The U.S. Cluster Mapping Project: A New Tool For Regional Economic Development

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Scott Stern, MIT Sloan and NBER

U.S. Cluster Mapping Launch Event
University of Minnesota, Minneapolis, MN
September 29th, 2014
Outline

• Clusters Are Everywhere

• Clusters Matter

• Cluster Mapping as a Tool for Economic Development

• Clusters Going Forward
Clusters Are Everywhere

A cluster is a **regional concentration of related industries** connected through various types of linkages and spillovers and supporting institutions.
How Important are Clusters?

• More than 50% of U.S. private payroll are generated in economic sectors that ‘cluster’

![Traded vs. Local Share of the U.S. Economy](chart)

- Employment: Traded 36% vs. Local 64%
- Income: Traded 51% vs. Local 49%
- Patents: Traded 91% vs. Local 9%

• In the traded economy, productivity, wage, and patenting are significantly higher than in the average of the economy

• Roughly 44% of traded employment is in strong clusters (i.e. regional clusters with significant critical mass)

• Regions at all stages of development benefit from cluster presence

• There is significant variation in terms of cluster presence and cluster portfolio composition across U.S. regions
Clusters Across US Regions

Seattle, WA
Aerospace Vehicles & Defense
IT & Analytical Instruments

San Jose-San Francisco, CA
IT and Analytical Instruments
Video Production & Distribution
Marketing, Design & Publishing

Chicago, IL-IN-WI
Distribution & E-Commerce
Transportation and Logistics
Upstream Metal Mfg

Pittsburgh, PA
Upstream Metal Mfg
Coal Mining
Electric Power Generation

Boston, MA-NH
Financial Services
IT & Analytical Instruments
Biopharmaceuticals

New York, NY-NJ-CT-PA
Financial Services
Performing Arts
Music & Sound Recording

Raleigh-Durham, NC
Livestock Processing
Vulcanized & Fired Materials
Education & Knowledge Creation

San Diego, CA
Recreational & Small Electric Goods
Biopharmaceuticals
Water Transportation

Houston, TX
Oil and Gas Production
Construction Products & Svc
Environmental Services

Atlanta, GA
Textile Mfg
Apparel
Communications Equipment

Do Clusters Matter?
Do Regions Specialized in Clusters Grow Faster?

• Data challenge
  • **Clusters are everywhere, but how do we measure them?**
  • We need benchmark cluster definitions that allow us to compare clusters across all regions

• Methodological challenge
  • **Cluster theory** suggests agglomeration arises *across related economic units* (Porter 1990, 1998)
  • We need a method that allows us to capture agglomeration that arises among related industries
  • Important prior work (e.g., Glaeser et al. 1992, 2010) focused on testing the impact of specific agglomeration channels such as localization or urbanization economies
Addressing the Data Challenge

The US Cluster Mapping Project V 1.0 (Porter, 2003)

• Industries in the County Business Patterns data are grouped empirically into **3 types:**
  • Local
  • Natural Resource Dependent
  • Traded

• **Traded industries** are grouped into **41 Traded Clusters**
  • Based on co-location patterns of industry employment across regions to capture revealed linkages of various types
  • Final cluster groupings informed by expert judgment
  • Clusters often contain **manufacturing and service industries** and industries from **different parts of the SIC system**
Do Clusters Matter?


• Our Approach: If clusters matter, then the growth of an industry in a region will be increasing in the strength of the regional cluster within which that industry operates

• Cluster-driven agglomeration could arise in different channels:
  • Across related industries Within a Cluster
  • Across Related Clusters
  • Across the Same Cluster in Neighboring Regions
Clusters and Jobs

- Industries within stronger clusters are associated with higher levels of job growth from the early 1990s to the mid-2000s

<table>
<thead>
<tr>
<th>Clusters and Jobs</th>
<th>INDUSTRY SPECIALIZATION</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Low</td>
</tr>
<tr>
<td>CLUSTER SPECIALIZATION</td>
<td>Low</td>
</tr>
<tr>
<td>Strength of Regional Clusters (presence of related industries)</td>
<td>High</td>
</tr>
</tbody>
</table>

Note: *Average Region-Industry Annualized Employment Growth over 1990-2005*. Region (EA) and Industry (4-digit SIC). N=55083. Cluster specialization variable is measured by Location Quotient. High means above the median of the variables.

