# Cluster Resilience: Implications for COVID-19

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# Outline

- Defining and Mapping Clusters

- Clusters and Resilience to Economic Shocks: Great Recession

- Does Location Still Matter?

- Tentative Predictions on Cluster Transformations in Response to COVID

# What Makes a Good Cluster?



Agios · GlaxoSmithKline · Ragon Institute · Schlumberger · Metabolix · Momenta Pharmaceuticals

Aveo Pharmaceuticals · Takeda Pharmaceuticals, USA · Akamai · Akceli · EMC · Ethanol Boosting Systems

Wistia · Ariad · Draper Laboratory · Amgen · Whitehead Institute · CIC

Partners Healthcare · Twitter · edX · Broad Institute · Yahoo! · Ironwood

24M Technologies · Biogen IDEC

Genomics Collaborative · Highland Capital

Acceleron · Charles River Ventures

Etex · Genzyme

· Facebook

· Apple

Sanofi · Veolia

Boston Biomedical · VM Ware · Microsoft · Amazon

Epizyme · Aileron · Shell Techworks · Lab|Central · Pfizer · Google · J&J Innovation

Nucleus Scientific · Novartis Institutes for Biomedical Research · Eisai · Flagship Ventures · Intersystems

**MIT    ENERGY    IT/DATA    BIO/PHARMA    VC**

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# What Makes a Good Cluster?

- A **set of related industries** versus specialization in one narrow industry
- Industries and firms related by **various types of links**
  - Input-Output
  - Labor occupations and skills
  - Knowledge/technology
- **Many** clustered **firms that compete and cooperate**
  - Startup and Incumbent
  - Small and Large
  - Domestic and Foreign
- **Support Institutions**
  - Finance, Universities, Chamber of Commerce, Industry Organizations, and
  - **Innovation Spaces** (co-working, industrial parks, accelerators, labs)

# Defining Clusters of Related Industries

- Clusters are everywhere, and they matter for economic performance

- But **how do we measure them**?

- **Major study to map clusters funded by** the U.S. Economic Development Administration

- **Novel clustering algorithm** to define sets of clusters: **What economic activities benefit from being co-located?**

- Method resulted in the **U.S. Benchmark Cluster Definitions (BCD)** which is used in the **U.S. Cluster Mapping Project** Portal

- **The BCD and algorithm are used by other countries:** European Union, Mexico and Canada

- Delgado, Porter, and Stern (2016)

# Defining Clusters of Related Industries: Cluster Analysis

- To define clusters, we use **cluster analysis**: numerical methods to classify similar objects (**industries**) into groups (Everitt et al., 2011)

- Create groups (clusters) in such a way that objects (industries) in the same group are more similar among themselves than to those in other groups

**Biopharmaceuticals Cluster**

Medicinal and Botanical

Pharmaceutical Preparation

Biological Product (except Diagnostic)

In-Vitro Diagnostic Substance

**Medical Devices Cluster**

Surgical & Medical Instrument

Surgical Supplies

Dental Equipment & Supplies

Optical Instrument & Lens

Ophthalmic Goods
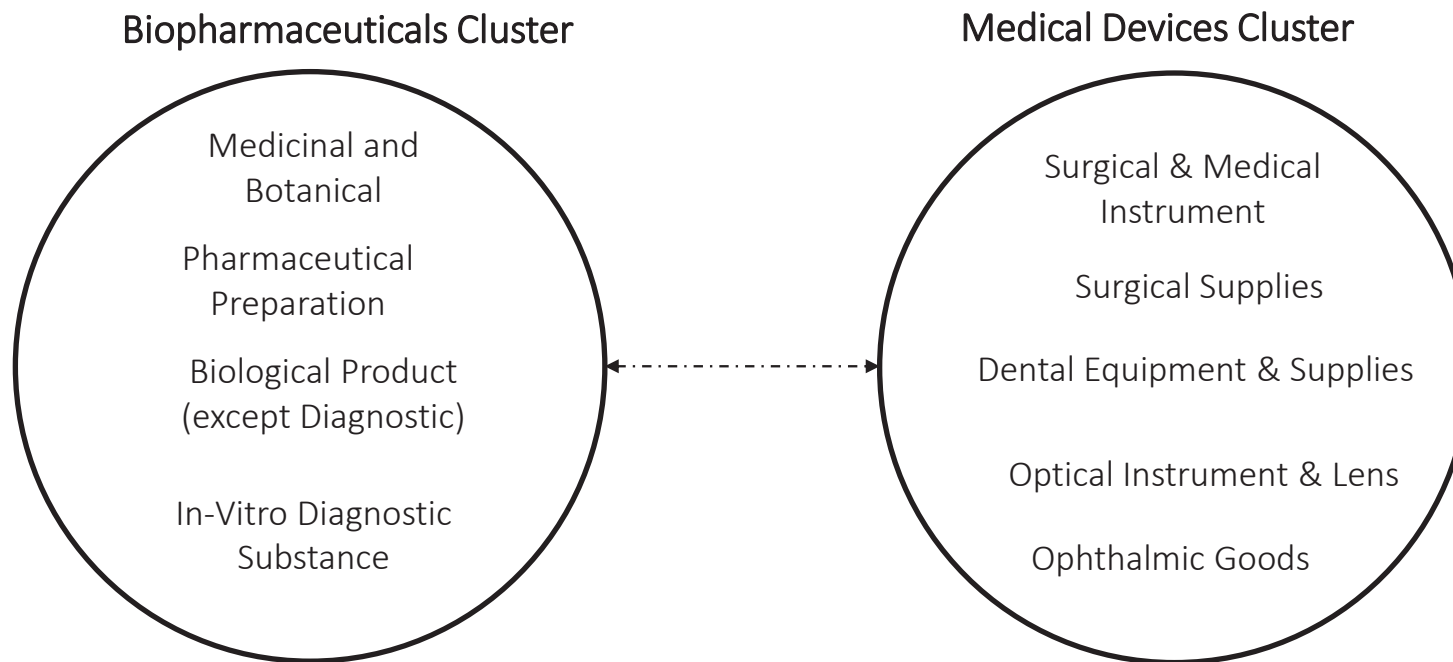
Source: Delgado/Porter/Stern (2016)

