned mismatch was in the form of over-supply for upper income groups during periods of dampening purchase power. On the other hand, shortage of supply for low and middle income groups that represents a major portion of the overall demand.

1.1 Formal Urban Housing Stock in Egypt

According to the 1996 census, the housing stock in Egypt included 15,707,666 units divided into 8,157,135 units in urban areas (51.9%) of the total stock and 7,550,531 units in rural areas (48.1%) of the total stock. Between 1996 and 2005 a total of 1,355,617 units were added to urban areas by public and private sector. As such, the total housing stock in urban Egypt reached 9,492,753 units by 2005. On the other hand, the total number of households living in urban areas was estimated to be 6.84 million. As a

result, in 2005, the number of available units in urban areas surpassed the number of households by more than 38% (World Bank 2007). This emphasizes the distortion problem present in the market.

1.2 Informal Urban Housing Stock in Egypt

The failure of the Egyptian government to provide affordable housing for low income groups has led many to build illegal houses on privately owned or public lands. Informal areas in Egypt host not only the poor, but also young, middle class, educated families and university students in search of accommodation at reasonable prices. In Greater Cairo, this phenomena began just after the world war two when migration from upper Egypt and the delta caused housing pressures to become critical (Sejourne 2000). In fact, figures about informal settlements and the population living there differs significantly among different governmental reports as shown in Table 1.

Table 1: Number of informal settlements and their population by various authorities (World Bank 2007)

Authority	Number of Areas	Population(Million)	Date
IDSC ¹	1,171	15	2007
Ministry of ED ²	1,210	N/A	2006
The World Bank	N/A	16-21	2008

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²Economic Development

1.3 Housing Finance in Egypt

Housing Finance does not only facilitate the process of house acquisition ,rather, it is a very important factor in economic development. Unfortunately, there is little to no mortgage financing in Egypt. Though the parliament passed the mortgage law in 2001, there have been a total of only 16 mortgages completed since that time(Everhart et al. 2006).Without a well-functioning mortgage financing, low and middle income groups cannot afford buying in the formal sector. Hence, leaving the opportunity for informal settlements to expand. This lack in housing finance relates to several issues. First, high registration fees and inefficient property registration procedures. Consequently, no mortgage loans could be given to non-registered properties. Second, the lack of valuation information which makes housing financing very difficult to implement. Last but not the least, restrictions on bank credit to the housing sector also influenced the absence of housing finance.

2 Literature review

2.1 Previous Applications of Statistical Models in the Housing Market

Within rapidly changing economic and industrial circumstances, reasonable predictions of the effects of policies, as well as the changes in housing market influence factors, is recognized as critical for policy decisions (Hwang et al. 2012).Therefore, in the past decades, researchers focused on studying various factors affecting the housing market. There has been many discoveries in statistically estimating the housing market variables and behavior. Some of these statistical efforts are listed below.

Park and Hong (2012) created trends and prospects of the U.S housing market using the Markov switching model. This study was created since the monthly indices of the U.S housing market indicators are released at the end of the following month creating a month-long standstill in making judgment regarding the housing market. Nagaraja et al (2009) proposed a statistical model for predicting individual house prices utilizing information regarding sale price, time of sale and location (ZIP code). This model is composed of a fixed time effect and a random ZIP (postal) code effect combined with an autoregressive

component. Yu and Lee (2010) developed a study that examines the impact of housing policies and macroeconomic variables on housing price instability in Korea. By using a statistical method, this research focuses on whether policy initiatives taken by the Korean government to stabilize housing prices resulted in the expected outcome of a stabilized housing market or not. Lin and Lin (2011) developed a statistical approach to analyze the integration relationships between stock markets and the real estate markets in Asia. Six economies were selected for empirical analysis: China, Hong Kong, Japan, Singapore, South Korea, and Taiwan. Results show that stock markets are integrated with real estate markets in Japan, and partially integrated with real estate markets in China, Hong Kong and Taiwan.

One of the shortcomings of these models is that they do not explain why something happens, rather, they only show what happens under what circumstances. In addition, they require extensive data collection for all of the variables affecting the market. In an effort to produce an explanatory model based on the Egyptian market behavior and due to the lack of reliable and comprehensive data relating to the real estate market in Egypt, this paper proposes the use of system dynamics as a modeling tool.

