Clusters and Competitiveness
Frameworks and Applied Research

Workshop on Applied Research
Centro de Investigación e Inteligencia Económica, UPAEP
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Richard Bryden
Director of Information Products
Institute for Strategy and Competitiveness
Harvard Business School
www.isc.hbs.edu

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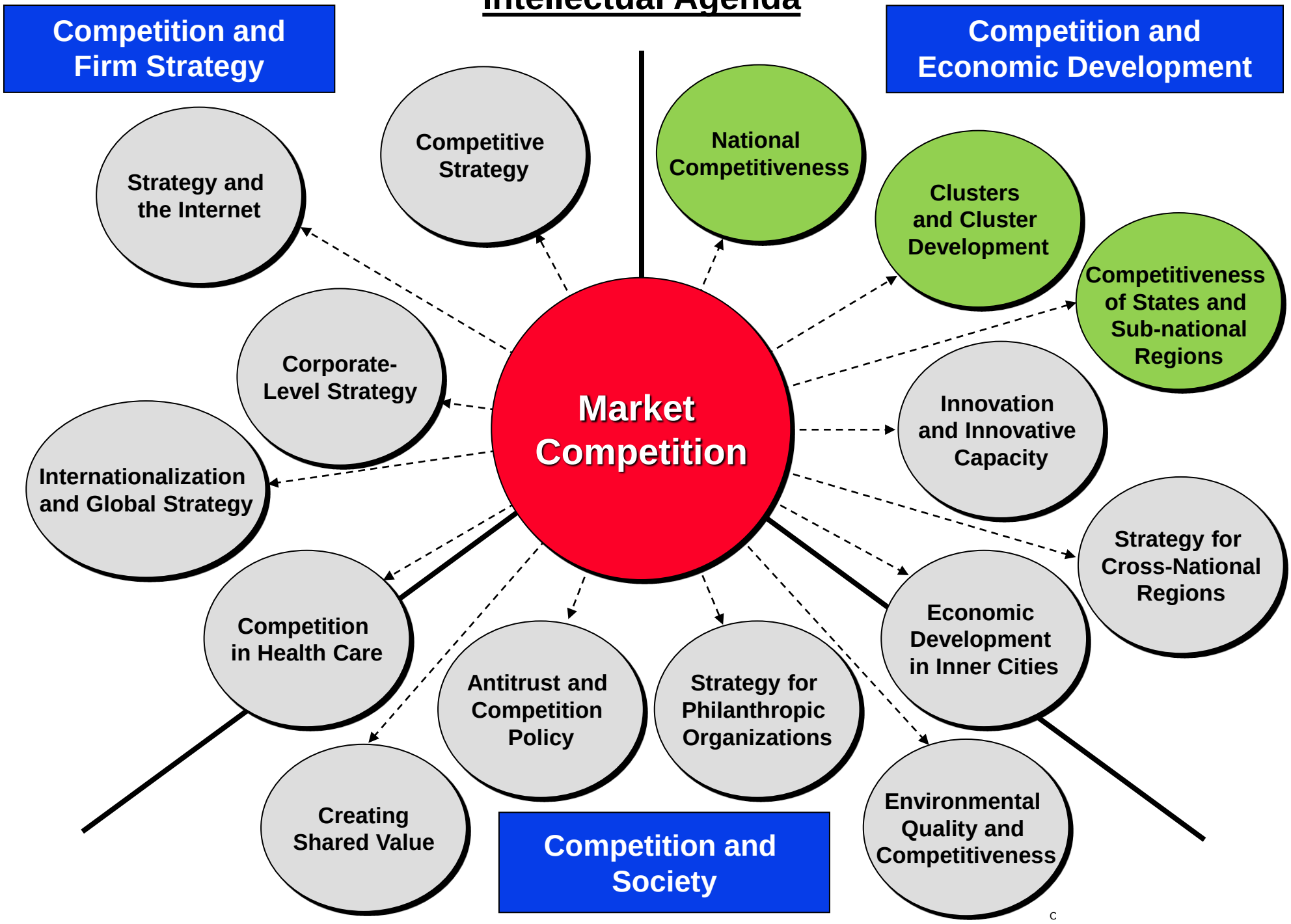
Institute for Strategy and Competitiveness

Intellectual Agenda



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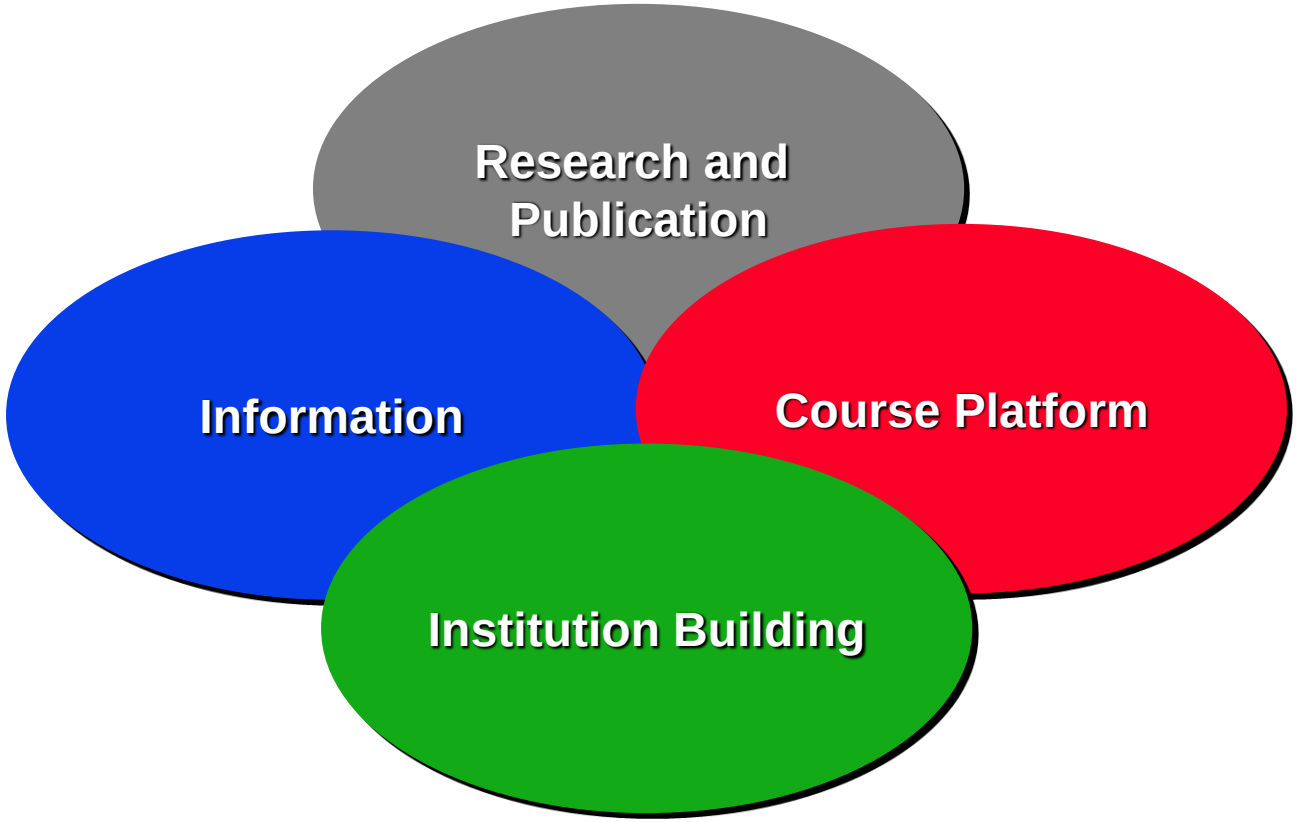
Institute for Strategy and Competitiveness

Leverage Model



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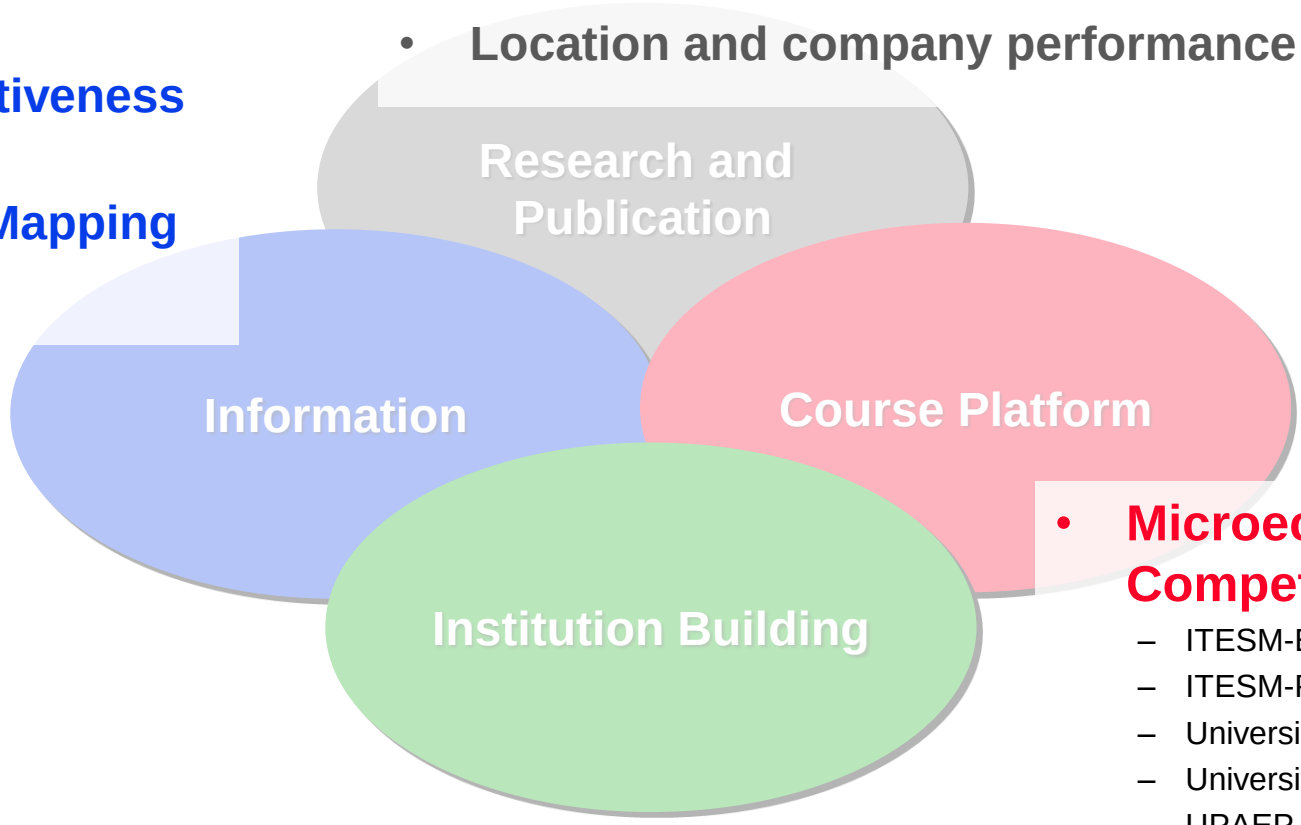
Competitiveness and Economic Development

Main Activity Areas

- Institutions for Competitiveness
- National Economic Strategy
- Cluster policy
- Export diversification
- Location and company performance

- **Competitiveness Index**
- **Cluster Mapping**



- **Microeconomics of Competitiveness**
  - ITESM-EGAP
  - ITESM-Puebla
  - Universidad Panamericana
  - University of Sonora (UNISON)
  - UPAEP

- **MOC Network**

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What is Competitiveness?

A nation or region is competitive to the extent that firms operating there are able to **compete successfully** in the global economy while supporting **rising wages and living standards** for the average citizen

- Competitiveness depends on the **long term productivity** with which a nation or region uses its human, capital, and natural resources
  - Productivity **sets sustainable wages**, **job growth**, and **standard of living**
  - It is not **what** industries a nation or region competes in that matters for prosperity, but **how productively** it competes in those industries
  - Productivity in a national or regional economy benefits from a **combination of domestic and foreign firms**

- Nations and regions compete to offer a **more productive environment for business**
- Competitiveness is **not a zero sum game**

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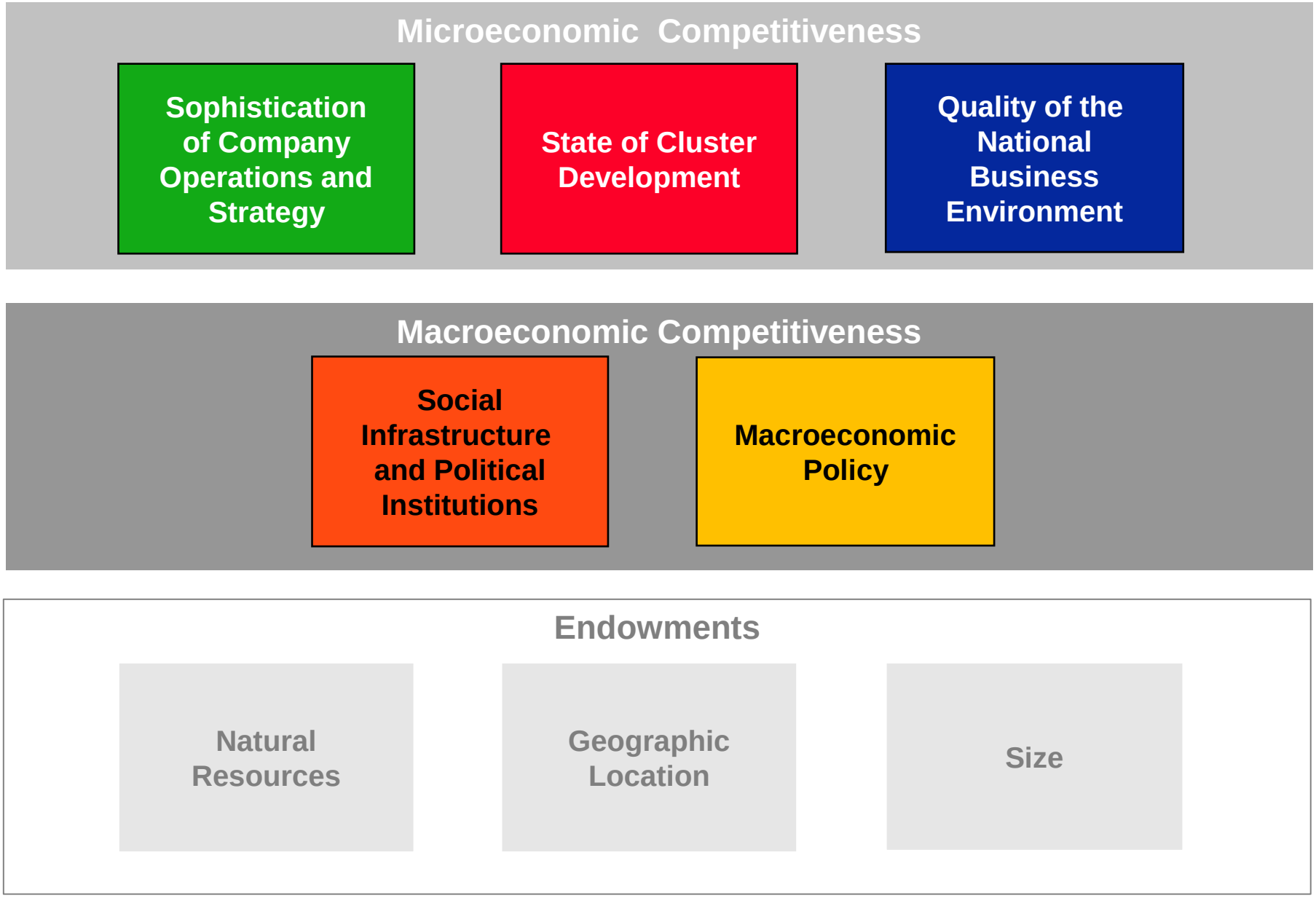
Conceptual Framework for Competitiveness

