Regional Foundations of Competitiveness

Issues for Wales

Professor Michael E. Porter
Institute for Strategy and Competitiveness
Harvard Business School

Future Competitiveness of Wales: Innovation, Entrepreneurship, and Technological Change
Wales (by video link)
April 3rd, 2002

Agenda

• Foundations of Competitiveness

• The Role of Regions in Competitiveness

• Issues for Wales
Sources of Rising Prosperity

• A region’s standard of living (wealth) is determined by the **productivity** with which it uses its human, capital, and natural resources. The appropriate definition of competitiveness is **productivity**
  
  – Productivity depends both on the **value** of products and services (e.g. uniqueness and quality) as well as the **efficiency** with which they are produced

  – It is not **what** industries a region competes in that matters for prosperity, but **how** firms compete in those industries

  – Productivity in a region is a reflection of what both domestic and foreign firms **choose to do in that location**. The location of ownership is secondary for national prosperity

  – The productivity of “**local**” industries is of fundamental importance to competitiveness, not just that of traded industries

• Regions compete in offering the **most productive environment** for business

• The public and private sectors play **different but interrelated roles** in creating a productive economy
Innovation and Prosperity

- Innovation is more than just scientific discovery
- There are no low-tech industries, only low-tech firms
Determinants of Productivity and Productivity Growth

Macroeconomic, Political, Legal, and Social Context for Development

Microeconomic Foundations of Development

- Sophistication of Company Operations and Strategy
- Quality of the Microeconomic Business Environment

- Sound macroeconomic policies, a stable political environment, a trusted legal framework and progress in improving social conditions are necessary to ensure a prosperous economy, but not sufficient
- Competitiveness ultimately depends on improving the microeconomic foundations of competition
Productivity and the Microeconomic Business Environment

Context for
Firm
Strategy
and Rivalry

- A local context that encourages efficiency, investment, and sustained upgrading
- Open and vigorous competition among locally based rivals

Factor (Input) Conditions

- High quality, specialized inputs available to firms:
  - human resources
  - physical infrastructure
  - administrative infrastructure
  - information infrastructure
  - scientific and technological infrastructure
  - capital resources
  - natural resources

Demand Conditions

- Sophisticated and demanding local customer(s)
- Unusual local demand in specialized segments that can be served globally
- Customer needs that anticipate those elsewhere

Related and Supporting Industries

- Presence of capable, locally-based suppliers and firms in related fields
- Presence of clusters instead of isolated industries
Clusters and Competitiveness
The California Wine Cluster

Sources: California Wine Institute, Internet search, California State Legislature. Based on research by MBA 1997 students R. Alexander, R. Arney, N. Black, E. Frost, and A. Shivananda.
Clusters and Competitive Advantage

• Current Productivity / Efficiency

• Innovation and Productivity Growth

• New Business Formation

• Competitive advantage is fundamentally enhanced by externalities / linkages across firms, industries, and associated institutions
Institutions for Collaboration

**General**

- Chambers of Commerce
- Professional associations
- School networks
- University partner groups
- Religious networks
- Joint private/public advisory councils
- Competitiveness councils

**Cluster-specific**

- Industry associations
- Specialized professional associations and societies
- Alumni groups of core cluster companies
- Incubators

- Institutions for Collaboration (IFCs) are **formal and informal organizations** that
  - facilitate the exchange of information and technology
  - foster cooperation and coordination
- IFCs can improve the business environment by
  - creating **relationships** and the level of trust supporting them
  - encourage the definition of **common standards**
  - facilitate the organization of **collective action**
  - support the definition and communication of **beliefs and attitudes**
  - providing mechanisms to develop a common economic or **cluster agenda**
## Institutions for Collaboration
### Selected Institutions for Collaboration in San Diego

#### Private Sector
- UCSD CONNECT
- San Diego Chamber of Commerce
- San Diego MIT Enterprise Forum
- Corporate Director’s Forum
- San Diego Dialogue
- Service Corps of Retired Executives, San Diego

#### Joint Private / Public
- San Diego Regional Economic Development Corporation
- Center for Applied Competitive Technologies
- San Diego World Trade Center

