Lecture 1: The Economic City
WWS 538

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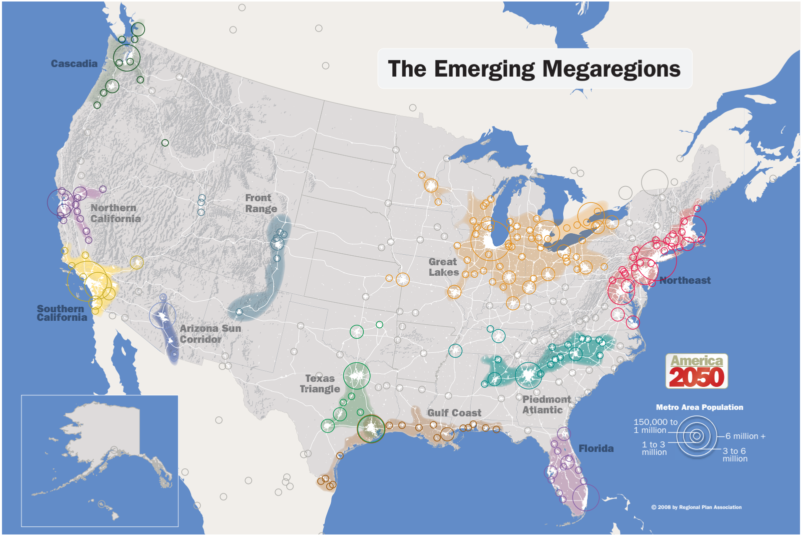
What is a City?

- Economics conceptualizes cities as the result of a trade-off between:
  - Agglomeration Effects
    - ★ Can take the form of: Externalities, Amenities, Lack of other Frictions
  - Congestion costs
    - ★ Transport costs of: people, ideas and information, goods, etc.
- Urban public policy depends crucially on what we identify as the key forces
  - Many types of agglomeration and congestion forces lead to externalities and, therefore, inefficient equilibrium outcomes
  - In those cases we need taxes, subsidies, regulation
- Welfare theorems in economics
  - In the absence of externalities, public goods, market power, information frictions, etc. the equilibrium allocation is efficient

Urban Economics

- Most work in the area of urban economics is concerned with measuring and identifying agglomeration and congestion forces
- We have a good set of empirical papers that point to the importance of many of these forces
  - Causality problem is the main obstacle
- However, we need models to understand how policy will affect the allocation and therefore welfare
  - Policy evaluation requires us to build countrefactuals
  - Economic policy counterfactuals require theory
- So large part of the literature is also dedicated to building analytical and quantitative models of cities (and systems of cities) that we can use to evaluate policy
- There is an important gap between policy analysis and urban economic knowledge: *America 2050 Megaregion Plan*

America 2050 Megaregion Plan



The Simplest Model of a City

- Consider a linear monocentric city with density of land equal to 1
- Firms locate at the center, $\ell = 0$
- Use labor to produce an homogenous good according to a production function

$$F(L) = A(\bar{L})\,L \tag{1}$$

- Agglomeration effect is an externality

$$A(\bar{L}) = a\bar{L}^{\alpha} \tag{2}$$

  - $\bar{L}$ is the number of workers in a city
  - So the more workers in the city, the more productive are firms (and labor)
  - Marginal product of labor goes up with population size
- Let w be the wage in the city. Firms maximize profits so $\max_L A(\bar{L})\,L - wL$, and so

$$A(\bar{L}) = w \Leftrightarrow w = a\bar{L}^{\alpha} \tag{3}$$

The Simplest Model of a City

- Workers are identical and maximize utility, $U(c) = c$ and can get utility $\bar{u}$ in any other city
  - So $\bar{u}$ is the reservation value. Hence they need to get at least $\bar{u}$ in this city, and in equilibrium exactly $\bar{u}$
- Agents live around the center in a unit of land that they rent at cost $R(\ell)$, where $\ell \in [-B, B]$ denotes the location of their house
- They need to commute to work at costs $\tau |\ell|$ in terms of goods (includes both trips)

