An Exploration of the Effect of Buyer Preference and Market Composition on the Rent Gradient using the ALMA Framework
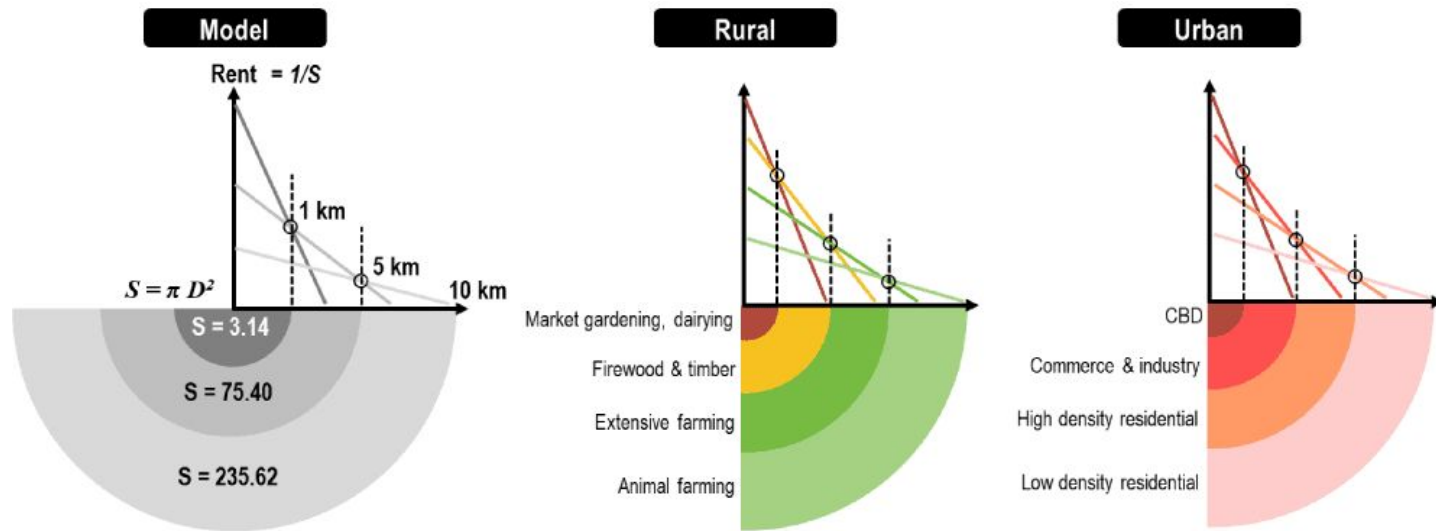
Alexander Michels[1,2,3], Jeon-Young Kang[4], and Shaowen Wang[1,2,3]

