Clusters and Cluster Life Cycles

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Outline

1. Short introduction

2. What is a cluster?

3. Is there an effect of being located in a cluster?

4. Which mechanisms cause cluster emergence?

5. How do clusters affect incumbent firms?
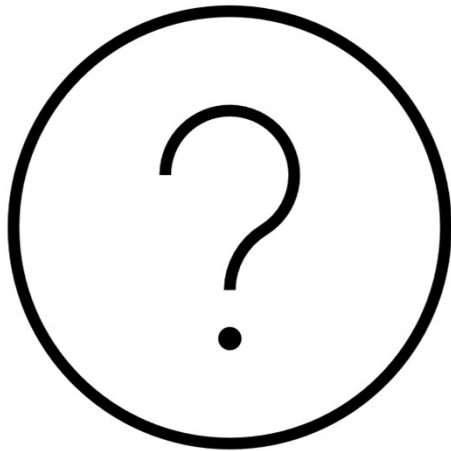
6. Which dynamics of clusters can be observed?

Prof. Dr. Dirk Fornahl

- Studies of Economics and Business Administration, University of Hannover, Dublin City University (Ireland) and University of California at Berkeley (USA)

- Doctoral studies at the Friedrich Schiller University, Jena, Germany
  - *Changes in Regional Firm Founding Activities – A Theoretical Explanation and Empirical Evidence*

- Visiting Research Fellow London Business School, Department "Strategic and International Management"

- Habilitation at the University of Bremen
  - *The Importance of Knowledge for the Emergence and Development of Local Clusters*

Prof. Dr. Dirk Fornahl

- Research assistant at the Max Planck Institute for Economics in Jena (1999-2006)
- Post-doc researcher at the Karlsruhe Institute of Technology (2006-2008)
- Scientific director and member of the management team at the BAW Institute for Regional Economic Research GmbH in Bremen (2009-2010)
- Foundation of the CRIE at the University of Bremen (2011)
- May 2020 - January 2021: Head of the Unit 101 at the Ministry for Federal and European Affairs and Regional Development of Lower Saxony

Can there be an uneven distribution of regional economic activities?

Different scientific perspectives

- Can regional differences exist? No.

  - Demand differences are equalized (infinitely fast)

  - Wage differences are equalized (infinitely fast)

  - Knowledge, human and financial capital are fully mobile (in the medium/long run)

  - Complete information available

  ➔ Persistent regional differences not possible.

Different scientific perspectives

- Findings from other studies

  - Heterogeneity of organizations

  - Economic development as an endogenous function of the economy

  - Innovation as a central process

  - Markets, organizations and their environment change permanently

  - Industries differ from each other and evolve

  - Adaptation to continuous change through learning

 - ➔ Structures are only temporary

Different scientific perspectives

- Industry differences and changes over time lead to different regional requirements and (lasting) differences between regions (depending on the location of the industry)

- Regional differences lead to differentiated industry development

➔ Analysis of regional distribution and regional dynamics

- Outlook
  - Empirical observations show that there are poorly and well developed regions
  - Developments can lead to lasting disparities under certain circumstances
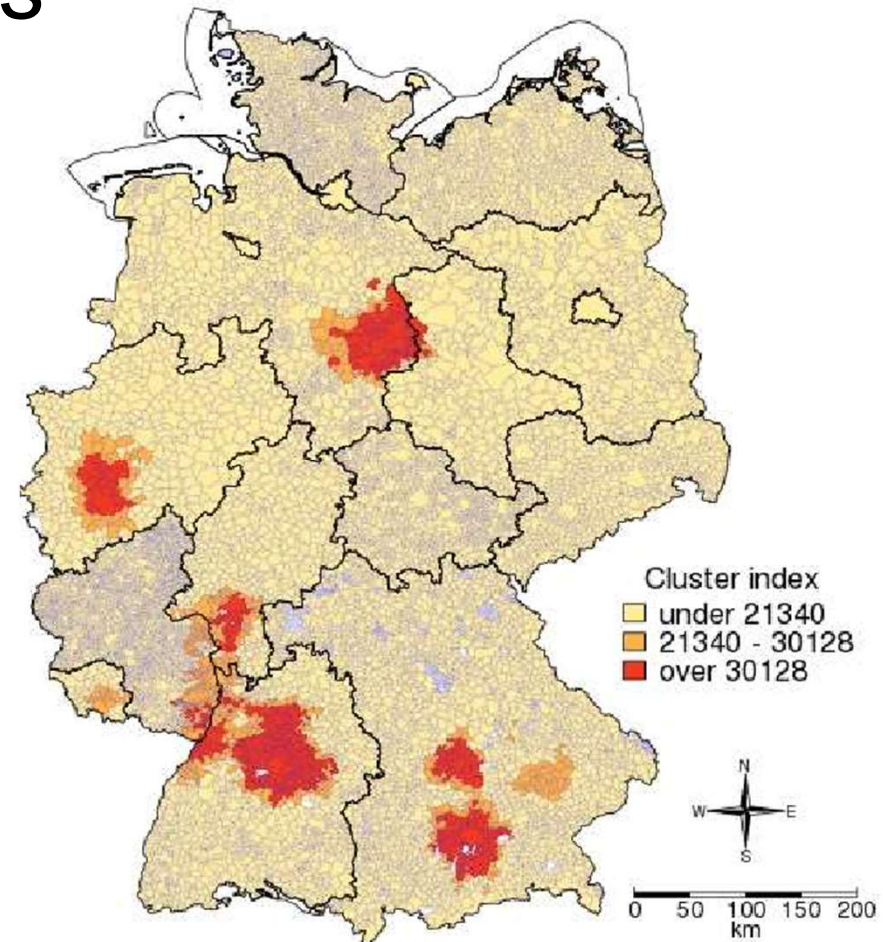
Example: Regional patent activities

- South dominates
- East weak (but not in R&D personnel, i.e. input)
- Commuter flows relevant
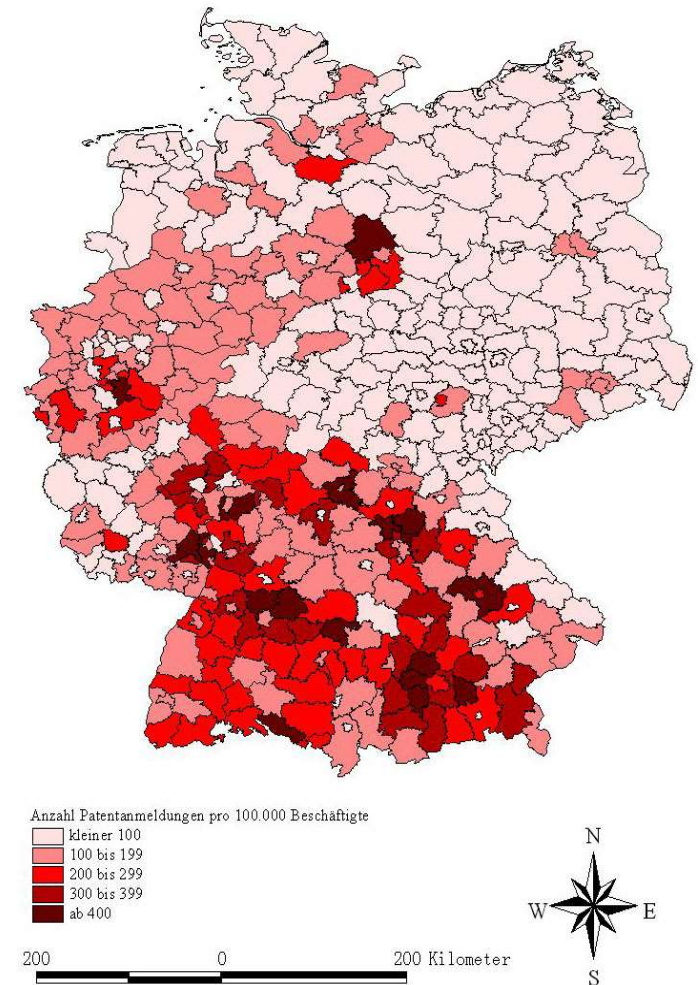
Example: Agglomeration of firms

- Automotive industry
- Employment
- Municipality level

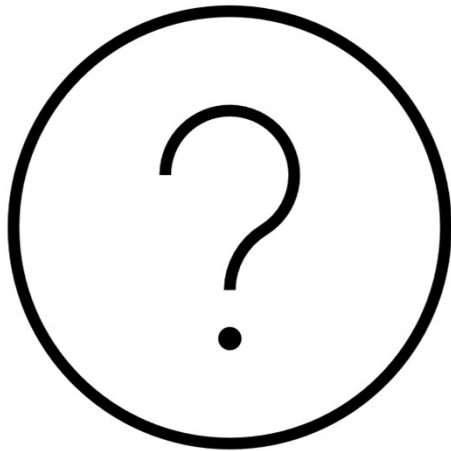*Brenner (2017): Identification of Clusters – An Actor-based Approach. P. 14*

Cluster index
- under 21340
- 21340 - 30128
- over 30128

Agglomeration of economic activites

- Empirical observation
  - Concentration of industrial activities in specific regions
  - Some industries form clusters, e.g. in Germany textile, wood and metal production

> Consider what might cause the distribution of economic variables to be so unequal.

Globalisation versus localisation

- Increasing global exchange of goods, people and services

- Reciprocal investments in production and research

- Worldwide communication

- But
    - Startups take place within 50 kilometers of current residence
    - Higher likelihood of knowledge diffusing locally (measured by patent citations)
    - Rapid feedback possible locally (customer-supplier relationships)
    - Role of informal networks (creation, maintenance)
    - Tacit knowledge / non-codified and non-codifiable knowledge ➔ Labor mobility and observation
    - Trust relationships form locally
    - Club property, i.e., knowledge diffuses only within the club ➔ Companies must be local to become members

What is a cluster?
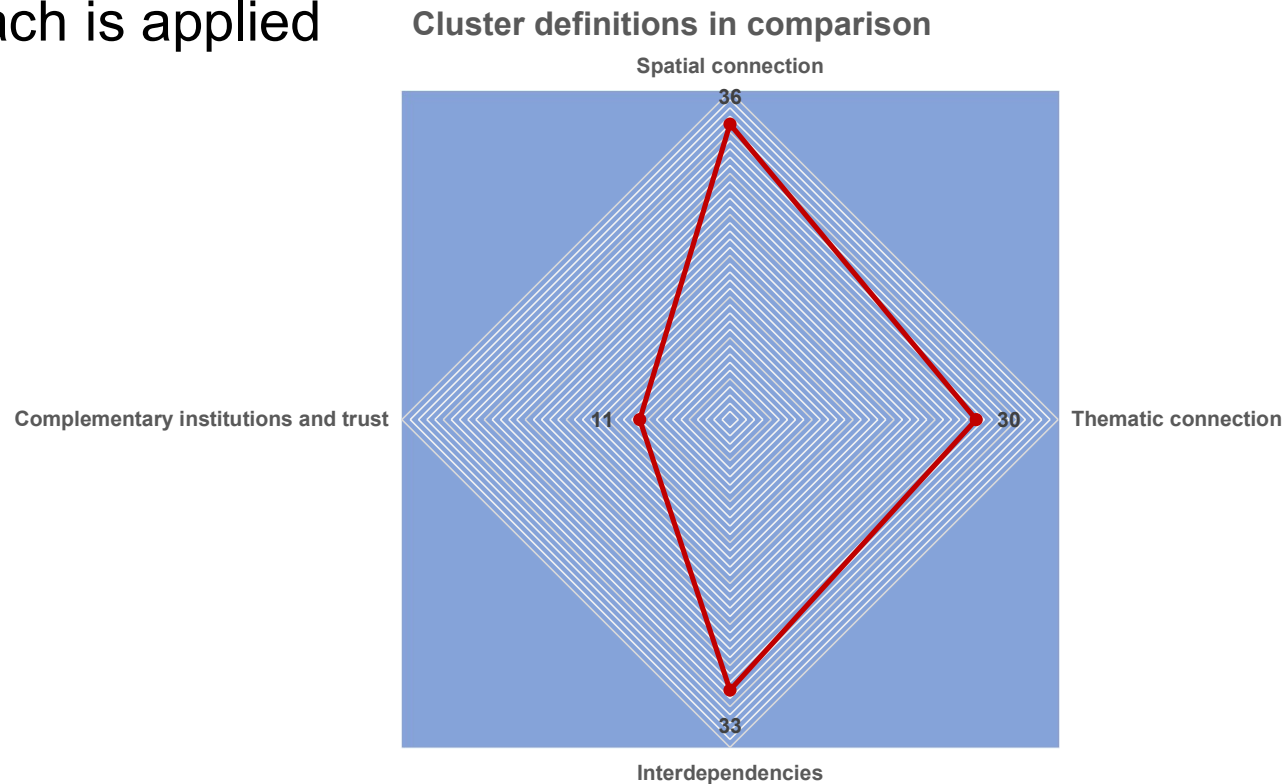
Defining "Clusters"

- Although the term cluster is a very popular theme, there are still fundamental differences in its definition (Martin and Sunley, 2003)

- Definitional inconsistency implies problem for a correct understanding and policy interventions

- Clusters are NOT
  - Industries
  - Cluster management organisations / cluster initiatives
  - Networks
    - *Spatial reference*: Spatially limited   – No (necessary) spatial dimension
    - *Thematic reference*: Given   – No (necessary) thematic dimension
    - *Interdependencies*: Cooperation and competition – Cooperation
    - *Cluster mechanisms*: Wide range of regional conditions, self-reinforcing processes and externalities lead to cluster development   – Focus on one condition and one process
    - *Activity level*: Active and passive – Rather active

Definitions

- "Clusters are defined as a geographical concentration of closely interconnected horizontal, vertical and lateral actors, such as universities, from the same industry that are related to each other in terms of a common resource and knowledge base, technologies and/or product-market." (Grashof & Fornahl 2021)

- „Clusters are geographic concentrations of interrelated companies, specialized suppliers, service providers, companies in related industries, and supporting organizations in specific industries that compete and cooperate at the same time." (Porter 1990)

- „Local clusters are collections of firms of one or few "related" industries that benefit from their co-locality and are therefore located in the same place." (Brenner 2005)

Defining "Clusters"

- Given the absence of a mandatory definition, a comparative empirical approach is applied

Cluster definitions in comparison

Spatial connection

36

Complementary institutions and trust   11   30   Thematic connection

33

Interdependencies

Defining "Clusters" – Spatial dimension

- Central component of the cluster concept

- Two categories
  - "concentration": Critical mass as a functional prerequisite of a cluster. ➔ Critical mass is not defined in most cases ➔ Problem of identification of clusters
  - "spatial proximity":
    - Often left open in the definition
    - Empirical studies use administrative units at different levels (e.g. NUTS I, II or III, labor market or spatial planning regions)
    - Empirical studies without predefined geographic boundaries conclude that a cluster effect occurs within relatively narrow spatial boundaries (0 to 50 kilometers for firms in the same industry and up to 120km for buyer-supplier relationships).
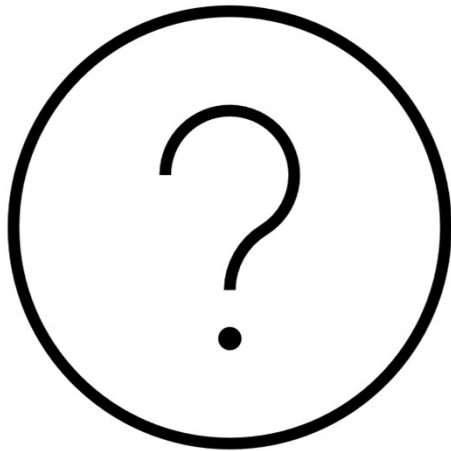
Defining "Clusters" – Thematic dimension

- Categories: "same, related or complementary industries", "value chain" and "specialization".

- Categories are intended to cover similar activities of the cluster firms / organisations as well as the possible specialization of the cluster.

- Firms and organizations have a relatively high technological or market proximity to each other.

- For an empirical investigation and also for political programs, the thematic boundaries are even more difficult to define than the geographical ones.

- Especially since innovation takes place at the interfaces of technologies / industries.

Defining "Clusters" – Interdependencies

- Various interdependencies and externalities occur in clusters and lead to firms benefiting from the existence of other firms and to a concentration.

- "Advantages through co-location" is broader, while "Knowledge & technology transfer" or "Cooperation and Competition" address specific mechanisms of clustering.

- However, whether externalities arise from specialization, diversification or "relatedness" is not specified.

Defining "Clusters" – Institutions and Trust

- Subcategories
  - "formal or institutional relationships and institutions": Institutions such as public economic development or universities and research institutions.
  - "informal exchanges and trust": Informal exchanges such as face-to-face contact and its importance for increased cognitive proximity and trust.
- Received relatively few mentions in the empirical analysis.
- Not all clusters are based on informal relationships, social capital and trust, but only specific forms of clusters (e.g. industrial districts in Italy).

Types of „Clusters"

Markusen 1996 – Firm structure and interaction

- "*Marshallian Clusters*":
  - Mainly local SMEs specializing in crafts, high technology or industrial services.
  - Strong vertical as well as horizontal interdependencies between these firms.
  - Firms rely on networks as a form of problem solving.
  - Low economies of scale
  - High market interaction / trade inside the district
  - Flexibel labour market
 - Policy measures flank the development and competitiveness of the cluster

A. Marshallian Industrial District

Suppliers → Customers
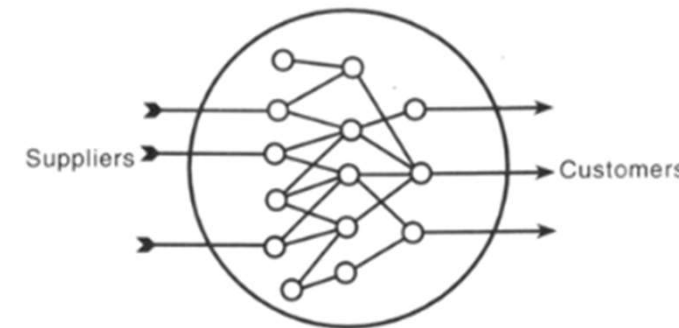
# Markusen 1996 – Firm structure and interaction

- "*Hub and spoke clusters*":
  - One or more large firms surrounded by smaller suppliers and the like.
  - Strong economies of scale
  - Presence of large firms offers opportunities for development, especially for smaller firms.
  - Long-lasting contracts but low level of cooperation
  - Cooperation between large and small firms exists, but rarely between large firms.

