Property Bidding War Strategies for the Dutch Housing Market Using an Agent-Based Model

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Abstract. The use of certain buyer strategies in the process of property bidding is being discovered in this paper. An Agent-based model is introduced where financial statistics are based on the Dutch housing market. Three types of agents are used in this model that uses cycles of two weeks. Thee hypotheses about the market are initially formulated. In the end, it proved that only the hypothesis "Initial overbidding on the list price results in a higher success rate" could be confirmed.

1 Introduction

The prices of houses on the real estate market are increasing because specific markets get more saturated. In the developed world, there recently has been a housing bubble [1]. In the Netherlands, property prices have been increasing over the last years and are expected to keep rising [2]. Due to the changes in the market, other buyer tactics are being required. In order to determine proper techniques for winning the property bidding war, a model is constructed that resembles the reality as much as possible. Several approaches of modeling exist. Mostly, models derived from an asset pricing theory, trade theory, hedonic price model, prospect theory life cycle model, and business cycle model exist to model the housing market [1]. The application of Agent-Based modeling to the housing market is relatively uncommon, however since 2008 some researchers did this actively [3] [4]. A bidding war in this context is a situation where two or more buyers are interested in buying a unique commodity, in this case property. In the past, bidding wars used to be quite unique with an occurrence in only around 4% of house purchases. This led to treating the list price as a ceiling in research on housing. After that, the share of bidding wars in house transactions rose even to more than 30% in 2005 [5].

This paper will discuss the design, implementation and outcomes of an Agent-Based Model of the Dutch housing market with emphasis on the buyer strategy that a potential buyer can practice. By running simulations of this model with different parameters and characteristics, conclusions can be drawn. The goal of this research is to define hypotheses and draw conclusions from a model that represents the housing market with emphasis on the property bidding war.

2 Methods

Accompanying this paper, is an Agent-Based Model that is used to run experiments. The model is built in NetLogo 6.0.3 [6]. The model is designed according to the *Overview, Design concepts, Details (ODD)* concept [7] and will be explained in detail in section 3. With the use of the model, multiple hypotheses are tested and possible conclusions with respect to strategies to win the property bidding war from the perspective of one unique buyer are drawn. The main question this paper seeks to answer is:

How can Agent-Based Modeling help in determining the best strategy for winning property bidding war?

In order to establish a representable model, first a look has to be taken to the flow of

typical processes in a property bidding process. Subsequently, parameters for the distribution of income, capital and mortgages of the buyers have to be established, as well as the house prices in a certain domain.

This paper presents multiple hypotheses. The first and most obvious one relates to overbidding of the buyer. Additionally two other hypothesis are formulated. This leads to a total of three hypotheses:

H$_1$*:Initial overbidding on the list price results in a higher success rate*

H$_2$*:Underbidding on the list price has success when the amount of competitors for the same house is low*

H$_3$*:Initial overbidding on the list price results in a short negotiation cycle*

The above mentioned hypotheses will be tested using the NetLogo [6] model.

3 Model Design

In this section, the design and implementation of the model is discussed. First the *Overview* part of the afore mentioned ODD concept [7] will be discussed. The purpose of this model is to establish a Agent-Based Model that represents the Dutch housing market such that buyer strategies can be derived from the model. The process overview from a basal bidding war is given in Fig. 1. Since it concerns a bidding war, the possibility for multiple buyers to place an offer on a property is of fundamental importance. In order to translate this flow into an Agent-Based Model, Three different agent sets with their variables have been determined. The design is displayed in Fig. 2

In terms for *Design concepts* [7], basic principles that are incorporated concern the financial statistics. The income of the owners is based on the income distribution in the Netherlands [8]. This can be modeled using a gamma distribution [9] with the condition that extremely low incomes

