

AGGLOMERATION ECONOMIES: WHY DO FIRMS CLUSTER?

EE464: Urban Economics

EE562: Selected Topics in Development Economics 2

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Faculty of Economics, Thammasat University

Main Contents

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2. Why do firms cluster?
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 - 2.2 Sharing a labor pool
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 - 2.4 Knowledge spillovers

1. Agglomeration economies

1. Agglomeration economies

- If **two firms compete** for customers in **a region**, will they locate **close together** or **far apart**?
- It is natural to imagine that the two firms **will split the region** into **two halves**, giving each firm **a local monopoly**.
- That's what happened in the **theoretical models**, and it happens for many firms in the real world.

- Yet all sorts of **competing firms locate close to one another**, including carpet producers in Georgia and television producers in Los Angeles. Why?

1. Agglomeration economies

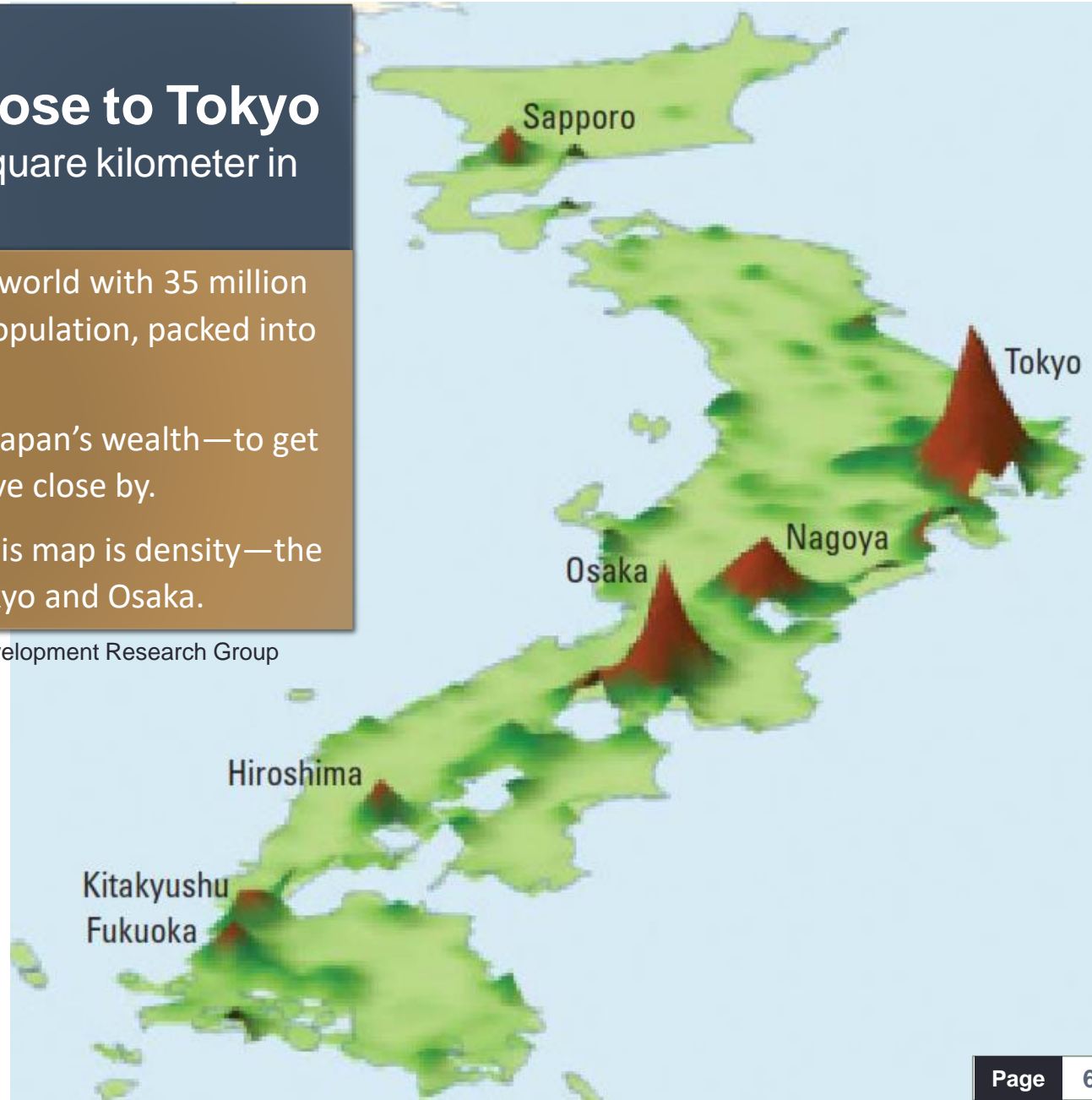
- **Agglomeration economies**
 - The **economic forces** that cause firms to **locate close to one another** in clusters.
 - The forces acting on firms in **a single industry** together are called **localization economies**, indicating that they are **“local”** to a **particular industry**.
 - For example, firms in the software industry cluster in Silicon Valley.
- When agglomeration economies **cross industry boundaries**, they are called **urbanization economies**.

Density: Why it pays to be close to Tokyo

(Economic production per square kilometer in Japan)

- Tokyo is the largest city in the world with 35 million people, a quarter of Japan's population, packed into less than 4 percent of its land.
- Tokyo generates a big part of Japan's wealth—to get a share of it, people have to live close by.
- The most striking feature of this map is density—the concentration of wealth in Tokyo and Osaka.

Source: WDR 2009 team and World Bank Development Research Group

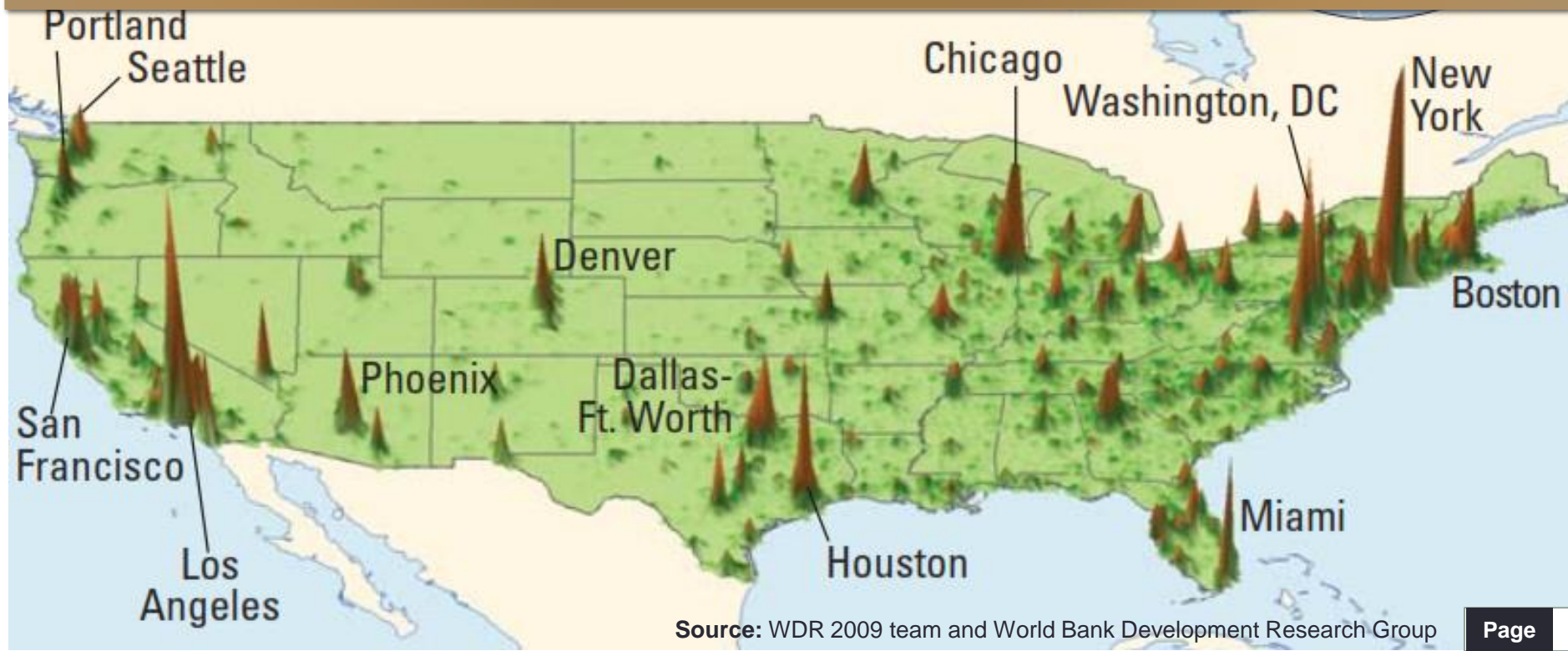


Distance:

why Americans must be mobile

(Economic production per square kilometer in the United States)

- United States, the largest economy in the world and perhaps also the most mobile, where about 35 million people change residences each year.
- Americans put up with the pain of leaving friends and family, because economic activity is concentrated in a few parts of the country.
- To get a part of this wealth, you have to get closer to it. That is why 8 million Americans change states every year, migrating to reduce their distance to economic opportunity.