B. Hub-and-Spoke District

Markusen 1996 – Firm structure and interaction
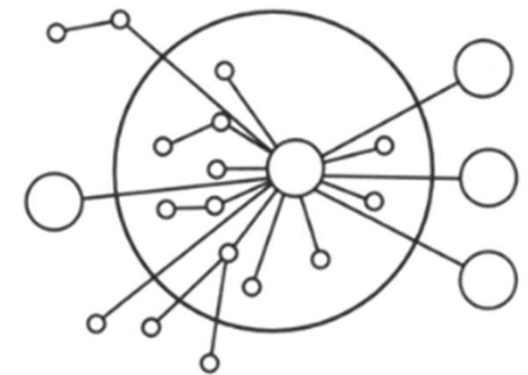
C. Satellite Platform District

- "*Satellite platforms*":
  - Industrial clusters characterized by production sites of large firms.
  - Medium economics of scale
  - Investment decisions are external
  - Horizontal and vertical interdependencies are rather weak, as are spin-offs and start-ups.

- "*State-anchored industry clusters*":
  - State institutions (e.g. military base, administration or university) dominate the structure.
  - Small suppliers and subcontractors settle here.

○ large locally headquartered firm
o small, local firm
□ branch office, plant
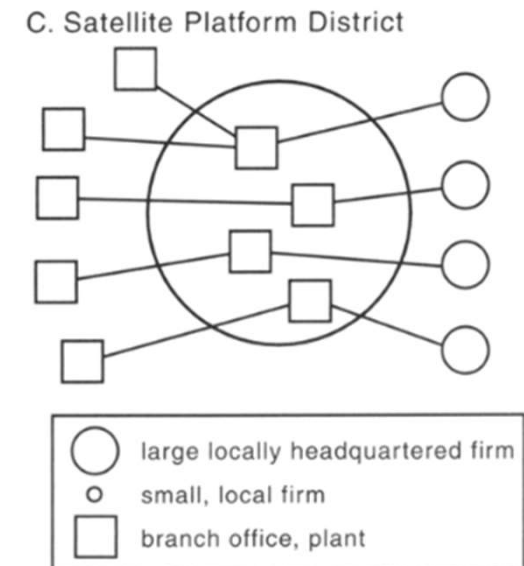
Gordon und McCann 2007 – Cluster structure and type of interaction

- "Pure agglomeration":
  - Interactions between firms or firms and customers tend to be short-lived ➜ relationships change frequently
  - Company structure is atomistic, i.e. they do not have any significant market power. ➜ Intense competition at the local level.
  - Advantages from co-location are derived, in Marshall's sense, from firm concentration.
  - No cluster management.
  - Access to the cluster is open.

- "Industrial complex":
  - Stable long-term relationships between cluster firms, e.g. in the steel or chemical industry.
  - Entry is regulated by long-term investments, such as in capital goods or land, making entry and exit costs relatively high.
  - Benefits from co-location usually result from lowered transportation and transaction costs.

Gordon und McCann 2007 – Cluster structure and type of interaction

- "Social network":
  - Importance of mutual trust between agents in key positions is emphasized, for example, in joint lobbying, joint ventures, informal alliances, and agreements to trade.
  - Mutual trust lowers transaction costs by minimizing the risk of opportunistic behavior.
  - Geographic proximity is particularly conducive to promoting this and is therefore a necessary, but not yet sufficient, criterion for successful network access.

Enright 2003 – Developmental stages

- *„Working Cluster*":
  - Critical mass of local knowledge, expertise, personnel and resources available.
  - Agglomeration advantages benefit member firms.

- "*Latent cluster*":
  - Critical mass of firms with a corresponding thematic connection is present.
  - But: no interaction or exchange of information between firms yet ➔ benefits of co-location are underdeveloped so far.
  - Reasons for this may include lack of information and lack of a shared vision of the future or trust.

Enright 2003 – Developmental stages

- "*Potential clusters*":
  - Necessary conditions for successful cluster development exist.
  - Need to be expanded and deepened in order to benefit from agglomeration effects.

- "*Policy driven clusters*":
  - These receive support from politics, nevertheless lack the critical mass and the framework conditions to enable organic cluster growth in the long term.
  - Selection is often made against the backdrop of political influence.

Enright 2003 – Developmental stages

- "*Whishful thinking clusters*":
    - Similar to "policy driven clusters", but lack any potential for developing agglomeration advantages.
    - This category often includes clusters of "future industries" such as semiconductors or biotechnology that are mentioned in government programs.

Meier zu Köcker 2009 – Governance and financing

- "*Bottom-up network*":
  - Decentralized governance, network coordinator or cluster management usually selected by cluster companies.
  - Serves as a kind of service provider.
  - Political influence is low.

- "*Top down network*", externally initiated:
  - Mostly centralized governance, but cluster management mostly by external parties and used by the initiator of the cluster.
  - Cluster initiative is usually financed by public funds.
  - Political influence is correspondingly high.

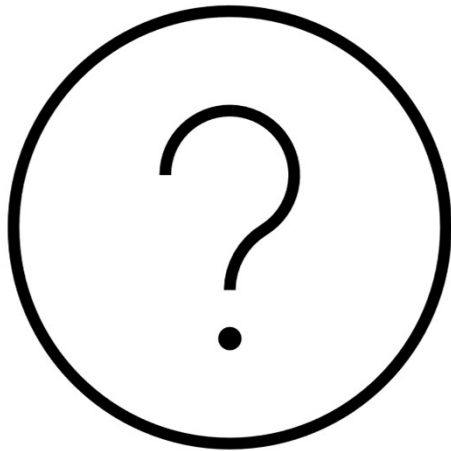# Meier zu Köcker 2009 – Governance and financing

- "*Top down network*", internally initiated:
  - Centralized governance, usually by internal actors.
  - Usually a leading organization of the cluster acts as coordinator (often research institutes or universities).
  - Political influence varies and there is usually a dependence on public funding.

Which type of clusters do you know from South Africa?

Some more concepts

- *Industrial district*: regional concentration of companies in closely interlinked industries (interdependence of suppliers), which are integrated into a social network.

- *Regional milieu*: socio-cultural factors and interpersonal relationships as a basis for company cooperation and learning

- *Regional innovation system*: focus on the emergence of innovations

- *Regional network*: horizontal and vertical linkage of regional actors as a central process

- *Learning regions*: Learning-by-doing, learning-by-using (consumer behavior), learning-by-interacting

- *Agglomeration*: concentration of firms / employees

- *Embeddedness in spatial perspective*: spatial, institutional and cognitive proximity in a region create a milieu controlled by trust and reputation

- Approaches are not free of overlap, but partly build on different cause-effect relationships and set different priorities

Is there an effect of being located in a cluster?

Which effects might be working / on which variables?

Effects of clusters on incumbents

- Positive effects of clusters
  - Higher productivity
  - High innovation rates in clusters
  - Increased growth rates
  - Outside innovators are not informed about the invention at all or too late
  - More start-ups in a regional cluster
  - Regional clusters attract companies
  - Effects on related industries

- Self-reinforcing processes
  - After critical mass is exceeded, the region continues to grow (number of firms, innovations, etc.) even without funding
  - Growth process is sustainable for some time (10 - 30 years)

Effects of clusters on incumbents

- Clusters do not always have positive effects
- Increasing cost of living
  - Increase in land prices and rents as a result
  - This can lead to social disparities and labor market segmentation, as only certain sectors of the economy benefit from cluster growth.
- Congestion effects
  - Overloading of infrastructure and transport logistics ➜ lower transport cost advantages ➜ more inefficient allocation of resources
- High wages
- Partially worse performance of companies in regional agglomerations

Effects of clusters on incumbents

- Risk of strategic misalignment (market, technology, products)

- Risk of collective failure: imitation behavior (technological lock-ins), overinvestment, competition on costs instead of innovation

- Negative effects on firms inside the region, but outside the cluster ➔ What is the net result?

- Not all firms in a cluster can participate to the same degree

    - Differentiate with regard to company size

    - Large, already market-established companies benefit very often

    - Small, inexperienced companies may have problems, be exploited or even taken over by competitors

Effects of clusters on incumbents - start-ups

- High number of start-ups in the cluster BUT decreasing chances of survival

- Death rate highest in the first 5 years

- Increasing competition for resources and sales markets too great

- Start-ups are mostly small companies with limited resource availability ➔ "liability of newness"

Effects of clusters on incumbents

- Study by Breschi/ Breaudy (2003)

- Main result ➔ Clusters not necessarily conducive to more innovative performance

- Even source of negative externalities

- Presence of other innovative companies in the cluster is essential ➔ Hence, not the quantity of the firms, but the quality is important

- Positive agglomeration externalities lead to more start-ups

➔ mixed results even in one study

Meta-analysis of cluster effects (Grashof and Fornahl 2021)

- Empirical evidence for a positive performance effect
- (Baptista and Swann, 1998; Bell, 2005)

- Empirical evidence for mixed or even negative performance effects (Knoben et al., 2015; Pouder and St. John, 1996)

   Does being located in a cluster influence firm´s success?

Meta-analysis of cluster effects
(Grashof and Fornahl 2021)

- Meta-analysis: „(…) the analysis of analyses." (Glass, 1976, p. 3)

- Adequate alternative for a traditional narrative review as (…)
  - Proceeding of narrative review is insufficient standardized and therefore difficult to verify
  - A narrative review is rather unsuitable for highly inconsistent results
- ➡ Descriptive meta-analysis is an appropriate approach to answer the research question

- Four performance variables are considered:
  - Innovativeness
 - Productivity
  - Survival
  - Employment growth

Meta-analysis of cluster effects (Grashof and Fornahl 2021)

- Literature collected from four different publication databases:
    1. Web of Science
    2. Google Scholar
    3. Ebsco
    4. Social Science Research Network (SSRN)

- Example search query (Web of Science):
    - TS=(((cluster) OR (agglomeration)) AND ("innovation") AND (firm OR company))

- Only the 200 most relevant articles are considered
    - Irrespective of year and publication type
    - → Comprehensive literature collection for the beginning

Meta-analysis of cluster effects (Grashof and Fornahl 2021)
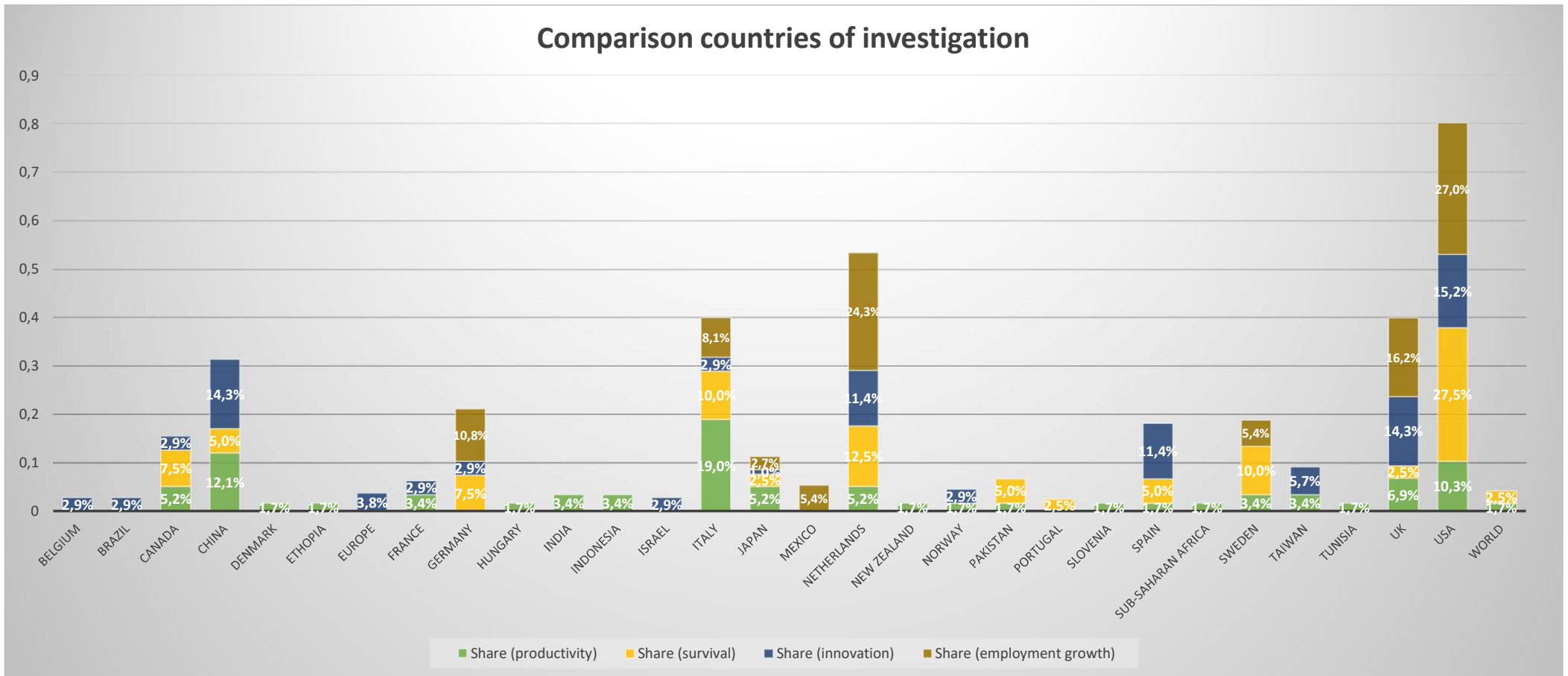
- Inclusion criteria
  - Studies need to be empirical
  - Studies need to have the same cluster understanding
  - Relative cluster measures have to be based on the national average
  - Productivity measures should not be based on worker wages
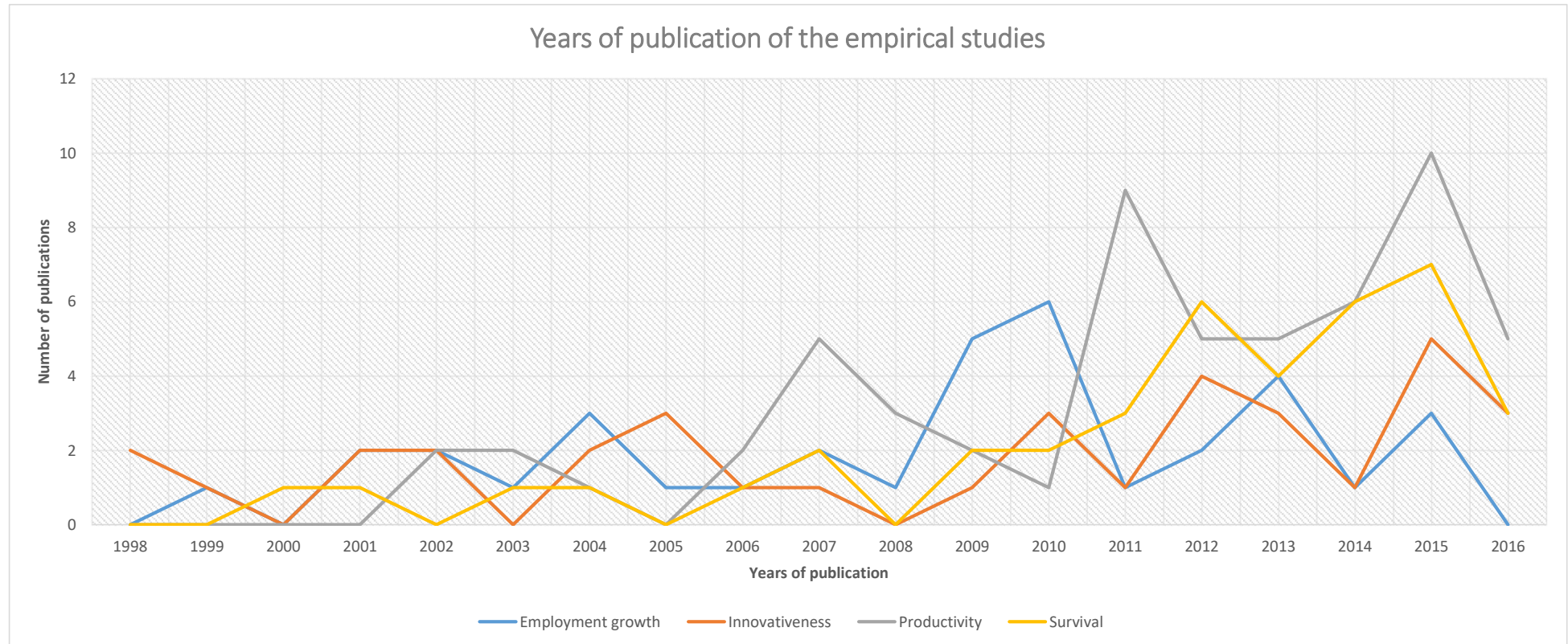 - Analytical focus of the studies needs to be on the firm-level
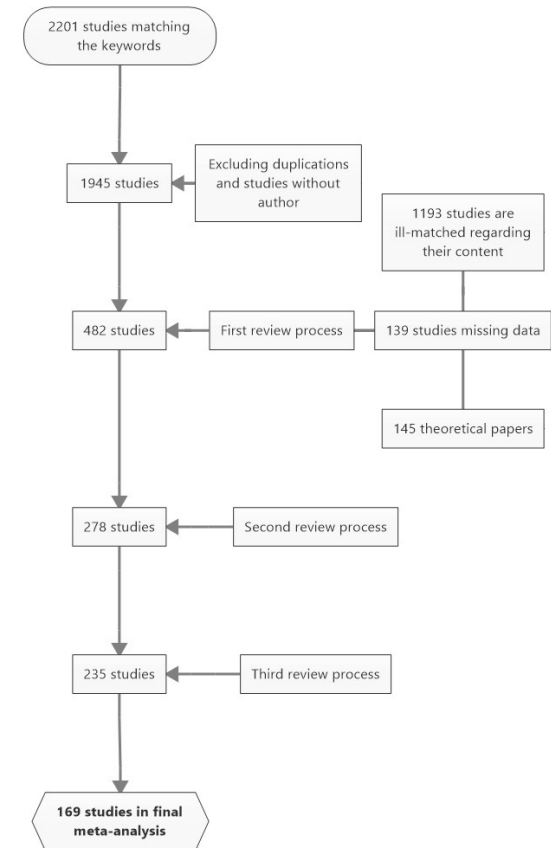
Meta-analysis of cluster effects (Grashof and Fornahl 2021)