[1] Illinois Informatics Institute
[2] CyberGIS Center for Advanced Digital and Spatial Studies
[3] University of Illinois at Urbana-Champaign
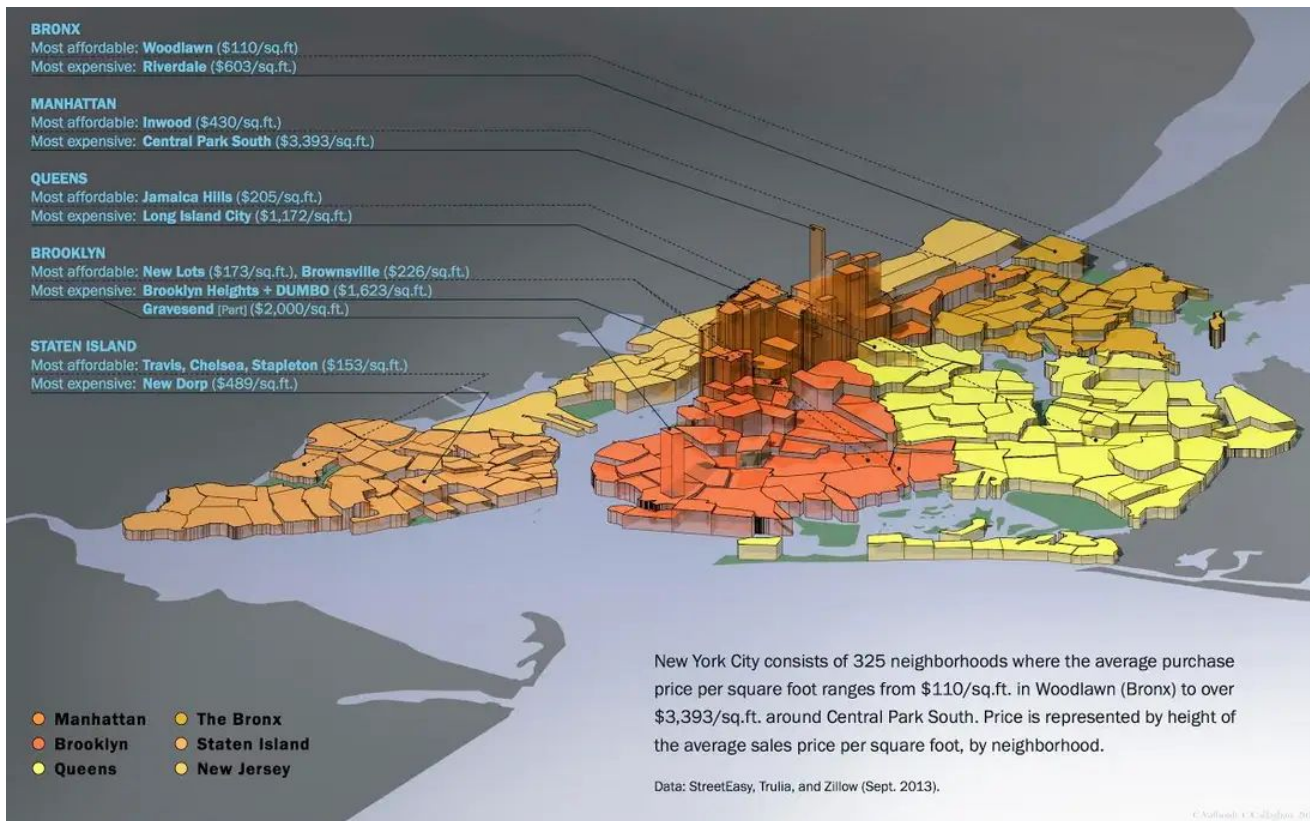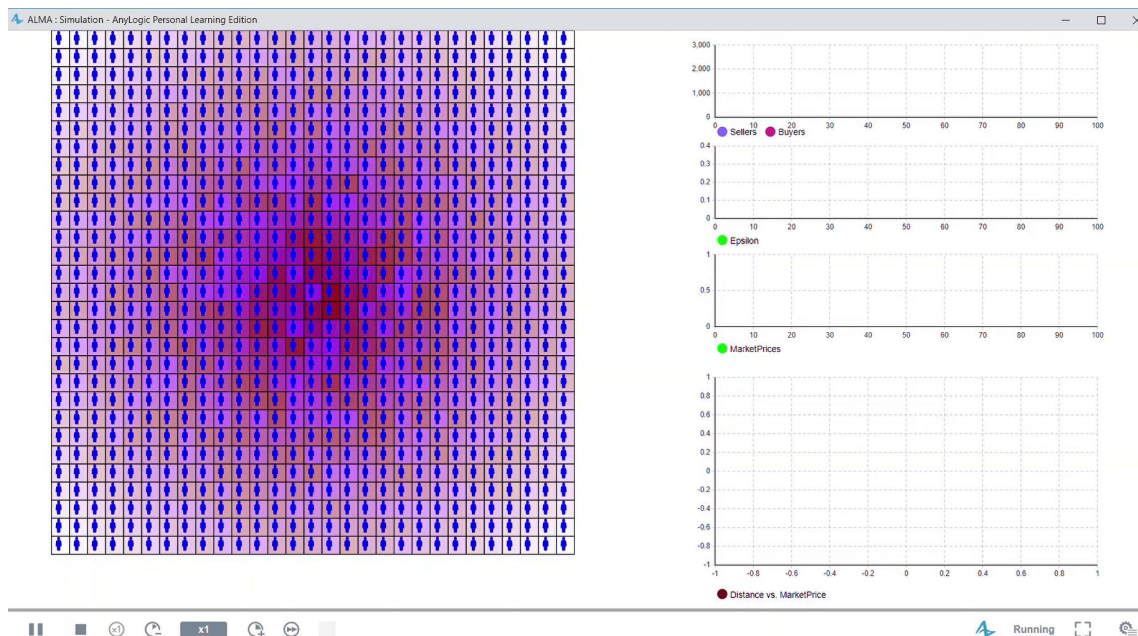[4] Kongju National University Gongju-si, Chuncheongnam-do, South Korea
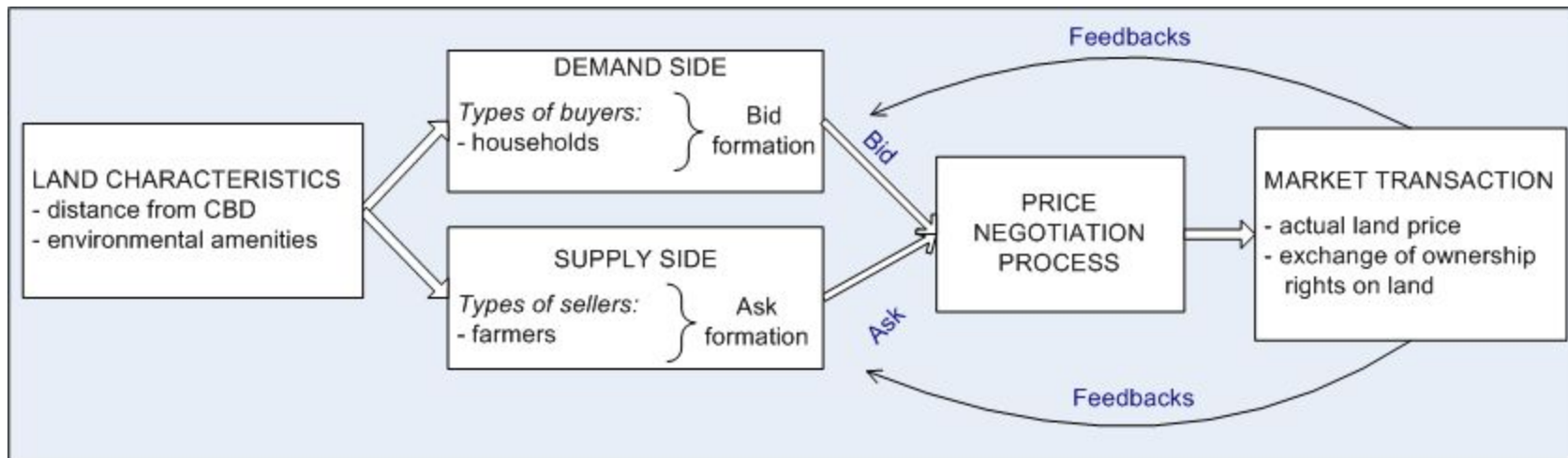
Bid-Rent Theory

Bid-Rent IRL

Bid-Rent is generally a decent predictor, but not entirely accurate.

BRONX
Most affordable: **Woodlawn** ($110/sq.ft)
Most expensive: **Riverdale** ($603/sq.ft.)

