



# The Economic Theory of Urban Form

*William Wheaton*

*USC*

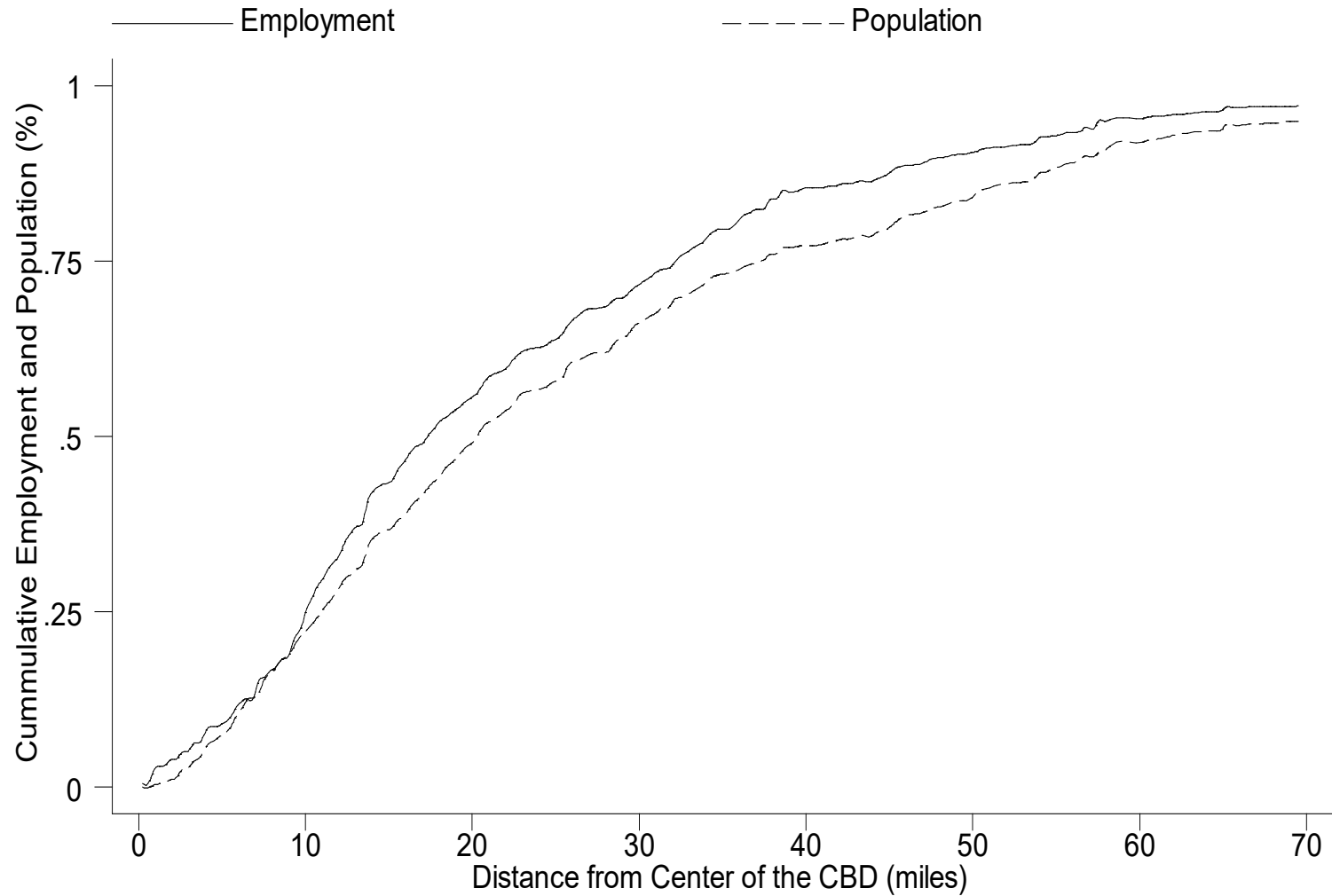
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- Historically economists have focused on Ricardian Rent, and residential density.
- Households living near desirable locations pay higher housing “rent”. Households who live further from these places pay less “rent” to insure market equilibrium.
- Over time higher rent incentivizes land owners/developers to build at higher density (capital-land substitution).
- Hence *market-based* residential Density gradients match “rent” gradients (Calif.- Fla coast comparisons).
- But what if there are multiple or many centers of employment, shopping, play. How “centralized” is employment? More/less than households?
- What determines the level of employment centralization? What are the consequences of centralization-dispersal?