US CLUSTER MAPPING

# Mapping Clusters: Medical Devices



Specialization in Medical Devices Cluster by Economic Area, 2016

Legend:
- High Employment Specialization and Share
- High Employment Specialization
- High Employment Share
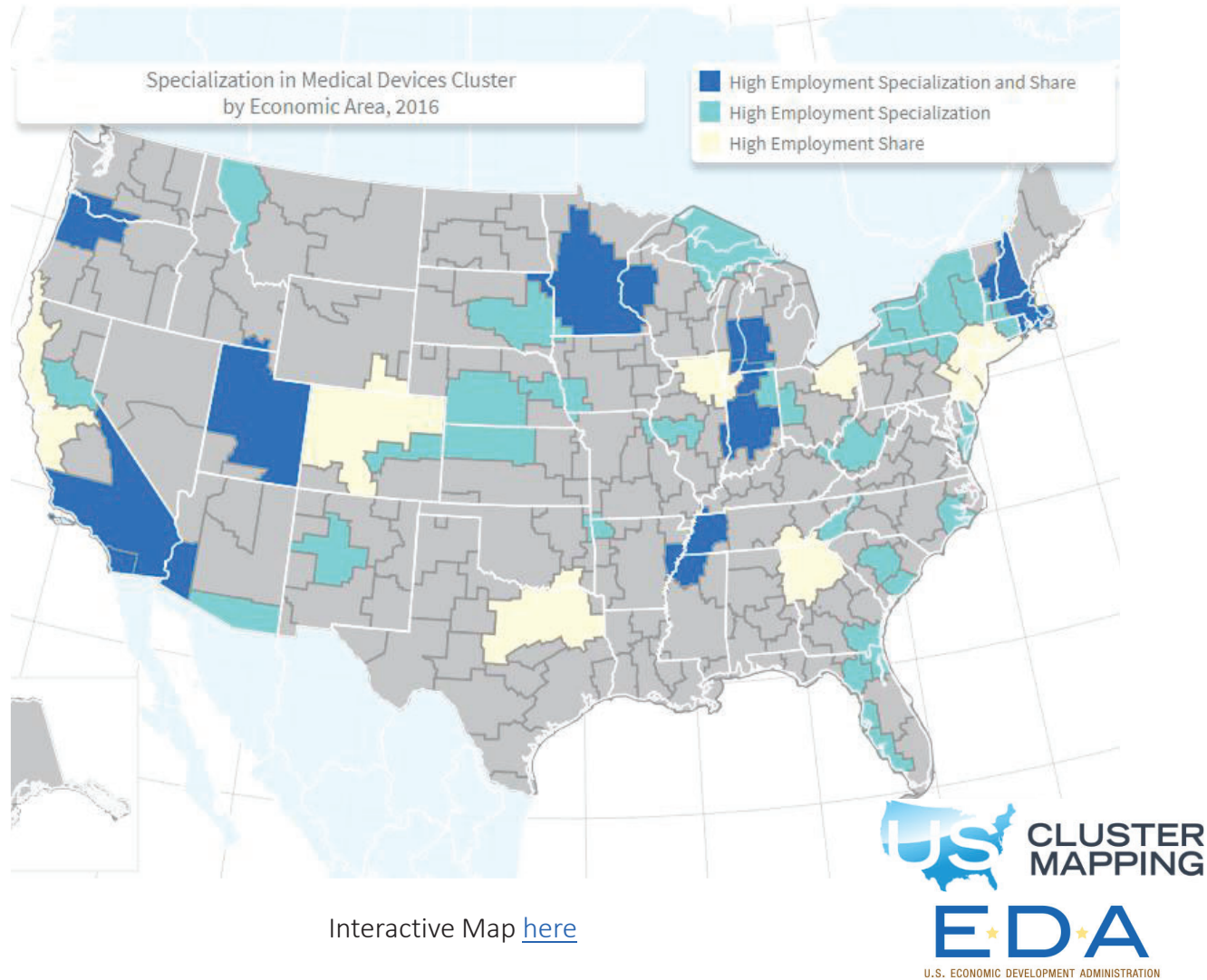
Interactive Map here

Source: Delgado, Porter, Stern (2016)

# Portfolio of 51 Traded Clusters and their Connections
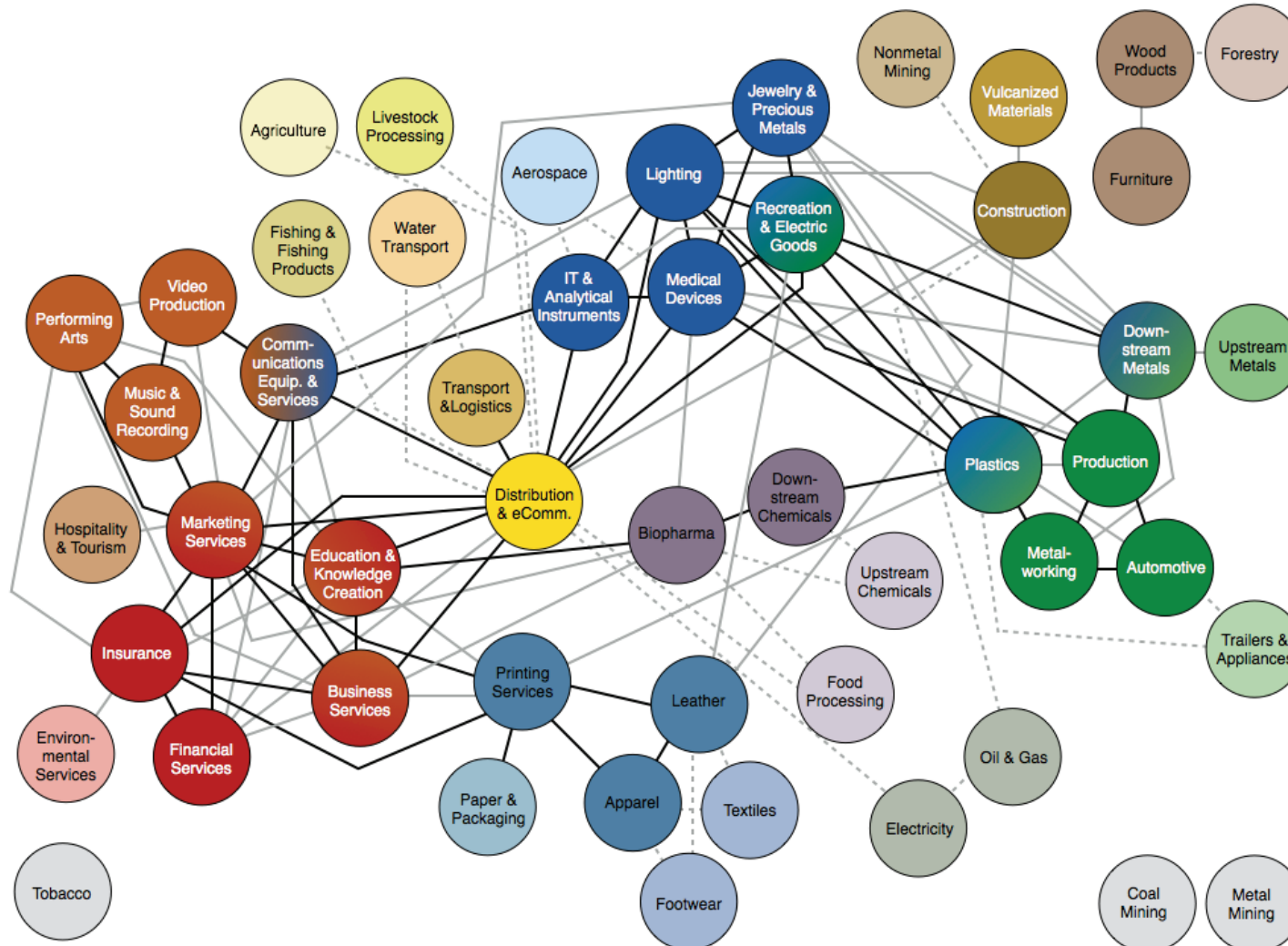


Note: Delgado/Porter/Stern (2016). Clusters with solid lines are highly related (dark line=stronger relatedness). Dotted lines are the next closest clusters.

