

Innovation: The *New* Australian Competitiveness Agenda

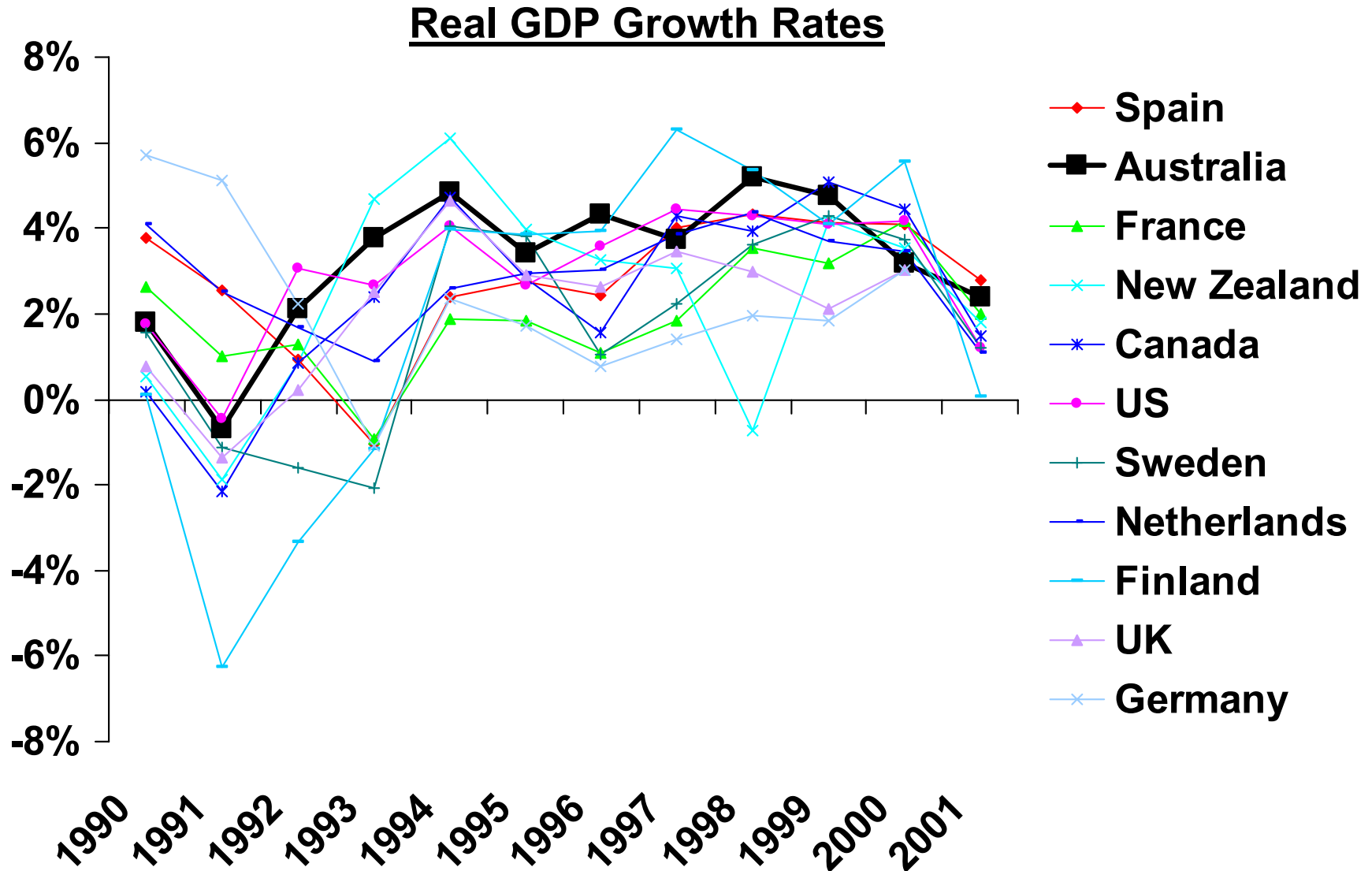
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Kellogg School of Management
Brookings & NBER

IPRIA & MBS
Thought Leaders' Forum
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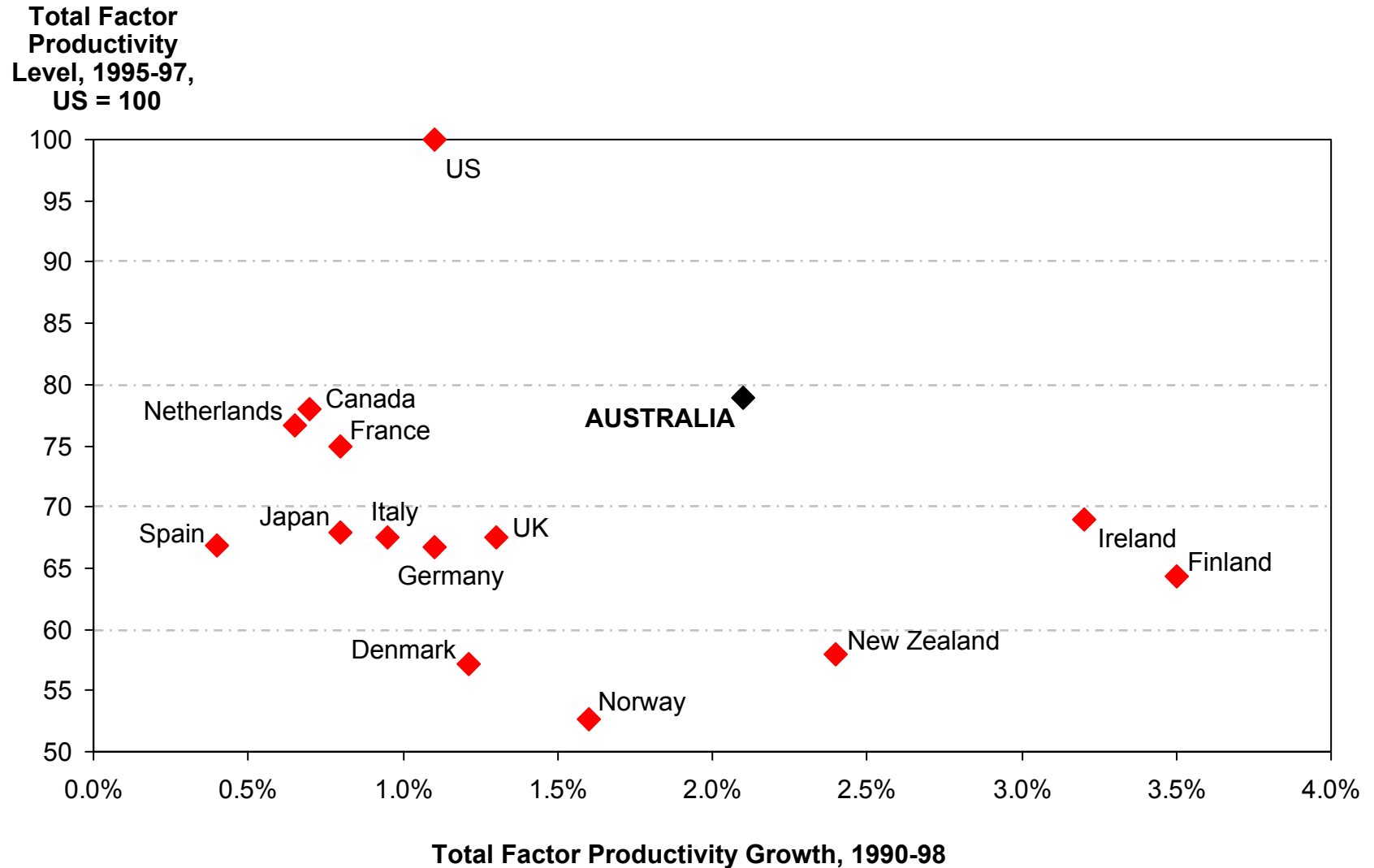
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The Last Decade of Australian Economic Growth Stands Out Among Leading Nations



Australia's economic growth driven by productivity advance, and Australian growth is not simply a case of "catch up"

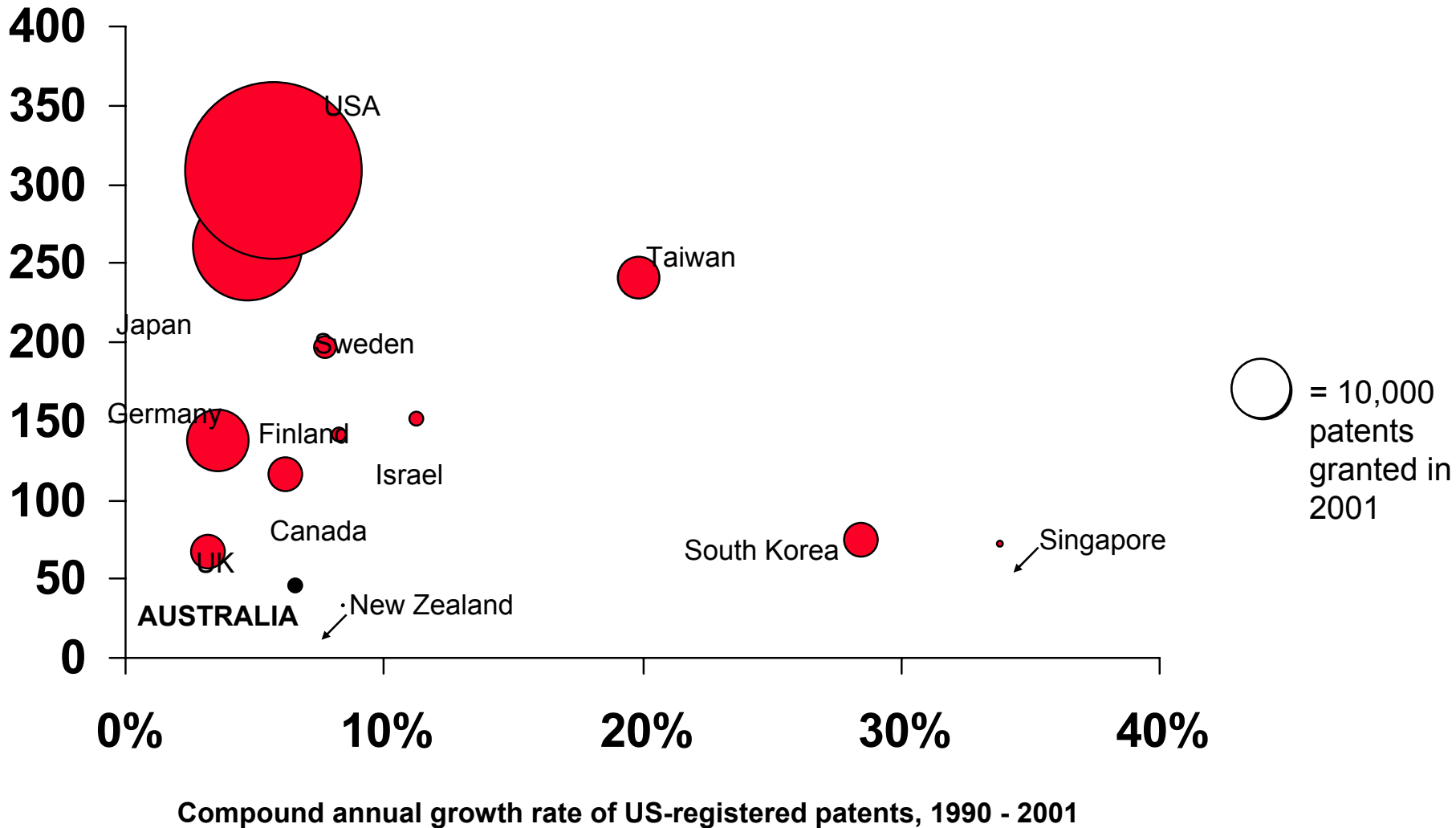


Australia's Achievements Are Linked to Fundamental Transformation in **Australia's business environment**

- Sound macroeconomic policies
 - Modernization of the tax system
 - Redesigned social policies to encourage participation in the economy
 - Deregulation of product and labor markets
 - Market opening for telecommunications, utilities, and the provision of public services
 - Strengthening of competition policy
 - Creation of institutions to monitor competitive upgrading, e.g. Productivity Commission
- 
- The positive effects of the past economic reforms have not yet been fully felt and **will continue to benefit** the performance of the Australian economy in coming years