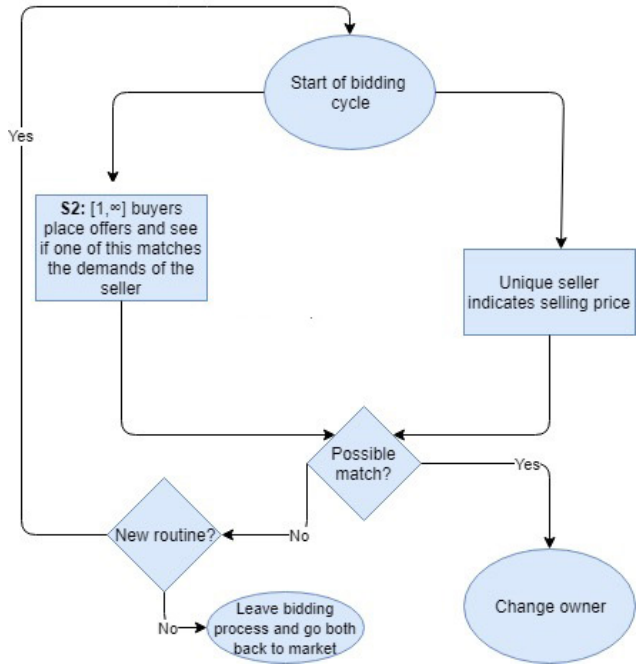

Fig. 1. The process flow in a bidding war

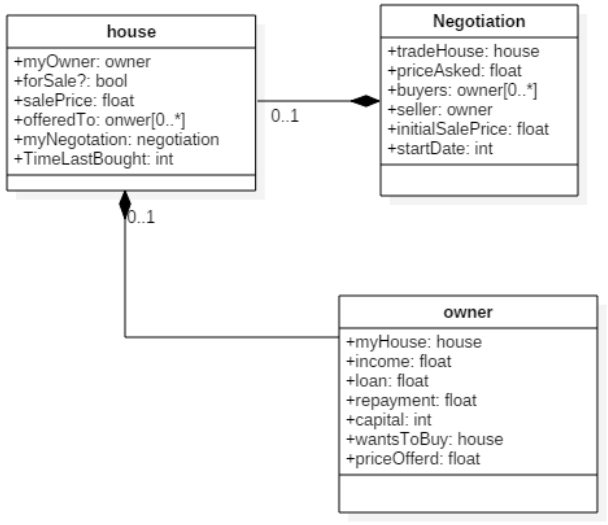

Fig. 2. UML Class diagram

are ignored since owners with such an income are not likely to enter the housing market [10]. The initial house prices are based on a 80% confidence interval that is given by the CBS [8]

from which reversely house prices are generated by using z-values [11]. To test a variety of different test cases, the city size can be set. Additionally, the initial percentage of occupied houses, duration of a mortgage and a maximum amount of houses that a buyer can choose from can be set. The objectives for the model are that owner agents are explicitly programmed to meet other owners. Both the buyer and the seller are modeled as an owner. Individuals can change their decision-making process if the model parameters are changed during runtime. In addition, the agents have adaptive traits since the negotiation cycle suggests that most sellers deal with buyers sequentially over a relatively long period [5]. The *Details* part of the model entails that the initial conditions of the model can be set dynamically in NetLogo, parameters that the user of the model can alter include:

— The size of the city

— The initial percentage of houses that are set in the city with respect to the total capacity

— The initial percentage of houses that are inhabited by owners

— The fact whether or not the model allows for new owners to arrive in the city and existing owners to arbitrarily move

— The upper and lower price limits of houses that a potential buyer can afford

— The maximum amount of negotiation cycles after a negotiation is determined to not reach a successful outcome

— The buyer strategy for one buyer that can either be *overbidding*, *underbidding* or *nothing special*.

The model however includes limitations about the possibilities for parameterization. The model is based on the following assumptions:

— Houses are mostly sold through sequential bidding [5].

— In a bidding war, the seller might not be able to assemble all bids that might be made before accepting one, therefore does not necessarily accept all bids [12]

— Bidders bid for houses with no knowledge about the other bidders. The bidder is therefore not allowed to know anything about the bids of his competitors.

