Rethinking Detroit

Owens, Rossi-Hansberg and Sarte

ITAM [1]

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City of Detroit

Figure 1: The NYT, Detroit by Air, by Alex S. MacLean

City of Detroit

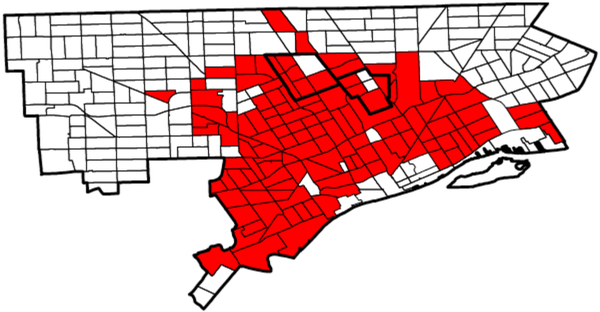

Figure 2: Pre-1930 residential census tracts in Detroit.

City of Detroit

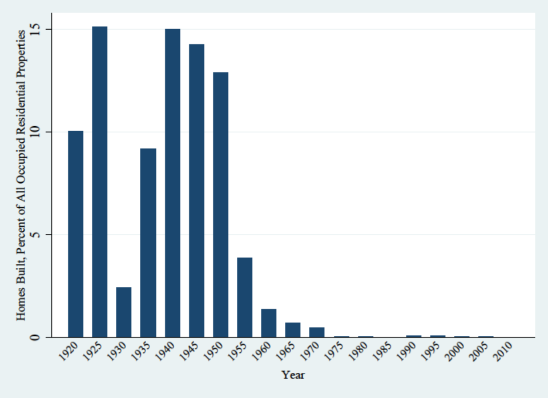

Figure 3: Construction of homes in Detroit (Source: Southeast Michigan Council of Governments).

City of Detroit

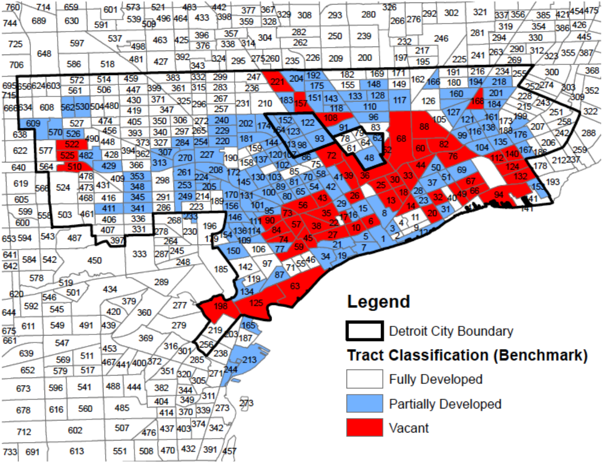

Figure 4: Empty and partially developed Census tracts in Detroit today.

City of Detroit

- This area was developed to accommodate a rapidly growing demand for workers in the automobile industry.
- As employment fell and some plants moved elsewhere, residential demand and income collapsed.
- Along with other factors, these changes helped foment riots in 1967 that drove this area into a no-development equilibrium.
- This was facilitated by radial highways constructed for a city that was four times bigger than its current size.
- Since 1980, more tan 131 thousand units have been demolished.

Motivation

- Detroit proper is a distorted, impractical, and inefficient city.
- The necessary density is simply not there, so new workers and firms do not enter.
- With residential areas close to downtown, workers would clearly benefit from commuting and downtown Detroit.
- But developers need to manage with residential and housing externalities.
- Challenges in coordinating different parties is a key impediment to revitalization and development.
- Economists have focused mostly on growth not on decline.

Hypothesis

- Coordination problems: neighborhoods have two equilibria, one that features a residential area with enough development and residents to make it sustainable, and one in which no investment is made and no residential activity occurs.
- Inefficiencies associated with urban decline can be related to specific areas of a city, that potentially retain sound underlying fundamentals, but are nevertheless trapped in local neighborhood equilibria in which developers and residents are unable to coordinate their actions.
- Residents do not want to be isolated in a neighborhood.
- High-skilled workers required by the high-tech industry would likely not want to start their lives in vacant neighborhoods near Detroit's downtown, even if such locations are cheaper.

Method

- The authors place the coordination problem in a quantitative spatial economics framework which allow them to model the city of Detroit in detail. Then they use the model to design and quantify the effects of a variety of policy proposals.
- They add residential externalities.
- In order to quantify the importance of neighborhood externalities, they first assume that residential amenities are caused entirely from residential externalities, which they assume are log-linear in the number of residents. Then, using the rest of the quantified model, this assumption allow them to estimate the strength of residential externalities for each neighborhood.