# Regions Have Comparative Advantages Manifested in Clusters
## Cluster composition of Copenhagen that is the core of the resilient iEcosystem
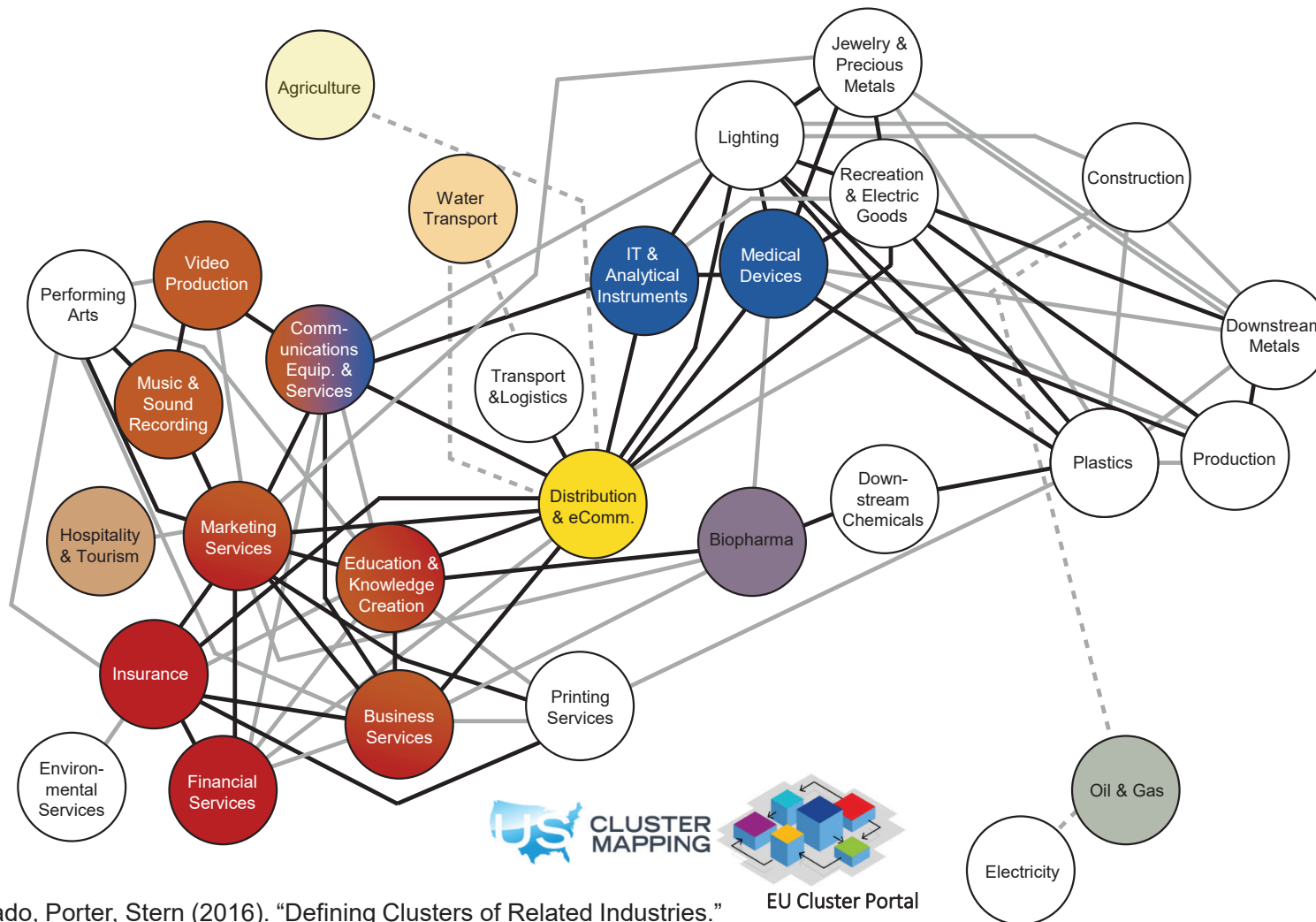


Delgado, Porter, Stern (2016). "Defining Clusters of Related Industries."
NUTS2 Region: Strong clusters (+75 percentile Specialization (Location Quotient); colored) and their connected clusters in 2014.

**Höganäs**

**Ängelholm**

**Helsingborg**

**Helsingør**

Ängelholm Airport

**Hillerød**

**Hässleholm**

**Landskrona**

**Eslöv**

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**Sjöbo**

Copenhagen International Airport

**Malmö**

Malmö Airport

**Roskilde**

Roskilde Airport

**Kalundborg**

**Ystad**

**DENMARK**

**Køge**

**SWEDEN**

**Trelleborg**

**Sorø**

**Næstved**

# Institutions for Collaborations to Strengthen Clusters & iEcosystems

- **Cluster Organization:** collective effort by firms, public entities, and other institutions **to improve the competitiveness of a specific regional cluster**



- **Regional Organizations** (across clusters)



- Innovation Spaces

# Clusters and Economic Resilience

# Clusters Matters for Innovation and E-ship

Industries that are part of a **strong cluster environment** register higher growth in jobs, startup activity, innovation, and resilience to economic shocks.