MANHATTAN
Most affordable: **Inwood** ($430/sq.ft.)
Most expensive: **Central Park South** ($3,393/sq.ft.)

QUEENS
Most affordable: **Jamaica Hills** ($205/sq.ft.)
Most expensive: **Long Island City** ($1,172/sq.ft.)

BROOKLYN
Most affordable: **New Lots** ($173/sq.ft.), **Brownsville** ($226/sq.ft.)
Most expensive: **Brooklyn Heights + DUMBO** ($1,623/sq.ft.)
                Gravesend [Part] ($2,000/sq.ft.)

STATEN ISLAND
Most affordable: **Travis, Chelsea, Stapleton** ($153/sq.ft.)
Most expensive: **New Dorp** ($489/sq.ft.)

● **Manhattan**   ● **The Bronx**
● **Brooklyn**   ● **Staten Island**
● **Queens**   ● **New Jersey**

New York City consists of 325 neighborhoods where the average purchase price per square foot ranges from $110/sq.ft. in Woodlawn (Bronx) to over $3,393/sq.ft. around Central Park South. Price is represented by height of the average sales price per square foot, by neighborhood.

Data: StreetEasy, Trulia, and Zillow (Sept. 2013).

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Image Source: https://www.businessinsider.com/new-york-city-real-estate-prices-3d-map-2015-1

Agent-based Land MArket (ALMA)
work done by Tatiana Filatova, Dawn Parker, and Anne van der Veen

Papers: https://doi.org/10.1016/j.compenvurbsys.2008.09.012 and http://jasss.soc.surrey.ac.uk/12/1/3.html

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Model Overview

$$\epsilon = \frac{NB - NS}{NB + NS}$$

Image Source: http://jasss.soc.surrey.ac.uk/12/1/3.html

ALMA Results

ALMA was able to produce a rent gradient, measured by the linear regression between land value and proximity.
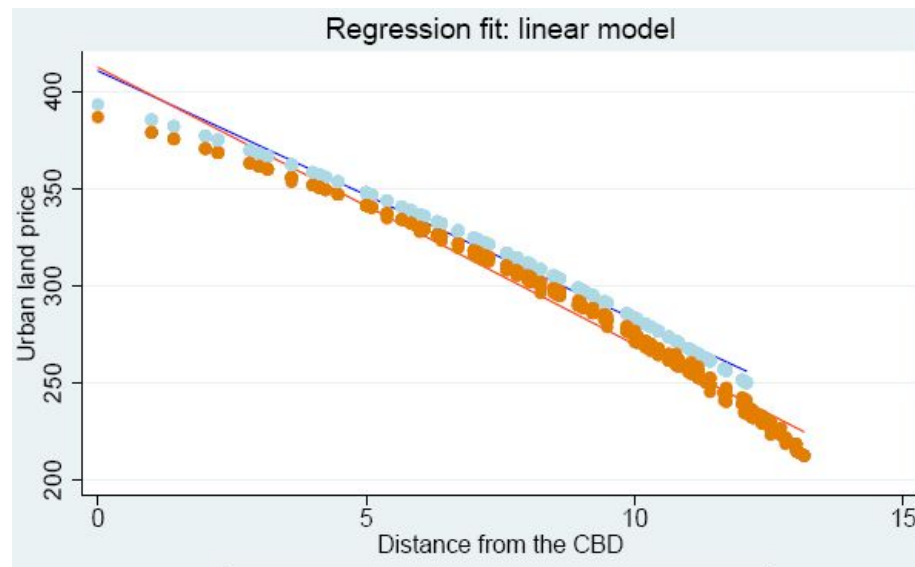
ALMA's Assumptions

- All agents have identical preferences and budgets
  - This means all utility functions are the same

- All cells have the same level of environmental amenities
  - This means buyers never face a trade-off between amenities and proximity. Therefore they will always seek to maximize proximity and disregard amenities entirely.

Does the ALMA model work under diverse buyer preferences and market compositions?

$z = A^\alpha \times P^\beta$ for P=1.0

$$U = A^\alpha \times P^\beta$$
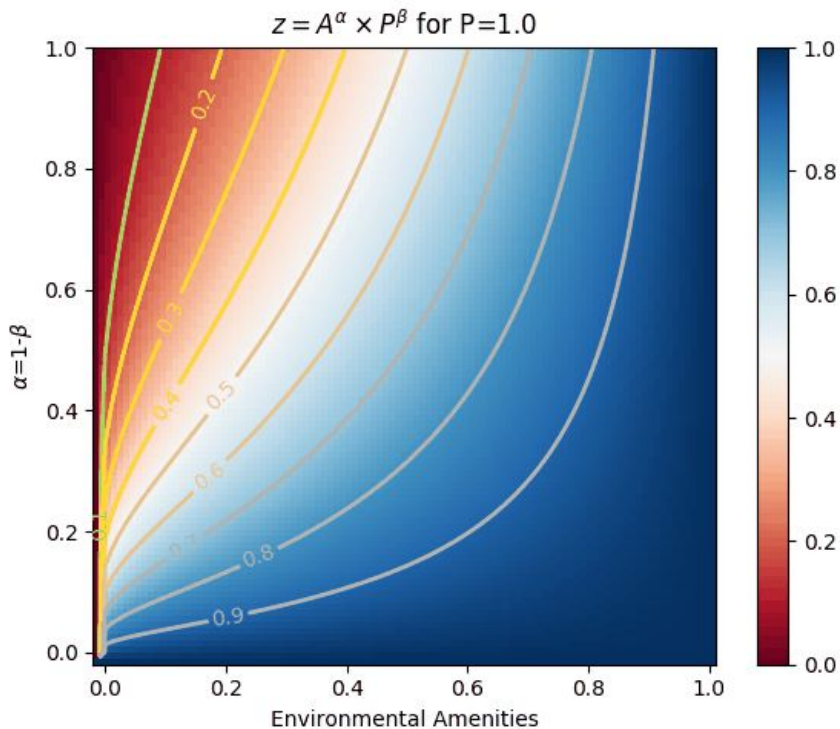
Preference for Green Amenities

Preference for Proximity

Utility (Usefulness)

Green Amenities

Normalized Proximity

Utility in ALMA

Weakening Assumptions

- **Heterogeneity in Buyers**:

    – The preference for amenities is drawn from a uniform distribution [0, $α_{max}$].