Key Building Blocks



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Components of Macroeconomic Competitiveness

Social Infrastructure and Political Institutions

- **Human development**
  - Basic education
  - Health
- **Political institutions**
  - Political freedom
  - Voice and accountability
  - Political stability
  - Government effectiveness
  - Decentralization of economic policymaking
- **Rule of law**
  - Security
  - Civil rights
  - Judicial independence
  - Efficiency of legal framework
  - Freedom from corruption

Macroeconomic Policies

- **Fiscal policy**
  - Government surplus/deficit
  - Government debt
- **Monetary policy**
  - Inflation

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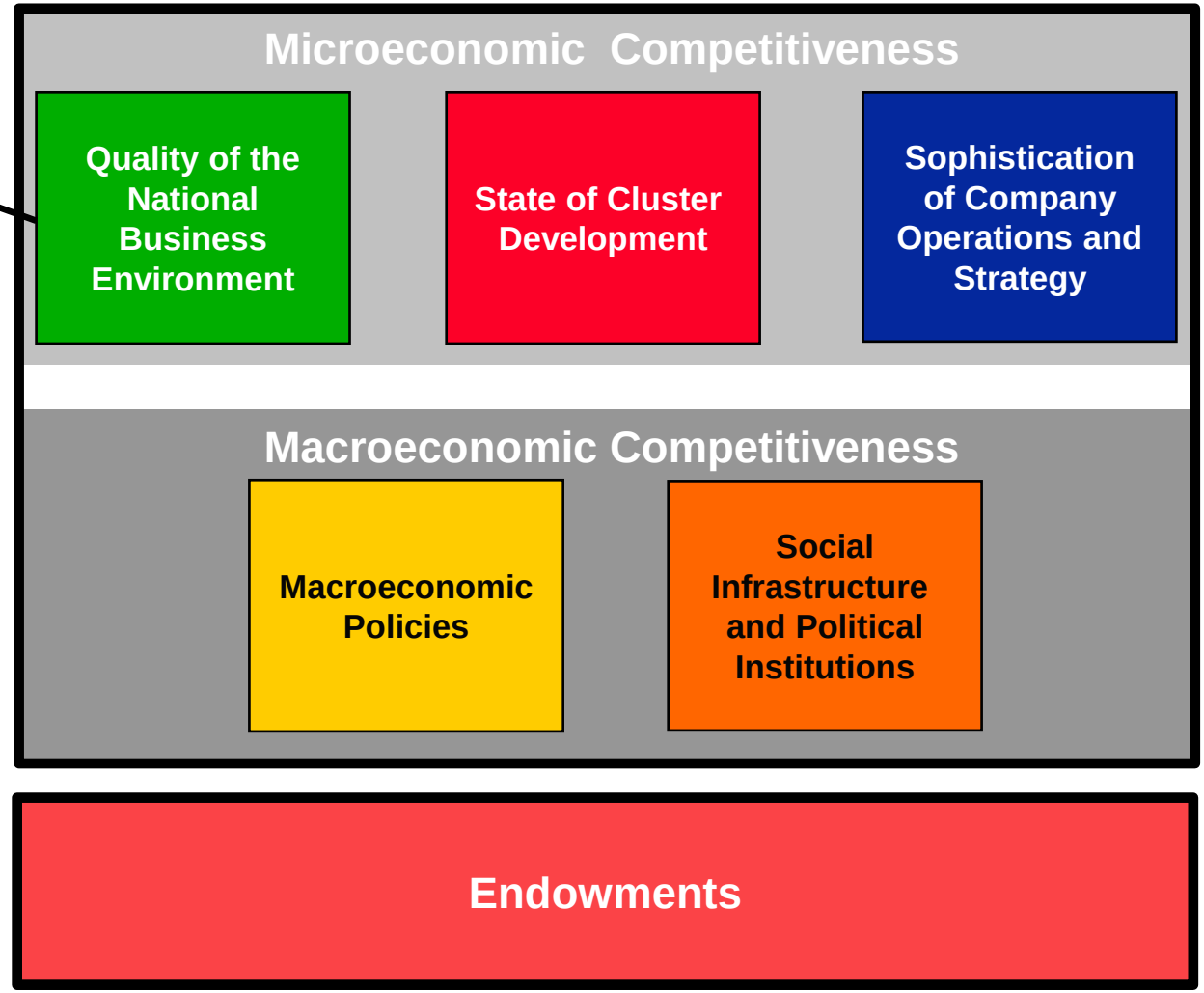
What Determines Competitiveness?

The **external business environment conditions** that enable company productivity and innovation



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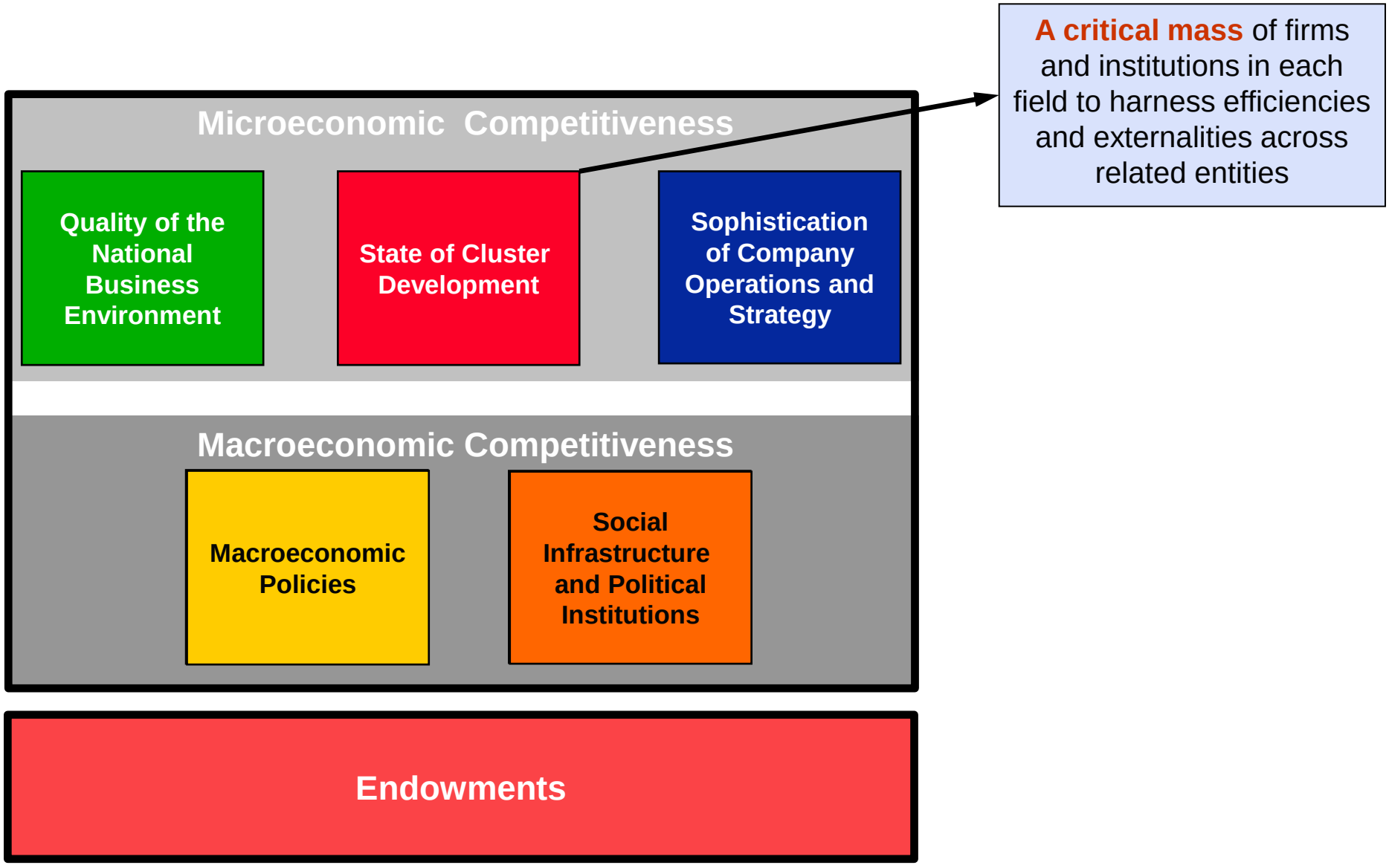
What Determines Competitiveness?



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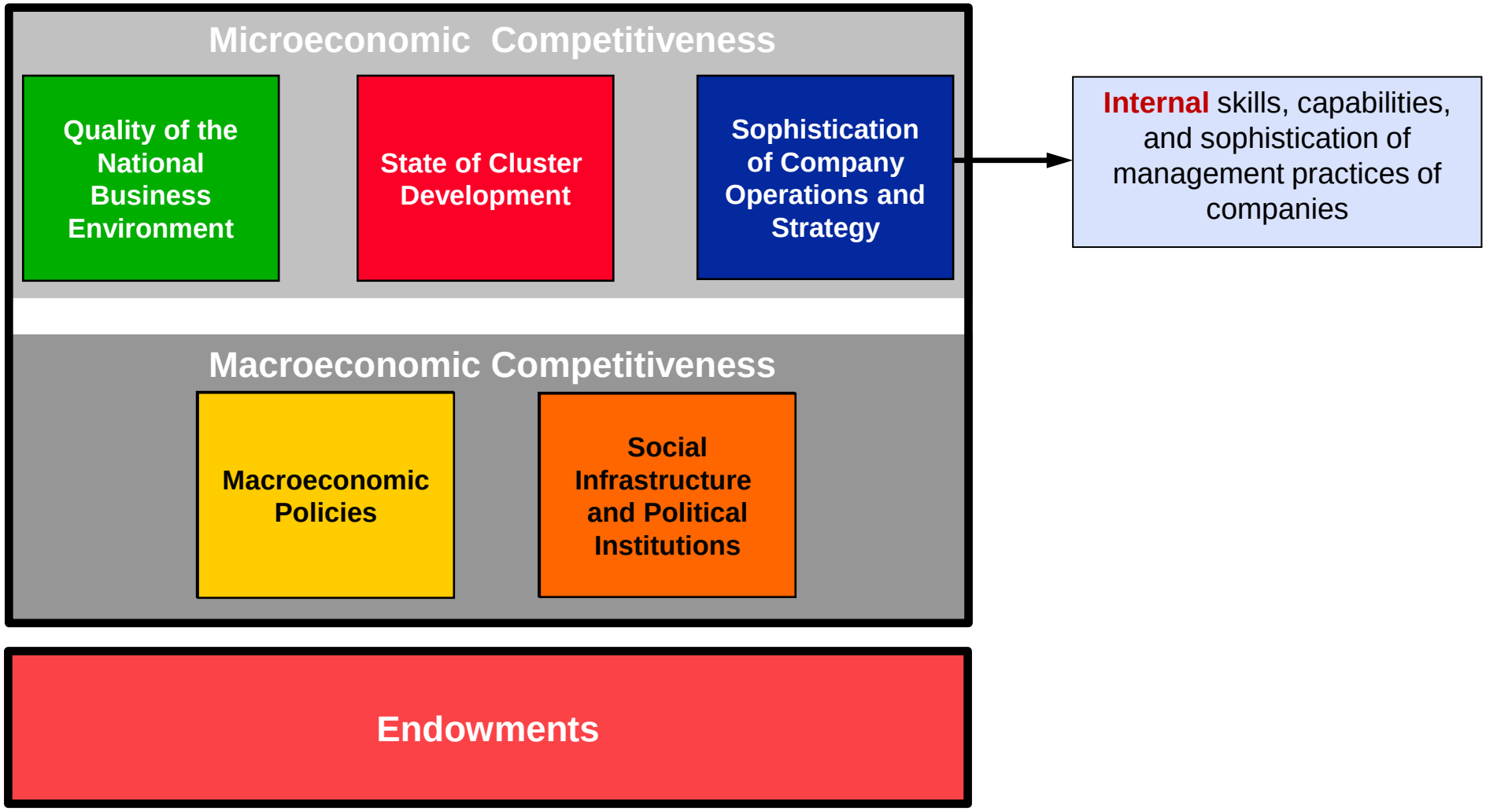
What Determines Competitiveness?



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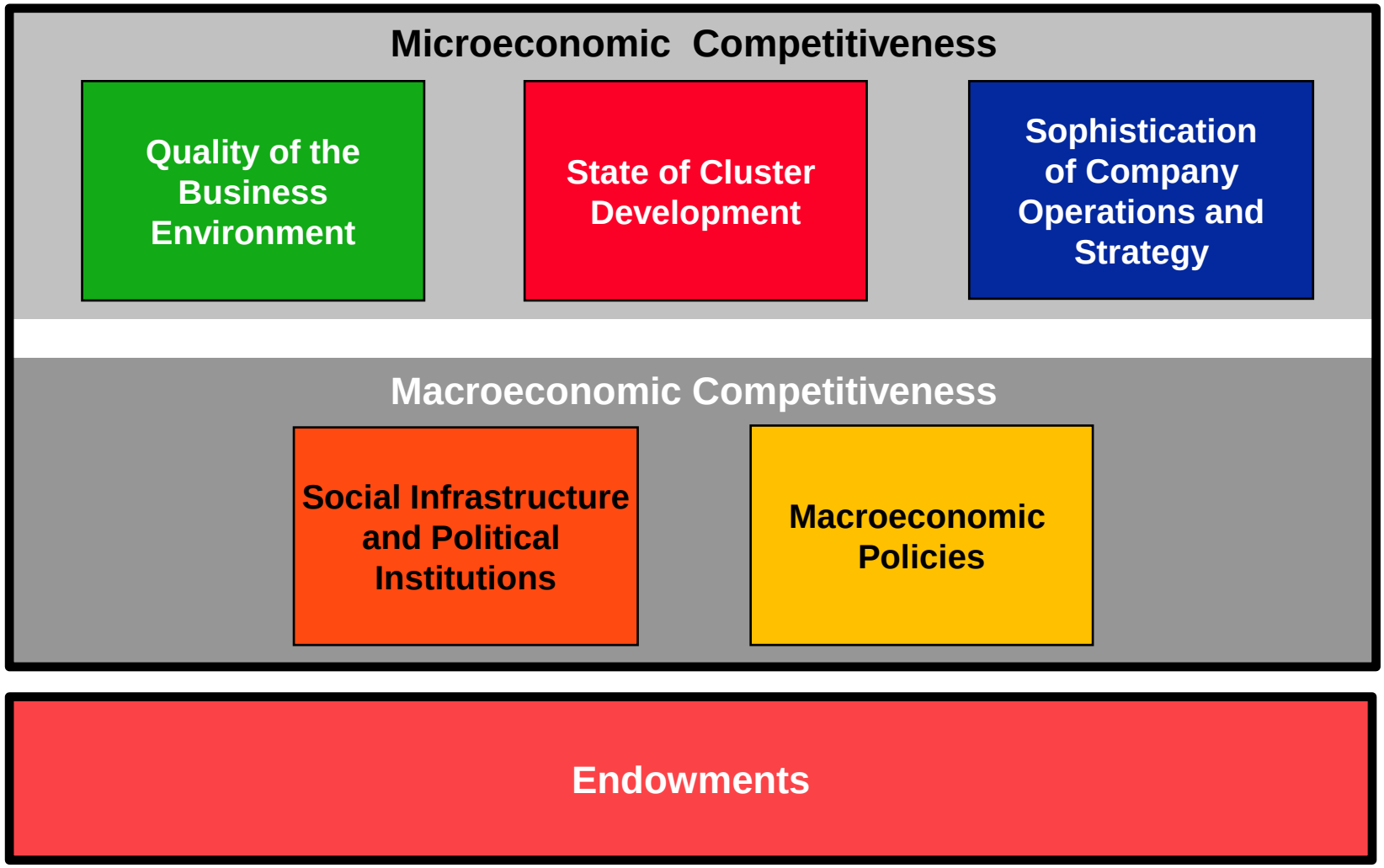
What Determines Competitiveness?



