Rethinking Detroit

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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

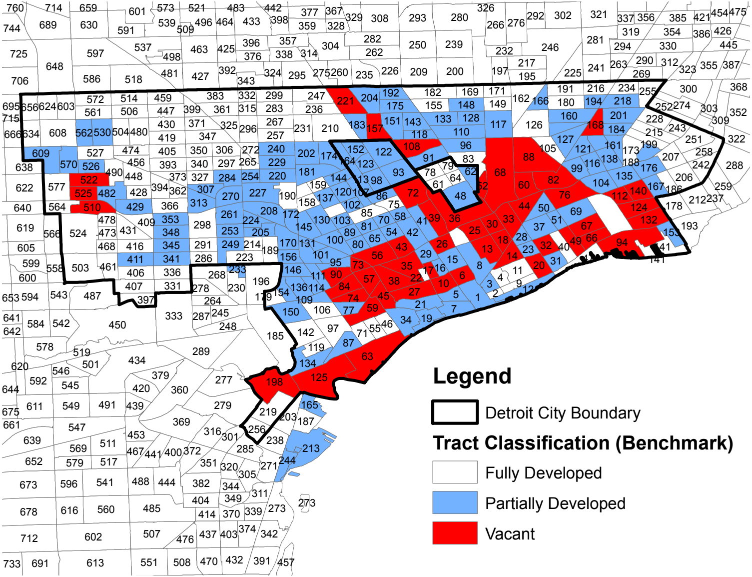
- In developed countries the structural transformation from manufacturing to services led to the decline of many cities
  - The Rust Belt in the U.S.
  - A prominent example is Detroit
- Why are industries locating elsewhere?
  - Urban infrastructure seems to be wasted: Detroit versus San Jose
  - Badly 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

Quantitative Spatial Economics

- Recent research has developed a quantitative spatial framework that connects closely to the observed data
  - Large numbers of locations with heterogenous 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

Detroit's City Structure



Detroit's City Structure

Photos: top, ©Burton Historical Collection, Detroit Public Library; bottom, ©Michael G. Smith

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 $\bar{T}_j^b \geq 0$ the total area of business land and $\bar{T}_j^r$ 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

$$\frac{Y_j}{T_j^b} \equiv y_j = a(l_j; j) l_j^\beta \equiv \left(A_j l_j^\alpha\right) l_j^\beta \qquad \text{where } l_j = \frac{L_j}{T_j^b}$$

- $a\left(l_j; j\right)$ 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

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

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

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

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

Commuting Patterns

- Individuals can move in and out of the city freely and obtain utility $\bar{u}$ elsewhere
- Let π_{ij} represent the proportion of residents living in j that commute to i. Then

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

and so

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

Resident Entry

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

$$q_j^r = \frac{(1-\gamma)\, R_j}{T_j^r} \sum_{i=1}^{J} \pi_{ij} w_i$$

- 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

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

  - 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

$$\Pi_j = \max_{h_j} h_j q_j^r - V(h_j) - F_j = \max_{h_j} h_j q_j^r - V h_j^v - F_j$$

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

$$n_j h_j = R_j H_j = T_j^r$$

where n_j is the number of active residential developers

- In equilibrium

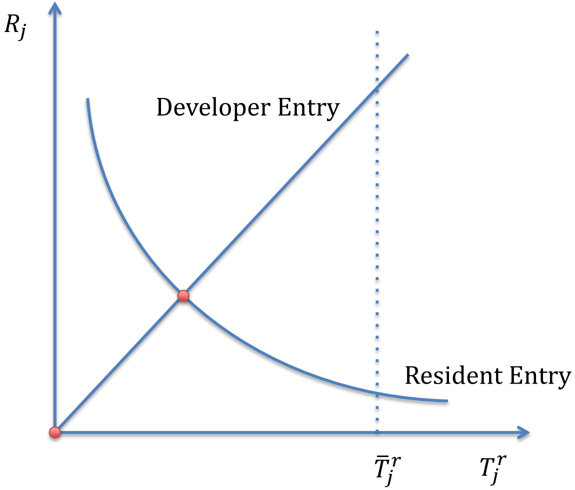
$$n_j = \left(T_j^r\right)^{\frac{v}{v-1}} \left(\frac{(1-\gamma)}{vV} R_j \sum_{i=1}^{J} \pi_{ij} w_i\right)^{\frac{-1}{v-1}}$$