The Simplest Model of a City: Equilibrium

- All agents in the city get $\bar{u}$ so

$$\bar{u} = w - R(\ell) - \tau |\ell| \tag{4}$$

  - This is the case for all ℓ

- Land at the boundary of the city can always be used for residential purposes at cost R_A. So

$$w - R(\ell) - \tau |\ell| = w - R_A - \tau B$$

- So land rents in the city are given by

$$R(\ell) = R_A + \tau(B - \ell)$$

The Simplest Model of a City: Equilibrium

- But B is endogenously determined. In particular, since everyone in the city lives in one unit of land,

$$2B = \bar{L} \Leftrightarrow B = \frac{\bar{L}}{2}$$

and so since by (3)

$$\bar{L} = \left(\frac{w}{a}\right)^{1/\alpha}$$

we obtain that

$$B = \frac{\bar{L}}{2} = \frac{1}{2}\left(\frac{w}{a}\right)^{1/\alpha} \tag{5}$$

The Simplest Model of a City: Equilibrium

- Hence land rents are given by

$$R(\ell) = R_A + \tau \left(\left(\frac{w}{a} \right)^{1/\alpha} - \ell \right) \tag{6}$$

- Note that w is also endogenously determined by

$$\begin{aligned} \bar{u} &= w - R_A - \tau B \\ &= w - R_A - \frac{\tau}{2} \left(\frac{w}{a} \right)^{1/\alpha} \end{aligned}$$

- Defines a function $w\left(\underset{-}{\bar{u}}, \underset{-}{\tau}, \underset{-}{R_A}, \underset{+}{a}, \underset{+}{\alpha}\right)$. Why? Multiple equilibria?
- The equilibrium city size is then given by

$$a\left(\bar{L}_E\right)^{\alpha} - R_A - \frac{\tau}{2}\bar{L}_E = \bar{u} \tag{7}$$

Optimal Allocation

- Equilibrium is not optimal
  - Total city output can be improved by adding more workers to the city
- Consider the problem

$$\max_{\bar{L}} A\left(\bar{L}\right)\bar{L} - R_A\bar{L} - \tau B^2 - \bar{u}\bar{L} = \max_{\bar{L}} a\bar{L}^{1+\alpha} - R_A\bar{L} - \frac{\tau}{4}\bar{L}^2 - \bar{u}\bar{L}$$

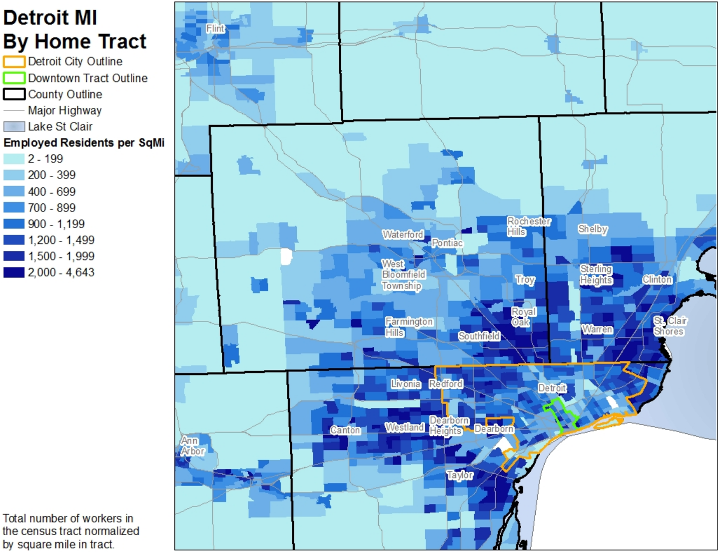
- Hence

$$a\left(1+\alpha\right)\left(\bar{L}_O\right)^{\alpha} - R_A - \frac{\tau}{2}\bar{L}_O = \bar{u} \tag{8}$$

