Parcel Assembly

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Toronto in 1903

Toronto Right Now

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Key components of the model

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- Each landowner offers price $p(i, x)$ to maximize

$$\max_{p(i,x)} \underbrace{\left[1 - F[\nu^\star(x)]\right] p(i,x)}_{\text{Sale successful}} + \underbrace{F[\nu^\star(x)] r(x) \bar{h}(x)}_{\text{Returns if sale failed}} \tag{1}$$

  where F is the distribution of developer productivity, $\nu^\star$ is the cutoff productivity

Developers

- If sale successful, developer of productivity ν earns

$$\pi(x, \nu) = \nu \kappa(x) r(x)^{1+\epsilon} \tag{2}$$

  and pays a price $\boldsymbol{p}(x) = \sum_i N(i, x) p(i, x)$ to assemble all parcels. Therefore, cutoff productivity $\nu^\star$ solves

$$\boldsymbol{p}(x) = \pi(x, \nu^\star) = \nu^\star \kappa(x) r(x)^{1+\epsilon}$$

- Developers accept all offers when $\nu \geq \nu^\star(x)$

Solution to game for a special distribution

- If $\nu \sim$ Weibull with CDF $F(\nu) = 1 - e^{-\sigma\lambda\nu^{\frac{1}{\sigma}}}$ then offered prices and cutoff productivity take a special form for empirical analysis

$$\boldsymbol{p}(x) = r(x)\bar{h}(x) + \kappa(x)r(x)^{1+\epsilon}\lambda^{-1}\nu^{\star}(x)^{\frac{\sigma-1}{\sigma}}N(x) \tag{3}$$

$$\nu^{\star}(x) = r(x)^{-\epsilon}\kappa(x)^{-1}\bar{h}(x) + \lambda^{-1}\tilde{N}(x)\nu^{\star}(x)^{\frac{\sigma-1}{\sigma}} \tag{4}$$

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- A special case when $\bar{h} = 0$ (land is undeveloped) gets

$$\nu^{\star}(x) = \lambda^{-\sigma}N(x)^{\sigma} \tag{5}$$

$$\boldsymbol{p}(x) = \lambda^{-\sigma}N(x)^{\sigma}\kappa(x)r(x)^{1+\epsilon} \tag{6}$$

$\implies$ σ is the elast. of $N(x)$ to prices $\boldsymbol{p}(x)$, productivity $\nu^{\star}(x)$ and **semi-elast. of development probability**!

Model conclusions

- Model elucidates two key empirical ideas:
  1. Rents $r(x)$ and construction productivity $\kappa(x)$ are confounders to estimate σ
  2. Heterogeneous treatments effects: hold up more severe when rents are higher/construction costs are lower

- Idea: use hyperlocal variation in parcel density, eliminating these cofounders (across streets)

- Get an estimate of σ from this regression using historical and modern parcel maps; allows us to directly answer research question

Data

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- Historical Toronto fire insurance maps (1818, 1858, 1880, 1889, 1903, 1913, 1924)
- Historical aerial imagery (1939, 1947, 1954, 1965, 1978)
- Rental rates by census tract (1961, 1971, 1981, 1991)
- Modern parcels, building footprints, and land use