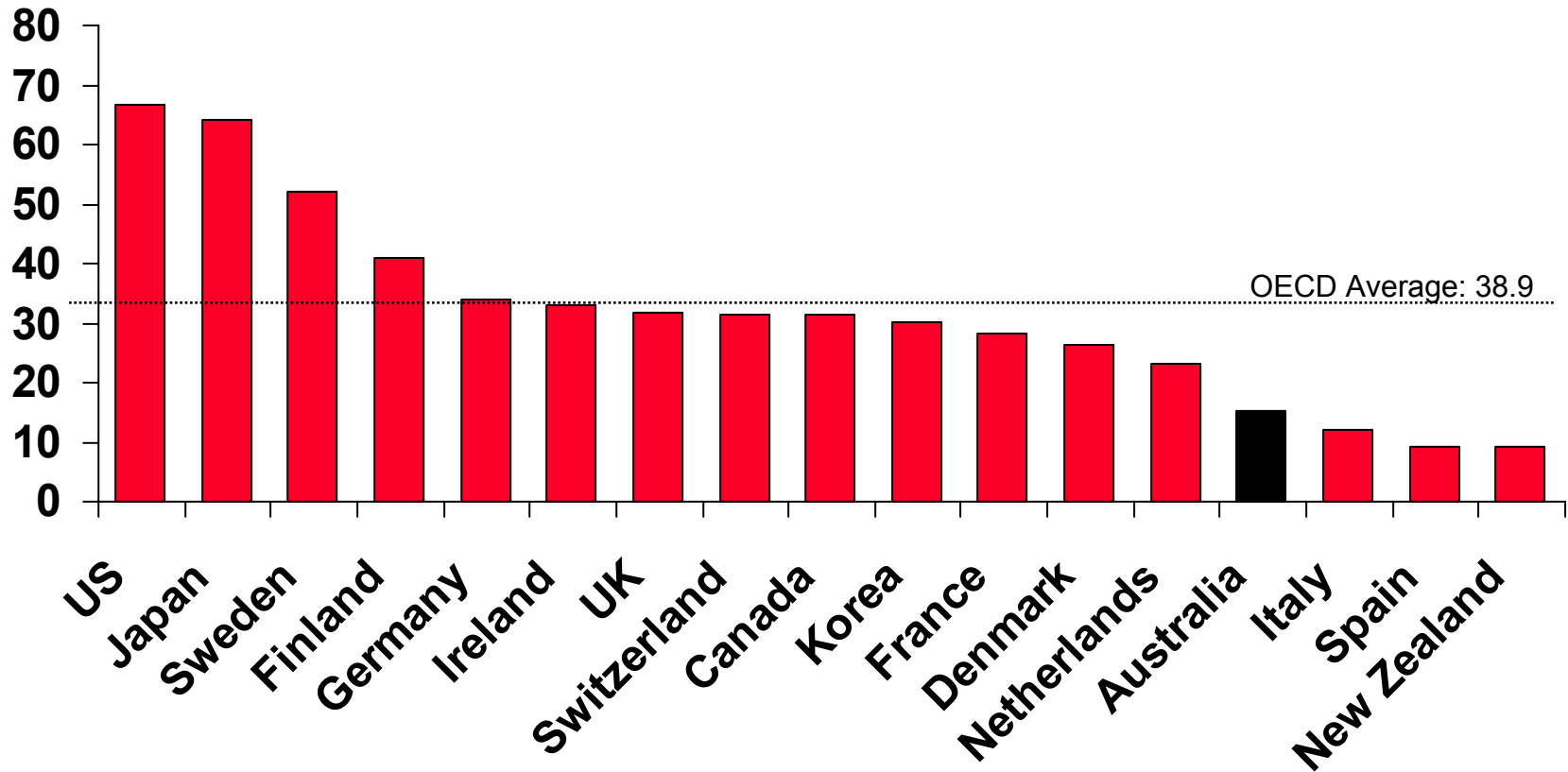
Despite this impressive performance, the Australian record on innovation is mixed

Annual U.S. patents
per 1 million
population, 2001



Not simply a matter of a national “IP Strategy,” Australian firm employs fewer innovators than other leading nations

Company Researchers
per 10'000 Employed,
1998



Australia's New Competitiveness Challenge

- A number of **corporate failures** and **company relocations** have shaken confidence in Australia's corporate basis
- The **innovation** performance of Australia is weak compared to international standards
- Australia has relatively few **clusters** that are well developed
- Government is under pressure to “do something” but there is no clear **vision** for the next stage in economic development after market opening and deregulation

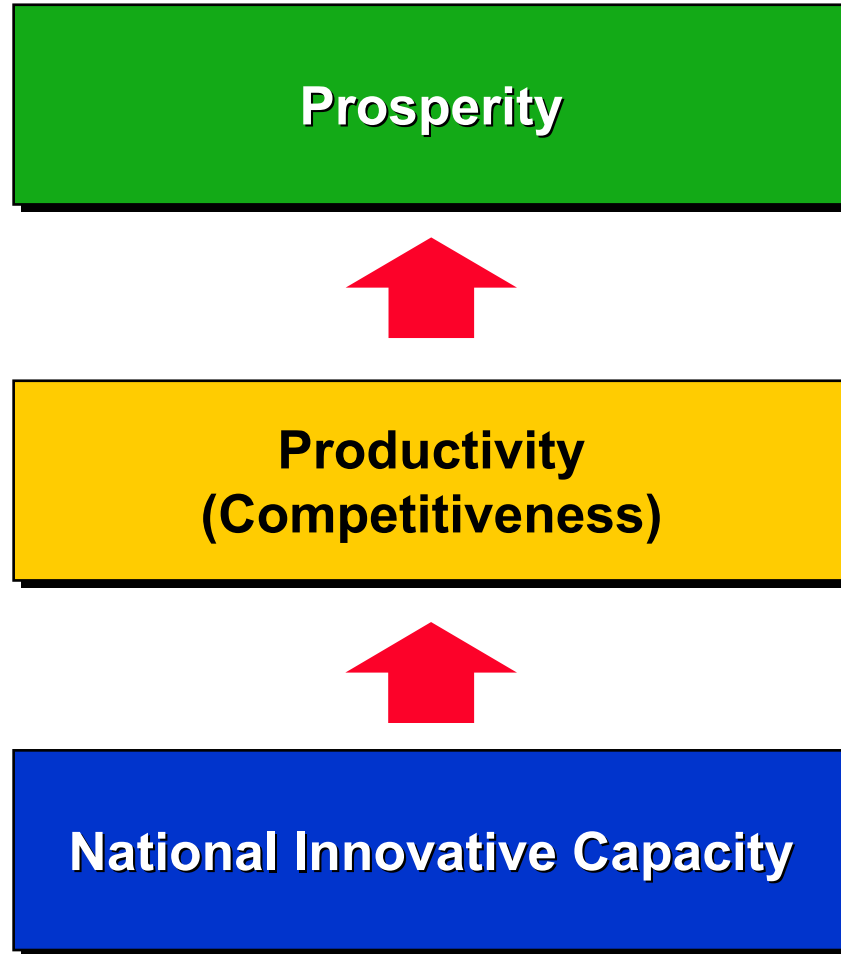


- These challenges are **connected**; a concerted strategy is needed to address them
- Australia's competitiveness must be built upon a clear understanding of the leading role of global innovation in central role that innovation will play in determining future competitiveness and sustaining economic prosperity

Outline

- **The Foundations of Innovative Capacity**
- Innovative Capacity Across the World
- Australian Innovative Capacity
- An New Australian Innovation Policy Agenda

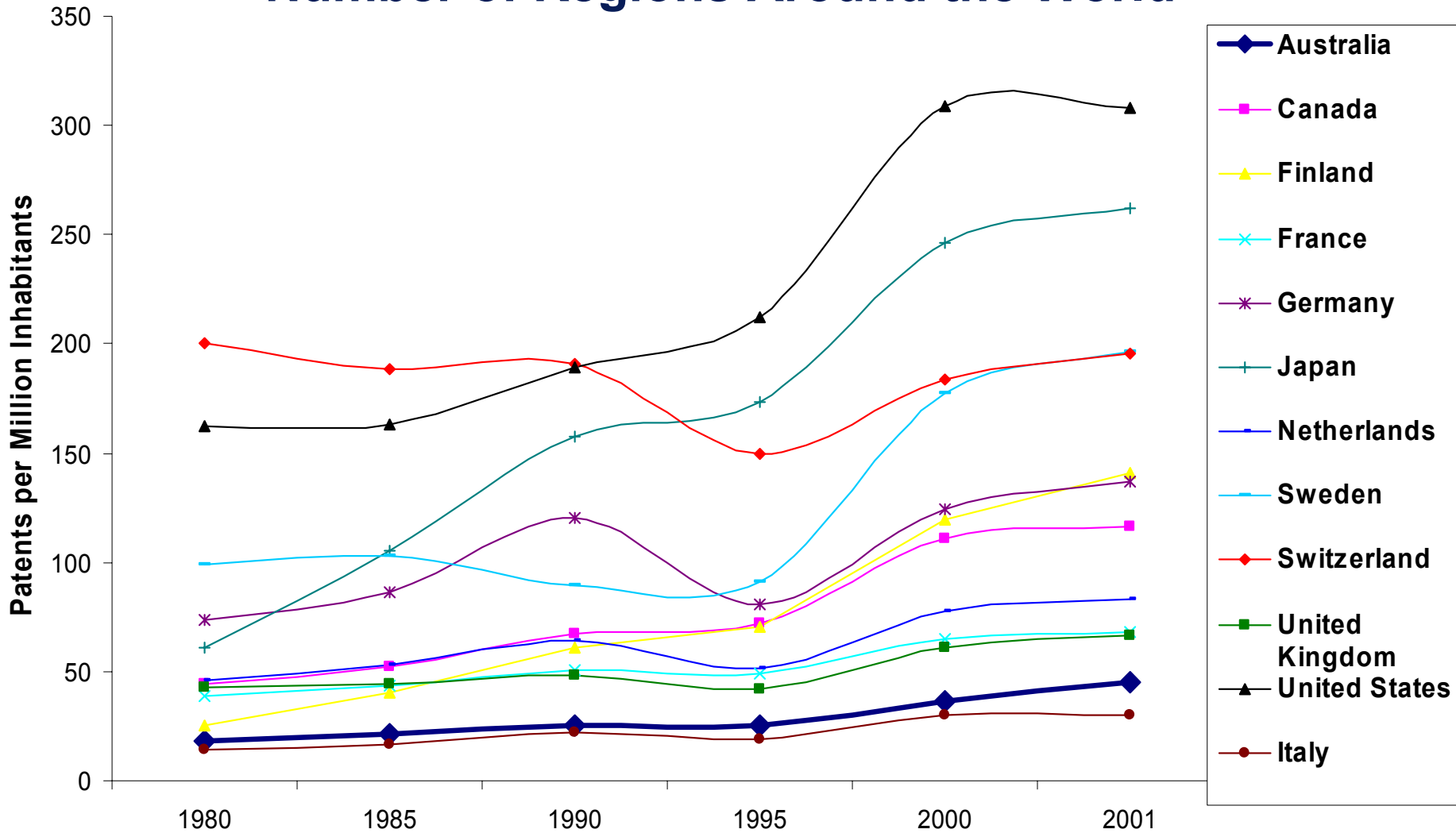
World-class competitiveness and prosperity depends on *national innovative capacity* -- the ability to develop and commercialize “new-to-the-world” technologies, products business organizations



Innovation & Prosperity in a Global Economy

- The capacity for innovation will determine the standard of living in the global economy
 - **No economy can support high wages and profits through producing standard products or services made with standard methods**
 - Australia's *future* prosperity depends on:
 - Creating **high value** products and services
 - Developing **unique** products, features, and processes
 - **Staying ahead** of technology diffusion
- Innovation is *more* than science discovery or technological inventions
- There are **no low-tech industries**, only low-tech firm
- Innovation is a key to addressing pressing **social** challenges

However, Global Innovation is Concentrated in a Small Number of Regions Around the World



Porter & Stern

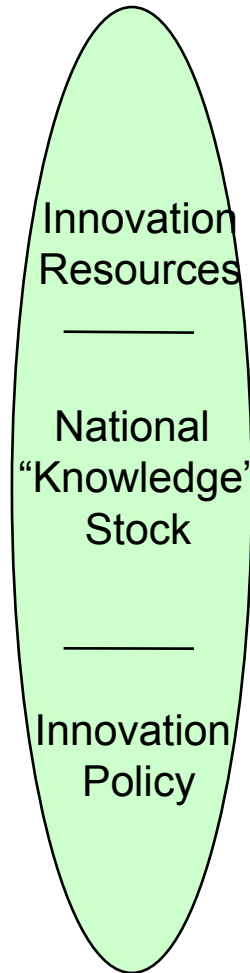
National Innovative Capacity Project

- *Objective*
 - Model the **drivers** of global innovation
 - Enrich policy discussion of the **linkage** between innovation and long-term competitiveness
- *Council on Competitiveness, 1999*
 - Quantitative analysis of **capacity for innovation** across select OECD countries through a regression based on historical data.
- *Global Competitiveness Report, 2001 & preliminary, 2002*
 - Extend and enrich analysis including over 30 new measures and over 70 countries