#### Informal Networks
- Linkabit Alumni
- Hybritech Alumni
- UCSD Alumni
- Scripps Research Institute Alumni

#### Public Sector
- San Diego Association of Governments
- San Diego Regional Technology Alliance
- San Diego Science and Technology Council
- Office of Trade and Business Development
- Small Business Development and International Trade Center

Source: Clusters of Innovation project (www.compete.org)
Agenda

- Foundations of Competitiveness
- The Role of Regions in Competitiveness
- Issues for Wales
## Regional Economic Performance Measures

### Overall Economy

<table>
<thead>
<tr>
<th>Category</th>
<th>Measure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Employment Growth</td>
<td>Rate of employment growth</td>
</tr>
<tr>
<td>Unemployment</td>
<td>Percentage of persons unemployed</td>
</tr>
<tr>
<td>Workforce Participation</td>
<td>Proportion of population in the workforce</td>
</tr>
<tr>
<td>Average Wages</td>
<td>Payroll per person</td>
</tr>
<tr>
<td>Wage Growth</td>
<td>Growth rate of payroll per person</td>
</tr>
<tr>
<td>Cost of Living</td>
<td>Cost of living index</td>
</tr>
<tr>
<td>Productivity</td>
<td>Output per employee or total factor productivity</td>
</tr>
<tr>
<td>Exports</td>
<td>Value of manufactured and commodity exports per worker</td>
</tr>
</tbody>
</table>

### Innovation Output

<table>
<thead>
<tr>
<th>Category</th>
<th>Measure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patents</td>
<td>Number of patents and patents per worker</td>
</tr>
<tr>
<td>Establishment Formation</td>
<td>Growth rate of establishments</td>
</tr>
<tr>
<td>Venture Capital Investments</td>
<td>Value of venture capital invested</td>
</tr>
<tr>
<td>Initial Public Offerings</td>
<td>Number of initial public offerings</td>
</tr>
<tr>
<td>Fast Growth Firms</td>
<td>Number of firms on the Inc. 500 list</td>
</tr>
<tr>
<td>Productivity growth</td>
<td>Growth in output per employee or total factor productivity</td>
</tr>
</tbody>
</table>
# Regional Economic Performance Measures

## State of Michigan

### Overall Economy

<table>
<thead>
<tr>
<th>Measure</th>
<th>Michigan</th>
<th>US</th>
<th>Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>Employment growth per year, 1990 to 1999</td>
<td>1.77%</td>
<td>1.90%</td>
<td>34</td>
</tr>
<tr>
<td>Average wages in 1999</td>
<td>$34,607</td>
<td>$32,109</td>
<td>11</td>
</tr>
<tr>
<td>Wage growth per year, 1990 to 1999</td>
<td>3.97%</td>
<td>4.03%</td>
<td>22</td>
</tr>
<tr>
<td>Gross state product per employee in 1999</td>
<td>$55,511</td>
<td>$56,882</td>
<td>19</td>
</tr>
<tr>
<td>Annual growth in exports, 1995-1999</td>
<td>2.83%</td>
<td>4.41%</td>
<td>32</td>
</tr>
</tbody>
</table>

### Innovation Output

<table>
<thead>
<tr>
<th>Measure</th>
<th>Michigan</th>
<th>US</th>
<th>Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patents per 10,000 employees</td>
<td>8.8</td>
<td>6.3</td>
<td>13</td>
</tr>
<tr>
<td>Patents growth per year, 1990 to 1998</td>
<td>2.64%</td>
<td>3.19%</td>
<td>37</td>
</tr>
<tr>
<td>New establishment formation, 1990 to 1999</td>
<td>4.55%</td>
<td>4.60%</td>
<td>27</td>
</tr>
<tr>
<td>Fast growth firms (Inc 500), 1991 to 2000</td>
<td>137</td>
<td>137</td>
<td>13</td>
</tr>
<tr>
<td>Venture capital investments, $ per worker, 1999</td>
<td>$13</td>
<td></td>
<td>38</td>
</tr>
<tr>
<td>Initial public offering proceeds per 1,000 firms, 1999</td>
<td>$6,982</td>
<td></td>
<td>11</td>
</tr>
</tbody>
</table>

Note: 1 Excludes government and agricultural employment. 2 Refers to the formation of establishments in traded industries, competing across regions.