    – The housing budget is drawn from a uniform distribution [800, 1000]

- **Variation in Cells** - amenities are uniformly distributed [0, 1].

- **Tested a wider variety of market compositions**

    – Parameterized ratio between number of buyers and sellers → Buyer Level
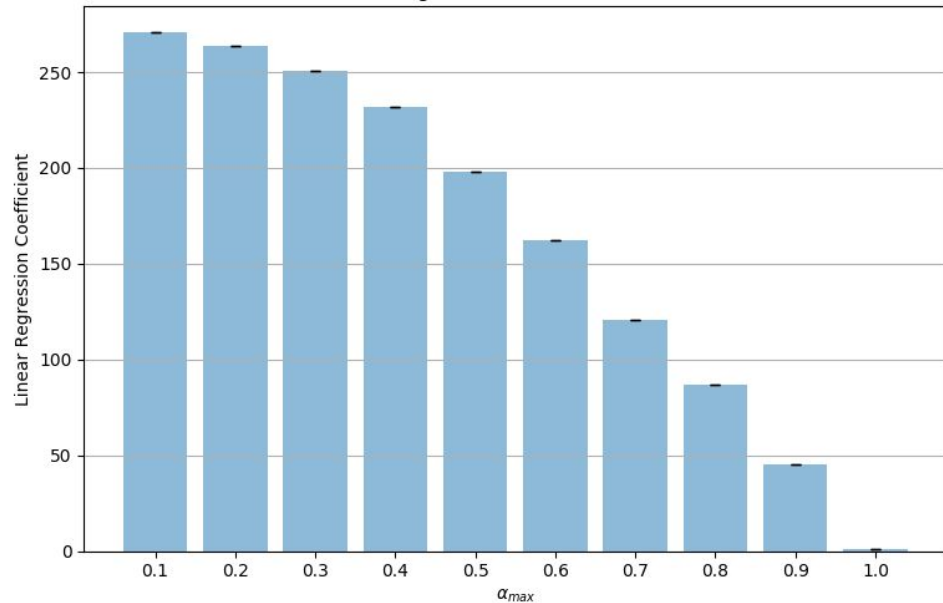
Percentage of Homes Sold vs. Buyer Level
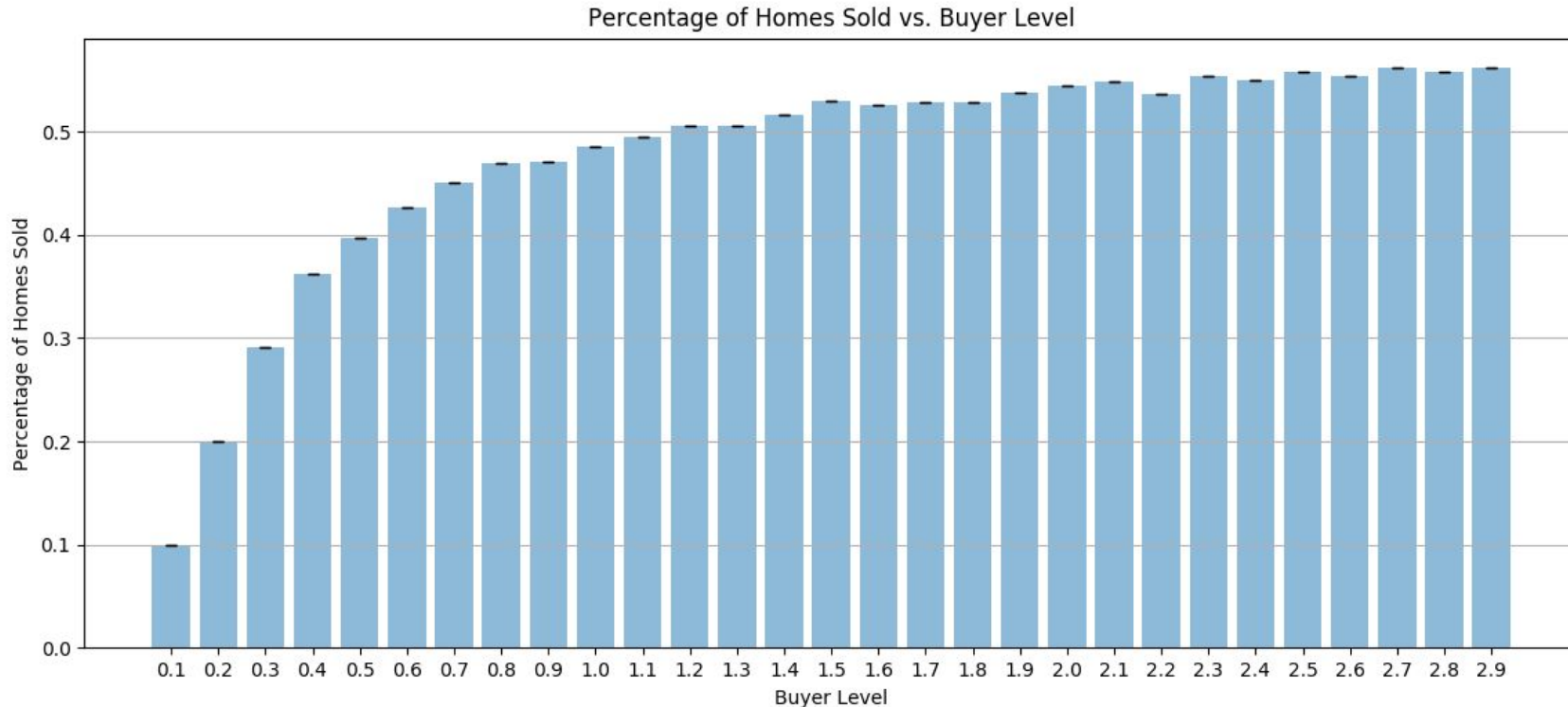
Percentage of Homes Sold