2.2 Previous Applications of System Dynamics Models in the Housing Market

Several studies in the real estate market were developed using system dynamics due to the complex nature of the housing market. Each model includes the variables that the modeller finds important with respect to the problem studied. While other variables not related to the problem under concern will not be included or treated exogenously. There are many advantages in using system dynamics over statistical/econometric models previously utilized. First, the extensive collection of data series for the independent variables is not required. Second, system dynamics gives the opportunity to understand the root causes behind the problem. The following are examples for the system dynamics models developed in the field of housing market.

Kwoun et al (2011) introduced a system dynamic approach to analyze dynamic cycles of unsold new housing stocks, housing investment, and housing supply-demand. This study develops a causal loop diagrams (CLDs), in which relationships between variables are presented. Variables used in this study were classified according to the aspects of macro-economy, policy, housing supply and housing demand. These causal loops are then converted into stock and flow diagrams (SFDs) for quantitative simulation. Mohammadi et al (2010) developed a simple dynamic model to portray a cyclic mechanism in land market. This model is then used in probing the effect of land market oscillation on house market price, which has not been addressed before. In this study, a combination of the land market with the house market model is introduced to develop an integrated model that offers better understanding of house market trends. Hwang et al (2011) proposed a Korean real estate and mortgage market dynamics models based on the fundamental principles of housing market, which are determined by supply and demand. The Korean government has enforced various policies, based on intend to deregulate real estate speculation, such as increasing the loan to value ratio (LTV) in order to stimulate housing supply, demand and accompanying housing transactions. These models were then used to study the potential effects of these deregulation policies by focusing on the main factor of these policies: the mortgage loan.

Most of the previous research efforts focused on either macro or micro economic variables to model the housing market. However, none of them took into account the effect of buyer/seller behavior on the house price. This research managed to merge different variable categories in order to produce a generic model appropriately resembling the housing market in Egypt. This was done through modeling the buyer preference of purchasing new homes over already existing ones due to financing schemes offered by developers. In addition, the model took into account the effect of vacant housing units on the house price. These vacant units are one of the major phenomena distinguishing the Egyptian market over other ones.

2.3 System Dynamics

System dynamics (SD) is a modeling technique developed in the late 1950s that was successfully applied to various disciplines such as industrial, economic, social, and environmental systems. A SD model provides an analytical solution for complex, non-linear, and dynamic systems by focusing on interactions among variables and understanding their structures (Sterman 2000).

SD modeling starts with creating a mental model of the problem known as the causal loop. The causal loop has two main categories: 1) balancing loop, which is a goal-seeking structure that produces balance and stability in a system; and 2) a reinforcing loop, which generates the growth process. Next, the created causal loop is then converted to a stock and flow model for quantitative analysis purposes. The stock and flow diagram is created based on the relationship between one variable and the other. The analysis of policies can be validated through running simulations, based on SD model, and by testing the model through sensitivity analysis. Therefore SD can provide a comprehensive solution for analyzing the impact of Egyptian housing governmental policies on the real estate market.

3 Methodology

In order to reach the research objectives, the following iterative steps were followed in this research:

1. Extensive literature research on past real estate models (econometric and system dynamics models).
2. Understanding the Egyptian real estate market through reports prepared by both the public sector as well as private developers. Also face to face interviews were performed for more understanding of the industry.
3. Based upon the collected data, a preliminary MBD “model boundary diagram” is prepared with the key variables and concepts that should be included in the model.
4. A survey/questionnaire is prepared in order to validate the preliminary MBD. Semi structured interviews with industry experts are then performed to fill in the survey. Depending on the survey results, the final version of the MBD is now prepared.
5. Going through literature describing the real estate theories (housing supply and demand, price elasticity of demand, profit elasticity of demand, etc..). These theories are then used to propose relationships between variables determined in step 5.
6. Using the previous two steps in preparing a preliminary causal loop that explains the problem dynamics as endogenous consequences of the feedback structure. Also variables that only affect the housing market in Egypt without being affected in return (or being slightly affected) are included as exogenous variables.
7. Preparing a questionnaire/survey to validate the preliminary causal loop through semi-structured interviews. Results from the interviews are then used to update the preliminary causal loop into the final one.
8. The final causal loop is then converted into a “stock and flow diagram”. Next, the relationship between each variable is inserted in the form of equations using Anylogic[®] software.
9. Estimating the value of each parameter in addition to initial stocks values based upon published data or interviews. Next, the model is being run and basic data analysis is performed.
10. Performing model testing (face validity, boundary adequacy, structural assessment, dimensional consistency, integration error, extreme condition and behavioral testing).
11. Implementing policy design and evaluation through sensitivity analysis.

