Green Development within Urban Environments

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Review

Research Question

What characteristics of urban neighborhoods relate to the number of certified green commercial buildings?

Previously,

- Spatial equilibrium model of firm sorting and green building adoption
- Missing: Clear equilibrium, specific prediction, testable prediction

Overview

Today's Goal

Continue to investigate last week's model by clarifying its predictions and beginning to consider it empirically.

1. Model Review & Refinement
2. Simulation
3. Towards Empirical Work

Model Review & Refinement

Model Environment & Overview

$\mathcal{N}$, a set of neighborhoods:

- Fixed number of workers N
- Ex ante, N is the only difference between neighborhoods
- Fixed amount of commercially developable land

Sorting Model: Where do different firms locate?

Adoption Model: Which firms go green?

Agents

Firms:

- Choose inputs (labor, real estate), design of real estate (green/brown), and neighborhood (N)
- Differ by:
  - Agglomeration Economies (sector)
  - Green Benefits (individual firms)

Developer:

- Chooses height, land footprint for green and brown buildings
- Higher material costs for green construction

Sorting

1. Firms with higher Agglomeration Economies locate in larger (higher N) neighborhoods

2. Firms do not sort based on their Green Benefits

3. Within neighborhoods:
   - Agglomeration Economies are homogeneous
   - Firms differ only in their Green Benefits ($High$, Low)

Green Adoption

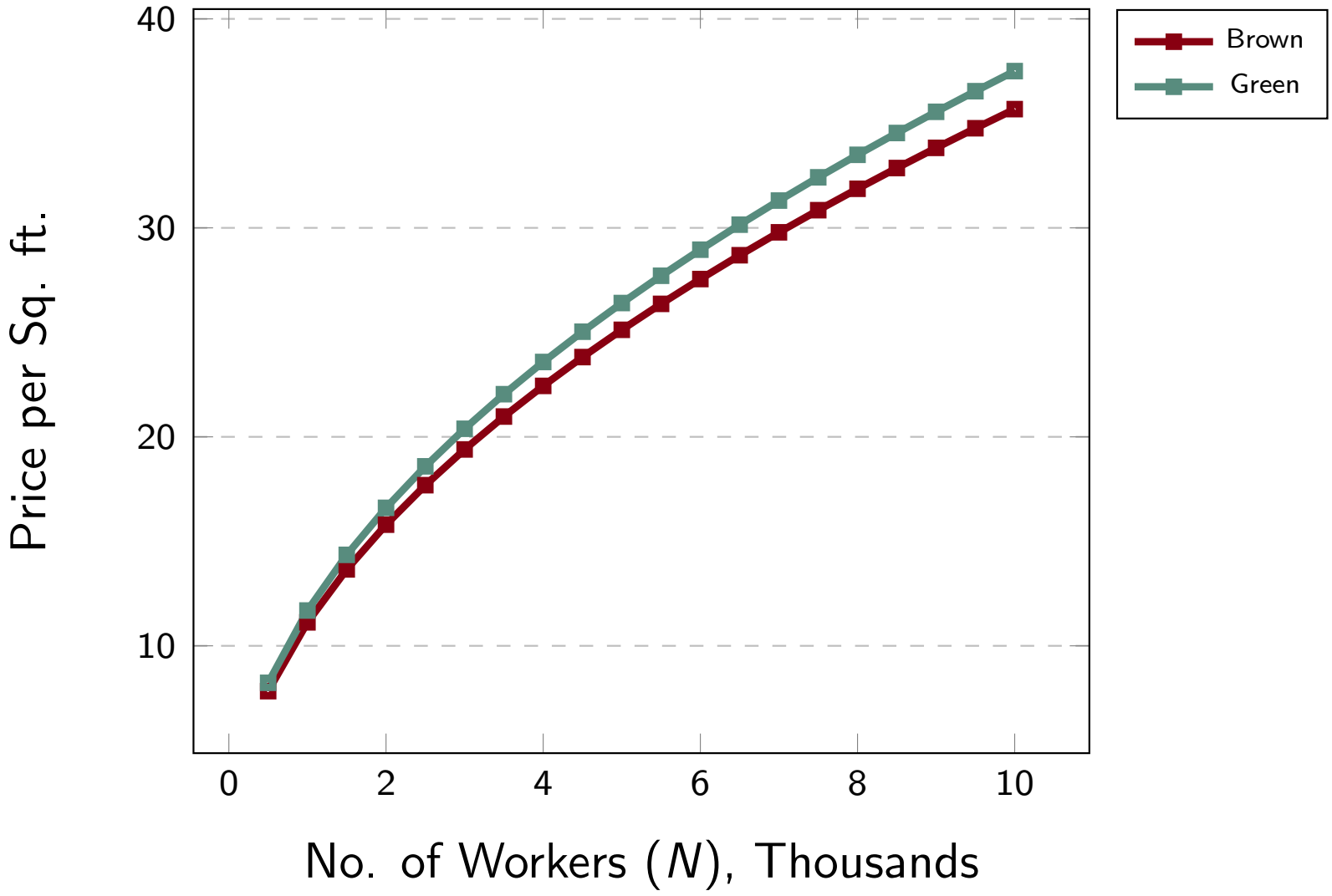
Differences in the proportion of Green real estate between neighborhoods come from the distribution of firm types:

Scenario #1: All Firms are equally likely to have a high Green Benefit

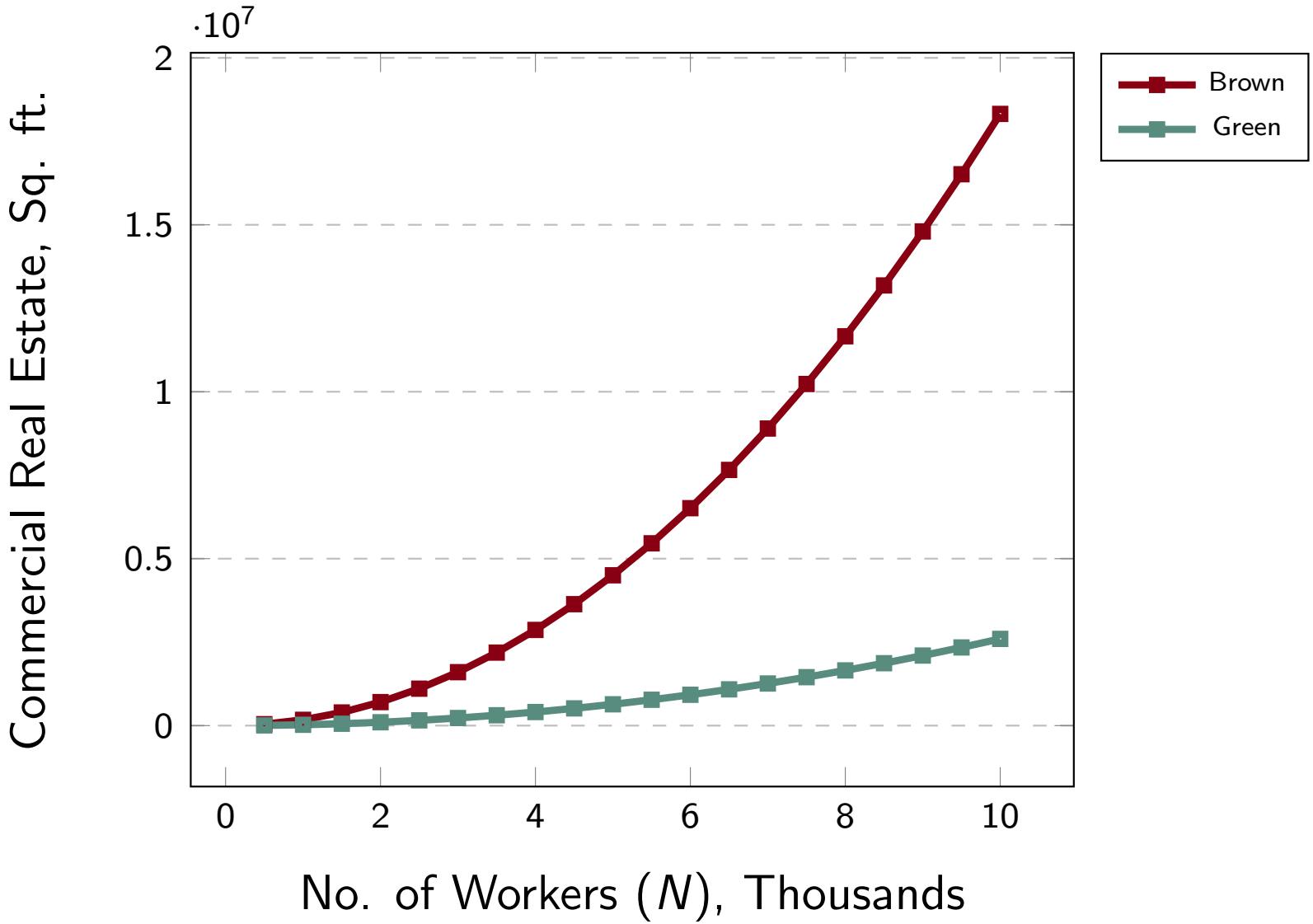
Scenario #2: Higher Agglomeration Economy Firms are more likely to have a high Green Benefit