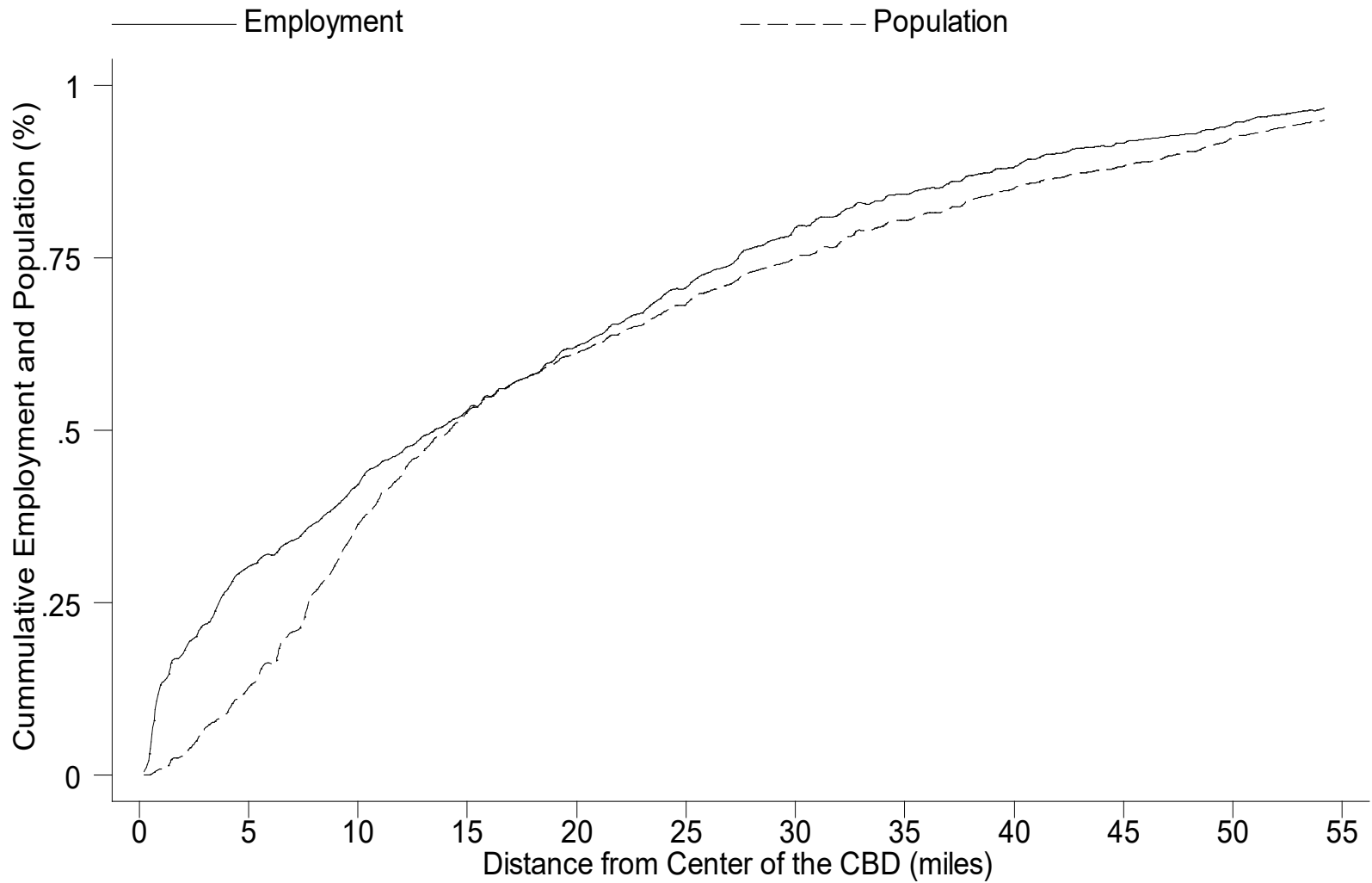
Figure 7: Los Angeles Spatial Distributions



Source: 2000 zip level data



Figure 6: New York Spatial Distributions



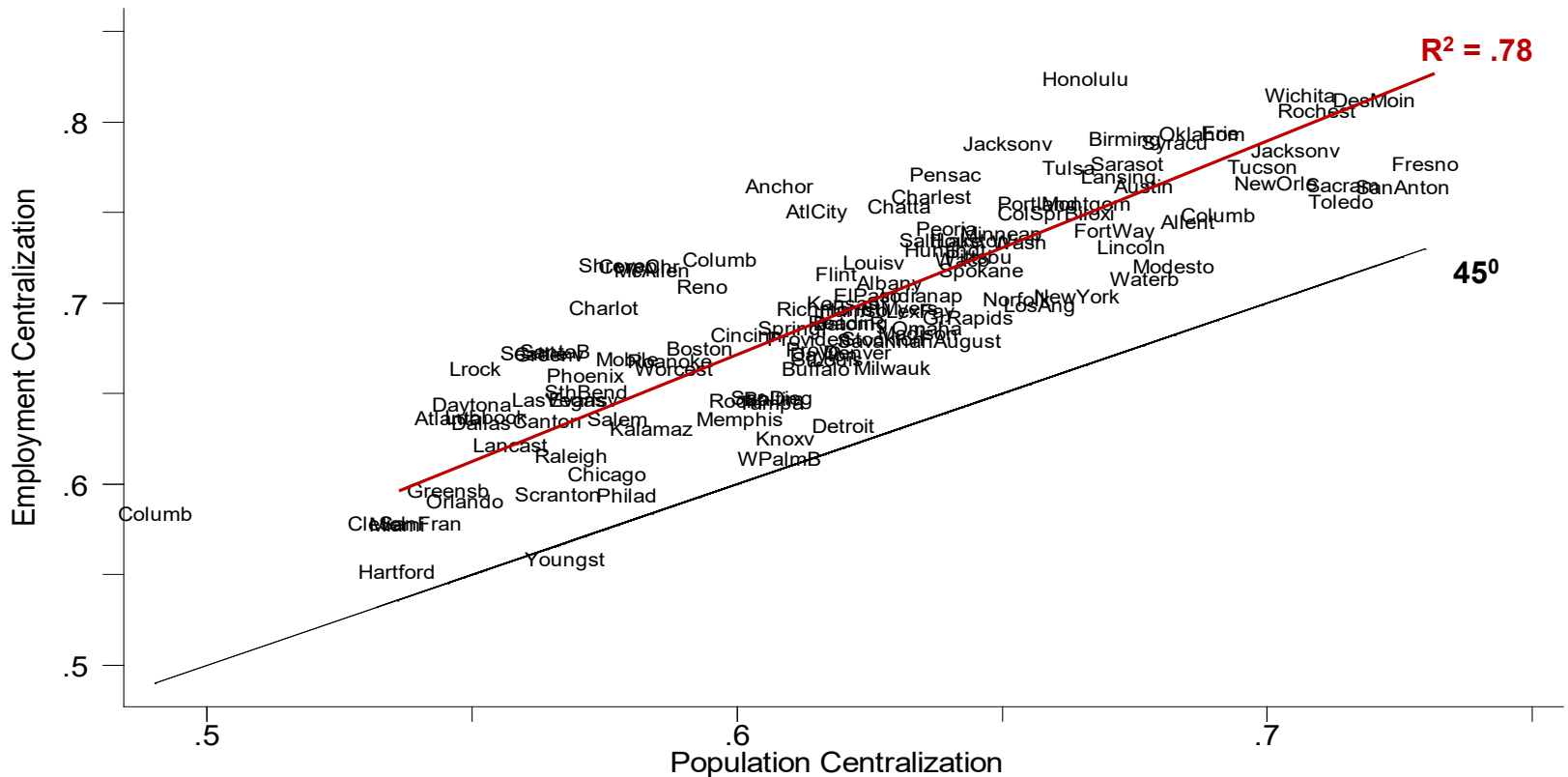
Source: 2000 zip level data



$$\text{Centralization} = \int_0^b \frac{e(t)}{t} dt \quad [1 - t_0 - 0]$$

Where: e(t): cumulative fraction of jobs (population) at distance t  
 b: distance at which 98% of population live.