Comparison countries of investigation

- Share (productivity)
- Share (survival)
- Share (innovation)
- Share (employment growth)

Meta-analysis of cluster effects (Grashof and Fornahl 2021)

Years of publication of the empirical studies

Meta-analysis of cluster effects (Grashof and Fornahl 2021)

- Vote counting is rather imprecise
  - Sample size of each study is not considered
  - Actual effect size is also not taken into account

- However, offers first way of approaching the firm-specific cluster effect
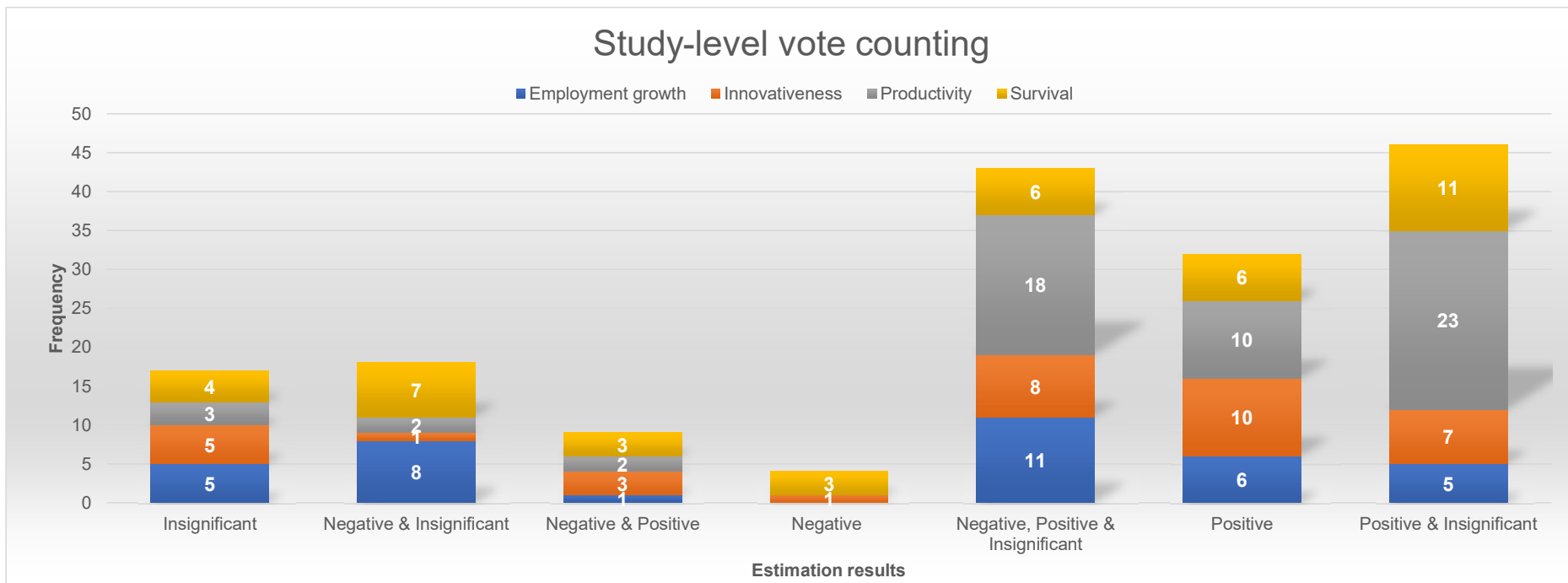
Meta-analysis of cluster effects (Grashof and Fornahl 2021)

Re-grouped vote counting

■ Employment growth ■ Innovativeness ■ Productivity ■ Survival
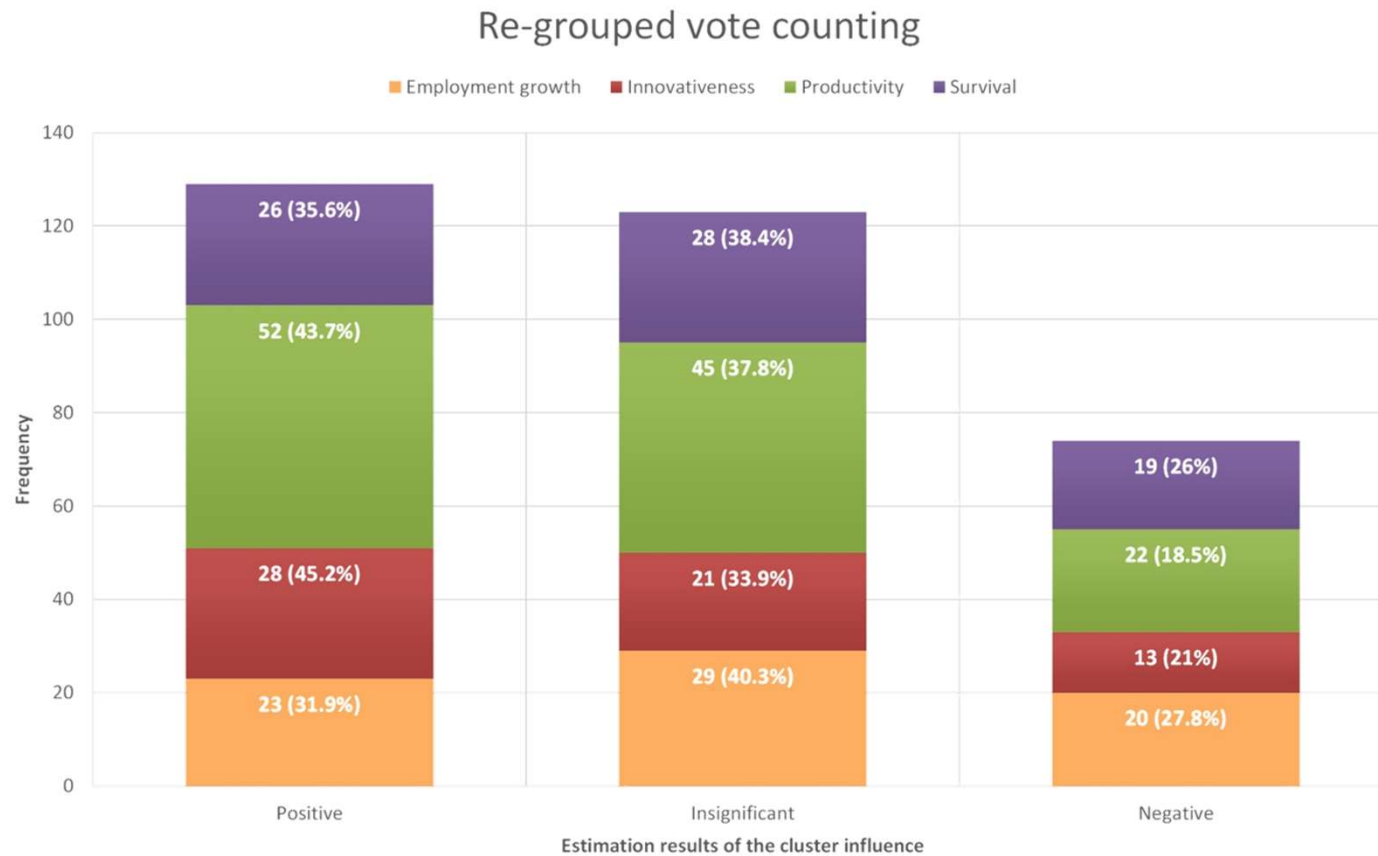
Meta-analysis of cluster effects (Grashof 2020)

Effects of clusters	Model 1 n = 2093	Model 2 n = 887	Model 3 n = 295
Indicator: Employment growth	0.466***	-0.240	2.298***
Indicator: Productivitiy	0.724***	0.616*	/
Indicator: Innovativeness	0.634***	0.256	/
Germany	-1.599***	-1.324***	/
Italy	-0.024	-0.046	-0.508
Japan	0.767**	1.372***	/
Netherlands	-1.604***	-0.856*	/
England	0.443**	1.039***	/
USA	0.186	0.843***	-3.271***
Spain	0.738	1.220	/
China	0.273	2.181***	/
High quality of method	0.700***	0.529	2.494***
IndustryHighTech		0.381**	
IndustryMidHighTech		-0.847***	
IndustryMidLowTech		-0.691**	
HighTech x Low Distance			0.939**
LowTech x Low Distance			0.689
HighTech x High Distance			-0.148
Pseudo R²	0.056	0.148	0.116

- Dualistic pattern in the countries studied
  - Coordinated market economy

  - Liberal market economy

- Industrial differences
  - Companies in high-tech industries are more likely to benefit from clusters
  - Medium-tech industries are less likely to benefit from clusters

- Interaction between industries and geographical distance
  - Low distance between firms in clusters is especially beneficial in high-tech industries

Summary on cluster effects

- Some evidence of a direct firm-specific cluster effect

- Results tend to be mixed ➔ Importance of context (e.g. organization)

- Multidimensional influence on cluster effect
  - Differences across performance indicators
  - Dualistic pattern among the countries studied (Western European countries vs. Anglo-Saxon countries)
  - Company level: size of companies
  - Industry level: high-tech vs. low-tech industries

- Interaction effects between the different levels

Which mechanisms cause cluster emergence?

Approaches

- Chance (but not only by chance)
    - Stochastic approaches
    - Core-periphery model
    - Window of locational opportunity
    - Pioneers

- Diversification

- Spin-offs

Core-Periphery model (New Economic Geography)

- Combination of transport costs and externalities (demand)

- 2 regions

- Decreasing transport costs

- Stable and unstable equilibria

- Critical point (B)

- Small accumulation of economic subjects triggers forces that reinforce themselves

- "Historical accidents"
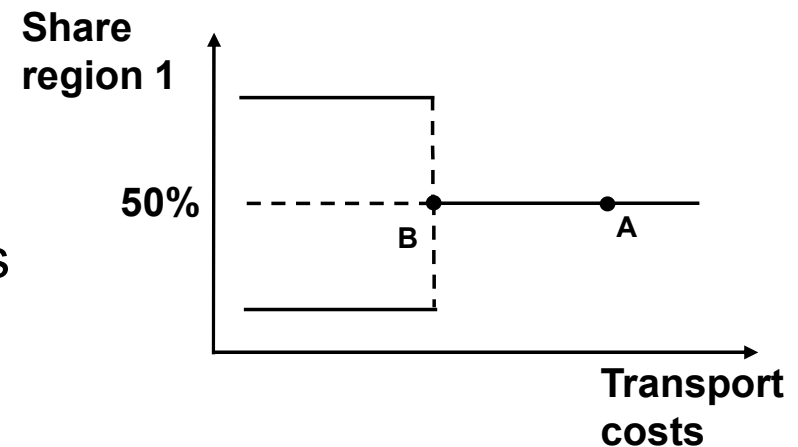
Window of locational opportunity

- Common in emerging industries

- Cluster formation is a random process (historical accidents)

- Clusters of a given industry emerge where agglomeration effects first take effect

Cluster formation by pioneers

- Company start-ups often result from previous employment relationships of the founder

- Often in regions where company founders had previously resided

- Reasons of the entrepreneurs
    - Familiarity with local conditions (e.g. suppliers, labor market and sales market)
    - Contacts with authorities and banks
    - Possibly received subcontracts or financial help from previous employers

- First-mover advantage for the region

- Localized human capital can form and be utilized
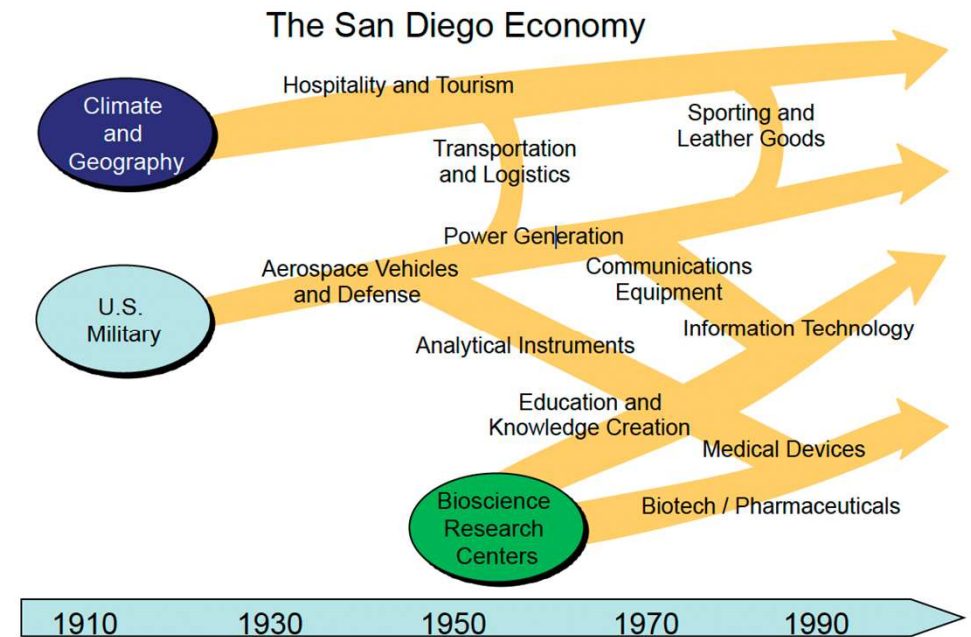
Cluster formation by pioneers

Steve Wozniak and Steve Jobs Apple Computer Manufacturing Plant from 1976-77 Apple Campus - Headquarter

- Risk of starting a business reduced
- Gradual transition from dependent to self-employment
- Business start-up not an actual location decision, as this is limited in the activity area
- Growth leads successively to expansion of company boundaries
- Attracts other companies that benefit from the know-how
- Specialized suppliers establish themselves near the pioneer

Diversification

- Cluster mutation through related variety

- Preferred in knowledge-intensive industries

- Competitive advantage through complementary knowledge

The San Diego Economy

Climate and Geography

Hospitality and Tourism

Transportation and Logistics

Sporting and Leather Goods

Power Generation

U.S. Military

Aerospace Vehicles and Defense

Communications Equipment

Information Technology

Analytical Instruments

Education and Knowledge Creation

Medical Devices

Bioscience Research Centers

Biotech / Pharmaceuticals

1910   1930   1950   1970   1990

Source: Porter, Monitor Company, Council on Competitiveness (2003)

Diversification - Incubator hypothesis

- Established industrial agglomerations act as incubators for start-ups
- Existing industrial areas offer numerous advantages for newly established companies
    - Open space and vacant buildings
    - Access to suppliers, markets and business services
    - Cost savings through access to an existing labor market
- In the high-tech sector, leading companies and universities have a central role as incubators for start-ups

Summary

- First phase of cluster development until the number of companies and institutions reaches a critical mass under researched until now

- Reasons for agglomeration are quite different, but show commonalities ➔ Consider agglomeration individually

- Cluster emergence can usually not be traced back to one individual factor

- Different industries have different cluster formation characteristics

- Window of locational opportunity is partly based on coincidences, whereas diversification and pioneers are used purposefully.