## Patents by Organization
### Research Triangle MSA, 1995–1999

<table>
<thead>
<tr>
<th>Organization</th>
<th>Patents Issued from 1995 to 1999</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 International Business Machines Corporation</td>
<td>495</td>
</tr>
<tr>
<td>2 Ericsson, Inc.</td>
<td>325</td>
</tr>
<tr>
<td>3 Becton, Dickinson and Company</td>
<td>128</td>
</tr>
<tr>
<td>4 North Carolina State University</td>
<td>128</td>
</tr>
<tr>
<td>5 Duke University</td>
<td>127</td>
</tr>
<tr>
<td>6 University of North Carolina — Chapel Hill</td>
<td>124</td>
</tr>
<tr>
<td>7 Square D Company</td>
<td>48</td>
</tr>
<tr>
<td>8 Novartis</td>
<td>46</td>
</tr>
<tr>
<td>9 ABB Power T&amp;D Company, Inc.</td>
<td>44</td>
</tr>
<tr>
<td>10 Alcatel Network Systems, Inc.</td>
<td>43</td>
</tr>
<tr>
<td>11 Mitsubishi Semiconductor America, Inc.</td>
<td>41</td>
</tr>
<tr>
<td>12 Lord Corporation</td>
<td>36</td>
</tr>
<tr>
<td>13 Kennametal, Inc.</td>
<td>29</td>
</tr>
<tr>
<td>14 Rhone-Poulenc, Inc.</td>
<td>29</td>
</tr>
<tr>
<td>15 Telefonaktiebolaget LM Ericsson</td>
<td>28</td>
</tr>
<tr>
<td>16 Caterpillar, Inc.</td>
<td>26</td>
</tr>
<tr>
<td>17 Cree Research, Inc.</td>
<td>26</td>
</tr>
<tr>
<td>18 E.I. DuPont De Nemours and Company</td>
<td>26</td>
</tr>
<tr>
<td>19 MCNC</td>
<td>25</td>
</tr>
<tr>
<td>20 Raychem Corporation</td>
<td>24</td>
</tr>
<tr>
<td>21 Reichhold Chemicals, Inc.</td>
<td>24</td>
</tr>
<tr>
<td>22 American Sterilizer Company</td>
<td>21</td>
</tr>
<tr>
<td>23 Siemens Energy and Automation, Inc.</td>
<td>21</td>
</tr>
<tr>
<td>24 Northern Telecom Limited</td>
<td>20</td>
</tr>
<tr>
<td>25 Research Triangle Institute</td>
<td>20</td>
</tr>
</tbody>
</table>

# The Composition of Regional Economies
## United States

<table>
<thead>
<tr>
<th>Traded Clusters</th>
<th>Local Clusters</th>
<th>Natural Resource-Driven Industries</th>
</tr>
</thead>
<tbody>
<tr>
<td>Share of Employment, Employment Growth, 1993 to 1999</td>
<td>32.1%</td>
<td>67.1%</td>
</tr>
<tr>
<td>Employment Growth</td>
<td>2.5%</td>
<td>2.8%</td>
</tr>
<tr>
<td>Average Wage</td>
<td>$41,678</td>
<td>$26,049</td>
</tr>
<tr>
<td>Relative Wage</td>
<td>134.0</td>
<td>83.8</td>
</tr>
<tr>
<td>Wage Growth</td>
<td>5.0%</td>
<td>3.8%</td>
</tr>
<tr>
<td>Relative Productivity</td>
<td>144.1</td>
<td>79.3</td>
</tr>
<tr>
<td>Patents per 10,000 Employees</td>
<td>20.48</td>
<td>1.38</td>
</tr>
<tr>
<td>Number of SIC Industries</td>
<td>592</td>
<td>241</td>
</tr>
</tbody>
</table>

Note: 1999 data, except relative productivity which is 1997 data, and patents data which is 1998 data
Average Wages in Traded Clusters