Figure 8: Employment and Population Centralization in a Sample of 120 Cities





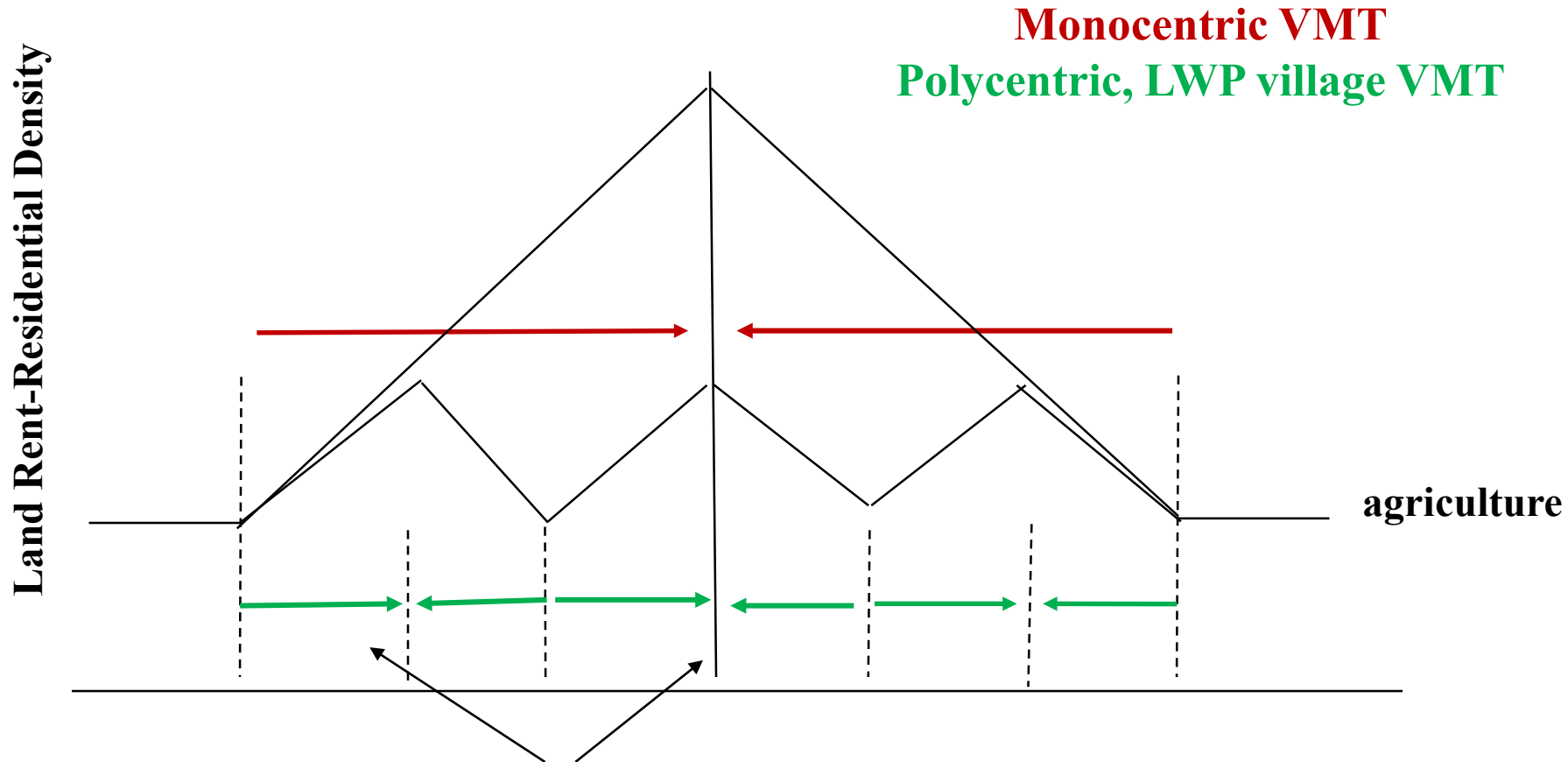
# Urban Forms

- Generalizing (2-dimensions) imagine a metropolitan area as varying in the number/size of work-play centers.
- At one extreme, there can be a single huge “monocentric” center where *all* work-play activity occurs. At the other extreme, activity is evenly spread in many small sub-centers. In between we might imagine a “polycentric” urban area with a number of medium sized sub-centers.
- Particularly during transitions, an MSA can have a range of subcenters of different sizes.
- Across this range of urban forms, travel and economic behavior will be quite different.
- There are 2 (bi-directional) relationships between urban form and travel costs. Lets label these I and II.



# Urban Form: I

**More Centralized Employment usually generates greater aggregate travel – through longer trips**



*Assumed:* Efficient sub-center commuting patterns = no “cross hauling”



The greater VMT from centralization (*holding transport capacity and technology constant*) will also *cause more congestion* – increasing the cost per mile of travel (TC). Most simply:  $TC = VMT / Capacity$

So centralization doubly increases aggregate travel expenditure:  $TC \times VMT = VMT^2 / capacity$

Even if capacity follows VMT, employment centralization will still increase travel expenditures linearly. But what about the *reverse causation*?

Travel costs (TC) also can *causally determine* the level of employment centralization? Complicated story.