— Buyers can enter a negotiation cycle when the seller is already negotiation with other bidders and does not have reached a successful outcome yet.

The design and variables of the agents are partially inspired on the model of Nigel Gilbert from 2009 when constructing an Agent-Based Model of the British market [10].

The city consists of an amount of houses that is dependent on the input parameters that the user provides and will show the agents as is depicted in Fig. 3. The remainder of the input and output parameters have explanation in the code where necessary. Each cycle of the model represents

Fig. 3. The different turtle appearances in the NetLogo model

one month, two weeks for the owners to set their houses for sale and two weeks for each negotiation cycle. The flow of the model is as follows:

— Annually, new potential owners arrive in the city and some leave this city

— Owners that live in a house that is either above or below their income level set their house for sale and are looking for a new house [10]

— Owners without a house get priority in entering a negotiation with a seller. After that, owners with a house that is for sale can join negotiations

— In the first negotiation cycle, an initial demand and initial offers are made by the seller and the buyer. If the house does not have a seller, the sale price of the house is treated as the list price

— According to the buyer-strategy that the models allows the user to select, one buyer out of all the competitors is randomly chosen. The initial offer on the house will be made according to the strategy being either overbidding or underbidding.

— If an agreement is reached or the negotiation has taken too long, the houses will be assigned to the proper owner and the negotiation will be aborted.

4 Results

In section 2, three hypotheses were formulated. In this section the results are presented and the conditions under which the experiments were carried out will be illustrated.

H$_1$*:Initial overbidding on the list price results in a higher success rate*

The model has been run 10 times for a period for 50 years and the success rate of the buyer that chose the overbidding strategy was 98.485% on average. When no specific strategy was selected and the buyer adopted the same strategy as his competitor, the success rate was 11.315% on average. Based on the model, this hypothesis can be regarded as confirmed. Tests have been conducted with the following parameters that resemble the Dutch housing market:

— gridslider: 6

— initial-occupation: 70%

— initial-house-occupation: 70%

— loan-duration: 25 years

— mean-income: 27000

— mean-savings: 45000

— buyers-lower-limit: 0.80

— buyers-upper-limit: 1.25

H$_2$*:Underbidding on the list price has success when the amount of competitors for the same house is low*

When the model was run 10 times for a period of 20 years with the same parameters as the previous experiments, there proved only to be minor differences between running it with a limitation on the maximum amount of competitors. The succes rate proved to be 88.274% on average with only a standard deviation of 0.21. Experiments have been conducted with imposing limits on the maximum amount of competitors for one house being either 2,3,4,5 or 9. Based on the model,this hypothesis can be rejected.

H$_3$*:Initial overbidding on the list price results in a short negotiation cycle*

When running the model 10 times for a period of 50 years with again the parameters that resemble the Dutch market, the mean duration of the negotiation cycle with the overbidding as a buyer strategy was 4.907 with a standard deviation of 0.273. When not letting a buyer adapt a specific strategy this proved to be 5.572 with a standard deviation of 0.250. This is insignificant and therefore based on the model, this hypothesis can be rejected.

5 Conclusion and discussion

In the results section is described how of the three initial hypotheses, only one could be confirmed. Based on the Agent-Based Model that is accompanying this paper, the conclusion that overbidding on the initial sale price yields a higher success rate for the buyer can be made. When adapting a critical attitude towards the model, it can be said that certain characteristics of the housing market are not taken into account yet. For instance, more economic values can be incorporated when simulation the property bidding wars for a period of several decades. Matters such as a varying income over the years and adding this to the owners' capital should be considered. As a result of this, the height of an owners' mortgage could be increased when further research is carried out on this domain. In addition, a more detailed simulation of a situation in which multiple buyers have the opportunity to negotiate on multiple houses simultaneously, and also demographically differentiating between the owners could be a subject for further research.

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