1. Agglomeration economies

Agglomeration Economies

- **Localization Economies**

- Cost savings when firms in the **same industry** are **clustering** in the same area.

- **Urbanization Economies**

- Cost saving when firms **across different industries** are **clustering**.
- One industry attracts others to relocate and form a cluster.
- Urbanization economies incurs the **diverse cities**.

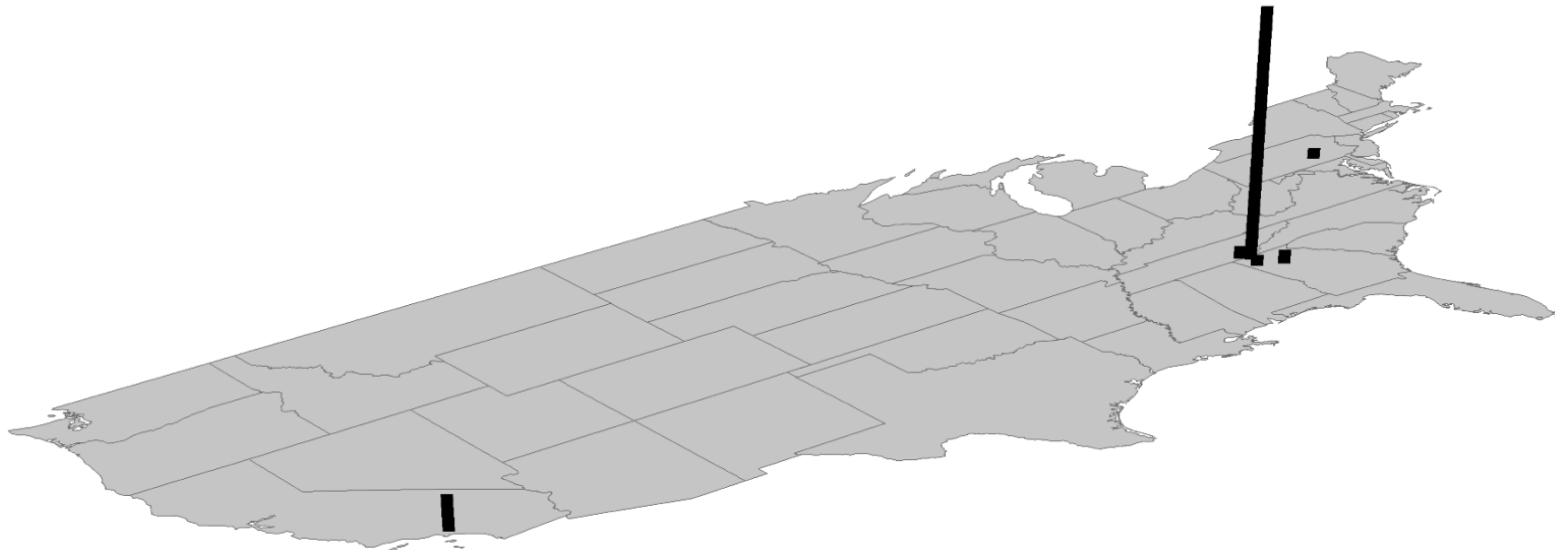
Note: Urbanization and localization economies are the characteristics of agglomeration economies

2. Why do firms cluster?

How do firms of a given industry locate?

Industry: Carpets and Rugs

Map 3-1 Job Clusters: Carpets and Rugs

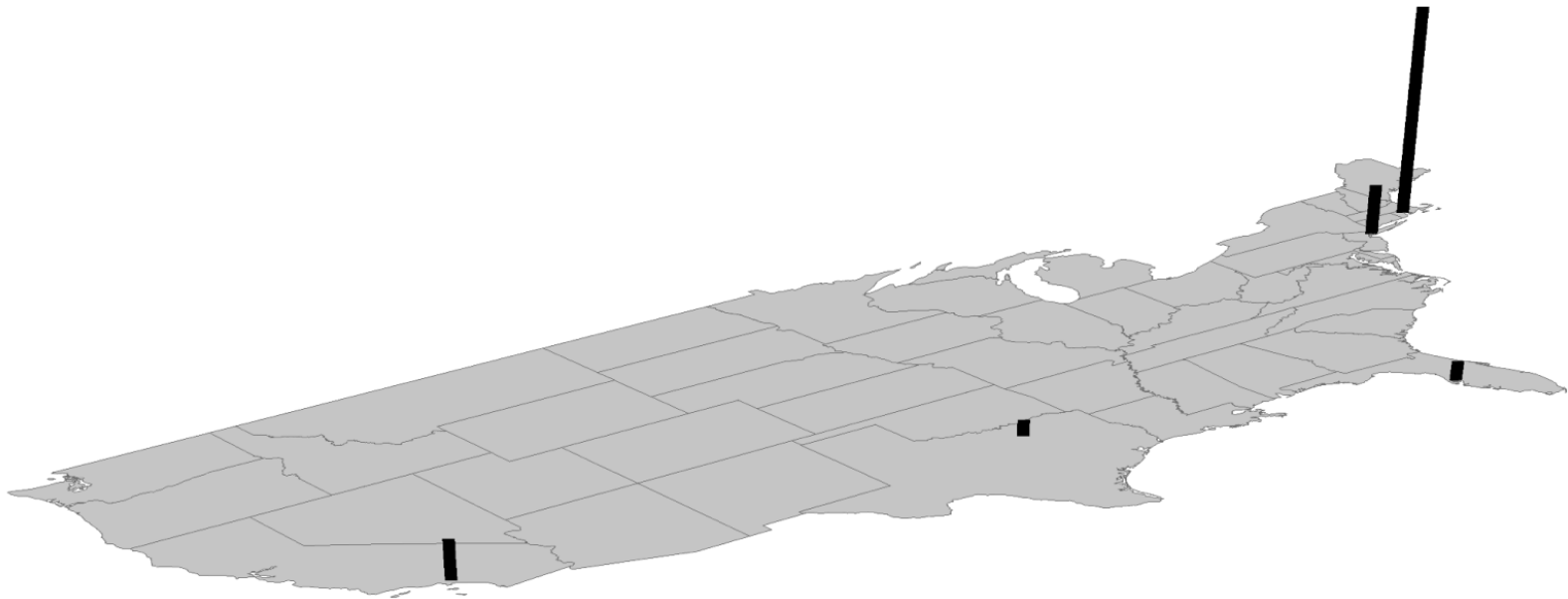


The bars show employment in the production of carpets and rugs, with 16,790 jobs in Dalton GA, and smaller clusters in Los Angeles, Atlanta, Chattanooga TN, Harrisburg PA, and Rome GA.

How do firms of a given industry locate?

Industry: Costume Jewelry

Map 3-2 Job Clusters: Costume Jewelry



The bars show employment in the production of costume jewelry, with 4,100 jobs in Providence RA, and smaller clusters in Los Angeles, New York, Tampa FL, and Dallas TX.