United States, 1999

1999 Average Wage

$80,000

$60,000

$40,000

$20,000

$0

Cluster


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Specialization of Regional Economies
Selected U.S. Geographic Areas

Note: Clusters listed are the three highest ranking clusters in terms of share of national employment.
Specialization of Regional Economies
Pittsburgh Metropolitan Area

Percentage Share of National Cluster Employment in 1999

Prefabricated Enclosures
Agricultural Products
Automotive
Distribution Services
Financial Services
Hospitality and Tourism
Processed Food
Production Technology
Transportation and Logistics
Construction Services
Metal Manufacturing

Percentage Change of Share — 1990 to 1999

= 0–4,999
= 5,000–9,999
= 10,000–29,999
= 30,000+

Note: Uses narrow cluster definitions that assign industries uniquely to one cluster each; data points that fall outside the graph are placed on the borders with their values given in parentheses (share, change)
Specialization of Regional Economies
State of Kentucky

Tobacco (6.9, -33.8)

Automotive
Motor Driven Products
Chemical Products
Apparel
Plastics
Metal Manufacturing
Process Food
Production Technology
Transportation and Logistics
Footwear
Business Services

Kentucky’s Average Share = 1.33%

Note: Uses narrow cluster definitions that assign industries uniquely to one cluster each; data points that fall outside the graph are placed on the borders with their values given in parentheses (share, change).

Traditional Strengths of Atlanta Area
Job Creation by Cluster, 1990–1999

Largest Growth in Traded Clusters

76,705 Jobs Added
37,135 Jobs Added
Net Employment Change = +218,649

Largest Loss in Traded Clusters

Note: Uses narrow cluster definitions that assign industries uniquely to one cluster each
Top 10 Highest Wage Traded Clusters, 1999
State of Colorado

Average wage, all traded clusters, Colorado: $44,502

Number of Workers

Note: Graph utilizes narrow cluster definitions to eliminate overlapping employment across clusters.
## The Evolution of Regional Economies
### Research Triangle

<table>
<thead>
<tr>
<th>Building the Foundation</th>
<th>New Cluster Development</th>
<th>Innovation Expands</th>
</tr>
</thead>
<tbody>
<tr>
<td>U.S. Environmental Protection Agency opens field office</td>
<td>Troxler Electronics becomes the first locally based tenant at Research Triangle Park</td>
<td>BASF opens R&amp;D center</td>
</tr>
<tr>
<td>Research Triangle Park Founded</td>
<td>Microelectronics Center of North Carolina founded by the State</td>
<td>Union Carbide opens R&amp;D facility</td>
</tr>
<tr>
<td></td>
<td>Glaxo opens R&amp;D center</td>
<td>Rhone-Poulec acquires Union Carbide</td>
</tr>
<tr>
<td></td>
<td>Union Carbide establishes operations</td>
<td>Red Hat Software establishes operations</td>
</tr>
<tr>
<td></td>
<td>Sumitomo Electric Lightwave founded</td>
<td>Covance opens manufacturing facility</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Paradigm Genetics founded</td>
</tr>
</tbody>
</table>

- **1950s**
  - Alcatel establishes presence
  - IBM establishes manufacturing facility
  - National Institute of Environmental Health Sciences offered space at Research Triangle Park
  - Chemstrand establishes a fiber R&D facility
  - U.S. Forest Service establishes small lab

- **1960s**
  - Burroughs Wellcome comes to the Research Triangle
  - Bencton Dickson opens office

- **1970s**
  - 1971
    - 1973
      - Univers of North Carolina Lineberger Comprehensive Cancer Center founded
  - 1974
    - General Electric sets up research and manufacturing facility
  - 1975
    - Northern Telecom establishes U.S. subsidiary
    - Center for Advanced Computing and Communication established
  - 1980
    - Quintiles founded

- **1980s**
  - 1982
    - North Carolina Biotechnology Center founded by the State
  - 1983
    - Ciba-Geigy establishes Biotechnology Center
  - 1984
    - Glaxo opens R&D center
    - Paragon builds mfg. facility

- **1990s**
  - 1995
    - Biogen builds mfg. facility
  - 1996
    - Sas opens manufacturing facility
  - 1997
    - North Carolina Information Highway project begun throughout the State

