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Agglomeration and Spatial Interaction

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Master in Business Analytics

18/04/2020

How did we get to live in cities?

- From a nomad to a sedentary society

- Ideas of what happened later?

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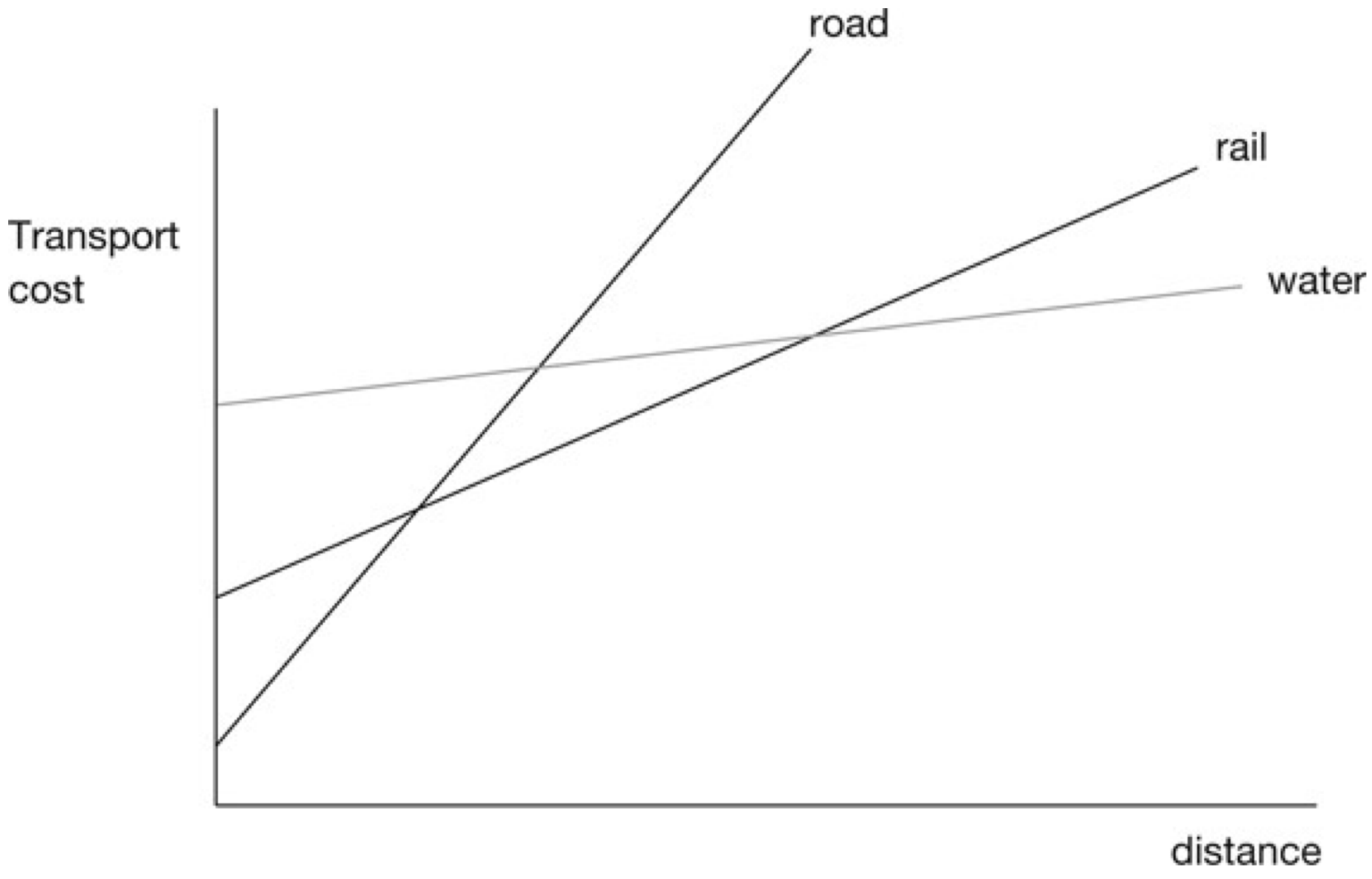
Transportation Costs



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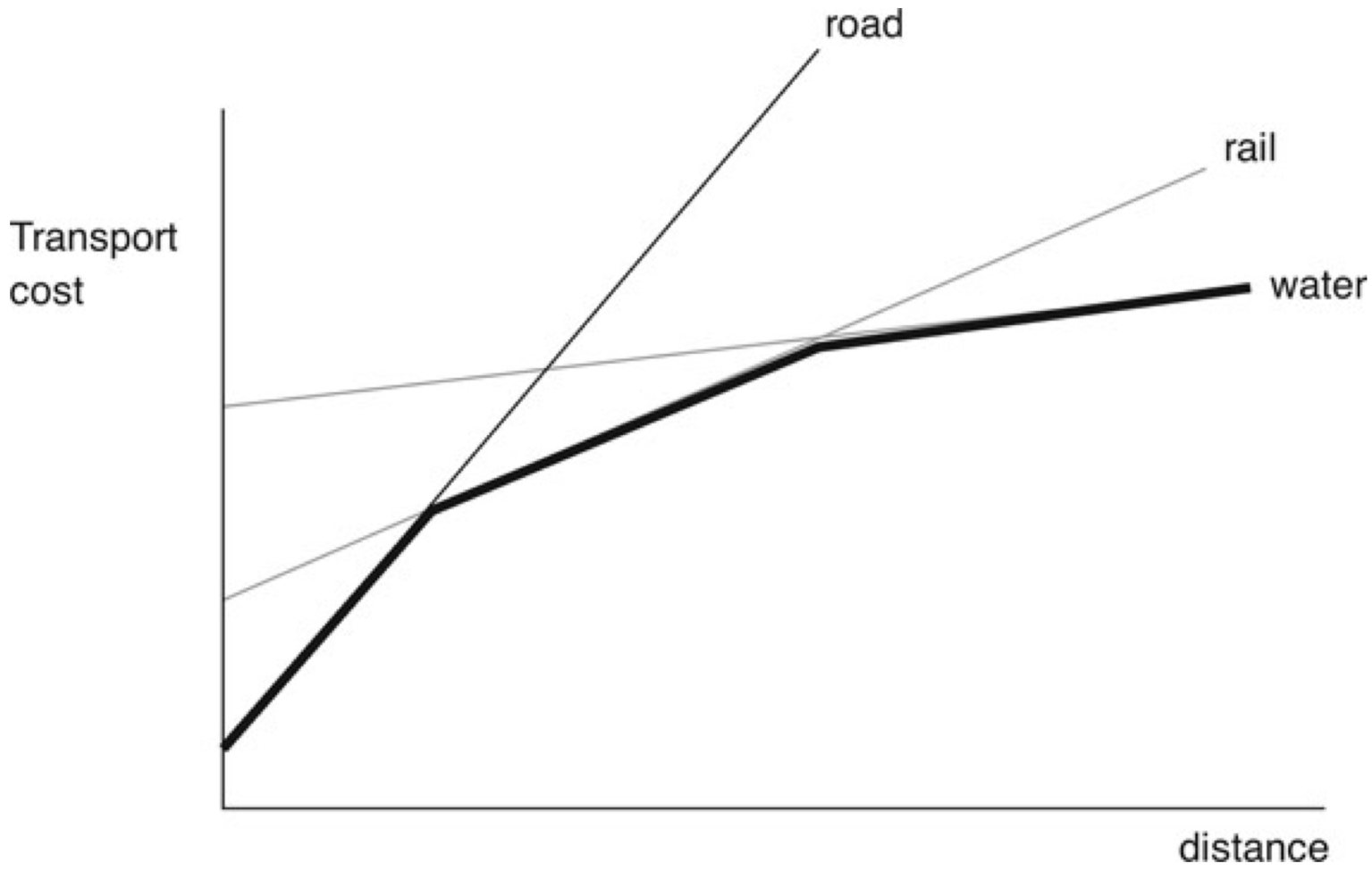
Transportation Costs