2.1 Sharing intermediate inputs

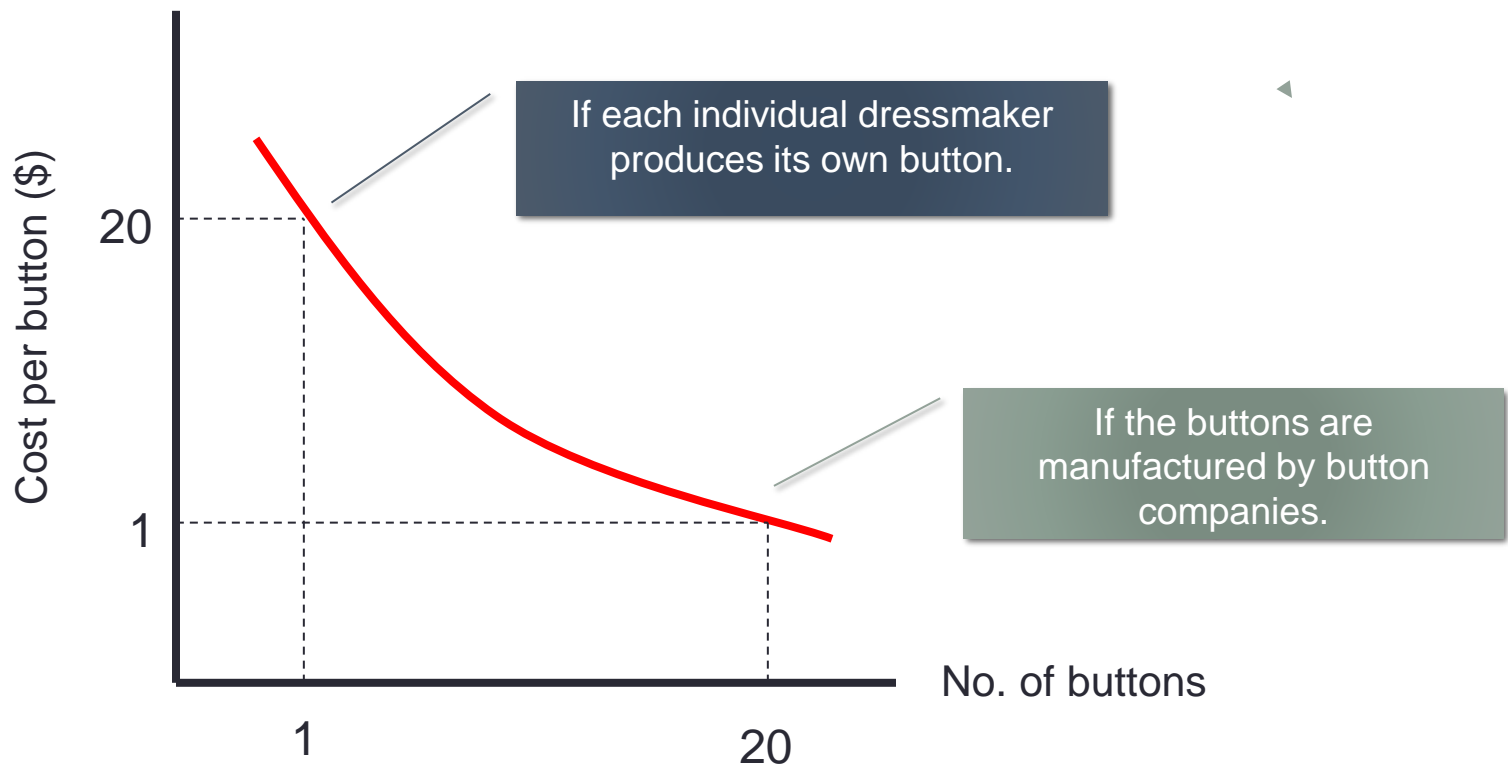
2.1 Sharing intermediate inputs

The Button-Dress model

- Consider the production of **high-fashion dresses**.
- The demand for dresses is subject to the whims of fashion, so the dressmaking firms must be **small and nimble**, ready to **respond quickly to changes in fashion**.
- The varying demand for dresses causes **varying demands** for **intermediate inputs** such as **buttons**.
- A dressmaker's **demand** for buttons **changes from month to month**, not in the quantity demanded, but in the **type of buttons demanded**.
- One month the dressmaker might use square blue buttons with a smooth finish and the next month round pink buttons with a rough finish.
- Consider that the **buttons** are the **intermediate inputs**

The Button-Dress model

- The production of button is subject to **economies of scale**.
- Dressmakers **do not produce** their **own buttons**.
- On the other hand, they **purchase buttons** from **the button companies**.
- The button companies can **save their production costs** when they can serve the **large demand**.



The Button-Dress model

- There are **two other assumptions** in the dress-button model:

(1) Face time

- A button for a high-fashion dress is not a standardized input that can be ordered from a catalog or a Web site, but requires **interaction between dressmaker and buttonmaker to design** and produce the perfect button for the dress of the month.
- The face time means that a dressmaker must be **located close to its button supplier.**

(2) Modification cost

- Once a dressmaker buys a button from a buttonmaker, the dressmaker may incur a **cost to modify** the button to **make a perfect match.**
- For example, the dressmaker might have to shave the edges of a square button to make it a hexagon.

The Button-Dress model

A dressmaker in a cluster has lower button costs for two reasons.

- (1) A cluster of several dressmakers will generate **sufficient button demand** to allow buttonmakers to **exploit scale economics**, leading to **lower button price**.
- (2) The large total demand for buttons will allow buttonmakers to **specialize in different varieties** of buttons, **reducing the modification costs** of dressmakers.

The case of movie industry

- The **U.S. movie industry** is **concentrated** in the area in and around **Hollywood, CA**.
- There are **seven major studios** and **hundreds** of independent movie **producers**.
- Both types of movie producers **rely on other firms** to provide all sorts of **intermediate inputs**, such as script writing, film processing and editing, orchestras, and set design and construction.
- **The scale economies** associated with producing these inputs are large relative to the demands of individual firms, so **movie producers share the suppliers of intermediate inputs**.
- The inputs are **not standardized** and require **face-to-face collaboration** in their design and production.
- The result is a **cluster of movie producers** and the **suppliers of intermediate inputs**.

Self-Reinforcing Effects of Clustering

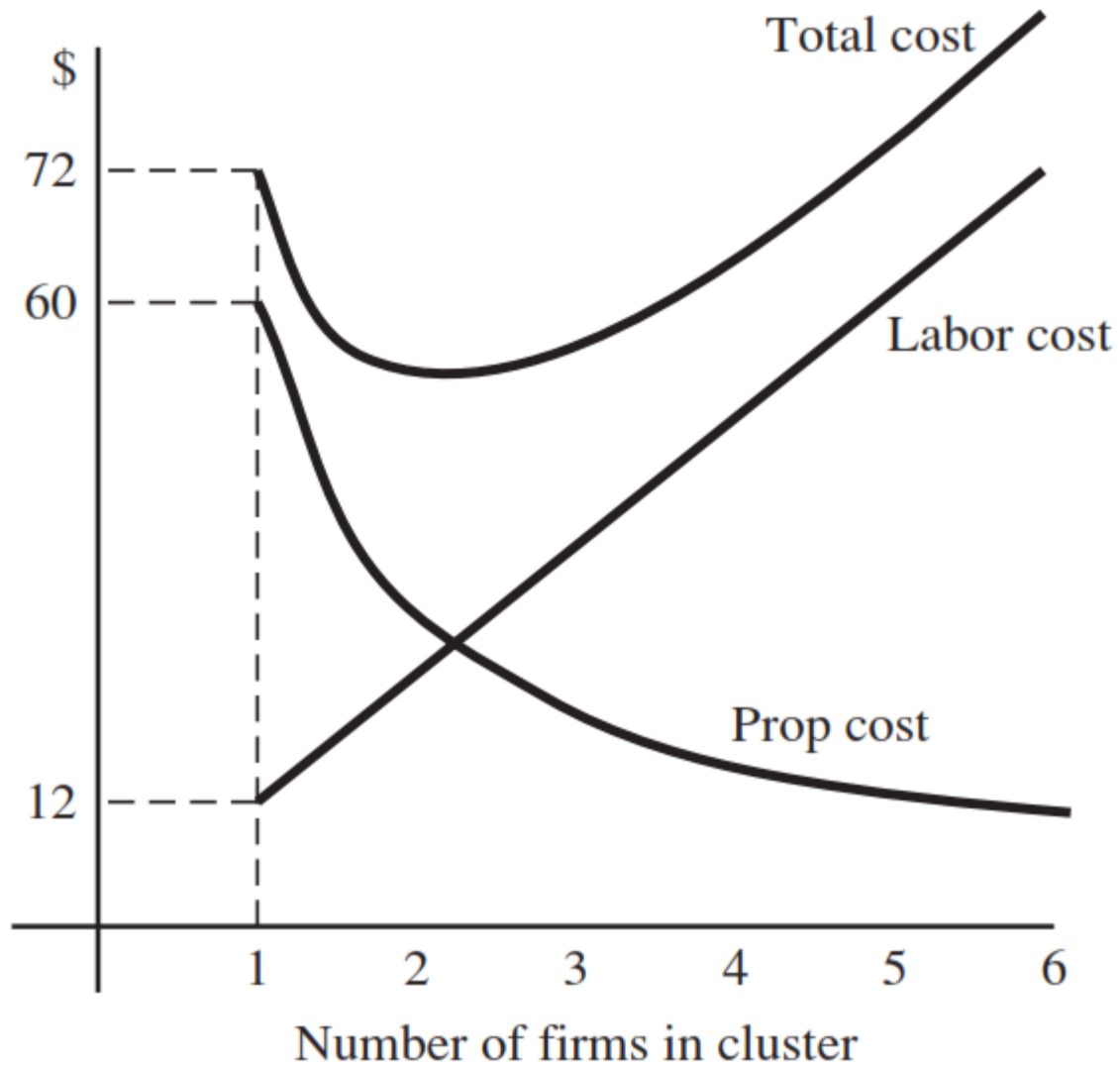
- We have seen that clustering is beneficial because it allows firms to take **advantage of agglomeration economies** from **input sharing**.
- What about **the costs**?
- In this part, we will use **an example of the clustering of movie producers** to explore the **costs and benefits of clustering**.
- When agglomeration economies are strong enough to **offset the cost of clustering**, firms will **form industry clusters**, causing the development of **specialized cities**.