- We test the role of clusters by estimating region-industry employment growth over 1990-2005 as a function of the initial *Industry Specialization* and *Cluster Specialization* (outside the industry) in a region, and a set of region and industry fixed effects
Clusters and Entrepreneurship

Industries that are part of a strong cluster environment register
- higher growth of start-up activity
- higher level of start-up activity
- higher level of employment in surviving start-up firms

Source: Delgado/Porter/Stern, Clusters and Entrepreneurship, Journal of Economic Geography, 2010
Clusters Matter for Innovation, Wages, and New Industries

We also estimate the effect of clusters on other dimensions of regional industry and regional performance:

- **Clusters contribute to the growth of existing industries**
  - Industries participating in a strong cluster register higher growth of wages and innovation (as well as higher employment growth)
  - There are complementarities between the innovation and employment performance in clusters

- **Clusters contribute to the creation of new industries**
  - New industries are more likely to emerge if they can integrate into an existing cluster, or if related or neighboring clusters are strong

- **Strong clusters contribute to the overall growth of the region**
  - Strong traded clusters in a region contribute to the employment growth of other traded and local activities in that region
Clusters Matter

• Positive effects of clusters on various facets of regional industry and regional performance

• No measured trade-offs across multiple performance dimensions

• Clusters matter at multiples levels of geography

• Clusters facilitate related economic diversification in regions
Cluster Mapping as a Tool for Economic Development
Building on a Decade of Cluster Research, Publications, and Projects

Recent History

2001: Clusters of Innovation Initiative
2003: Launch of the EDA-sponsored U.S. Cluster Mapping Project
2004: "Competitiveness in Rural Regions"
2005: "The Economic Performance of Regions"
2006: "EU-10 Cluster Mapping"
2007: International Cluster Competitiveness Profiles
2008: European Cluster Observatory
2009: "Clusters and Entrepreneurship"
2010: European Cluster Observatory v2.0

"Cluster and Economic Policy" White Paper
"European Cluster Memorandum"
"Clusters, Convergence and Economic Performance"
The Need for a National Cluster Tool

• The cluster composition of regions differs greatly


• A case for Cluster-Based Economic Development to be grounded in empirical evidence and practitioners experience

• A focus on the unique cluster composition in regions to
  • Reinforce established and emerging clusters and their related clusters
  • Exploit the cluster strength in neighboring regions

• The U.S. has lacked a national cluster portal to provide the necessary data, analytical tools, and contacts, even though important cluster-based programs have been launched around the country
The EDA Opportunity

The U.S Economic Development Administration sponsored the US Cluster Mapping Project

• National economic initiative based at Harvard Business School and sponsored by the U.S. Department of Commerce’s Economic Development Administration.
U.S. Economic Development Administration
Sponsored U.S. Cluster Mapping Project

U.S. Cluster Mapping Project

Research

• Better cluster data
• New regional data
• New cluster initiative data

• Next phase of comprehensive, action-oriented analysis

Action

• New interface
• New tools

• Step change in scope and quality of public and private efforts
Core Project Partners
USCMP
Better Cluster Data: Principles

• Use the latest industry definitions and data

• Define a transparent and robust set of cluster definitions that can “raise the bar” for cluster analysis and regional policymaking going forward

• Develop a systematic methodology for cluster definitions (building on prior work) that allows definitions to be easily revised overtime

• Ensure that cluster definitions (and underlying methodology) are publicly available through an interactive and accessible website
Defining Clusters of Related Industries
Novel Clustering Methodology

• We develop a clustering algorithm that systematically generates and assesses alternative sets of cluster definitions – i.e. groups of industries closely related by skill, technology, supply, demand, and/or other linkages

• Our method generates comparable sets of cluster definitions (i.e., the industries that constitute a cluster are the same for all regions)

• The method is novel by providing scores that assess the quality of each set of clusters (i.e., its ability to capture meaningful inter-industry linkages within clusters).