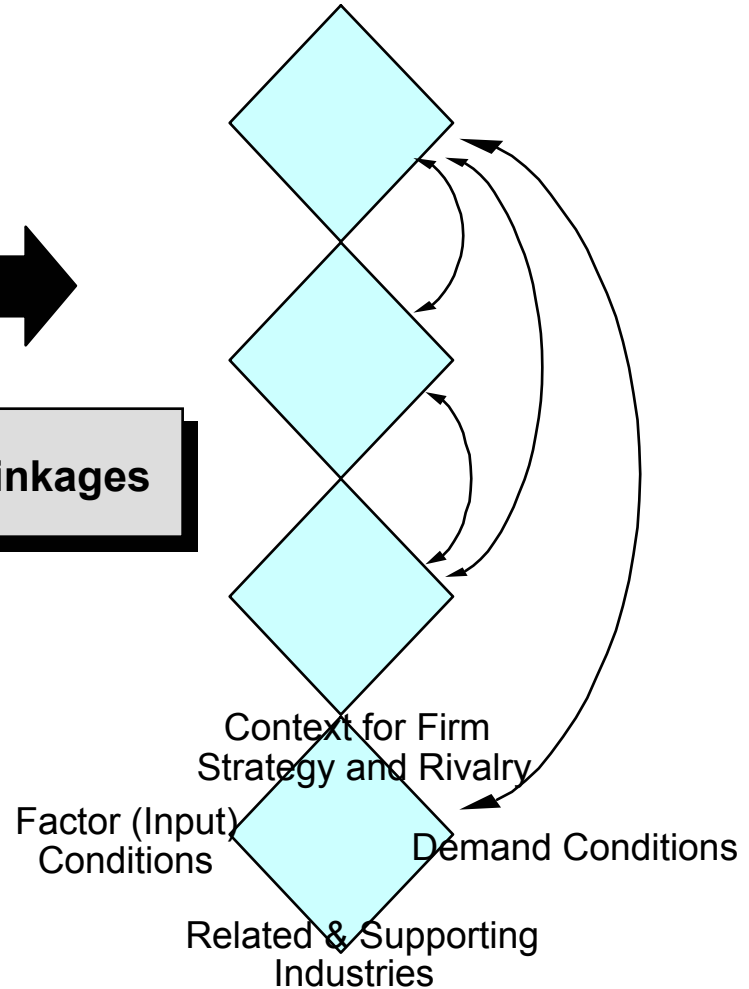
The Drivers of National Innovative Capacity

Common Innovation Infrastructure

Cluster-Specific Environment for Innovation



Quality of Linkages



The National Innovation Infrastructure

Innovation Resources

- Science & Engineering Workforce
- Access to Higher and Postgraduate Education
- Availability of Risk Capital
- High Quality of Information Infrastructure

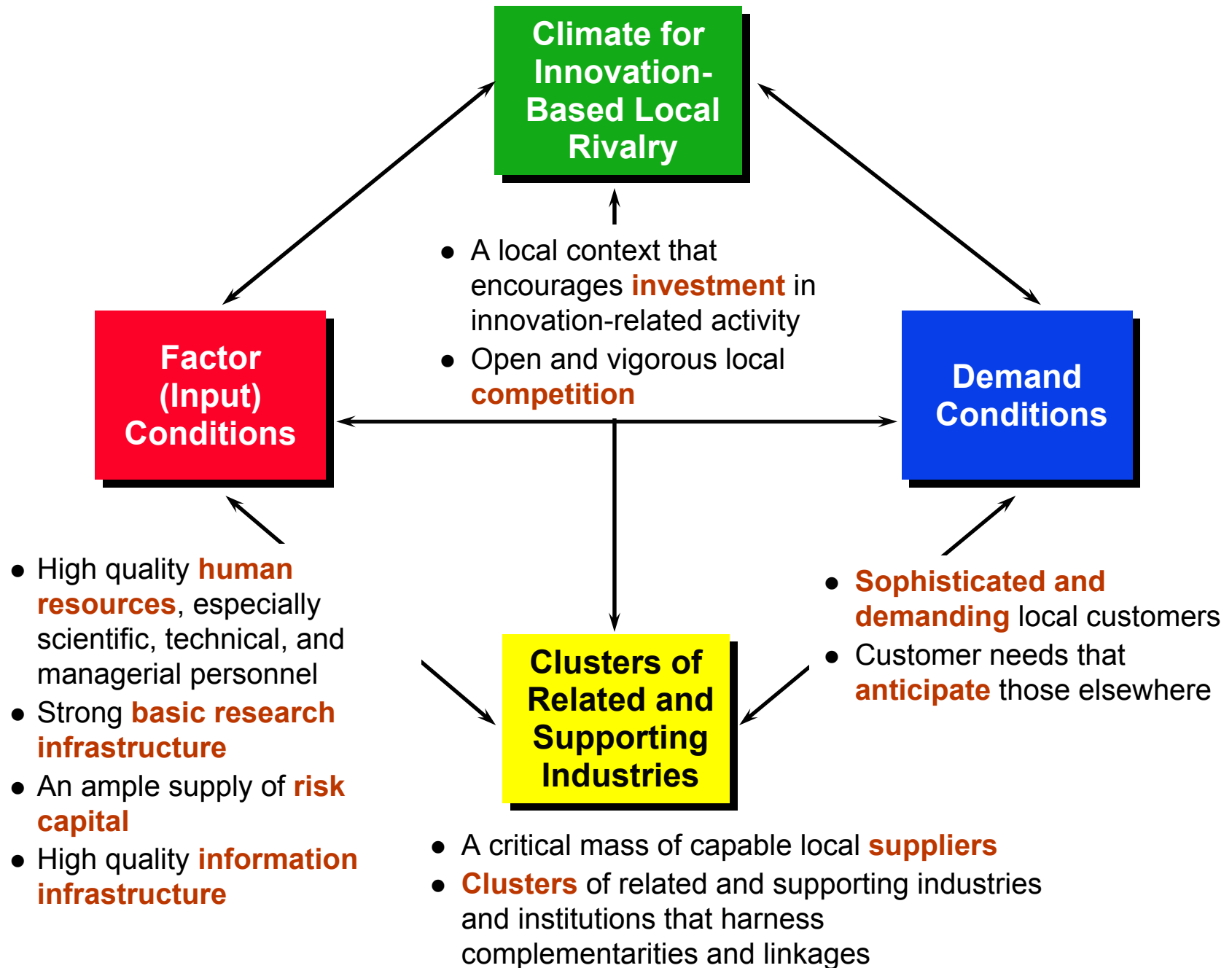
Innovation Policy

- Subsidy and Grant Programs
- R&D Tax Policy
- Education Policy & Funding
- Intellectual Property Protection Policy
- Openness to International Trade and Investment

National “Knowledge” Stock

- “Basic” Research Investments
- Cumulative Innovation Record
- Overall Technological Sophistication

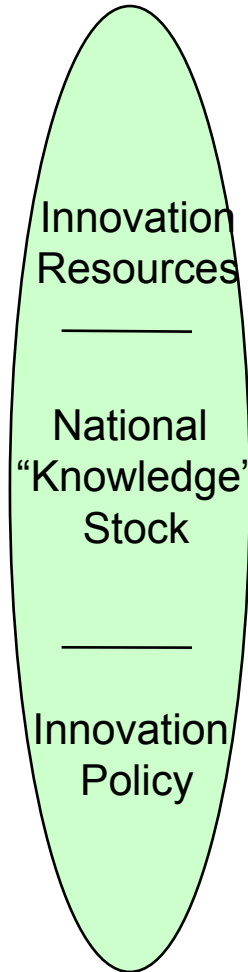
Innovation-Oriented National Industrial Clusters



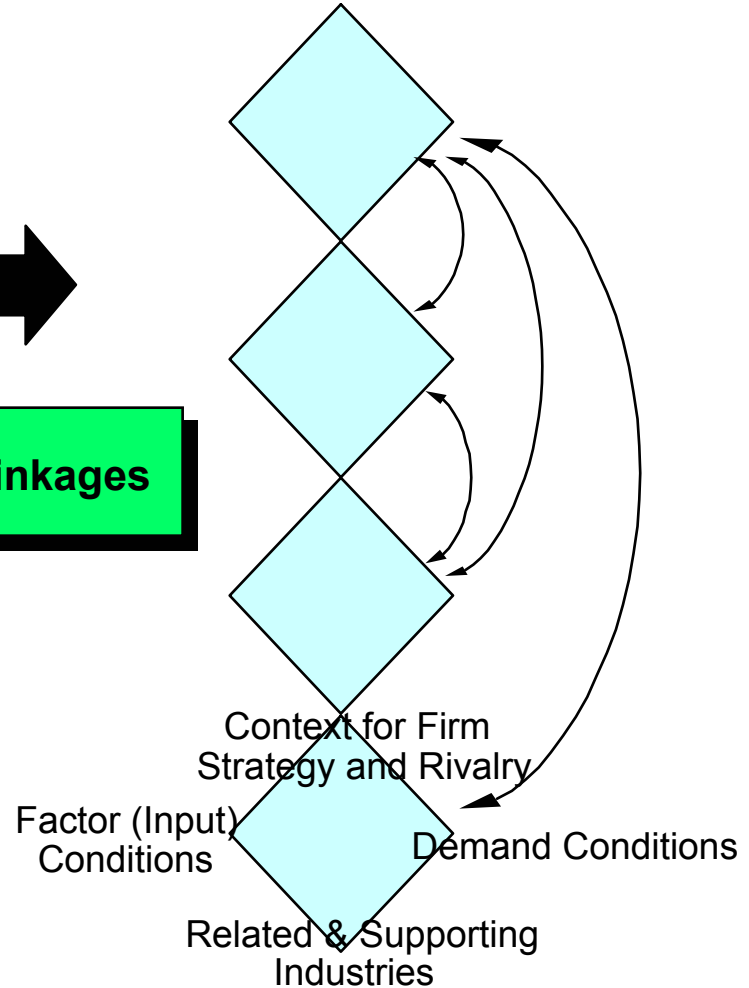
Innovative Capacity Depends on Strong Linkages Between Solid Infrastructure & Dynamic Clusters

Common Innovation Infrastructure

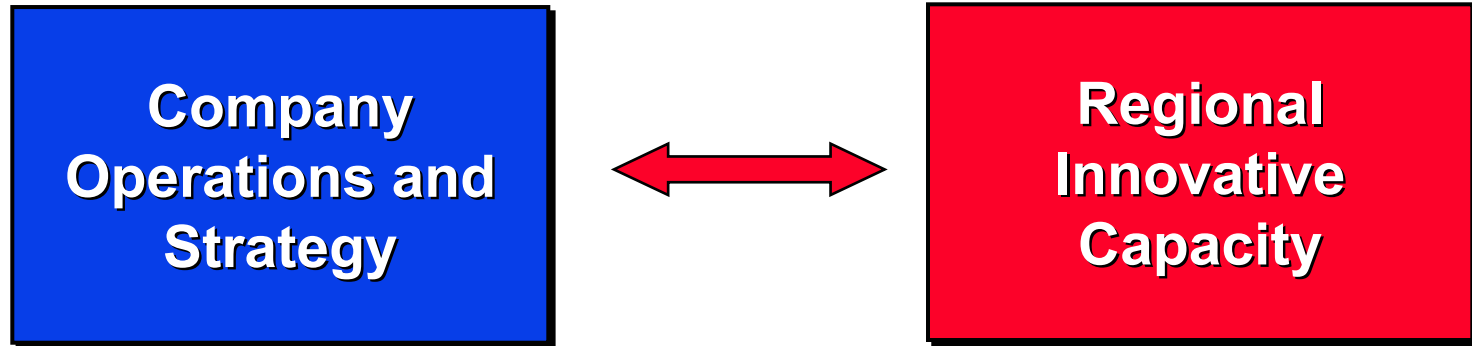
Cluster-Specific Environment for Innovation



Quality of Linkages



Finally, global innovation leadership results from **leveraging** local innovative capacity through effective and sophisticated **firm operations and strategy**