Method

- All the policies they assess involve coordinating on vacant residential neighborhoods.
- 'Development guarantees' to resolve coordination challenges where the city government, or some other outside institution, guarantees a minimum investment in residential development in a neighborhood targeted for development.
- They use a quantitative framework to compute the magnitude of the required guarantees that would allow a neighborhood to coordinate in the equilibrium with a positive number of residents and residential investment.

Spacial framework along different dimensions:

- employment
- residential
- population
- commuting
- land prices

Their contribution

Their quantitative framework can inform the decision making process in Detroit and other declining cities, and facilitate their transformation into cities that can host the "industries of the future."

Data

1. Census tracts.
   - Benchmark year is 2014.
   - 297 census tracts in Detroit.
   - Surrounding metro area includes 866 additional tracts. 12 tracts where excluded due to missing or "problematic".
2. Bilateral census commuting data.
3. Local development and price data form assessors.
4. Urban blight, gathered by local Detroit organizations.
5. Google Analytics data on actual commuting times and distances.
6. Data from Motor City Mapping project. Helped designate tracts as:
   - Vacant: if 50 % of parcels or 30% of buildings are vacant.
   - Fully occupied: if more than 66% of parcels are occupied.

For data of tracts in Metro-Detroit they use a linear model based on data from Detroit proper. The model's R^2 is 0.59.

Model

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

They 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.

There are 4 types of agents that 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:

$$\frac{Y_j}{T_j^b} \equiv \mathrm{y}_j = a(l_j; j) l_j^{\beta} \equiv (\mathrm{A}_j l_j^{\alpha}) l_j^{\beta} \text{ where } l_j = \frac{L_j}{T_j^b}$$

$a(l_j; j)$ is an externality that firms take as given. And they 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,

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

Individuals

The problem of an individual that lives in location j and works in i is $U_{ij}(s) =$

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

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

- Commuting costs are given by $\kappa_{ij} > 1$, with $\kappa_{jj} = 1$
- Residential amenities at location j are given by $B(R_j;j) = R_j^{\sigma j}$ with $\sigma_j \geq 1-\gamma$ for all j. Neighborhood demand by residents is an increasing function of the number of residents.
- Individuals 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.

π_{ij} represent the proportion of residents living in j that commute to i. Then: $\pi_{ij} = \Pr\left[U_{ij} > \max_{n \neq i} U_{nj}\right]$

and so: $\pi_{ij} = \frac{\lambda_{ij}(w_i/\kappa_{ij})^{\sigma}}{\sum_{n=1}^{J} \lambda_{nj}(w_n/\kappa_{nj})^{\theta}}$

Resident Entry

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Equilibrium in the residential market j implies that $R_j H_j = T_j^r$, so residential rents are:

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

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

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

The expression above represents the resident entry condition.

Residential Developers

There is a large number of small residential developers, none of whom is large enough to internalize residential externalities. Residential developers then maximize:

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

with $v > 1$

Developers enter as long as profits are non-negative or:

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

The expression above represents the resident entry condition.

Market Equilibrium

Equilibrium in the residential market implies that:

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

In which 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 $\mathrm{n}_j = 0 otherwise$.

Equilibrium in the labor market is guaranteed when:

$$L_i = \sum_{j=1}^{J} \pi_{ij} R_j ; \forall i \in J$$

Neighborhood Residential Equilibrium

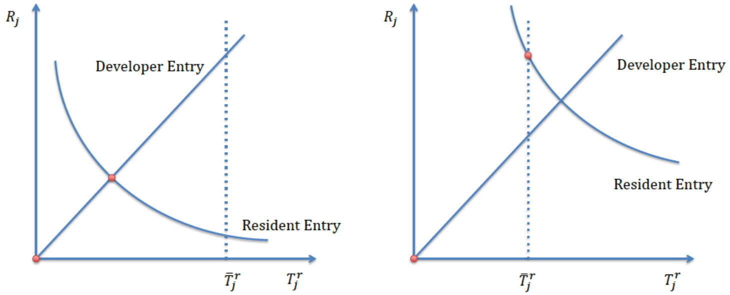


Figure 5: Determination of R_j and $T_j^r < \bar{T}_j^r$ (left) or $T_j^r = \bar{T}_j^r$ (right)

Neighborhood Residential Equilibrium

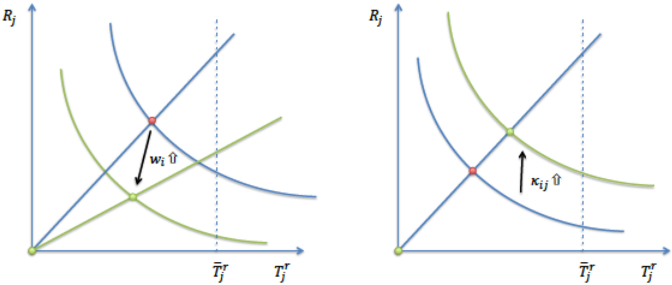


Figure 6: Neighborhood equilibrium and an increase in all wages (left) or commuting costs (right)

Citywide Parameters

Figure 7: Citywide parameter values and sources.