- Coincidence affects agglomeration formation, but not decisive ➔ still there are existing regional conditions which might favor specific regions (Windows of locational opportunity, pionieers)

Spinoffs and Cluster Formation

Cluster formation by spin-offs - Theory

- Experiential knowledge and learning effects
  - Learning effects while working for a company (factual knowledge, market information, entrepreneurial skills)
  - Success-breeds-success ➜ good routines
    - Successful parent companies have more spinoffs
    - Successful parent companies have more successful spinoffs
    - Spinoffs are more successful compared to the average start-up
  - Spinoffs start in related fields to parent company or even the same field ➜ potential for synergies
- Motivation and strategy conflicts ➜ triggering event
  - Crises, disagreement about future strategies, dissatisfaction in general, unemployment or M&A / change in management lead to spinoff
  - Costs of staying > costs for spinoff
  - Examples: IBM - SAP, XEROX

Cluster formation by spin-offs - Theory

- Local startups
  - Founders are immobile and are most likely to found where they are at the time of founding or in their home region.
  - Spinoffs enter markets close to those of parent firm (includes technological relatedness)

- Successful entrepreneurship and cluster formation
  - Impact on regional conditions (e.g. attract and educate human capital, visibility of industry, support infrastructure)
  - Positive entrepreneurial role models

Cluster formation by spin-offs - Examples

- Semiconductor cluster in Silicon Valley (Shockley / Fairchild)
  - 124 companies can trace their roots back to Fairchild
  - Fairchild's spinoffs = Intel, Advanced Micro Devices, National Semiconductor, LSI Logic and their spin-offs
  - Moore was a founder of Fairchild and Intel

- Tire cluster in Akron (Goodrich)

- ECommerce cluster in Jena (Intershop)

- Wireless Telecommunication in North Jutland (SP Radio)

Case study: Intershop and Jena

- Observations
    - For investors shares of many dot.com firms were a financial desaster
    - Single firms can trigger regional development and the emergence of localised clusters

- Approach
    - Case study of German dot.com star: Intershop Communication

Case study: Intershop and Jena

- Case study of German dot.com star: Intershop Communication

- Before March 10, 2000
  - Founded in 1992 by three founders
  - Producer of web-related high-end e-commerce software
  - Dot.com boom supported rapid growth of Intershop
  - Stock market value (11.1 billion Euro), 1,218 employees, 123 Euro revenues

- After March 10, 2000 ➜ Triggering event
  - Firm lost 70% of its stock market value on one day
  - All three founders resigned
  - High quality products, but marketing and strategy weak
  - Down-sizing: 222 employees, 15 million Euro revenues

Case study: Intershop and Jena

- Serial Entrepreneurship
  - All three Intershop founders started new firms (ePages, Pixaco, Demandware)
  - Managers and employees from Intershop
  - Intershop experiences influened new ventures
    - 2 remained in Intershop's core market
    - 1 used web portal based on Intershop software

Case study: Intershop and Jena

- Intershop as incubator
  - Former employees started IT-related firms

Firm	Previous position	Business model / field of activity
Clienthouse	Customer and partner services	Customer relation management consulting
Cresco Services	CFO	Financial consulting services
J-media	Press relations	Standard software for marketing / PR
Moccafish	User interface design	Interface design, e-learning
Towerconsult	VP Human resources	Human resource consulting (recruiting); software development
Xceptance	Quality control	Quality management for software development

Case study: Intershop and Jena

- Intershop as incubator continued
  - One firm started in Intershop's core market
  - Exploitation of knowledge and experiences
  - Intershop enabled emergence of spinoffs
  - TowerByte eG as a privately organised technology park

- Overall assessment
  - > 30 spinoffs emerged
  - Inheritance based von accumulated knowledge
  - Intershop's Peculiar Situation: Failure Breeds Success?
    - Down-sizing as triggering event
    - High quality captabilities and opportunities Intershop could not exploit
    - Industry characteristics

Case study: Intershop and Jena

- Direct regional effects of Intershop
  - Human capital
    - Attraction of IT/software-related human capital to the region
    - Capabilities acquired on the job
    - Intershop foundation
    - ➢ Pool of employees a new entrepreneur can pick from
  - Custom-made IT/software-infrastructure in Intershop Tower
    - ➢ Used now by Intershop, spinoffs, TowerByte and other IT firms
  - Purchasing power
    - Regular salaries
    - Wealth from stocks and options
    - ➢ Unclear effect on current local financial capital

Case study: Intershop and Jena

- Regional role models
  - Mixed empirical evidence
  - Experts: Stephan Schambach affected local entrepreneurial activities by providing a positive role model
  - Firm survey: Entrepreneurial climate and earlier regional founders affected founding decision
  - But: no significant quantifiable effect of Intershop's role was found

Case study: Intershop and Jena

- Regional Impact and Cluster Formation
  - Emergence of new technological development path
  - Crisis of Intershop let to spinoff processes
  - Business models often based on regional capabilities induced by Intershop
  - Entrepreneurs stayed in the region they were active in
  - Regional conditions favoured establishment of new firms
  - Software-related human capital stayed in the region
  - Small but growing nucleus of IT / software cluster (?)

Case study: Intershop and Jena

- Findings
  - Former dot.com firm may have had a lasting beneficial effect on regional development
  - Intershop created and shaped conditions
    - Firm's internal knowledge accumulation and spinoffs relevant
    - Firm's impact on regional conditions
  - New development path
  - Basis for evolving cluster

Case study: Silicon Valley and Fairchild

- 1947: Transistor is developed by three Bell Labs researchers

- 1955: William Shockley founds company in Paolo Alto (Shockley Semiconductor Laboratory)

- 1957: "Traitorous Eight" started spin-off (Fairchild Semiconductors)
  - Unhappy with management of Shockley ➔ tried to kick Shockley out of the company but when unsuccessful they left
  - Supported by Fairchild Camera and Instruments Company (Sherman Fairchild)

- 124 companies can trace their roots back to Fairchild

- Fairchild's spinoffs = Intel, Advanced Micro Devices, National Semiconductor, LSI Logic and their spin-offs

Genealogy: Shockley Transistors
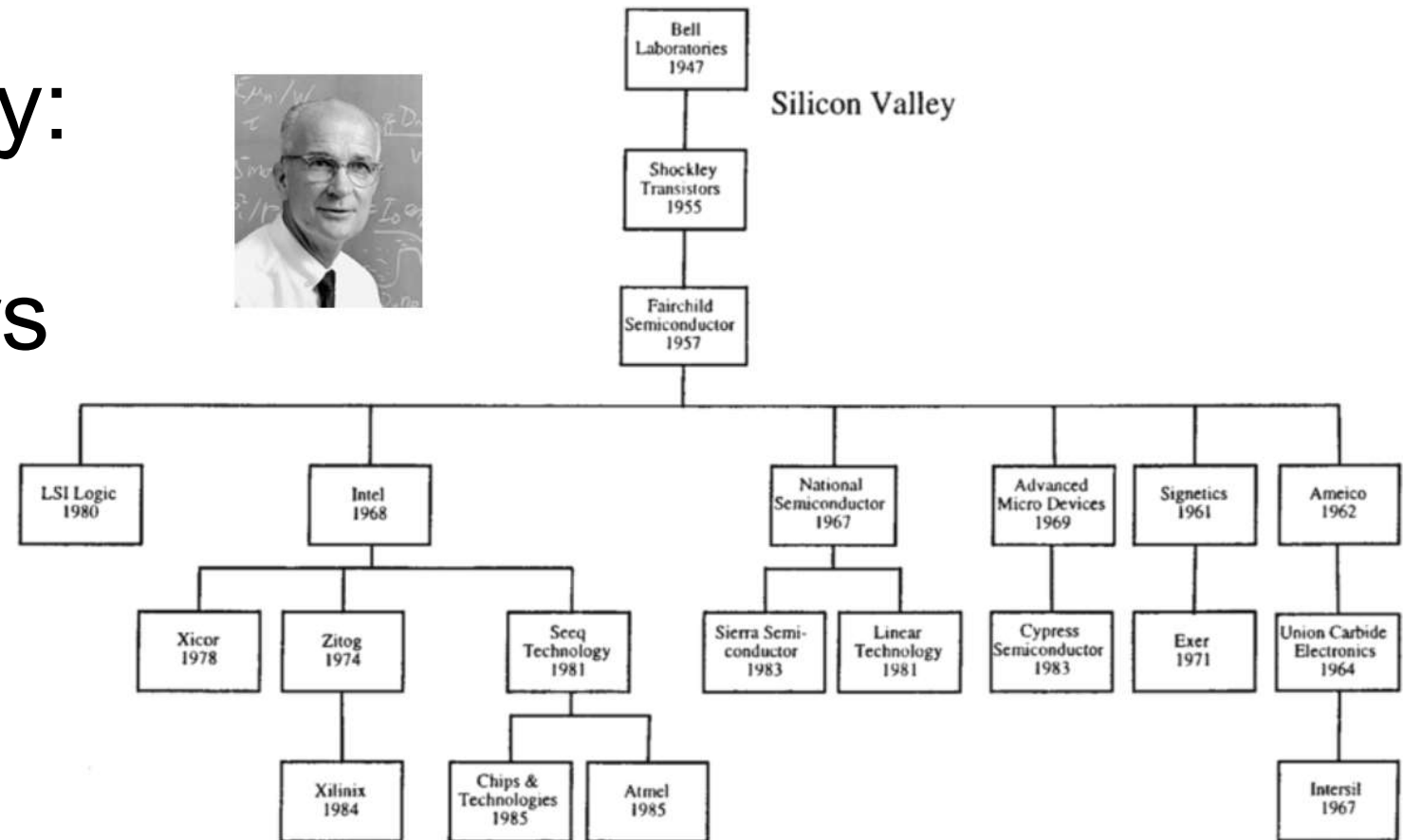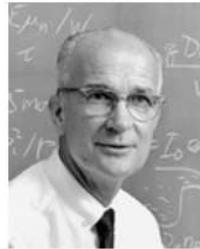
FIGURE 2. Genealogy of Silicon Valley start-up semiconductor firms. *Source:* adapted from Semiconductor Equipment and Materials Institute (1987) and various oher sources.
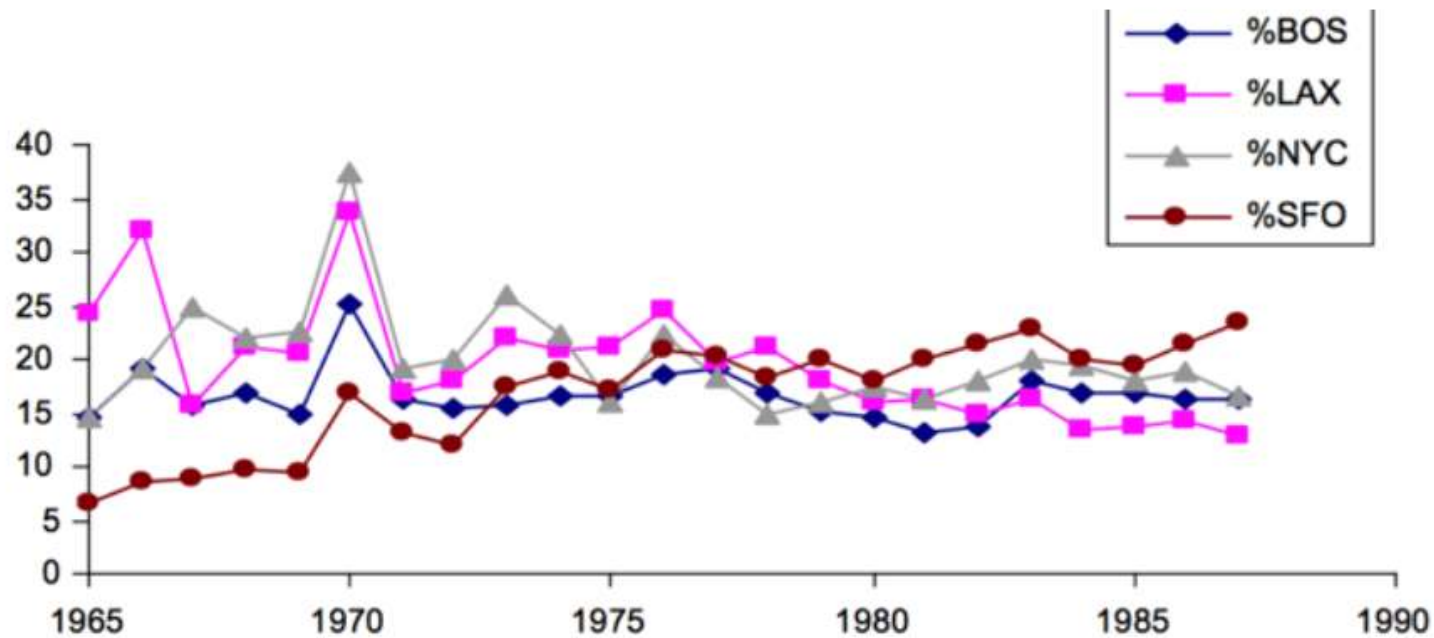
Case study: Silicon Valley and Fairchild

**Fig. 6.** Percentage of IC firms in Boston, Los Angeles, New York, San Francisco.

# „Traitorous Eight"

What happened to the "Traitorous Eight"?

- Victor Grinich: Professor at Berkeley and Stanford
- Robert Noyce and Gordon Moore: Founded Intel
- Eugene Kleiner: Co-founder of venture capital firm Kleiner Perkins
- Sheldon Roberts, Jean Hoerni and Jay Last: predecessors of Teledyne
- Julius Blank: co-founder of Xicor

Case study. Genealogy Nordjütland
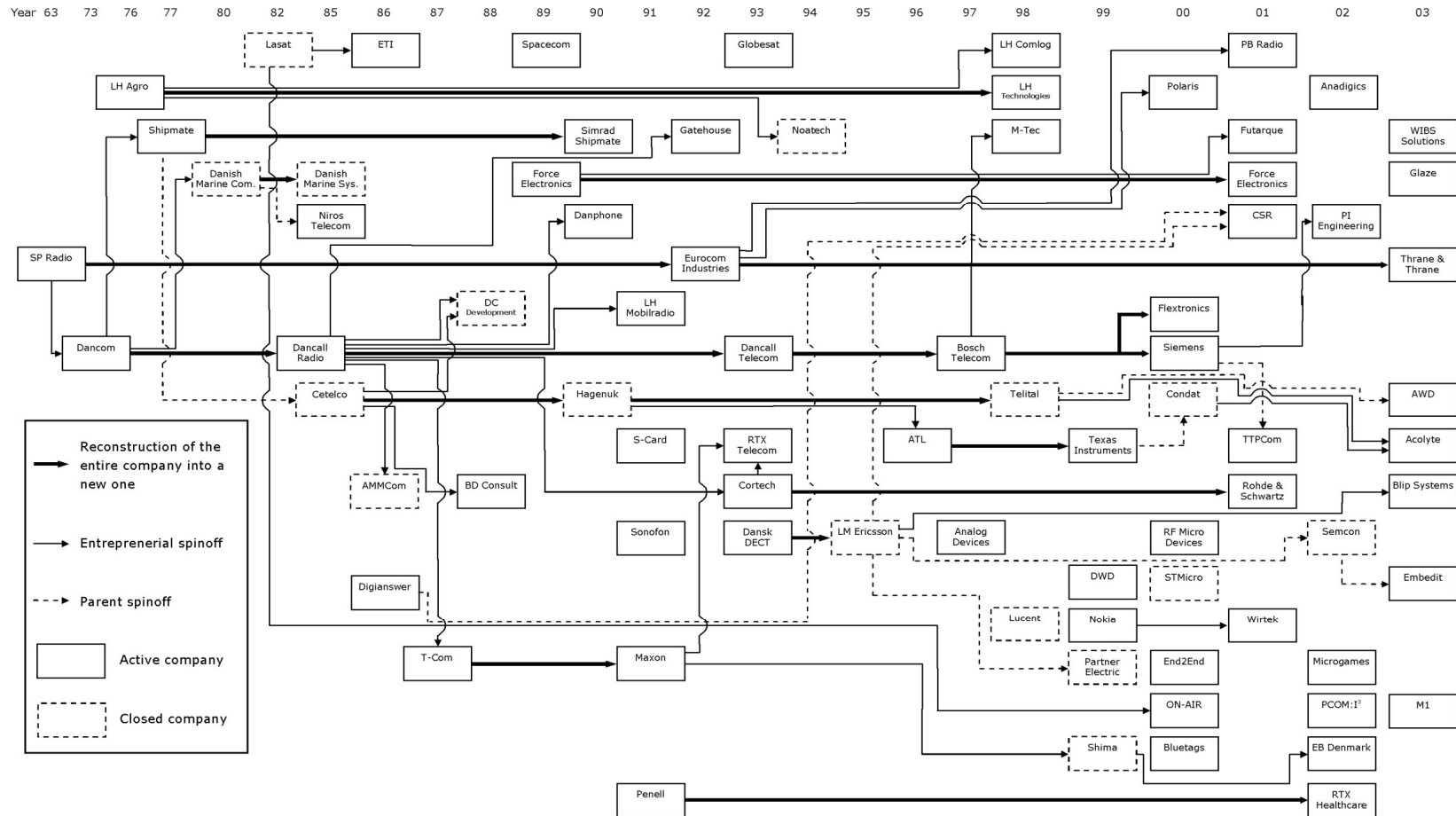
Case study: Genealogy Olds, Ford, Buick/GM (Detroit)

Figure 4   Spinoffs of Olds, Cadillac, Ford, Buick/GM
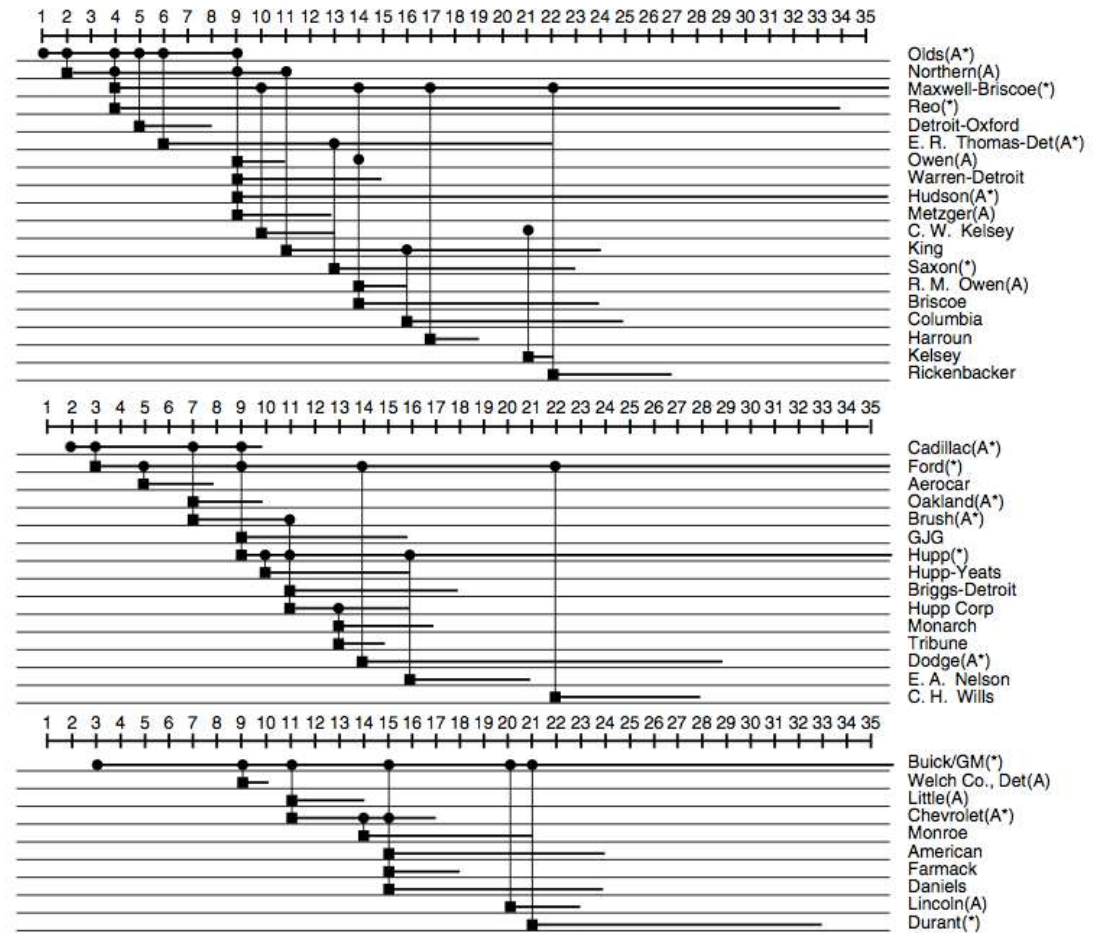
Notes. ●—Year of a spinoff from a parent. ■—Entry year of spinoff. A—Firm exited by acquisition by an automobile firm. *—Car make produced by firm attained ranks of leading makes. ——Years of firm production through 1936.