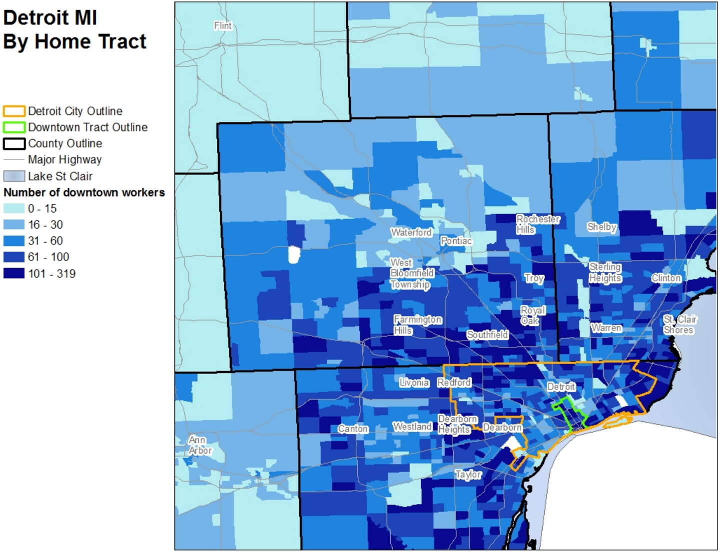
- Compare (7) and (8) to conclude that $\bar{L}_O > \bar{L}_E$
  - Since $a\left(1+\alpha\right)\left(\bar{L}_O\right)^{\alpha} - \frac{\tau}{2}\bar{L}_O$ decreasing in $\bar{L}_O$ by second order condition
  - Sufficient to impose that $\tau > 2a(1+\alpha)\alpha$
    - ⋆ Otherwise optimal city is infinitely large
- Optimal policy is to increase w by a fraction $1+\alpha$
  - Subsidize employment by firms, or city population, and charge workers in the whole country

Detroit

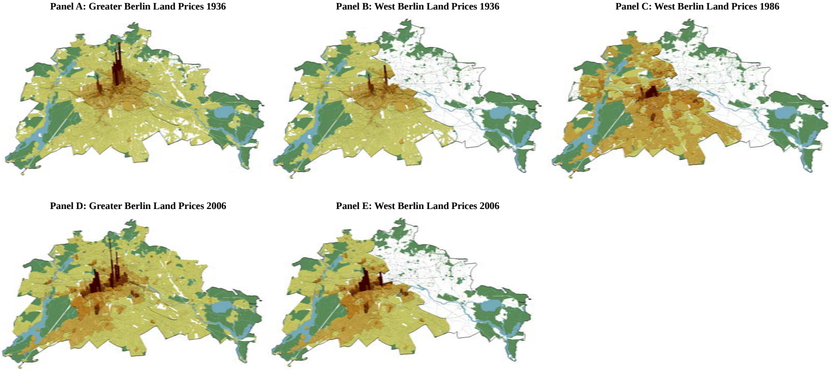
Detroit


Detroit MI
By Home Tract
Detroit City Outline
Downtown Tract Outline
County Outline
Major Highway
Lake St Clair
Employed Residents per SqMi
2 - 199
200 - 399
400 - 699
700 - 899
900 - 1,199
1,200 - 1,499
1,500 - 1,999
2,000 - 4,643
Total number of workers in the census tract normalized by square mile in tract.
Flint
Waterford
Pontiac
Rochester Hills
Shelby
West Bloomfield Township
Troy
Sterling Heights
Clinton
Royal Oak
Farmington Hills
Southfield
Warren
St. Clair Shores
Livonia
Redford
Detroit
Canton
Westland
Dearborn Heights
Dearborn
Ann Arbor
Taylor

Detroit


Detroit MI
By Home Tract
Detroit City Outline
Downtown Tract Outline
County Outline
Major Highway
Lake St Clair
Number of downtown workers
0 - 15
16 - 30
31 - 60
61 - 100
101 - 319
Flint
Rochester Hills
Shelby
Waterford
Pontiac
West Bloomfield Township
Troy
Sterling Heights
Clinton
Royal Oak
Farmington Hills
Southfield
Warren
St. Clair Shores
Livonia
Redford
Detroit
Canton
Westland
Dearborn Heights
Dearborn
Ann Arbor
Taylor

