Computers, Environment and Urban Systems 55 (2016) 33–43

Contents lists available at ScienceDirect

Computers, Environment and Urban Systems

journal homepage: www.elsevier.com/locate/ceus

Microeconomic model of residential location incorporating life cycle and social expectations

Héctor A. López-Ospina [a,*], Francisco J. Martínez [b], Cristián E. Cortés [b]

[a] Industrial Engineering Department, Pontificia Universidad Javeriana, Cra 7 #40-62, Ed. Jose Gabriel Maldonado P.3, Bogotá, Colombia
[b] Civil Engineering Department, Universidad de Chile, Blanco Encalada 2002, Santiago, Chile

ARTICLE INFO

Article history:
Received 9 November 2014
Received in revised form 18 September 2015
Accepted 20 September 2015
Available online xxxx

Keywords:
Residential location
Equilibrium
Social learning
Imitation
Household life cycle
Residential segregation
Multinomial logit
Bid functions

ABSTRACT

This paper is focused on the dynamics of residential location decisions based on the microeconomic theory of urban land use, in which we assume that each property is assigned to the agent with the highest bid. The agents' behavior includes expectations of their future based on the life cycle or social influence processes, which are anticipated or solved using a hypothesis of imitation of the behavior of other households currently living in those situations. Relocation decisions are then modeled, incorporating expected utilities by means of transition probabilities among households. An imitation multi-objective bid function is postulated for each alternative location depending on the expected income per unit of time, the current household value of amenities and the expected value obtained by the imitated agent in this location. A multinomial logit model is assumed to calculate the location equilibrium, where willingness to pay is determined by dwelling characteristics and spatial socioeconomic segregation (location externalities). Numerical examples and simulations are presented using linear bid functions to explain the proposed modeling approach and the impact of imitation on the dynamics of residential segregation.

1. Introduction

The study of land use dynamics in the context of an urban system involves the description and modeling of interactions between a variety of agents that change their socioeconomic characteristics and preferences over time and, therefore, make different decisions across both time and space during the residential relocation process. This dynamic feature appears as the result of various issues, such as the joint location decision of various households. These issues, in turn, affect the urban system's configuration, causing variations in real estate market behavior. In addition, there are some processes associated with the location decisions of households that are not explicitly considered in classical models of short- and long-term urban land use equilibrium, such as social learning, imitation, the formation of habits, the generation of expectations, uncertainty regarding availability of resources and fluctuation/disruption of the social and economic changes that establish a complex system.

In particular, households have internal dynamics such as changes in life cycles, changes in structure, and social interactions (new children, divorce, job changes, level of education, etc.), which affect consumption patterns and residential location. In addition, there are variations in urban land use due to the generation of new real estate projects in different areas of a city, motivating relocations. This type of expected dynamics associated with a household's life cycle induces transitions among possible states (or household types). Under the condition of uncertainty regarding the future, these states can be represented as a set of possibilities that can be anticipated and used as the basis for modeling the residential relocation process, not only in the short but also in the long term, such as residential relocation and intra-urban mobility (Li & Tu, 2011). Such relocation forces are denoted by Huff and Clark (1978) as cumulative inertia (resistance to movement) and residential stress (incentive for movement), given by possible dissatisfaction with certain attributes associated with the current household and its surroundings. This dissatisfaction can be generated by changes in the household life cycle and social network effects. For example, some empirical studies explain the residential relocation dynamics in urban areas through effects such as expected future salary or the importance that agents assign to the utility drawn by others through the consumption of various goods. One way to produce these decision changes is by assessing their anticipation through knowledge of the cluster, household type expectations or future change probabilities. For example, future expected revenues could be used as an estimate of the payment capacity of certain households (Kennan & Walker, 2011).

There are few studies that model residence choice using future expectations through stochastic dynamic programming. Among them, worth mentioning are the results of Bayer, McMillan, Murphy, and Timmins (2011) and Ortalo-Magne and Rady (2006). In Ortalo-Magne and Rady (2006), the authors design a model of the housing market

* Corresponding author.
E-mail addresses: hectorlopez@javeriana.edu.co (H.A. López-Ospina), fmartine@ing.uchile.cl (F.J. Martínez), ccortes@ing.uchile.cl (C.E. Cortés).

http://dx.doi.org/10.1016/j.compenvurbsys.2015.09.008
0198-9715/

life cycle with a focus on equilibrium outcomes, explicitly including credit constraints, particularly for young households. Bayer et al. (2011) develop a model of neighborhood choice in a dynamic environment that estimates housing preferences in dynamic evolution and neighborhood attributes. In addition, other influential factors in relocation decision making are possible changes in the long-term activities of any of the household members in terms of work, education, or other activities (Hooimeijer, 1996; Li & Tu, 2011) and changes in the household structure due to the departure or arrival of new members, etc. (Eluru, Sener, Bhat, Pendyala, & Axhausen, 2009).

An important concept in relation to residential relocation phenomena is transaction or moving costs, which depend on various factors, especially life cycle and various household characteristics (Bayer et al., 2011; Kennan & Walker, 2011). These relocation costs refer to not only monetary costs but also social, psychological and temporary losses due to the search for a new dwelling and the moving process. Moreover, some studies in the fields of psychology and sociology show that social and individual learning, along with socioeconomic changes in the life cycle, are important factors when a household makes decisions about intra-urban mobility (Rossi, 1955; Ritchey, 1976; Anderson & Milson, 1989; among others).