Transportation Costs

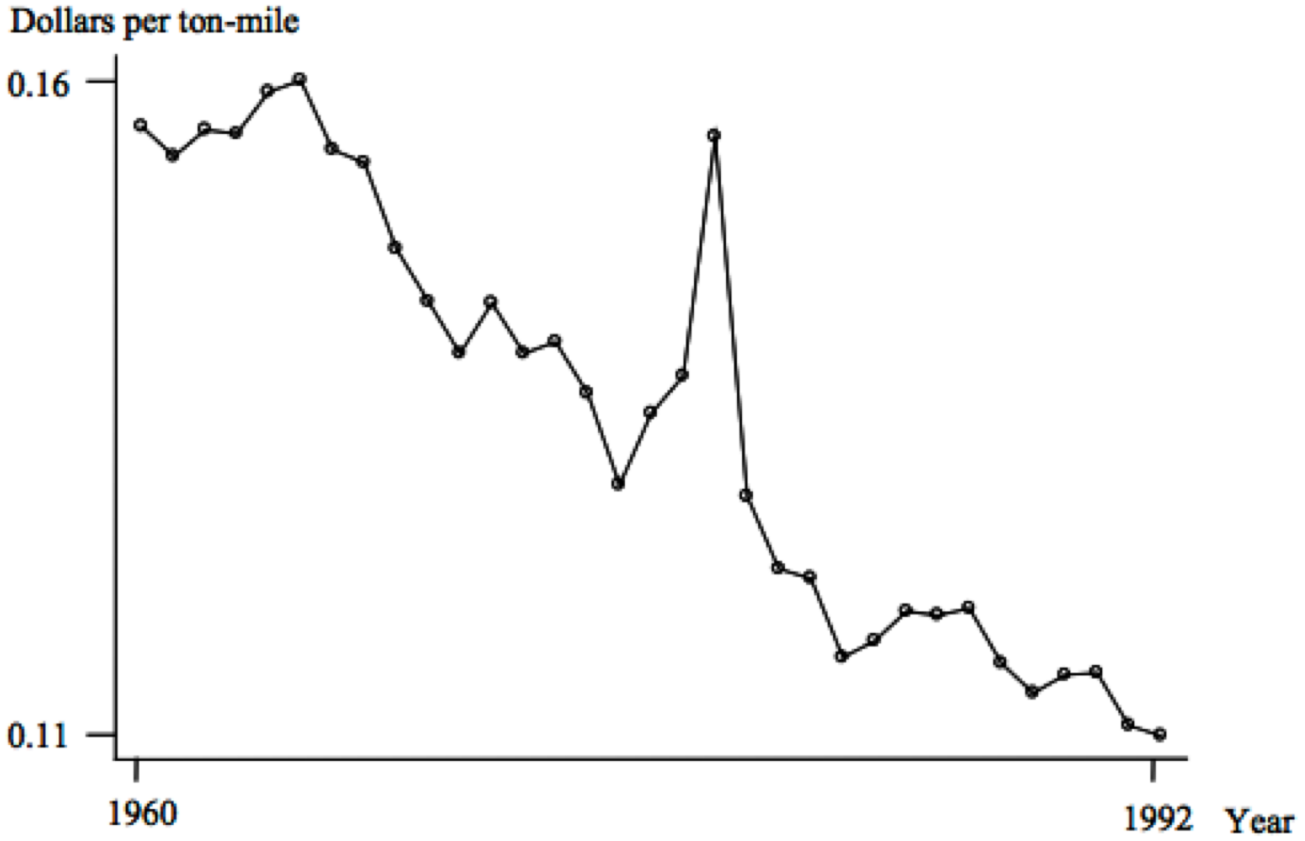


Fig. 5. Revenue per ton-mile, all modes together
Source: Bureau of Transportation Statistics Annual Reports

In: Glaeser, & Kohlhase (2003) Cities, Regions and the decline of Transport Costs

Transportation Costs

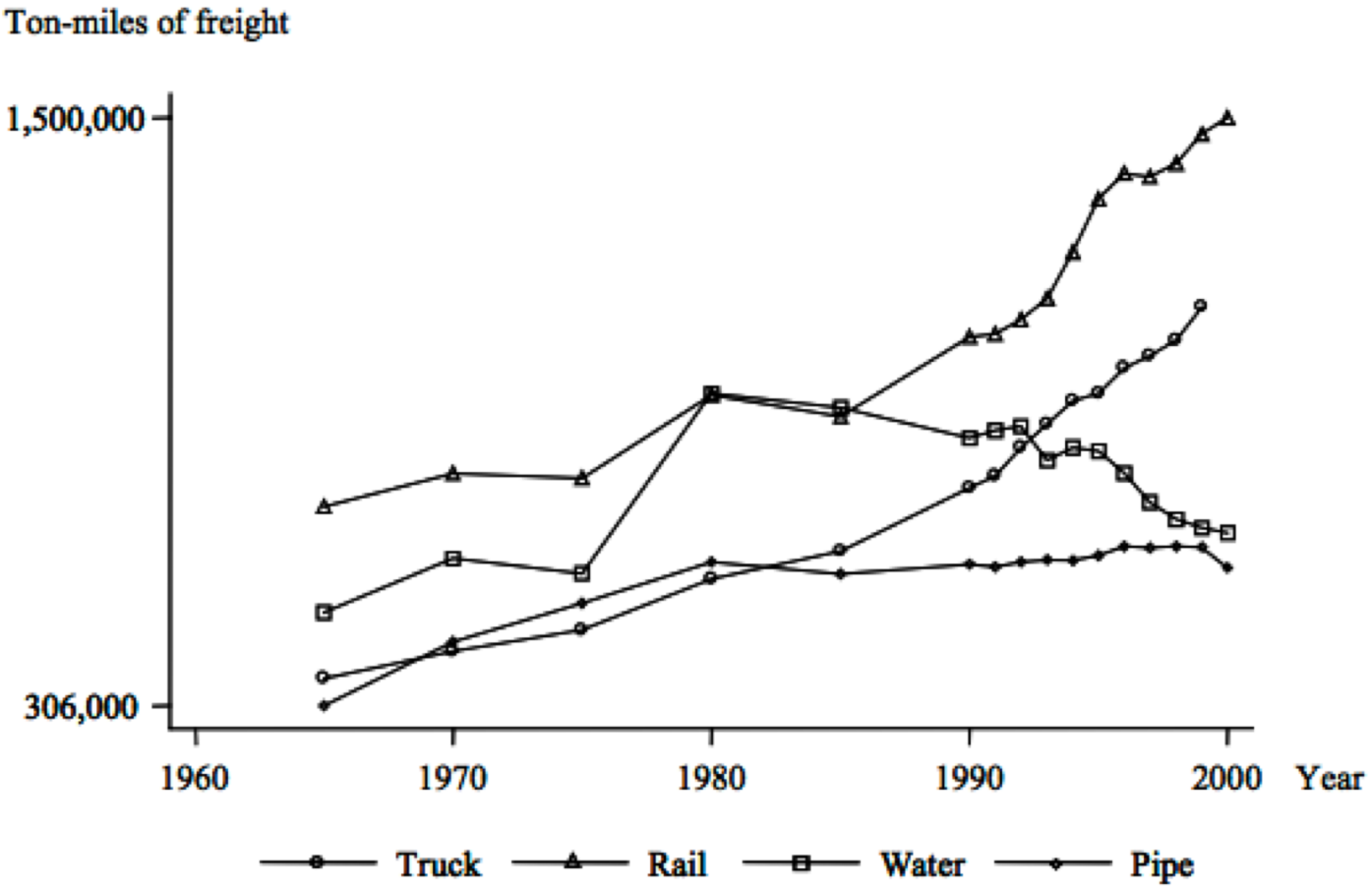


Fig. 6. Ton-miles of freight over time
Source: Bureau of Transportation Statistics Annual Reports

In: Glaeser, & Kohlhase (2003) Cities, Regions and the decline of Transport Costs

trade

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Learning Objectives

1. Agglomeration Economies
2. Agglomeration as a human condition
3. Types of Agglomeration Economies
4. Empirical Evidence
5. Markets and Spatial Markets

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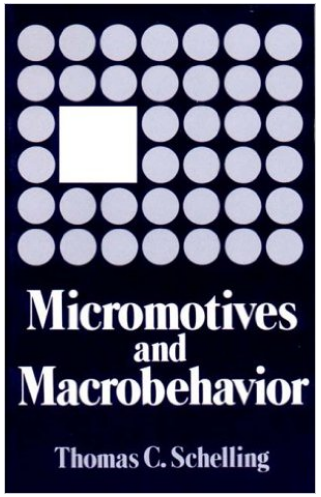
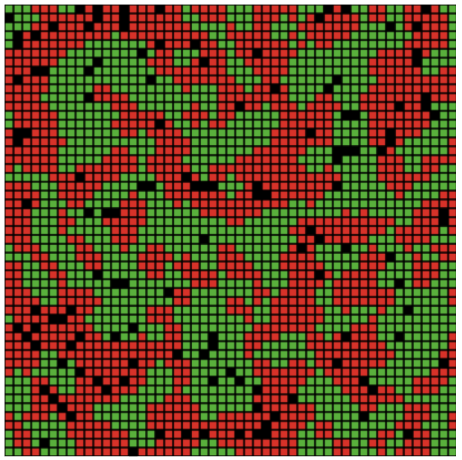
The Schelling Model

- A 1978 model of spatial segregation
  - Book: Micro-motives and Macro-behaviors
- Micro-motive: People move if they are unhappy
- Macro-behavior: Spatial segregation
- Have you seen any other patterns?





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Homophily = Love for the similar

- Some spatial configurations we see come from individual preferences
  - How much these preferences reveal more than just social constructs?

- Is the Schilling model telling us something about economics as well?
- Is there a version of this in the economic world?

