Introduction

- Many local and global shocks challenge the prospects of cities

- In the past and present:
  - Industry shocks (like decline in manufacturing employment)
  - Local shocks (local union regulations)

- In the future:
  - Global shocks with heterogenous local effects (like climate change)

- As a result many cities have seen (and will see) their population shrink considerably
  - Even in contexts where aggregate urbanization is growing
  - Economists have focused mostly on growth not on decline
The Past and Present

In developed countries the structural transformation from manufacturing to services led to the decline of many cities

▶ The Rust Belt in the U.S.
▶ A prominent example is Detroit

Why are industries locating elsewhere?

▶ Urban infrastructure seems to be wasted: Detroit versus San Jose
▶ Badly managed transitions have created a lot of dissatisfaction
▶ City structures and organization are durable

Important to urbanize in a way that takes these costs into account
Recent research has developed a quantitative spatial framework that connects closely to the observed data

- Large numbers of locations with heterogeneous geography, productivity, amenities, local factors
- Trade in goods, migration, and commuting
- Surveyed recently in Redding and Rossi-Hansberg (2016)

We develop and quantify such a model but add residential externalities

- Coordination problem in the residential neighborhood equilibrium leads to multiplicity of local equilibria
- Helps rationalize important features of current allocation
Detroit’s City Structure
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Detroit’s City Structure

- Structure of Detroit was easy to rationalize with standard urban models when city was larger.
- Clearly, this structure is not optimal today:
  - Empty ring between downtown and thriving residential areas.
  - Commuting could be reduced by bringing residents closer to their jobs.
- Part of the persistence of this suboptimal structure can be attributed to housing durability (as in Glaeser and Gyurko, 2005).
- But many empty lots have not generated large investments, yet:
  - Since 1980, 131245 units have been demolished.
- Coordination problems: Multiple local/neighborhood equilibria within cities that depend on resident and developer coordination:
  - Facilitated by radial highways constructed for a city four times its current size.
The Model

- The city consists of a set of $J$ areas located on a two dimensional surface.

- We denote by $\overline{T}_j^b \geq 0$ the total area of business land and $\overline{T}_j^r$ the total area of land zoned for residential purposes.

- Four types of agents live and do business in the city:
  - Firms that produce consumption goods
  - Individuals
  - Residential developers
  - Absentee landlords of business land
Firms

- Production per unit of land in the business district of location \( j \) is given by

\[
\frac{Y_j}{T_j^b} \equiv y_j = a(l_j; j) l_j^\beta = \left( A_j l_j^\alpha \right) l_j^\beta
\]

where \( l_j = \frac{L_j}{T_j^b} \)

- \( a(l_j; j) \) is an externality that firms take as given
  - We assume that \( 1 - \beta > \alpha \) to guarantee that local labor demand is downward sloping

- Firm maximization implies that

\[
L_j = \left( \frac{A_j \beta}{w_j} \right)^{\frac{1}{1-\beta-\alpha}} T_j^b
\]

- Firms compete for land and are willing to bid for business land at \( j \) until they make zero profits. Hence,

\[
q_j^b = (1 - \beta) A_j^{\frac{1}{1-\beta-\alpha}} \left( \frac{\beta}{w_j} \right)^{\frac{\beta+\alpha}{1-\beta-\alpha}}
\]
Individuals

- The problem of an individual that lives in location $j$ and works in $i$ is

$$U_{ij}(s) = \max_{C_{ij}, H_{ij}} \frac{s B(R_j; j)}{\kappa_{ij}} \left( \frac{C_{ij}(s)}{\gamma} \right)^{\gamma} \left( \frac{H_{ij}(s)}{1 - \gamma} \right)^{1-\gamma}$$

s. t. $w_i = q_j^r H_{ij}(s) + C_{ij}(s)$

where

- Commuting costs are given by $\kappa_{ij} \geq 1$, with $\kappa_{jj} = 1$
- Residential amenities at location $j$ are given by $B(R_j; j) = R_j^{\sigma_j}$ with $\sigma_j > 1 - \gamma$ for all $j$
  - Neighborhood demand by residents is an increasing function of the number of residents
- Individual have idiosyncratic preferences for residing in location $j$, and working in location $i$; $s$ is drawn from a Fréchet distribution

$$\Pr(s_{ij} \leq s) = e^{-\lambda_{ij}s^{1-\theta}}$$
Commuting Patterns

- Individuals can move in and out of the city freely and obtain utility $\bar{u}$ elsewhere.