Case study: Detroit

- Development Detroit (1900-1930) → Agglomeration
- Olds, Cadillac, Ford and GM successfully produced the most spinoffs.
- Spinoffs responsible for success in Detroit
  - Spinoffs were responsible for the larger share of market entries in Detroit
  - Spinoffs in Detroit were more successful than spinoffs elsewhere, other companies comparable
- Quality of parent firm
  - When the legacy of the parent company is taken into account, spinoffs and other firms were equally successful everywhere

Case study: Detroit

- Detroit as a location not an advantage for other companies
- Detroit „inexperienced firms" worse than „inexperienced firms" elsewhere
- Agglomeration in Detroit = byproduct of spinoffs
- Not theory of overall advantages within an agglomeration critical to success (in the emergence phase)
- Strategic location in an agglomeration here only beneficial for spinoffs
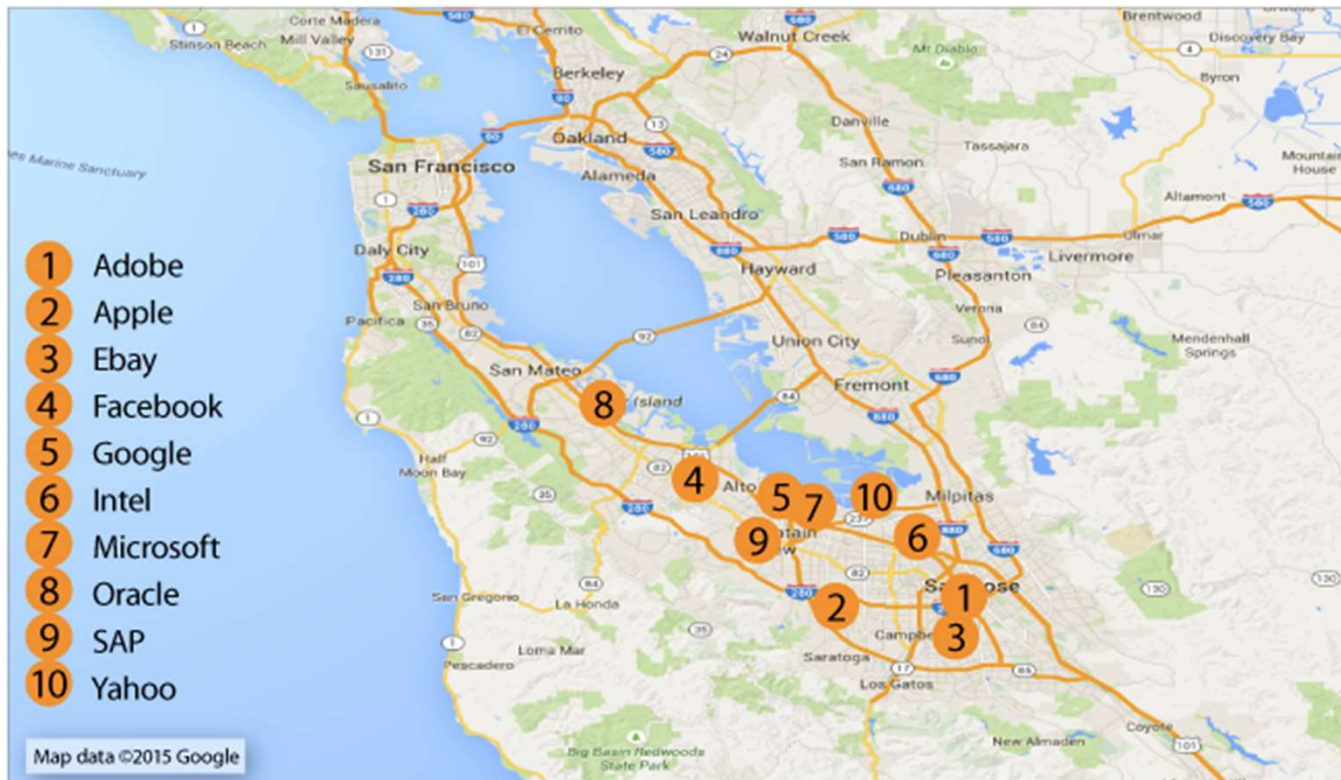- Strategic location in an agglomeration not always advantageous

Academic Spinoffs and Cluster Formation

(Academic) Spinoffs

- Academic spin-offs are, for example, companies founded by former academic employees, which are to supply and push new product ideas and research results to the market
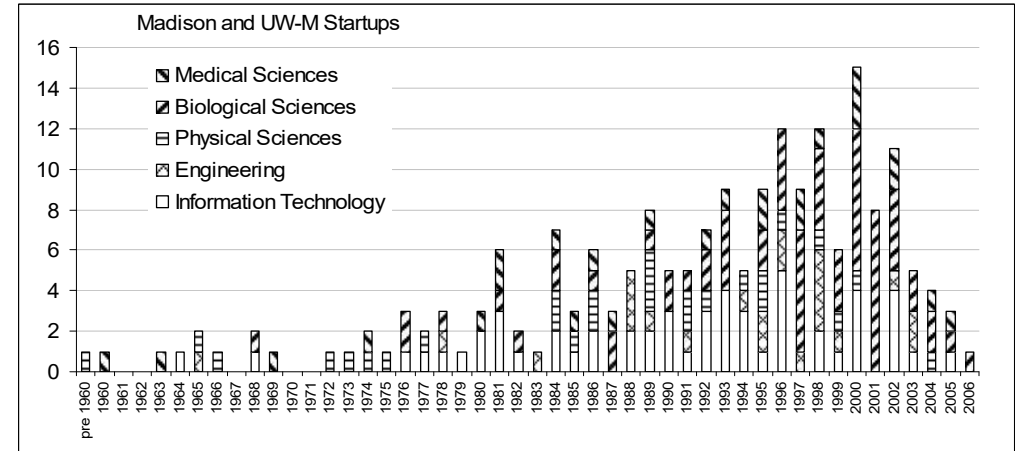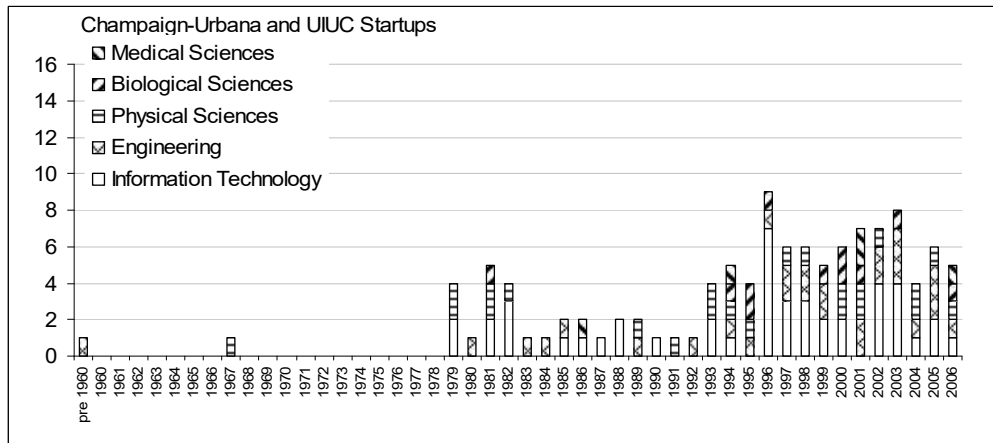
(Academic) Spinoffs

1. Adobe
2. Apple
3. Ebay
4. Facebook
5. Google
6. Intel
7. Microsoft
8. Oracle
9. SAP
10. Yahoo

Map data ©2015 Google

Quelle: https://www.boerse.de/wissen/silicon-valley/

- Most important location for the IT and high-tech industry
- Created through the establishment of a research and industrial area adjacent to Stanford University
- Former employees and graduates founded small companies and developed new ideas and products

(Academic) Spinoffs

Champaign-Urbana and UIUC Startups
- Medical Sciences
- Biological Sciences
- Physical Sciences
- Engineering
- Information Technology

Madison and UW-M Startups
- Medical Sciences
- Biological Sciences
- Physical Sciences
- Engineering
- Information Technology

- 117 spinoffs from Champaign and 200 from Madison

- Netscape and Paypal left Champaign because ressources were missing (e.g. managers)

- Madison ➔ second generation spinoffs generated because of better eco-system

Can such spinoffs be observed for South Africa as well?

How do clusters affect incumbent firms? - Mechanisms

Which mechanisms **might** positively affect other firms in a cluster?

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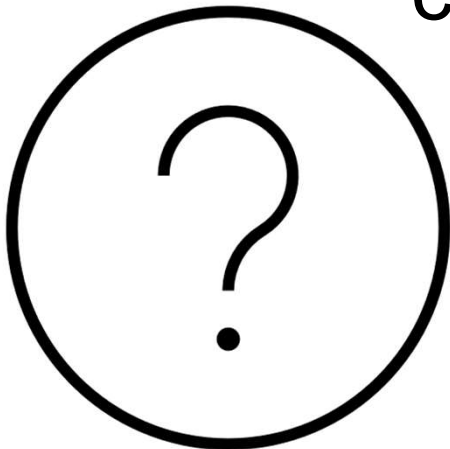
# Nothing is in the air - „There is no free lunch"

- Fitjar and Andrés Rodríguez-Pose (2016).
  - Questions the hypothesis that the "atmosphere" encourages innovation using data from a survey of Norwegian firms maintaining innovation partnerships
  - Findings indicate that there is possibly 'much less in the air' than is commonly assumed in the field
  - Relationships contributive to innovation by Norwegian firms are the result of purpose-built searches; little influence of chance encounters and proximity

Theoretical approaches

- Many explanations for geographical concentration of industrial activities
  - Geographical conditions (e.g. close to natural resources)
  - Transportation costs
  - Etc.

- Urbanization externalities
  - Land rents, wage premium, congestion (negative)
  - Highly skilled employees
  - Knowledge infrastructure
  - Market access

Theoretical approaches

- Porter 1990
  - Not actually a specific regional model
  - Porter's examples span hundreds of miles
  - "It should be clear that clusters represent a combination of competition and cooperation. Competition and cooperation may coexist because they occur to different degrees or because cooperation at one level contributes to winning competition at another."
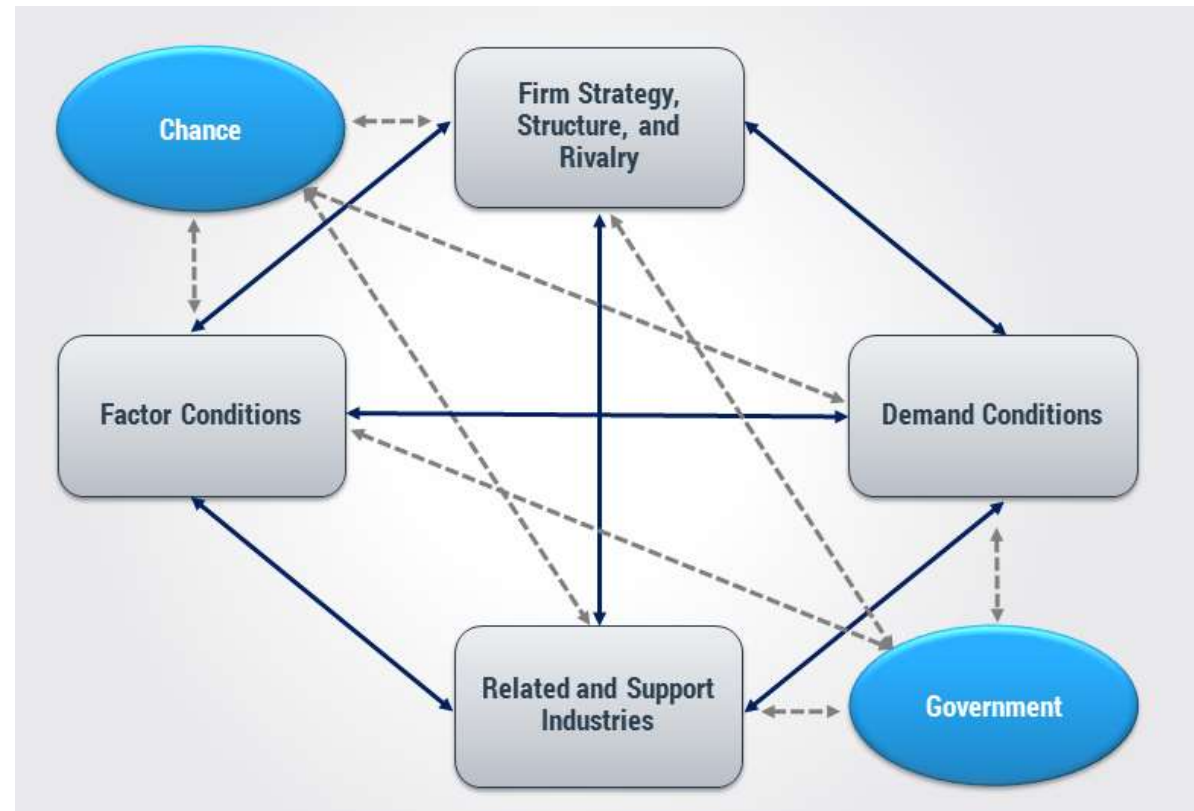
Theoretical approaches

- Marshallian Externalities (Specialisation)
  - Minimize inventories
  - Transportation costs within the value chain
  - Market for specialised labour (knowledge and cost aspect)
    - Matching costs labour market
    - Risk diversification in large labour markets
    - High accumulated knowledge
  - Exchange of spatially bound tacit knowledge ➔ Intra-industry knowledge spillover (new)
  - Access to specialised buyers and suppliers

Theoretical approaches

- Jacobian Externalities (Diversification)
  - Inter-industry knowledge spillovers
  - Low risk environment
  - Love of variety but lack of focus
- Creativity as a production factor
  - "jobs follow people" (Florida 2002)
  - Urbanity and creative milieus
- "Public procurement"
  - Locally focused research and procurement activities of the state
  - E.g. contracts for defence research in the USA and Munich
- **Self-reinforcing local processes (based on Marshall and partly on Jacobs)**

Self-reinforcing local processes

- Market factors / market conditions
  - Local clusters emerge in growing markets which in most cases are associated with new industries or technologies
  - Number of clusters is partly determined by the size of the market

- Industrial factors: Industry must tend to cluster
  - Many process innovations
  - Local cooperation with suppliers and research organizations
  - Many spillovers within the industry

- Regional factors
  - Long-term constant local conditions
  - Variable local conditions
  - Triggering processes / specific events
  - Self-reinforcing processes

Self-reinforcing local processes – local conditions

- Local conditions have an impact on the probability that a local cluster will occur

- Critical value below which the probability of a cluster is zero

- The better the local conditions, the higher the probability of cluster emergence ➔ but no guarantee

- Local industry-specific activity influences local conditions

Self-reinforcing local processes – local conditions

- Meta-analysis of 159 case studies

Factor	Relevant	Not relevant	Not mentioned
Presence of human capital	105	10	44
Existence of networks	78	37	44
Existence of public reasearch	70	22	67
Tradition in the region	66	10	83
Industrial structure in the region	61	2	96
Local policy	56	18	85

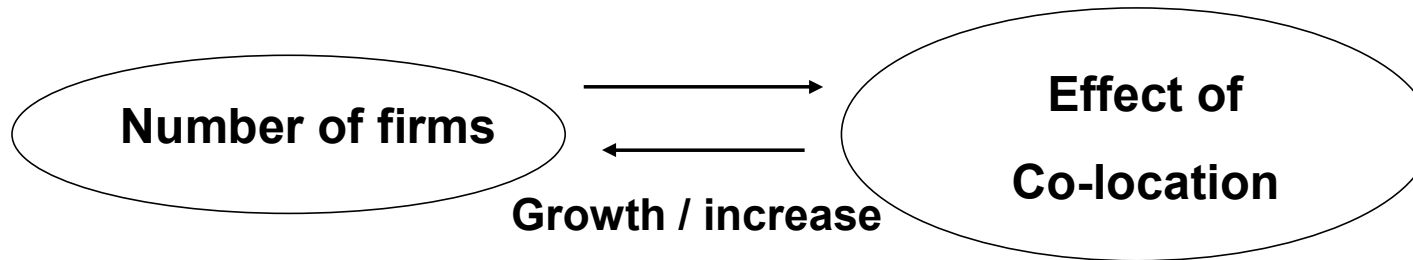# Self-reinforcing local processes – local conditions