• We implement this clustering algorithm to create a new set of U.S. Benchmark Cluster Definitions (BCD)

The Clustering Algorithm

• Categorize industries as traded vs. local (778 traded 6-digit NAICS)

• Group traded industries into clusters accounting for multiple measures of inter-industry relatedness:

<table>
<thead>
<tr>
<th>Region-Industry measures</th>
<th>National Industry measures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Co-location of Industry Employment</td>
<td>Input-Output Links</td>
</tr>
<tr>
<td>(US Census CBP)</td>
<td>(BEA National Input-Output Tables)</td>
</tr>
<tr>
<td>Co-location of Industry Establishments</td>
<td>Occupational Correlation</td>
</tr>
<tr>
<td>(US Census CBP)</td>
<td>(BLS Occupational Employment Statistics)</td>
</tr>
</tbody>
</table>

• Derive candidate cluster configurations, \( C \), using advanced methods from cluster analysis (Everitt et al., 2011)

\[
C = \text{Function (Inter-Industry Relatedness Measures, Parameter Choices)}
\]

• Optimize a score function to choose a \( C^* \) that captures the broadest range of inter-industry linkages. The methodology concludes with an expert assessment and adjustment of individual clusters

• This results in the U.S. Benchmark Cluster Definitions (BCD) which groups 778 traded industries into 51 clusters
# USCMP
## Aerospace Vehicles and Defense Cluster

**Description:** Establishments in this cluster manufacture aircraft, space vehicles, guided missiles, and related parts. This cluster also contains firms that manufacture the necessary search and navigation equipment used by these products.

<table>
<thead>
<tr>
<th>NAICS 7 Industries</th>
<th>NAICS Name</th>
<th>Subcluster Name</th>
<th>Within Cluster Relatedness (WCR_{ic})</th>
</tr>
</thead>
<tbody>
<tr>
<td>336411</td>
<td>Aircraft Manufacturing</td>
<td>Aircraft</td>
<td>1</td>
</tr>
<tr>
<td>336412</td>
<td>Aircraft Engine and Engine Parts Manufacturing</td>
<td>Aircraft</td>
<td>1</td>
</tr>
<tr>
<td>336413</td>
<td>Other Aircraft Parts and Auxiliary Equipment Manufacturing</td>
<td>Aircraft</td>
<td>1</td>
</tr>
<tr>
<td>336414</td>
<td>Guided Missile and Space Vehicle Manufacturing</td>
<td>Missiles &amp; Space Vehicles</td>
<td>1</td>
</tr>
<tr>
<td>336415</td>
<td>Guided Missile and Space Vehicle Propulsion Unit and Propulsion Unit Parts Manufacturing</td>
<td>Missiles &amp; Space Vehicles</td>
<td>1</td>
</tr>
<tr>
<td>336419</td>
<td>Other Guided Missile and Space Vehicle Parts and Auxiliary Equipment Manufacturing</td>
<td>Missiles &amp; Space Vehicles</td>
<td>1</td>
</tr>
<tr>
<td>334511</td>
<td>Search, Detection, Navigation, Guidance, Aeronautical, and Nautical System and Instrument Manufacturing</td>
<td>Search &amp; Navigation Equipment</td>
<td>1</td>
</tr>
</tbody>
</table>

US Job Creation in Traded Clusters, 2009-2012

Net traded job creation, 2009 to 2012: +379,896
US Job Creation in Traded Clusters, 2009 to 2012

Across all traded clusters:
+379,896

In the five clusters adding the most jobs:
+974,509

In the five clusters losing the most jobs:
-394,373

Across all traded clusters:
+379,896

In the five clusters adding the most jobs:
+974,509

In the five clusters losing the most jobs:
-394,373
Each Cluster Can Be Mapped Into Regions: Mapping Strong Clusters

Aerospace Vehicles and Defense

Specialization in Aerospace Vehicles and Defense by Economic Area, 2012

Source: U.S. Cluster Mapping Project, Institute for Strategy and Competitiveness, Harvard Business School, Data Sources
### Benchmarking Regional Clusters:
**Aerospace Vehicles and Defense**