- Let $\pi_{ij}$ represent the proportion of residents living in $j$ that commute to $i$. Then

$$\pi_{ij} = \Pr \left[ U_{ij} > \max_{n \neq i} \{ U_{nj} \} \right]$$

and so

$$\pi_{ij} = \frac{\lambda_{ij} \left( \frac{w_i}{\kappa_{ij}} \right)^\theta}{\sum_{n=1}^{J} \lambda_{nj} \left( \frac{w_n}{\kappa_{nj}} \right)^\theta}$$
Resident Entry

- Equilibrium in the residential market $j$ implies that $R_j H_j = T^r_j$ and so residential land rents are such that

$$q^r_j = \frac{(1 - \gamma) R_j}{T^r_j} \sum_{i=1}^{J} \pi_{ij} w_i$$

- Thus, if an area within the city has a positive number of residents it must be the case that $U_j \geq \bar{u}$, or

$$R_j \geq \left( \frac{\bar{u} (1 - \gamma)^{1-\gamma} \left\{ \sum_{i=1}^{J} \pi_{ij} w_i \right\}^{1-\gamma}}{\Gamma \left( \frac{\theta - 1}{\theta} \right) \left( T^r_j \right)^{1-\gamma} \left[ \sum_{i=1}^{J} \lambda_{ij} \left( \frac{w_i}{\kappa_{ij}} \right)^\theta \right]^{\frac{1}{\theta}}} \right)^{\frac{1}{\sigma_j + \gamma - 1}}$$

- This is the resident entry condition
Residential Developers

- Large number of small residential developers, none of whom is large enough to internalize residential externalities
- Residential developers then maximize

\[ \Pi_j = \max_{h_j} h_j q_j^r - V(h_j) - F_j = \max_{h_j} h_j q_j^r - Vh_j^Y - F_j \]

with \( v > 1 \)
- Developers enter as long as profits are non-negative or

\[ R_j \geq \frac{vV \left( \frac{F_j}{(v-1)V} \right)^{\frac{v-1}{v}}}{(1 - \gamma) \sum_{i=1}^{J} \pi_{ij} w_i} T_j^r \]

- This is the developer entry condition
Residential and Labor Market Equilibrium

- Equilibrium in the residential market implies that
  \[ n_j h_j = R_j H_j = T'_j \]
  where \( n_j \) is the number of active residential developers

- In equilibrium
  \[ n_j = \left( T'_j \right)^{\frac{v}{v-1}} \left( \frac{1 - \gamma}{vV} R_j \sum_{i=1}^{J} \pi_{ij} w_i \right)^{\frac{1}{v-1}} \]
  if developers make non-negative profits and \( n_j = 0 \) otherwise

- Equilibrium in the labor market is guaranteed when
  \[ L_i = \sum_{j=1}^{J} \pi_{ij} R_j \text{ for all } i \in J, \]
Neighborhood Residential Equilibrium: Partially Developed

\[ R_j \]

Developer Entry

Resident Entry

\[ T_j \]

\[ \bar{T}_j^r \]

\[ T_j^r \]
Neighborhood Residential Equilibrium: Fully Developed

\[ R_j \]

Developer Entry

\[ T_{jr} \]

Resident Entry

\[ \bar{T}_{jr} \]

\[ T_{jr} \]
If Coordination Fails in More Neighborhoods

\[ w_i \uparrow \]

\[ R_j \]

\[ T^r_j \]

\[ T^r_j \]
If Relative Commuting Cost of a Neighborhood Rise

\[ R_j \]

\[ \kappa_{ij} \uparrow \]

\[ \bar{T}_j^r \]

\[ T_j^r \]
Mapping to the Data

- We use current data characterizing Detroit to quantify the spatial urban framework described above

  ▶ Benchmark year in our analysis is 2014
  ▶ Our unit of analysis is the census tract

- 297 census tracts in Detroit
- Surrounding metro area (Wayne County, Oakland County, Macomb County) includes 866 additional tracts
- Exclude 12 tract due to missing or problematic data, and perform the analysis for the resulting 1151 tracts

- We collected data at the census tract level on: $T_j^b$ and $T_j^f$, $R_j$, $L_j$, $w_j$, $\pi_{ij}$, $q_j^r$, $q_j^b$ and $\kappa_{ij}$ (as measured by Google Analytics)
Vacant, Partially Developed and Fully Developed Tracts

- Additional data from the Motor City Mapping project helps designate tracts as vacant, partially developed, or fully developed
  - Vacant if 50% of parcels vacant and 30% of buildings empty
  - Fully occupied if more than 66% of parcels occupied

- For tracts outside Detroit proper we fit a linear model based on data from Detroit proper
  - Includes residents, residential land, average census tract wages, and commuting costs from downtown
  - The model’s $R^2$ is 0.59
Mapping to the Data: Citywide Parameters