CLUSTER ENVIRONMENT

Within a Cluster
Related Clusters
Neighboring Clusters

Growth in Startup Activity

Growth in Innovation

Resilience to Economic Shocks
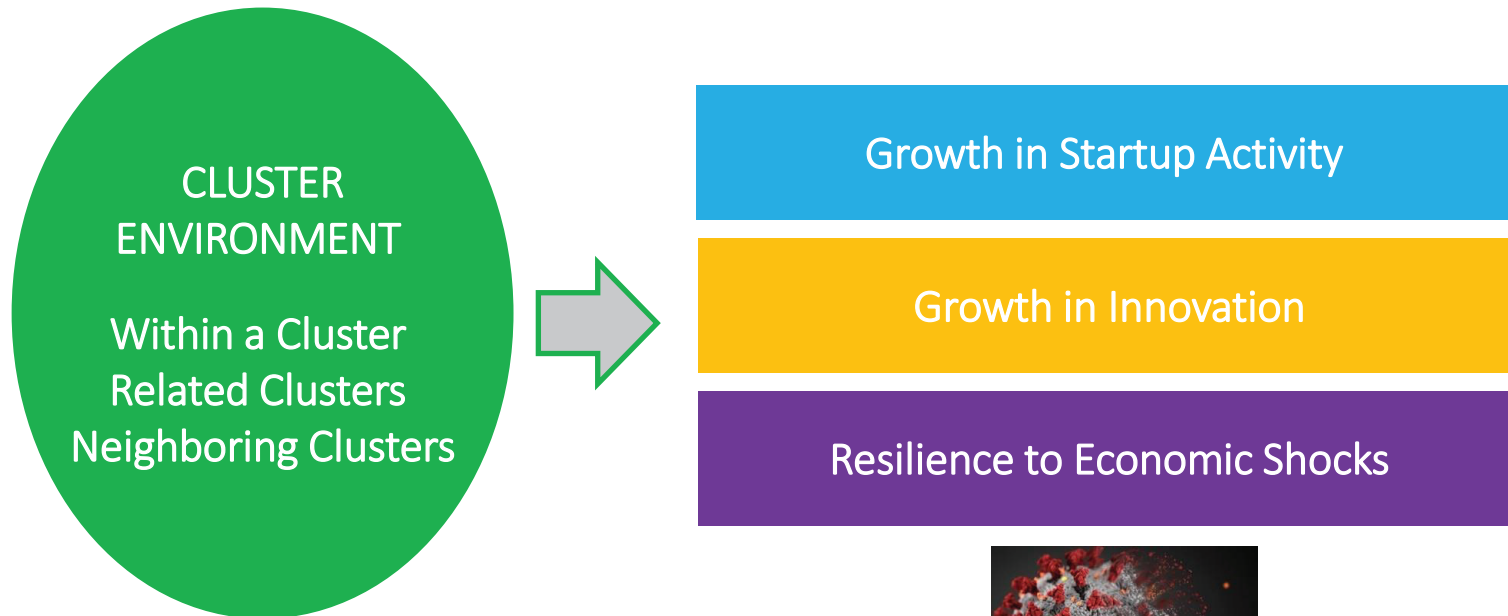
Source: Delgado/Porter/Stern (2010, 2014).
Delgado/Porter (2018)Delgado (2018, 2020).

# Clusters and the Great Recession

## Mercedes Delgado, CBS and MIT

## Michael Porter, Harvard Business School

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# Motivation:
# How to Make a Location More Resilient to Economic Shocks?

- **Many shocks**: Economic crises, Natural Disasters, and COVID-19

- The Great Recession **destroyed many jobs** and had the **slowest job recovery** in US
    - **6 millions jobs lost** in 2007-09 (~ 5% of the US economy)
    - **Regions varied in resilience**: Salt Lake City, UT vs. Redding, CA
    - **Clusters varied in resilience**: Medical Devices in Salt Lake City vs. Madison, WI

- There are **two opposing hypotheses** on how to mitigate shocks and **uncertainty**:
    - Most studies argue that **industry diversification** will avoid that a shock propagates/amplifies ("avoid all eggs in one basket")
    - We argue that **cluster agglomerations** can help mitigate the shock

# Do Clusters Matter for the Resilience of their Regional Industries?

- **Cluster theory** suggests agglomeration arises *across related economic units* (Marshall, 1920; Porter, 1990, 1998; Delgado, Porter, and Stern, 2010, 2014)

- **Empirical Approach**: If clusters matter for mitigating shocks, then a regional industry located in a 'stronger' cluster will grow relatively faster during the recession period (as compared to industries in weaker clusters)
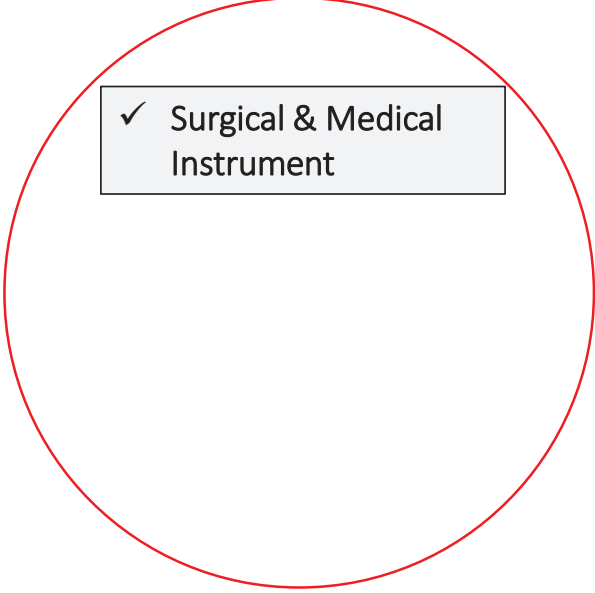
Medical Devices Cluster
**Strong**

Medical Devices Cluster
**Weak**

Surgical & Medical Instrument

Surgical Supplies

Optical Instrument & Lens

Dental Equip. & Supplies

Ophthalmic Goods

Surgical & Medical Instrument
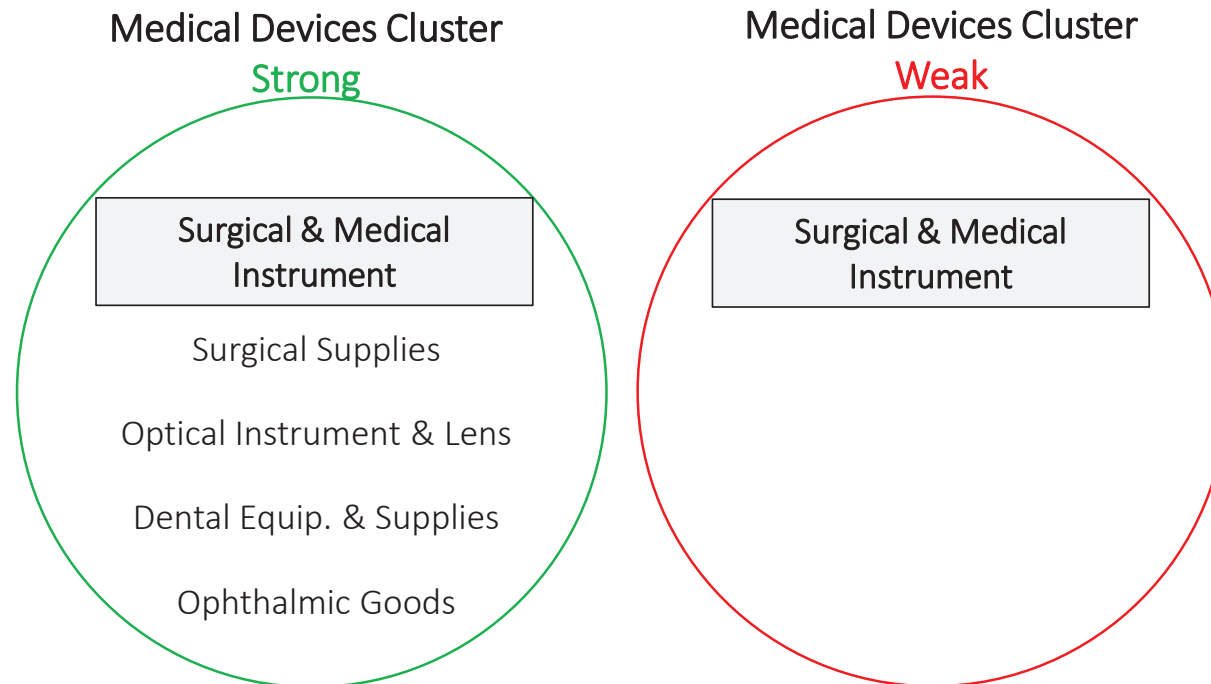
# Same Industry in two Regions:
# Who was Resilient to the Great Recession?