Source: Clusters of Innovation project (www.compete.org)
The Military, Climate, and Research in San Diego

Source: Clusters of Innovation project (www.compete.org)
The Evolution of Regional Economies

• Building strong regional economies takes decades

• Key influencing factors include
  – Natural endowments
  – Government actions
  – Civic leadership
  – Entrepreneurship
  – Specialized assets

• Successful regions leverage their unique mix of assets to build specialized clusters

• Regional development involves some inheritance and serendipity, but also purposeful action

• Institutions for Collaboration play an important role in building regional economies

• A coherent strategy is an important prerequisite for effective action
Determinants of Regional Competitiveness

Levels of Influence

Context for Firm Strategy and Rivalry

Factor (Input) Conditions

Demand Conditions

Related and Supporting Industries

National
- E.g., Intellectual property legislation
- E.g., Monopolies policy

Regional
- E.g., Regional tax policy

Regional Cluster
- E.g., Number of local competitors

National
- E.g., Environmental regulation
- E.g., Consumer protection legislation

Regional
- E.g., State consumer protection laws

Regional Cluster
- E.g., Sophistication of local customers

National
- E.g., Financial market conditions

Regional
- E.g., Public education system
- E.g., Regional universities
- E.g., Communications infrastructure

Regional Cluster
- E.g., Cluster-specific research institutions

Regional
- E.g., Breadth of the regional economy
- E.g., Regional institutions for collaboration

Regional Cluster
- E.g., Presence of supplier industries
Regional Competitiveness and Innovative Capacity
Key Findings from the Clusters of Innovation Project

• A strong physical and information infrastructure is a baseline requirement to establish and sustain a prosperous regional economy

• A strong K–12 educational system is the foundation for developing local talent and attracting outside talent

• Specialized talent and training are more important than abundant labor

• Universities and specialized research centers are the driving force behind innovation in nearly every region

• Mechanisms for commercialization are essential if innovation is to translate to economic success

• Government can have a significant influence on the business environment, both positively and negatively

• Poor coordination among local jurisdictions often impedes efforts to improve the business environment

• Regions face the need for strategic transitions, when the limits of the past strategy create the need for a new strategy

The Development of Clusters
History of the San Diego Biotech / Pharma Cluster

1955
- Salk Institute Founded

1960
- Scripps Research Institute Founded

1976
- Burnham Institute Founded

1985
- UCSD Connect Founded

1991
- Biomedical Industry Council Founded

1992
- Nanogen Founded

1998
- Novartis Agricultural Discovery Institute Founded

1964
- UCSD Founded

1978
- Hybritech Founded

1986
- Hybritech Sold to Eli Lilly

1991
- Biocom Founded

Source: Clusters of Innovation project (www.compete.org)
Anchor Companies
Spin-outs in the San Diego Biotech / Pharma Cluster

Source: Clusters of Innovation project (www.compete.org), USCD CONNECT, University of California, San Diego
Opportunities at the Intersection of Clusters
Commonwealth of Massachusetts

Health

Information Technology

Medical Software

Networking

Medical Information Processing

Telecommunications

Tertiary Hospital Services

High Capacity Computers

Medical Devices

Software

Biopharmaceuticals

Universities

Universities

Medical Outcomes Measurement

Medical Research

Medical Research

Consulting

Think Tanks

Research Organization

Knowledge Creation

Consulting
Creating and Implementing a Regional Economic Strategy

Key Findings from the Clusters of Innovation Project

- A **shared economic vision** helps elicit broad support and coordinate activities.
- Strong **leadership** is a necessary part of any successful economic development strategy.
- **Broad-based collaboration** across business, government, universities, and other institutions is needed for development strategies to succeed.
- An overarching **organized structure for economic development** helps coordinate and routinize the process.
- Regions need to overcome **transition points** in the development of their economies.
- Economic strategy must explicitly address **inequality and economically distressed areas**.