- Macroeconomic competitiveness sets the **potential** for high productivity, but is **not sufficient**
- Productivity ultimately depends on improving the **microeconomic capability** of the economy and the **sophistication of local competition**

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A New Definition of Competitiveness

Broad measure of productivity. Productivity ultimately drives prosperity, the key outcome policy makers are concerned about

Captures both productivity of employees and of labor market institutions

"GDP relative to the available labor force given the quality of a location to do business"

Linked to all ultimate drivers of productivity, in particular those amenable to policy action

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Testing the Competitiveness Framework
An Empirical Approach

- Data
  - Broad set of data covering all dimensions of the framework
  - Unit of observation is the average response per indicator, country, and year
  - Data set is a panel across more than 130 countries and up to 8 years, using the World Economic Forum's Global Executive Survey and other sources

- Approach
  - Step 1: Conduct separate, step-wise principal components analyses for MICRO, SIPI, to derive their averages per country-year; simple average for MP
  - Step 2: Comprehensive regression of MICRO, SIPI and MP on log GDP per capita with endowment controls and year dummies.

$$\text{Ln Output per Potential Worker}_{c,t} = \alpha + \beta_{MICRO}\text{MICRO}_{c,t-1} + \beta_{SIPI}\text{SIPI}_{c,t-1} + \beta_{MP}\text{MP}_{c,t-1} + \alpha_{END}\text{ENDOWMENTS}_{c,t-1} + \alpha_{t}\,\text{year}_{t} + \varepsilon_{c,t} \qquad (1)$$

Source: Delgado/Ketels/Porter/Stern, 2012

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Country Competitiveness Model
Subindex Impact at Various Stages of Development

	Stage of Development		
Subindex	Low	High	Linear Model (all Economies)
MICRO	0.21	0.48	0.31
SIPI	0.49	0.36	0.41
MP	0.30	0.16	0.28
	1	1	1

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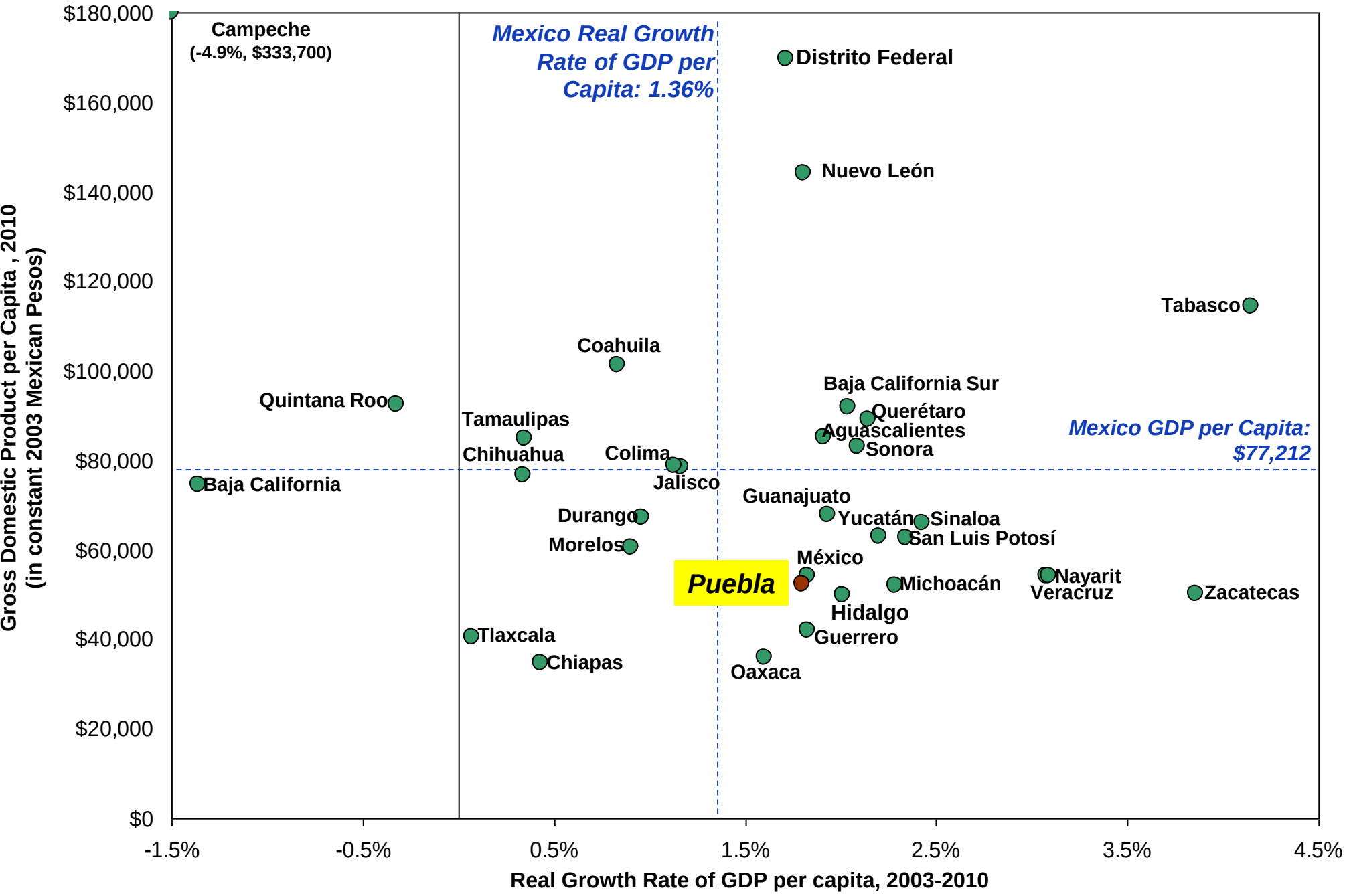
Prosperity Performance in Mexican States



Source: INEGI. Sistema de Cuentas Nacionales de México.

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The Changing Nature of International Competition

- Falling restraints to trade and investment
- Globalization of markets
- Globalization of value chains
- Shift from vertical integration to relying on outside suppliers, partners, and institutions
- Increasing knowledge and skill intensity of competition

- Nations and regions compete on becoming the **most productive locations for business**
- Many essential levers of competitiveness reside at the **regional level**
- Economic performance **varies significantly** across sub-national regions (e.g., provinces, states, metropolitan areas)

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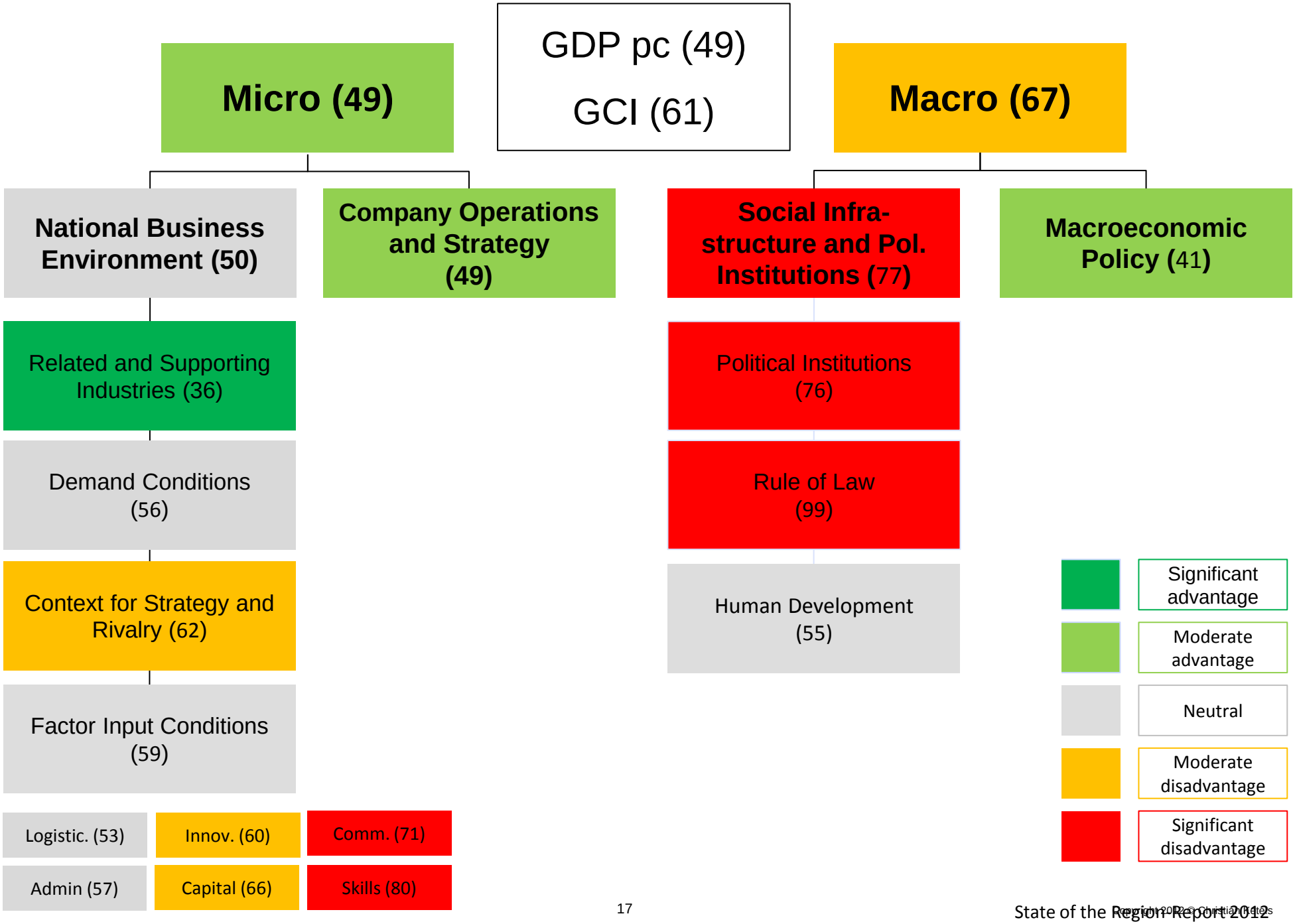
Mexico's Competitiveness Profile 2011



Source: Unpublished data from the Global Competitiveness Report (2012), author's analysis.

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What is a Cluster?

A geographically proximate group of interconnected companies and associated institutions in a particular field, linked by commonalities and complementarities (external economies)

- An end product industry or industries
- Downstream or channel industries
- Specialized suppliers
- Providers of specialized services
- Related industries (those with important shared activities, labor, technologies, channels, or common customers)
- Supporting Institutions: financial, training, trade associations, standard setting, research

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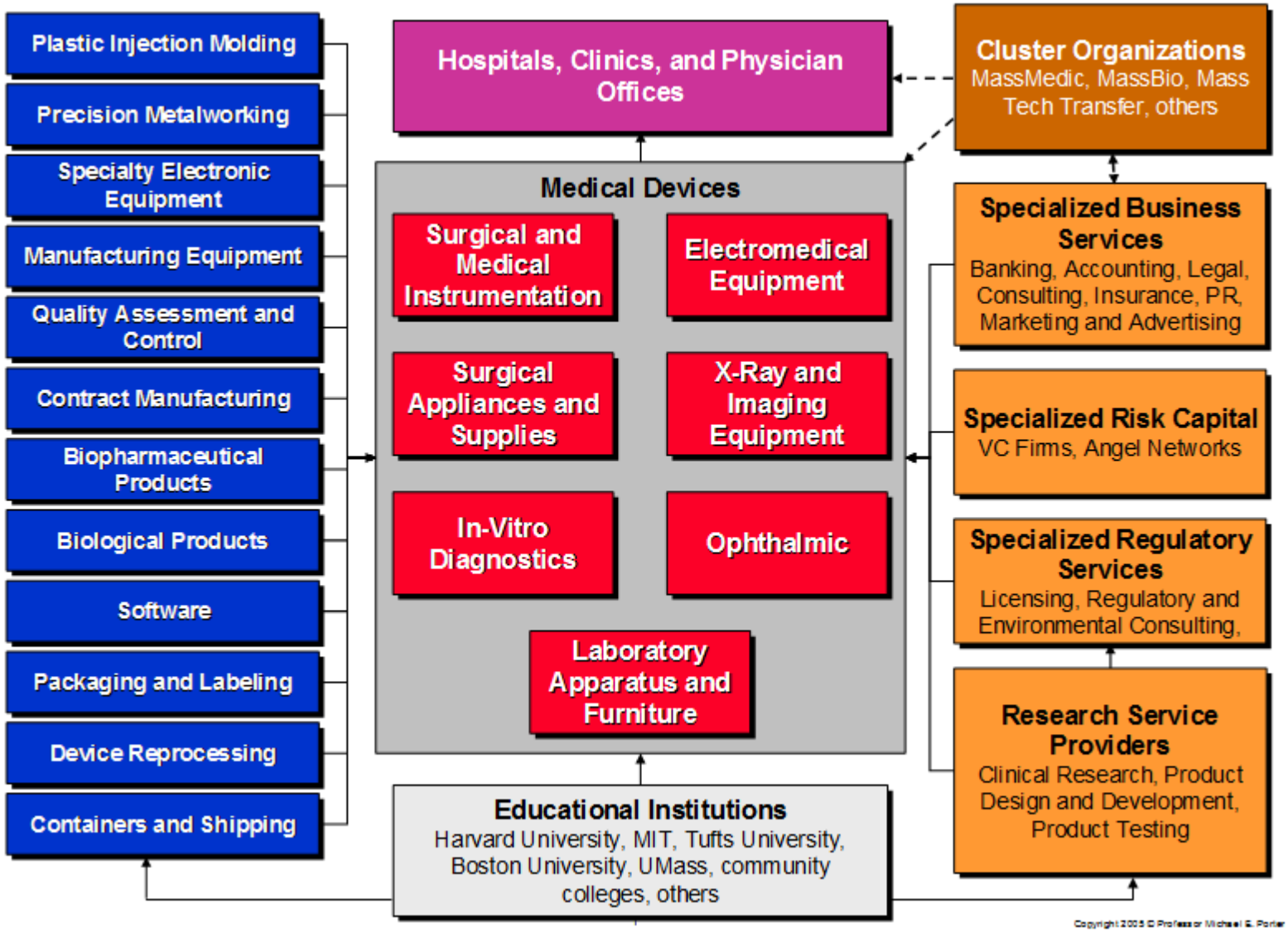
Massachusetts Medical Devices Cluster