The Wall and Berlin

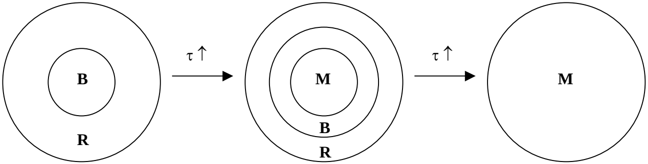


Generalizations

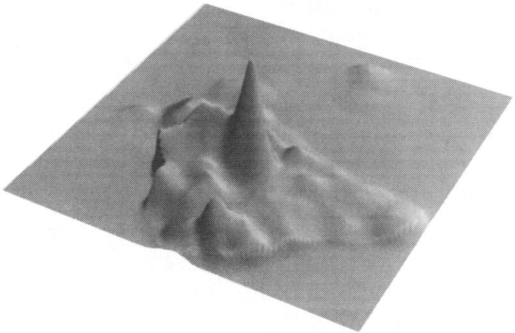
- Model can be generalized in multiple ways
- Two important ones are:
  - Circular city
  - Firms can use land for production and so business areas emerge
  - Density of employment and residents could be endogenous
  - External effect that depends on distance to other workers
- The equilibrium and optimal allocations are studied in Lucas and Rossi-Hansberg (2002) and Rossi-Hansberg (2004)

Equilibrium Allocation of Generalized Model

- Monocentric city is an equilibrium only for small commuting costs
- Higher commuting costs (τ) result in mixed areas at the center
  - Areas in which both firms and residences coexist
    - Realistic feature of many cities: residents in downtown areas commute to work by foot
- If externality decays fast, possibility of many business areas

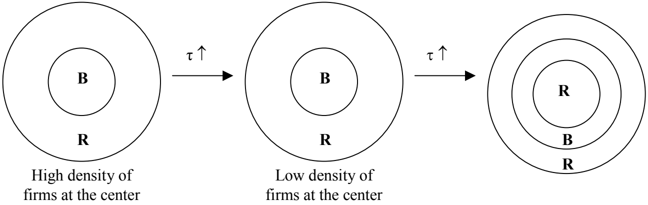


Employment Density in LA in 1990

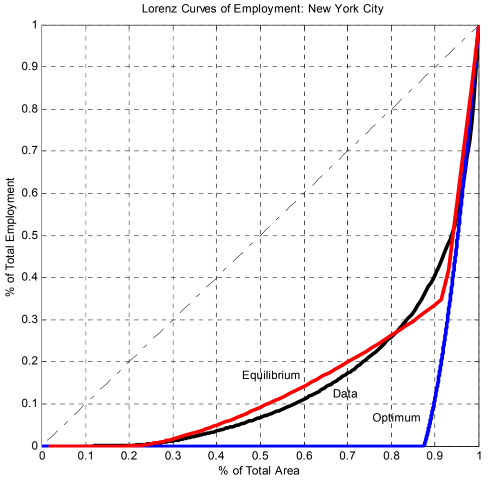


Optimal Allocation of Generalized Model

- The optimal allocation has no mixed areas
- Location specific subsidies can implement optimal allocation
- High commuting costs result in multiple business areas