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Agglomeration Economies

- Can happen at:
  - the social level & the economic level
- Why?: Benefits of agglomeration
- Economies of Scale: *Internal*
  - *Def*.: Advantages from the size of production per firm
    - division of labor / factory system → Pins
    - Capital Indivisibility → farming
    - Statistical scale Economies → shoe sizes

"if production is at a larger scale it will be concentrated at fewer points in the landscape"

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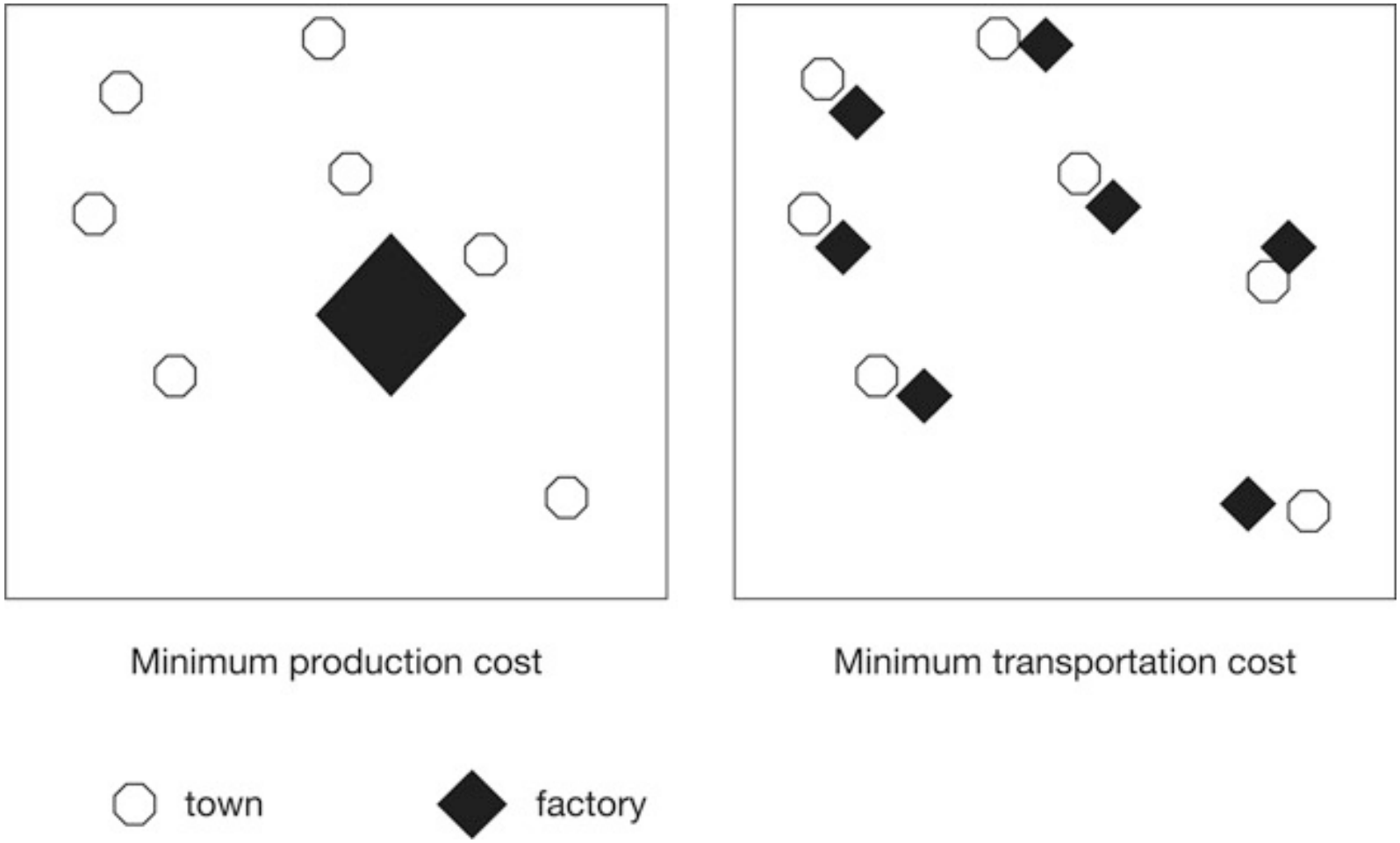
Agglomeration Economies

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Agglomeration Economies

- Economics of Scale: *External*
  - *Def*.: Advantages from the size of an industry or groups of firms
    - *Main benefit*: combined scale of production in an industry
    - Industrial complexes (collaboration)
  - The Akron tire cluster:
    - Does anyone knows about this?

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Types of Agglomeration Economies

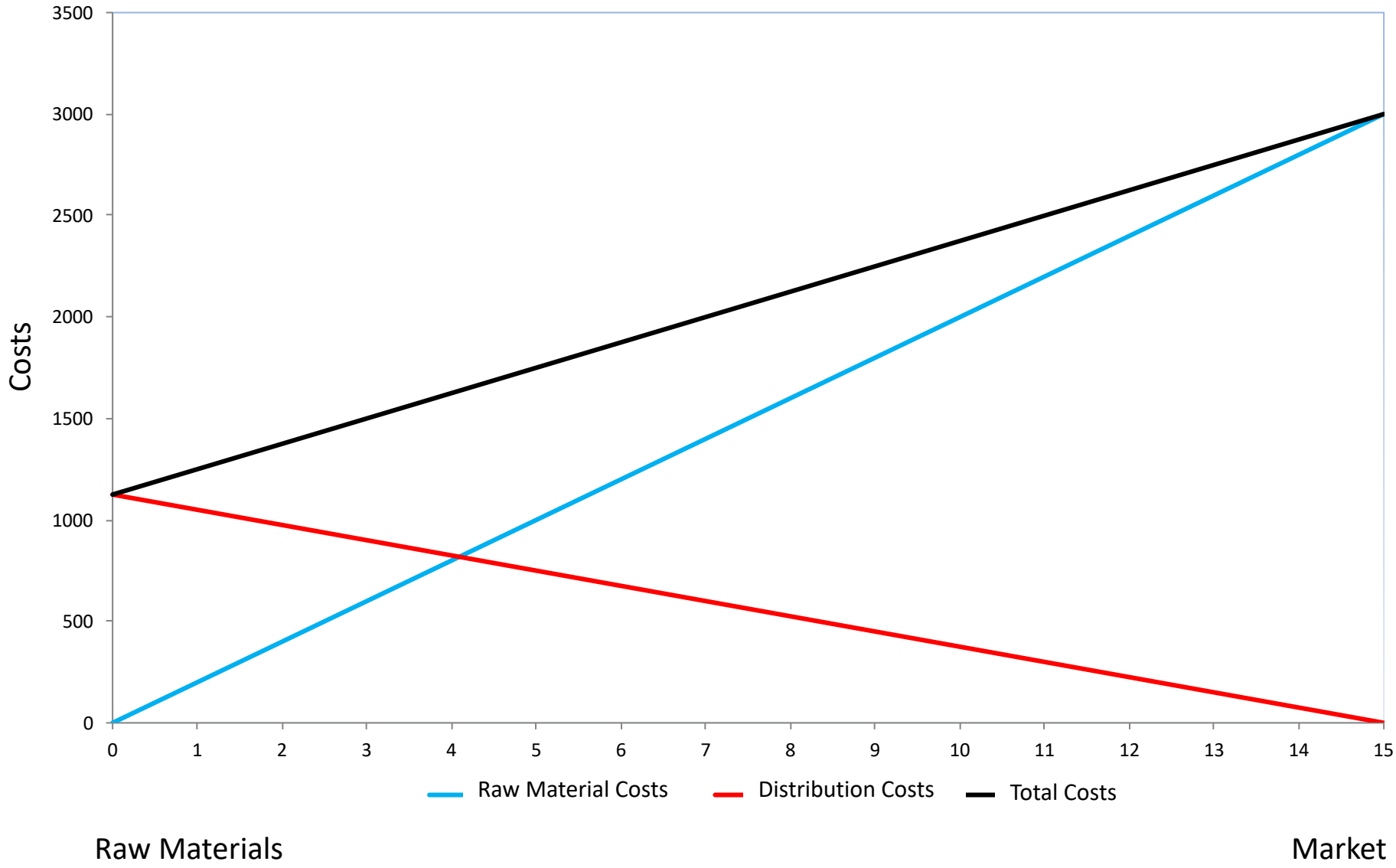
- Urbanization Economies
  - Sewer pipes
  - Juxtaposition economies
  - Diversity/Creative Class
- Localization Economies
  - Labor sorting/skills
- Natural advantage
  - Natural and localization economies are not mutually exclusive

Resource Oriented vs. Market Oriented

- *Type of Firms*: Transportation Costs are the main factor to decide a location
- *Objective*: Minimize Total Costs
- *Type of Cost*: It doesn't matter the brut cost, but the "monetary weight"
  Weight Input * Trans. Cost
  Weight Product * Trans. Cost

	Resource Oriented	Market Oriented
Type of Activity	Weight loss	Weigh gaining
High costs in	Raw Materials (RM)	Distribution (D)
Costs differences	RM > D	D > M
Distance to the market	High	Low