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	175, 472, 386	Equation for 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.

Estimation

They estimate the following equation:

$$log\left(\frac{\pi_{ij}}{\pi_{jj}}\right) = -\theta log\left(\frac{\kappa_{ij}}{\kappa_{jj}}\right) + \mu_i + \mu_j + \lambda_{ij}$$

And they obtained:

Figure 8: Gravity equation estimation using different measures of commuting.

	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

$(w_j, q_j^r, R_j, T_j^r, T_j^b)$ by adjusting $(A_j, F_j, \sigma_j, \bar{T}_j^r, \bar{T}_j^b)$

Throughout, $\bar{T}_j^b = T_j^b$

F_j is only obtained for partially developed tracts.

$\bar{T}_j^r$ only obtained for fully developed tracts.

Residential development fixed cost

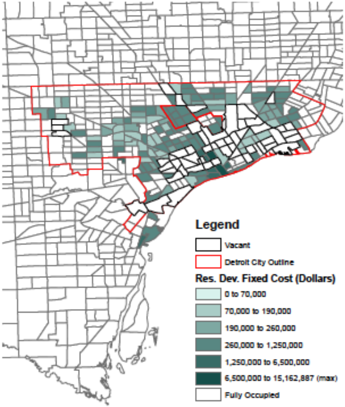


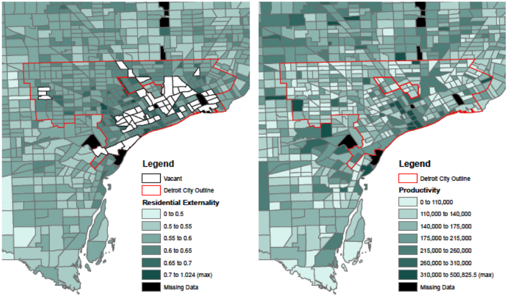
Figure 9: F_j in the baseline quantification

The highest fixed costs are in downtown Detroit.

Residential Externalities at the Tract Level

Resulting values for σ_j:

Figure 10: Residential externality, σ_j, and productivity A_j, in the baseline quantification.



The estimated value of the parameter governing residential externalities continues to satisfy the condition $\sigma > 1 - \gamma$.

Policy Exercises: Coordinating Residential Development

The authors studied counterfactual policy scenarios where they coordinate vacant neighborhoods in order to be in the positive resident equilibrium.

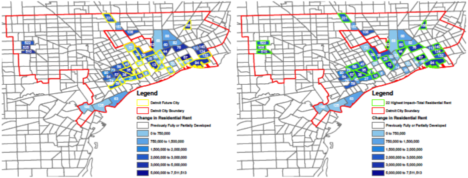
For this, they consider the following development guarantees:

- Commit the issuer to invest a minimum amount of resources in the treated area.
- They calculate the size of the required guarantee: $(n_j - 1)(Vh_j^v + F_j)$

They also use the policy proposal of Detroit Future City (DFC), that coordinates tracts selected for residential development.

Coordinating Vacant Residential Tracts

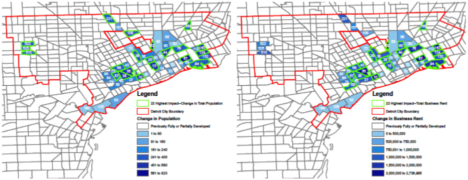
Figure 11: Detroit Future City and best 22 residential plans compared to gains in total rents from Coordinating Individual Tracts.



DFC proposal (left). 'Best 22 Residential Plan' (right), which provides the highest increases in residential rents as each tract switches to an equilibrium with residential population individually. DFC proposal focuses on developing the areas closest to the downtown core, while the Best 22 Residential plan covers also areas in a wider outer ring.

Coordinating Vacant Residential Tracts

Figure 12: Best 22 tracts based on population and business rents



22 tracts that, when individually switched to an equilibrium with coordination among residents and developers, yield the largest gains in citywide population and business rents.

The selection of 'Best 22' tracts based on implied changes in business rents focuses on coordinating only the tracts located in a relatively tight ring across the business area.