- Processes are not equally relevant everywhere
- Min. 2 factors mentioned in each case study
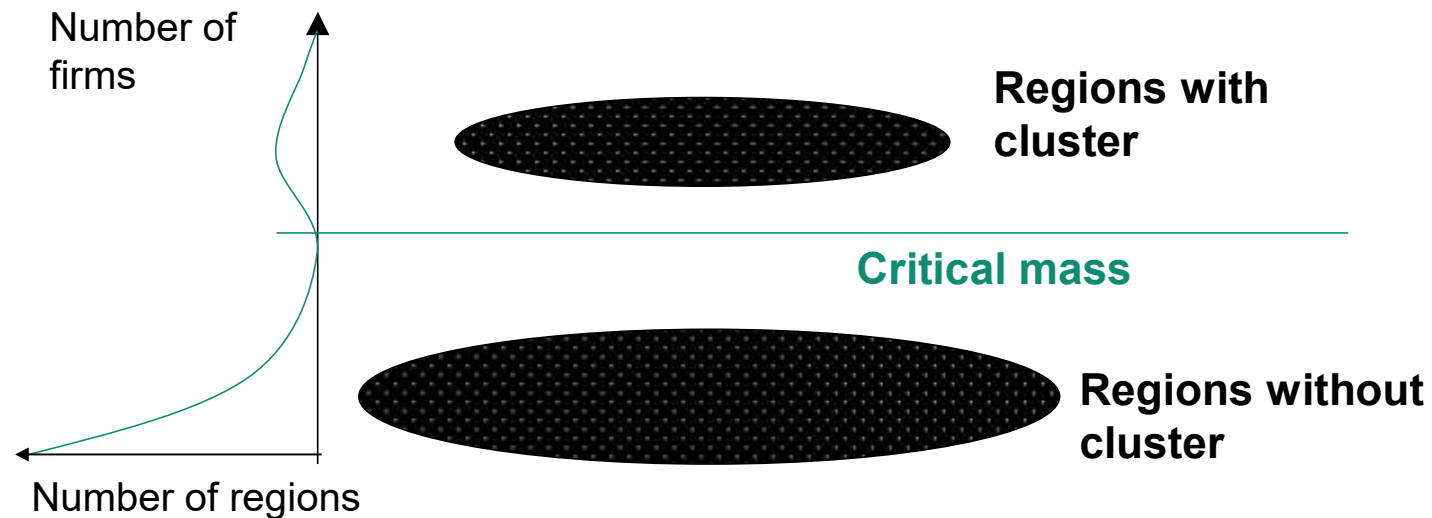
Self-reinforcing local processes – trigger

- Leads to overcoming the critical mass (measured in the number of companies / activities) by using the regional potentials

Prozess	Relevant	Not relevant	Not mentioned
Establishment of a central company for the region	62	4	93
Specific policy measure	53	10	96
Historical event	52	0	107
Appearance of a regional promotor	22	7	130
Appearance of a decisive innovation	15	4	140

Self-reinforcing local processes

o Self-reinforcement leads to 2 stable states

Self-reinforcing local processes

Prozesses	Relevant	Not relevant	Not mentioned
Accumulation of human capital	116	10	33
Cooperation among firms	87	22	50
Choice of co-location with other firms	83	3	73
Intra-industry spillovers	81	14	64
Interaction with public education and research	66	19	74
Spin-offs	60	4	95
Interaction with local policy makers	49	10	100
Inters-industry spillovers	46	1	112
Interaction with local public opinion	44	9	106
Interaction with local venture capitalists	35	6	118
Support of start-ups by firms	31	6	122
Byer-supplier relations	30	8	121

Self-reinforcing local processes

- Processes are not equally relevant everywhere

- Differences by industry, region, timing, etc.

- Evidence found for all processes

- 155 of 159 mention at least one self-reinforcing process

Which mechanisms do you think are the **most important** for your cluster?

https://www.menti.com/682tm879zn

Which dynamics of clusters can be observed?

Cluster dynamics - Motivation

- Empirical observation
  - Firms in clusters are not advantageous in all stages of the industry life cycle, e.g. Audretsch and Feldman (1996):
    - Comparison of innovation activities of 210 industries
    - Located in the same region (with the same industry)
      - Higher innovation activities
      - Only in the growth phase
      - Companies from outside have a higher innovation activity during the later phases
  - Process and structures in established clusters
    - … cannot explain cluster emergence
    - … can later on lead to cluster decline
 - Politically especially emergence and renewal / transformation are of interest

Cluster dynamics - Motivation

- Conclusions
  - Clusters can be described by sequential (but not deterministically linked) stages (emergence, growth, stability, renewal / transformation, decline)
  - Cluster stages have peculiar characteristics
  - Secondly, theories that explain the dynamics of functioning clusters are not sufficient to explain their evolution.

Cluster dynamics - Motivation

- Core questions
  - How can the different stages be characterized and separated from each other?
  - By which events and processes a transition between stages takes place?
  - Which processes and structures can be identified in the specific stages?
  - *Focus here on one factor:* knowledge generation, composition and diffusion

Cluster between regional and industrial dynamics
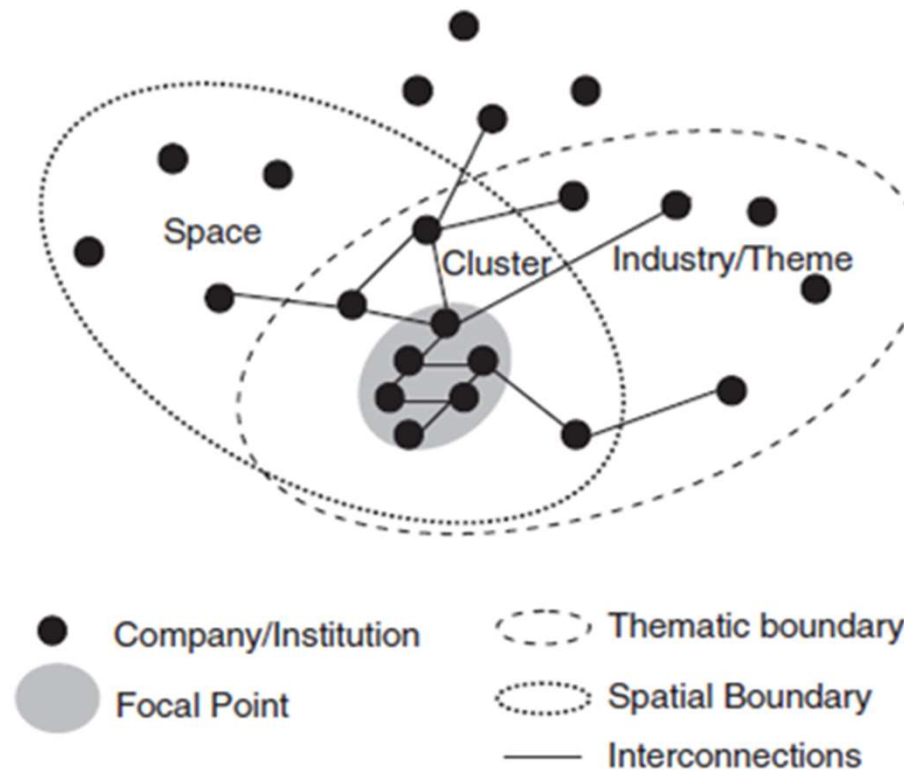
1. **Analysis of the industrial and regional factors that affect cluster dynamics**

2. **Combination of these factors for a cluster life cyle model**
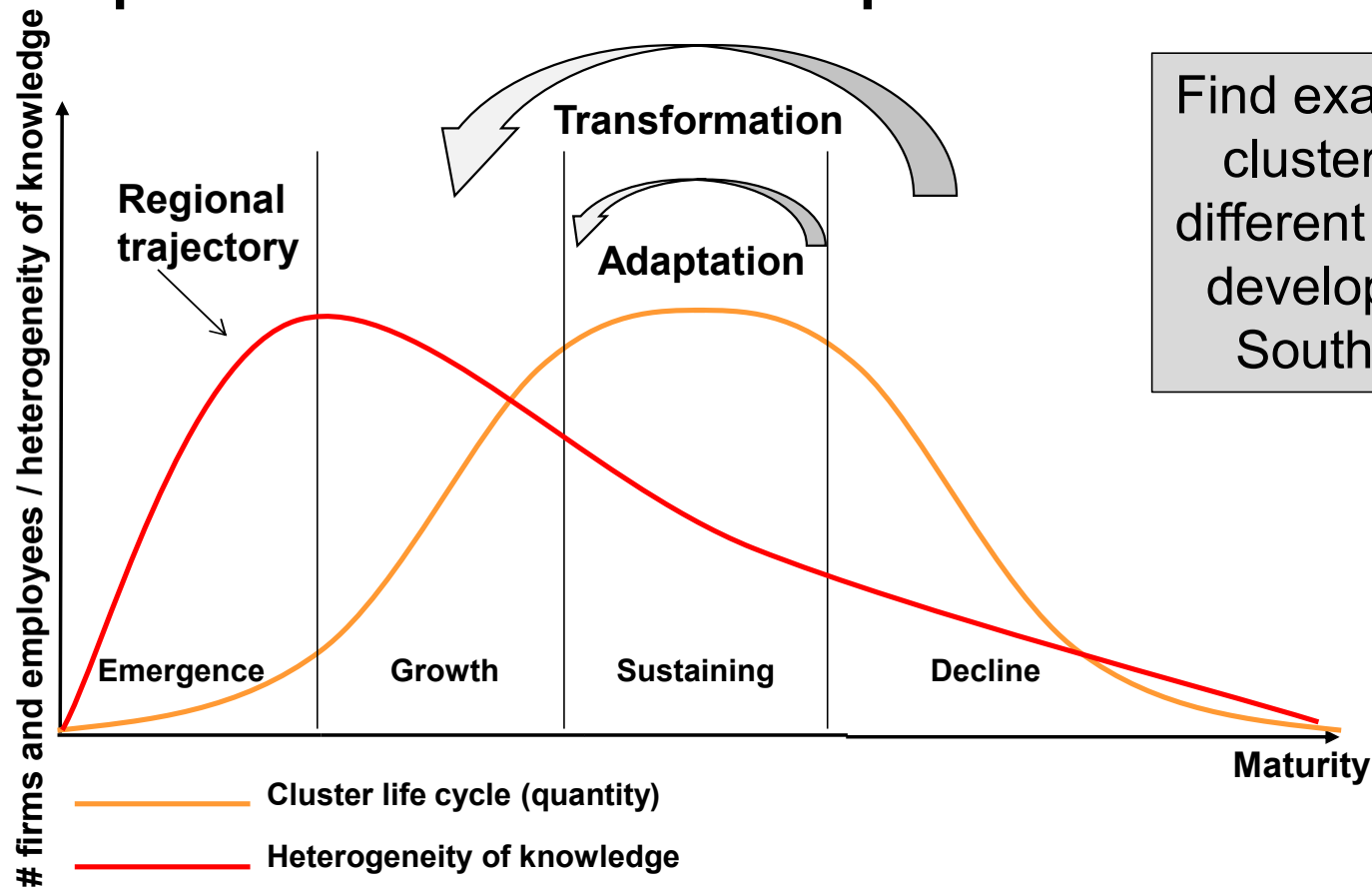
Quantitative and qualitative dimensions of clusters

	Quantitative	**Qualitative**
Direct	Size: -Number of firms / organizations -Number of employees	Diversity of knowledge: -Knowledge, competencies and organizational forms (heterogeneity vs. focusing)

1. **Factor of the cluster life cycle: Connection between heterogeneity and quantitative development and core elements to describe the current cluster status**

Industrial dynamics and the industry life cycle
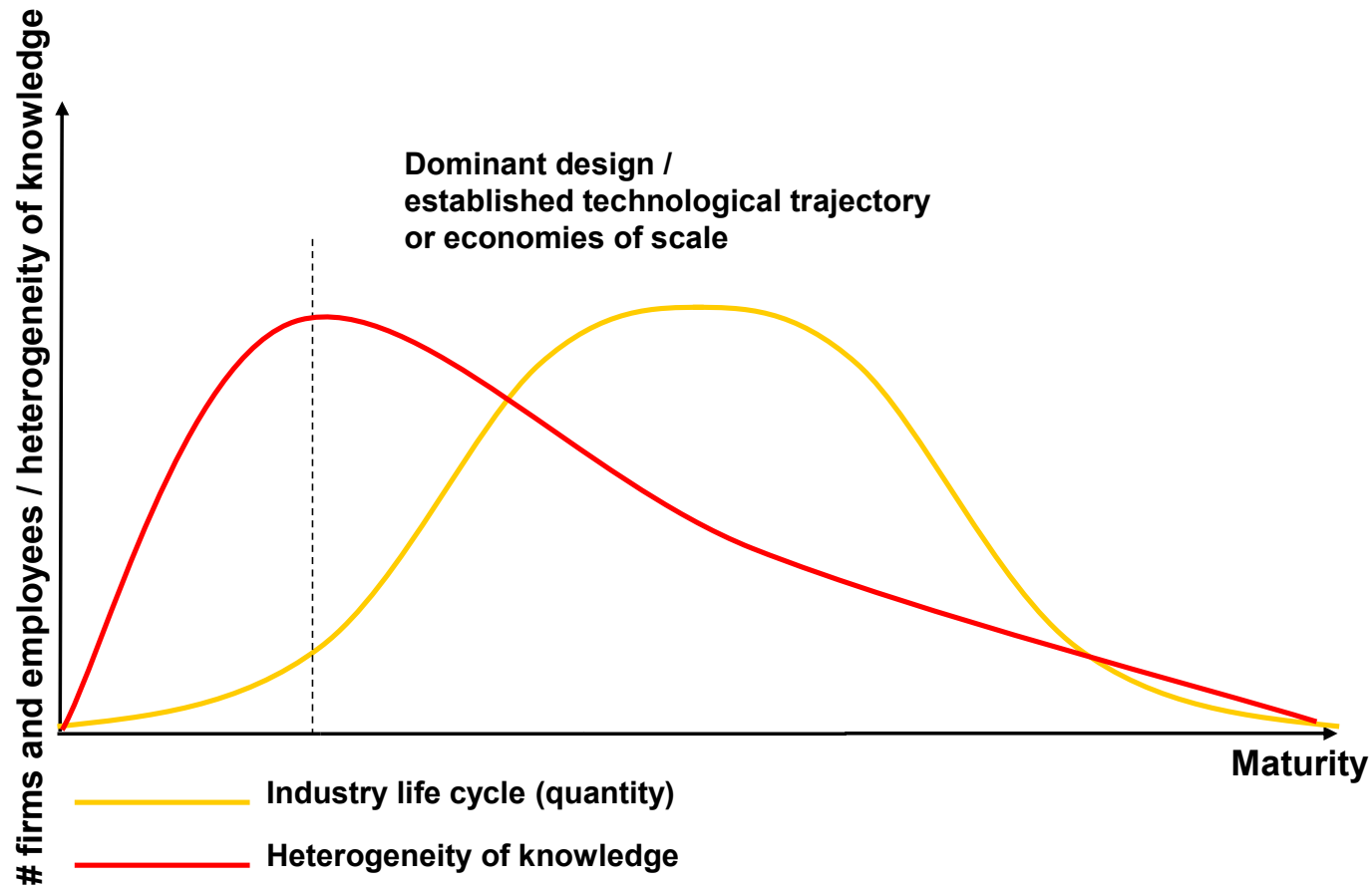
Connection between heterogeneity and quantitative development

Find examples for clusters in the different stages of development in South Africa.

Transformation

Regional trajectory

Adaptation

Emergence   Growth   Sustaining   Decline

Maturity

firms and employees / heterogeneity of knowledge

Cluster life cycle (quantity)

Heterogeneity of knowledge

Quantitative and qualitative dimensions of clusters

- But neither the quantitative nor the qualitative dimension can explain

  - …the movement of the cluster through different stages

  - …the differences between cluster and industry life cycle

Systemic dimension of clusters

|	Quantitative	Qualitative
Direct	Size: -Number of firms / organizations -Number of employees	Diversity of knowledge: -Knowledge, competencies and organizational forms (heterogeneity vs. focusing)
Systemic	Utilization of size: -Perception of the cluster -Capabilities for collective actions -Low transaction costs -Easy face-to-face interaction	Utilization of diversity: -Exploitation of synergies, networks and value chains -Labor mobility -Knowledge spillover -Interaction over larger technological distances

Rational for the movement of clusters through different stages lies in the systemic dimension

Interaction over larger technological distances
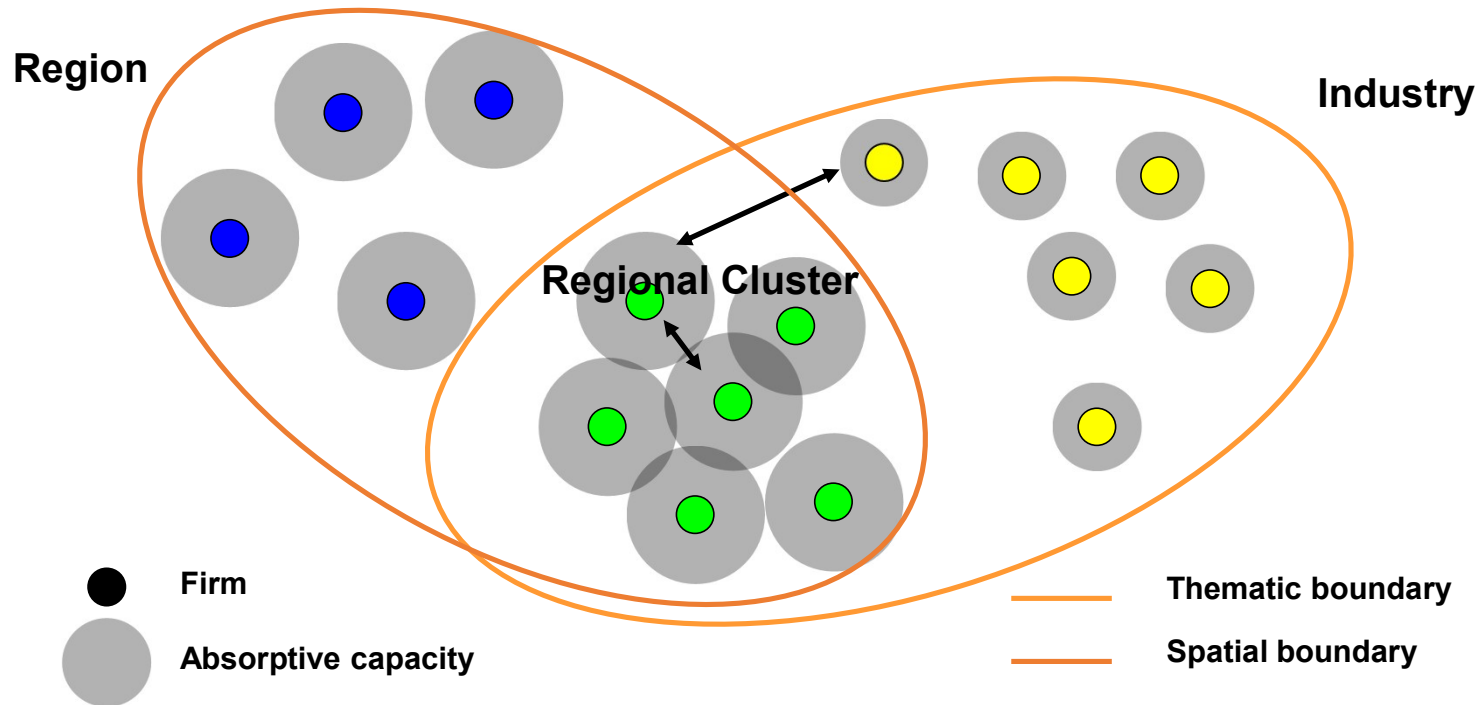
2. Factor of the cluster life cycle: Organizations in the same location have a larger relative absorptive capacity than firms in other locations