Medical Devices Cluster
Salt Lake City, UT
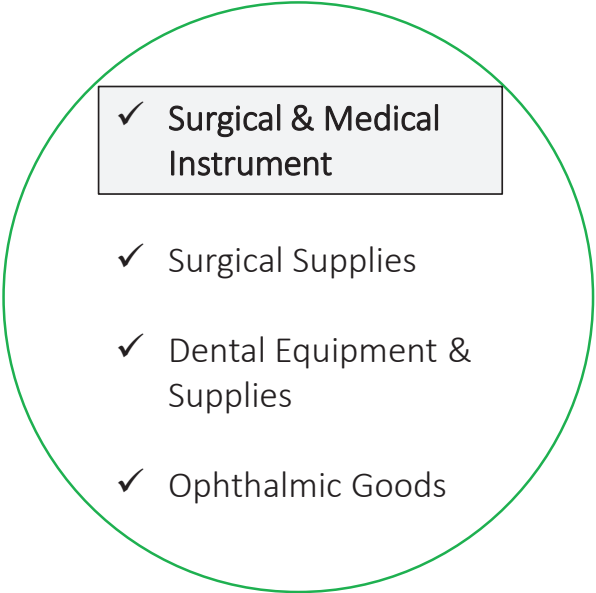
Medical Devices Cluster
Madison-Baraboo, WI

- ✓ Surgical & Medical Instrument

- ✓ Surgical Supplies

- ✓ Dental Equipment & Supplies

- ✓ Ophthalmic Goods

- ✓ Surgical & Medical Instrument

| | Annual Employment Growth of Surgical & Medical Instrument Industry | | Medical Devices Cluster Recovery |
| --- | --- | --- | --- |
| | 2007-2009 (Great Recession) | 2009-2011 (Recovery Period) | Ratio of Employment$_{2011}$ to Employment$_{2006}$ |
| Salt Lake City, UT | 5% | 6% | 1.11 |
| Madison-Baraboo, WI | -31% | -6% | 0.93 |

# Preview of Findings: Cluster Resilience & Industry Specialization Risk

**CLUSTER STRENGTH**
Presence of related Industries
- Employment
- **No. of Businesses**
- Shared Labor Occupations
- Upstream Industries
- Downstream Industries
- Patenting
- Breadth of Industries

Higher Regional Industry Growth in Employment and No. of Businesses, especially during the crisis
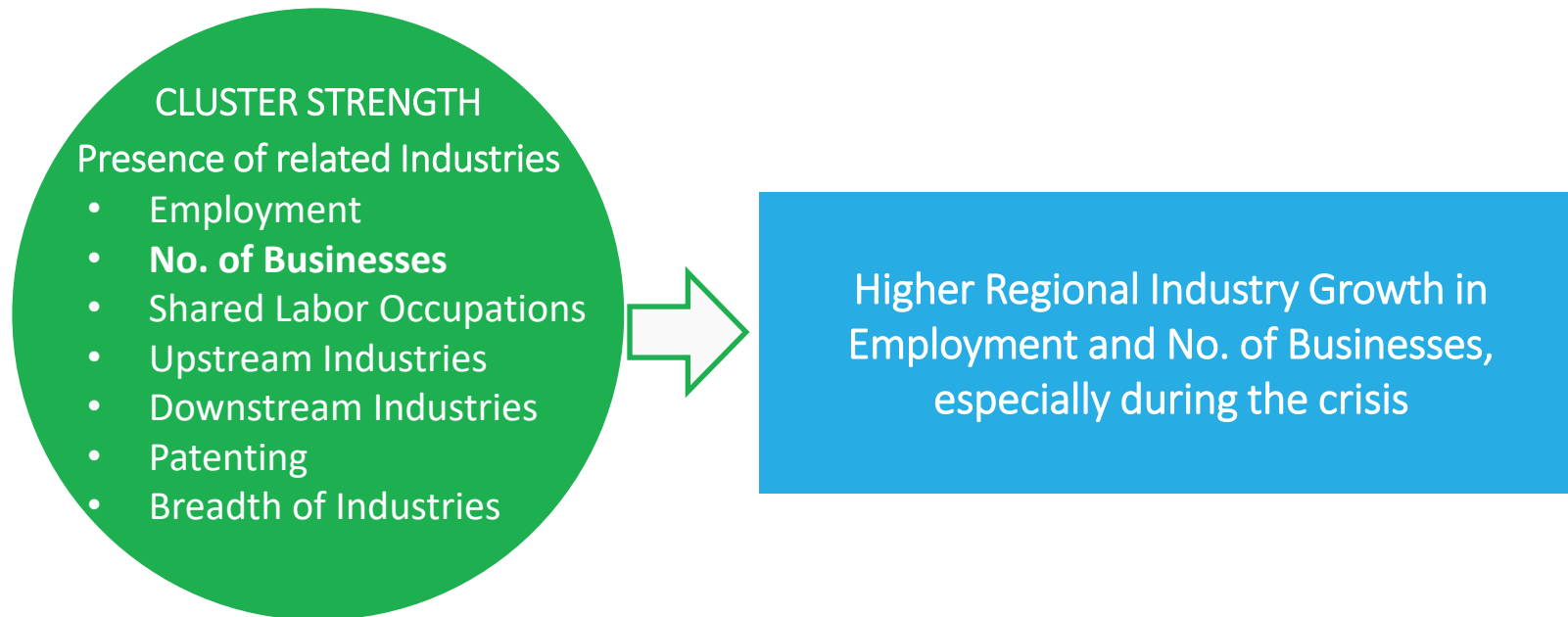
- Industries within a **strong cluster** register higher growth (jobs and no. of businesses) during the whole business cycle, especially during the crisis
- **Multiple types of agglomerations arise within clusters during a recession**
- The benefits of location in a cluster were greater for Supply Chain vs. B2C industries: inter-firm links are important for resilience
- **Industry specialization risk**: Large industries in weak clusters were very vulnerable

# Mechanism of Cluster Resilience:
## Agglomeration Benefits and Reduced Uncertainty

- Economies of agglomeration that arise among related industries
  - Better access to inputs and demand (input-output links)
  - More efficient labor markets
  - Better access to complementary knowledge and technology
- Firms can **respond better to uncertainty in demand with supplier-buyer collaborations** vs. vertical integration
  - The Silicon Valley model – *or* – Open Innovation model
  - These supplier-buyer collaborations are more likely in clusters!
- **Supporting institutions in clusters** can foster collaborations
  - Cluster organizations, universities, trade associations, accelerators, Venture Capital
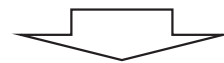
The strength of a cluster may allow
**broader inter-industry collaborations** and **pooling resources** during a crisis