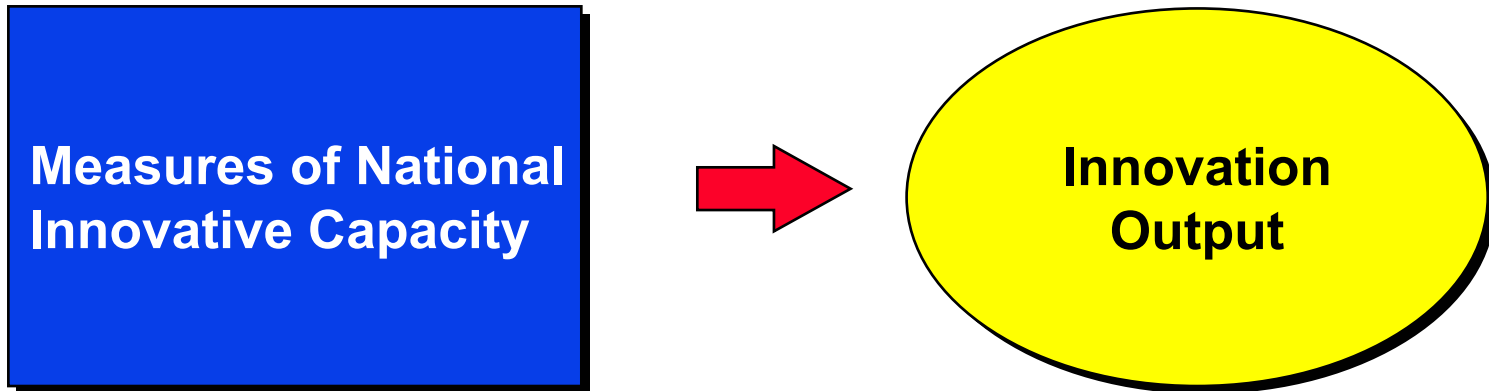


- National innovative capacity may be **squandered** through **ineffective innovation management**
- Innovation leadership **within a region** results from integrating external resources with internal capabilities
- R&D productivity depends on the **locations** at which a company's business units are based
- **Cluster participation** is an important contributor to innovative success

Assessing National Innovative Capacity

An objective, quantitative international benchmark of the national capacity for innovation

Methodology



- Council on Competitiveness (“COC”), 1999
 - Evaluate the historical basis of innovation leadership and changes over time in national positioning
- Global Competitiveness Report (“GCR”), 2001, 2002
 - Enriched framework and analysis
 - Thorough analysis of distinct drivers and across over 70 countries

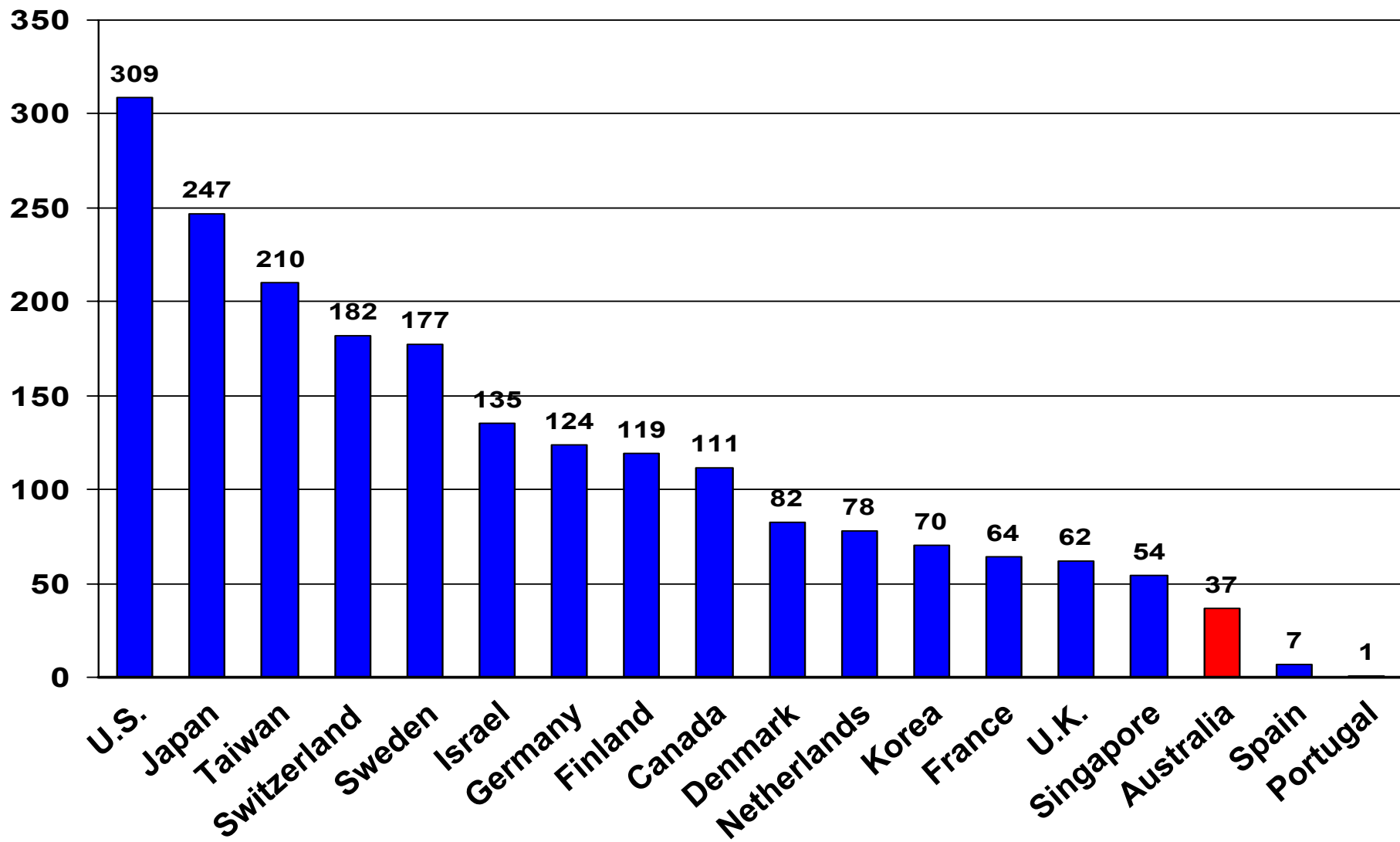
Assessing National Innovative Capacity

- Approach: “Weighted” Sum of National Innovative Capacity Drivers
 - Weights derived from regression analysis relating the **development** of new-to-the-world technologies to drivers of national innovative capacity
 - Technology “output” is measured by **international** patents
 - National Innovative Capacity drivers:
 - Innovation Infrastructure, Cluster Environment, Linkages
- Advantage of this Approach
 - Avoids ‘ad-hoc’ weighting of proposed drivers
 - Per capita evaluation in order to allow international comparison
 - Focuses attention on **relative** changes in National Resources and Policies versus other nations

Assessing the Drivers of Innovative Capacity Using International Patents

- "International" patents are **recognized** as a useful though incomplete measure of commercially relevant innovation.
 - Reflects commercial value of innovations
- Our approach **only** utilizes patenting to assign the weights associated with distinct drivers of national innovative capacity
- While patenting is not a complete measure of innovation, it is a **useful**, first order guide
 - **Significant** link with labor productivity and exports
 - **Robust** to use of labor productivity and high-tech exports data
 - **Robust** to use of licensing and copyrighting data associated with low-patenting sectors (e.g., software or e-business)

Per-Capita International Patenting Varies Markedly Across Countries



Data are Patents Per Million Population, 2000. Source: United States PTO

Calculating the COC 1999 Index

Stage I

- Create innovative capacity measures database
 - 17 OECD countries from 1975 to 1996
- Regression analysis determines
 - **significant influences** on innovative output three years ahead
 - **weight** associated with each influence

Stage II

- **Calculate** Innovation Index for each country for each year using Stage I weights
- Evaluate differences in the Index among countries and over time

Stage III

- **Project** Innovation Index for each country, given recent policy and resource commitment trajectory

The Foundations of Innovative Capacity

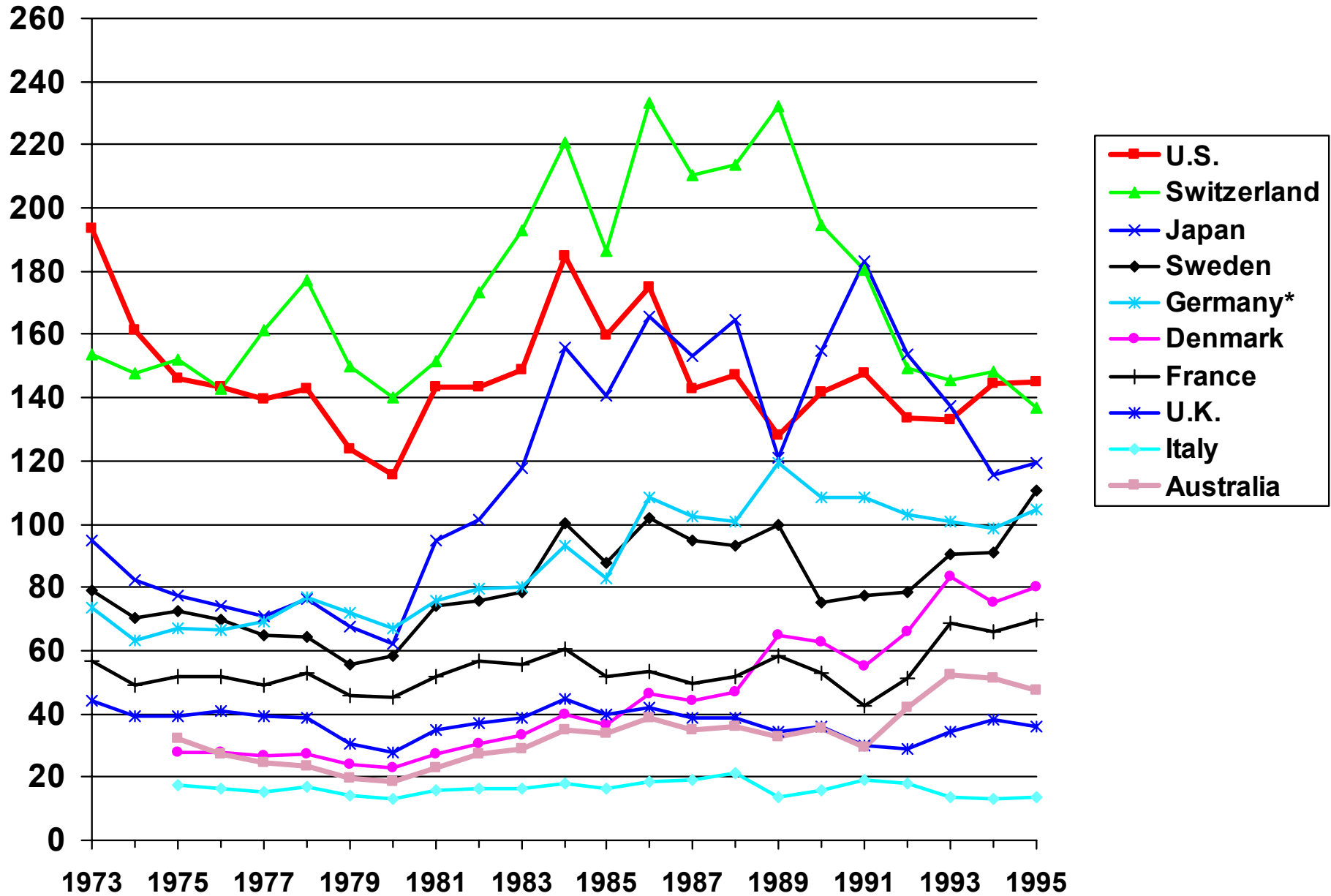
- Measures of Innovative Capacity are **highly significant** in explaining international patenting output
 - Model is robust and explains overwhelming share of variance
- Infrastructure Investments and Policies have a significant influence
 - R&D spending & Employment
 - Intellectual Property and Openness to Intl. Trade
 - Higher Education & Overall Technological Sophistication
- R&D **composition** has an additional impact
 - R&D spending by **business** more productive than Govt. R&D
 - Universities play a key (and distinct) role in translating funding into innovation performance

Outline

- The Foundations of Innovative Capacity
- **Innovative Capacity Across the World**
- Australian Innovative Capacity
- An New Australian Innovation Policy Agenda

Historical Innovation Index

Selected Countries, 1973-1995



* From 1973 to 1989, the Index is based on data for West Germany only.