Another model type that analyzes the dynamics of urban location based on individuals' behaviors is the multi-agent model (see Benenson, 1998; Ettema, 2011; Filatova, 2014, etc.). In Benenson (1998) it is assumed that households can change their behavior according to their neighbors and to residential properties in their neighborhood as well as the entire city. In Ettema (2011), some economic concepts are integrated using multi-agent simulation models, which consider that household decisions are based on the perception of probabilities of the evolution of the real estate market. Filatova (2014) proposes a model that includes natural hazard risks and environmental amenities through hedonic econometric models.

In an interesting work, Parker and Filatova (2008) present a conceptual design for a residential market context for interaction between multiple buyers and sellers, adding the expectation formation prospect as a main subject in the decision-making process. In particular, the authors analyze and incorporate the effects associated with household life cycle such as age and size. In this way, agents can shape their own households, generating searches for independent residences or searching locations with attributes that are different from those of the current location. The interesting contribution of this model is the interaction between agent modeling and urban economic concepts.

Due to the low relevance that the literature gives to the life cycle effect of households in urban dynamics, in this paper, we propose a microeconomic model of residential location that incorporates some aspects of the agents' or decision makers' dynamics over time and their influence on the decision regarding a residential relocation. Here, we must highlight the importance of applying a microeconomic modeling approach to two key aspects related to imitation in the decision-making process. The first aspect is the possibility that some agents have (either households or firms) to evaluate expected life cycle dynamics, making urban location decisions at present dependent on the expected future, in terms of both future planned decisions (namely, education, workplace, expected number of children) and possible changes in the global economy. The second aspect is the social effects of decisions and valuations made by other individuals on the personal decisions of the decision maker. This latter feature makes the connection of the developed simulations (see Section 4) to life cycles a key aspect of social dynamics in the phenomenon of social segregation.

We use the aggregate model that assumes that households split into clusters according to a set of common features. Moreover, each agent of a specific cluster makes similar decisions regarding residential location under the assumption that these agents share a utility function with the same parameters. Idiosyncratic differences in decisions among members of the same cluster are captured by a Gumbel (Type I) stochastic distribution of willingness to pay. However, features defining such groups are dynamic over time for each agent (for example, age, number of household members, income, number of cars, and education level), leading households of the same cluster to evolve into different clusters in the subsequent time period. To trace this evolution, we develop a microeconomic model that has a formulation similar to stochastic dynamic programming models and is designed to capture some of these elements associated with the likelihood of changing clusters in the future. We also assume that the set of potential cluster changes and the likelihood of changing into each of them have an impact on the current assessment of the willingness to pay for the different dwelling types.

In building the willingness to pay, we hypothesize that households observe and imitate the behavior of other households. In other words, households build their expected or social network utility by observing the utilities of households in other clusters using a transition probability that reflects the chances of a change between clusters in the next time period or the social influence weight among socioeconomic groups. This imitation process allows us to simplify the forecasting problem, which under such conditions, becomes a static model of consumption at each period.

This process of imitation in decision-making is supported by other areas such as the economy, social science and engineering. For example, in the context of game theory, theoretical studies associate imitation and social learning dynamics with strategic decision making (Alós-Ferrer & Schlag, 2009). An interesting example in this area is the work developed by Berg (2010), in which firms make location decisions using information regarding the profit or utility obtained by other firms already in these locations.

Furthermore, in the context of the intertemporal modeling of goods consumption, several studies address the effect of social learning and imitation processes between agents (Allen & Carroll, 2001; Ballinger, Palumbo, & Wilcox, 2003; Páez, Scott, & Volz, 2008; Brown, Chua, & Camerer, 2009; Carbone & Duffy, 2014 among others). Note that in most of these studies, the imitation processes of other agents' choice are analyzed, not directly from the utility obtained but rather indirectly because the choice is effectively related to the achieved utility level. In contrast, we develop an imitation model that is combined with current socioeconomic characteristics, preferences and constraints to build a willingness to pay function for residential relocation. In this sense, the household willingness to pay reflects the annualized expected long-term value of the residence, which is built under the myopic assumption that consumers cannot forecast but can observe the dynamics of the population's socioeconomics and the different behaviors of the households of other clusters. In our model, households with such behavior enter the market in one period and submit bids, and an absentee auctioneer assigns locations in a static equilibrium market clearing process; equilibrium is attained by adjusting the households' utility levels such that all are allocated to available housing options in that period.

The paper is organized as follows. In Section 2, we include the theoretical background and initial considerations required to formulate the imitation model. In the third section, a discrete choice deterministic microeconomic model associated with residential location is developed, incorporating the household's change expectations by means of transition probabilities between household clusters during the life cycle. In the fourth section, numerical examples showing the proposed modeling and its effects in an urban configuration are developed. The paper concludes with a section that includes remarks and final discussions.

2. Mathematical and microeconomic fundamentals

This section describes the basic urban economy guidelines needed to understand the model developed in Section 3. In particular, the fundamentals of the Random Bidding and Supply Model (RB&SM) demand model are shown (Martínez & Henríquez, 2007). Urban economics offers two main approaches to explain location equilibrium. The first