Resource Oriented Firms



Raw Materials

Market

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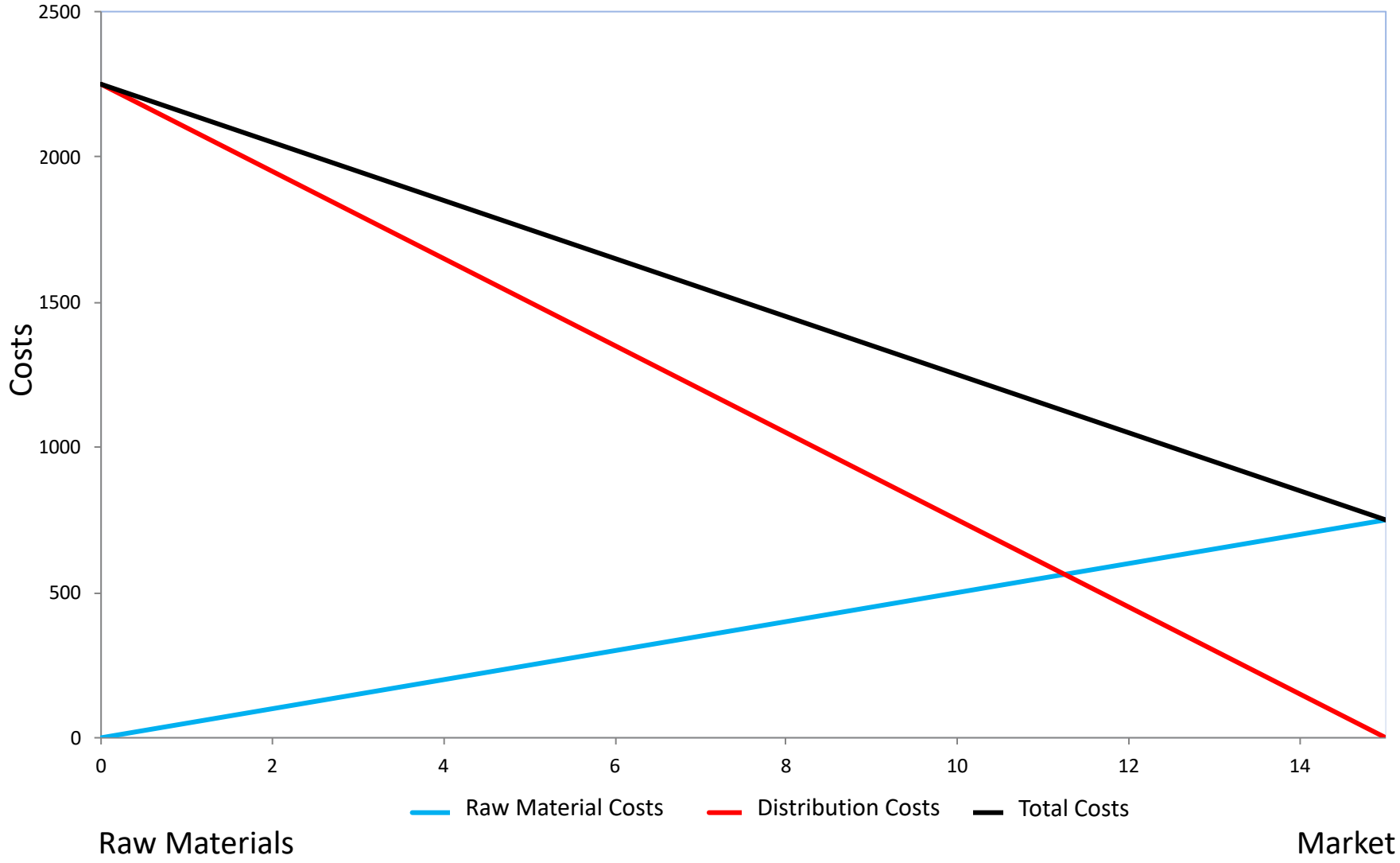
Market Oriented Firms



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Economies of Scale in Transportation

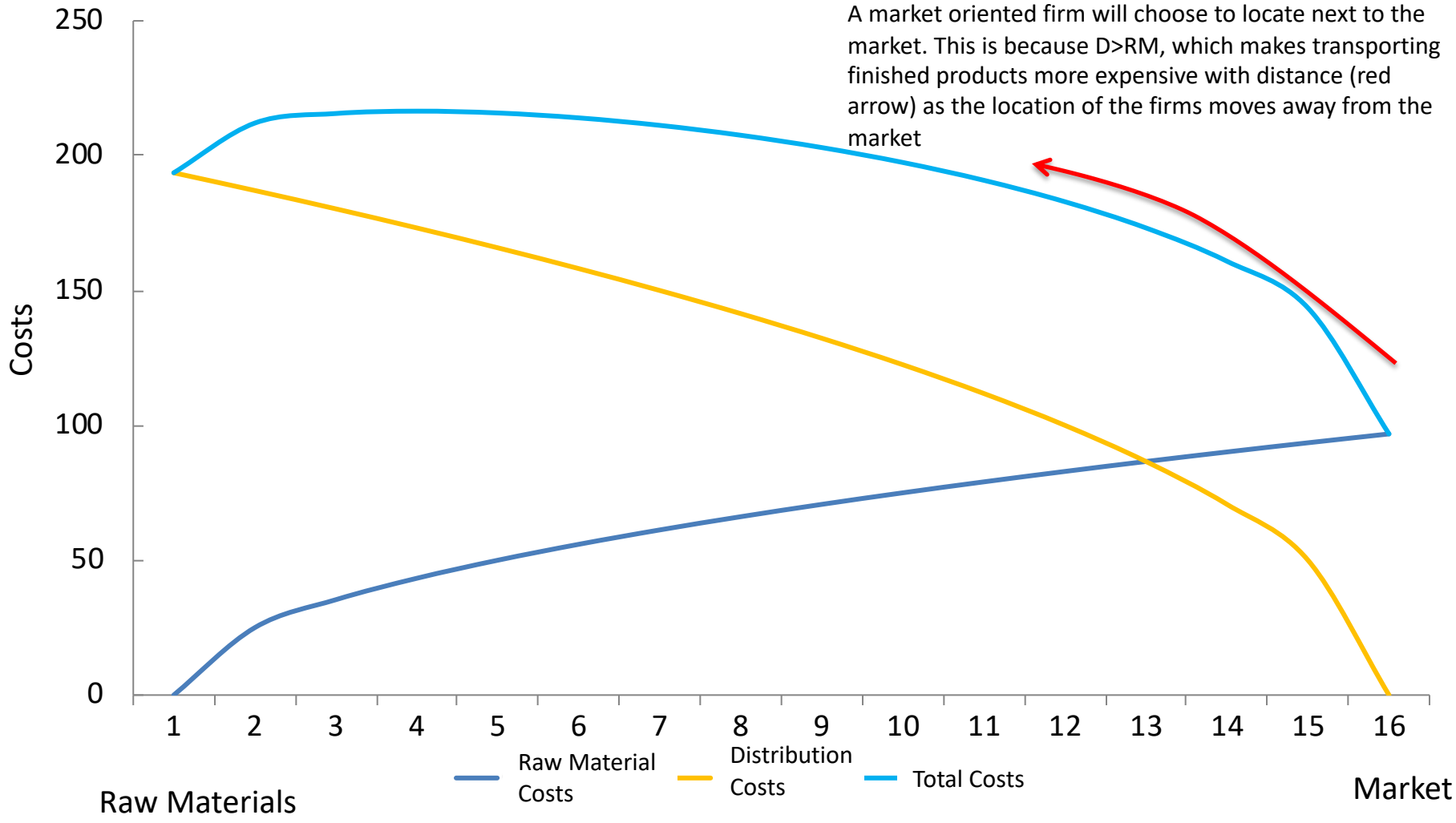
- The medium costs *decrease* with distance
  - Bureaucracy fixed costs
  - Efficiency of new technologies

- Examples?

- *This reinforce the tendency of businesses to locate next to:*
  - *Inputs -> Resource oriented firms because RM>D*
    - *These firms will prefer transporting finished products (Distribution costs) rather than raw materials (RM)*
  - *Markets -> Market oriented firms because RM<D*
    - *These firms will prefer transporting raw materials instead of finished products*