α_{max} and α_{max} with Buyer Level vs. % Sold

Percentage of Homes Sold vs. α_{max}

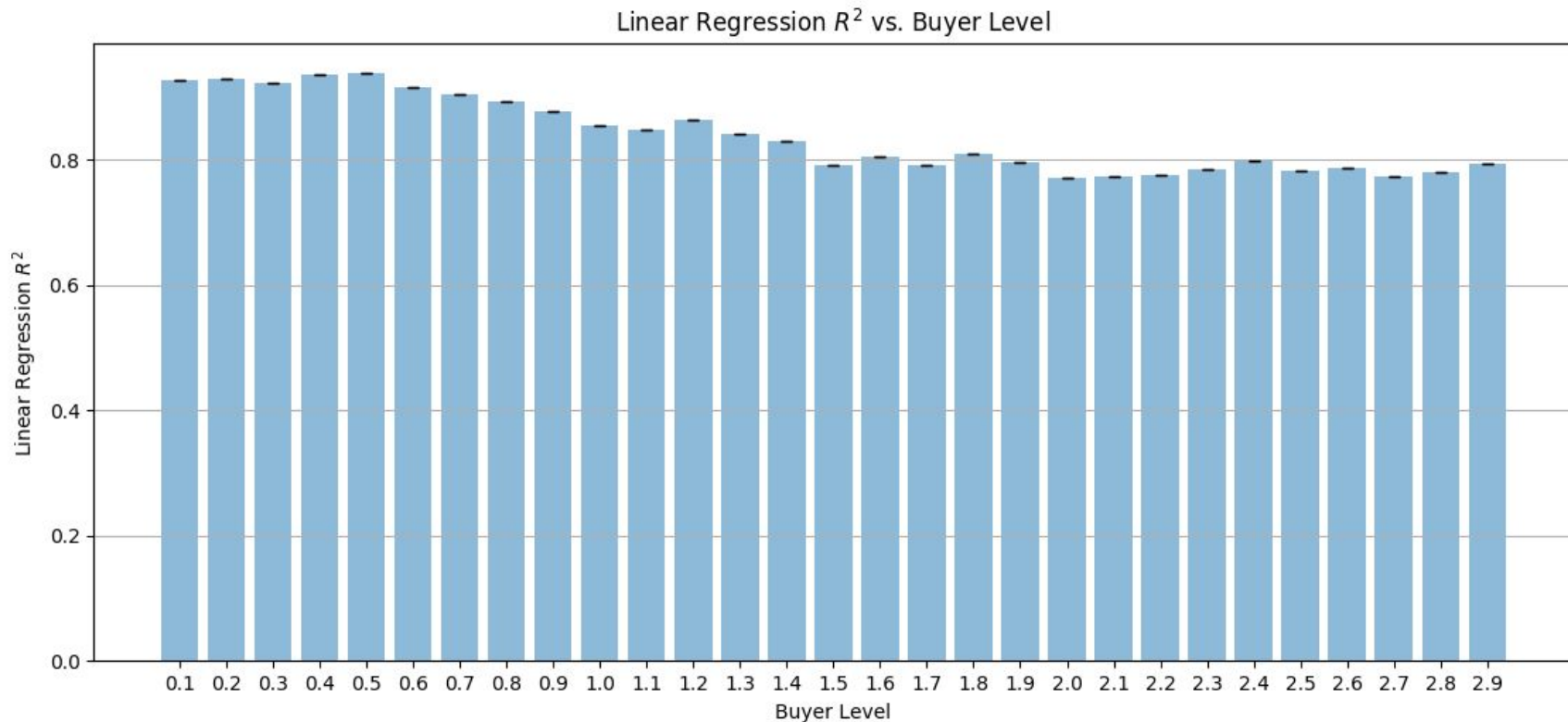α_{max} and Buyer Level Affect on Percent Sold
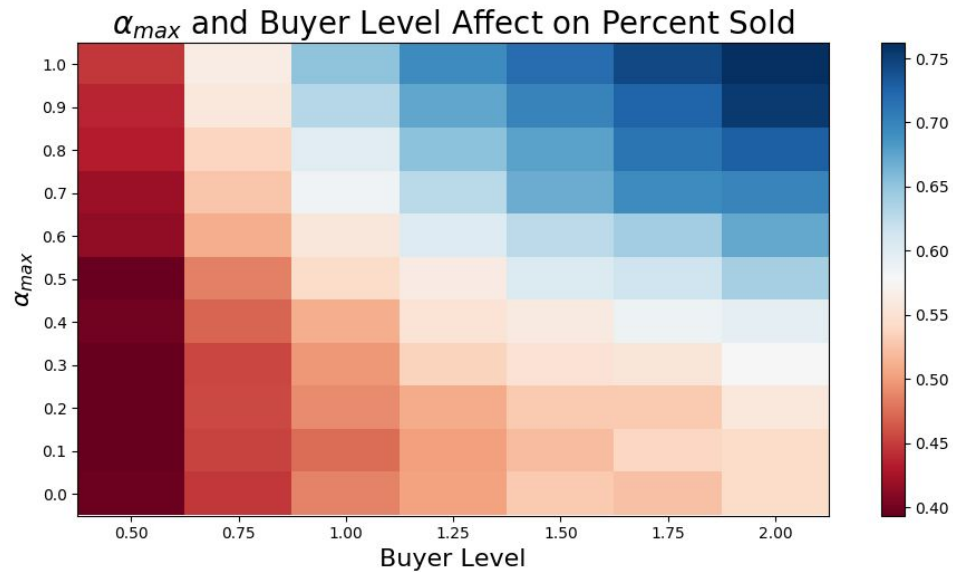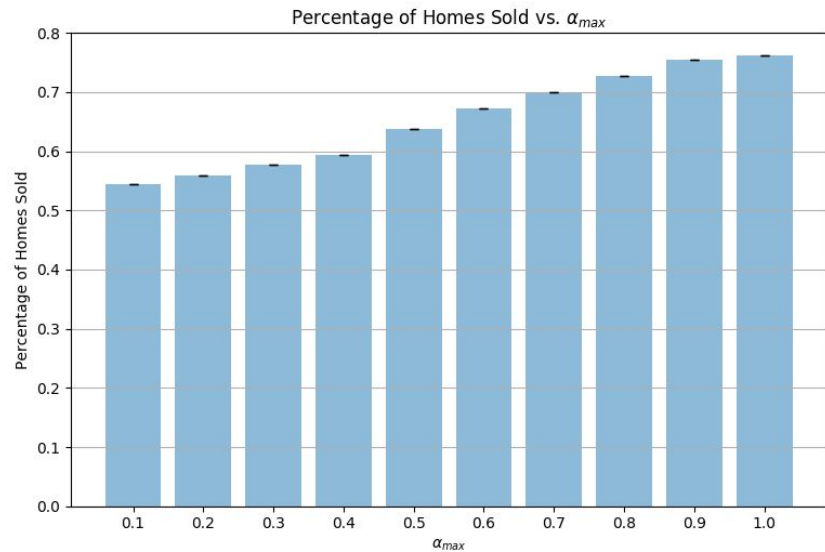
How is the rent gradient is affected by $\boldsymbol{\alpha}_{max}$?

