## **AIA Pitch**

### Team

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**An Agent-Based Model of Urban Economics:**

**Evaluating Emergence & Evolution**

### Brief

We are creating a spatial agent-based model to analyse the relationship between several different types of agents to form an economic system. Workers look for somewhere to live based on a utility function (distance to work, spending on land and goods). Firms (workplaces) provide goods for workers and a wage. Landlords provide land for workers to live and base their costs on demand.

Workers receive a wage and a chance to move every tick by randomly selecting 10 patches of land and then moving to the most suitable location. Our model is devised from the interactions between the three sets of agents during this event. By experimenting with different sets of parameters we will be able to analyse emergence throughout the system

### Hypothesis

Can interacting agents create a stable, equal-utility settlement pattern in an economic system?

### Primary Reference(s)

(An Agent Model of Urban Economics: Digging into Emergence) Computers, Environment and Urban Systems (Volume 54), (November 2015), pp. 414-427 [https://doi.org/10.1016/j.compenvurbsys.2014.12.003]

### Anticipated Behaviour

We anticipate that:

* The agent’s behaviour will converge into equilibrium. The speed of which they do this depends on the range of several parameters (land, density, goods cost & wage).
* The system will exhibit longer-lived and more chaotic behaviour when the range of parameter values becomes larger throughout our experiments.

### Agent Deliberation/Interaction

Our main agent’s (People) goal is to find the most suitable housing depending on land cost and goods cost. They do this through random selection and as there is limited amount of land, these agents will select the complete their goal at some point and stop moving. This selection is based off their spending on land and goods; meaning unless the price of these two commodities changes drastically the descent into equilibrium will be gradual.

### Control Variables for Testing/Evaluation

**Agents**

People

*Control Variables:*

**- Base Land Cost [P(L)]**

Set by the Landlord of the current patch.

**OR**

**- Density Cost [P(D)]**

Interchangable in the model with *Base Land Cost*, *Density Cost* is used to supply *People* with a cost being within proximity to other *People*. By adding radii to each agent we can evaluate which agents prefer to live out of proximity and which have sacrificed their space for less *Utility* cost. This is a result of the sum of normalized distances with the radius divided by the total number of *People*.

**- Commute Cost [C]**

The cost of commuting per patch. Set at the start of the simulation.

**- “Love of Variety” Modifier [ρ]**

This modifier describes the need for spending a similar amount on Land and Goods

(Brakman et al., 2009, p. 94) & (A.K. Dixit et al. 1977, p. 297)

*Determined Variables*

**- Budget [Y]**

Result of (Wage - Commute Cost), is used for determining spending on Land and Goods

**- Spending on Land [L]**

Determined from P(L), Budget & “Love of Variety” Modifier ρ, total spending on land for current tick.

**- Spending on Goods [G]**

Determined from P(G), Budget & “Love of Variety” Modifier ρ, total spending on goods for current tick.

**- Utility**

Determined from Spending on Goods, Spending on Land & “Love of Variety” Modifier ρ, *People*’s goal is to reduce the amount of *Utility* by moving to a cheaper location.

- **Income**

Determined from remaining amount of money after all *Utility* costs are subtracted, can be used to evaluate the prosperity of *People* – allowing us to see the behaviour of poorer or richer agents.

Firms

**- Wage Output**

Set for each firm at the start of the simulation, *People* employed by the firm receive this wage every tick.

**- Product Cost**

Set for each firm at the start of the simulation, used to determine *People*’s Spending on Goods [G]

Landlords

**- Base Land Cost [P(L)]**

Reduced when plot of land is not sold for a certain number of iterations

**- Net Stock**

Aims to keep this at zero (Land Rented - Land Owned). The change in price of land is proportional to the amount that net stock deviates from zero: Δpg = f (stock)/x, where x controls the magnitude of the price change.

### Experiments

*Spatial equilibrium from density cost and Landlords*

These include all of the key variables and will be the first tests carried out on our model. Swapping out *Land* costs for *Density* costs.

*Spatial morphology: reaction to cost changes*

“What drives agent location choice to produce stable emergent equilibria?”

This section looks at how *People* in the model respond to changes in costs, as reflected in settlement size. To avoid any agent’s ‘locking-in’, each time an increment is made the model must be fully restarted.

*The impact of differences in wealth and preferences*

Four different wealth points so that the richest *People* are four times wealthier than the poorest.

In the paper they demonstrate a bidding system, based upon ABM (Account-Based Marketing) models. When two or more agents pick the same piece of land and consequently bid for rental rights.

*Analysis of two and three Person decisions*

This is a mathematical model in the paper but should enable a basis for us to test our agent based model around.

It includes communication between agents in order to “decide” how to share land and commute costs between each other.

“Economically, the impact of People's choices on proximity costs cause externalities for others: if ‘my’ location decision is before others, it will change land or density costs for them with no compensation being made (Button, 2010, p. 161)”

### References

(Brakman et al., 2009, p. 94) S. Brakman, H. Garretsen, C. van Marrewijk

The new introduction to geographical economics

(2nd ed.), Cambridge University Press (2009)

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