A geographically proximate group of interconnected companies and associated institutions in a particular field, linked by commonalities and complementarities

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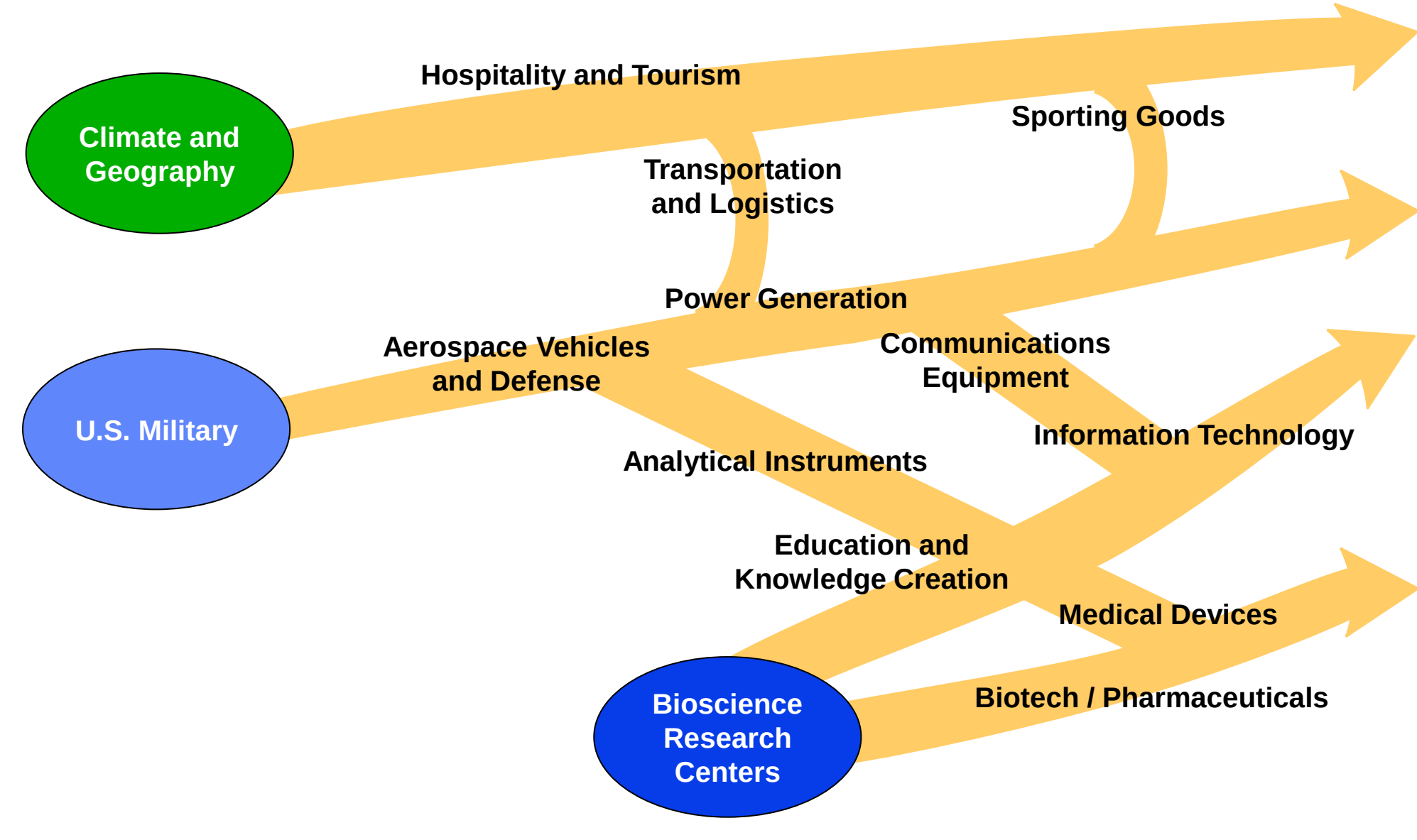
The Evolution of Regional Economies

San Diego



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Clusters and Competitiveness

- Regions **specialize** in different sets of clusters
- **Cluster strength** directly impacts regional performance

- Each region needs its own distinctive **competitiveness strategy and action agenda**
  - Business environment improvement
  - Cluster upgrading

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Defining clusters of related industries

- Assigning industries to clusters is challenging because **there are numerous types of externalities and they are hard to measure directly**

- Some studies measure industry relatedness, but do not define clusters
  - E.g., Ellison, Glaeser and Kerr (2010): input-output, skills and knowledge linkages for manufacturing industries

- Very few studies define regional clusters:
  - Feldman and Audretsch (1999) for science-based manufacturing clusters
  - Feser and Bergman (2000) for input-output-based manufacturing clusters
  - Porter (2003) for **clusters of industries related by any type of externalities** (in both manufacturing and service)

A major constraint to the analysis of clusters has been the lack of a systematic approach to defining the industries that should be included in each cluster and the absence of consistent empirical data on cluster composition across a large sample of regional economies. Lack of large sample empirical data is understandable, since knowledge spillovers and other positive externalities are difficult if not impossible to measure directly.

We proceed indirectly, using the locational correlation of employment across traded industries to reveal externalities and define cluster boundaries.

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Porter's (2003) US Cluster Mapping Project

- The 879 industries are grouped empirically into **3 types of industries** (and industries) with very different location drivers:
  - **Local** clusters: utilities, retail clothing
  - **Natural Resource Dependent** clusters: water supply, metal mining
  - **Traded** clusters: footwear, biopharma, business services

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The Composition of Regional Economies

United States

	Traded	Local	Natural Resource-Driven
Share of Employment	27.4%	71.7%	0.9%
Employment Growth Rate	0.3%	1.5%	0.5%
Average Wage	$57,706	$36,911	$40,142
Relative Wage	135.2%	86.5%	94.1%
Wage Growth Rate	3.7%	2.4%	2.4%
Relative Productivity	144.1	79.3	140.1
Patents per 10,000 Employees	21.5	0.3	1.6
Number of SIC Industries	590	241	48
Number of NAICS Industries	677	352	43

Source: Prof. Michael E. Porter, Cluster Mapping Project, Institute for Strategy and Competitiveness, Harvard Business School; Richard Bryden, Project Director.

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  - **Local** clusters: utilities, retail clothing
  - **Natural Resource Dependent** clusters: water supply, metal mining
  - **Traded** clusters: footwear, biopharma, business services

- The 592 traded industries are grouped into **41 traded clusters:**
  - Relatedness between a pair of industries is based on the employment correlation of pairs of industries across regions. The **locational correlation captures any type of externalities** (e.g. technology, skills, demand, or others)
  - Industries are then grouped into clusters by **maximizing within-cluster relatedness**
  - Clusters often contain **manufacturing and service industries** and industries from **different parts of the SIC system**

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Automotive Cluster

Broad Cluster Definition

NARROW CLUSTER DEFINITION

SUBCLUSTERS (16)	SIC	LABEL
Motor Vehicles	**3711**	**Motor vehicles and car bodies**
Automotive Parts	2396	Automotive and apparel trimmings
	3230	Products of purchased glass
	3592	Carburetors, pistons, rings, valves
	3714	Motor vehicle parts and accessories
	3824	Fluid meters and counting devices
Automotive Components	3052	Rubber and plastics hose and belting
	3061	Mechanical rubber goods
Forgings and Stampings	3322	Malleable iron foundries
	3465	Automotive stampings
Flat Glass	3210	Flat glass
Production Equipment	3544	Special dies, tools, jigs and fixtures
	3549	Metalworking machinery, n.e.c.
Small Vehicles and Trailers	3799	Transportation equipment, n.e.c.
Marine, Tank & Stationary Engines	3519	Internal combustion engines, n.e.c.
Related Parts	3364	Nonferrous die-casting, except aluminum
	3452	Bolts, nuts, rivets, and washers
	3493	Steel springs, except wire
	3495	Wire springs
	3562	Ball and roller bearings
	3566	Speed changers, drives, and gears
	3641	Electric lamps
Motors and Generators	3621	Motors and generators
Related Vehicles	3795	Tanks and tank components
Metal Processing	3316	Cold finishing of steel shapes
	3398	Metal heat treating
Machine Tools	3541	Machine tools, metal cutting types
	3542	Machine tools, metal forming types
	3545	Machine tool accessories
Related Process Machinery	3543	Industrial patterns
	3548	Welding apparatus
Industrial Trucks and Tractors	3537	Industrial trucks and tractors
Die-castings	3363	Aluminum die-castings

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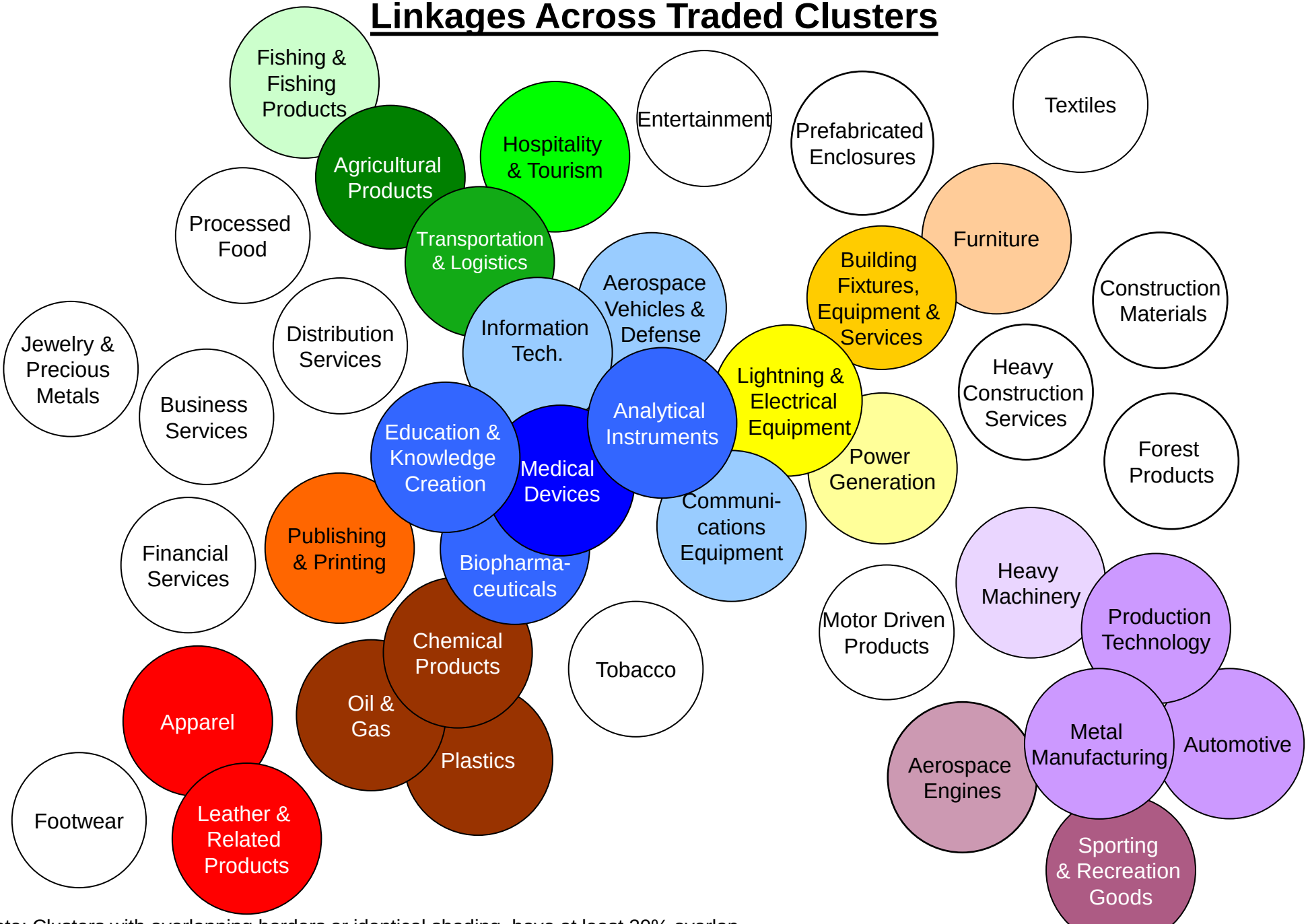
Competitiveness and the Composition of the Economy

Linkages Across Traded Clusters



Note: Clusters with overlapping borders or identical shading have at least 20% overlap (by number of industries) in both directions.

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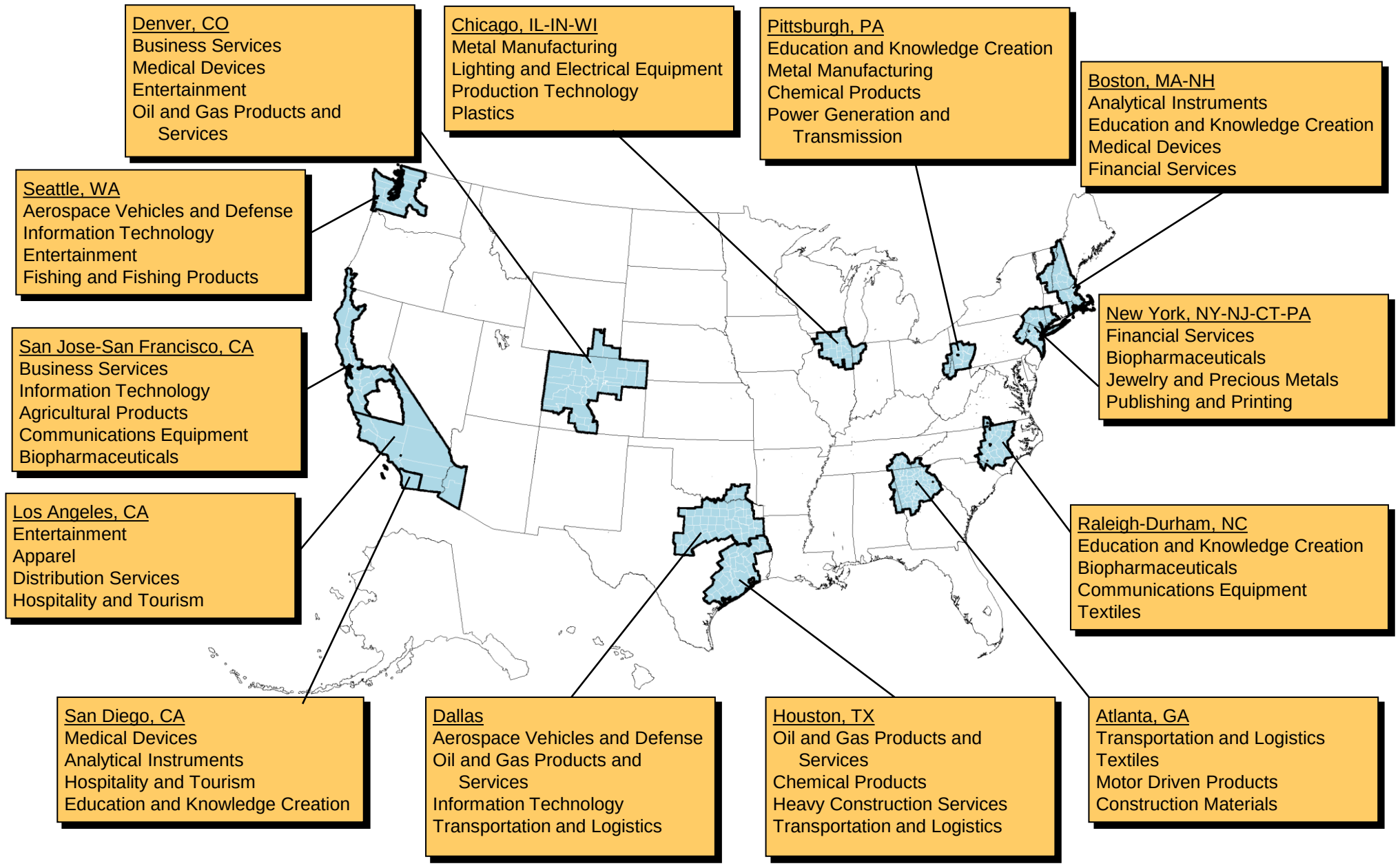
Specialization of Regional Economies

Leading Clusters in U.S. Economic Areas



Source: Prof. Michael E. Porter, Cluster Mapping Project, Institute for Strategy and Competitiveness, Harvard Business School; Richard Bryden, Project Director.