# Public Data

- Using County Business Pattern (CBP) data and the US Cluster Mapping Project dataset, we measure employment at the **region-industry and region-cluster level**

  - We focus on a dataset that spans the **years 2003-2011**

  - includes **177** mutually exclusive **Economic Areas** (EAs)
    - Why EAs vs MSAs?
    - Clusters can expand beyond the city (e.g., mfg)

  - incorporates **778 traded industries** (6-digit NAICS)

    - **Traded**: Manufacturing and service industries that concentrate in particular regions and sell their products across regions/countries
    - **Local** industries **are excluded** (e.g., retail, restaurants)

  - grouped into **51 clusters** of related industries for each EA
    - **U.S. Benchmark Cluster Definitions** developed by Delgado, Porter, and Stern (2016) grouping industries based on input-output links, shared labor occupations, and co-location patterns

# Clusters Can Improve Resilience to Economic Shocks

- **Using all industries, clusters and regions** (EAs), we find a positive relationship between the annual employment growth of industries and the strength of their clusters during the whole business cycle, and specially during the financial crisis (2007-2008)

## Estimated Effect of Cluster Specialization on
## Region-Industry Annual Employment Growth, 2003-2011
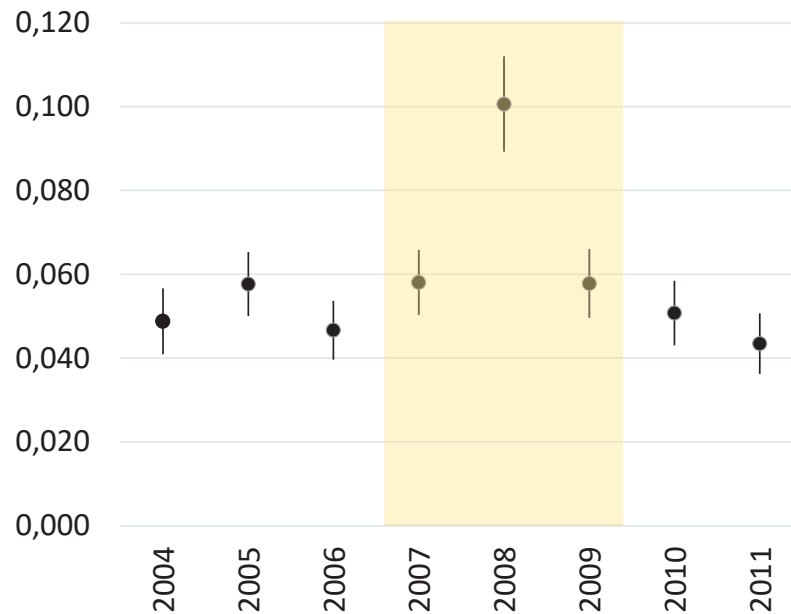
Fig 1: Clusters of Related Industries
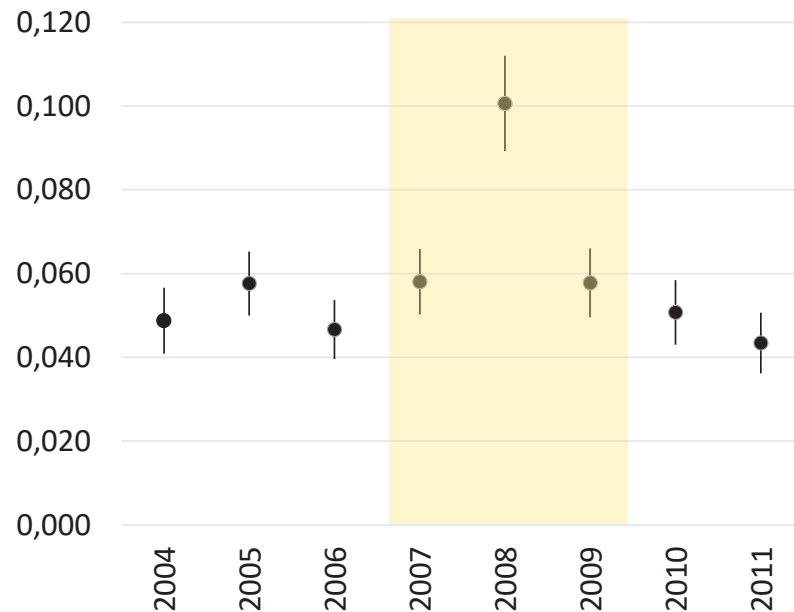


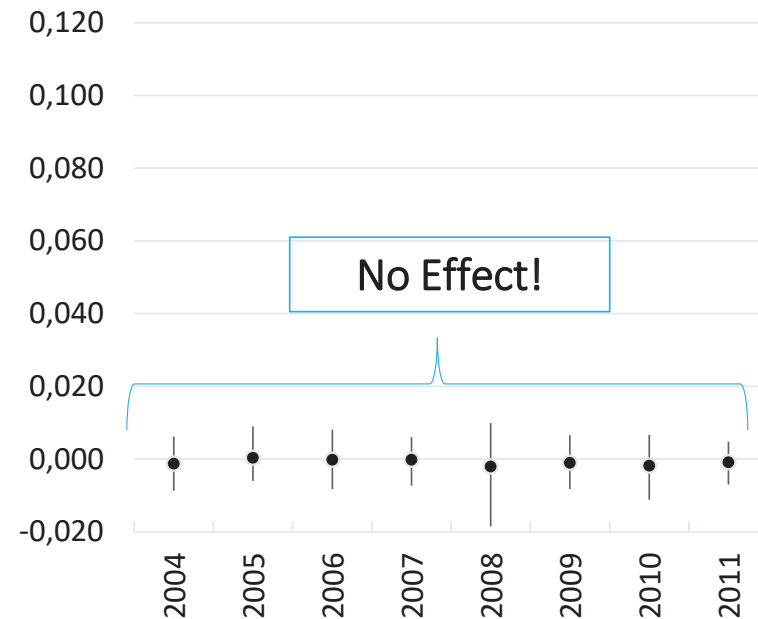Source: Delgado/Porter, 2017. *Clusters and the Great Recession*

# Clusters Can Improve Resilience to Economic Shocks

- While most policy prescriptions call for industry diversity to mitigate shocks, random clusters of **unrelated industries do not improve resilience**
- Instead, **pooling resources among related industries mitigate shocks**

## Estimated Effect of Cluster Specialization on Region-Industry Annual Employment Growth, 2003-2011

### Fig 1: Clusters of <u>Related Industries</u>



### Fig 2: Random Clusters of <u>Unrelated Industries</u>



No Effect!