4 Overall Stock and Flow Policy Model

The created model is a combination of physical housing stocks in addition to Egyptian buyer/seller decision making behavior. Separate causal loops reflecting each attribute/phenomena in the Egyptian housing market were first interpreted. These loops were based upon various sources ranging from government-published statistical data and text books to subjective semi-structured interviews. Next, these loops were then put together to give the overall stock and flow policy model. The following paragraphs will give a brief description for each of the loops included in the model.

Loop R1: This loop shows that the expected house prices and housing demand are caused by mutually rising tendencies; more powerful speculative demand thus influences the market due to consumer's expectations of future house prices increases (Hwang et al. 2012).

Loop R2: This loop shows that any increase/decrease in the demand will in turn increase/decrease the demand respectively based on the 'transfer rate to demand concept'. Since people who sold their homes generate a new form of demand.

Loop R3: This loop shows the decline of vacant housing contribution in demand absorption. This happens due to the increase in newly built housing purchases as a response to demand increase. Therefore any increase/decrease in the demand will correspond to further increases given the dominance of this loop.

Loop R4: This loop follows the same concept in loop R3. Showing the decline of existing housing contribution in demand absorption due to the purchase of newly built housing.

Loop B1: This loop shows that any increase/decrease in the formal demand will stimulate the developer's reaction to instantly increase/decrease their prices respectively. In case of formal demand increase, the house price and house price to income ratio will also increase (given constant average annual income). Causing more people to move informally and in return decreasing the formal demand.

Loop B2: This loop shows how the increase in the formal demand will drive the developers to increase their house prices-with a maximum upper and lower limit price changes- and vice versa. Consequently, some portion of the middle income (MI) group will not afford buying these formal houses based upon their affordability. Hence moving to informal middle income housing (MIH). This increase in the Informal MIH purchases will contribute in absorbing the overall demand.

Loops B3, B6, B7: These loops show the contribution of vacant housing on market, existing housing on market and formal newly built housing respectively in demand absorption.

Loop B4: This loop shows that as the demand and formal demand increases, the formal forms of house supply might be insufficient in absorbing the demand at that time. In addition, the vacant housing stock might be on hold due to the absence of a firm house tax policy implementation which makes the situation even getting worse. Therefore the un-met formal demands have no other choice than going informally operating loop B4.

Loop B5: This loop shows that any increase in the existing housing will in turn increase the existing housing on market by the 'sales rate of existing housing'. Increasing the amount of existing houses offered for sale will decrease the purchases of the vacant houses on market. Hence, decreasing the stock of existing housing once again.

Where, the average house price is given by the following Equation 1.

$$[1] \text{ Average house price}(t) = \text{average house price}(t_0) + [\text{price change}] \cdot dt.$$

And the effect of price change on housing units is delayed from the expected until actual transactions take place in the market. This delay is the "time to reflect prices". Hence the flow of price change is given by the following Equation 2.

$$[2] \text{ Price change} = \text{Delay}(\text{expected formal price change, time to reflect prices}).$$

The overall stock and flow policy model described earlier is shown in the following Figure 1.

On the other hand, all the factors contributing in demand absorption are given in the following Equation 3.

[3]Demand change=exponential growth-purchase of existing housing on market-purchase of vacant housing on market-purchase of formal newly built housing-increase in informal middle income housing

5 Policy Analysis.

In this section, the effect of implementing a house tax policy will be studied and analyzed. The main target of this policy is to prevent/decrease the phenomena of owning more than one house at a time. Sensitivity analysis on different policy severities was implemented.

The original bill for this property tax law was proposed under the Hosni Mubarak regime and approved by parliament in 2008. In this law, properties valued under 500,000 EGP (Egyptian Pounds), as well as properties with an annual rental income of less than 6,000 EGP is tax exempt. As for units exceeding these values, the law levies 10 percent tax on annual rent after deducting 30 percent of this value for maintenance purposes. Egypt's post revolution cabinets took the decision to postpone the implementation of this law until July 2013. The cabinet also introduced amendments to the law exempting single house owners from the tax and raising exemption levels to 2 million up from 500,000 EGP.