Market Oriented Firms

With Economics of Scale in Transportation



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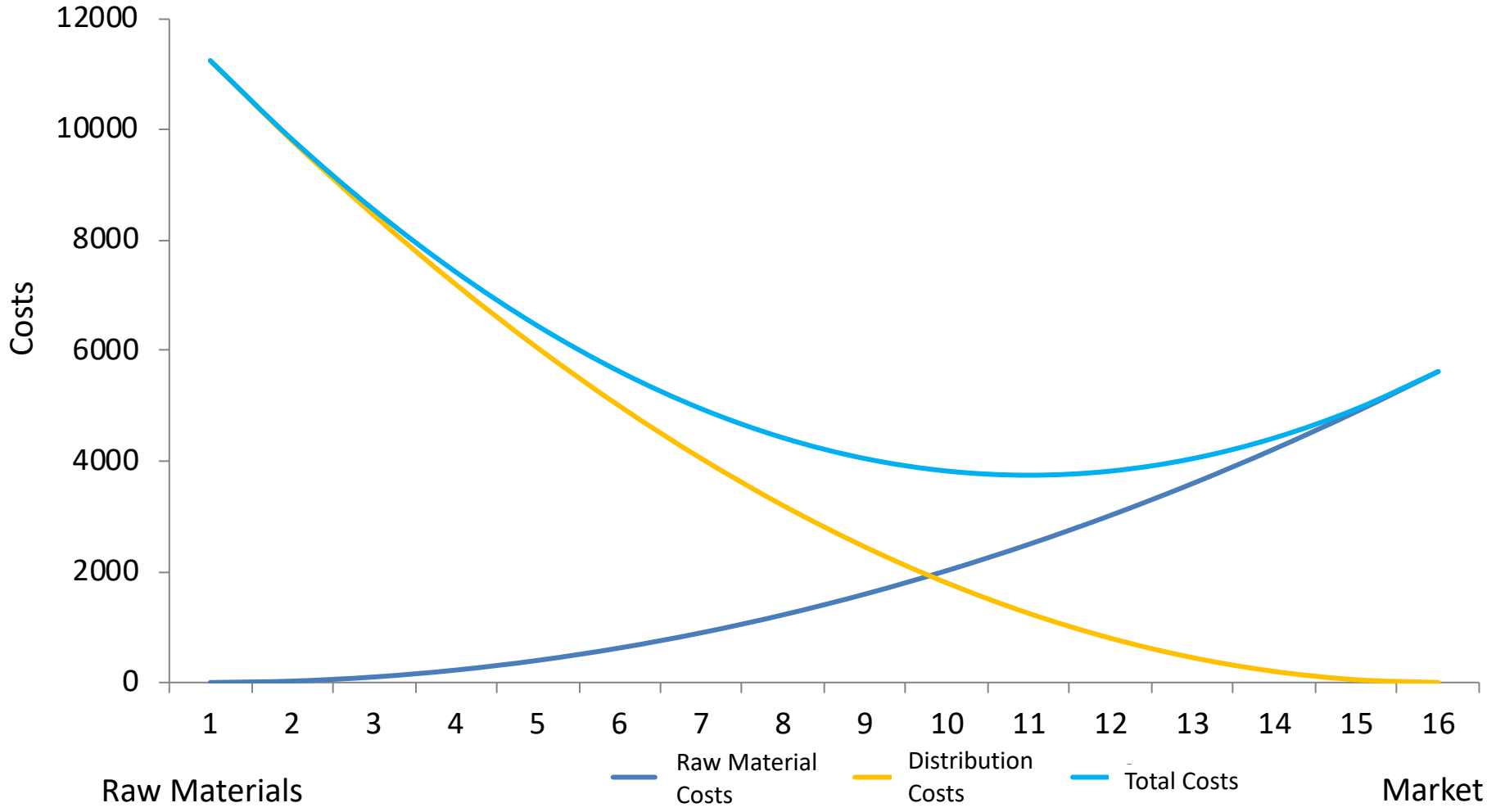
Diseconomies of Scale in Transportation

- The medium costs *increase* with distance
  - Bureaucracy costs increase (border, tolls, etc.)
  - Changes in means of transportation
- Examples?
- *This reinforce the tendency of businesses to locate intermediate to inputs or markets*
  - *This is because as costs increase with distance, shipping long distances of one or the other makes them expensive regardless of their initial costs*
  - *As a result, the firm will prefer to locate where the monetary weight from transporting raw materials equals the one of distributing a product RM =D*

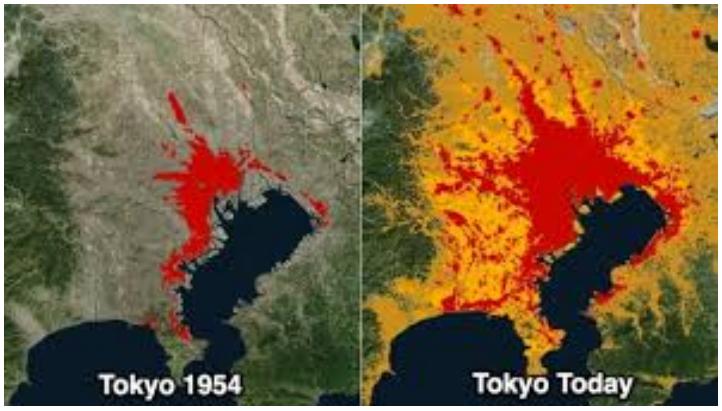
Market Oriented Firms

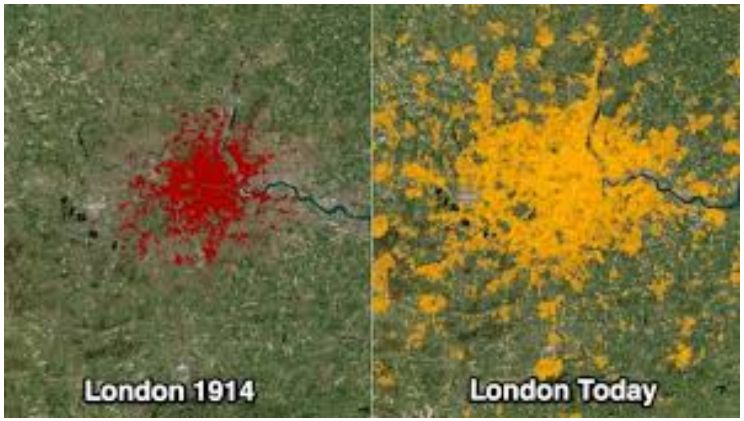
With diseconomies of Scale in Transportation



Empirical Evidence

- Cities are the best example of agglomeration economies





Chicago's Expansion??

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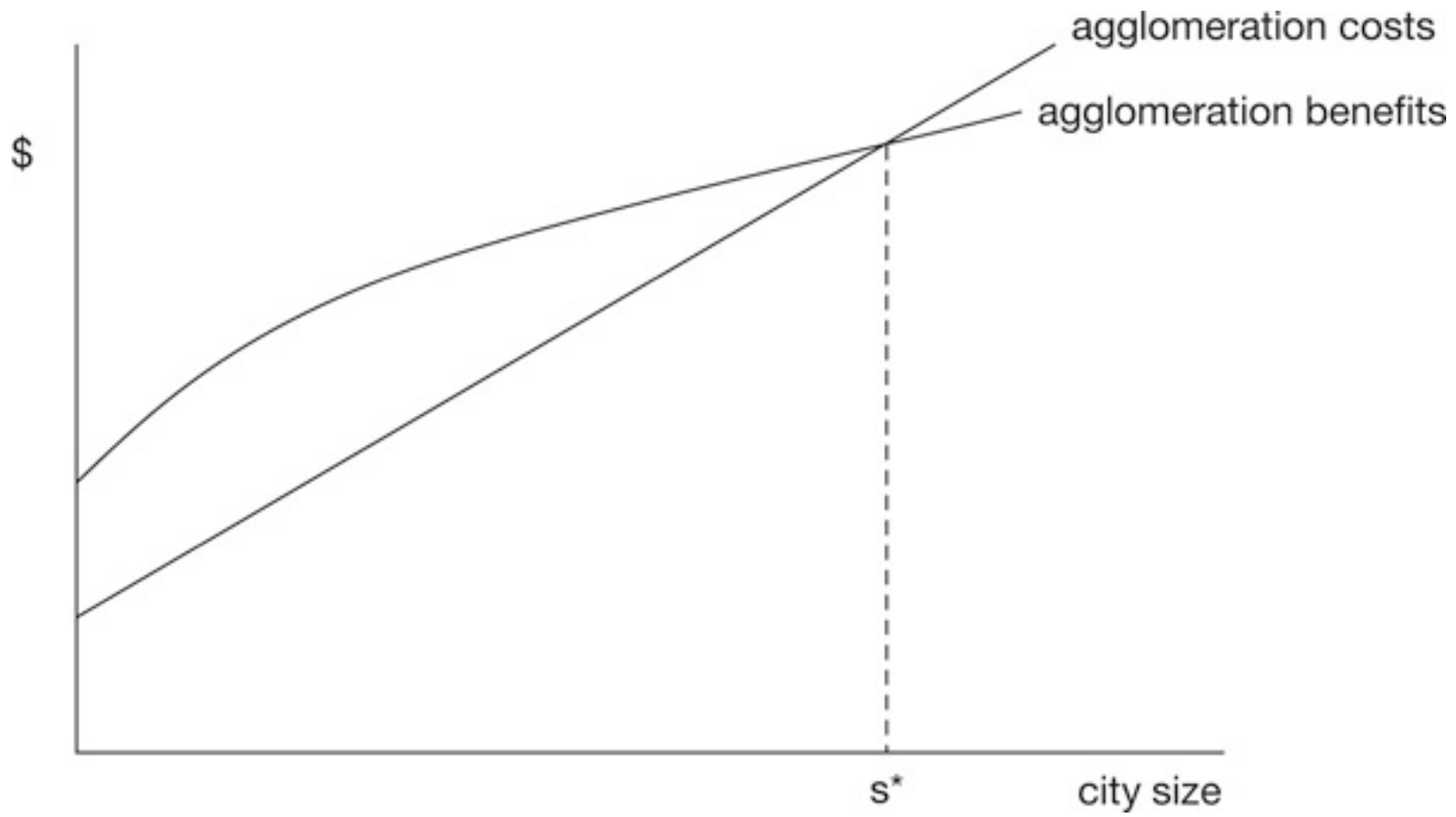
Is agglomeration always good?