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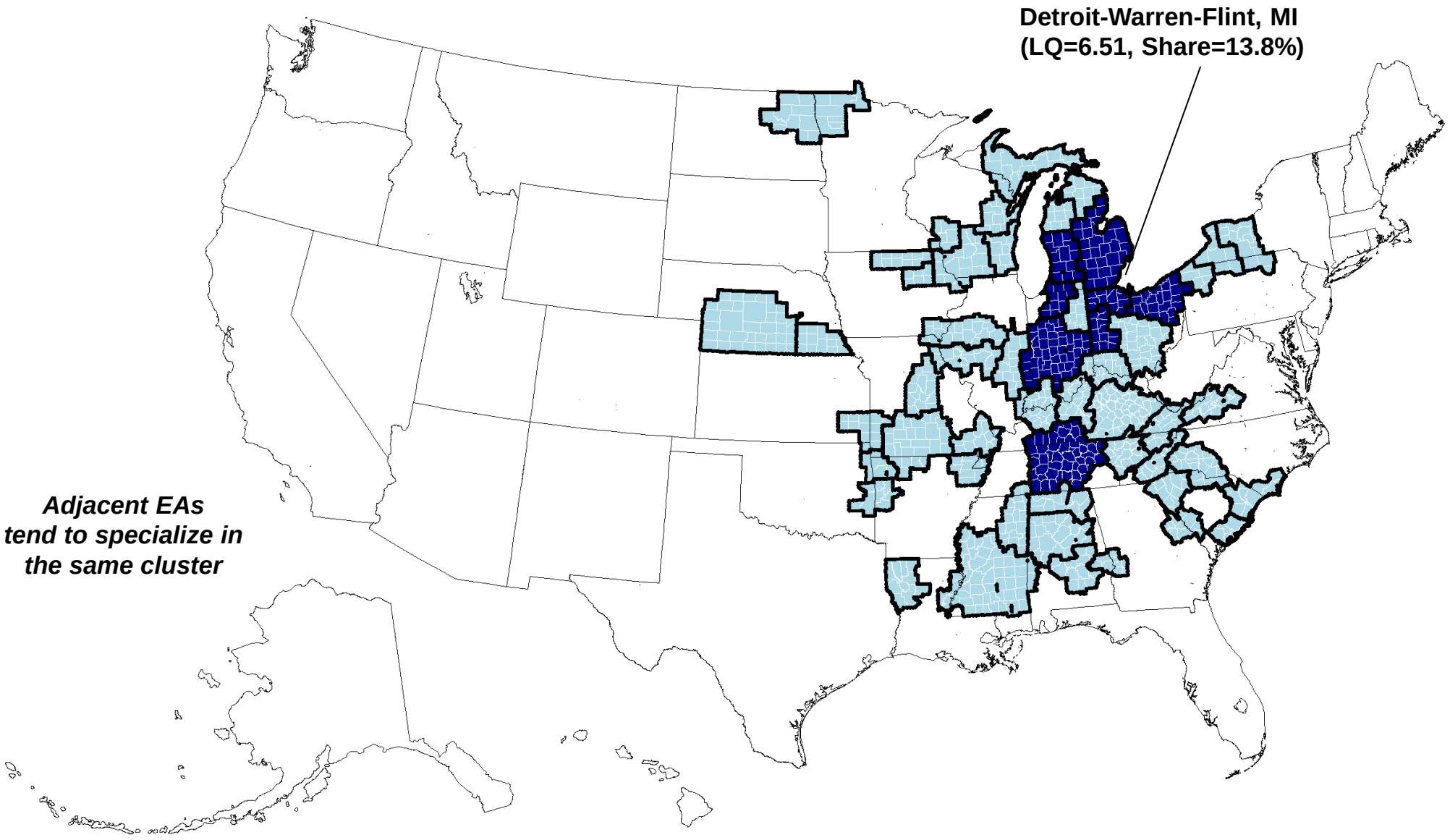
Automotive Cluster Specialization
by Economic Area



Regions with high cluster specialization and high share of US employment (LQ>1.3 and top 10 employment)

Regions with high cluster specialization and moderate share (LQ>1.3 and cluster employment > 1000)

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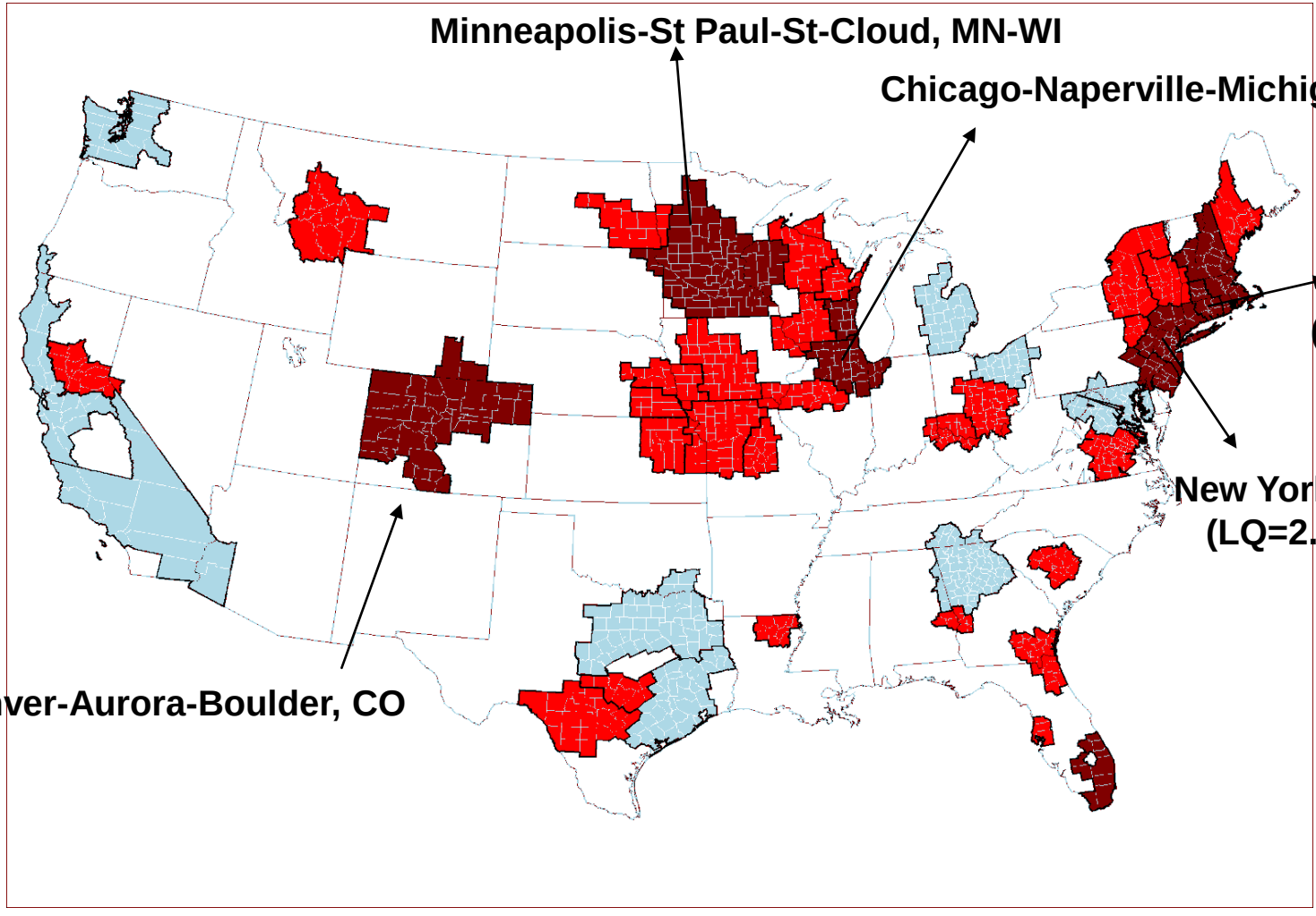
Financial Services Clusters by Economic Areas, 1997



Regions with high share of US financial services employment (in top 10% of all regions; share>2.5%) & high cluster specialization (LQ>1.01)

Regions with high cluster specialization (LQ>1.03 ; $LQ_{c,r} > LQ_c$ 80-th Percentile)

Weak clusters with large employment size in high population areas

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Clusters and Regional Prosperity: Leveraging the CMP data

- **Using a mix of databases:**
  - CMP, County Business Patterns (CBP) data, Census Bureau Longitudinal Business Database (LBD), USPTO data
- **Clusters, Jobs, Wages and Innovation**
  - "Clusters, Convergence and Economic Performance," Mercedes Delgado, Michael E. Porter and Scott Stern, CES WP
- **Clusters and New Business Creation**
  - "Clusters and Entrepreneurship," Mercedes Delgado, Michael E. Porter and Scott Stern, JOEG 2010
- **Evaluating U.S. Cluster Performance**
  - Using the CMP data, we can examine the cluster composition of regions: what are the strong clusters in a region? Which ones are creating jobs/innovations?

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Clusters and Region-industry Growth in Employment, Patents, Establishments

$$\ln\left(\frac{y_{ir2005}}{y_{ir1990}}\right) = \alpha_0 + \delta \ln(\text{Industry Spec}_{ir,1990}) +$$
$$\beta_1 \ln(\text{Cluster Spec})^{\text{outside i}}_{icr,1990} + \beta_2 \ln(\text{Related Clusters Spec}^{\text{outside c}}_{cr,1990}) +$$
$$\beta_3 \ln(\text{Cluster Spec in Neighbors}_{cr,1990}) + \alpha_i + \alpha_r + \varepsilon_{icr,t}.$$

- Dep. variable is the EA-industry (ir) growth rate in y (employment/patents/…)
  - E.g., Pharmaceutical preparations industry in Raleigh-Durham-Cary (NC) EA
- Two types of explanatory variables (based on y):

  Convergence (δ): Specialization of the EA in the industry
  Agglomeration (β): Cluster environment for the focal EA-industry:
  - Specialization of the EA in the cluster (β_1) and in related clusters (β_2) and strength of neighboring clusters (β_3)
  - E.g., Strength of the biopharmaceutical and related clusters (Medical devices, Analytical instruments) in the EA and strength of biopharma cluster in adjacent EAs

- Controls: Industry and EA FEs (α_i , α_r)

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Clusters and Region-industry Growth in Employment, Patents, Establishments

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- For all measures of economic performance (employment, patents, establishments), we find that
  - Convergence ($\delta<0$)
  - Cluster-driven agglomeration benefits ($\beta> 0$)
    - **Regional Industries in stronger clusters are associated with higher growth**
    - The positive impact of clusters on region-industry employment growth does not come at the expense of innovation, investments or wages but enhances them

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Clusters and Region-industry Wage Growth

$$\ln\left(\frac{\text{Wage}_{ir2005}}{\text{Wage}_{ir1990}}\right) = \alpha_0 + \delta \ln(\text{Industry Wage}_{i,r,1990}) +$$
$$\beta_1 \ln(\text{Cluster Wage}^{\text{outside i}}_{c,r,1990}) + \beta_2 \ln(\text{Related Clusters Wage}^{\text{outside c}}_{c,r,1990}) +$$
$$\beta_3 \ln(\text{Cluster Wage in Neighbors}_{c,r,1990}) + \alpha_i + \alpha_r + \varepsilon_{i,c,r,t}.$$

- Findings:
  - Convergence ($\delta < 0$)
  - **Cluster-driven wage growth** ($\beta > 0$):
    - Wages in the cluster ($\beta_1 > 0$) and in neighboring clusters ($\beta_3 > 0$)
    - **The "productivity" of the cluster influences the "productivity" growth of the industries within the cluster**

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Clusters and Creation of New Regional Industries 1990-2005

$$\text{New EA-industry}_{ir2005} = \alpha_0 + \beta_1 \ln(\text{Cluster Spec}_{c,r,1990}) + \beta_2 \ln(\text{Related Clusters Spec}^{\text{outside c}}_{c,r,1990}) + \beta_3 \ln(\text{Cluster Spec in Neighbors}_{c,r,1990}) + \alpha_i + \alpha_r + \varepsilon_{i,c,r,t}.$$

- Sample: EA-industries non existing (zero employment) in the base year (1990)
- We examine the probability of the creation of a new EA-industry as of 2005
- Findings: $\beta>0$
  - **New regional industries emerge in regions with a stronger cluster environment**

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Clusters and Regional Growth

$$\ln\left(\frac{\text{Employ}_{r,2005}}{\text{Employ}_{r,1990}}\right)^{\substack{\text{Outside}\\ \text{strong clusters}}} = \alpha_0 + \delta \ln(\text{Employ}^{\substack{\text{Outside}\\ \text{strong clusters}}}_{r,1990}) + \beta \text{Reg Cluster Strength}_{r,1990}$$

$$+ \lambda \text{National Employ Growth}^{\text{Strong clusters}}_{r,1990-05} + \alpha_{\text{Census Region}} + \varepsilon_r .$$

- Findings (β> 0)
- The **set of strong traded clusters in a region contribute to the employment growth of other activities** in that region
- Same findings for regional **patent** and **wage growth**

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Clusters and Entrepreneurship, JOEG, 2010

- This paper focuses on **early stage entrepreneurship**, using two indicators of **start-up activity:**
  - count of new establishments by new firms in a EA-industry (i.e., **start-up establishments**), and the
  - employment in these new firms (i.e., **start-up employment**)

- We then compute the **growth rate in start-up activity** in regional industries

$$\ln\left(\frac{y_{irt}}{y_{irt_0}}\right) = \alpha_0 + \delta \ln(y_{ir,t_0}) + \beta \ln(\text{Cluster Environment})_{icr,t_0} + \alpha_i + \alpha_r + \varepsilon_{icr,t}.$$