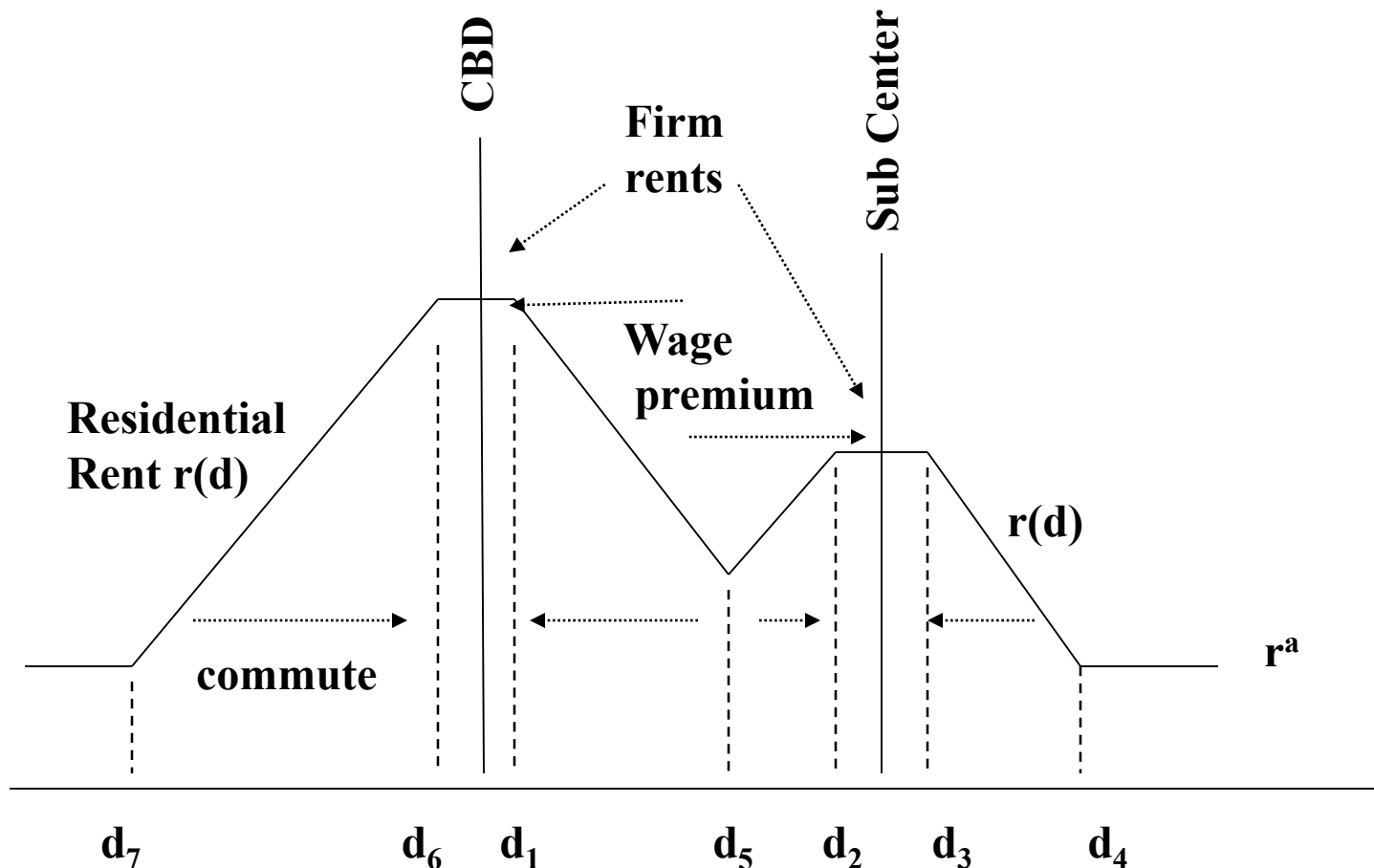


# Full Spatial Equilibrium: Requires Wage as well as Rent Gradients

- In a location equilibrium, no one wants to change the location of *either* their home or workplace.
- For workers at a particular work location – what insures that they are indifferent to various residential locations? Traditional Ricardian housing Rent gradients.
- For residents at a particular home location what insures that they are indifferent to switching jobs? *Different Wages*. Job locations with longer commutes, higher travel expenditures must compensate for that incremental cost.
- Hence “Wage Gradients”. Larger employment centers (e.g the CBD) must draw workers from a farther work-shed and hence pay more for that longer commute
- Not so for a smaller LWP employment sub-center.



**Commuting, Land Rent and wages in an MSA with multiple centers. In Larger centers Firms pay a wage premium as well as higher land rent. How large are these premiums?**





## The cost of greater Subcenter Size.

- Subcenter workers living at  $d_5$  pay the same for land/housing as CBD workers living there, but have a shorter commute. Hence CBD wages must be higher by the commute difference:  $(d_5 - d_1)$  versus  $(d_2 - d_5)$ .
- Note that land rents still make workers that are employed at each center indifferent about living at different locations *around that* center.
- Firms at the CBD now must pay both higher land rent (equal here to residential), and also pay higher wages for labor. Typically:
  - Rent (per worker): 200sqft x \$15-20 [e.g. \$3500]
  - Wages: 15% more [e.g. \$13,500] .....



# MIT Center for Real Estate

## MIT study for 4 MSA of wages and average commuting time by location of employment [POWPUMA], Boston results

POWPUMA	Wage Premia <sup>2</sup>	Commute Time
1	<b>-.073</b>	22.8
2	<b>-.040</b>	25.3
3	<b>-.149</b>	19.3
4	<b>-.057</b>	22.8
5	<b>-.130</b>	18.4
6	<b>-.119</b>	20.4
7		34.3
8	<b>-.101</b>	22.7
9	<b>-.084</b>	21.9
10	<b>-.045</b>	29.1
11	<b>-.013</b>	27.6
12	<b>-.060</b>	26.3
13	<b>-.080</b>	25.6
14	<b>-.066</b>	21.1
15	<b>-.045</b>	24.1
16	<b>-.027</b>	27.2
17	<b>-.028</b>	28.6
18	<b>-.034</b>	27.1
19	<b>-.129</b>	25.6
20	<b>-.146</b>	20.7
21	<b>-.060</b>	24.4
22	<b>-.051</b>	25.0
23	<b>-.114</b>	20.6
24	<b>-.104</b>	19.4
Adj-R2 obs	.419 53979	mean 26.9 Std. Dev. 5.0