Linear Regression Coefficient vs. Buyer Level
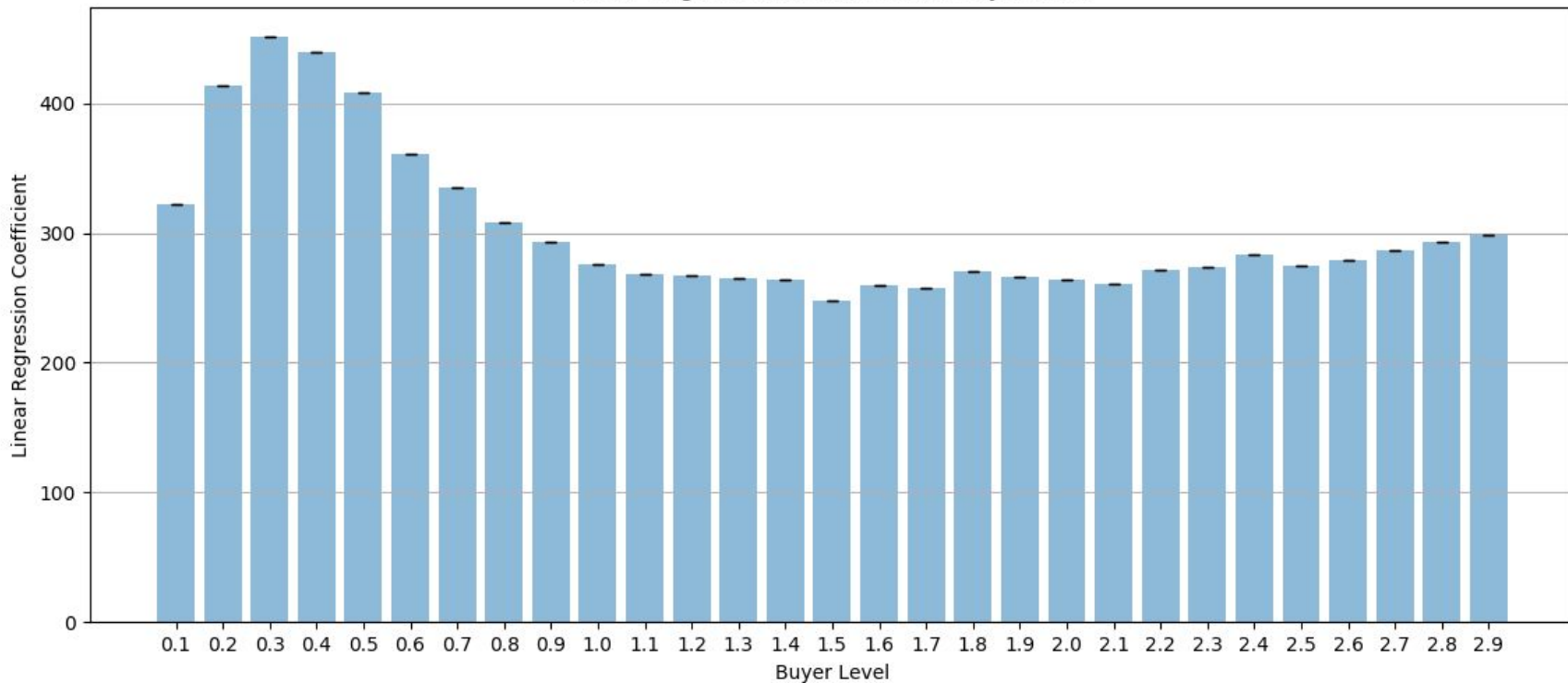
How is the rent gradient affected by buyer level?