- Citywide parameters are given by

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\alpha$</td>
<td>0.06</td>
<td>Ciccone and Hall (1996)</td>
</tr>
<tr>
<td>$\beta$</td>
<td>0.80</td>
<td>Ahlfeldt, et. al (2015)</td>
</tr>
<tr>
<td>$\gamma$</td>
<td>0.76</td>
<td>Davis and Ortalo-Magné (2011)</td>
</tr>
<tr>
<td>$\theta$</td>
<td>8.34</td>
<td>Gravity equation for commuting</td>
</tr>
<tr>
<td>$\nu$</td>
<td>2.50</td>
<td>Ahlfeldt and McMillen, (2015)</td>
</tr>
<tr>
<td>$V$</td>
<td>174,941,657</td>
<td>Mean number of contractors</td>
</tr>
</tbody>
</table>

- $V$ is calculated using the mean number of contractors, $\sum_j n_j / J = 9.25$, with active permits in the benchmark year, 2014
  - Variance of $n_j$ matches almost perfectly (4.51 versus 4.52)
Gravity Equation

- We estimate \( \log \left( \frac{\pi_{ij}}{\pi_{jj}} \right) = -\theta \log \left( \frac{\kappa_{ij}}{\kappa_{jj}} \right) + \mu_i + \mu_j + \lambda_{ij} \), and obtain

<table>
<thead>
<tr>
<th></th>
<th>Straight-Line Distance</th>
<th>Google Distance</th>
<th>Google Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \theta )</td>
<td>6.57</td>
<td>4.62</td>
<td>8.34</td>
</tr>
<tr>
<td>S.E.</td>
<td>(0.017)</td>
<td>(0.013)</td>
<td>(0.022)</td>
</tr>
<tr>
<td>Work F.E.</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>Home F.E.</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>Observations</td>
<td>1,187,423</td>
<td>1,187,423</td>
<td>1,187,423</td>
</tr>
<tr>
<td>( R^2 )</td>
<td>0.39</td>
<td>0.37</td>
<td>0.38</td>
</tr>
</tbody>
</table>

- \( \lambda_{ij} \) are calculated from the residuals
Model Inversion

The rest of the parameters can be obtained by inverting the model to match \( (w_j, q_{jr}, R_j, T_{jr}, T_j^b) \) by adjusting \( (A_j, F_j, \sigma_j, \overline{T}_{jr}, \overline{T}_j^b) \)

Throughout, \( \overline{T}_j^b = T_j^b \)

\( F_j \) is only obtained for partially developed tracts

\( \overline{T}_{jr} \) only obtained for fully developed tracts
The restriction, $\sigma_j > 1 - \gamma = 0.24$ is always satisfied.
We study counterfactual policy scenarios where we coordinate vacant neighborhood to be in the positive resident equilibrium

Can be achieved using development guarantees

- Commit the issuer to invest a minimum amount of resources in the treated area
- Policy is costless if successful
- We calculate the size of the required guarantee: \((n_j - 1) (Vh_j^x + F_j)\)

Use the policy proposal of Detroit Future City (DFC)

- Expert and resident organization’s strategic plan for the city
- Coordinate the tracts selected for residential development
- We provide the first quantitative evaluation of these proposals
Two Strategic Plans: DFC and Best 22 Residential

Legend

- Detroit Future City
- Detroit City Boundary

Change in Residential Rent

- Previously Fully or Partially Developed
- 0 to 750,000
- 750,000 to 1,500,000
- 1,500,000 to 2,000,000
- 2,000,000 to 3,000,000
- 3,000,000 to 5,000,000
- 5,000,000 to 7,511,513

Legend

- 22 Highest Impact--Total Residential Rent
- Detroit City Boundary

Change in Residential Rent

- Previously Fully or Partially Developed
- 0 to 750,000
- 750,000 to 1,500,000
- 1,500,000 to 2,000,000
- 2,000,000 to 3,000,000
- 3,000,000 to 5,000,000
- 5,000,000 to 7,511,513

Owens, Rossi-Hansberg and Sarte
Rethinking Detroit
EMUEA, Copenhagen 2017
Two More: Best 22 Business or Population

Legend
- 22 Highest Impact--Change in Total Population
- Detroit City Boundary

Change in Population
- Previously Fully or Partially Developed
- 1 to 80
- 81 to 160
- 161 to 240
- 241 to 400
- 401 to 560
- 561 to 823

Change in Business Rent
- Previously Fully or Partially Developed
- 0 to 500,000
- 500,000 to 750,000
- 750,001 to 1,000,000
- 1,000,000 to 1,500,000
- 1,500,000 to 2,000,000
- 2,000,000 to 2,736,965
## Policy Evaluation: Detroit Proper