if developers make non-negative profits and $n_j = 0$ otherwise

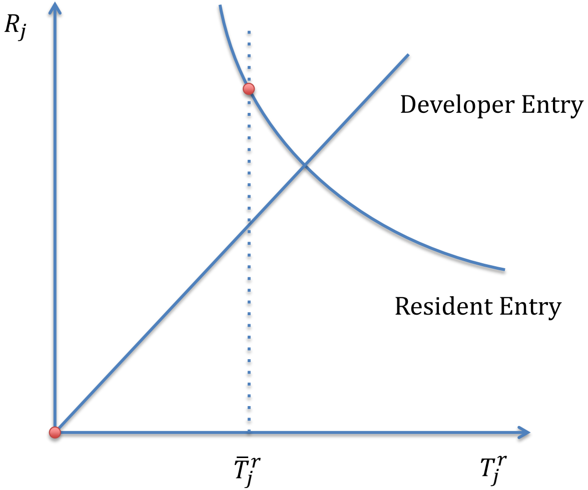
- Equilibrium in the labor market is guaranteed when

$$L_i = \sum_{j=1}^{J} \pi_{ij} R_j \text{ for all } i \in J,$$

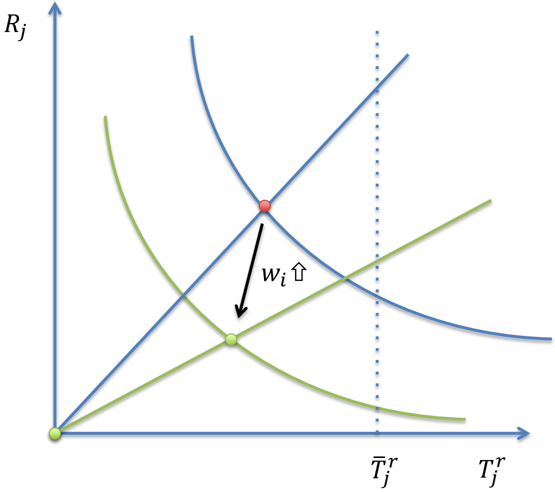
Neighborhood Residential Equilibrium: Partially Developed



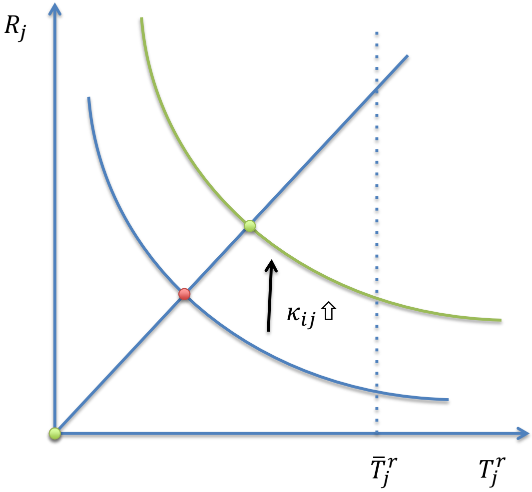
Neighborhood Residential Equilibrium: Fully Developed



If Coordination Fails in More Neighborhoods



If Relative Commuting Cost of a Neighborhood Rise



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^r, R_j, L_j, w_j, π_{ij}, q_j^r, $q_j^b$and κ_{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

Parameter	Value	Source
α	0.06	Ciccone and Hall (1996)
β	0.80	Ahlfeldt, et. al (2015)
γ	0.76	Davis and Ortalo-Magné (2011)
θ	8.34	Gravity equation for commuting
ν	2.50	Ahlfeldt and McMillen, (2015)
V	$174,941,657$	Mean number of contractors

- 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

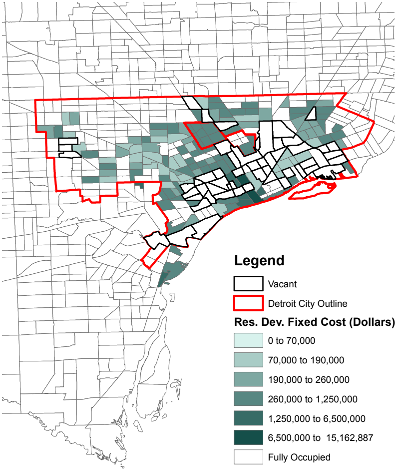
	Straight-Line Distance	Google Distance	Google Time
θ	6.57	4.62	8.34
S.E.	(0.017)	(0.013)	(0.022)
Work F.E.	yes	yes	yes
Home F.E.	yes	yes	yes
Observations	1,187,423	1,187,423	1,187,423
R^2	0.39	0.37	0.38

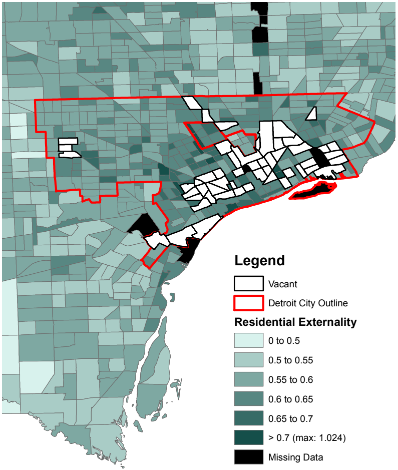
- λ_{ij} are calculated from the residuals