Simulation

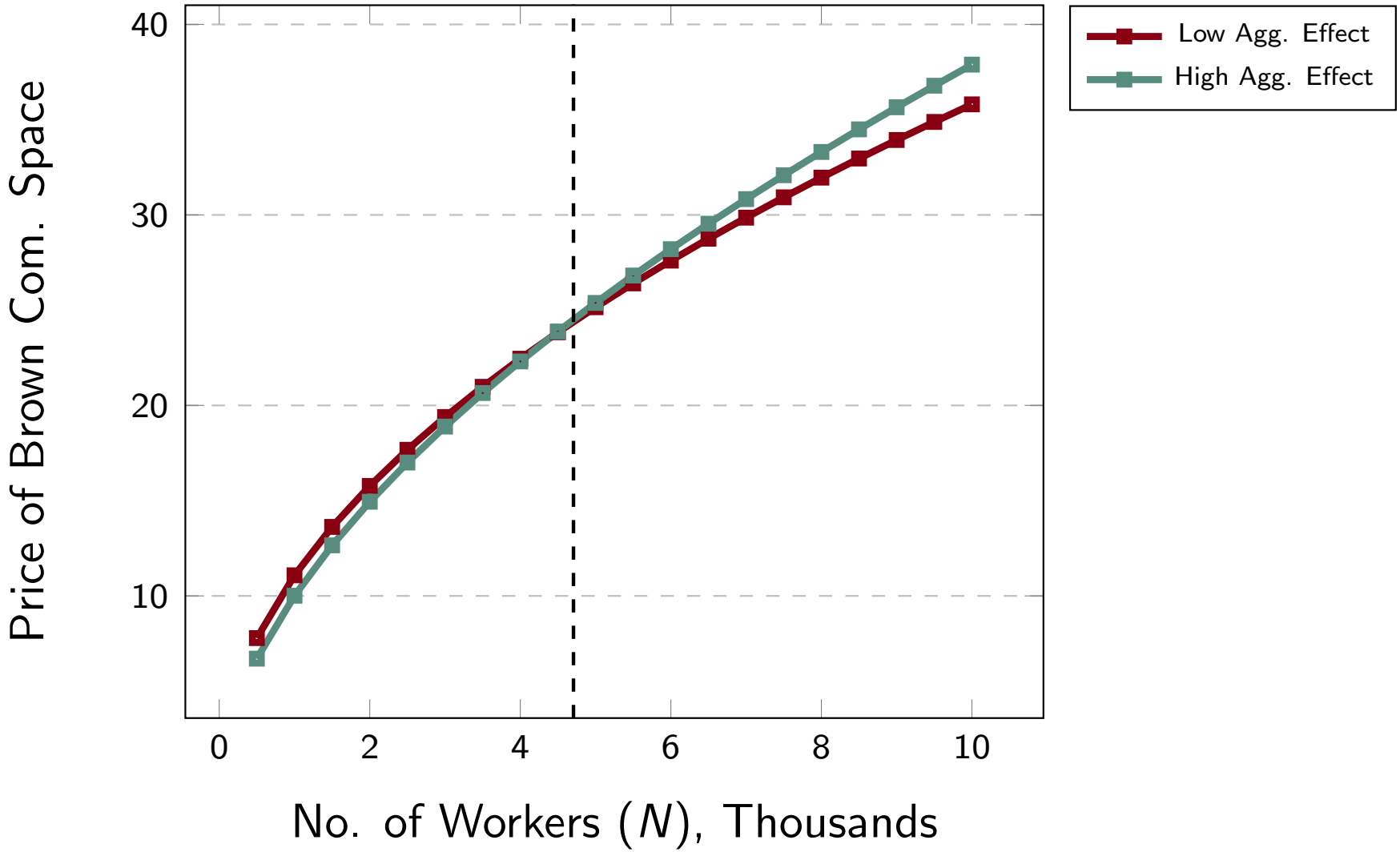
Price of Commercial Real Estate



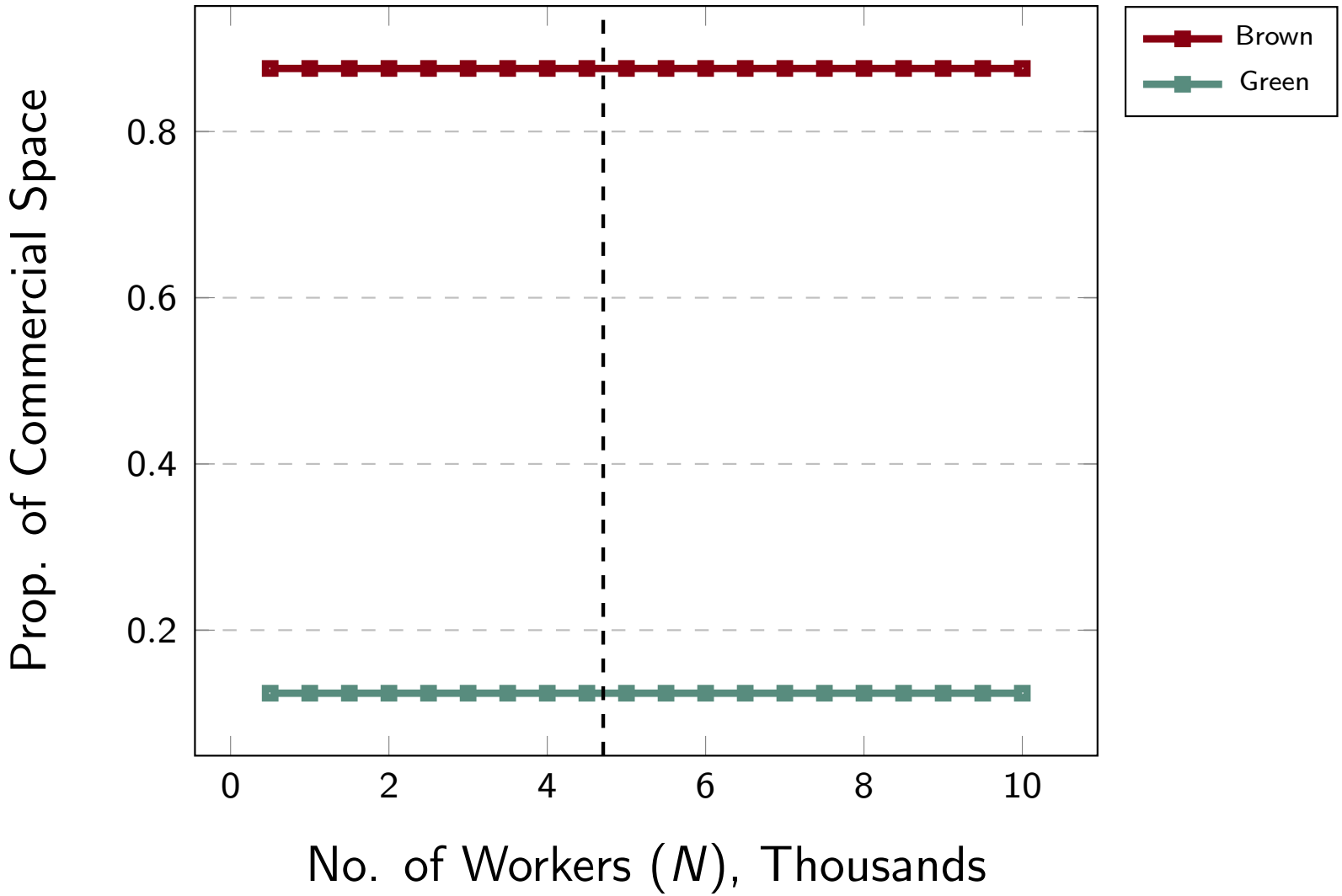
Commercial Space



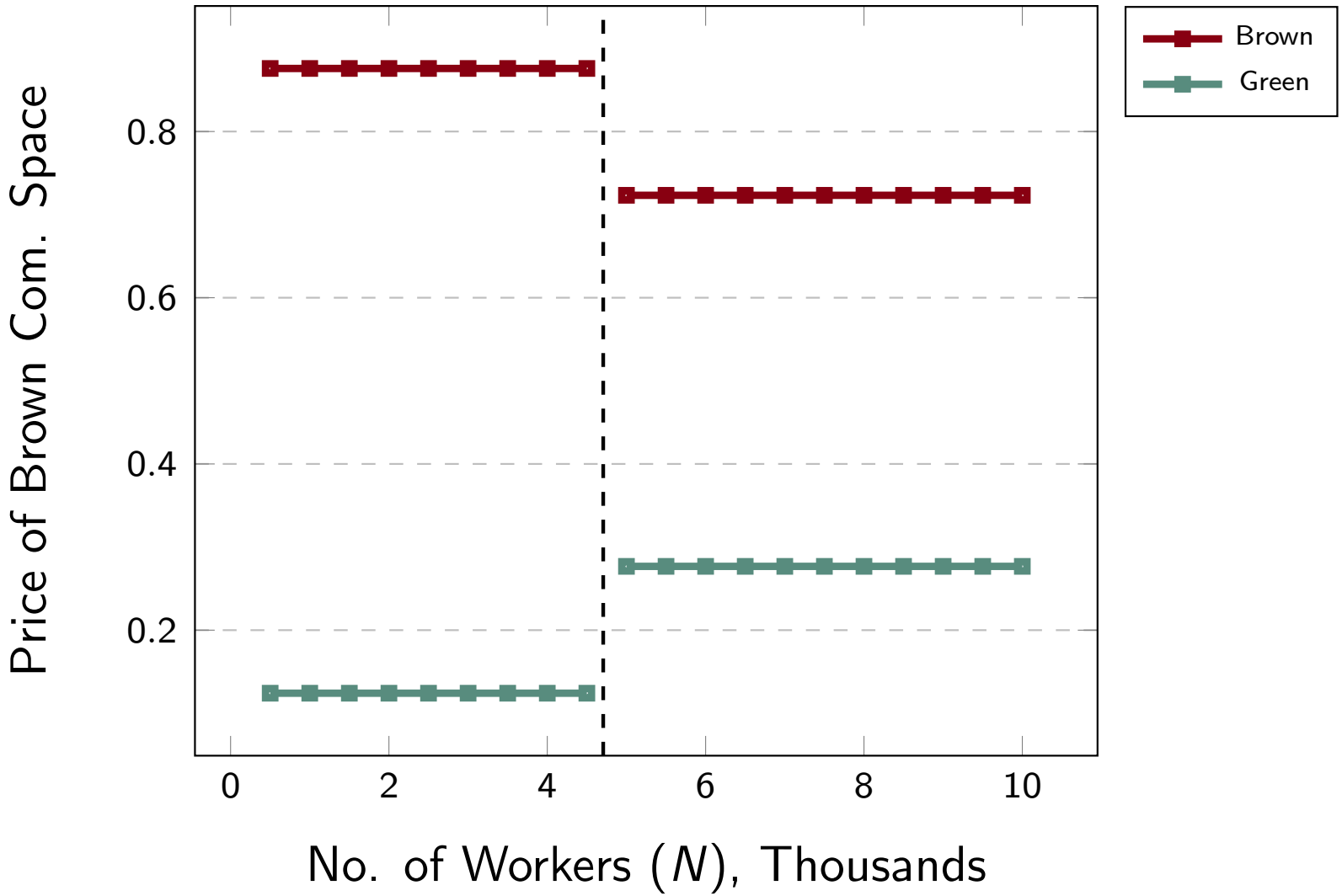
Firm Sorting



Scenario #1


Brown
Green
Prop. of Commercial Space
0.8
0.6
0.4
0.2
0
2
4
6
8
10
No. of Workers (N), Thousands

Scenario #2


Brown
Green
Price of Brown Com. Space
0.8
0.6
0.4
0.2
0
2
4
6
8
10
No. of Workers (N), Thousands

Towards Empirical Work

A Regression?

If sector i inhabits a neighborhood, then

$$\log(Rg) = \beta_0 + \beta_1 \log(N) + \beta_2 \log(\Psi_i(N)) + \beta_3 \log(\alpha_1 \mu_i + \alpha_2(1 - \mu_i)) + \beta_4 \log\left(\alpha_3 \left(\frac{1 - \mu_i}{\mu_i}\right) + 1\right)$$