Source: Delgado/Porter, 2017. Fig.2: Placebo test. 10% bootstrap confidence intervals based on 200 random sets of clusters

## Supply Chain vs. Business-to-Consumer Industries

Assess the importance of inter-firm, inter-industry links for **mitigating** shocks and the associated **uncertainty**

# The Supply Chain Economy is Important for Innovation and Jobs

**EMPLOYMENT**

Supply chain 44M · Business-to-consumer 74M

**AVERAGE WAGE**

$61,700 · Overall $47,700 · $39,200

**STEM INTENSITY**

11.4% · Overall 5.6% · 2.1%

**PATENTS**

88.6% · 11.4%
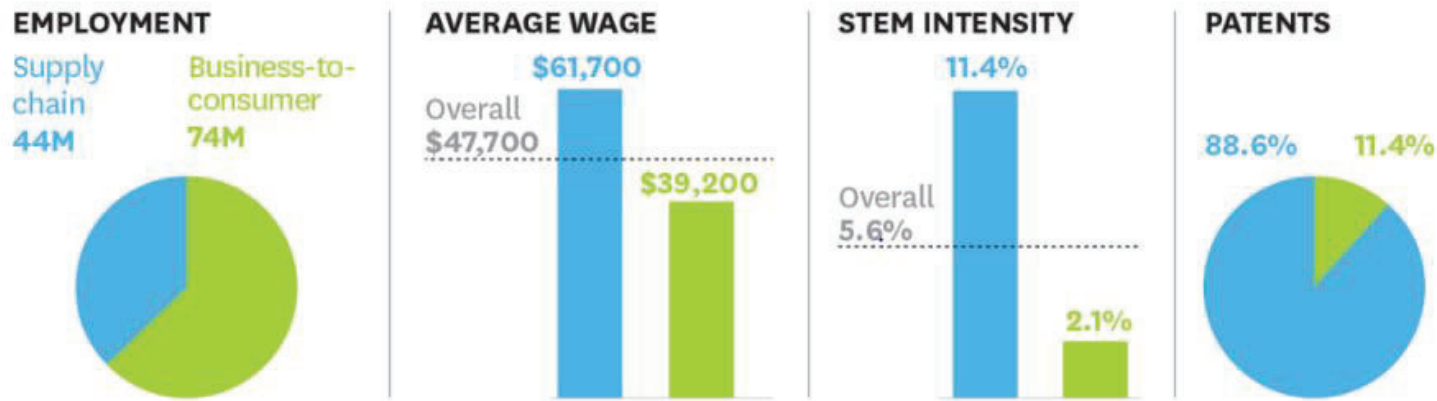
SOURCE "THE SUPPLY CHAIN ECONOMY: A NEW FRAMEWORK FOR UNDERSTANDING INNOVATION AND SERVICES," BY MERCEDES DELGADO AND KAREN G. MILLS, OCTOBER 2017

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- **Supply Chain Industries** are those selling most of their value to businesses or the government (versus Business to Consumers Industries)
- Businesses producing **manufacturing or** increasingly **service inputs**: from semiconductors, to cloud computing, R&D, and design
- **1 Mill Service Suppliers** 97% of them small businesses (fewer than 500 employees**)**

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Delgado/Mills (2018, 2020). HBR.org

# Supply Chain vs. B2C Industries in Industry Clusters

- SC industries are more likely to develop inter-firm, inter-industry links
  - They produce inputs for business customers
  - They have more downstream links with other industries
- SC industries are more **vulnerable to crisis:** face more uncertainty

Annual Employment Growth During the Business Cycles: SC vs. B2C
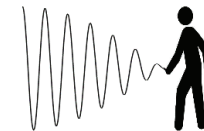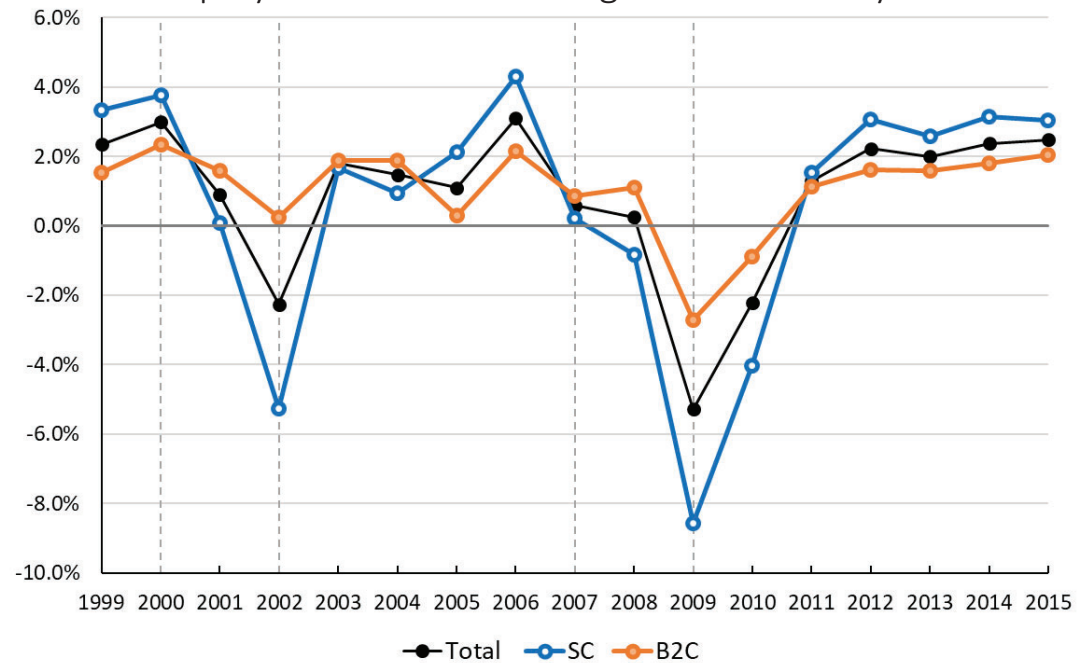
# Supply Chain Industries Benefit more from Clusters

- SC industries experienced **greater cluster effects** than B2C **during the whole business** cycle and, especially, **during the recession**