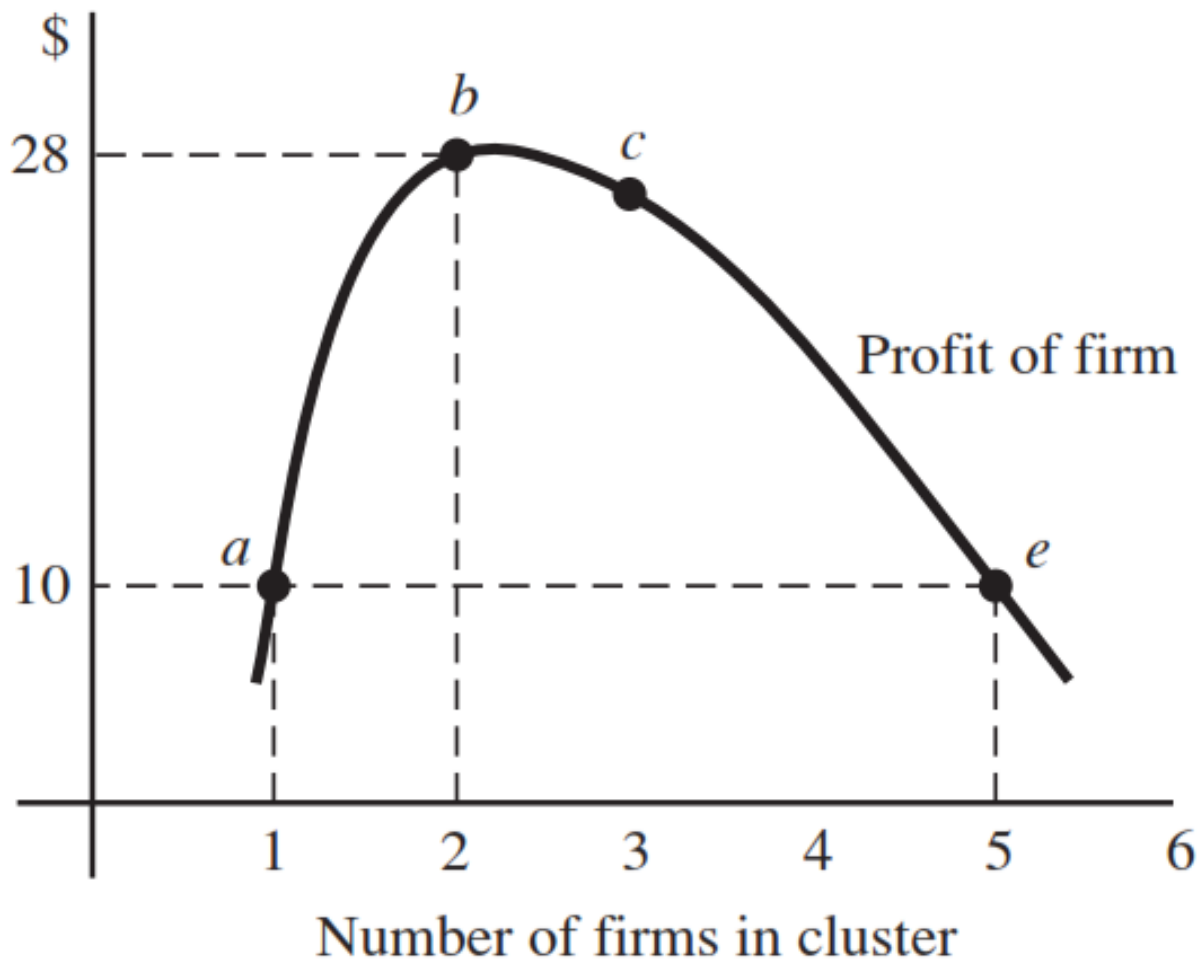
Self-Reinforcing Effects of Clustering

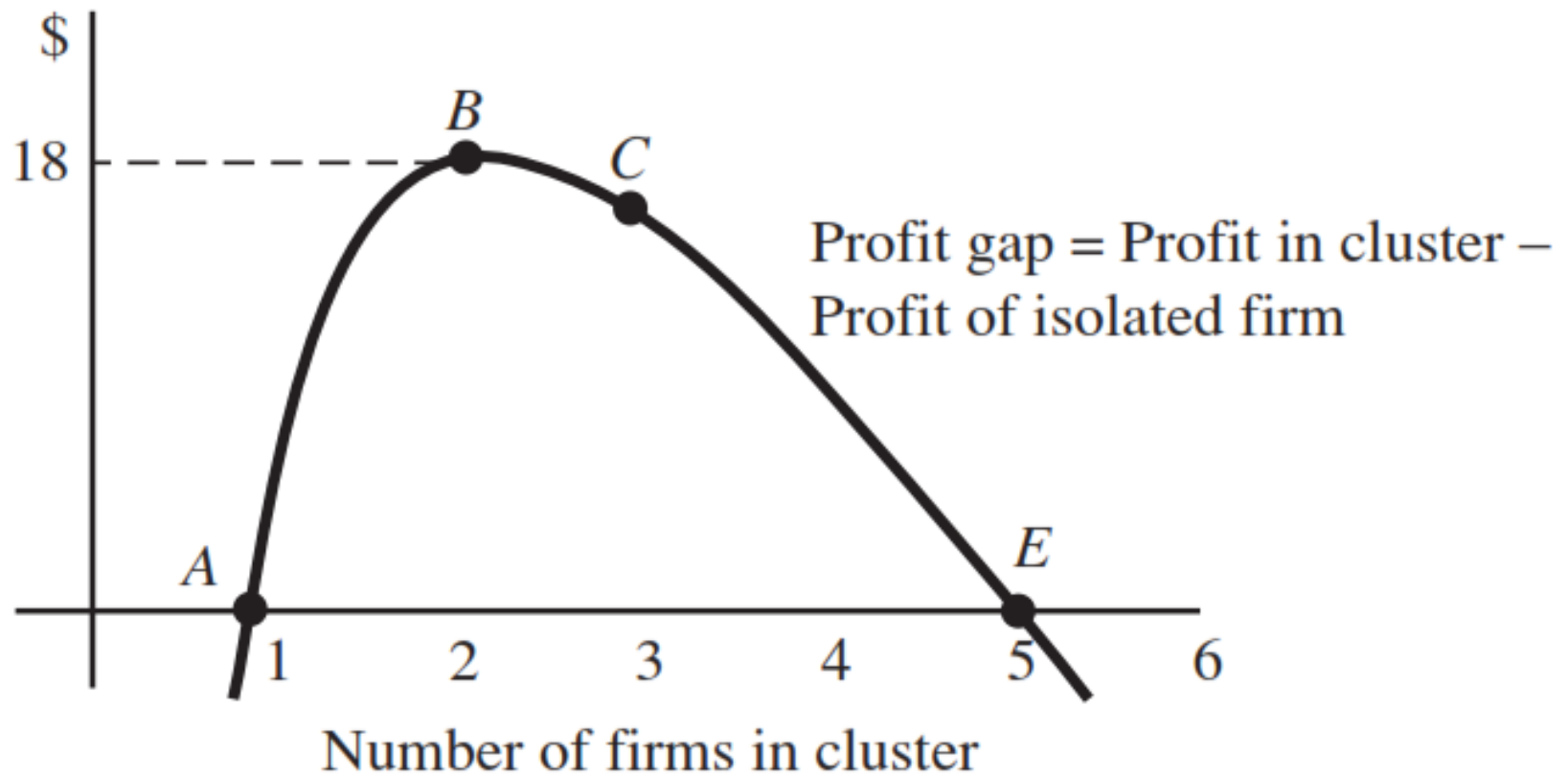
Main tradeoff

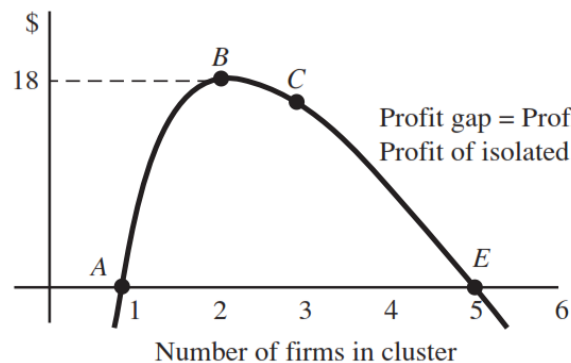
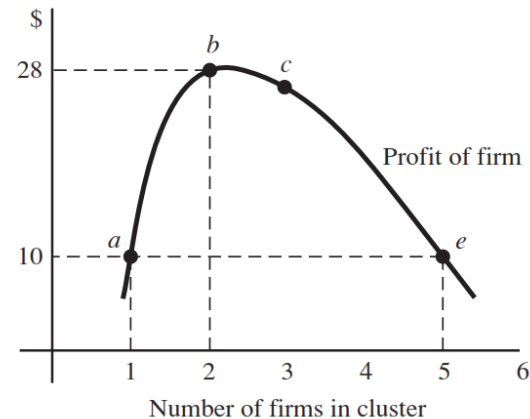
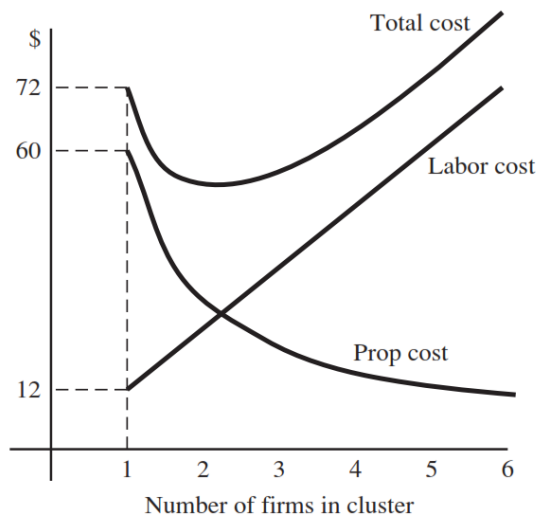
- **Benefit:** Localization economies **reduce costs of intermediate inputs.**
- **Cost:** Competition for workers **increases the labor cost.**

What is the optimal size of cluster?