R_g	Quantity of Green Real Estate
N	No. of Workers
Ψ_i	Agglomeration Effect for Industry i
μ_i	Proportion of High Green Benefit Firms in i
α, β's	Constants

Continued Work

Model Modifications and Extensions:

- Economies of Scale in Green Construction
- Dynamic Model
- Connect Agglomeration and Green Benefits

Empirically:

- Move towards variables that are measurable and known
- Methodologies for estimating unobserved costs/benefits

References

Gaubert, Cecile, "Firm sorting and agglomeration," *American Economic Review*, 2018, *108* (11), 3117–53.

Glaeser, Edward Ludwig, *Cities, agglomeration, and spatial equilibrium*, Oxford University Press, 2008.

Appendix

Firm Problem

Choose inputs (*Number of workers*, *Real estate*), Design (g, b), and neighborhood (N):

$$\max_{L,R,d,N} \left\{ \Psi_i(N) \lambda_{jd} L^{\beta} R^{\gamma} \bar{K} - \bar{W} N - p_d R - k_i \right\}$$

Ψ_i	Agglomeration effect to firm type i
λ	Benefit from design d to firm type j
$\bar{K}$	Fixed (tradeable) capital inputs
W	Wage
p_d	Price per sq.ft. with design d
k_i	Fixed capital cost for firm type i

Developer Problem

Chooses *height* and *land* for both green and brown real estate, subject to its land use constraint:

$$\max_{h_g, h_b, \ell_g, \ell_b} \{\pi_g(h_g, \ell_g) + \pi_b(h_b, \ell_b)\} \quad \text{s.t.} \quad \bar{\ell} = \ell_g + \ell_b$$

where

$$\pi_d(h, \ell) = p_d h \ell - c_d h^{\delta} \ell - p_\ell \ell$$

Assume $c_g > c_b$ and $\delta > 1$

Equilibrium Conditions

1. Labor Market Clearing
2. Green Real Estate Market Clearing
3. Brown Real Estate Market Clearing
4. Spatial Equilibrium Condition for Green Firms
5. Spatial Equilibrium Condition for Brown Firms

We derive these from the agents' problems and then proceed to solve the system of equations they create