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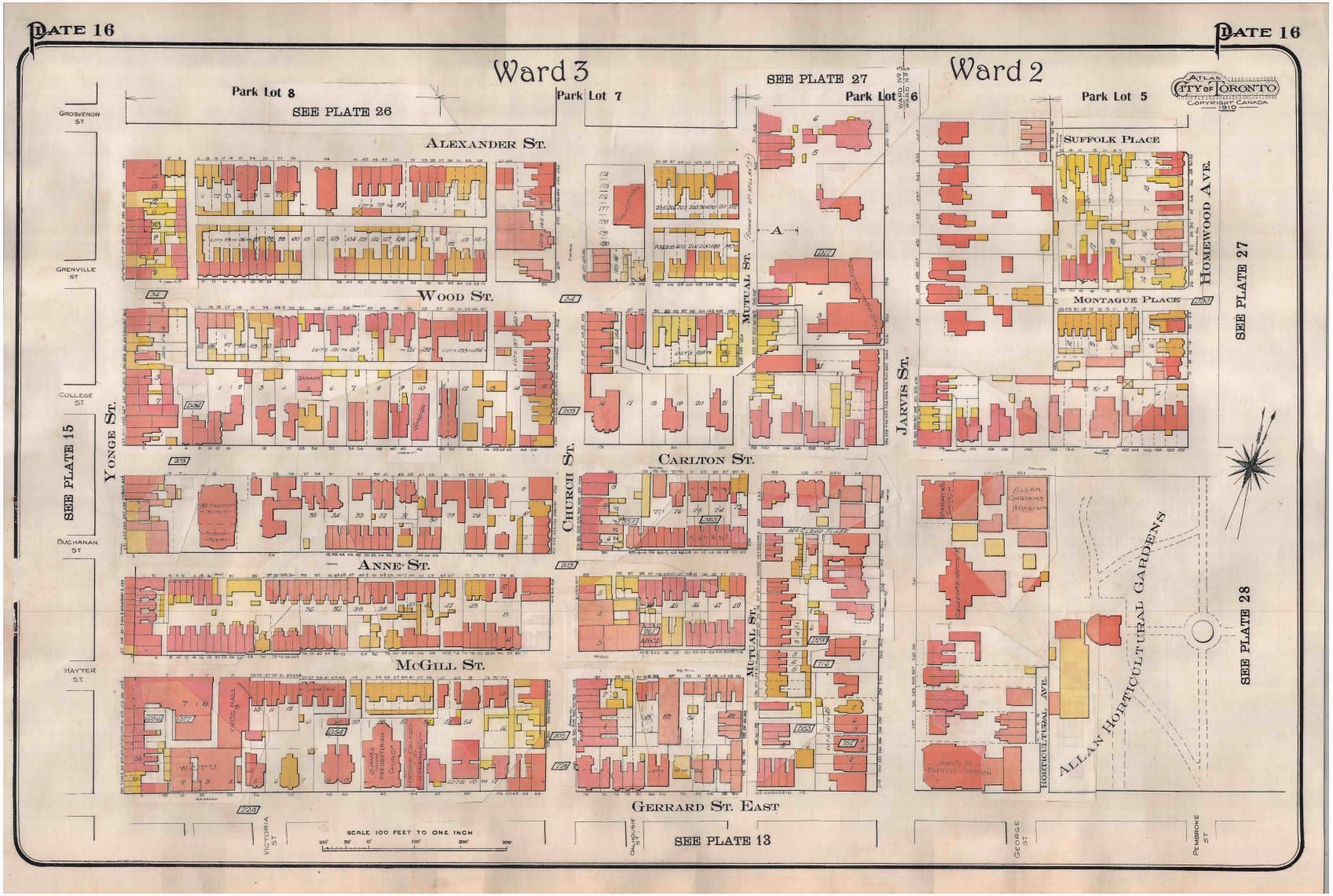
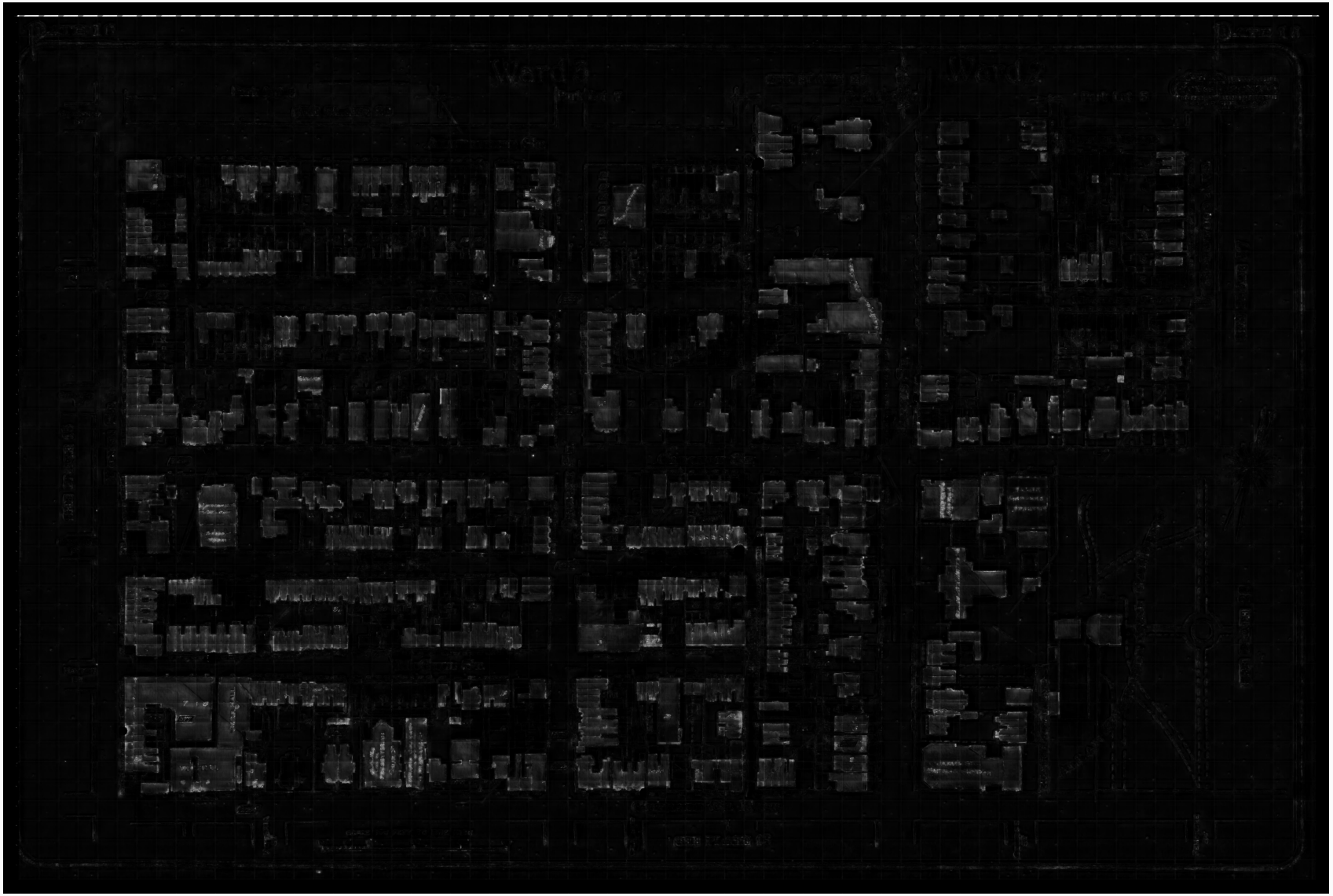
- This is a work in progress

Toronto in 1923



Toronto in 1923



Thank you!