In this study, the policy severity is being reflected by the term 'policy rate'. Which is the rate at which vacant housing stock is being offered on market by their owners. In another words, this policy rate reflects landlords reactions to the government's actions of levying property tax. These reactions are in the form of offering their vacant units on market. Since keeping them will no longer be feasible. The number of landlords offering their units will depend upon the severity of the taxes being imposed. The higher the taxes imposed by the government, the more severe the policy is, and hence the more landlords offering their vacant units for sale, leading to a higher policy rate. After applying this policy, the vacant stock will be released from the status of being on hold and is offered on market. The increase in informal MIH and purchase of vacant existing housing as a result of policy implementation are given in Equation 4 and Equation 5.

[4] Increase in informal settlements= $\max(\text{informal demand},0)+\max((\text{formal demand}-\text{purchase of formal newly built housing}-\text{purchase of existing housing on market}-\text{purchase of vacant housing on market}),0)$.

[5]Purchase of vacant existing housing= $\max(\min((\text{transaction rate}*\text{vacant housing on market}),(\text{formal demand}-\text{purchase of formal newly built housing on market}-\text{purchase of existing housing on market})),0)$.

After policy implementation, it was found that demand, formal demand, informal demand and formal newly built housing on market will not be affected. However, vacant housing stock will be released from the freeze status as shown in Figure 2.

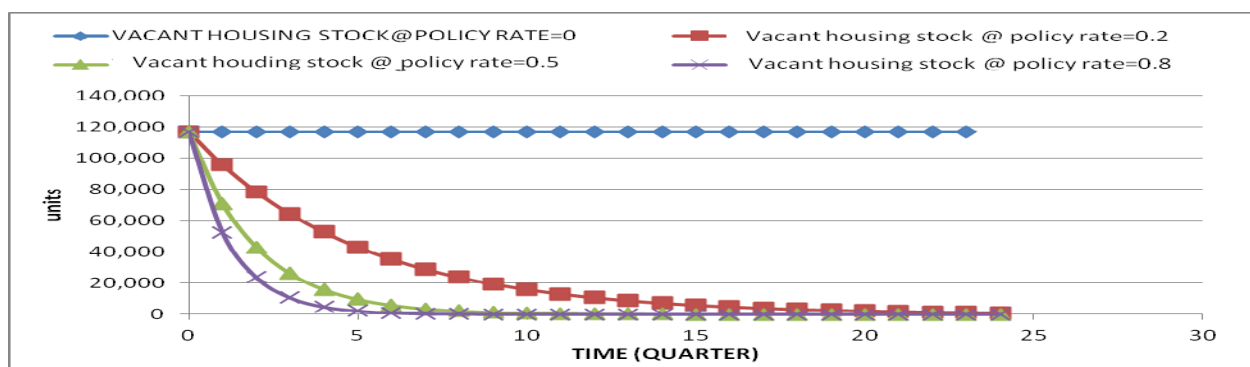


Figure 2: Vacant housing stock as a function of varying the policy severity

Consequently, vacant housing stock offered on market starts accumulating based upon the severity as shown in Figure 3.