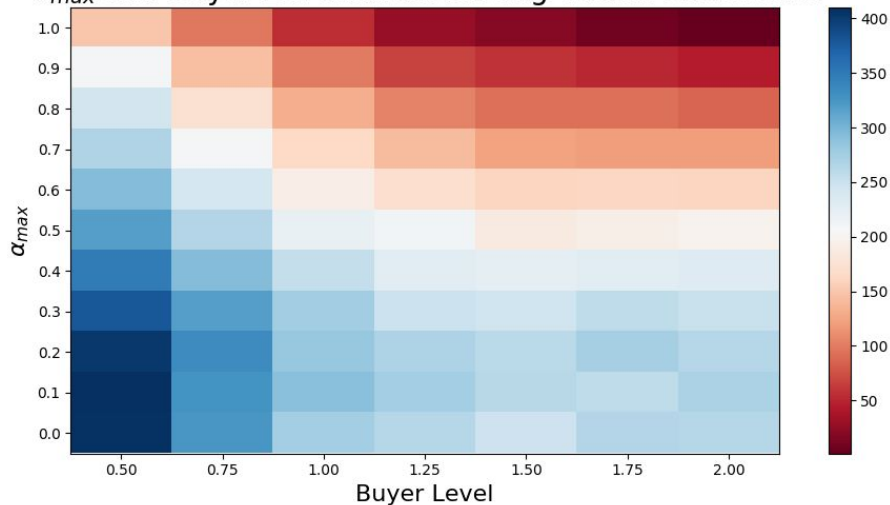Linear Regression R^2 vs. Buyer Level

How is the rent gradient affected by buyer level?
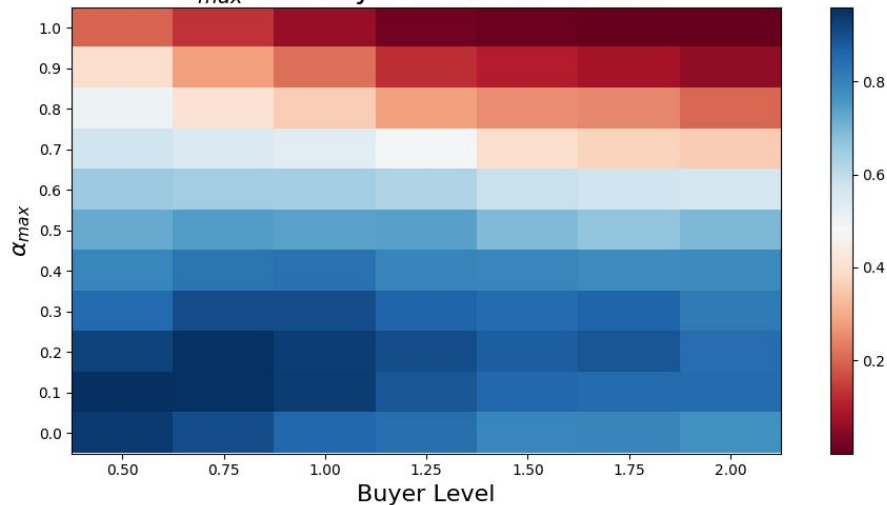
α_{max} and Buyer Level vs. Rent Gradient

α_{max} and Buyer Level Affect on Regression Coefficient

α_{max} and Buyer Level Affect on R^2

Future Directions

- Find more data for model verification/validation!
- More rigorous sensitivity analysis
- Expanded models
    - coupled housing and land markets (CHALMS)
    - models that include commerce and industry
- Exploring models of polycentricity
    - Losch's model of location

References

Dawn Cassandra Parker, Tatiana Filatova, "A conceptual design for a bilateral agent-based land market with heterogeneous economic agents." Computers, Environment and Urban Systems,Volume 32, Issue 6, 2008. https://doi.org/10.1016/j.compenvurbsys.2008.09.012.

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Nicholas Magliocca, Elena Safirova, Virginia McConnell, and Margaret Walls. 2011. An economic agent-based model of coupled housing and land markets (CHALMS). Computers, Environment and Urban Systems 35, 3 (2011), 183 – 191. https://doi.org/10.1016/j.compenvurbsys.2011.01.002

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W. Alonso. 1964. Location and land use: toward a general theory of land rent. Harvard University Press. https://books.google.com/books?id=-E9ZmQEACAAJ