PUMA	Largest Cities
1	1400 Lowell
2	1500 Chelmsford-Tewksbury-Dracut
3	1600 Lawrence-Haverhill
4	1700 Methuen-North Andover-Newburyport
5	1800 Salem-Beverly-Marblehead
6	1900 Peabody-Danvers-Gloucester
7	2000 Boston
8	2100 Revere-Everett-Chelsea
9	2200 Malden-Medford
10	2300 Cambridge-Somerville
11	2400 Waltham-Belmont-Lexington-Arlington
12	2500 Newton-Brookline
13	2600 Quincy-Milton
14	2700 Lynn-Saugus-Lynnfield
15	2800 Woburn-Melrose-Stoneham-Winchester
16	2900 Burlington-Reading-Wakefield
17	3000 Acton-Maynard-Concord
18	3100 Natick-Needham-Wellesley
19	3200 Framingham-Marlboro-Sudbury
20	3300 Milford-Franklin-Foxboro
21	3400 Dedham-Norwood-Westwood
22	3500 Braintree-Randolph-Stoughton
23	3600 Weymouth-Hingham-Hanover
24	3700 Brockton-Whitman

<sup>1</sup> Values in bold are significantly different from zero at the 5% level

<sup>2</sup> For full-time, private sector employees



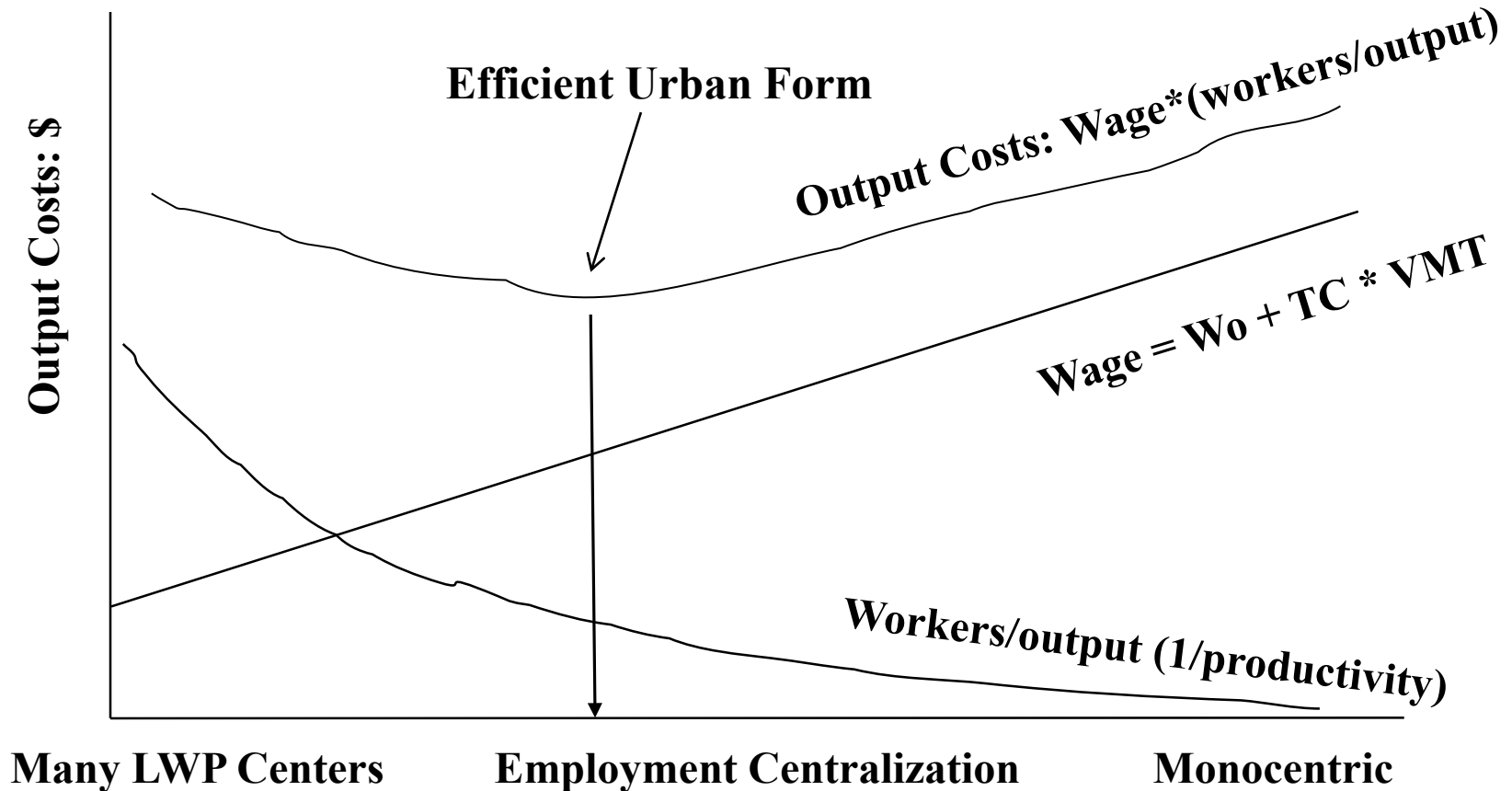
## What prevents complete employment decentralization? Economic “Agglomeration”