### Estimated Effect of Cluster Specialization on
### Region-Industry Annual Employment Growth, 2003-11

SC Industry: Coef. of Ln Cluster Spec          B2C Industry: Coef. of Ln Cluster Spec
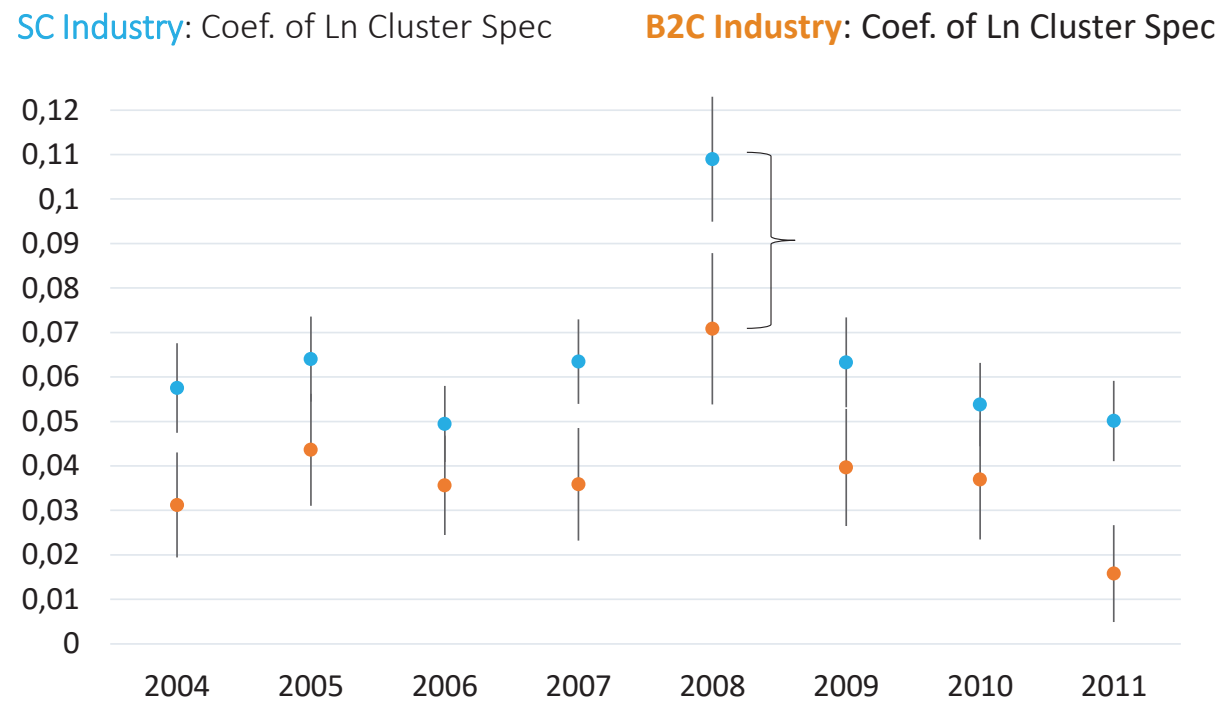
# How to Improve Employment Resilience to Economic Crises?
## Invest in Your Comparative Advantage

- **Why do strong clusters matter during a recession?**
  - **Pooling resources** (skills, knowledge) among related & co-located industries
  - **Collaborations** between proximate **supplier and buyers** (repeat interactions, relational assets)
  - Presence of many **firms that compete in related but distinct markets**
  - These benefits can be especially important when firms experience **high uncertainty**

⬇
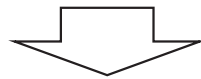
- **Regions should improve the breadth of emerging & established clusters:**
  - **Specialization in a set of related industries** instead of specialization in one narrowly defined industry
  - Improve and **support the presence of Supply Chain Industries** (in particular services)

# Does Location Still Matter?
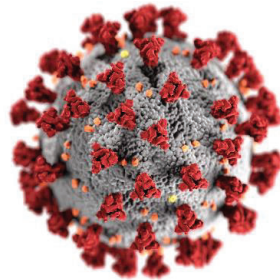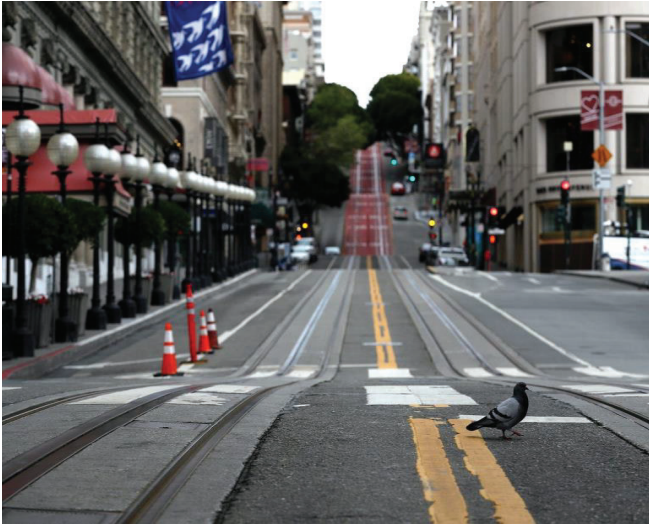
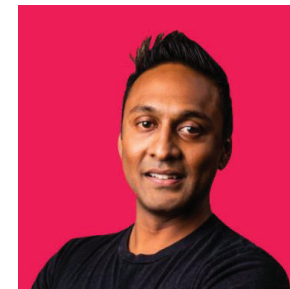# Startups and Universities Taking on COVID-19
## Summer 2020

**Fiona Murray**
Associate Dean of Innovation MIT Sloan
Co-director MITii

**Marta Ortega-Valle**
Co-founder
Biopharma (mRNA)

**Brett Sternfield**
CEO, Co-founder
e-Health eye care

**Arjun Thyagarajan**
CEO, Co-founder
Fintech

COVID-19 Rapid Innovation Dashboard

GreenLight BIOSCIENCES™

Ocular TECHNOLOGIES

WISE

MIT MANAGEMENT SLOAN SCHOOL

FUNDACIÓN RAFAEL DEL PINO

# Cluster Resilience: Implications for COVID-19 Crisis

## How is similar to the Great Recession?

- Uncertainty and negative demand shock for many industries

- Many inter-firm collaborations

## How is different?: Natural Disasters

- Large negative shock for local industries (restaurants, retail) vs. traded industries

- Positive demand shock for Recovery products, including digital transformation services

- Increase in Virtual linkages (remote work)
  - They take place within the cluster, nearby clusters and in global locations
  - They are challenging for startups and established firms building new relationships with potential employees, investors, and buyer
  - Universities and Cluster organizations are building Online Communities
  - Large industry and firm heterogeneity in the ability to use remote work: from software firms (e.g., Wise) to lab-based life science firms (e.g., GreenLight)

# Cluster Resilience to COVID-19 Crisis
## Tentative Predictions

- **Re-discovery of regional clusters and nearby locations** given the disruption in global supply chains (movement of people & goods): more iEcosystems

- High **job potential** of **Supply Chain Traded Services in clusters**: cloud computing, enterprise software, AI, design, fintech services, ….

- High opportunity for **innovation in Distribution and e-Commerce cluster** (smart supply chain logistics) to improve resilience of locations

- Opportunity for **mission-driven innovation in industry clusters**
  - Green Transition
  - Inclusivity in the Innovation Economy

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- Data: US Cluster Mapping Project: http://clustermapping.us/

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Data: Supply Chain vs B2C industry categorization
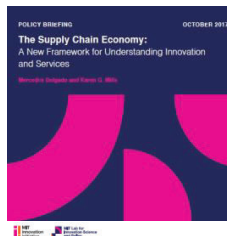
Policy Briefing: Delgado M. and K. Mills, 2021, *The Supply Chain Economy: New Policies to Drive Innovation and Jobs*, forthcoming *Revista de Economia Industrial*.

"The Servicification of the U.S. Economy: The Role of Startups vs. Incumbent Firms", Delgado, Kim, and Mills, 2020, *The Role of Innovation and Entrepreneurship in Economic Growth*, MJ. Andrews, A. Chatterji, J. Lerner, S. Stern (eds.), University of Chicago Press, forthcoming