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SPATIAL STATISTICS
PART 1

Slides inspired on Luc Anselyn's Lectures on Spatial Data, Spatial Analytics, and Spatial Data Science
Watch Luc's video on: https://youtu.be/MmCYeJ27DsA

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ESDA

- Exploratory Spatial Data Analysis (ESDA)
  - Extended EDA to space
  - More than just mapping
    - Mapping – take a variable and plot it (results)
  - ESDA Definition
    - Understand that spatial information as a key component of the data exploration process
    - Focuses on spatial patterns
  - ESDA Activities
    - Describe spatial distributions – dynamic maps
    - Identify atypical observations – spatial outliers
    - Discover patterns of spatial dependence and spatial heterogeneity
      - Spatial clusters, hot/cold spots
      - Spatial structured breaks
      - Spatial aggregation – Functional Labor Market areas

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Types of spatial association

- Spatial randomness (null)
- Spatial autocorrelation
  - Clustering pattern vs. Finding Clusters
  - Positive
  - Negative
- Common issues
  - Scale of Aggregation - MAUP
- Statistics
- Spatial weights

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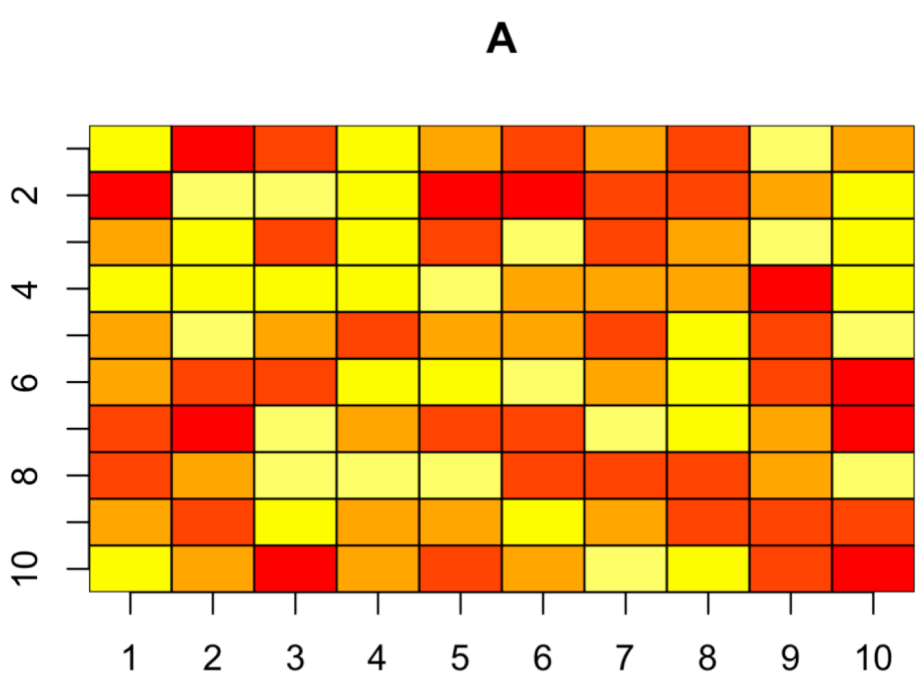
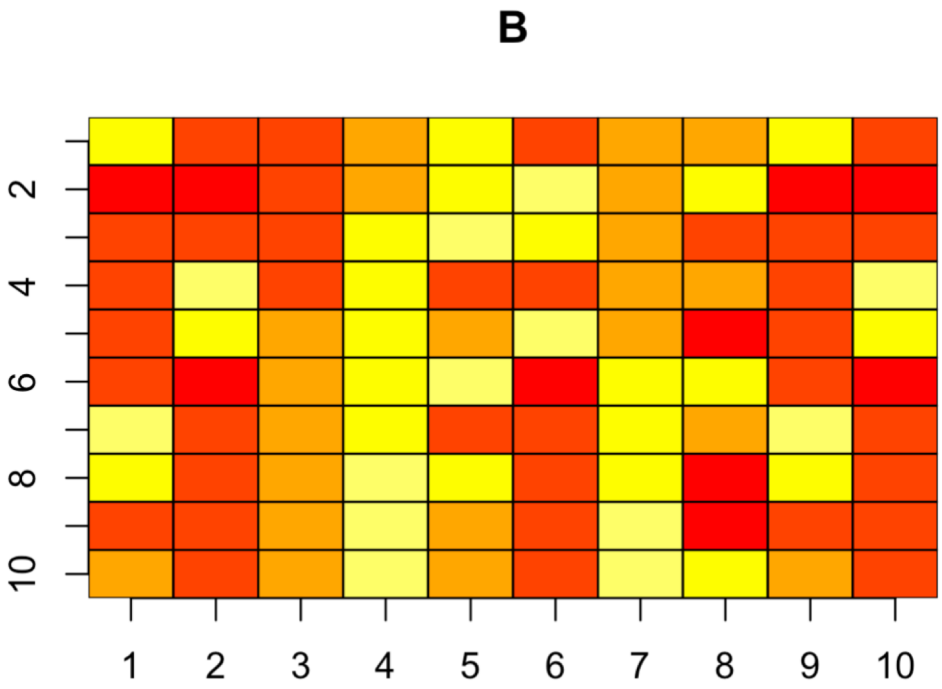
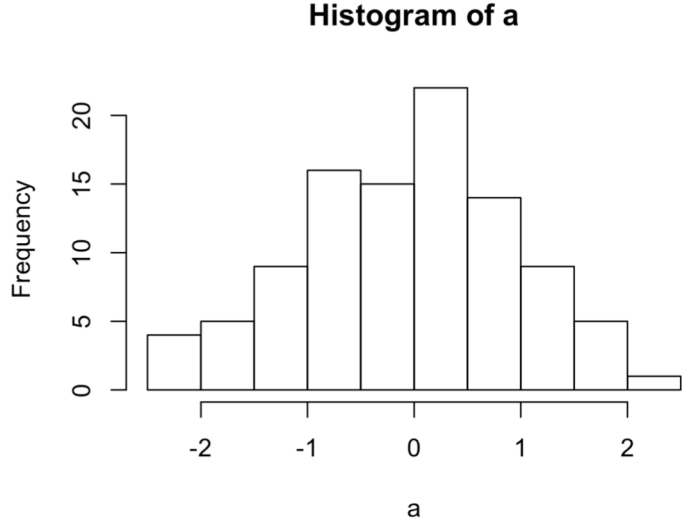
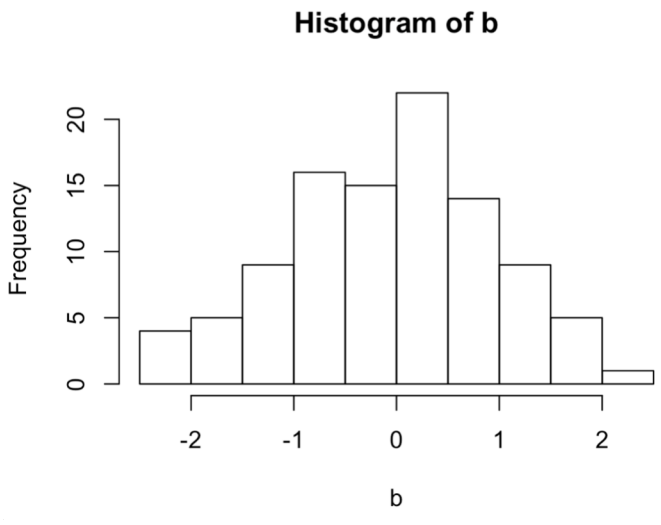
Spatial Randomness?









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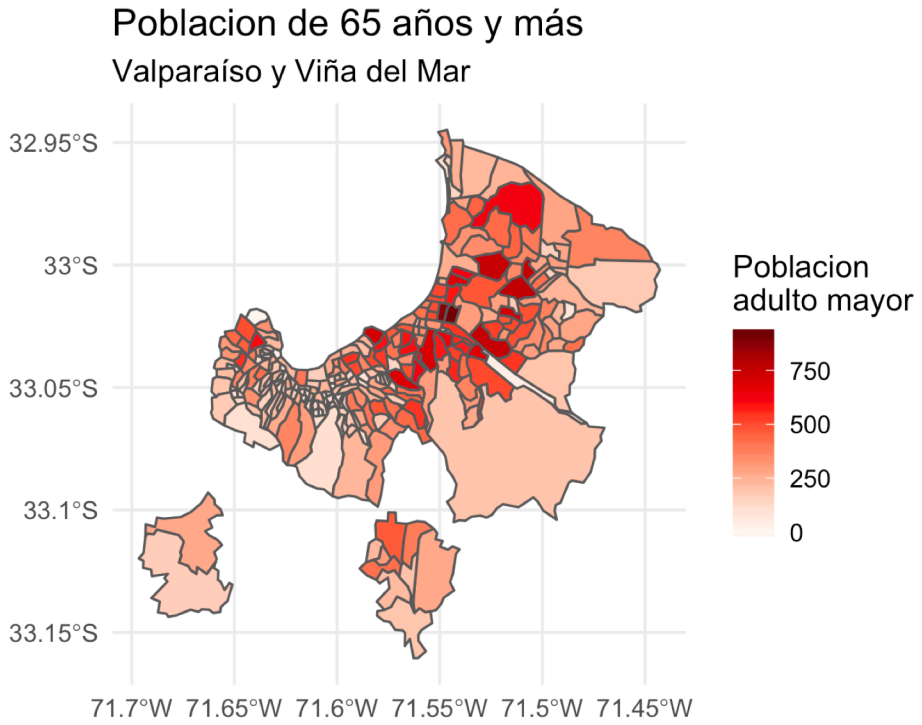