<table>
<thead>
<tr>
<th></th>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Seattle-Tacoma-Olympia, WA</td>
<td>70,099</td>
<td>-4.4%</td>
<td>7.81</td>
<td>114</td>
<td>$70,169</td>
<td>1,285</td>
</tr>
<tr>
<td>Los Angeles-Long Beach-Riverside, CA</td>
<td>53,063</td>
<td>-4.8%</td>
<td>1.61</td>
<td>324</td>
<td>$90,527</td>
<td>2,441</td>
</tr>
<tr>
<td>Dallas-Fort Worth, TX</td>
<td>39,157</td>
<td>-0.3%</td>
<td>2.51</td>
<td>97</td>
<td>$62,550</td>
<td>899</td>
</tr>
<tr>
<td>Wichita-Winfield, KS</td>
<td>28,191</td>
<td>-4.2%</td>
<td>13.21</td>
<td>84</td>
<td>$69,597</td>
<td>43</td>
</tr>
<tr>
<td>Boston-Worcester-Manchester, MA-NH</td>
<td>26,357</td>
<td>-2.6%</td>
<td>1.50</td>
<td>66</td>
<td>$93,668</td>
<td>1,758</td>
</tr>
<tr>
<td>Phoenix-Mesa-Scottsdale, AZ</td>
<td>22,296</td>
<td>0.4%</td>
<td>3.09</td>
<td>74</td>
<td>$55,257</td>
<td>499</td>
</tr>
<tr>
<td>Washington-Baltimore-Northern Virginia, DC-MD-VA-WV</td>
<td>19,815</td>
<td>0.6%</td>
<td>1.09</td>
<td>42</td>
<td>N/A</td>
<td>755</td>
</tr>
<tr>
<td>Tucson, AZ</td>
<td>19,075</td>
<td>-1.8%</td>
<td><strong>13.98</strong></td>
<td>15</td>
<td>$84,507</td>
<td>164</td>
</tr>
<tr>
<td>Hartford-West Hartford-Willimantic, CT</td>
<td>18,322</td>
<td>-3.3%</td>
<td>4.30</td>
<td>84</td>
<td>$64,370</td>
<td>227</td>
</tr>
<tr>
<td>San Diego-Carlsbad-San Marcos, CA</td>
<td>16,468</td>
<td><strong>3.9%</strong></td>
<td>3.00</td>
<td>51</td>
<td>$83,060</td>
<td>1,077</td>
</tr>
</tbody>
</table>

Note: Selected Strong clusters (high specialization): top-10 by employment size.

Source: CBP and USPTO data
Rich Data on Regional Performance & Drivers

- **Detailed data based on multiple databases:** U.S. Census Bureau, USPTO, StatsAmerica, ...

**PERFORMANCE**

- **Outcomes:** GDP per Capita, Average Wages, Labor Mobilization, Employment Growth, Unemployment, Poverty

- **Intermediate Outcomes:** Labor Force Productivity, Innovation, Exports, Growth Rate for Traded Establishments

- **Factor Input Conditions:** R&D Expenditure, Federal Funding for R&D, Venture Funding, Scientific Degrees Awarded, Advanced Scientific Workers, High School and College Degrees

- **Context for Firm Strategy and Rivalry:** Unionization, Tax Rates, Corporate Tax Rates

**BUSINESS ENVIRONMENT**

- **Related and Supporting Industries:** Regional Cluster Strength, Manufacturing Intensity

- **Population:** Demographic Structure, Overall and Young Adult Population Growth, Density, Domestic and International Migration

- **Neighborhood:** Prosperity of Neighboring Regions

**DEMOGRAPHICS & GEOGRAPHY**

- **Firm Demographics:** Average Traded Establishment Size, Headquarters of Fortune 1000 Firms
Linking Clusters to Local Institutions and Cluster Initiatives

Who are the Institutions for Collaboration in your region?

• The **new Organizations data** register cluster initiatives and other organizations
• Registered users can post resources and relevant news
• Facilitates connectivity among firms and supporting institutions
Clusters Going Forward

• Things **we can learn**: The tool as a platform

• Things **we can do**: Cluster-based economic development

• Things **we can create**: Dynamic tool
Things We Can Learn: The Tool as a Learning Platform

• New Action-Oriented Research Opportunities using the Tool
  
  • Clusters and the Great Recession
  
  • Local versus Traded Clusters and Entrepreneurial Quality
  
  • Clusters and the Inner City

• A Community of Practice to Develop Assessments of Individual Regions and Clusters
  
  • Policy Evaluation
  
  • Role of Institutions for Collaboration (IFCs)
Things We Can Learn: Clusters and The Great Recession

• Using the new BCD data, we examine the role of clusters in employment growth during the business cycle in the context of the recent Great Recession (2003-2011)

• Two opposing forces may be at work:
  • Agglomeration economies that arise in regions specialized in clusters (e.g., Delgado, Porter and Stern, 2010, 2012, 2014), and could facilitate resilience and recovery from a recession
  • However, negative shocks could propagate among related industries, and could increase the depth of a recession (Acemoglu et al., 2013)
Things We Can Learn: Clusters Can Improve Resilience

- We find a positive relationship between the employment growth of regional industries and the strength of their clusters, during the whole business cycle and specially during the crisis (2007-2008)

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

Things We Can Learn: Clusters and Entrepreneurial Quality

• As part of the MIT Regional Entrepreneurship Acceleration Program, the need for a step change to measure the quality of start-ups within a region, on a real-time basis and at an arbitrary level of generality,

• We combine “big data” (using comprehensive business registration records) with a predictive algorithm that assesses the likelihood of a meaningful growth outcome (e.g., IPO or high-value acquisition) based on observables available at the time of incorporation (e.g., the name, patents and copyrights, etc).