Implication for NYC in 1992



Optimum with Low Commuting Costs

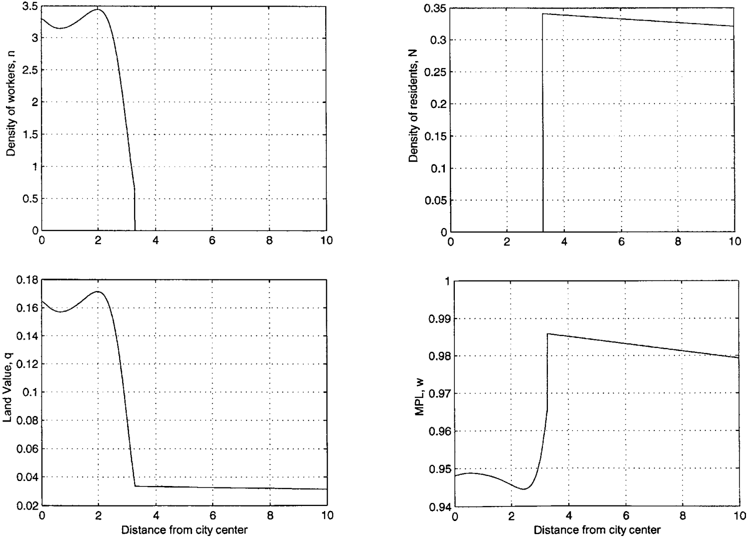


Fig. 4. Optimal allocation for $\kappa = 0.001$.

Optimum with High Commuting Costs

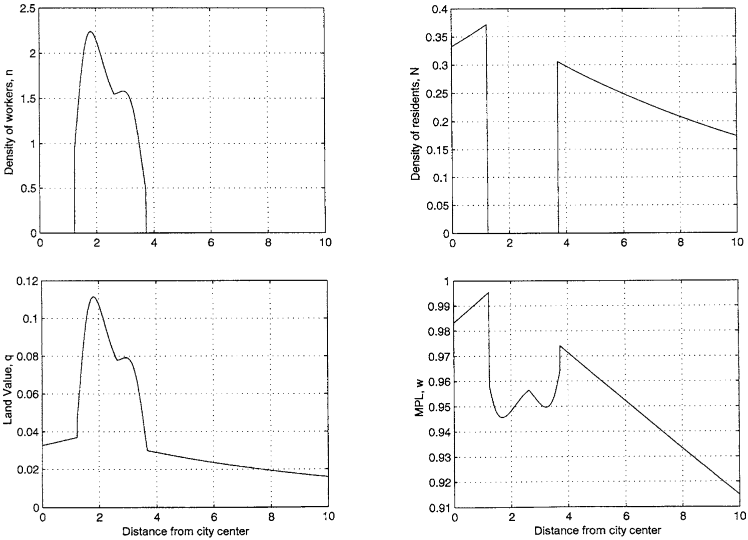


Fig. 5. Optimal allocation for $\kappa = 0.01$.

Comparing the Equilibrium and Optimal Allocations

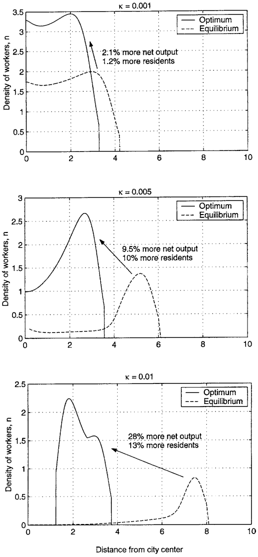


Fig. 6. Optimal density of workers.

Policy Examples: Labor Subsidies

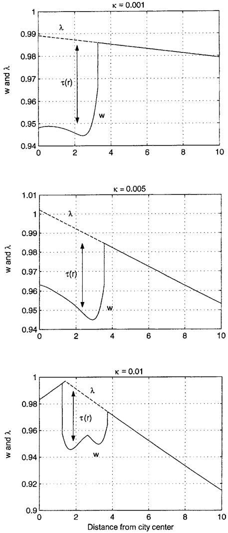


Fig. 8. Labor subsidy.

Policy Examples: Zoning Restrictions

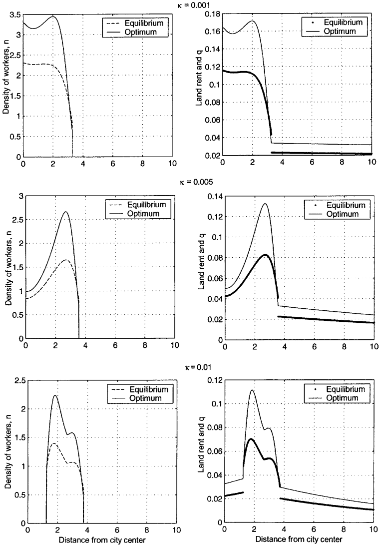


Fig. 9. Optimum and equilibrium with zoning restrictions.