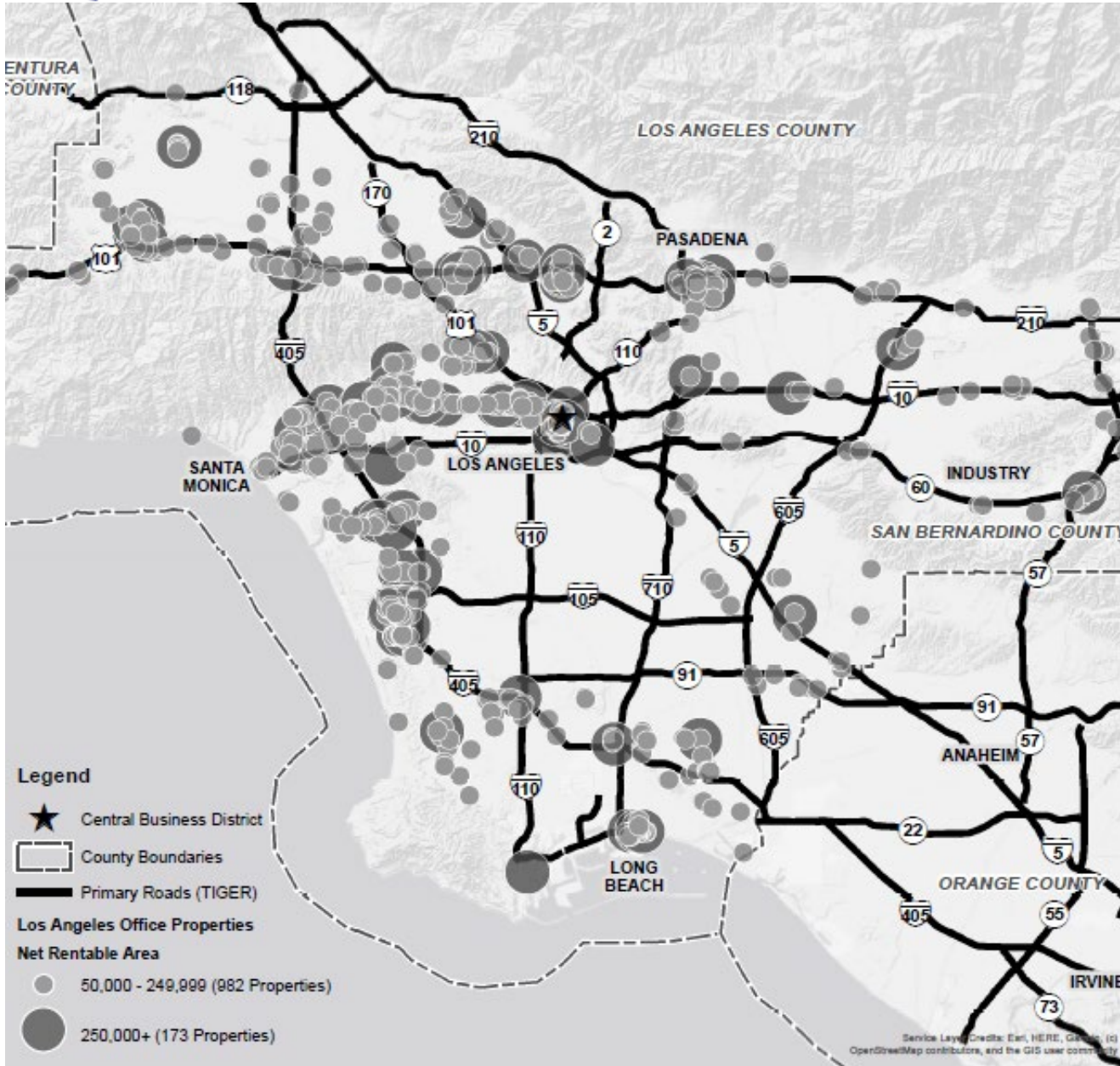
- Firms of the same type share information and ideas if they are in proximity to each other. [non competes?]
- Firms of different types that do business with each other find it more convenient if in proximity. [transportation costs are trivial and the Internet?]
- Workers can switch jobs more easily (not have to move residence) when there are many similar jobs in proximity (Fallick, Fleischman, Rebitzer, 2006).
- Firms find it easier to fill vacancies when there are many workers in other (similar) companies nearby.
- Hence firms with high worker turnover benefit from labor market density. Firms with “lifers” or low turnover do not [HQ locations, Shilton, 1999].



# Urban Form: II

Firms/workers, through the labor and land markets determine the level of employment centralization to minimize travel expenditures + production costs.





**Identifying  
LA Office  
Clusters:  
agglomeration  
versus  
commuting  
costs**



# Travel Costs (TC) and Urban Form: II

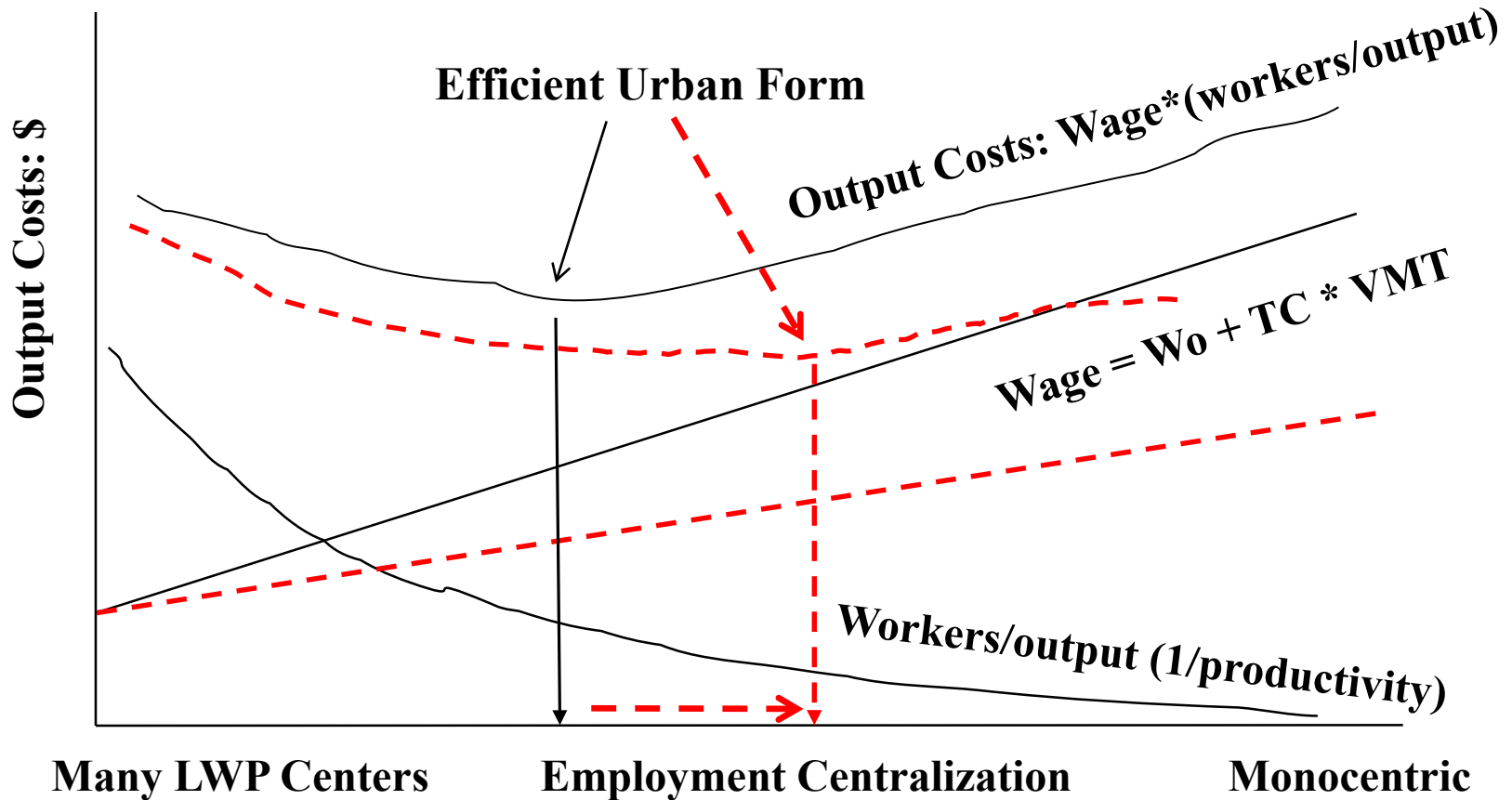
- **Any change that reduces the marginal cost of travel (TC) will provide households with greater flexibility and lower cost in deciding where to live. This flattens residential rent gradients and leads to greater *residential decentralization*.**
- **But better transportation also will reduce the wage premium that firms must pay if they choose central locations where trips are longer, congestion worse.**
- **So *firms centralize* because the opportunity cost of achieving the productivity advantages that come from clustering – is lower!**
- **Households don't mind the long commutes that come from this centralized pattern, because travel is now less onerous.**





