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Introduction to the Special Issue on Agent-based Models in Urban Economics

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Welcome to the Special Issue on Agent-based Models (ABM) in Urban Economics. The issue contains six articles that highlight how agent-based models can be used to study economic activity across space and within dense urban areas. Today, nearly 60% of the world's population lives in cities and this figure will continue to rise (World Bank, 2022).

It is thus crucial that both urban scholars and agent-based modelers collaborate to better understand the causes and consequences of urban life. To aid in this endeavor, the papers in this issue model a variety of urban phenomena. Two papers cover housing price formation, two papers discuss retail markets, and two articles investigate the economics of epidemiology in cities.

In their article, "The Impact of Social Influence in Australian Real Estate: Market Forecasting with a Spatial Agent-based Model," **Evans, Glavatskiy, Harré, and Prokopeno** introduce a new graph-based approach for incorporating a spatial component in a large-scale urban housing agent-based model. The model is calibrated and validated with the housing market data for the Greater Sydney region.

Bonakdar and Roos in their paper, "Dissimilarity Effects on House Prices: What is the price of similar neighbors?" explore residential choice and housing prices, with a focus on the population composition within a neighborhood. They show that a preference to live among similar neighbors has a strong competitive effect on rich households and drives up their house prices.

Regarding agent-based modeling of retail, **Torrens'** paper, "Agent Models of Customer Journeys on retail high streets," provides a comprehensive literature review describing how the various agent-based models in geography can be used to better inform our understanding of retail markets and consumer behavior as it particularly relates to the "high streets" of the world.

Fain, in his article, "Should Stores Locate Close to a Rival?" revisits the classic Hotelling model but within an ABM framework. Firms compete in an urban landscape that is segregated by income level. Some firms are located close to wealthy neighborhoods and far from competitors, but other firms do not enjoy these advantages. He finds the degree of market power is then determined by the transportation costs, with more pricing power as transportation costs rise.

Turning to epidemiology, in **Souther, Chang and Tassier's** paper, "It's Worth a Shot: Urban Density, Endogenous Vaccination Decisions, and Dynamics of Infectious Disease," the authors address the issue of influenza vaccination rates across space. They model the decision of agents to get a vaccine or not based on the probability of getting infected, which is a function of the number of agents they are connected to in their social networks. Because the thickness of social networks varies across spaces, urban and rural areas can have very different vaccination rates. They find that higher neighborhood density leads to higher levels of vaccine usage and lower rates of infection in urban regions within the model.

Finally, **Beaudoin and Isaac**, in their article, "Direct and Indirect Transmission of Avian Influenza: Results from a Calibrated Agent-Based Model" also model viral transmission but this time avian influenza transmitted within the poultry sector, with a focus on the situation in Thailand. Their model demonstrates how to realistically calibrate a model of disease spread while highlighting the relative importance of different pathways. Their model helps support public policy by providing a framework that may be used to simulate interventions to reduce or prevent the regional transmission of avian influenza.

The Advantages of ABM for Urban Economics

Collectively, these papers demonstrate the advantages of ABMs for urban systems as complementary to conventional urban models. For example, ABMs can include more realistic and heterogeneous behaviors. Both **Evans et al.** and **Southern et al.'s** papers introduce the role of social influences and social networks in decision-making in an urban context. **Evans et al.** look at the role of social influence—trend-following behavior, in particular—and fear of missing out (FOMO) when deciding to purchase a house. **Southern et al.** study the influence of heterogeneous social networks on the decisions to vaccinate or not. Network effects often means non-linear changes in urban systems (e.g., a long dormant period followed by the sudden outbreak of a transmissible disease) and heterogeneous neighborhoods (e.g., segregation), which are an important phenomenon in complex urban system that can be best captured with ABMs.

Another advantage of ABM is that it can incorporate high-resolution urban geography, which is crucial when the interaction between an individual and the urban environment is the driving force of the dynamics, such as in a pandemic. **Torrens** discusses the importance of representing the geography using rich, high-solution spatial data in the modeling of customer journeys in a retail center so that one can understand "how people come into contact with urban environments."

Relatedly, ABM is a natural tool to incorporate new types of high-resolution, individual-level data, such as activity and trajectory data from cell phones and wearable devices, which could be fed into the ABM to model individual's movements and activities in an urban space. The papers in the special issue have used rich and diverse spatial data at an appropriate scale to calibrate and validate the ABMs, which ensures the validity of the models and demonstrates the credibility of the method.

Finally, ABM's ability to simulate dynamic human-environment interactions in a realistic urban space makes it a useful tool for planning, such as for a retail center, a new road, or a housing development. The flexible ABM provides a virtual environment to conduct what-if scenarios when planning or designing a new policy before it is implemented in the real world, after which it would be very costly to change or revoke. **Bonakdar and Roos** analyze the impact of increased universal credit access on neighborhood segregation, and **Torrens** discusses the potential of ABMs for retail planning. The full potential of ABMs as a tool for urban planning has yet to be fully explored.

Future Research Possibilities

While these papers give a flavor of ABM for urban modeling, much work remains to be done. First is that models can better connect the various sectors that make up urban systems. For example, it would be nice to see the development of integrated frameworks that connects housing, retail, labor markets, and transport, as they influence each other in non-trivial and non-linear ways.

Second, it would also be nice to see the use of novel, individual-level, and real-time data in more urban ABMs. The increasing availability of high-resolution data opens opportunities to study individual behaviors and interactions in an urban environment. The applications should not be limited to traditional areas such as retail, transport, or crowd modeling, but could also be in areas like housing and labor markets where the data can be used to inform individuals' work and residential locations, commutes, and other activities.

Finally, this issue has shown the importance of social influence and social networks for urban outcomes. Going forward, it's crucial to see more urban models that incorporate these elements. Social influence and network effects may lie behind many urban phenomena and patterns that traditional urban models have failed to fully understand and project (such as segregation patterns, varying vaccination rates across neighborhoods, or the location and health of retail shops). Having a tool like ABM that could explicitly model these network effects is therefore important.

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