Self-Reinforcing Effects of Clustering

- The profit gap, equal to the profit for firm in a cluster, minus the profit of an isolated firm increases, then decreases, reflecting the **tradeoffs** from **lower prop costs** and **higher labor costs**.
- The profit gap reaches zero with **five firms** in the cluster, the **equilibrium number**.
- The inverted U reflects decreasing, then increasing total cost.
- With five producers in the cluster, the **profit per producer again** equals the **profit of the isolated producer** (point *e*).
- The agglomeration economies from **sharing an intermediate input supplier** generate **self-reinforcing changes**.
- Recall the **second axiom** of urban economics.

Alternative example: Electronics industry

- An annual introduction of new model (i.e., mobile phones, tablet) requires the rapid adjustment of production and intermediate inputs.
- **Economies of scale:** electronics firms share the same intermediate input suppliers to exploit the economies of scale.
- **Face time and modification cost:** electronics firms locate in the same cluster to lower times and costs in their design and production.

Self-reinforcing changes generate extreme outcomes

- In this case, movie producers that compete for labor **don't disperse to minimize labor costs**, but instead cluster to realize agglomeration economies.
- In this example, rising labor costs generate **diseconomies of scale that limit clustering**, but the same logic applies with other diseconomies, such as **rising land costs** or **rising transport costs** for inputs and outputs.

2.2 Sharing a labor pool

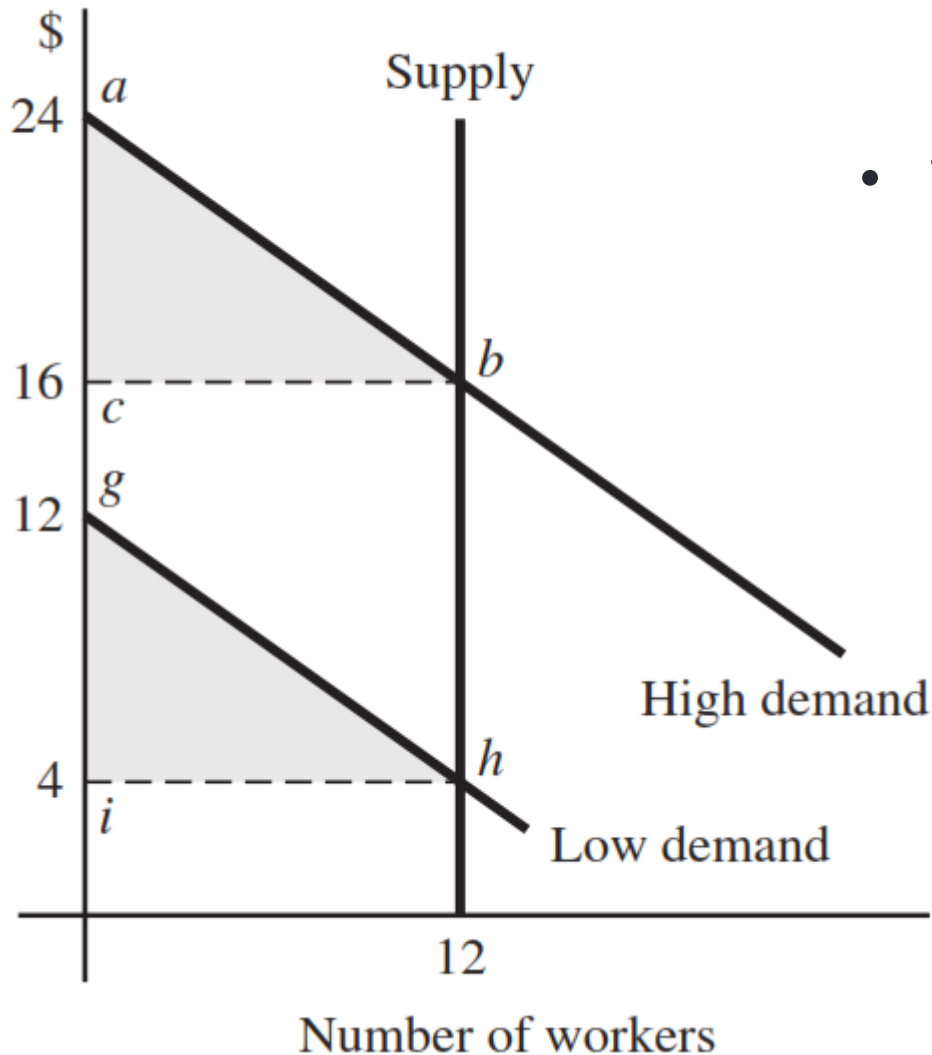
2.2 Sharing a labor pool

- In the **rapidly changing industry**, hundreds of new products are introduced every year, and **only a few succeed**.
- For an individual firm in either industry, this year's new product may be wildly successful, and next year's may be a dud.
- In this environment of rapidly changing demand, **unsuccessful firms** will be **firing workers** at the same time that **successful firms** are **hiring them**.
- A **cluster** of firms **facilitates the transfer of workers** from unsuccessful firms to successful ones.

2.2 Sharing a labor pool

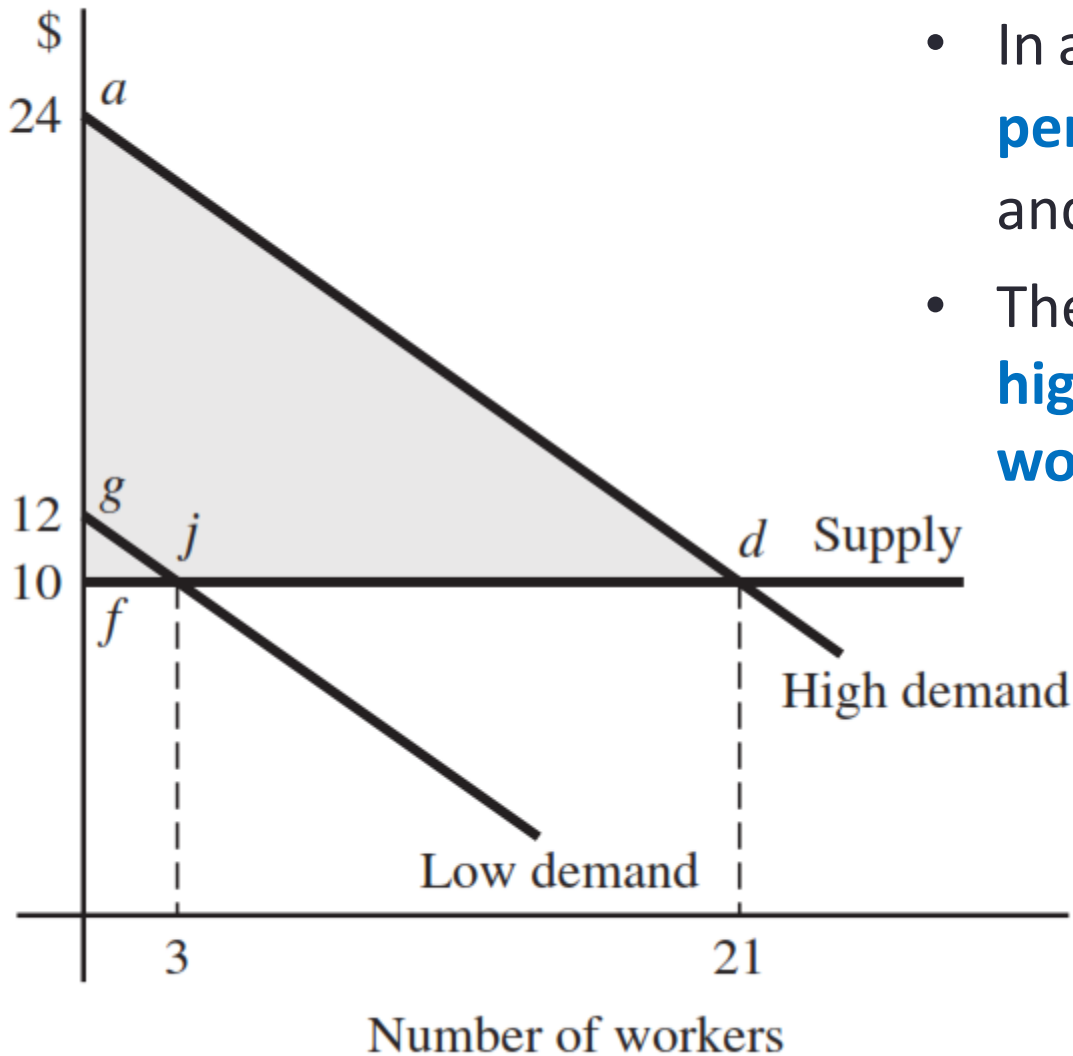
- Consider first the situation for an **isolated firm outside any industry cluster**.
- The isolated firm doesn't face any competition for labor within its town, and to simplify matters, we assume that **labor supply** in the isolated site is **perfectly inelastic**, fixed at 12 workers.
- This means that **wages** will **rise and fall** with the demand for the firm's product.

A: Isolated Site



- In an isolated site, the firm faces a perfectly **inelastic supply of labor** (12 workers).
- The firm hires the **same number of workers** during high demand and low demand but pays **a higher wage** during **high demand**.

B: Cluster with Many Firms



- In a cluster, the firm faces a **perfectly elastic supply** of labor, and the **wage is fixed at \$10**.
- The firm **hires 21 workers** during **high demand** but only **three workers** during **low demand**.