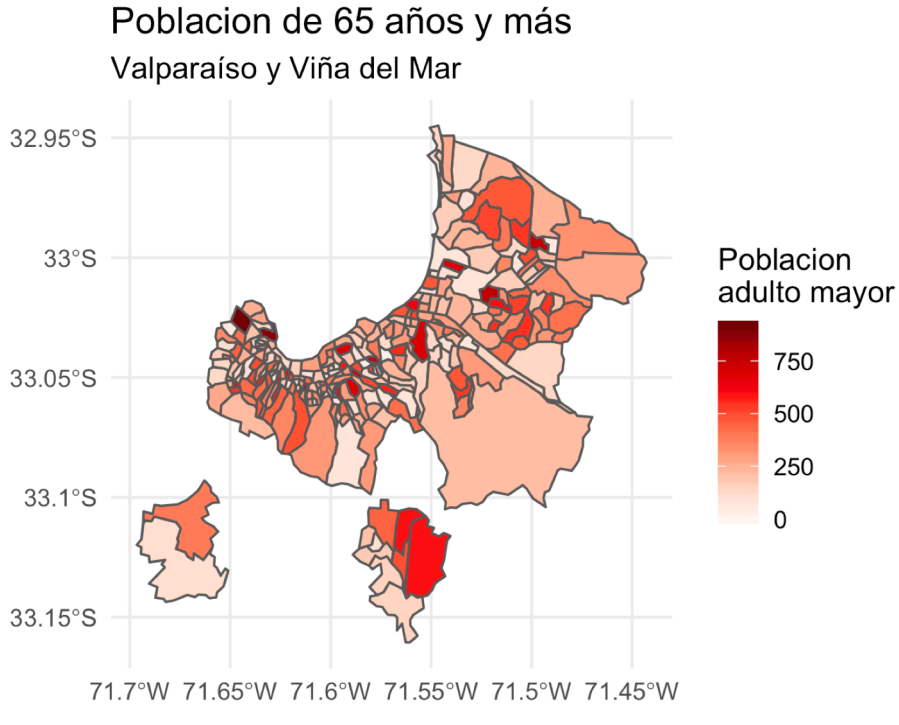

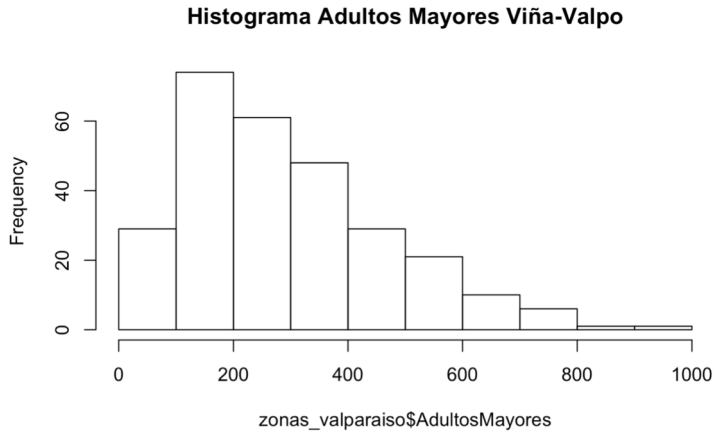

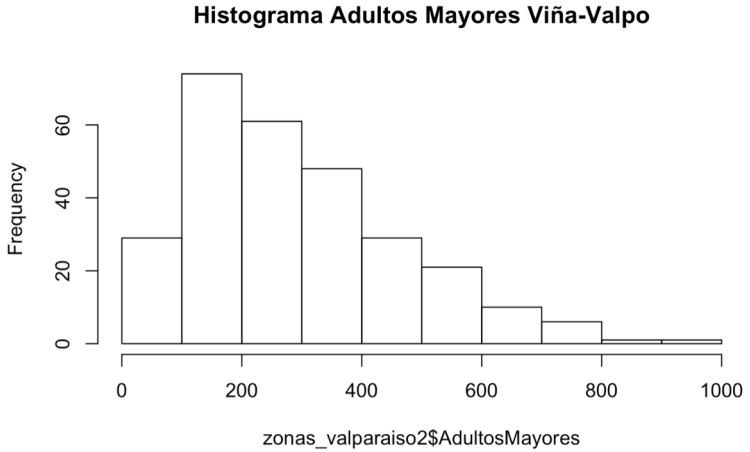

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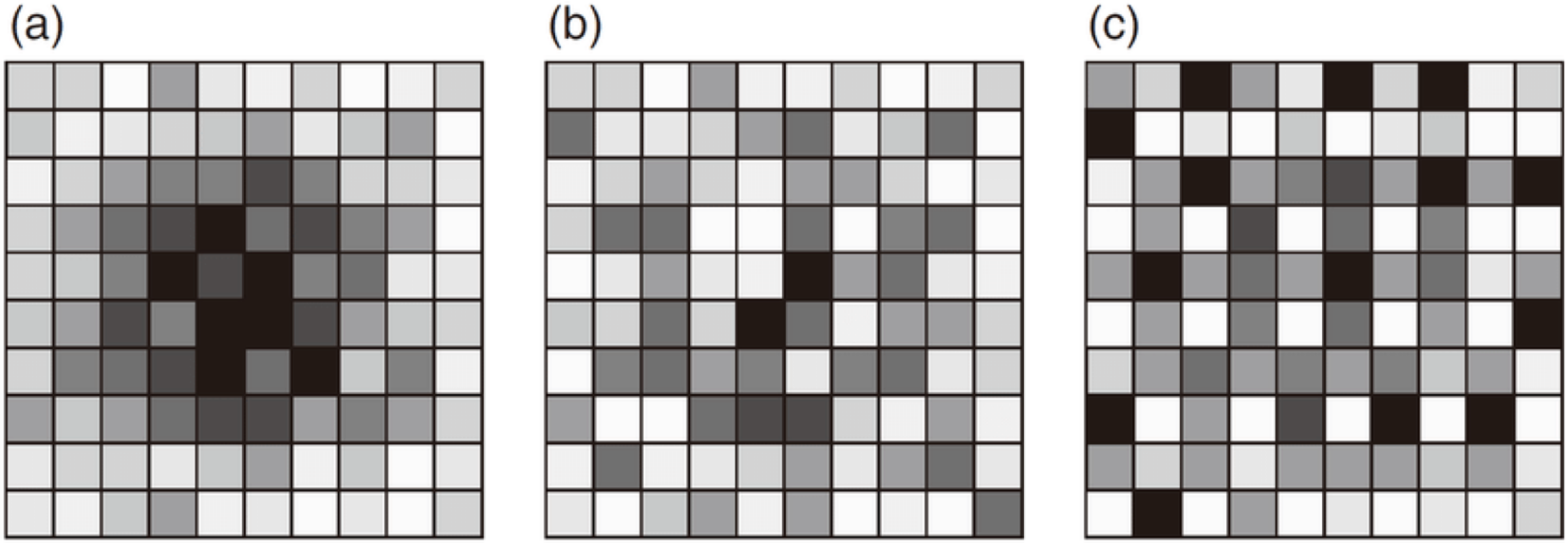
Autocorrelación Espacial Positiva

- Agrupamiento general de valores de una variable
  - valores similares estan más cerca que valores menos similares
    - First Law of Geography – Tobbler
  - Valores similares pueden ser altos (high → hot spots) o bajos (low → cold spots)
  - Dificultad para confiar en la percepción humana

Spatial patterns of correlation



Positive Autocorrelation

Spatial Randomness

Negative Autocorrelation

Source: https://www.researchgate.net/publication/327345078_Modelling_Irregular_Spatial_Patterns_using_Graph_Convolutional_Neural_Networks