Source: Clusters of Innovation project (www.compete.org)
Transitions in Economic Development
An Economic Vision for the Research Triangle

- **Research Triangle Park:**
  Original vision of increasing employment narrow geographic area

- **“High-tech” clusters:**
  Concentrate efforts and resources on supporting a few specific clusters in technologically-intensive fields

- **Metro Area:**
  Gathering scarce assets in a concentrated geographic area

- **New Strategy for the Region:**
  An updated strategy is now needed after the success of the initial model

- **Broader innovation economy:**
  Develop new and existing clusters

- **Economic Area:**
  Grow, attract, and support clusters relevant to a wider geographic region

Source: Clusters of Innovation project (www.compete.org)
Agenda

• Foundations of Competitiveness

• The Role of Regions in Competitiveness

• Issues for Wales
Welsh Economic Performance
Prosperity and Growth by UK Region

Per Capita Income, 2000

Annual Growth in Employment, 1996-2000

Source: Office for National Statistics

R² = 0.245
Welsh Economic Performance
Productivity Levels by UK Region

Source: Office for National Statistics
Welsh Innovation
Research & Development Activity by UK Region

The Top 2 regions account for 43% of all R&D expenditures but only 24% of employment

R&D per Employee, 1999

UK Average = 575

Source: Office for National Statistics; R&D includes business, government, and institutions of higher education
Composition of the Local and Traded Welsh Economy

Share of regional economy relative to UK average (LQ), 2000

Annual Growth in Employment, 1990-2000

Electricity, Gas and Water (-15.7%, 0.77)
Transport, Storage, and Communication
Financial Services
Manufacturing
Education
Agriculture
Hotels & Restaurants
Mining
Public Sector
Construction
Other Community Services
Health & Social Work
Business Services
Wholesale & Retail
Other Community Services

Source: Winning Wales, authors analysis

Source: Winning Wales, authors analysis
Priorities in Enhancing the Microeconomic Business Environment

Context for Firm Strategy and Rivalry

Factor (Input) Conditions
- Lagging educational attainment relative to UK average
- Cardiff University ranked 7 in national research study
- Below average information and communication infrastructure

BUT
- Openness to and high level of inward FDI
- Few companies; low level of business formation
- Low private R&D and other business investment

Demand Conditions
- Low level of sophistication due to lack of local HQs and advanced research

Related and Supporting Industries
- Lack of financial and other business services to serve advanced cluster needs
- Low productivity in non-manufacturing
- Few well developed clusters, and limited interaction within clusters
# Leading Welsh Holders of U.S. Patents

**Total Patents per Organization, 1996-2000**

<table>
<thead>
<tr>
<th>Organization</th>
<th>Patents</th>
</tr>
</thead>
<tbody>
<tr>
<td>DOW CORNING LIMITED</td>
<td>12</td>
</tr>
<tr>
<td>GYRUS MEDICAL LIMITED</td>
<td>7</td>
</tr>
<tr>
<td>UNIVERSITY COLLEGE CARDIFF CONSULTANTS LIMITED</td>
<td>7</td>
</tr>
<tr>
<td>SPRAYFORMING DEVELOPMENTS LIMITED</td>
<td>4</td>
</tr>
<tr>
<td>LION LABORATORIES PLC</td>
<td>3</td>
</tr>
<tr>
<td>TRIKON TECHNOLOGIES LIMITED</td>
<td>3</td>
</tr>
<tr>
<td>UNIVERSITY OF WALES COLLEGE OF MEDICINE</td>
<td>3</td>
</tr>
<tr>
<td>MASSACHUSETTS INSTITUTE OF TECHNOLOGY</td>
<td>2</td>
</tr>
<tr>
<td>SOUTH GLAMORGAN HEALTH AUTHORITY</td>
<td>2</td>
</tr>
<tr>
<td>UNIVERSITY COLLEGE OF WALES ABERYSTWYTH</td>
<td>2</td>
</tr>
<tr>
<td>UNIVERSITY OF GLAMORGAN COMMERCIAL SERVICES LIMITED</td>
<td>2</td>
</tr>
</tbody>
</table>