Regional perspective
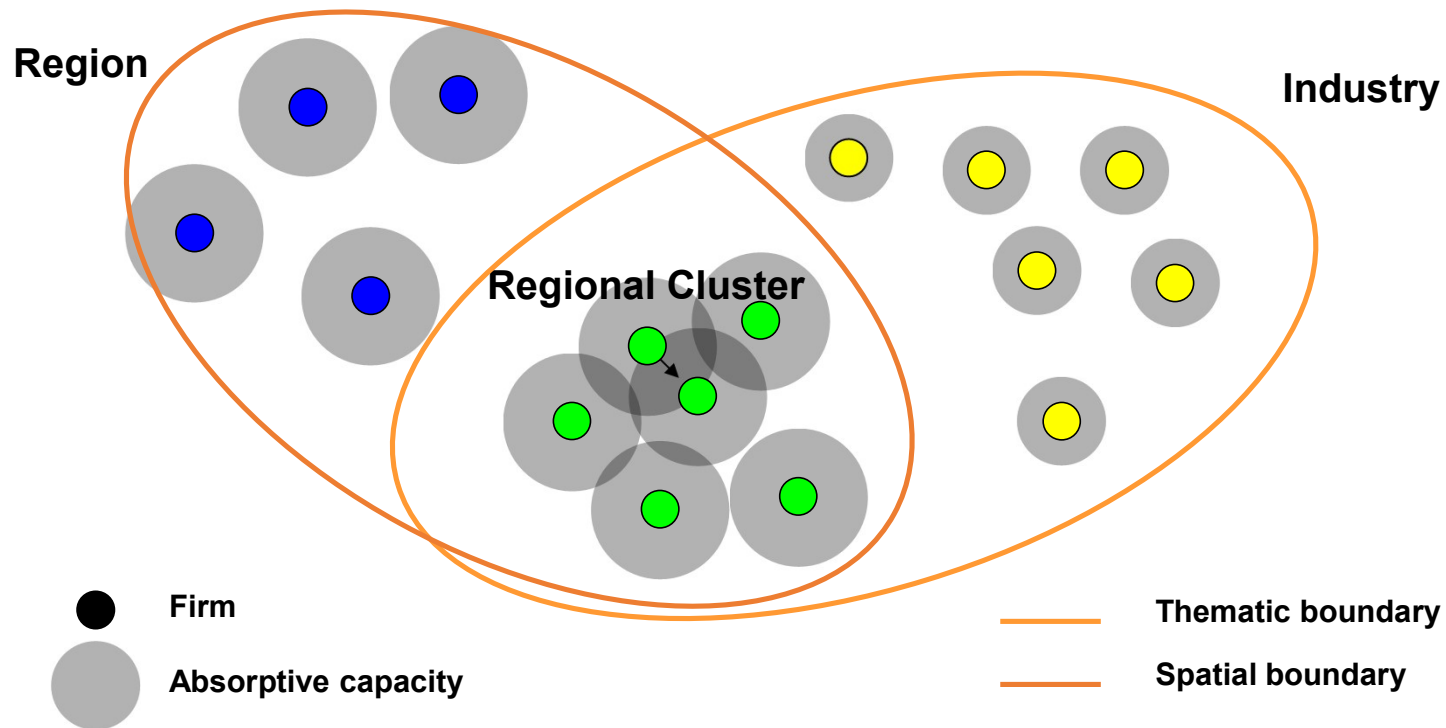
3. Factor of the cluster life cycle: Localized learning leads to mutual adjustment of organizations

Factors of the cluster life cycle

Rational for the movement of clusters through different stages lies in the systemic dimension

- Connection between heterogeneity and quantitative development
- Organizations in the same location have larger relative absorptive capacity than firms in other locations
- Localized learning leads to mutual adjustment of organizations
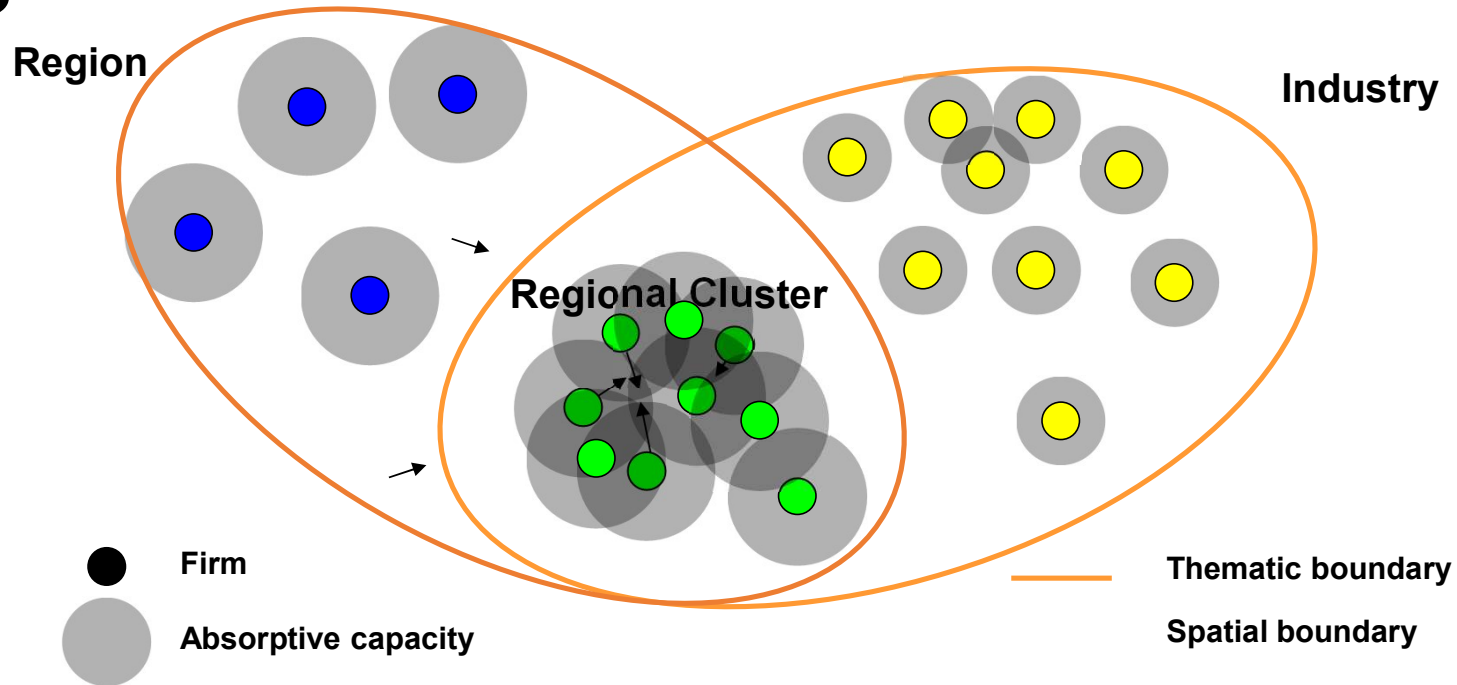
Emerging clusters

Region

Industry

Regional Cluster

● Firm

● Absorptive capacity

— Thematic boundary

— Spatial boundary
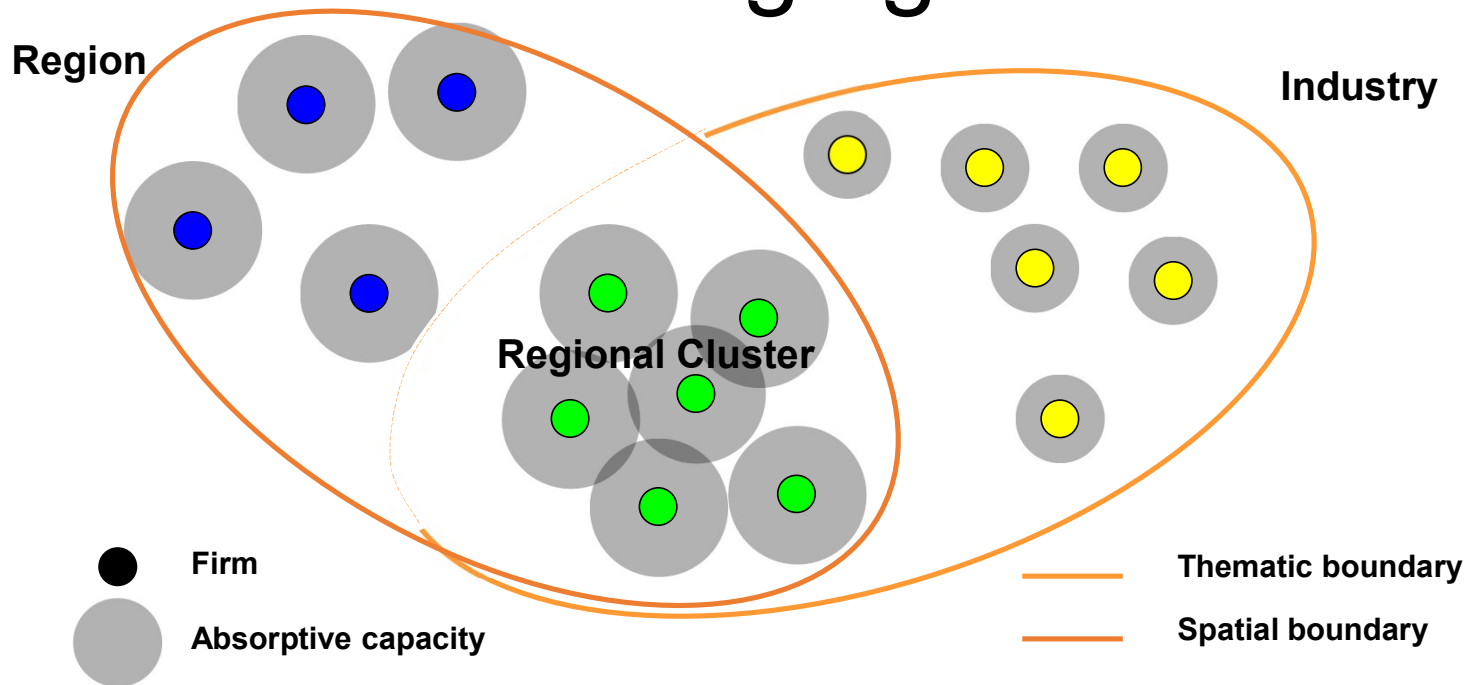
	Quantitative	Qualitative
Direct	few firms and employees	quite heterogeneous, strong diversification, large distances
Systemic	hardly perceivable	scarce possibilities for interactions

Emerging cluster

- Emerging cluster difficult to determine
- Local and global factors are responsible (see week 1)
- A few, often small companies (few employees)
- Two central points
  - Sustainable vision for a new technology
  - Certain conditions of the environment
- Two possible ends for emergence phase:
  - Transition to growth phase
 - Emerging cluster loses potential and may disappear completely

Growing cluster

Region

Industry

Regional Cluster

● **Firm**

⬤ **Absorptive capacity**

— **Thematic boundary**

Spatial boundary

	Quantitative	**Qualitative**
Direct	growing number of firms / employment	focusing of competencies, **Marshallian** externalities
Systemic	growing perception, ability for collective action	open and flexible networks exploit diversity of competencies

Growing cluster

- Strong increase in employment

- Boundaries of the cluster are definable ➔ Cluster gets more focus

- Many startups

- High density of companies and institutions
  - Possibility for innovation networks
  - Customer-supplier relationships emerge
  - Specialized labour market emerges

- Growth phase ends when the growth of the cluster adjusts to the industry average

Sustaining cluster
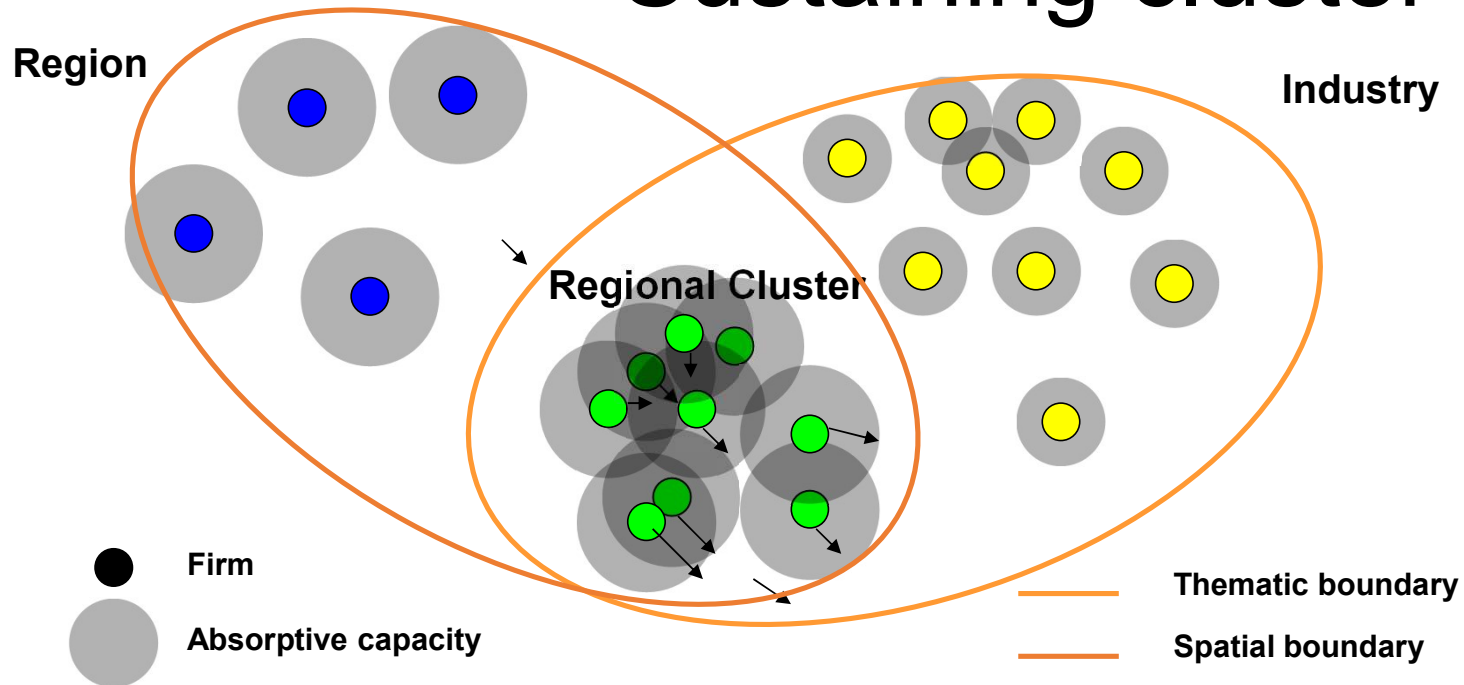
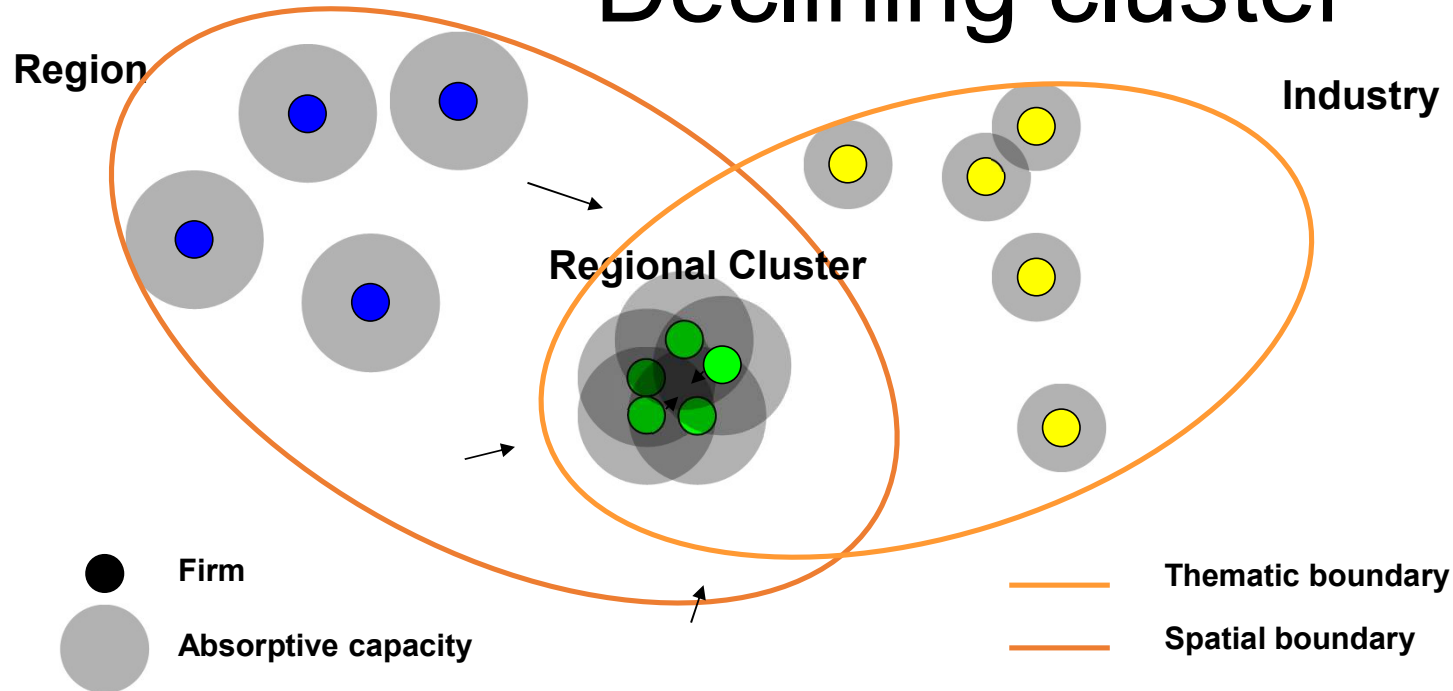|	Quantitative	Qualitative
Direct	High but stagnating number of firms / employment	homogeneous or focussed competencies, strong bias of the regional economy
Systemic	cluster shapes the region	open networks to utilize synergies and external knowledge