COC, 1999 - Innovation Index Findings

- **Over time, convergence has occurred.**
- Prior to mid-1980s, the U.S. and Switzerland **stood apart**.
- Japan's dramatic improvement in international patenting is well explained by national innovative capacity measures.
- After rising through the 1980s, Germany has struggled to maintain its innovative capacity after reunification
- Denmark and Finland have made **major gains** in innovative capacity, especially since the mid-1980s, while Sweden, France and the UK have treaded water
- Between 1973 and the late 1990s, **Australia** transformed itself from a **“classical” imitator** economy countries to a low **“second-tier innovator”** economy

GCR Innovative Capacity Rankings, October 2001

- Newly introduced into the World Economic Forum/Harvard University Global Competitiveness Report
 - Chairs: Michael E. Porter and Jeff Sachs
 - Historical GCR Focus
 - Early 1990s Macroeconomic Stability
 - Mid-1990s: Competitiveness Fundamentals
 - 2000+: Drivers of Competitiveness Fundamentals
 - Innovation
 - Environment
 - Labor Markets
- Similar approach extending and updating COC Report
 - Over 70 countries
 - Over 30 nuanced metrics of National Innovative Capacity

“New” Innovative Capacity Measures

GCR, 2001

Common Innovation Infrastructure

- Attractiveness of National Environment for Retaining S&E
- Intellectual Propriety Protection
- Government R&D Tax Credits
- Government Subsidies for R&D
- Company Spending on R&D
- Environmental Regulation
- Regulatory Standards
- Effectiveness of Antitrust Policy
- Procurement of Advanced Technology Products

Cluster-Specific Conditions

- Production Process Sophistication
- Extent of Product and Process Collaboration
- Local Supplier Quality
- State of Cluster Development

Quality of Linkages

- Absorption of New Technology
- University/Industry Research Collaboration
- Venture Capital Availability

GCR, 2001 – National Innovative Capacity Findings

- The determinants of the sub indexes of innovative capacity are **highly significant**
 - Innovation Policy
 - Effectiveness of Intellectual Propriety Protection
 - Country's Ability to Retain its Scientists and Engineers
 - Size and Availability of R&D Tax Credits for the Private Sector
 - Cluster Innovation Environment
 - Sophistication and Pressure to Innovate from Domestic Buyers
 - Presence of Suppliers of Specialized Research and Training
 - Prevalence and Depth of Clusters
 - Linkages
 - Overall Quality of Scientific Research Institutions
 - Availability of Venture Capital for Innovative but Risky Projects

GCR, 2001 – National Innovative Capacity Rankings

Country	GCR Growth Rank	Innovative Capacity		S&E Rank	Inn. Policy Rank	Cluster Innovation Rank	Linkages Rank
		Rank	Index				
U.S.	2	1	30.3	6	1	1	1
Finland	1	2	29.1	7	4	3	2
Germany	17	3	27.2	11	7	4	10
U.K.	12	4	27.0	18	13	3	9
Switzerland	15	5	26.9	13	15	5	7
Australia		7	26.8	8	10	9	5
Israel	24	11	26.5	19	14	15	2
Ireland	11	16	25.4	12	16	16	16
Spain	22	21	23.4	30	17	23	28
Czech Rep.	37	26	21.3	36	26	29	29
Hungary	28	28	21.1	34	25	38	25
Brazil	44	33	20.1	48	27	25	32

Moving Beyond Second-Tier Innovation: The Australian Challenge

- Australia's Rank (7th) masks the close “bunching” between Ranks 6 and 16
- Indeed, *preliminary* evidence from the 2002 GCR Innovative Capacity Index highlights key challenges for Australia in its quest to become a first-tier global innovator

Outline

- The Foundations of Innovative Capacity
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National Innovative Capacity in Australia

- **Objective**

- Evaluate Australian Innovative Capacity

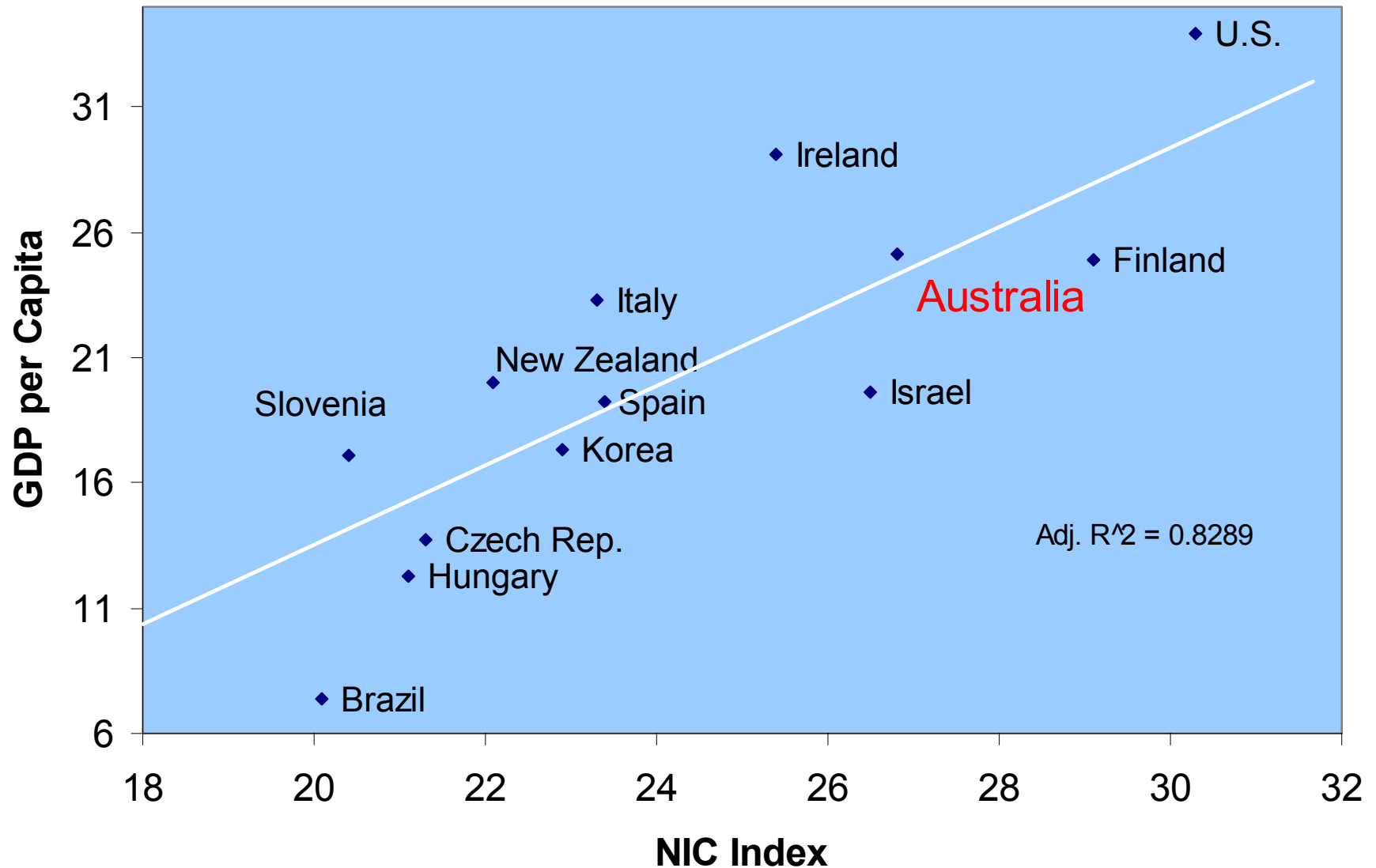
- **Approach**

- **Review** Australian GCR Innovative Capacity & Sub-Index Rankings

- **Compare** Australian Innovative Capacity and Performance with alternative economic units

- **Assess** two key clusters – wine and life sciences – with the potential for global innovation and competitive leadership

Overall, Australian Innovative Capacity is just behind its position in terms of GDP per capita

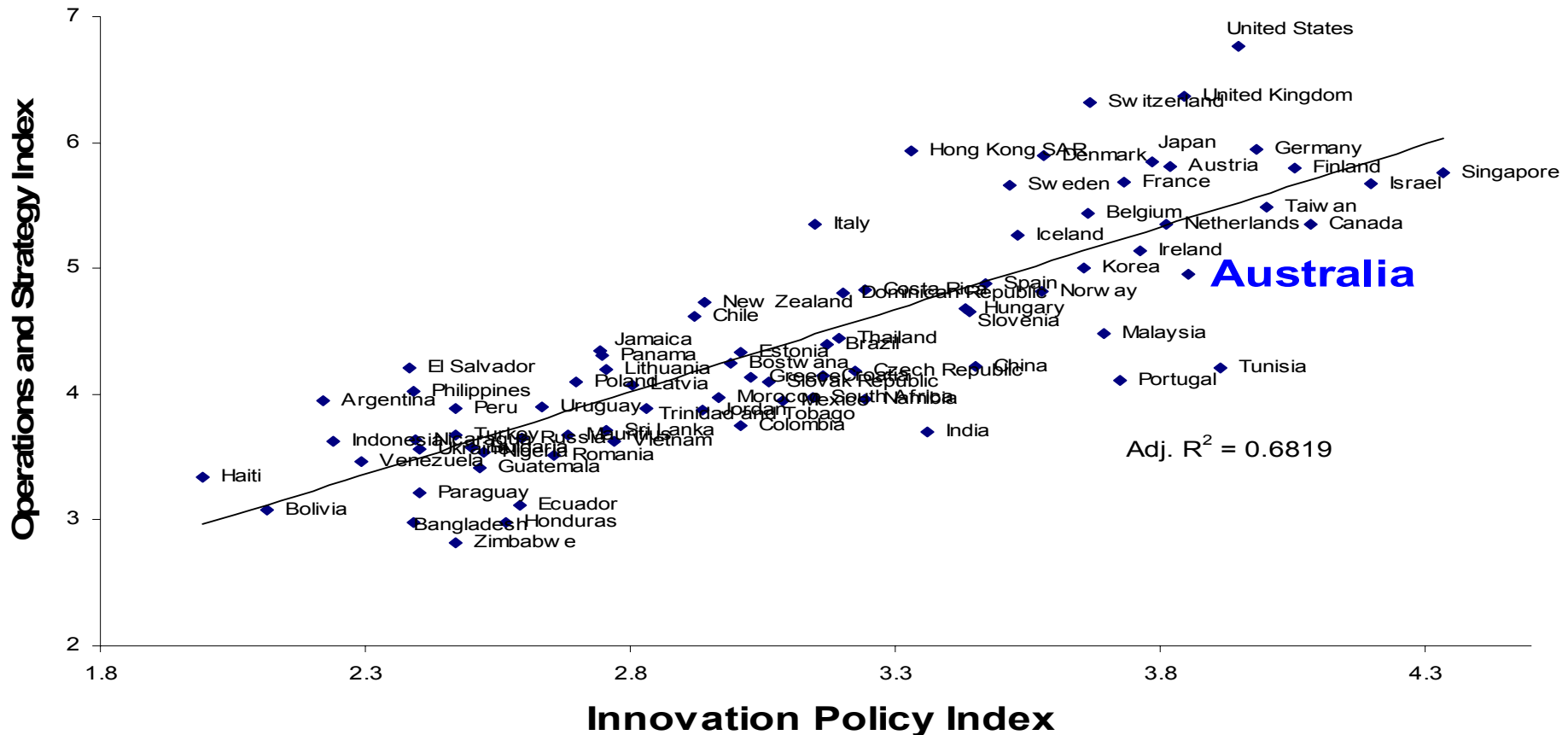


Elements of Innovative Capacity across Selected Countries

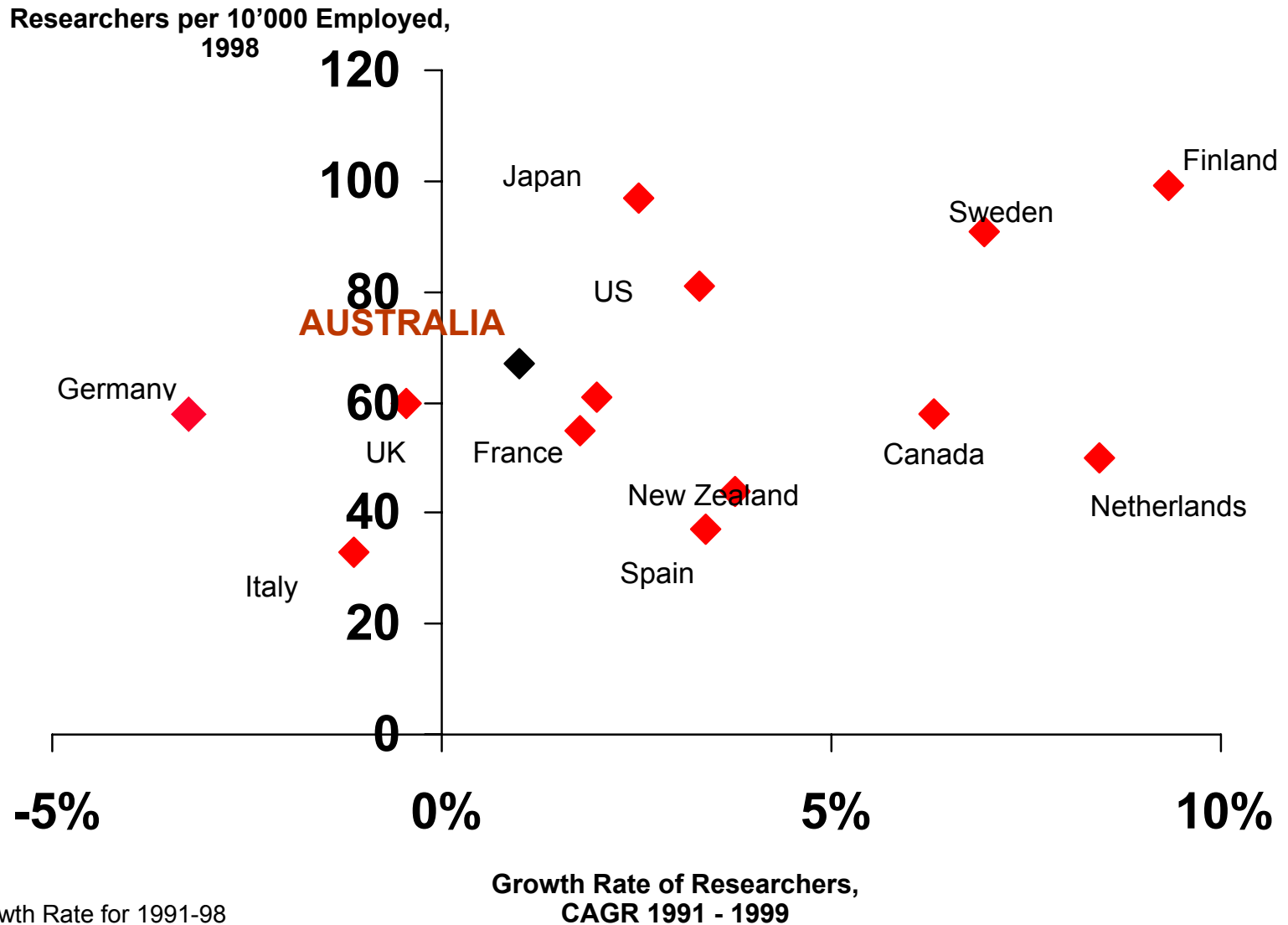
Country	NIC Rank	Scientists and Engineers Rank	Innovation Policy Rank	Cluster Innovation Environment Rank	Linkages Rank
USA	1	6	1	1	1
Finland	2	7	4	3	2
UK	5	18	13	3	9
Australia	7	8	10	9	5
Israel	11	19	14	15	2
Singapore	13	17	2	17	15
New Zealand	24	28	35	27	19