…and 23 other organizations with 1 patent each

Source: US PTO, author’s calculations
# Welsh Innovative Performance

**Total U.S. Patents per UK University, 1996-2000**

<table>
<thead>
<tr>
<th>Rank</th>
<th>Name of University</th>
<th>Total Patents</th>
</tr>
</thead>
<tbody>
<tr>
<td>55.</td>
<td>IMPERIAL COLLEGE OF SCIENCE, TECHNOLOGY &amp; MEDICINE</td>
<td>36</td>
</tr>
<tr>
<td>102.</td>
<td>UNIVERSITY COLLEGE OF LONDON</td>
<td>23</td>
</tr>
<tr>
<td>102.</td>
<td>ISIS INNOVATION LTD. (OXFORD UNIVERSITY)</td>
<td>23</td>
</tr>
<tr>
<td>107.</td>
<td>VICTORIA UNIVERSITY OF MANCHESTER</td>
<td>22</td>
</tr>
<tr>
<td>137.</td>
<td>UNIVERSITY OF STRATHCLYDE</td>
<td>16</td>
</tr>
<tr>
<td>164.</td>
<td>UNIVERSITY OF SHEFFIELD</td>
<td>13</td>
</tr>
<tr>
<td>164.</td>
<td>UNIVERSITY OF SOUTHAMPTON</td>
<td>13</td>
</tr>
<tr>
<td>180.</td>
<td>UNIVERSITY OF MANCHESTER INSTITUTE OF SCIENCE AND TECHNOLOGY</td>
<td>12</td>
</tr>
<tr>
<td>213.</td>
<td>UNIVERSITY OF GLASGOW THE, UNIVERSITY COURT OF</td>
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*Note: Rank is rank among all UK holders of U.S. patents*

*Source: US PTO, author’s calculations*
## Patenting Performance of U.S. Universities

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<thead>
<tr>
<th>Rank</th>
<th>University</th>
<th>Total Patents, 1995–1999</th>
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Source: US PTO, author’s calculations
Action Agenda for Wales

• Address Weaknesses in the Welsh Business Environment

• Mount an aggressive cluster development strategy which also drives investment momentum

• Charge subregions with developing distinct strategies

• Create an integrating Welsh economic vision and an organizational structure for implementing
Address Weaknesses in the Welsh Business Environment

• Factor Conditions
  – Improve basic education
  – Programs to integrate the 45+ workforce
  – Link research and training to clusters

• Demand
  – Use public procurement as early / sophisticated demand
  – Harness multinationals as sophisticated buyers and focus on supplier development

• Related and supporting industries
  – Program to attract and develop business services serving specific clusters
  – FDI promotion focused on clusters
The Development of Clusters

• Create an explicit cluster development program
  – Conscious efforts can meaningfully raise cluster competitiveness and innovative capacity

• Recruit for clusters
  – Recruitment strategies should target strong and emerging clusters, not individual firms
Public / Private Cooperation in Cluster Upgrading
Minnesota’s Medical Device Cluster

Factor (Input) Conditions
- Joint development of vocational-technical college curricula with the medical device industry
- Minnesota Project Outreach exposes businesses to resources available at university and state government agencies
- Active medical technology licensing through University of Minnesota
- State-formed Greater Minnesota Corp. to finance applied research, invest in new products, and assist in technology transfer

Context for Firm Strategy and Rivalry
- Aggressive trade associations (Medical Alley Association, High Tech Council)
- Effective global marketing of the cluster and of Minnesota as the “The Great State of Health”
- Full-time “Health Care Industry Specialist” in the department of Trade and Economic Development

Demand Conditions
- State sanctioned reimbursement policies to enable easier adoption and reimbursement for innovative products

Related and Supporting Industries
Organizing to Compete
Massachusetts Governor’s Council on Economic Growth and Technology

Governor’s Council on Economic Growth and Technology

Industry Cluster Committees
- Advanced Materials
- Biotechnology and Pharmaceuticals
- Defense
- Marine Science and Technology
- Medical Devices
- Software
- Telecommunications
- Textiles
- Information Technology

Functional Task Forces
- International Trade
- Marketing Massachusetts
- Tax Policy and Capital Formation
- Technology Policy and Defense Conversion

Issue Groups
- Cost of Doing Business
- Financing Emerging Companies
- Health Care
- Western Massachusetts
- Business Climate
- Competitive Benchmarking
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