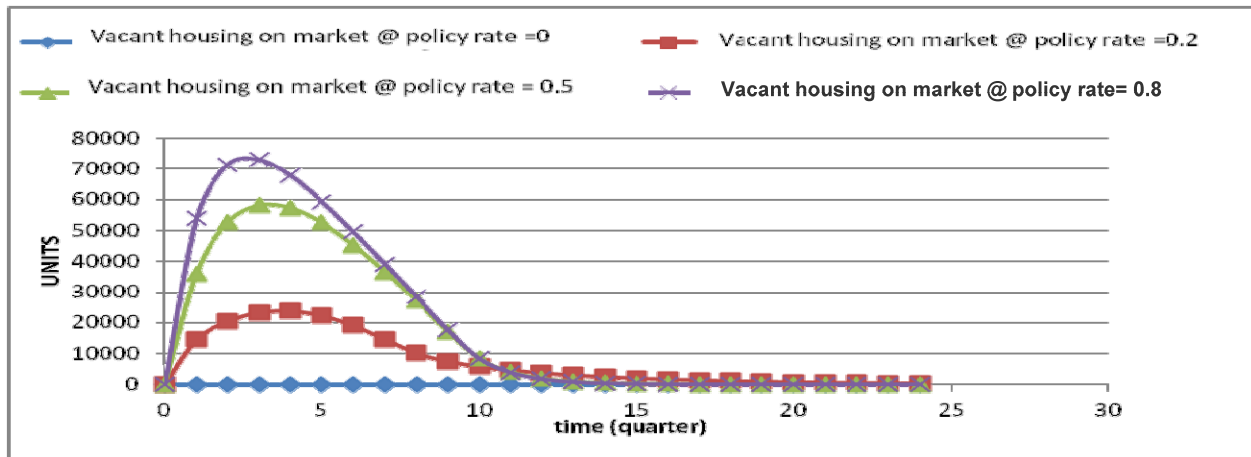


Figure 3: Vacant housing on market as a function of varying the policy rate

As shown in Figure 3, the more severe the policy is being implemented, the more the accumulation of vacant units on market above demand needs. This happens due to the high affordability index in addition to the absence of the mortgage market in Egypt. Therefore, a very small portion could only afford buying these units. On the other hand, all of the remaining demand will go towards informal housing with lower prices. This could be interpreted from figure 3, where high policy severities give more steep behaviour in stock accumulation than milder ones. This happens due to the large amount of landlords suddenly offering their units on market upon policy implementation. However, the purchasing power stays the same with different severities. Therefore, the vacant stock keeps accumulating until all landlords had offered their units on market. By then, no more units are being offered and the stock starts diminishing based upon its purchases. On the contrary, in case of mild policy implementation, the units offered on market almost stays in line with the affordable demand needs and purchases, hence, giving balance to the system.

It was also found that the informal MIH will decrease after the policy implementation. However, policy severity showed minor significance in absorbing the informal MIH as shown in the following Figure 4.

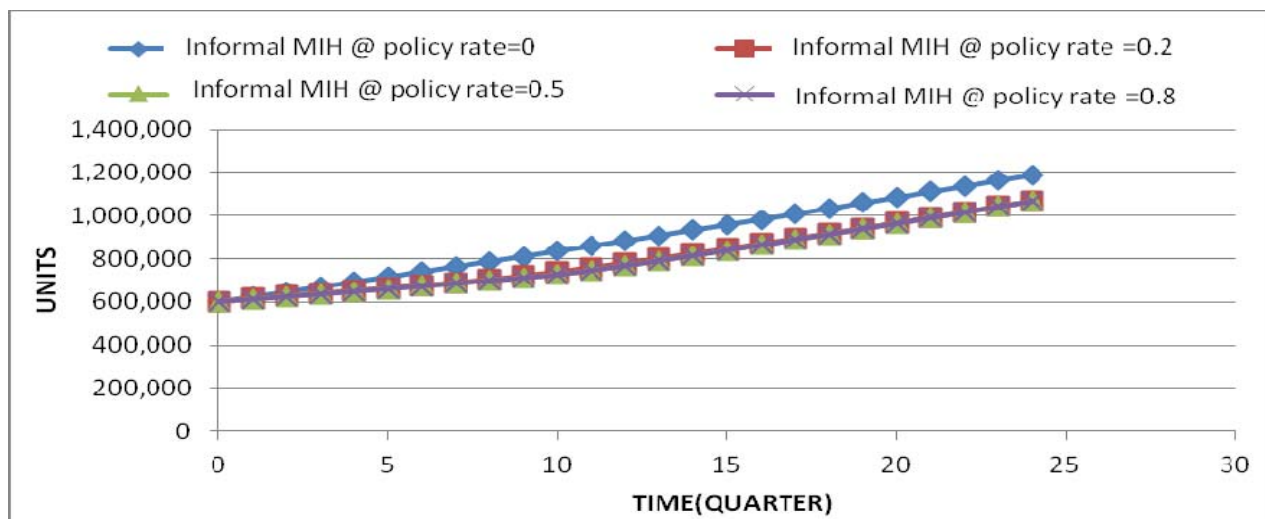


Figure 4: Informal MIH as a function of varying the policy rate

This informal MIH increases through two main sources, the informal demand in addition to the un-met formal demand. In this study, the un-met formal demand is assumed to be the amount of demand who could afford going formally, however, they go informal due to the insufficiency of formal units supplied. Therefore, as shown in Figure 4, implementing a property tax law will contribute in decreasing the informal MIH stock through absorbing the Un-met formal demand. This is being absorbed by the vacant units offered on market upon policy implementation. However, imposing higher policy severities did not show further contribution in absorbing the informal MIH. This due to the dominance of the demand over the vacant units offered on market

Finally, the purchases of the vacant units began at 12,000 units and then started to decrease as soon as the vacant stock drops below the demand needs as shown in Figure 5. Therefore, it was noticed that in case of a severe policy implementation, the vacant housing stock uselessly accumulates above the formal demand needs. This is due the high house price to income ratio present in the Egyptian market.