- Australia sub indexes rank suggests the need for **improvements across** multiple dimensions:
 - Australia does not maintain innovative capacity leadership
 - Overall ranking results from the absence of specific problems

Australia's position within "second-tier" innovator nations (and potential for establishing itself as a global leader) is limited by ineffective company operations and strategy



Australia's relative weakness in the science and engineering workforce has persisted, despite the boom over the last decade

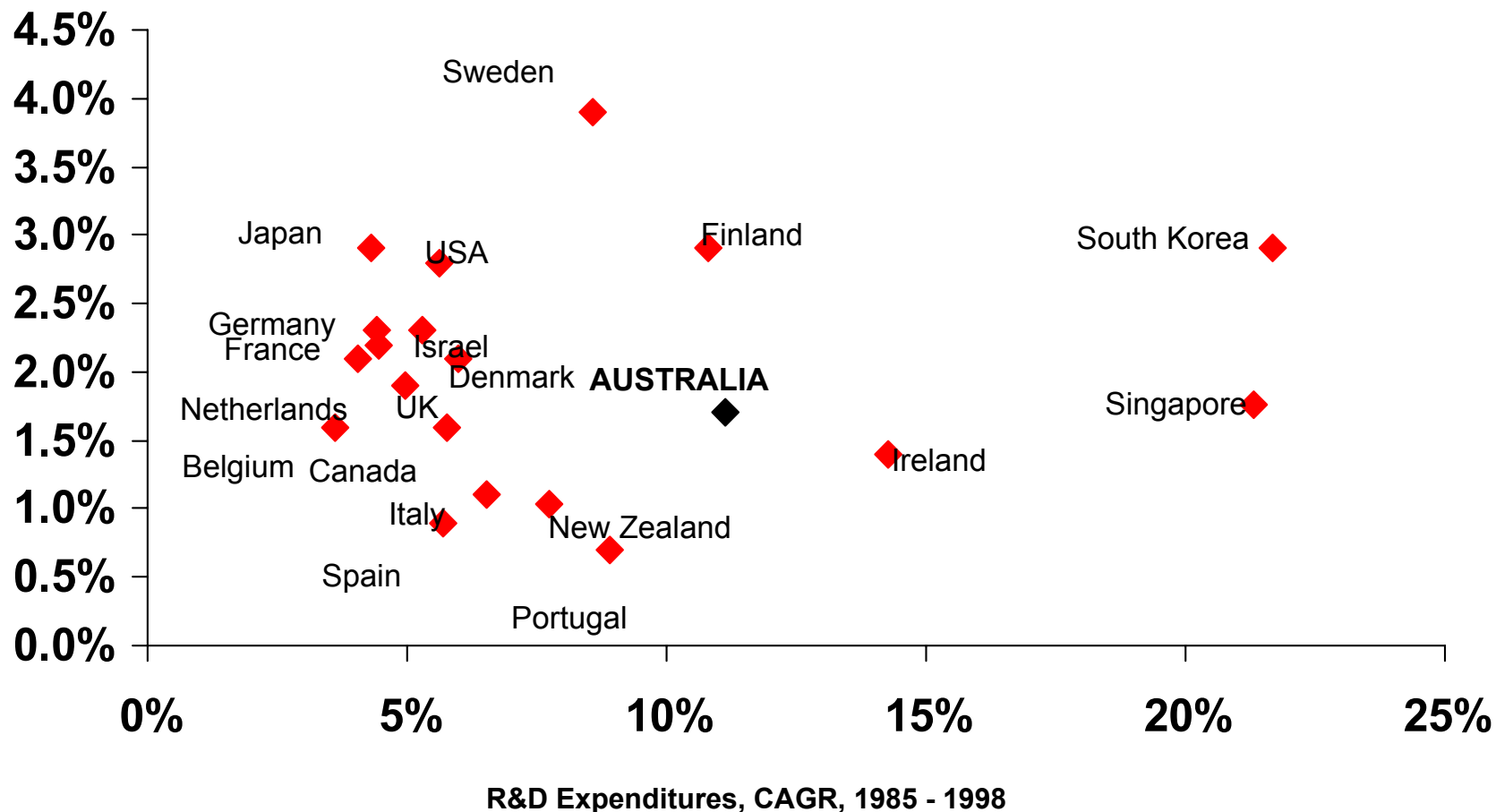


Note: Finnish Growth Rate for 1991-98

Source: OECD, 2001

Despite limited growth in the science and engineering workforce, Australia's late 1990s R&D boom was distinctive relative to other nations

R&D Spending as Share of GDP, 1998

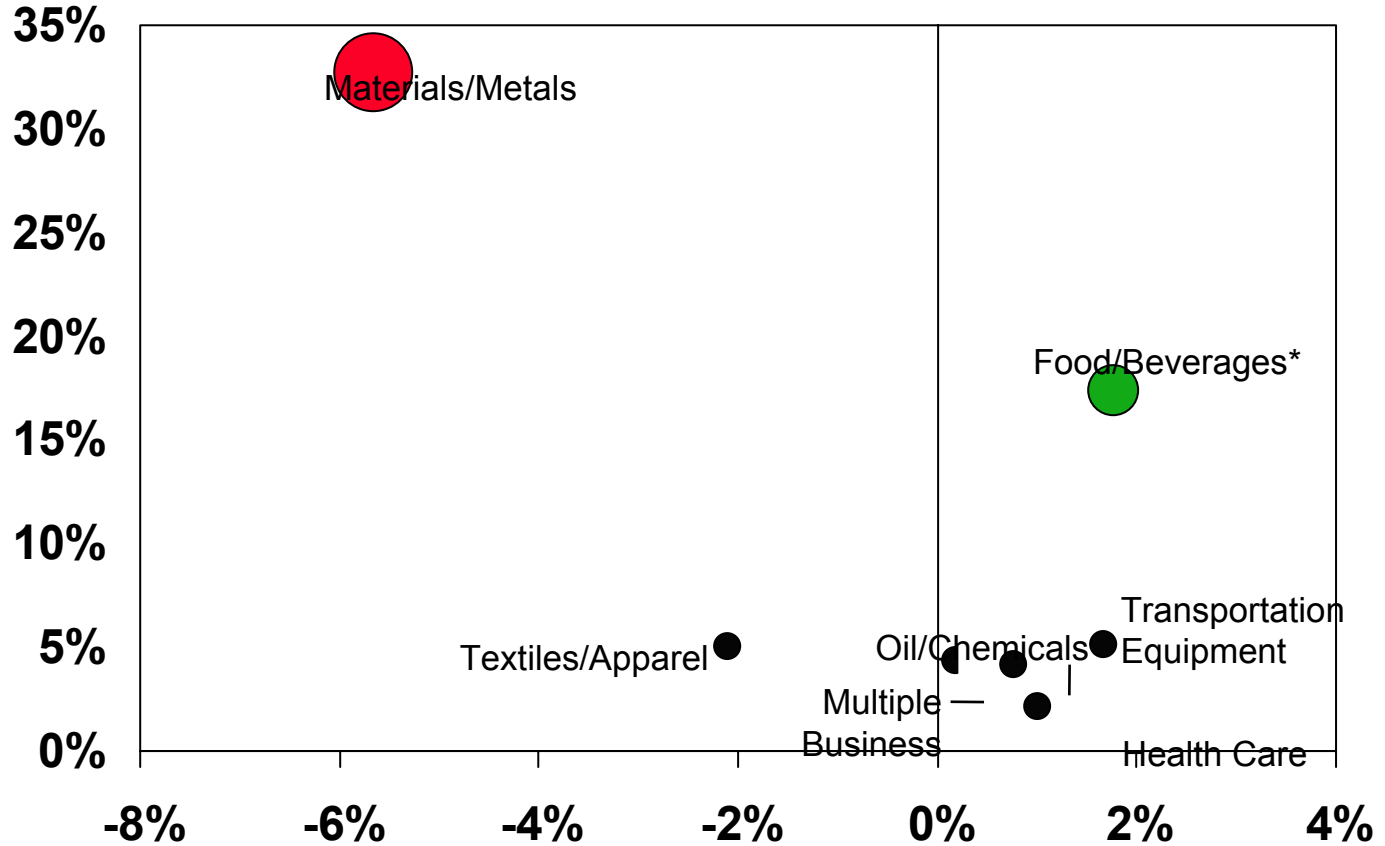


In Depth: Two Key Australian Clusters

- Wine
- Life Sciences / Biotechnology

Over the past decade, growth in Australian exports has been driven by improvement in Australia's wine cluster

Share of Australian Exports,
2000



Change in Share of Australian Exports,
1995-2000

Note: Wine export growth accounts for >45% of the increase in the export share of food/beverages