<table>
<thead>
<tr>
<th></th>
<th>DFC</th>
<th>Best 22 Bus.</th>
<th>Best 22 Res.</th>
<th>Best 22. Pop.</th>
<th>All 52</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dev. Guarantee, Mill. $</td>
<td>41.156</td>
<td>70.581</td>
<td>73.440</td>
<td>73.001</td>
<td>106.281</td>
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<tr>
<td><strong>Detroit Proper:</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Change in Res. Rent, Mill. $</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>47.452</td>
<td>77.829</td>
<td>80.758</td>
<td>80.502</td>
<td>120.347</td>
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<tr>
<td>Treated Tracts</td>
<td>45.797</td>
<td>75.159</td>
<td>77.443</td>
<td>77.064</td>
<td>115.894</td>
</tr>
<tr>
<td>Other Tracts</td>
<td>1.656</td>
<td>2.670</td>
<td>3.315</td>
<td>3.438</td>
<td>4.453</td>
</tr>
<tr>
<td>Change in Bis. Rent, Mill. $</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>23.502</td>
<td>35.922</td>
<td>34.525</td>
<td>33.792</td>
<td>54.254</td>
</tr>
<tr>
<td>Treated Tracts</td>
<td>9.857</td>
<td>8.657</td>
<td>4.469</td>
<td>4.505</td>
<td>22.370</td>
</tr>
<tr>
<td>Other Tracts</td>
<td>13.645</td>
<td>27.265</td>
<td>30.056</td>
<td>29.287</td>
<td>31.884</td>
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<tr>
<td>Change in Population</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>5,036</td>
<td>8,354</td>
<td>8,856</td>
<td>8,882</td>
<td>13,025</td>
</tr>
<tr>
<td>Treated Tracts</td>
<td>4,746</td>
<td>7,893</td>
<td>8,347</td>
<td>8,369</td>
<td>12,296</td>
</tr>
<tr>
<td>Other Tracts</td>
<td>290</td>
<td>461</td>
<td>510</td>
<td>514</td>
<td>730</td>
</tr>
</tbody>
</table>
## Policy Evaluation: Detroit MSA

<table>
<thead>
<tr>
<th></th>
<th>DFC</th>
<th>Best 22 Bus.</th>
<th>Best 22 Res.</th>
<th>Best 22. Pop.</th>
<th>All 52</th>
</tr>
</thead>
<tbody>
<tr>
<td>Detroit MSA:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Change in Res. Rent, Mill. $</td>
<td>58.676</td>
<td>96.350</td>
<td>102.751</td>
<td>103.142</td>
<td>150.847</td>
</tr>
<tr>
<td>Change in Bis. Rent, Mill. $</td>
<td>61.112</td>
<td>100.356</td>
<td>107.024</td>
<td>107.431</td>
<td>157.124</td>
</tr>
<tr>
<td>Change in Population</td>
<td>7,043</td>
<td>11,663</td>
<td>12,540</td>
<td>12,617</td>
<td>18,301</td>
</tr>
</tbody>
</table>
Coordination in All 52: Workers and Residents

Legend
- Detroit City Outline

Change in Workers
- < 0
- 0 to 3
- 3 to 10
- 10 to 20
- 20 to 35
- 35 to 70
- 70 to 180
- > 180
- Missing Data

Legend
- Vacant
- Detroit City Outline

Change in Residents
- < 0
- 0 to 1
- 1 to 3
- 3 to 5
- 5 to 10
- 10 to 150
- 150 to 475
- > 600
- Missing Data
Coordination in All 52: Business and Residential Rents

Legend
- Detroit City Outline

Business Rent Change in Business Rent
- 0 to 25,000
- 25,000 to 50,000
- 50,000 to 100,000
- 100,000 to 200,000
- 200,000 to 500,000
- 500,000 to 1,000,000
- > 1,000,000
- Missing Data

Residential Rent Change in Residential Rent
- < 0
- 0 to 1,500
- 1,500 to 15,000
- 15,000 to 30,000
- 30,000 to 60,000
- 60,000 to 100,000
- > 100,000
- Missing Data

Legend
- Missing Data
- Vacant
Conclusions

- Quantitative Spatial Economics
  ▶ Powerful methodology to analyze spatial issues and policies
- We have applied it to study how to reorganize declining cities: Detroit
  ▶ Had to incorporate a novel developer coordination mechanism
- Urban policies coordinate a ring of neighborhoods around CBD, but particular choices are important
- Optimal policy can differ substantially from proposed ones at similar organizational, political and financial costs
  ▶ Coordinating development in 22 optimally selected tracts generates 50% larger gains than DFC plan
  ▶ Important to incorporate counties in outer Detroit since they will obtain a large fraction of the gains