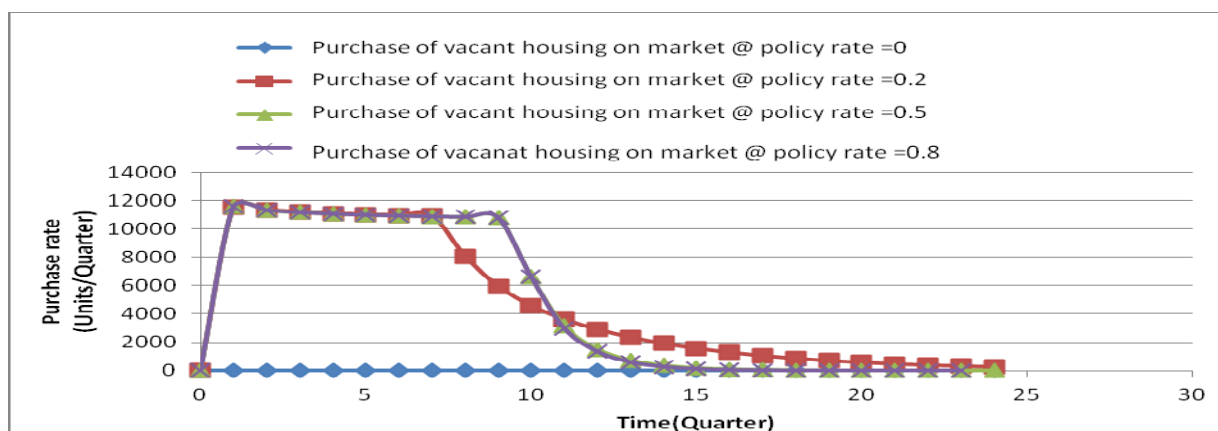


Figure 5 Purchase of vacant housing on market as a function of varying the policy rate

As shown in Figure 5. The purchasing power of the vacant units offered on market in the first 10 quarters are almost the same for different policy severities. This happens since the number of people who could afford buying these vacant units dominates over the number units on market. As soon as the vacant stock falls below the demand, people will buy the remaining stock. However, the deficit will be urged going informally. Therefore, in order to effectively utilize the vacant units offered on market, decision makers should consider implementing the following recommendations alongside:

- A moderate policy severity would be enough. This could be done through phasing the policy implementation over a long period of time. This will decrease the likelihood of having useless stock accumulation.
- Decreasing the house price to income ratio. Either by imposing restrictions on landlords when offering their vacant units on market. Or by financially funding vacant units purchasers.

Implementing these recommendations will create the balance in the market, preventing the dominance of one loop over the other. Therefore, efficiently utilizing the units offered by policy implementation.

6 Conclusions and Future Work

This paper presents a model that captures the dynamics of the real estate market in Egypt through defining the cause-effect relationship between variables. These relationships were interpreted from several sources ranging from well-defined urban economics fundamentals to semi-structured interviews

with industry experts. Next, after completing the model, it was utilized in analyzing the effect of applying a house tax policy on other related variables in the market.

After policy implementation it was found that, 1) the average house price, demand, formal demand and informal demand were not affected and 2) the informal MIH at 2014 decreased by 10.1%, 10.23% and 10.24% in case of low, medium and high policy severities respectively. Therefore it can be concluded that low policy severity is enough and there is no need for severe implementation, since the vacant stock uselessly accumulates above the formal housing needs.

This research could be expanded and updated at many directions. First, the model boundary could be expanded to include more variables. For the current research, the macroeconomic effect, material prices were excluded. Second, various variables in the research could be disaggregated into more specific and detailed variables to study them separately. Since system dynamics is a top-bottom simulation approach describing overall system behaviour, future work is underway to develop micro-level simulation approaches capturing exact buyer/seller behaviour using the agent based modeling. In this case autonomous decision-making entities (agents) represent buyers and sellers in the market. Individual behaviour of these entities would result in overall market behaviour.

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