- We find that the **strength of the cluster environment contributes to**
  - **higher growth in new businesses formation** in EA-industry
  - **higher growth in employment in new businesses** in EA-industry
  - **higher survival rates of new business** in EA-industry

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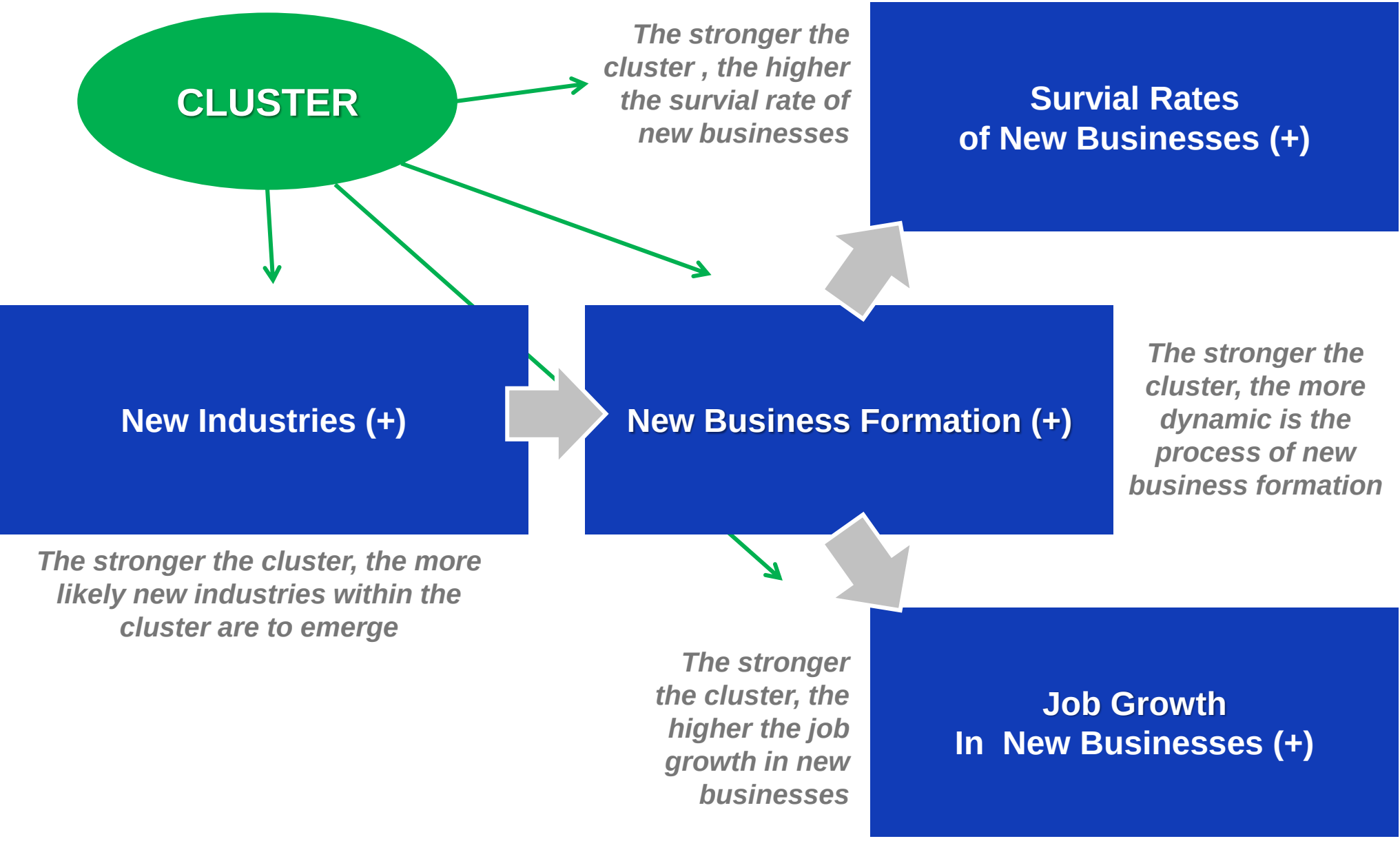
Clusters and Economic Outcomes: Entrepreneurship

The Evidence



Source: Porter, The Economic Performance of Regions, Regional Studies, 2003; Delgado/Porter/Stern, Clusters and Entrepreneurship, Journal of Economic Geography, 2010; Delgado/bPorter/Stern, Clusters, Convergence, and Economic Performance, mimeo., 2010.

Productivity Depends on How a State Competes, Not What Industries It Competes In

State	State Traded Wage versus National Average	Cluster Mix Effect	Relative Cluster Wage Effect
Connecticut	+27,171	7,028	20,142
New York	+24,102	3,628	20,474
Massachusetts	+16,169	4,391	11,778
New Jersey	+13,535	3,761	9,774
California	+9,573	349	9,224
Maryland	+6,651	2,496	4,155
Washington	+5,652	2,692	2,960
Virginia	+5,319	1,617	3,702
Illinois	+2,658	16	2,642
Colorado	+1,662	2,416	-754
Texas	+352	2,494	-2,142
Delaware	+164	11,060	-10,896
Alaska	-930	-2,417	1,487
Pennsylvania	-3,970	-995	-2,975
Louisiana	-4,280	95	-4,375
Georgia	-5,322	-1,102	-4,220
Minnesota	-5,576	-425	-5,150
New Hampshire	-6,387	374	-6,761
Arizona	-7,021	1,149	-8,169
Kansas	-7,705	2,241	-9,946
Wyoming	-8,057	1,040	-9,097
Michigan	-8,176	-2,544	-5,633
North Carolina	-9,245	-4,330	-4,915
Ohio	-9,284	-2,495	-6,788
Rhode Island	-9,791	-2,290	-7,501

State	State Traded Wage versus National Average	Cluster Mix Effect	Relative Cluster Wage Effect
Oregon	-10,359	-1,304	-9,056
Missouri	-10,427	-1,425	-9,002
Alabama	-10,934	-3,563	-7,371
Florida	-11,007	-1,559	-9,448
Wisconsin	-11,722	-3,516	-8,206
Nebraska	-11,777	241	-12,018
Utah	-11,992	2,072	-14,064
Tennessee	-12,172	-3,156	-9,016
Indiana	-12,554	-4,840	-7,714
Vermont	-13,368	-1,572	-11,796
Oklahoma	-13,572	497	-14,069
Nevada	-14,277	-2,365	-11,911
North Dakota	-14,394	1,004	-15,397
South Carolina	-15,276	-5,067	-10,209
Arkansas	-15,378	-4,560	-10,818
Hawaii	-16,043	-12,555	-3,487
New Mexico	-16,123	-288	-15,835
Kentucky	-16,215	-5,024	-11,191
Maine	-16,379	-968	-15,412
Iowa	-16,606	-2,721	-13,885
West Virginia	-16,645	-3,894	-12,751
Idaho	-18,671	-787	-17,884
Mississippi	-19,942	-5,291	-14,651
Montana	-20,073	-2,259	-17,815
South Dakota	-20,968	289	-21,257

On average, cluster strength is much more important (78.1%) than cluster mix (21.9%) in driving regional performance in the U.S.

Source: Prof. Michael E. Porter, Cluster Mapping Project, Institute for Strategy and Competitiveness, Harvard Business School; Richard Bryden, Project Director. 2009 data.

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Cluster Efforts Enhancing Competitiveness: The Case for Action

- Agglomeration largely driven by business environment conditions and 'automatic' cluster effects **in a market process**

BUT

- Exploitation of localized spill-overs **not automatic**
- Exploration of opportunities for joint action **not automatic**

- Cluster efforts enable locations to **benefit more from what they have**

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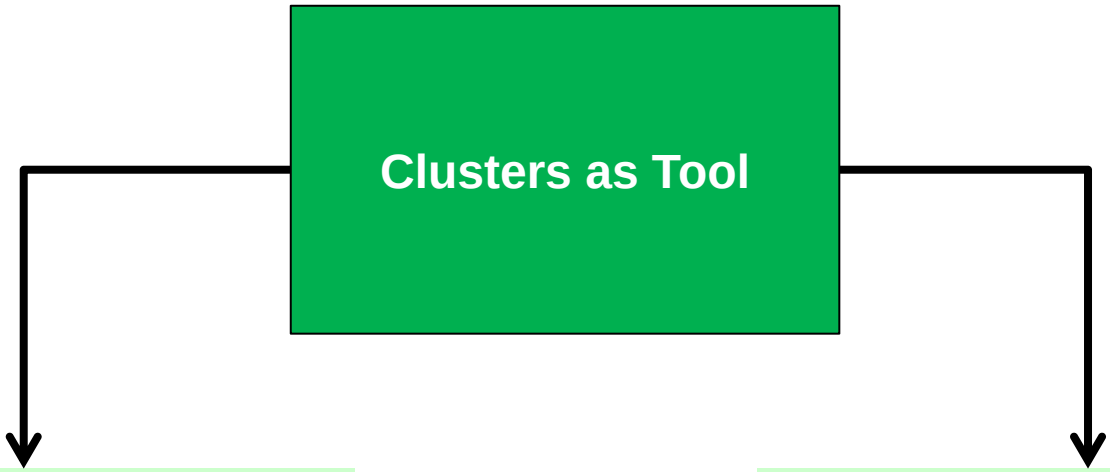
Cluster Efforts Enhancing Competiveness

Creating Positive Feed-Back Loops



Better Actions

Cluster initiatives provide a platform to discuss necessary improvements in competitiveness at the level where firms compete

More Impact

The organization of economic policies around clusters leverages positive spill-overs and mobilizes private sector co-investment

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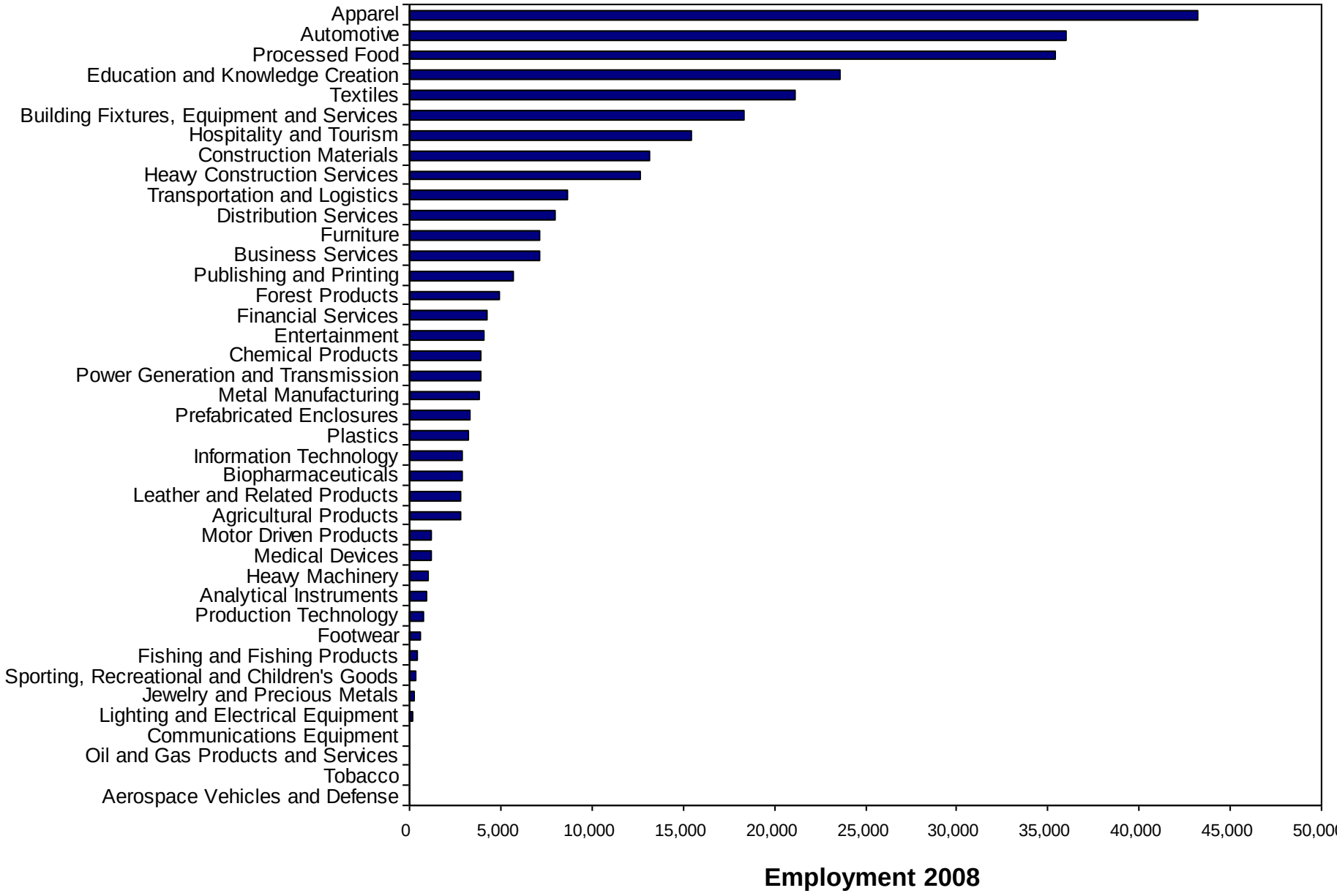
Puebla Employment in Traded Clusters



Source: Mexico Censos 2009; Prof. Michael E. Porter, Cluster Mapping Project, Harvard Business School; Richard Bryden, Project Director. Contributions by Prof. Niels Ketelhohn.