# Urban Form: II (contd)

**Lower travel costs per mile (TC), resulting from improved transportation generates greater employment centralization, and increased VMT**





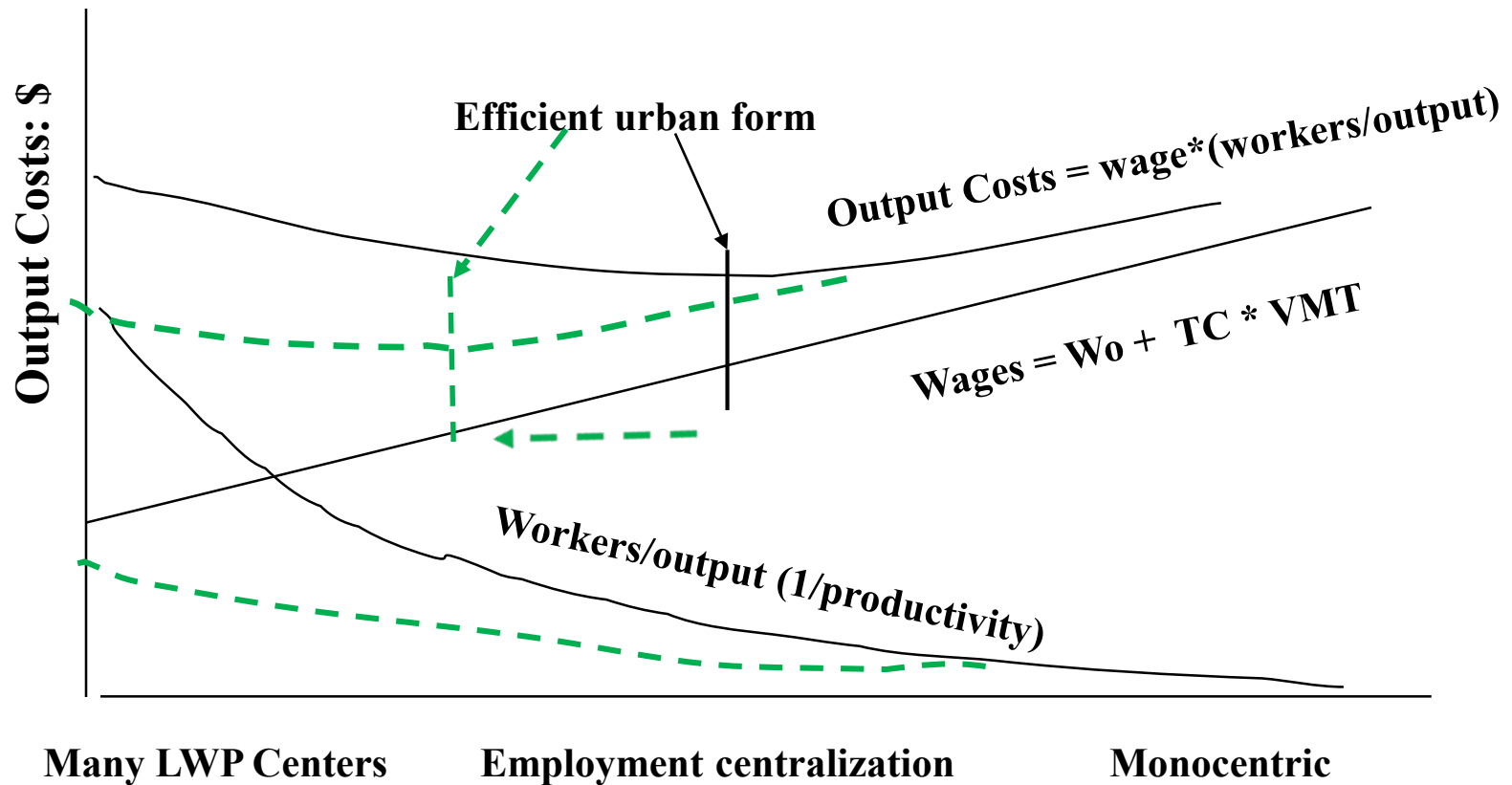
## Improvements and Travel Costs (TC)

- **EV's have 25% of the operating cost (repairs, fuel..) as do current Internal Combustion cars. Also easier fueling (at home) may offset range anxiety.**
- **Autonomous driving offers the *promise* of a robot chauffeur. Time spent in a car should become far less onerous. Ditto ride hailing.**
- **Autonomous driving offers the promise of vehicle coordination. This increases the capacity of the current road system – faster travel.**
- **Average store purchase uses 7.8 VMT to get it home  
Average UPS delivery uses .6 VMT to get it to you!**
- **All generate reductions in the cost of travel (TC).**