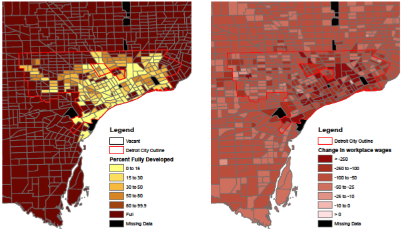
Detroit Proper and Greater Detroit (MSA)

	DFC	Best 22 Bus.	Best 22 Res.	Best 22. Pop.	All 52
Dev. Guarantee, Mill. \$	41.057	70.367	73.243	72.805	106.001
Detroit Proper:					
Δ in Res. Rent, Mill. \$					
Total	47.451	77.828	80.758	80.502	120.346
Treated Tracts	45.796	75.158	77.443	77.064	115.893
Other Tracts	1.656	2.670	3.315	3.438	4.453
Δ in Bis. Rent, Mill. \$					
Total	23.502	35.921	34.525	33.792	54.253
Treated Tracts	9.857	8.656	4.469	4.505	22.370
Other Tracts	13.645	27.265	30.056	29.287	31.884
Δ 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
Greater Detroit:					
Δ in Res. Rent, Mill. \$	58.675	96.348	102.751	103.142	150.846
Δ in Bis. Rent, Mill. \$	61.111	100.355	107.024	107.432	157.123
Δ in Population	7,043	11,663	12,540	12,617	18,301

Figure 13: Development guarantees and policy outcomes in Detroit proper and Greater Detroit.

Coordination in all 52 vacant tracts

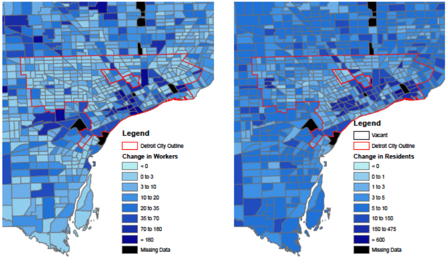
Figure 14: Coordinating all 52 vacant tracts, percent of developed residential land and change in workplace.



Even after implementation, most of Detroit proper is still only partially developed. In no sense, therefore, does this policy lead to a booming residential area that becomes congested. This is consistent with the idea that these were initially trapped in the equilibrium without development.

Coordination in all 52 vacant tracts

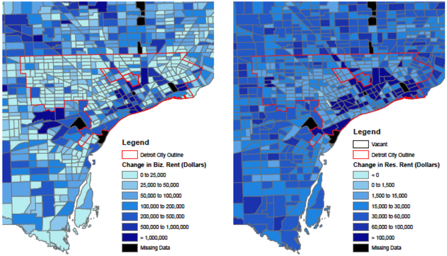
Figure 15: Change in workers and residents.



Clearly, a development-guarantee policy raises the number of residents in essentially all tracts (more in treated). Increase of labor supply nearby, which depresses wages and encourages firms to employ more workers. Workers are not worse off since they enjoy additional amenities and shorter commutes.

Coordination in all 52 vacant tracts

Figure 16: Change in business and residential rents.



Tracts that gain the most workers are those where business rents increase most, and tracts that gain the most residents are those where residential rents increase most.

There is heterogeneity in the magnitudes of the implied changes.

Coordination in all 52 vacant tracts

These findings are natural given their specification of technology and preferences with Cobb-Douglas functions that feature constant factor and consumption shares respectively. Perhaps more interesting in this case are the heterogeneity in the magnitudes of the implied changes.

- While some of the tracts in downtown Detroit, Dearborn, and other suburbs, can see increases of more than a million dollars in yearly business rents...
- Other tracts near the boarder of Detroit see business rents increase by less than 25,000 dollars.

Most tracts experience modest increases in residential land rents, between 15,000 and 60,000 dollars.
Only the residential tracts that have switched from being vacant to an equilibrium with residential development show increases in rents of more than one hundred thousand dollars.

Conclusion

Declining cities have become a pervasive phenomenon.

Inefficiencies associated with urban decline can be related to specific areas of a city, that potentially retain sound underlying fundamentals, but are nevertheless trapped in local neighborhood equilibria in which developers and residents are unable to coordinate their actions.

The authors consider as a way for addressing this issue: development guarantees, provided by the government or outside parties, that commit to a minimum amount of investment in a targeted vacant area.

Advantages

1. Learning how to deal with urban downturns can lead to improved utilization of past investments, and less dissatisfaction by local residents with respect to technological progress and globalization.
2. This can help cities or regions specialized in declining industries, in order to being able to reinvent themselves.

Caveat

1. Vacant neighborhoods might be caused by other elements different than coordination problems.
2. The lack of local, practical, and specific knowledge of the characteristics of these neighborhoods, among other tract-specific characteristics.
3. The effects studied operate only within and not across census tracts.
4. They lack of citywide or region-wide agglomeration effects.