Sustaining cluster

- Competition pushes firms to innovate

- Boundaries of the cluster are gradually shifting

- Industrial / thematic dimension
  - Adaptation in the existing industrial core
  - Process innovations, incremental innovations and imitation

- Geographic dimension
  - Optimal level of diversification of knowledge (related variety)
  - „global pipelines" = Access to external knowledge

- Two possible ends for maturity phase:
  - Follows cluster life cycle ➔ decline
  - Step back in the cluster life cycle ➔ new growth phase

Transformation and renewal ➔ increase diversity

- Cluster moves back to earlier phase of cluster life cycle → new growth impetus and high competitiveness

- Diversification into a new thematic area Industrial / thematic dimension
  - Change in the industrial core
  - Radical innovations, but ideally building upon existing competencies
  - Encourage start-ups

- Geographic dimension
  - Jacobian externalities offer opportunities for diversification
  - Emergence of a new regional trajectory necessary for further or new growth
  - Open up networks
  - Import knowledge

Declining cluster

	Quantitative	Qualitative
Direct	decline of the number of firms, but potentially high employment	low diversity and strong focus on a narrow technological trajectory
Systemic	negative sentiments with respect to cluster	closed networks result in an insufficient adaptability

Declining cluster

- Region is strongly characterized by cluster-oriented economic activities
- Cluster cannot maintain diversity and can or will no longer adapt to changing conditions
- Decrease in the number of companies and employment, few start-ups
- Three possible ends of decline phase:
  - Follows cluster life cycle → cluster downsizes
  - Renewal through introduction of new or similar technologies
  - Transition to completely new area

Conclusions

- Clusters can be described by peculiar stages with specific characteristics
- Cluster stages and transitions are affected by interaction between industrial and regional dynamics
- Transitions between stages based on changes in heterogeneity of knowledge or knowledge externalities
- Different externalities are operating in the stages
- Dependent on the stage different degrees of specialization are necessary for growth and competitiveness
- Organizations in clusters have advantages, but only…
  - After the emergence, when focal points emerge
  - Before the decline, when it is able to sustain or renew its diversity
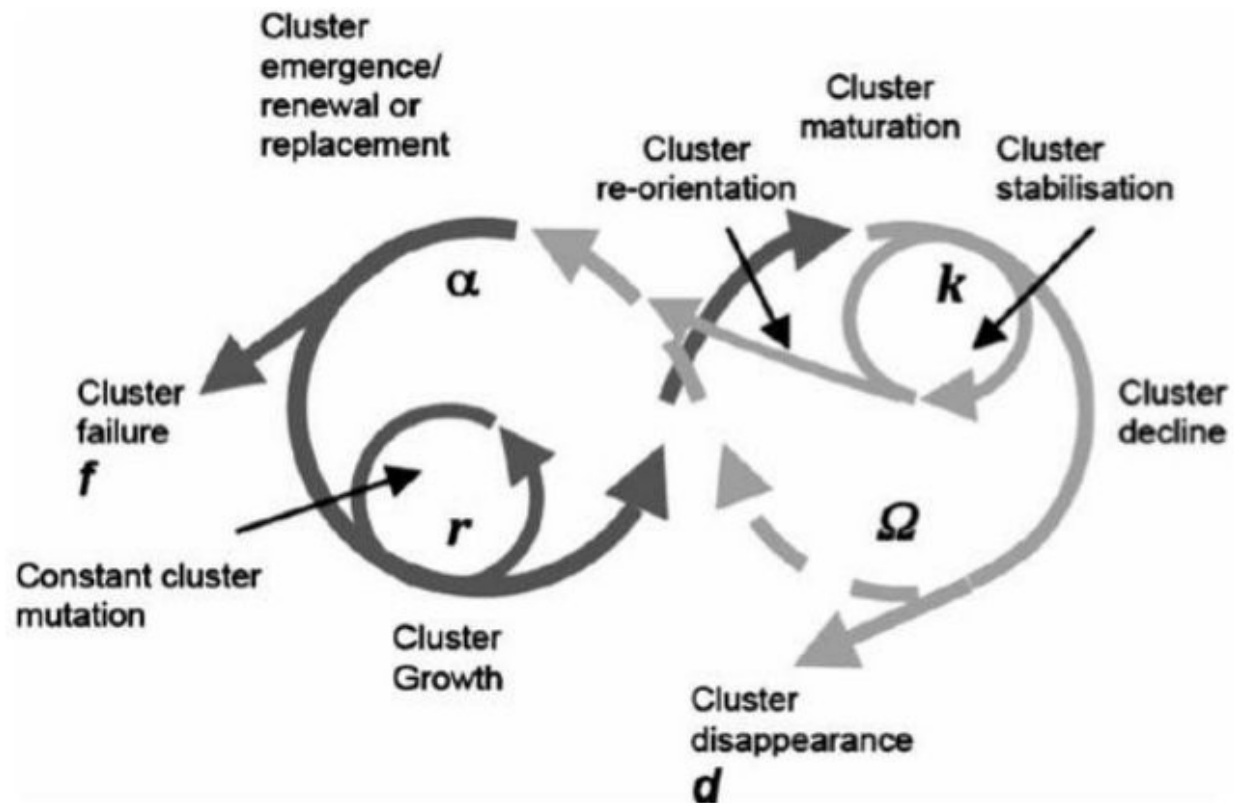
Empirical approaches

- Comparison inside and outside clusters in the peculiar stages
  - Survival of firms, Start-up rates
  - Firm growth, GDP growth
  - Innovation rates
  - Networks (e.g. structure, central actors, openness)
  - Externalities (e.g. Marshall, Jacobs, relatedness)
  - Labor / human capital (e.g. accumulation, mobility patterns)

- Peculiar characteristics over the cluster life cycle
  - Externalities (Neffke et al. 2008)
    - Increasing effect of Marshallian externalities
    - Decreasing effect of Jacobian externalities
  - Policy (Brenner and Schlump 2009)

Empirical approach – Comparison of cluster stages

- Ter Wal and Boschma 2007

	Firm	Industry			Network	Clustering
	Variety	Number of firms	Technological regime			
			Tacitness	Uncertainty		
1. Introductory stage	High	Low	High	High	Unstable	No clustering
2. Growth stage	Increasing	Increasing	High, but decreasing	High, but decreasing	Towards core-periphery	Emergence of clusters
3. Maturity stage	Decreasing	Decreasing (shake-out)	Low	Low	Network Lock-in	Cluster lock-in
4A Decline	Decreasing	Decreasing	Low	Low	Dissolving network	Disappearing clusters
4B Start of a new cycle	Increasing	Low	High	High	Unstable	No clustering

Cluster and Cluster Life Cycle – Prof. Dr. Dirk Fornahl – Chair of Microeconomics – Friedrich-Schiller-University Jena

11

Adaptive cycle (Martin und Sunley 2011)

Are there any questions?

Have a nice
day!

Additional material

Case study: North Jutland Wireless-Cluster

- **Beginning of the cluster (1960-1980s)**

- Start with maritime communication technology

- Spinoffs established in the 1970s

- Spinoffs of the 2nd generation in the 1980s

- Topic area: Mobile communication devices

- Development of 1st generation cell phones (1G)

- End of 1980s 15 companies in the cluster

Case study: North Jutland Wireless-Cluster

- **First disruption (1988-1992) and impact in the 1990s**

- Introduction of a pan-European telecommunications system on a digital basis (2G)

- Larger market means more potential, but also more competition

- Cooperation within the cluster brings advantages in development

- New companies founded on the basis of 2G technology

- Companies that stayed with 1G switch to 2G

- Employment grows steadily from 1992 to the end of the 1990s

- Number of companies doubles

- Multinational corporations settle in the cluster

Case study: North Jutland Wireless-Cluster

- **Second disruption (2000-2003)**
- Stagnating sales figures due to bursting of the dotcom bubble
- Corporations withdraw research and development
- Skilled workers absorbed by companies
- No growth due to overall economic situation
- Problems with research strategy
- Development of 3G as global standard
- Companies wait or fail to develop new technology
- As of 2004, skilled workers are being laid off and companies are closing

Case study: North Jutland Wireless-Cluster

- **Third disruption (2007-2009)**

- Development of smartphones

- Financial crisis in 2008

- Decreasing demand for cell phones

- Corporations migrate from cluster and take some of the skilled workers with them

- Remaining skilled workers cannot be absorbed and move away

Case study: North Jutland Wireless-Cluster
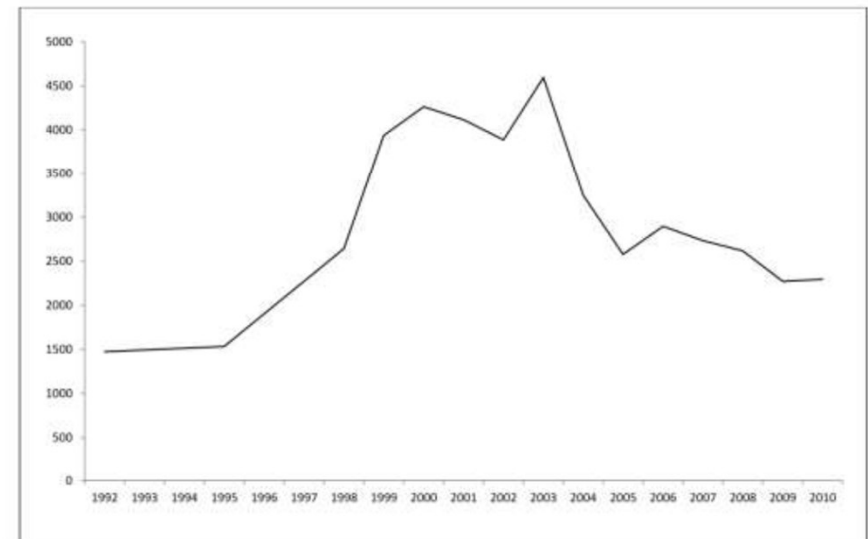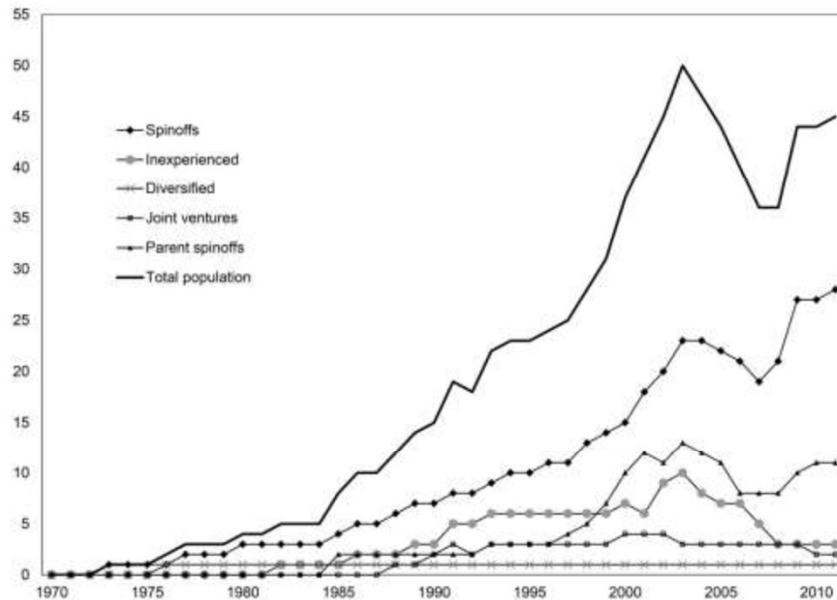
Buzz and pipelines - What is the problem?

- The problem is that little material exchange happens within clusters (Karakas, 1969)

→What advantages do companies have from being in the cluster then - above site-related factors?

→THE ATMOSPHERE must be a decisive factor.

Buzz and pipelines - The nature of buzz

- A buzz is a situation within a cluster, where information is commonly shared, gossip is spread and advantages are shared. →"complex multilayered information and community ecology"

- The buzz develops shared values, attitudes and interpretations
  - Leads to shared knowledge, learning and innovation
  - More dynamic in the cluster and more competition
  - Encourages diversification and increases development

Buzz and pipelines - The nature of pipelines

- Purposely created communication streams between institutions

- Helps the company itself and the cluster

- Importantly: comparative advantage arises out of the fact that one company alone cannot manage an infinite amount of pipelines, but various institutions can indeed.
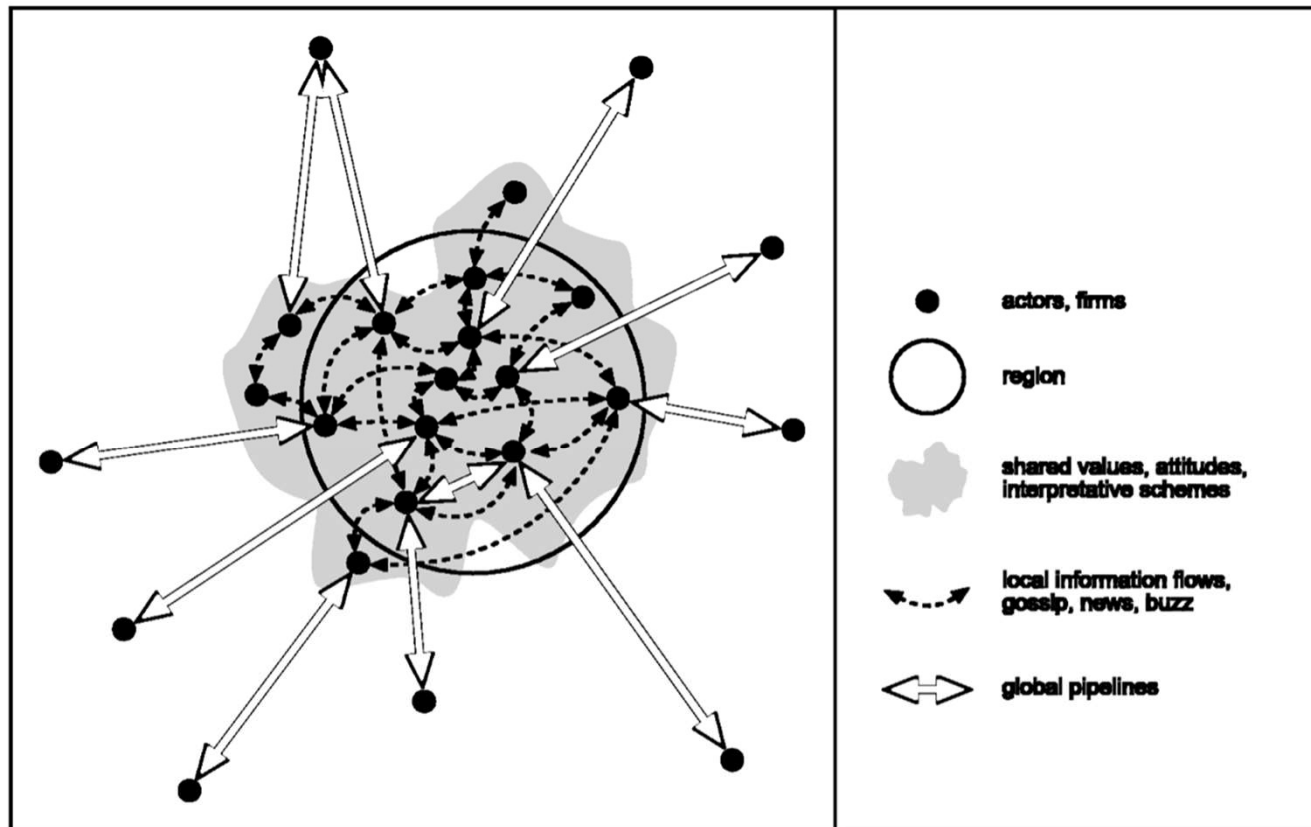
Buzz and pipelines

Figure 1 The structure and dynamics of local buzz and global pipelines

Buzz and pipelines - Countervailing forces

- The larger the number of similar and related firms in a spatial cluster, the more vibrant and valuable the local buzz and the better the pipelines

- But
    - Is there a possibility for too much buzz? What about the information fatigue syndrome?
    - If the pipelines get too strong, the buzz might be lost
    - Developing filters is possible, though the focus can be wrong („discriminative attention")
    - A vibrant cluster acts as a filter due to information being constantly assessed.
    - Pipelines support segmentation
    - Shift of attention: →A cluster which is more or less empty due its actors travelling the world to maintain the pipelines, is threatened to run out of communicating forces.