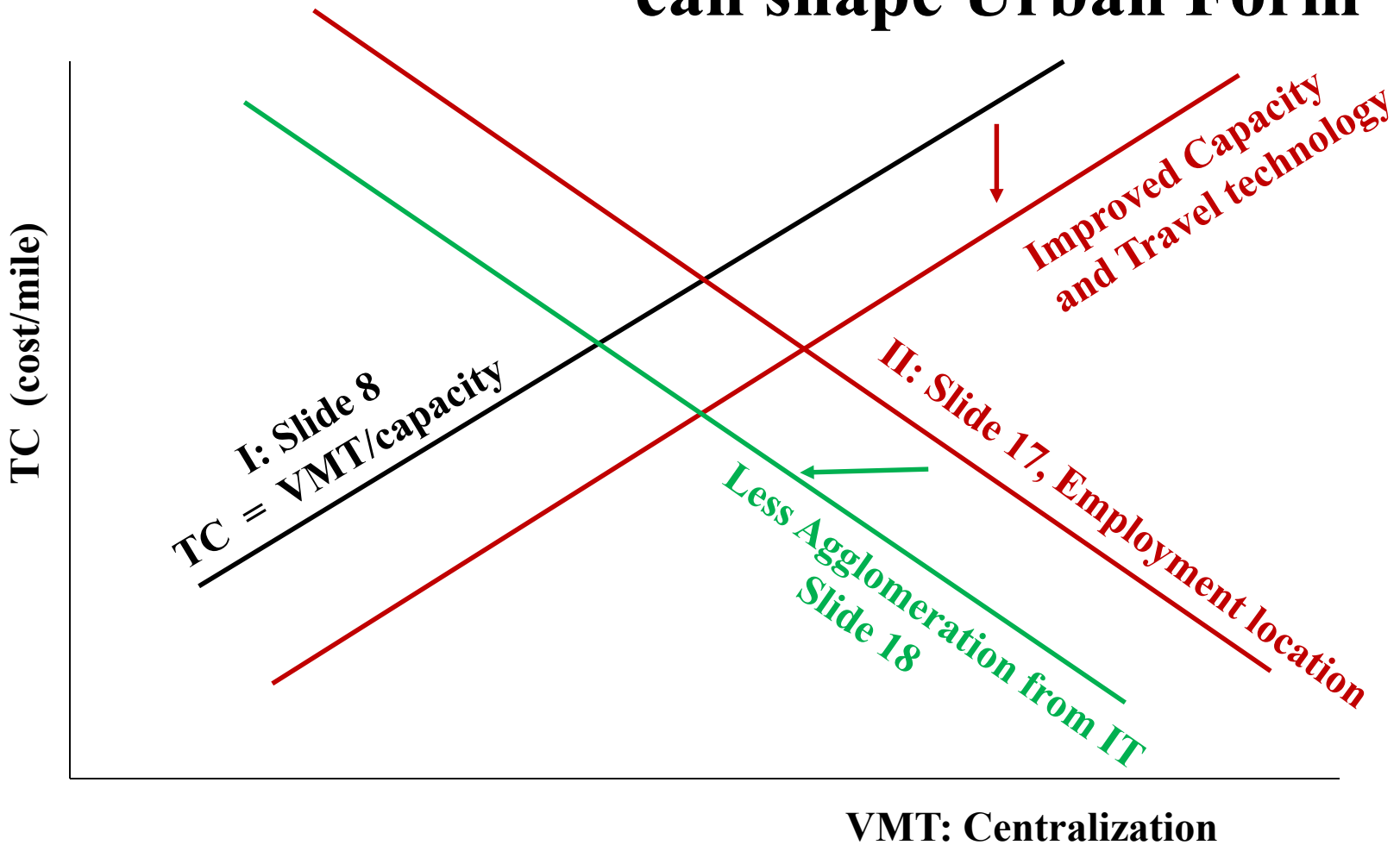
# Urban Form: II (contd)

Information Technology often thought to **reduce Agglomeration benefits** (work remotely, teleconferences, common data platforms).  
Traded off against travel expenditures -> disperses employment .





# Combining Relationships I and II: how Technology can shape Urban Form





# Urban Form: wrapping it up

- Firms prefer higher productivity from central clustering but pay higher wages if their workers commute further.
- Monocentric cities = long commutes, higher wages, but higher productivity (firm agglomeration)
- LWP villages = short commutes, lower wages, but lower productivity from loss of firm agglomeration
- Empirical hypotheses:
  - Monocentric: where/when TC is low, agglomeration strong
  - Dispersed: where/when TC is high, agglomeration weak
- What about the role of history – particularly in older cities?



- “Making the Modern Metropolis: London”, Heblich, Redding, Sturm (2017). London’s urban form evolves exactly with the economic forces in slides 17 - 18.
- Pre 1840, London was a series of neighborhoods each with shops, small fabricators. Those working there also lived nearby, intermingled uses. Travel was tedious and slow (walking through narrow streets). Carts...
- Post 1840, the invention of rail, then subway allowed for people to start living apart from their work, and for the first time real commuting began
- Post 1840, firms agglomerated both from industrial revolution scale economies and also because modern transportation permitted employing commuting workers.



# Recent MIT work on Technology and Real Estate

1). Industrial Automation and industrial space demand.

[[https://mitcre.mit.edu/wp-content/uploads/2018/09/Industrial-Robots-and-Space-Demand\\_102220181.pdf](https://mitcre.mit.edu/wp-content/uploads/2018/09/Industrial-Robots-and-Space-Demand_102220181.pdf) ]

2). The cost/space efficiency of alternative retail venues

[<https://mitcre.mit.edu/wp-content/uploads/2019/02/Bricks-clicks-III1.pdf>

3). Will “CoWorking” actually work?

[<https://mitcre.mit.edu/wp-content/uploads/2018/05/will-coworking-work-II.pdf>]

4). Technology and Urban Form

<https://mitcre.mit.edu/news/prof-wheaton-presents-research-automation-urban-form>]