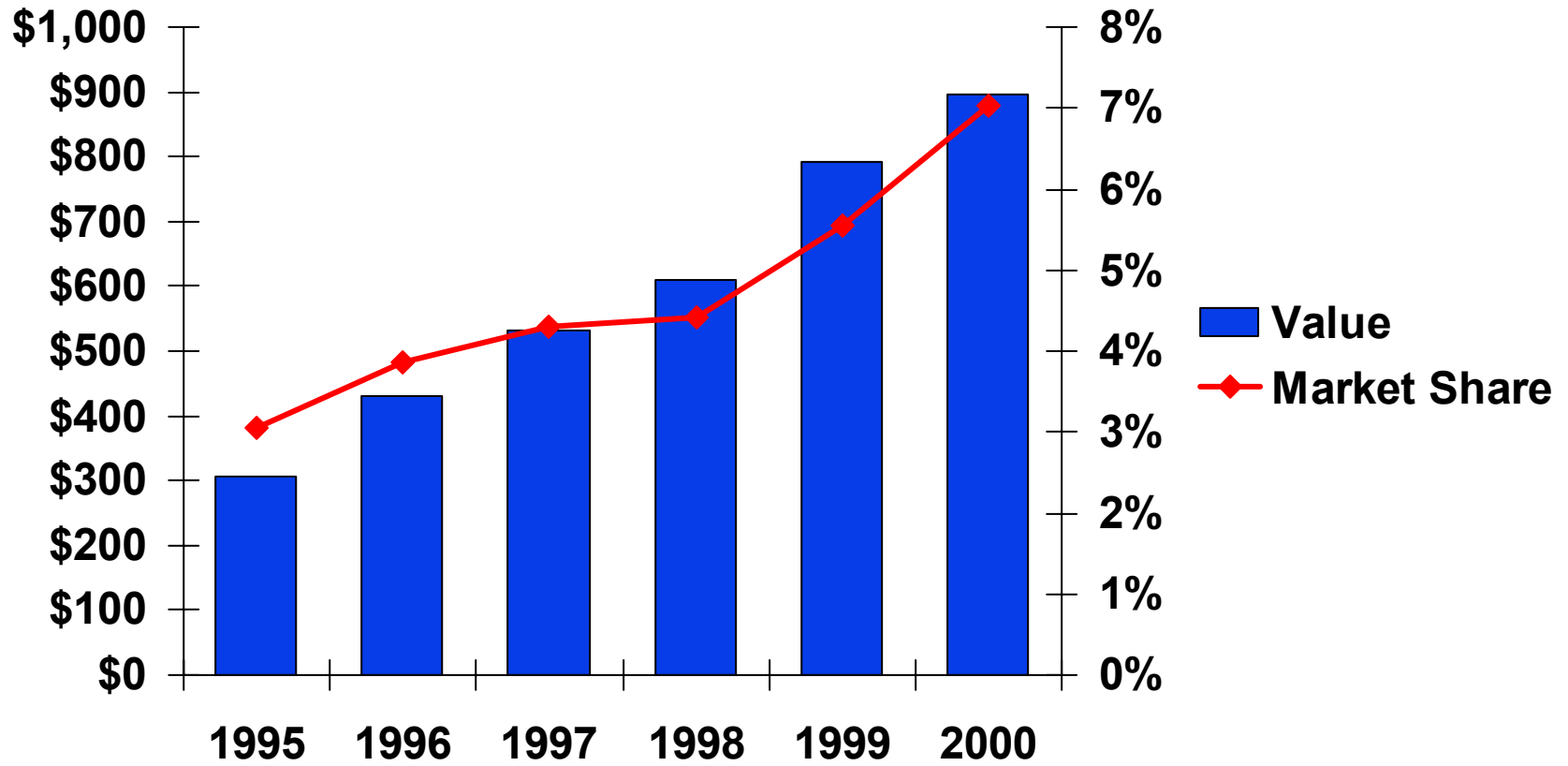
Source: UN Trade Statistics

The Australian Wine Cluster

Trade Performance

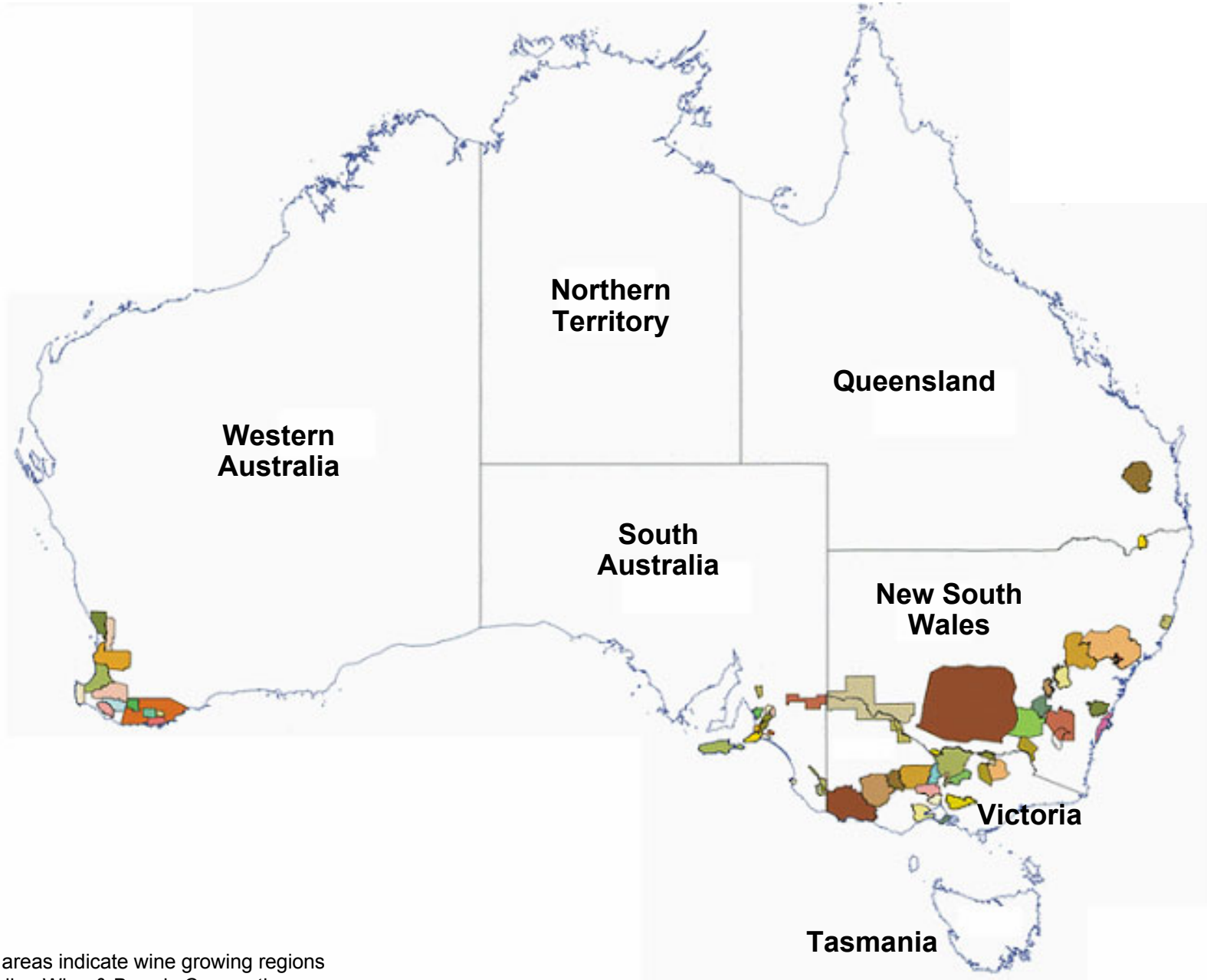
Australian Wine
Exports in million US Dollars

Australian Wine
World Export Market Share



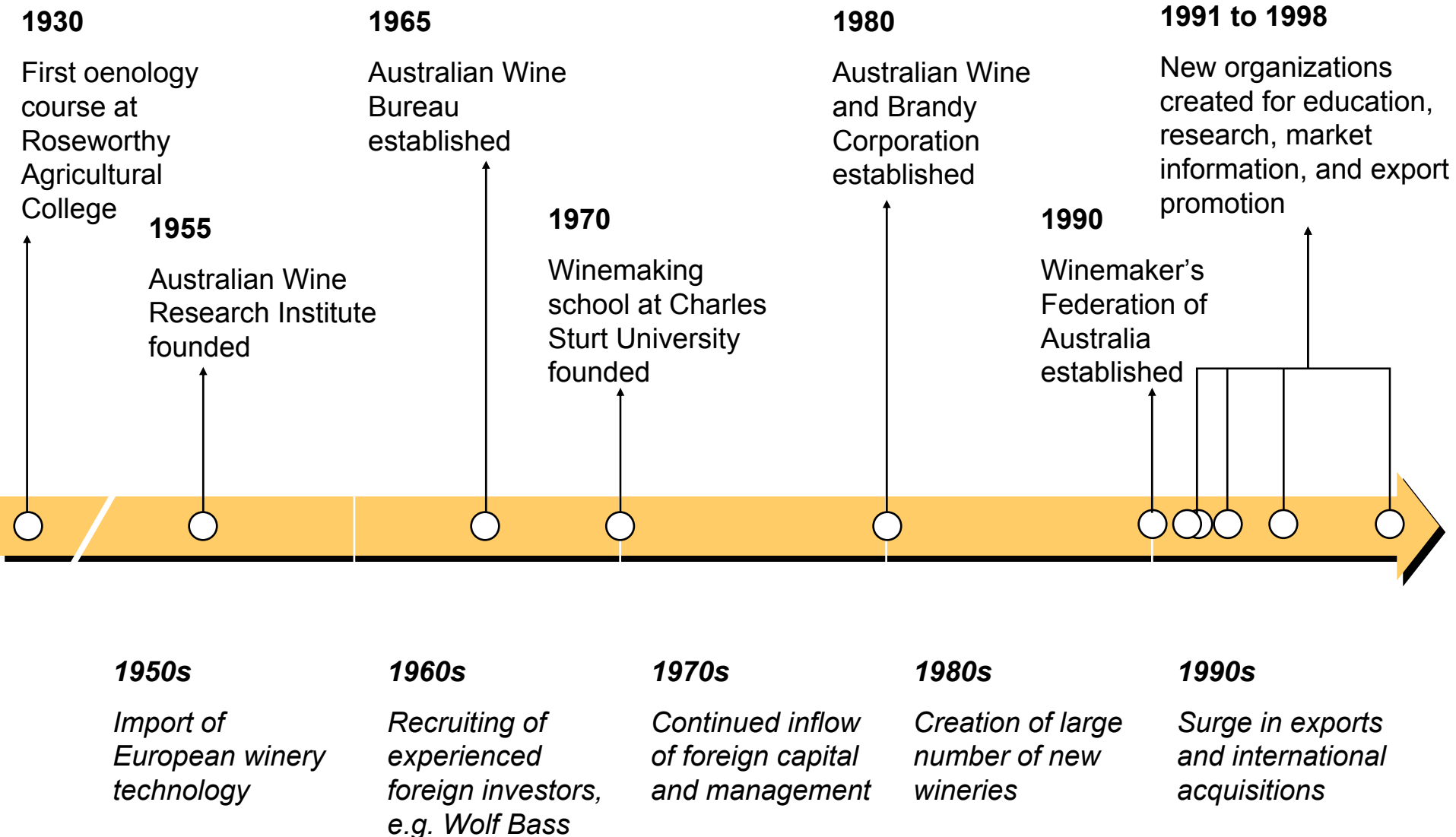
The Australian Wine Cluster

Locations



Note: Colored areas indicate wine growing regions
Source: Australian Wine & Brandy Corporation

The Australian Wine Cluster History



The Australian Wine Cluster

Recently founded Institutions for Collaboration

Winemakers' Federation of Australia

- Established in 1990
- Focus: Public policy representation of companies in the wine cluster
- Funding: Member companies

Cooperative Centre for Viticulture

- Established in 1991
- Focus: Coordination of research and education policy in viticulture
- Funding: other cluster organizations

Australian Wine Export Council

- Established in 1992
- Focus: Wine export promotion through international offices in London and San Francisco
- Funding: Government; cluster organizations

Grape and Wine R&D Corporation

- Established in 1991 as statutory body
- Focus: Funding of research and development activities
- Funding: Government; statutory levy

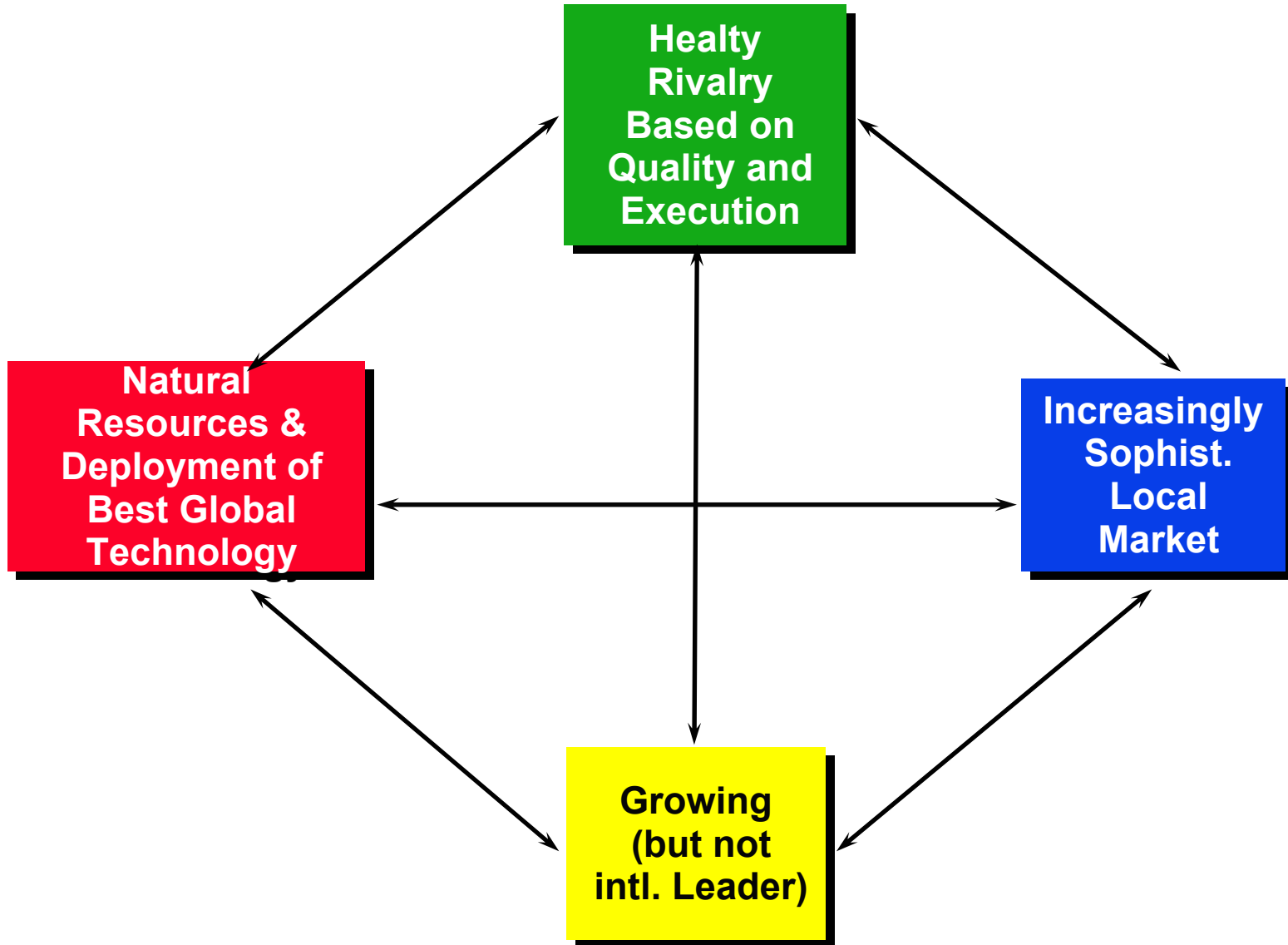
Wine Industry Information Service

- Established in 1998
- Focus: Information collection, organization, and dissemination
- Funding: Cluster organizations

