

Market Clearing in Agent-Based Models of Conversion: A Bid-Rent Function (32)

Richard Iovanna
USDA

Colin Vance
RWI Essen

Topic area: Socioeconomic, demographic, and other factors of land-use change
Approach: Modeling

An advantage of simulation when pondering the dynamics of land-use change is that the researcher can reasonably safely focus on particular aspects of the process of interest. By making a few simplifying assumptions and subscribing to a few underlying general principles, a simulation model can abstract away from confounding factors that may obfuscate or bias the relationships being examined.

Although many agent-based models of land-use change exist in the literature, they tend to fall into two quite distinct camps: Some models are quite elaborate, requiring technical support to understand and use them. Sometimes intending to painstakingly portray a locale of interest, they are not easily applied to other contexts. Berger and Bolte (2004) provide such an example. Other models are such abstractions that the degree to which they have something to say about a real-world process—land-use change—can be subject to debate (Sasaki and Box 2003). Moreover, as Parker and Meretsky (2004) observe, many ABM focus on the supply or demand-side of the conversion process, taking the other for granted.

To fill this gap, we develop an exceedingly simple and versatile, if not realistic, agent-based model of land-use change from the economic first principles of utility and profit maximization. Our agents wholly define a market for land-use change: On the demand side are households that are seeking to carve out a lot from the open-space parcels on the landscape that will maximize their utility. On the supply side are landowners that maximize future returns by either continuing to engage in agricultural production or will develop their land.

The model accounts, not only for variation in agricultural returns—landowners' conversion opportunity cost—and household incomes, but also the variation across the landscape of amenities (aesthetics, proximity to the CBD, etc.) that determine parcels' relative appeal to households. Each open-space parcel is assumed to offer to each household an alternative site from which a utility maximizing lot can be carved. These prices vary systematically in accordance to the relationship of price, amenity, and lot size that underlies the household utility function. The indifference of households to where they situate their lot that results from the variation in amenity and prices establishes a necessary equivalence across dissimilar parcels. The approach, which is based on Alonzo (1964), obtains the vector of equilibrium prices (that reflect parcels' relative appeal) that clears the regional market for open space.

Within this framework, we explore the how land-use policy and the landscape characteristics affect both the pattern of land-use change and the overall amount of change. In particular, we examine the impact of lot-size restrictions and discuss their ability to influence conversion decisions, as well as their potential for unintended consequences.

We further explore the model's capabilities in three ways: First, the flexibility of the model in terms of how "amenity" is specified is illustrated by expressing it as a negative spatial externality. Second, the model is iterated over successive periods to illustrate the time dependence of the likelihood of conversion and to enable the number of households that enter the market for conversion to be influenced by the previous period's prices.

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