Model Inversion

- The rest of the parameters can be obtained by inverting the model to match $\left(w_j, q_j^r, R_j, T_j^r, T_j^b\right)$ by adjusting $(A_j, F_j, \sigma_j, \overline{T}_j^r, \overline{T}_j^b)$
- Throughout, $\overline{T}_j^b = T_j^b$
- F_j is only obtained for partially developed tracts
- $\overline{T}_j^r$ only obtained for fully developed tracts

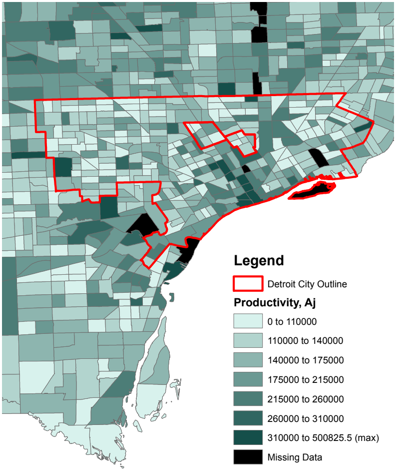
Developer Fixed Costs and Residential Externalities





- The restriction, $\sigma_j > 1 - \gamma = 0.24$ is always satisfied

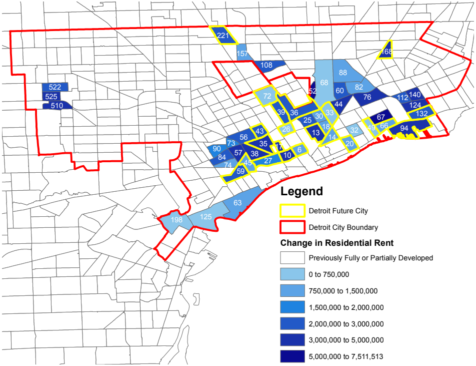
Technology

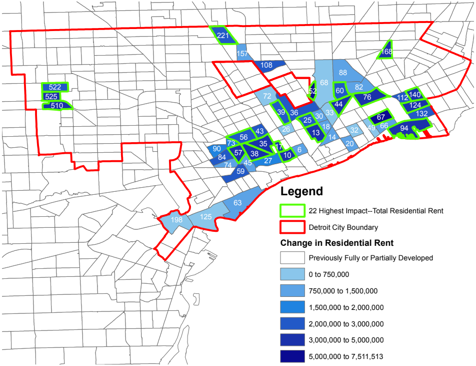

Legend
Detroit City Outline
Productivity, Aj
0 to 110000
110000 to 140000
140000 to 175000
175000 to 215000
215000 to 260000
260000 to 310000
310000 to 500825.5 (max)
Missing Data

Policy Exercises: Coordinating Residential Development

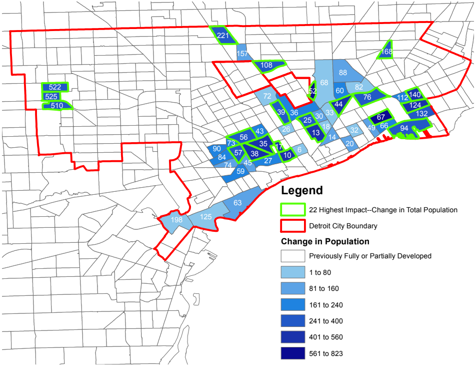
- We study counterfactual policy scenarios where we coordinate vacant neighborhood to be in the positive resident equilibrium
- Can be achieved using development guarantees
  - Commit the issuer to invest a minimum amount of resources in the treated area
  - Policy is costless if successful
  - We calculate the size of the required guarantee: $\left(n_j - 1\right)\left(Vh_j^v + F_j\right)$
- 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

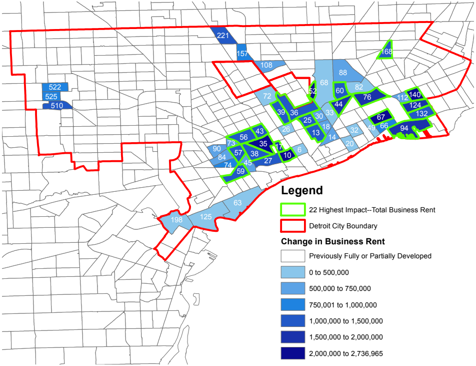
Two Strategic Plans: DFC and Best 22 Residential