2.2 Sharing a labor pool

- The **key difference** between an isolated site and a cluster concerns the **competition for labor** and the variability of wages.
- Workers in the cluster can choose from a large number of firms.
- For every successful firm hiring workers, there is an unsuccessful firm firing them.
- Therefore, the **total demand** for labor in the **cluster is constant**, and so is the **equilibrium wage**.
- Workers are **mobile between** the **isolated site** and the **cluster**, and **in equilibrium** they will be **indifferent** between the two locations.
- Recall the **first axiom** of urban economics.

Prices adjust to generate locational equilibrium

- At the **isolated site**, the wage is uncertain, being either **\$16** during **high demand** or **\$4** during **low demand**.
- The two outcomes are equally likely, so the **expected wage**(the sum of the probabilities times the wages) is **\$10**:

$$\text{Expected wage} = \frac{1}{2} * 16 + \frac{1}{2} * 4 = 10$$

- To make workers **indifferent** between the two sites, the **certain (constant) wage** in the **cluster** must be **\$10**.
- In the cluster, when the demand for a firm's product goes from high to low, the **firm fires 18 workers** at **the same time** that **another firm** in the cluster is **hiring 18 workers** as its demand goes from low to high.

Expected profits are higher in the cluster

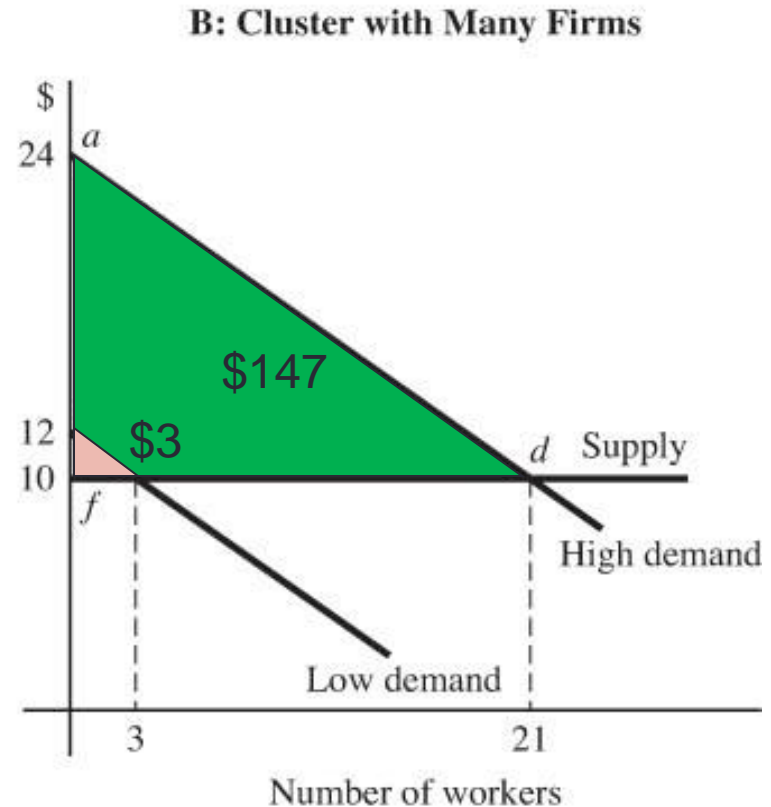
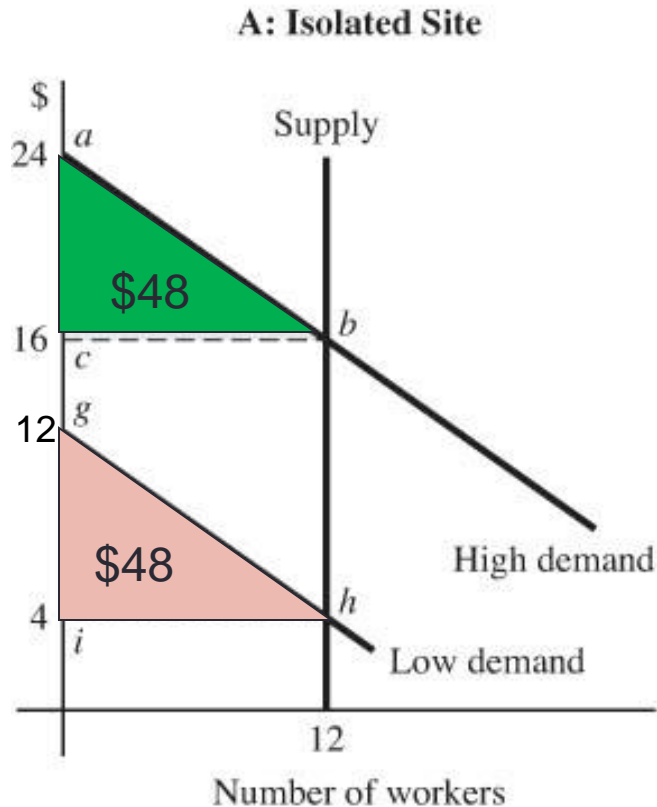
- When a firm moves from the **isolated site** to a **cluster** and then experiences one year of high demand, followed by one year of low demand

Good news when demand is high. The move to the cluster **cuts the wage** (from \$16 to \$10) and allows the firm to hire more workers (21 instead of 12), generating **higher profit in the cluster**.

Bad news when demand is low. The move to the cluster **increases the wage** (from \$4 to \$10), generating **lower profit in the cluster**.

- The profit with high demand is shown by triangle *adf* (\$147), and the profit with low demand is shown by triangle *gjf* (\$3).
- So if the two outcomes are equally likely, the **expected profit** in the **cluster** is **\$75** (the average of \$147 and \$3), compared to **\$48** in the **isolated site**.

Expected profits are higher in the cluster



Expected profit in an isolated site = $\frac{1}{2} * 48 + \frac{1}{2} * 48 = \48

Expected profit in the cluster = $\frac{1}{2} * 147 + \frac{1}{2} * 3 = \75

Labor pooling in the movie industry

- The U.S. movie industry, concentrated in the area in and around **Hollywood**, CA, provides an example of the **benefits of labor pooling**.
- One segment of the labor market includes workers involved in the craft and technical side of the industry.
- These workers **move periodically** from one producer to another as projects come and go, and rely on an “**economy of favors**,” building and **maintaining personal relationships** to keep informed about potential jobs and ease the moves from one firm to another.
- The same phenomenon occurs **for creative workers** (actors, directors, writers) as they **move between firms** to work on different projects.
- In a cluster of movie producers, firms draw from a **common labor pool**, facilitating the flow of workers between firms.