• Using the CMP Cluster Definitions, we are able to assign business names to “local” versus “traded” clusters based on the historical incidence of business names in particular clusters.

• Among other results, we find that businesses within traded clusters are more than 4x more likely to achieve a meaningful growth outcome.

Where is Silicon Valley?

Using complete CA business registration records, and novel algorithm to predict start-up success, this project uses CMP cluster definitions and local versus traded industry definitions to estimate entrepreneurial quality score by zip code across California.
While per capita start-up quantity is similar in Los Angeles, a lower level of entrepreneurial quality than the heart of Silicon Valley
Things We Can Learn: Clusters and the Inner City

• How do clusters matter at different levels of geographic aggregation?

• Many cluster studies either focus on narrow geographic units (e.g., an industrial district or individual city) while others focus on the impact of clusters on regional economies (Delgado, Porter and Stern; Glaeser, etc)

• With Kim Zeuli and the Institute for Competitiveness in the Inner City, we are exploring whether the impact of the cluster environment is particularly important for inner cities
  • Are more dense areas within an economic region particularly sensitive to the cluster environment?
  • How does the cluster environment impact distressed economic regions?

Source: ICIC, JP Morgan Chase and Co.
“The Missing Link: Clusters, Small Business Growth and Vibrant Urban Economies”
Things We Can Learn: Policy Assessment

• **Assessment of specific economic development initiatives**

  • In recent work, Maryann Feldman and coauthors (2012, 2013) have worked with the EDA to assess projects such as the i6 Challenge, and the Jobs and Innovation Accelerator Challenge (JIAC) Project.

• **Success Metrics**: Moving beyond aggregate outcome measures such as employment and investment, novel Capacity Based Measures based on the connectivity among firms and supporting institutions.

• **Benchmarking Approach**: To examine changes in clusters and regions before and after policy initiatives, specification of a control group of “similar” regional clusters based on CMP definitions.
Clusters Going Forward: Things *We Can Do*
Things We Can Do

• Use the data for cluster-based economic development

  • How is your region doing? How are your peer regions doing?

  • What clusters are you strong in? And your neighbors?

  • What is the positioning in your clusters? Emerging Clusters?

• Engage and contribute to the community of practice

  • Who are the Institutions for Collaboration in your region? How are they already working together? How might they work better together?

  • How do the cluster initiatives in your region relate to the cluster composition of your region? How can we leverage regional strengths as a source of economic development?
Policy Guides and Studies

• By developing policy guides and policy and impact studies (available on www.clustermapping.us), the U.S. Cluster Mapping Project provides new insights on the role of clusters in driving regional economic outcomes.
Clusters Going Forward: Things *We Can Create*
Core Project Partners

- Harvard Business School
- Institute for Strategy & Competitiveness
- EDA
- U.S. Economic Development Administration
- Martin Trust Center for MIT Entrepreneurship
- MIT Sloan Management
- Fox School of Business
- Temple University
- Phase2
- New Carolina
- North Carolina's Council on Competitiveness
- University of Minnesota
- Massachusetts Technology Collaborative
- Oregon Business Council
- StatsAmerica
- rian Regional Innovation Acceleration Network
Things We Can Create

• This conference is a milestone in the evolution of the community of practice of cluster researchers and practitioners

• The Cluster Mapping Project has already brought together researchers, practitioners, and policymakers to design, develop and test a robust and transparent cluster mapping tool

• The future of the Cluster Mapping Project is limited only by our creativity, and our commitment to move this agenda forward together
  • Serving as a transparent, robust, and timely source of data for cluster development efforts
  • Connecting the ever-growing community of cluster organizations, both in the United States and abroad
  • Serving as the hub to track cluster-led economic development efforts, identify best practice, and diffuse new data and insights

• Accelerating economic and social progress through a new generation of research, collaboration, and action
Let’s get started together!