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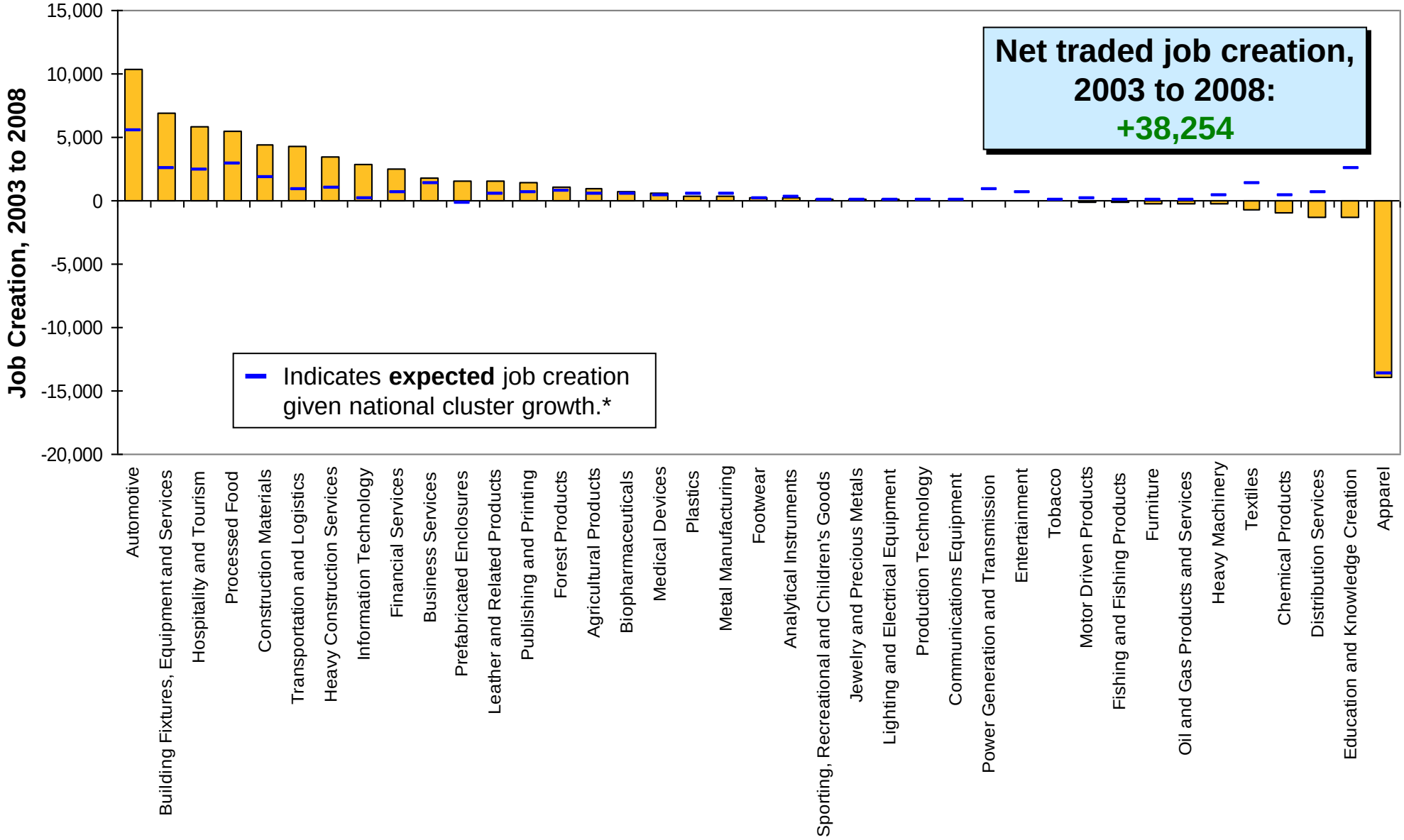
Puebla Job Creation in Traded Clusters

2003 to 2008



* Percent change in national benchmark times starting regional employment. Overall traded job creation in the state, if it matched national benchmarks, would be +15,863

Source: Prof. Michael E. Porter, Cluster Mapping Project, Institute for Strategy and Competitiveness, Harvard Business School; Richard Bryden, Project Director. Contributions by Prof. Niels Ketelhohn.

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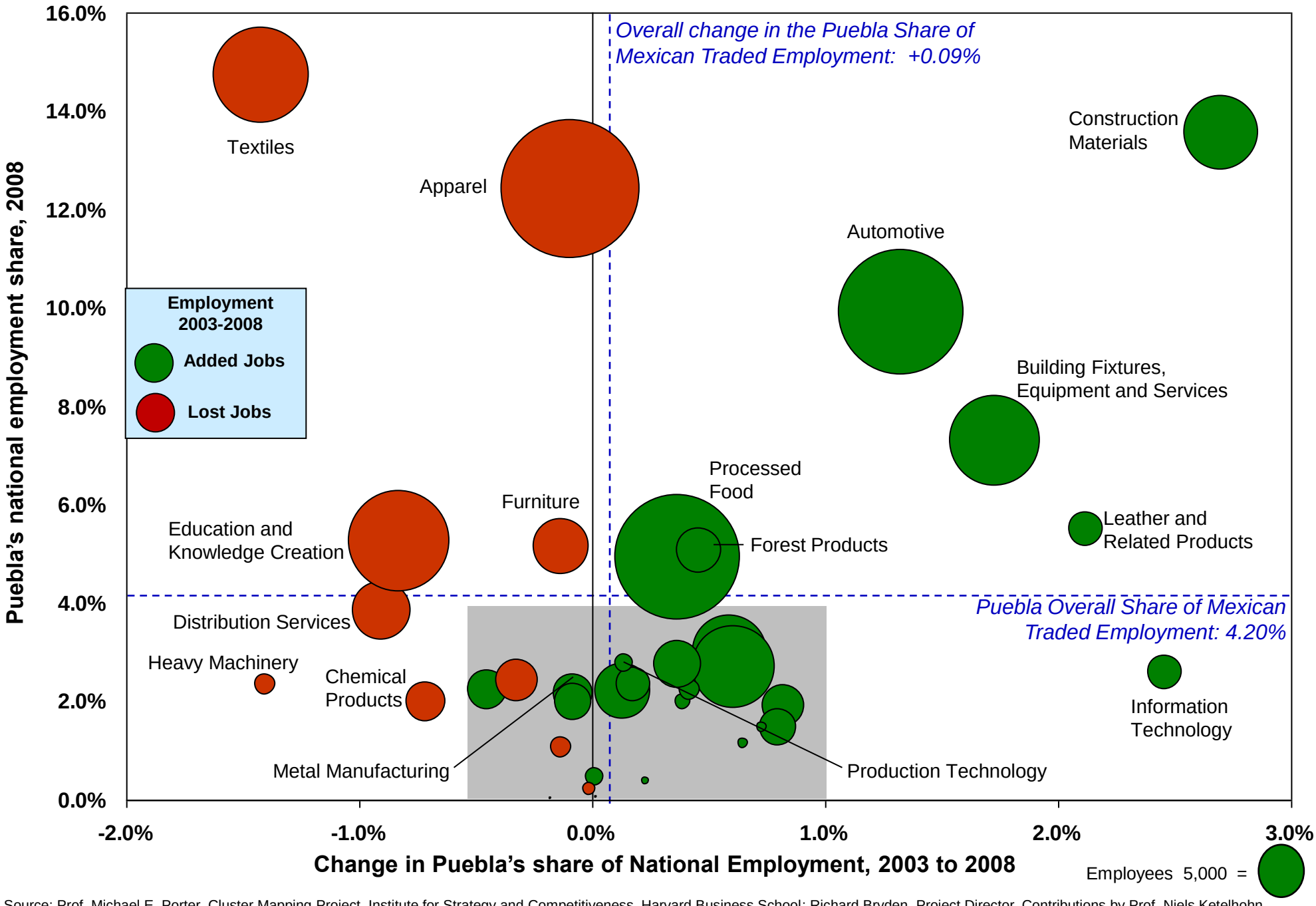
Traded Cluster Composition of the Puebla Economy



Source: Prof. Michael E. Porter, Cluster Mapping Project, Institute for Strategy and Competitiveness, Harvard Business School; Richard Bryden, Project Director. Contributions by Prof. Niels Ketelhohn.

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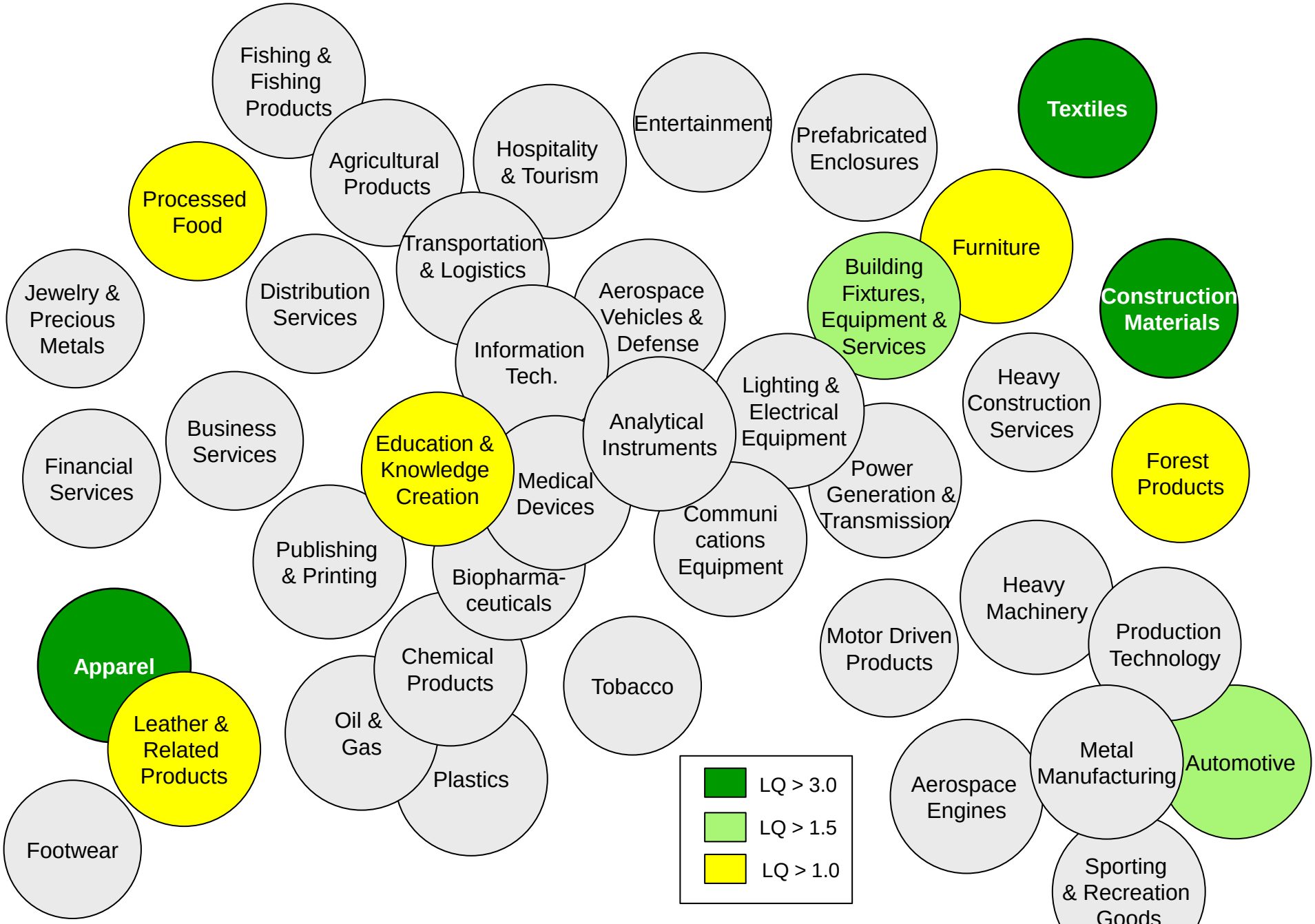
Puebla Cluster Portfolio, 2008



LQ, or Location Quotient, measures the state's share in cluster employment relative to its overall share of Mexican employment. An LQ > 1 indicates an above average employment share in a cluster.

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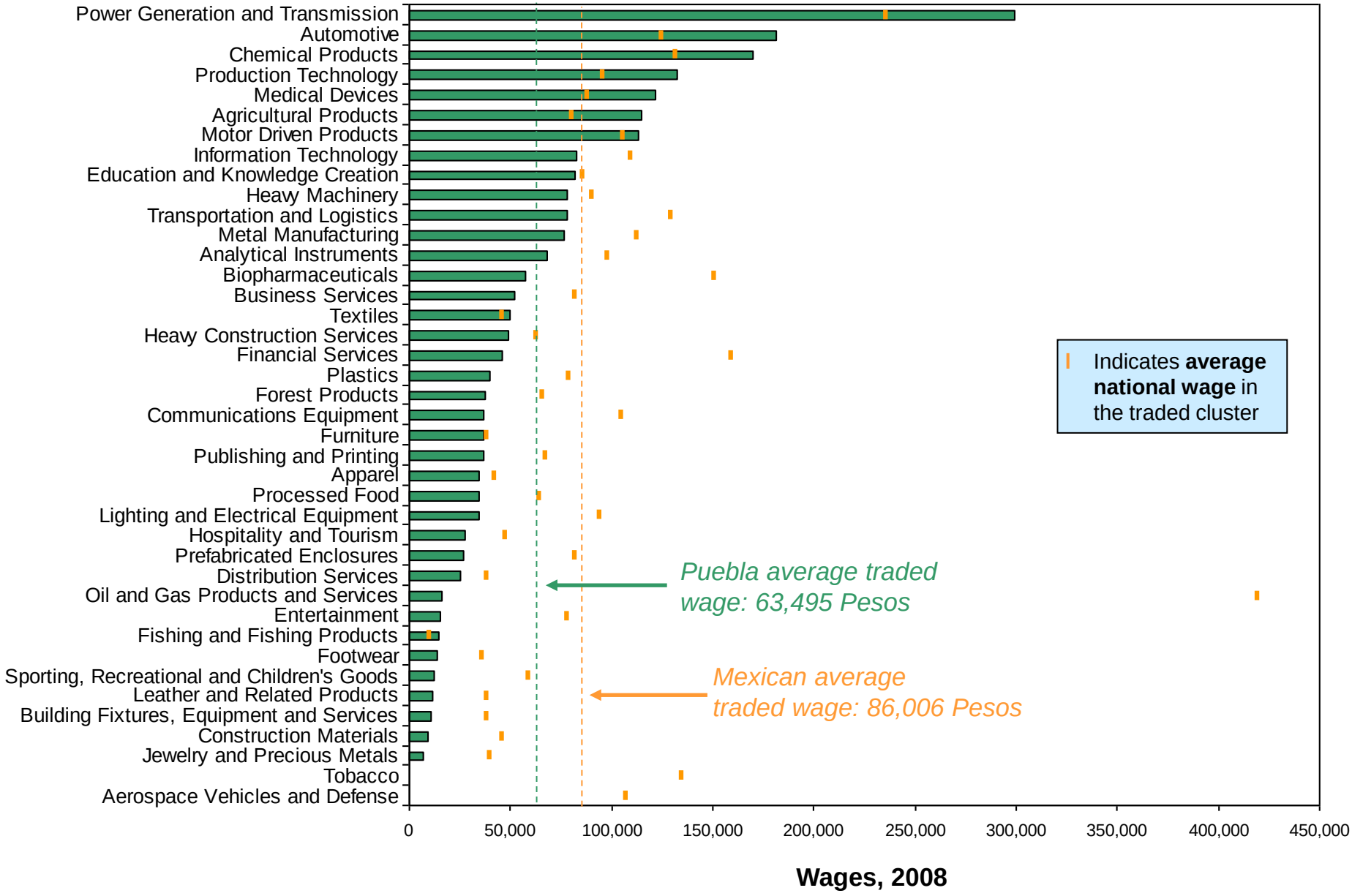
Puebla Wages in Traded Clusters
vs. National Benchmarks



Source: Prof. Michael E. Porter, Cluster Mapping Project, Institute for Strategy and Competitiveness, Harvard Business School; Richard Bryden, Project Director. Contributions by Prof. Niels Ketelhohn.