2.3 Labor matching

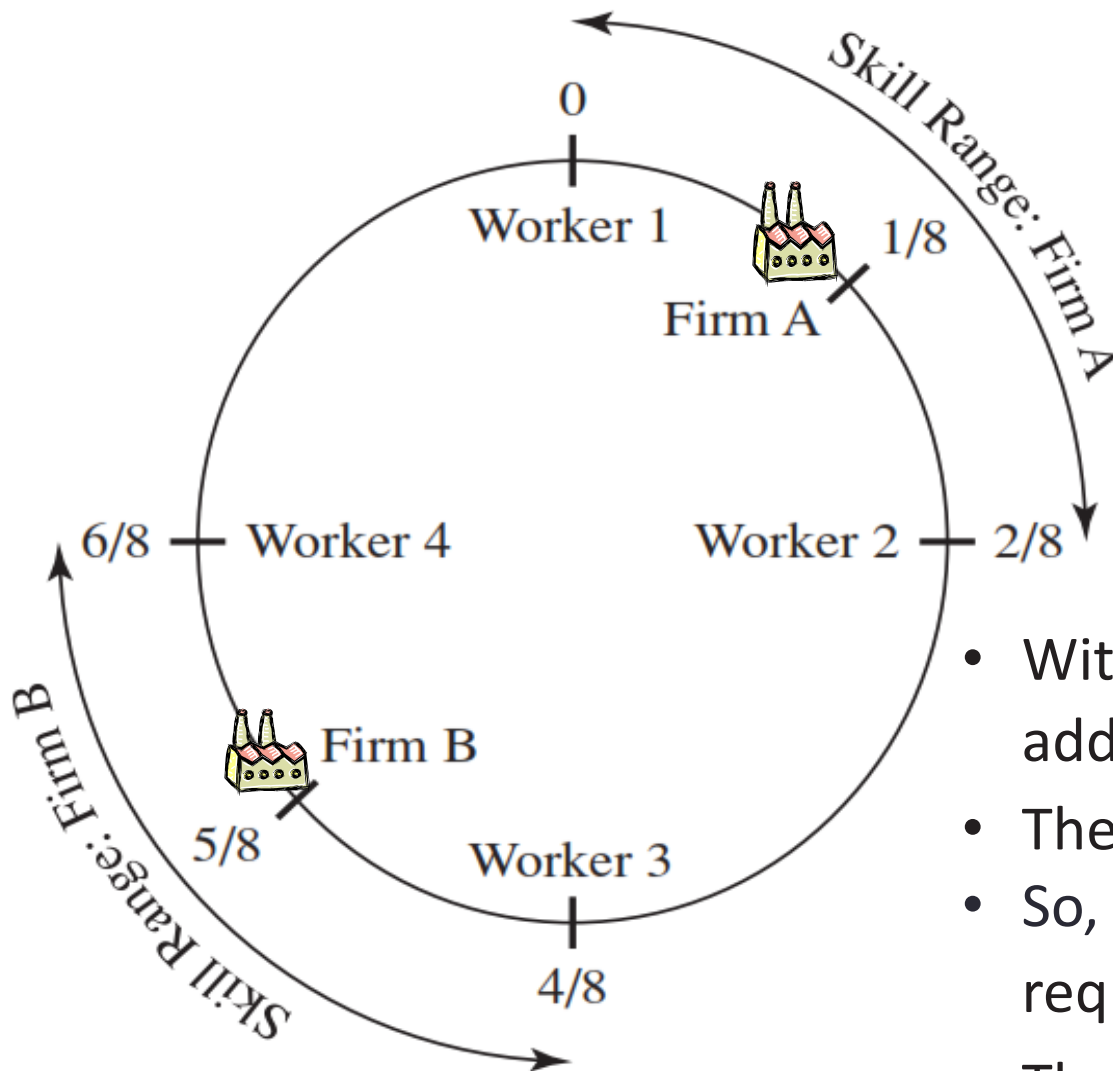
2.3 Labor matching

- In a **typical economic model** of a labor market, we assume that **workers** and **firms** are **matched perfectly**.
- Each firm can hire workers who have precisely the skills the firm requires.
- In the **real world**, things are not so tidy. Workers and firms are **not always perfectly matched**, and **mismatches require costly worker training**.
- A **large city** can **improve the matching** of workers and firms in the untidy real world, **decreasing training costs** and increasing productivity.

A model of labor matching

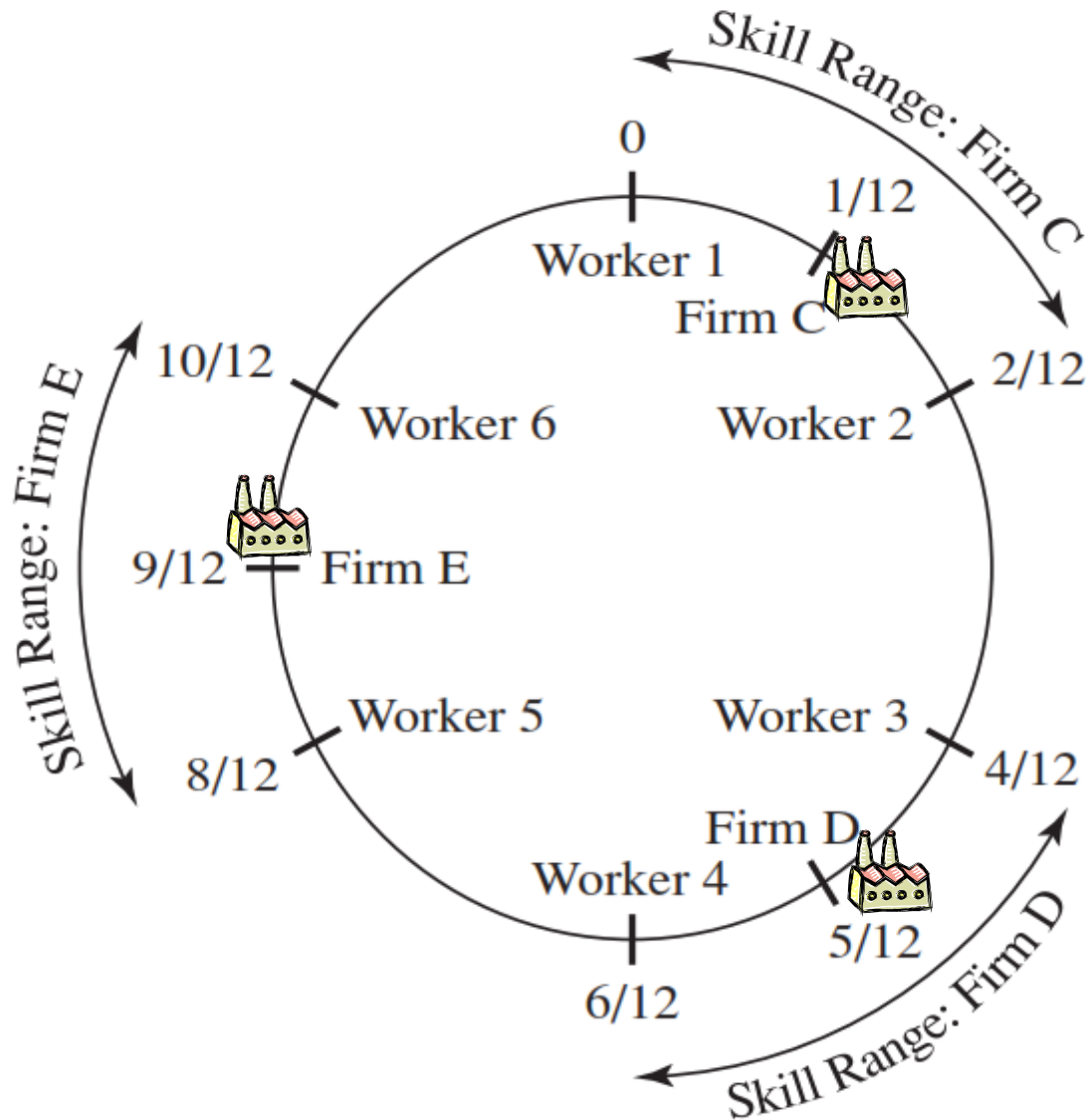
- Helsley and Strange (1990) developed a formal model of labor matching.
- The model uses several key assumptions about workers and firms.
 - **Variation in worker skills.** Each worker has a **unique skill** described by a **position or “address” on a circle** with a one-unit circumference.
 - **Firm entry.** Each firm enters the market by **picking a product** to produce and an **associated skill requirement**.
 - **Training costs.** Workers incur the **cost associated** with **closing the gap** between the worker’s skill and the skills required by a firm.
 - **Competition for workers.** Each firm offers a wage payable to any worker who meets its skill requirement, and each worker accepts the offer with the highest net wage, which is equal to the **wage minus the training cost** required to close the skills gap.

A: Four Skill Types



- With **4 skill types**, worker addresses are $\{0, 2/8, 4/8, 6/8\}$.
- There are **2 workers per firm**.
- So, **2 firms** will enter with skill requirements $\{1/8, 5/8\}$.
- The **mismatch** per worker is **1/8**.

B: Six Skill Types



- With **6 skill types**, worker addresses are $\{0, 2/12, 4/12, 6/12, 8/12, 10/12\}$.
- There are **2 workers per firm**.
- So, **3 firms** will enter the market with the skill requirement $\{1/12, 5/12, 9/12\}$.
- The mismatch per worker is **1/12**.

A model of labor matching

- The worker **incurs** the **training cost**.

Training cost = skill gap * unit training cost

Net wage = gross wage - training cost

- Suppose the gross wage = \$12, the unit training cost is 24 (which is the training cost for a unit of skill difference).

Net wage = \$ 12 - $1/8$ * \$ 24 = \$9

Agglomeration economies: More workers Implies better matches

- What happens to skill mismatching as an urban economy grows?
- An increase in the size of the workforce can be represented by increasing the numbers on the unit circle.
- This increases the density of workers with respect to skills but does not change the range of the skills.

Number of Workers	Skills Gap	Training Cost	Net Wage
4	1/8	$\$24/8 = \3	$\$12 - \$3 = \$9$
6	1/12	$\$24/12 = \2	$\$12 - \$2 = \$10$
12	1/24	$\$24/24 = \1	$\$12 - \$1 = \$11$

- **More workers** means **better skill matches** and **higher net wages**.

Agglomeration economies: More workers Implies better matches

- What are **the implications of skill matching** for the **clustering of firms** and urban development?
- The presence of a **large workforce attracts firms** that compete for workers, generating **better skill matches** and **higher net wages** for workers.
- The **higher net wage attracts workers** to live in large numbers in **cities**.
- So, the **attraction between firms and workers** is **mutual**.
- **Both firms** and **workers benefit** from better skill matching.

2.4 Knowledge spillover

2.4 Knowledge spillover

A fourth agglomeration economy comes from sharing knowledge among firms in an industry. As Marshall (1920) explained:

“ ... When an industry has chosen a locality for itself, it is likely to stay there for long; so great are the advantages which people following the same skilled trade get from near neighborhood to one another. The mysteries of the trade become no mysteries; but are as it were in the air, and children learn many of them unconsciously. Good work is appreciated; inventions and improvements in machinery, in processes and the general organization of the business have their merits promptly discussed; if one man starts a new idea, it is taken up by others and combined with suggestions of their own; and thus it becomes the source of new ideas. ...”

2.4 Knowledge spillover

Detroit: The motor city

“...there was an explosion in automotive entrepreneurship in Detroit in 1900. Detroit seemed to have had a budding automotive genius on every street corner. Ford Ransom Olds, the Dodge brothers, David Dunbar Buick and the Fisher brothers all worked in the Motor City.....Ford was able to open a new company with backing from the Dodge brothers who were making engine and chassis components. They supplied Ford with both financing and parts. ... ” Glaeser (2011)

2.4 Knowledge spillover

- A large volume of economics literature examines the magnitude of **localization economies**.
- In searching for evidence of localization economies, researchers focus on the effects of industry concentration on:
 - (1) worker productivity
 - (2) the number of new production plants (plant births)
 - (3) growth in industry employment
- If there are localization economies, we expect industry clusters to generate **higher productivity, more births**, and more **rapid employment growth**.

