Understanding Urban Rental Market through Agent-based Modeling

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The previous decade saw a substantial increase in the number of renters across the United States. According to statistics from the American Community Survey, the population of almost a quarter of the 100 largest cities have now become renter-majority. While economists have had a discussion of how rent operates since 1930s, their models were largely based on supply and demand curves or general equilibrium relationships which focus on aggregate totals rather than individual market participants. The recent shortage of rental housing units and price surges, however, call for a more sophisticated understanding of urban rental market.

I spent most of my summer building a computational agent-based model in R, which allows me to incorporate heterogeneity in agent characteristics as well as observe interactions between landlords and tenants at a micro-level. I started off with a simple musical chair algorithm where original tenants dynamically leave or relocate with a fixed probability while new tenants enter the neighborhood according to a Poisson distribution. Rental prices are initialized at 25% of tenant income on average and are assumed to correlate with quality. Tenants looking for housing by the end of each month are assumed to have perfect information about available rental units in the neighborhood and are constrained to apply only to those priced at no more than 50% of their income. With a constant probability, landlords select their incoming tenant using a fair lottery, and they pick the applicant with the highest income otherwise.

In addition, I tried to capture rent-setting behavior of landlords by considering two separate price formation processes. For renewed units, rent is assumed to vary at a rate linear in market trend, which I calculate as the average percentage change in prices for units that changed hand within last three months. Once the occupancy rate hits 95%, rent will also increase proportionally to occupancy due to scarcity effect. The rent-setting process for turnover units differs from that of renewed units by a vacancy term which reflects the common practice for landlords to lower their list price if their property sat vacant last month. Since the turnover cost could be fairly high for landlords, they are tempted to keep tenants longer by maintaining a relatively stable rent for renewed contracts. As a result, the coefficients for the market trend term and the scarcity term should be smaller in the renewed process than in the turnover process. In the more complex version of the model, I also allow tenants to respond to new rents by modelling their chance of moving as a logistic function of rent-to-income ratio.

While exploring the parameter space, I noticed that the simulation outcomes are extremely sensitive to model parameters. A slight modification in parameter values can lead to drastically different first-order and second-order behavior, as witnessed by average occupancy, average income of tenants, average price of units and market volatility. The next step of this project will be to connect simulation results to demographic data from American Community Survey and postings on Zillow, as well as set up an approximate Bayesian computation to reliably infer model parameters.

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