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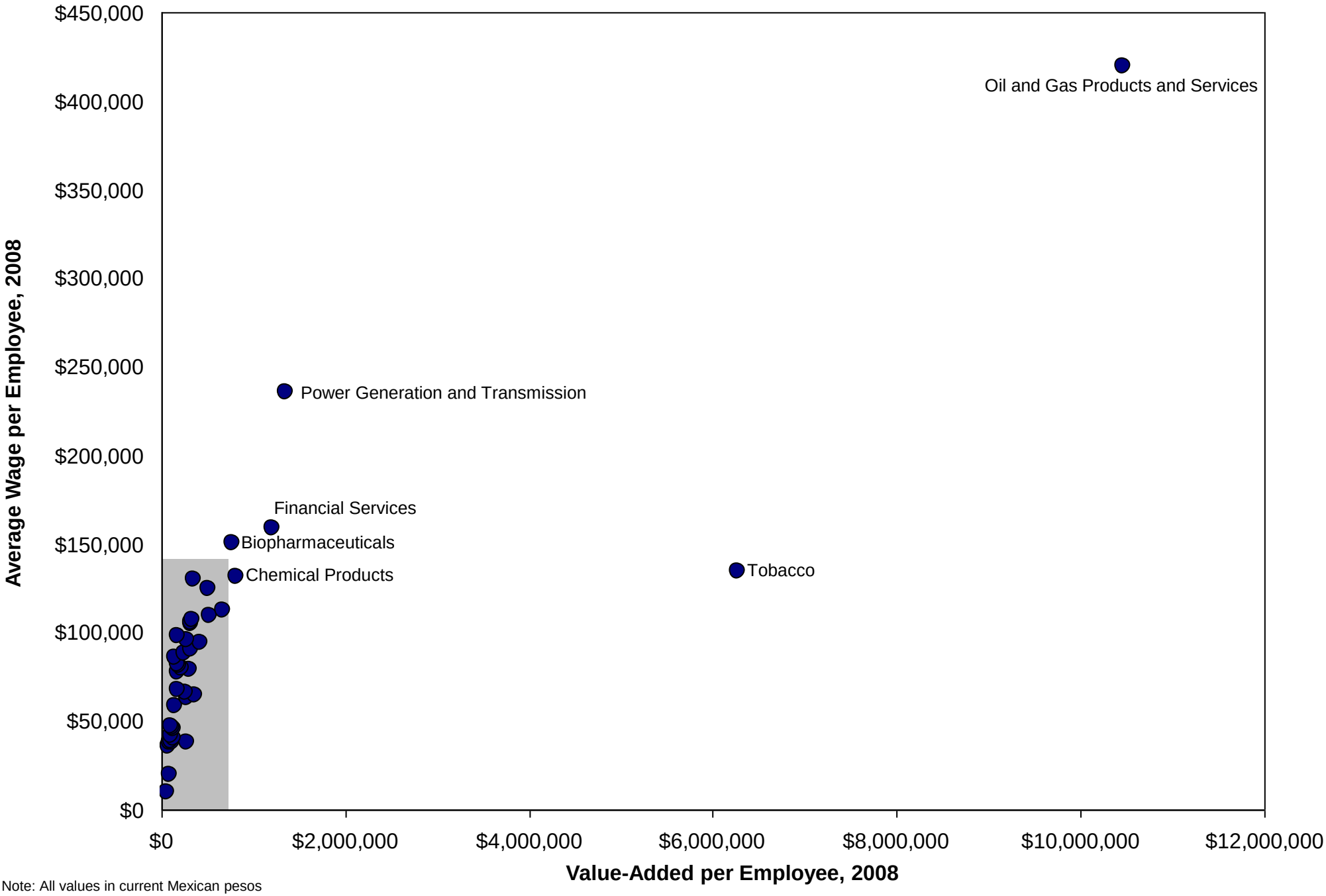
Mexico Value-Added and Wage Levels in Traded Clusters



Note: All values in current Mexican pesos

Source: Mexico Censos 2009; Prof. Michael E. Porter, Cluster Mapping Project, Harvard Business School; Richard Bryden, Project Director. Contributions by Prof. Niels Ketelhohn.

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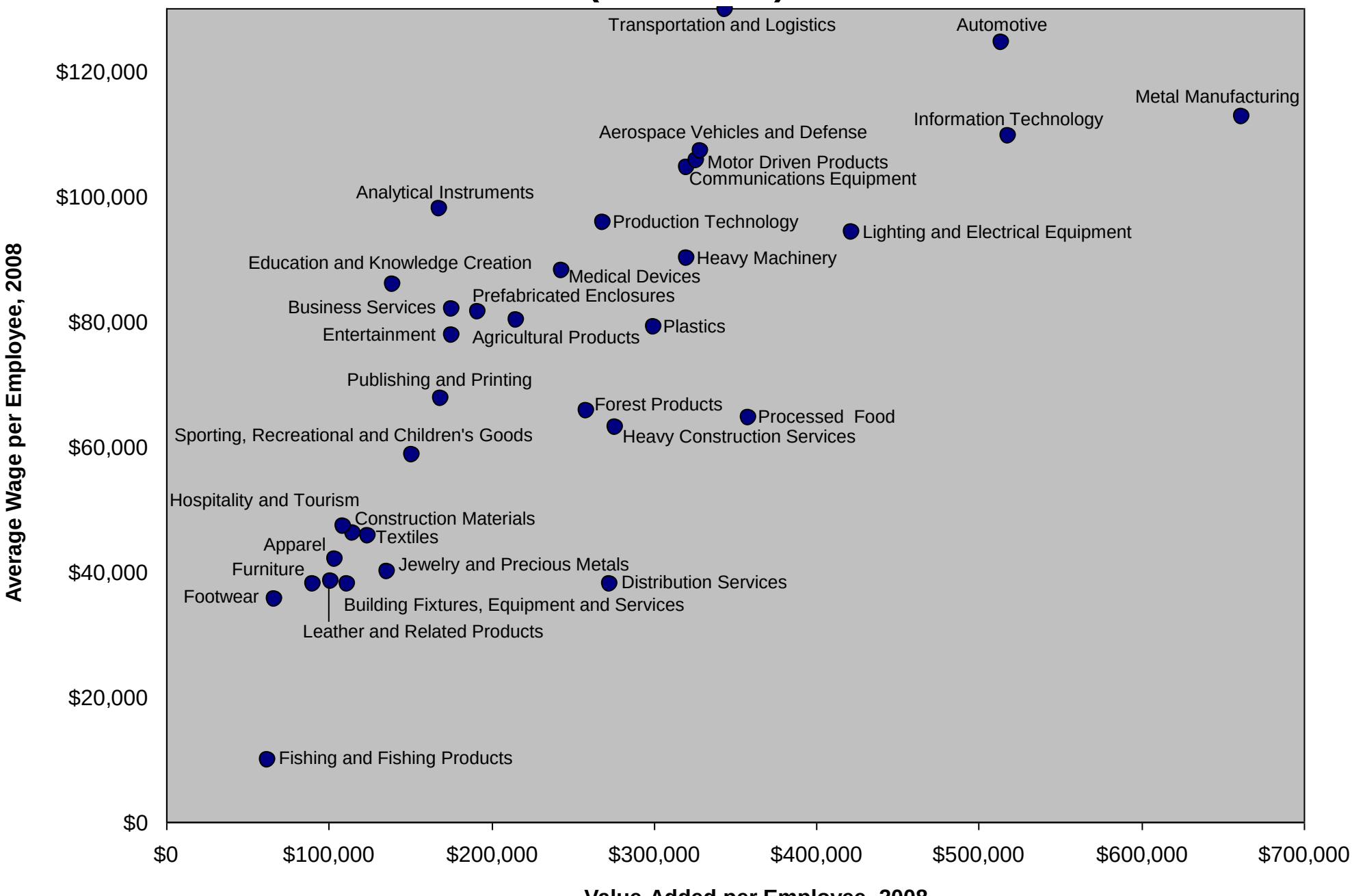
Mexico Value-Added and Wage Levels in Traded Clusters (continued)



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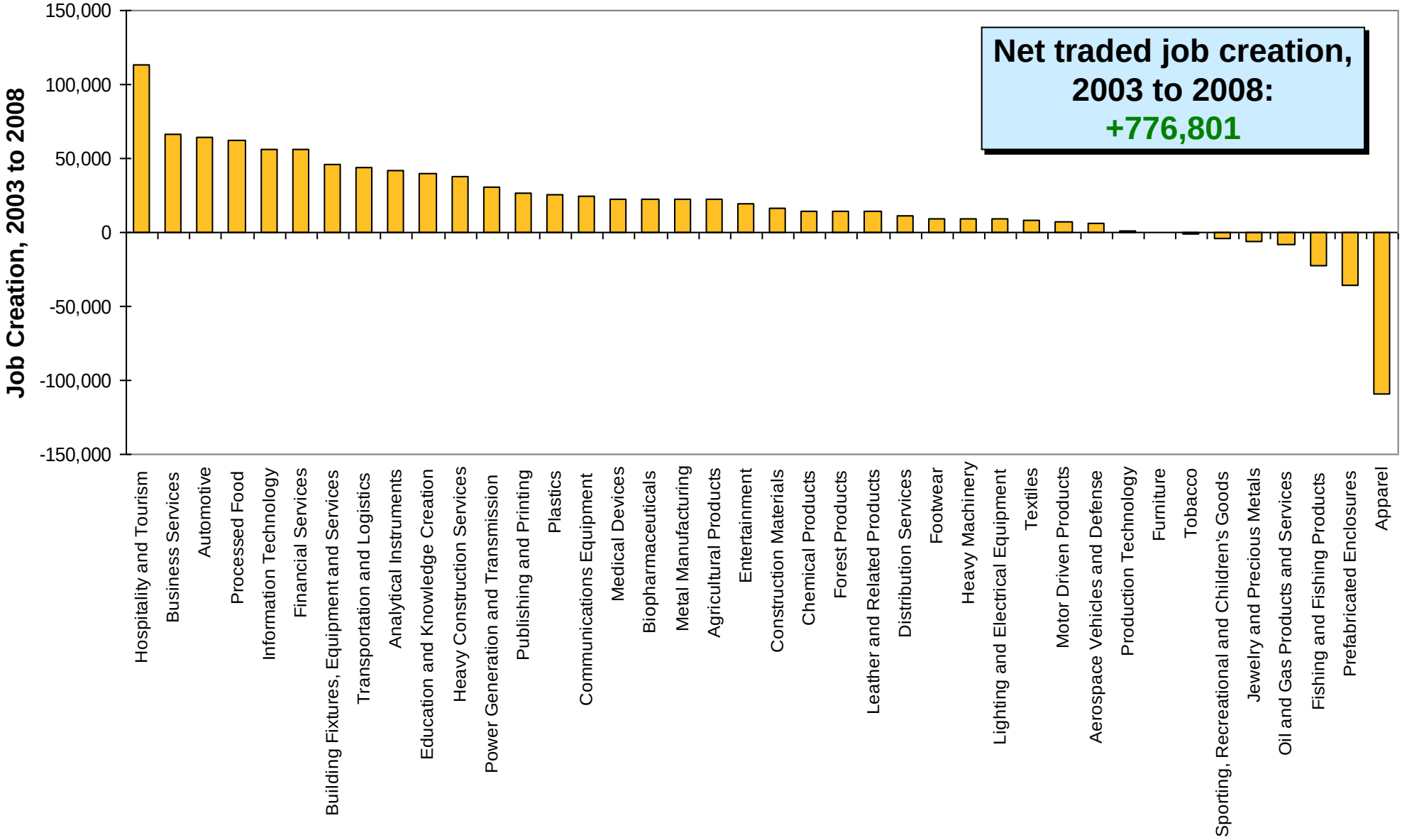
Mexico Job Creation in Traded Clusters

2003 to 2008



Source: Prof. Michael E. Porter, Cluster Mapping Project, Institute for Strategy and Competitiveness, Harvard Business School; Richard Bryden, Project Director. Contributions by Prof. Niels Ketelhohn.

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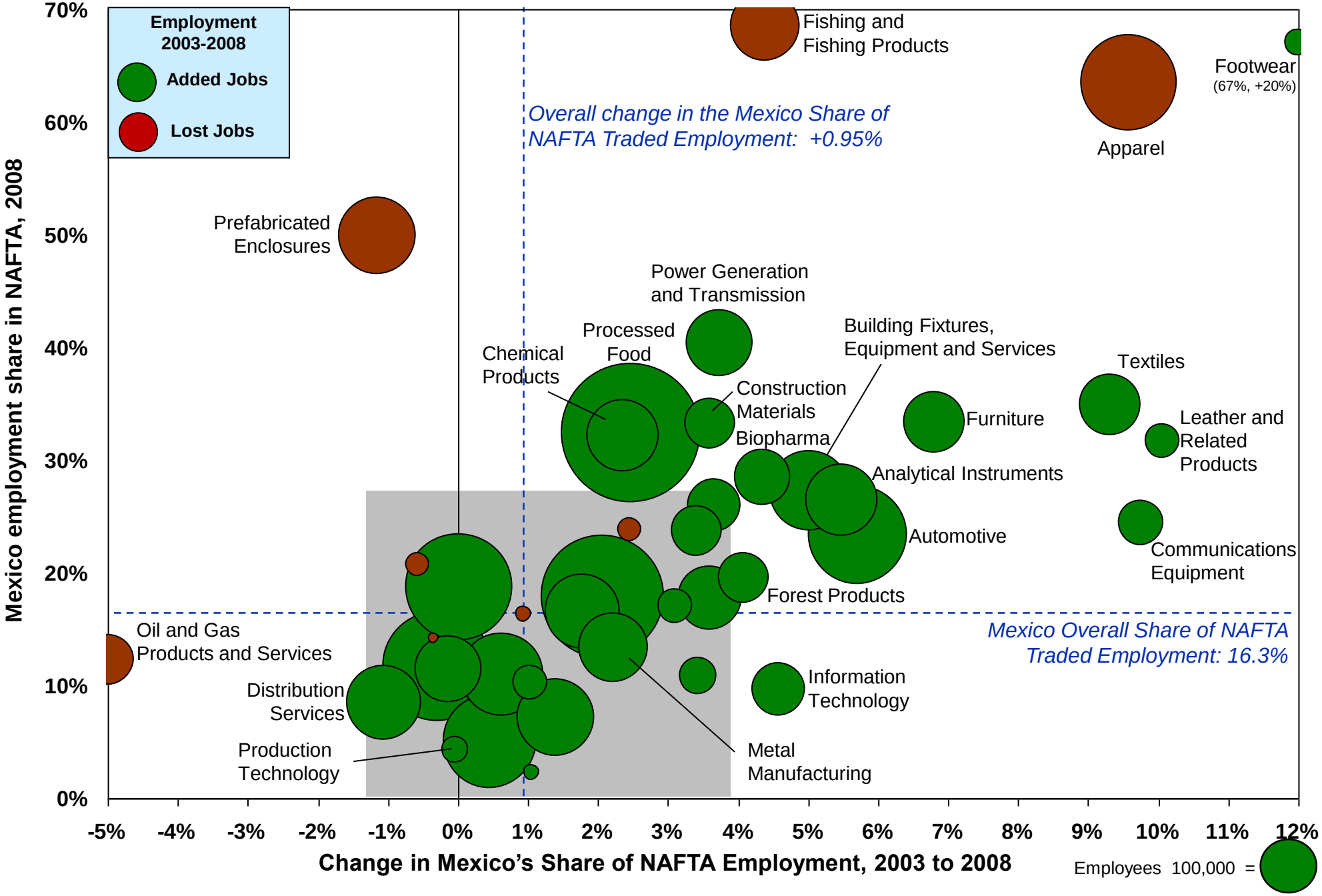
Mexico Traded Cluster Specialization within NAFTA



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Gracias

Please see: www.isc.hbs.edu/econ-clusters.htm
www.isc.hbs.edu/econ-natlcomp.htm

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