Two More: Best 22 Business or Population





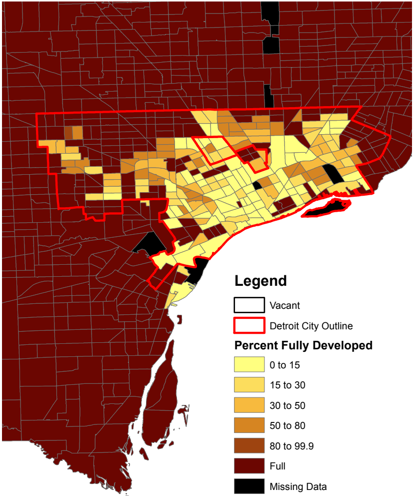
Policy Evaluation: Detroit Proper

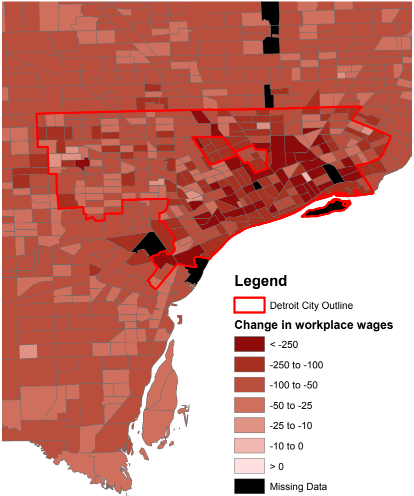
	DFC	Best 22 Bus.	Best 22 Res.	Best 22. Pop.	All 52
Dev. Guarantee, Mill. $	41.156	70.581	73.440	73.001	106.281
Detroit Proper:					
Change in Res. Rent, Mill. $					
Total	47.452	77.829	80.758	80.502	120.347
Treated Tracts	45.797	75.159	77.443	77.064	115.894
Other Tracts	1.656	2.670	3.315	3.438	4.453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

Policy Evaluation: Detroit MSA

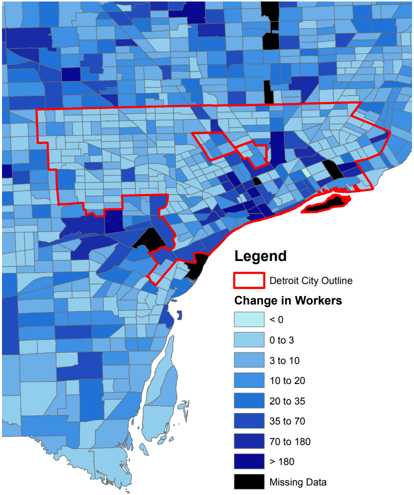
	DFC	Best 22 Bus.	Best 22 Res.	Best 22. Pop.	All 52
Detroit MSA:					
Change in Res. Rent, Mill. $	58.676	96.350	102.751	103.142	150.847
Change in Bis. Rent, Mill. $	61.112	100.356	107.024	107.431	157.124
Change in Population	7,043	11,663	12,540	12,617	18,301

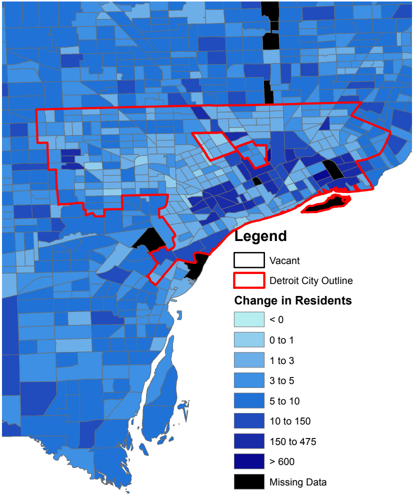
Coordination in All 52: Fraction Developed and Wages



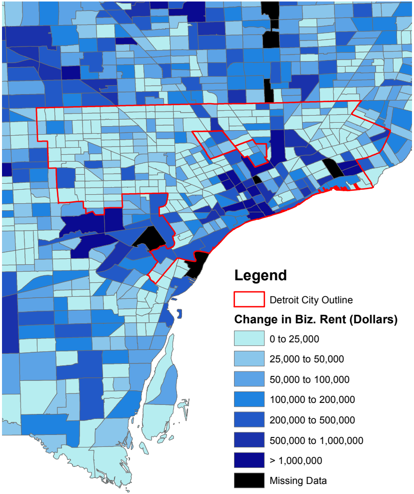


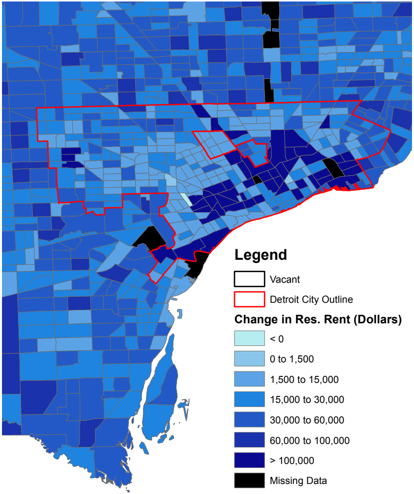
Coordination in All 52: Workers and Residents





Coordination in All 52: Business and Residential Rents





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