Evidence of localization economies

(1) Higher labor productivity

- Henderson (1986): Elasticity (output per worker) = 0.02 to 0.11
- Mun & Huchinson (1995):
 - Productivity elasticity = 0.27
 - **Localization economies** are **more powerful** in the office sector than in the manufacturing sector.
 - The productivity effects are **larger** for growth in **central locations** and are **localized**.

(2) Firm births

- Carlton (1983): Elasticity (births, industry output) = 0.43
- Head, Reis, Swenson (1995): Japanese corporations locate their **new plants close to other Japanese plants** in the same industry.
- Rosenthal & Strange (2003): births **more numerous** in locations **close to industry concentrations**.

Evidence of localization economies

(3) Employment growth

- Henderson, Kuncor, Turner (1995): growth in mature industries is **more rapid** in areas that start with **large concentrations** of the industry.
- Rosenthal & Strange (2003):
 - The localization effect peters out at a rate of about **50 percent per mile**.
 - The **rapid attenuation of the localization economies** explains the local in **“localization economies.”**
 - Localization economies **attenuate rapidly with distance**.

Evidence of urbanization economies

- Benefits generated by the **concentration of firms** from **different industries**.
- The general conclusion is that the **elasticity of productivity** with respect to **population** is in the range **0.03 to 0.08** (Rosenthal and Strange, 2004).
- In other words, a **doubling of population increases output per worker** by between **3 percent and 8 percent**.
- Two studies (Glaeser, Kallal, Scheinkman, and Schleifer, 1992, and Henderson, Kuncoro, and Turner, 1995) suggest that **diversity promotes employment growth**, especially in new and innovative industries.
- Hanson (2001) concludes that long-run **industry growth** is **higher** in cities with a **wider variety of industries**, suggesting that **diversity promotes growth**.

Evidence of urbanization economies

- In the last several decades, there has been a **fundamental shift** in the **specialization of cities**.
- **Large cities** have become increasingly **specialized in managerial functions**, while smaller cities have become more specialized in production.
- Duranton and Puga (2005) compute the ratio of managerial workers to production workers for the nation as a whole and for different metropolitan areas.

TABLE 3–3 Increase in Functional Specialization of Metropolitan Areas

Population	Percentage Gap between Metropolitan Ratio of Management to Production Workers and the National Ratio		
	1950	1970	1990
5–20 million	+10.2	+22.1	+39.0
1.5 to 5 million	+0.30	+11.0	+25.7
75,000 to 250,000	–2.1	–7.9	–20.7
67,000 to 75,000	–4.0	–31.7	–49.5

Source: Gilles Duranton and Diego Puga. “From Sectoral to Functional Specialization,” *Journal of Urban Economics* 57 (2005), pp. 343–70.

Evidence of urbanization economies

- Corporations locate their **headquarters** in **big cities** to **exploit urbanization economies**.
- Corporate executives and managers perform a **variety of tasks**—developing marketing campaigns, picking locations for new plants, and fending off lawsuits—and draw on other firms to accomplish these tasks.
- Corporate expenditures on **outsourced legal, accounting, and advertising services** are equivalent to about **two-thirds** of their wage bill (Aarland, Davis, Henderson, Ono, 2003).

Other Benefits of Urban Size

Joint labor supply

- **Big cities** provide a **variety of job opportunities** for **two-earner families**.
- For example, within the same city, there are job opportunities for:
 - Men: metal-processing plants
 - Women: textile factories

Learning opportunities

- Human capital can be increased through **learning by imitation**, that is, **observing other workers** and **imitating** the **most productive workers**.
- A **larger city** provides a **wider variety of role models** for workers so it attracts workers looking for learning opportunities
- Glaeser (1999): The evidences from **emigrants** showed that the **higher productivity** resulting from **urban learning** leads to a **higher wage outside the city**.

Localization vs Urbanization Economies

- Localization economies → Specialized cities
 - Specialized cities can attract the incumbent firms.
- Urbanization economies → Diverse cities
 - Infant companies can benefit from a diversity of economic activities.

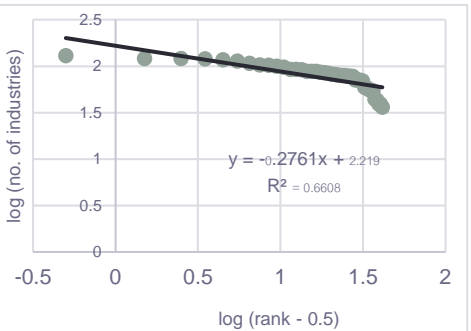
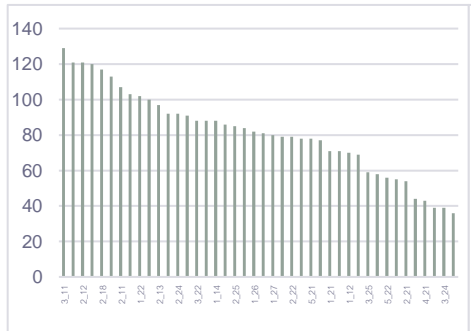
With improvements in telecommunications technology:

- Headquarters → located in diverse cities (urbanization economies).
- Production plants → located in specialized cities (localization economies).

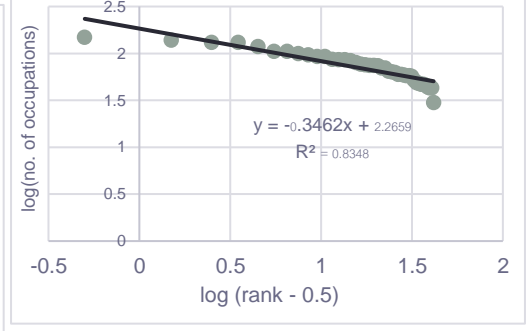
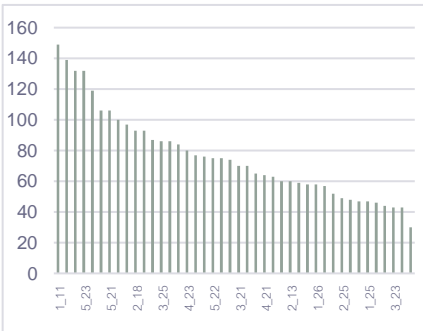
Thailand: Nationwide distribution of industries and occupations

1978

(a) Nationwide distribution of no. of industries

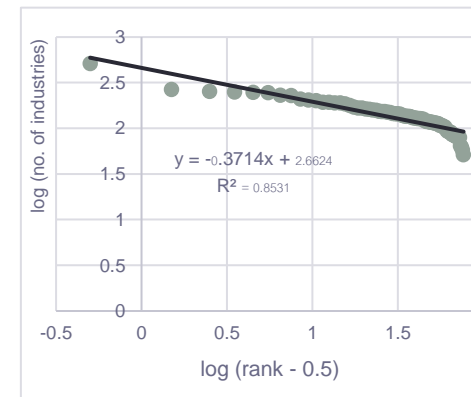
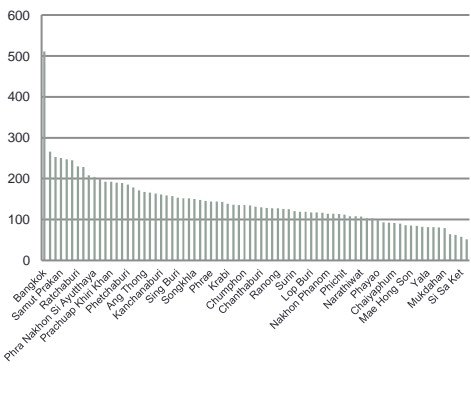


(b) Nationwide distribution of no. of occupations

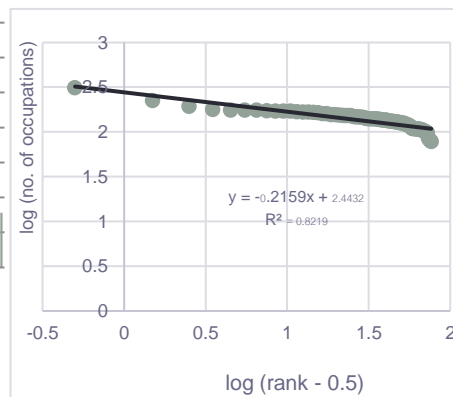
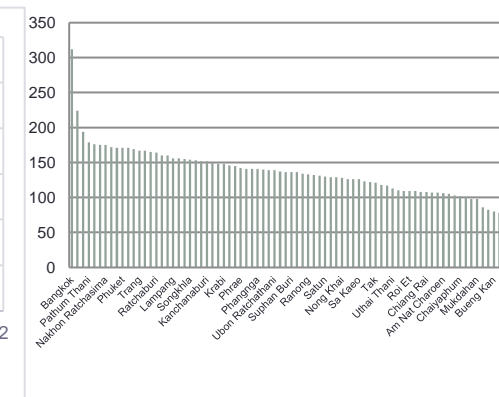


2016

(a) Nationwide distribution of no. of industries



(b) Nationwide distribution of no. of occupations



Thailand: Variety of occupations and GPP (2016)