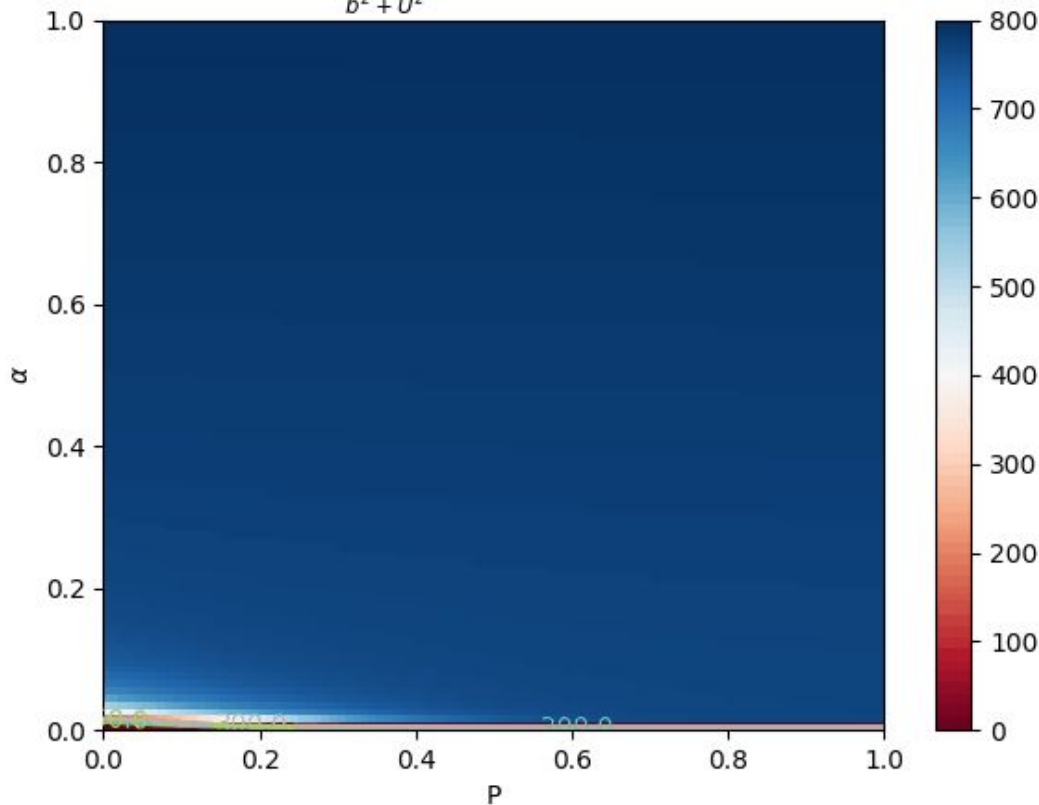# Questions?

Email: michels9@illinois.edu

Willing to Pay (WTP)

$$WTP = \frac{Y \cdot U^2}{b^2 + U^2} \text{ for A=1 and b=0.02}$$

Recall:

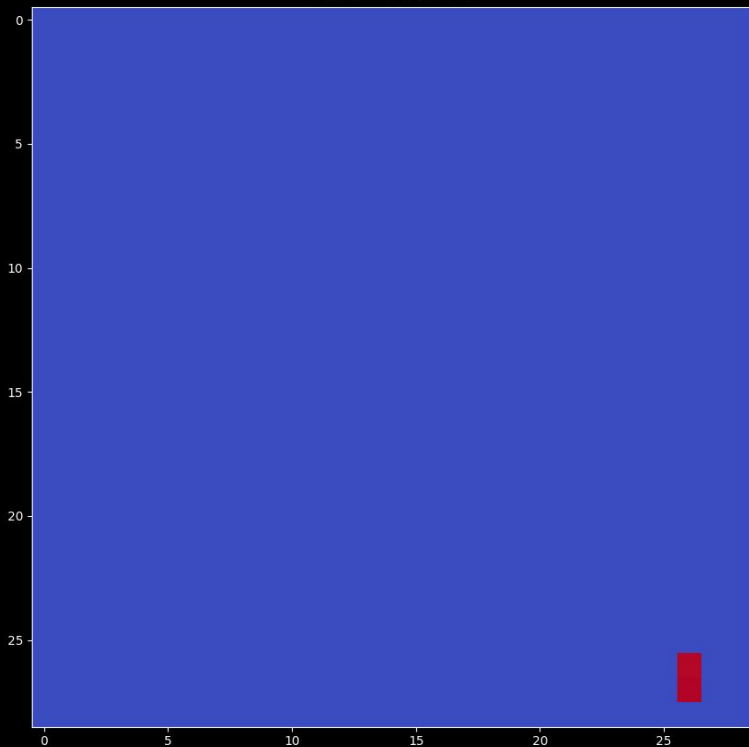- b - "affordability"
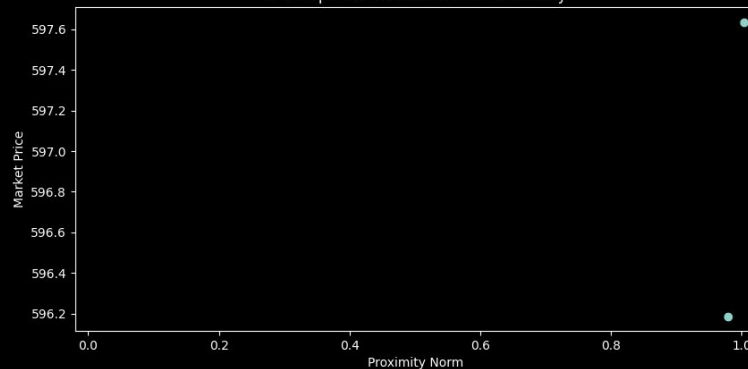- Y - budget

$$U = A^{\alpha} \times P^{\beta}$$

Preference for Green Amenities → A^{α}

Preference for Proximity → P^{β}

Utility (Usefulness) → U

Green Amenities → A

Normalized Proximity → P

20
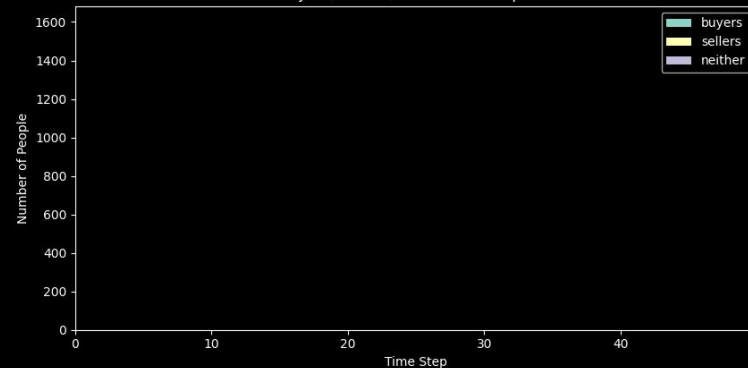
Polycentricity in the ALMA Model