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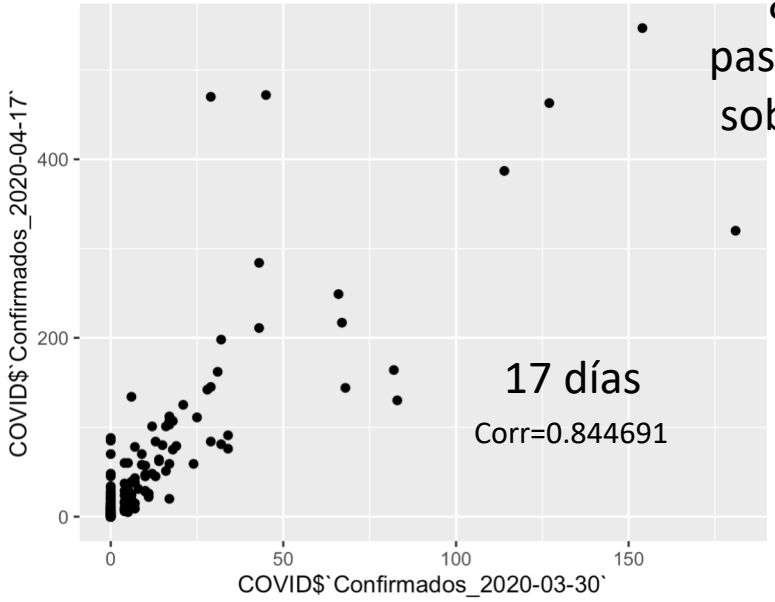
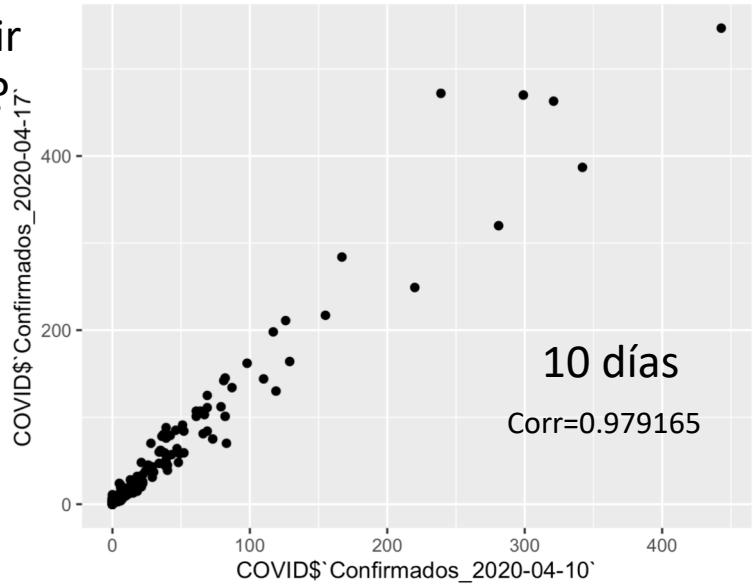
Test Statistics

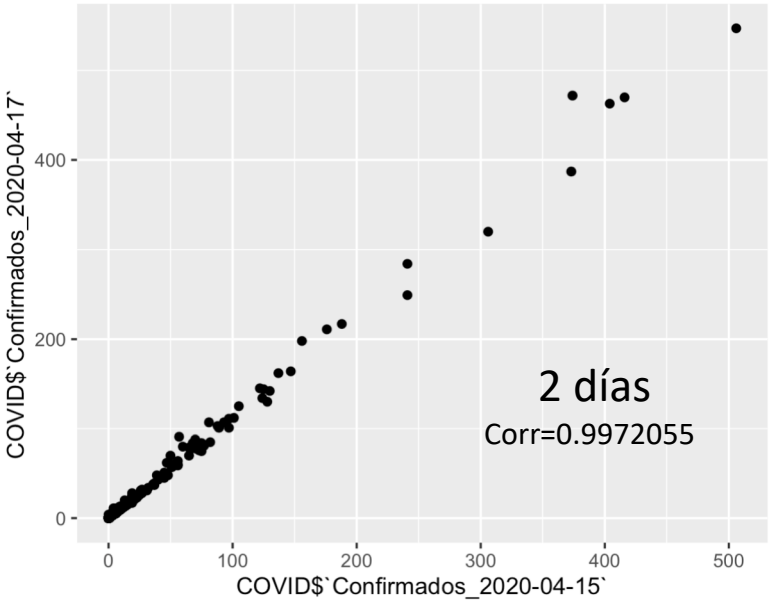
- Statistic
  - value that summarizes the distribution
  - Calculated from the data
  - Compared to a reference distribution
  - How far is the statistics from the null hypothesis?
- Spatial autocorrelation Statistic
  - Attribute similarity
    - Based on the values of the data
    - Autocorrelation corr(y_i,y_j), with i,j as different locations
  - Locational similarity
    - Based on the location of the data

Time correlation

¿Qué tanto el pasado puede decir sobre el presente?







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Spatial 'auto'-correlation?

Attribute similarity

- Time: correlation of a variable with a realization of the same variable at a different time
- Space: Correlation of a variable with itself, considering cases at different locations
  - Main idea: is there any correlation between values of a variable considering their locational similarity?

- Similarity measures
  - Cross-product:
    - $y_i, y_{j.}$ (linear) larger values are closer → large product
- Dissimilarity measures:
  - Squared differences: $(y_i - y_{j.})^2$
  - Absolute differences: $|y_i - y_j|$
  - the smaller the more simmilar

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Spatial 'auto'-correlation?

Locational similarity

- Time: correlation of a variable with a realization of the same variable at a different time
- Space: Correlation of a variable with itself, considering cases at different locations
  - Main idea: is there any correlation between values of a variable considering their locational similarity?

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Spatial 'auto'-correlation?

Statistic - spatial weights

- Spatial weights
  - Let W be an n by n matrix indicating the level of association between n spatial observations w_{ij}
  - Let $f(y_i, y_j)$ be an attribute similarity measure between i and j

- Then:
  - Statistic: $\sum_{ij} f(y_i, y_j) * w_{ij}$

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Spatial 'auto'-correlation?

Statistic - spatial weights

- Capturing interaction
  - *n* spatial units, can be interacting with all *n* observations
  - This is an n^2 problem, but we only have *n* observations
  - Classic solution
    - Let's impose a structure of how interaction works → spatial structure
    - Exclude some interactions
    - Capture in a single parameter → spatial autocorrelation coefficient

- Spatial weights
  - Let W be an *n* by *n* matrix indicating the level of association between n spatial observations w_{ij}
  - Let $f(y_i,y_j)$ be an attribute similarity measure between i and j
  - Then:
    - Statistic: $\sum_{ij} f(y_i, y_j) * w_{ij}$

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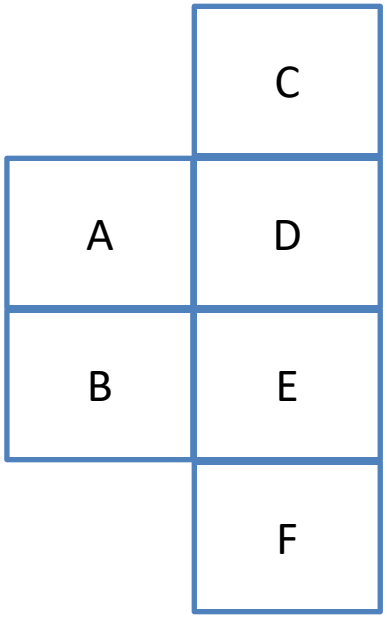
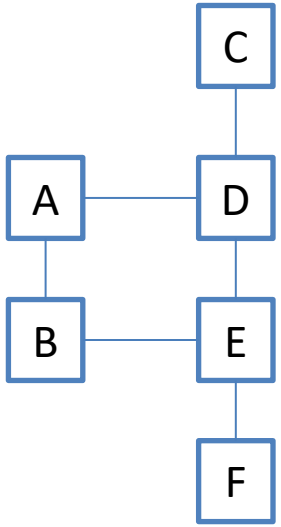
Spatial structure



Imposed Spatial linking structure



Spatial Weight Matrix

$$W = \begin{pmatrix} 0 & 1 & 0 & 1 & 0 & 0 \\ 1 & 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 & 0 & 0 \\ 0 & 1 & 0 & 1 & 0 & 1 \\ 0 & 0 & 0 & 0 & 1 & 0 \end{pmatrix}$$

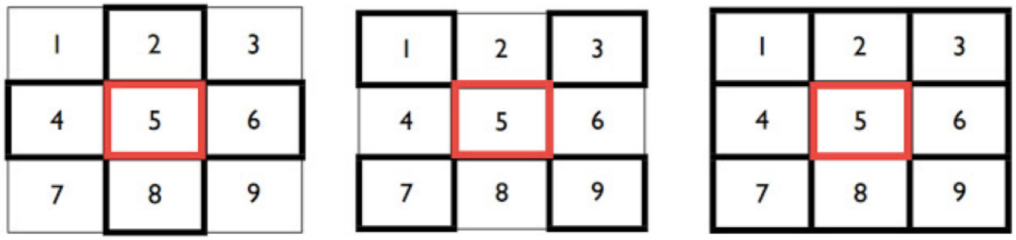


Figure (3): Three types of contiguity (source: Luc Anselin Lectures, 2016)

Standardizing weights

- Row-Standardized weights
  - $w'_{ij} = w_{ij} / \sum_j w_{ij}$
  - Row-sum equals to 1
  - Spatial lag = ave. of the neighbors
  - Makes analysis more comparable

$$W = \begin{pmatrix} 0 & 1 & 0 & 1 & 0 & 0 \\ 1 & 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 & 0 & 0 \\ 0 & 1 & 0 & 1 & 0 & 1 \\ 0 & 0 & 0 & 0 & 1 & 0 \end{pmatrix} \quad W' = \begin{pmatrix} 0 & 1/2 & 0 & 1/2 & 0 & 0 \\ 1/2 & 0 & 0 & 0 & 1/2 & 0 \\ 0 & 0 & 0 & 1 & 0 & 0 \\ 0 & 1/3 & 0 & 1/3 & 0 & 1/3 \\ 0 & 0 & 0 & 0 & 1 & 0 \end{pmatrix}$$