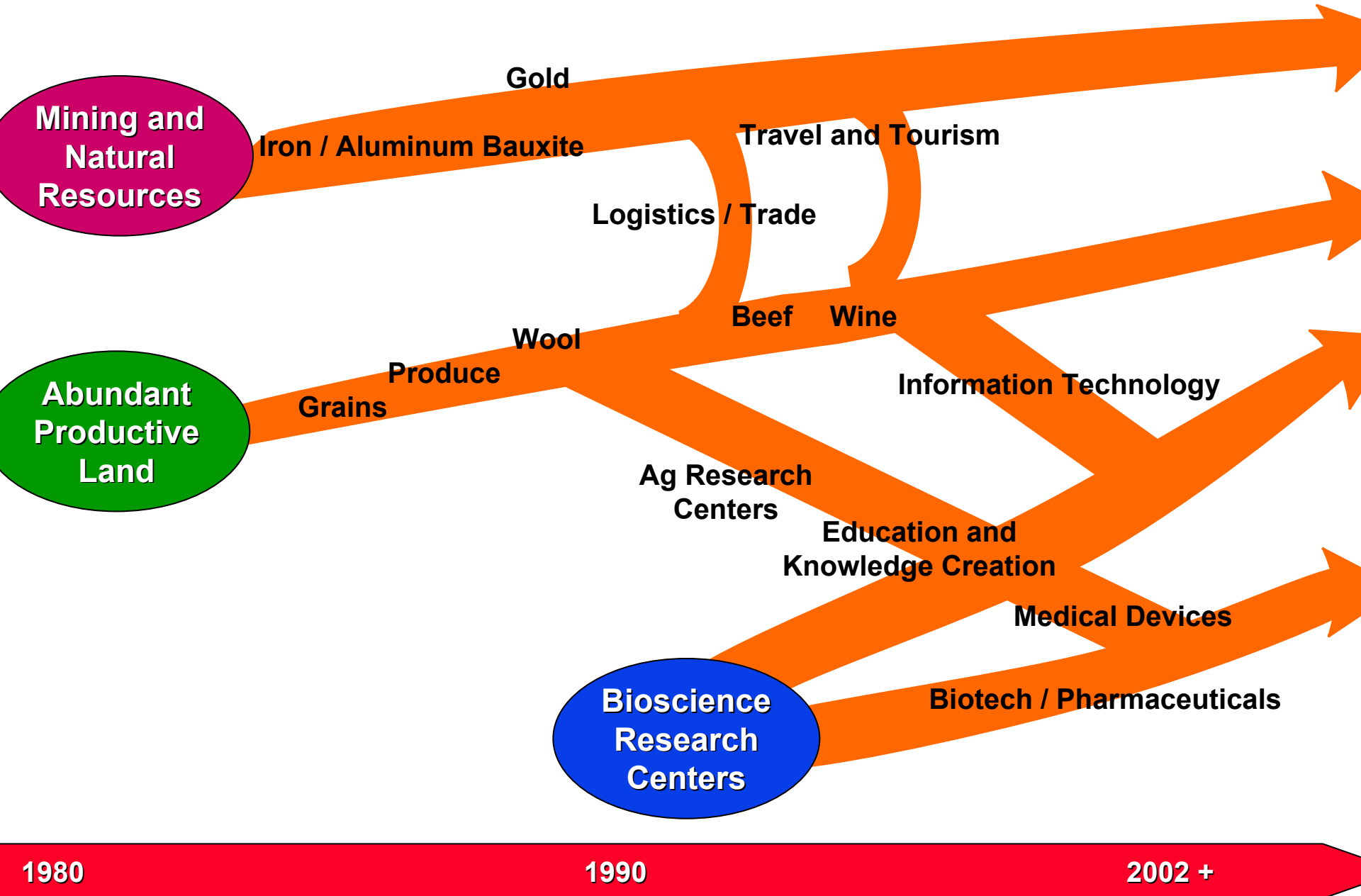
Wine Industry National Education and Training Council

- Established in 1995
- Focus: Coordination, integration, and standard maintenance for vocational training and education
- Funding: Government; other cluster organizations

Wine Industry



The Evolution of Australian Clusters



U.S. Patents by Australian Organization

	Organization	Patents Issued from 1997 to 2001
1	COMMONWEALTH SCIENTIFIC AND IND. RES. ORG.	153
2	SILVERBROOK RESEARCH PTY. LTD	127
3	CANON KABUSHIKI KAISHA	56
4	UNIVERSITY OF QUEENSLAND	42
5	EASTMAN KODAK COMPANY	36
5	UNIVERSITY OF MELBOURNE	36
7	ORBITAL ENGINE COMPANY (AUSTRALIA) PTY. LTD.	34
8	ISHIKAWAJIMA-HARIMA HEAVY INDUSTRIES CO., LTD.	31
9	UNIVERSITY OF SYDNEY	29
10	RESMED LIMITED, AN AUSTRALIAN COMPANY	28
11	AUSTRALIAN NATIONAL UNIVERSITY	19
12	CANON INFORMATION SYSTEMS RES. (AUS) PTY LTD.	18
12	TECHNOLOGICAL RESOURCES PTY, LTD.	18
14	AMRAD CORPORATION LIMITED	17
14	LUDWIG INSTITUTE FOR CANCER RESEARCH	17
16	BIOTECH AUSTRALIA PTY LIMITED	16
16	TELSTRA CORPORATION LIMITED	16
18	COMALCO ALUMINUM LIMITED	15
19	GENE SHEARS PTY. LIMITED	14
20	AUSTRALIAN MEMBRANE AND BIOTECH. RES. INST.	13
20	USF FILTRATION AND SEPARATIONS GROUP INC.	13
22	BHP STEEL (JLA) PTY. LTD.	12
22	SOLA INTERNATIONAL HOLDINGS LTD.	12
22	UNISEARCH LIMITED	12
25	COCHLEAR LIMITED	11
25	IMMULOGIC PHARMACEUTICAL CORP.	11
25	SRP 687 PTY LTD	11
25	WOMEN'S AND CHILDREN'S HOSPITAL	11

Note: Shading indicates universities and research institutions

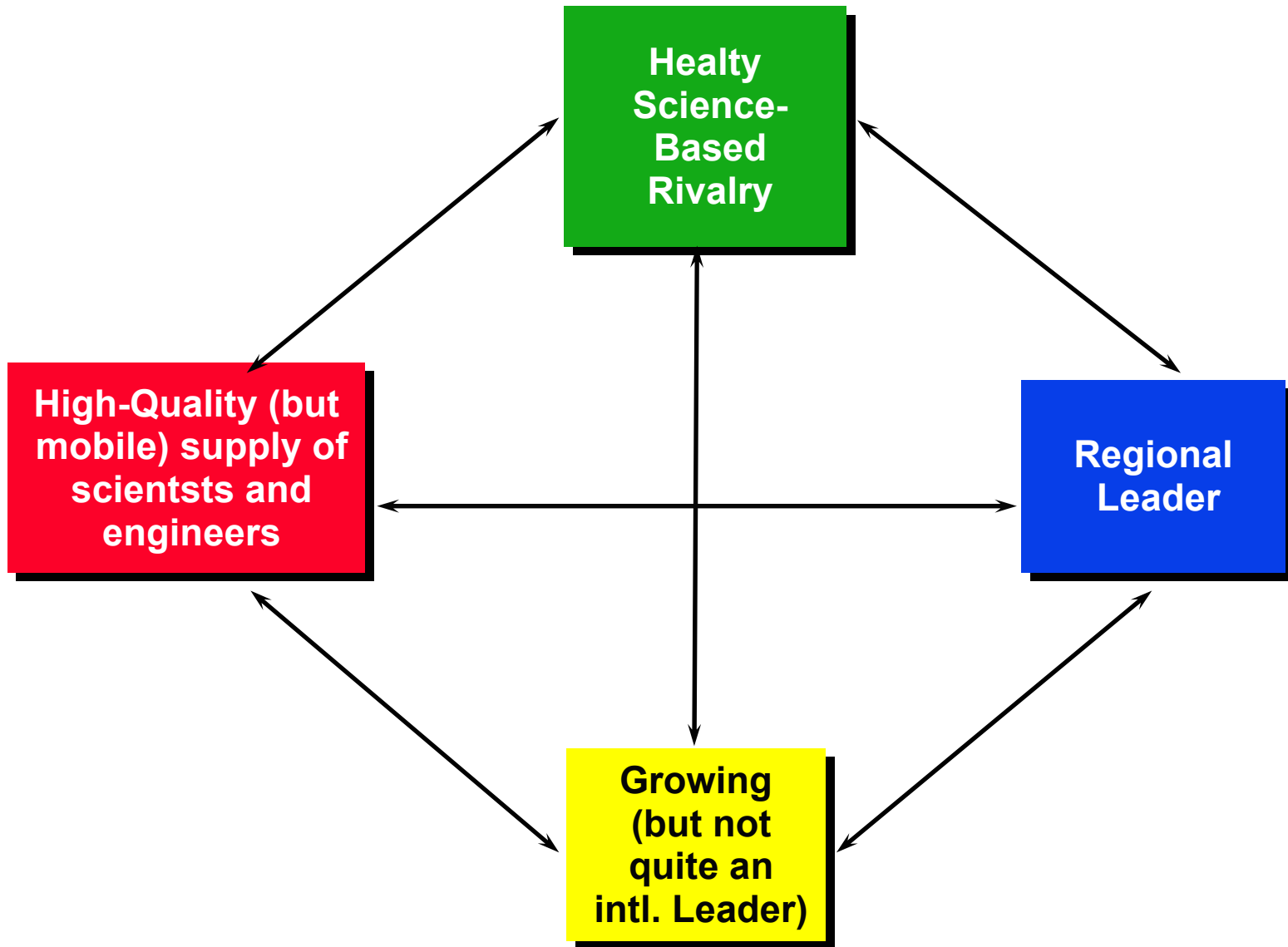
Source: US Patent and Trademark Office (www.uspto.gov). Author's analysis

Patents by Organization

Commonwealth of Massachusetts, 1995–1999

	Organization	Patents Issued from 1995 to 1999
1	DIGITAL EQUIPMENT CORPORATION	382
2	MASSACHUSETTS INSTITUTE OF TECHNOLOGY	369
3	POLAROID CORPORATION	220
4	MASSACHUSETTS GENERAL HOSPITAL	138
5	ANALOG DEVICES, INC.	136
6	HARVARD COLLEGE, PRESIDENT AND FELLOWS	105
7	GENETICS INSTITUTE, INC.	82
8	EMC CORPORATION	82
9	GENERAL ELECTRIC COMPANY	79
10	MOTOROLA, INC.	79
11	QUANTUM CORP. (CA)	79
12	BOSTON SCIENTIFIC CORPORATION	77
13	HEWLETT-PACKARD COMPANY	69
14	CHARLES STARK DRAPER LABORATORY, INC.	66
15	SAINT GOBAIN/NORTON INDUSTRIAL CERAMICS CORP.	65
16	RAYTHEON COMPANY	64
17	BOSTON UNIVERSITY	63
18	BRIGHAM AND WOMEN'S HOSPITAL	62
19	DANA-FARBER CANCER INSTITUTE, INC.	60
20	TEXAS INSTRUMENTS, INCORPORATED	59
21	GILLETTE COMPANY	57
22	SHIPLEY COMPANY INC.	52
23	UNITED STATES OF AMERICA, AIR FORCE	52
24	LISCO, INC.	50
25	HYBRIDON, INC.	48

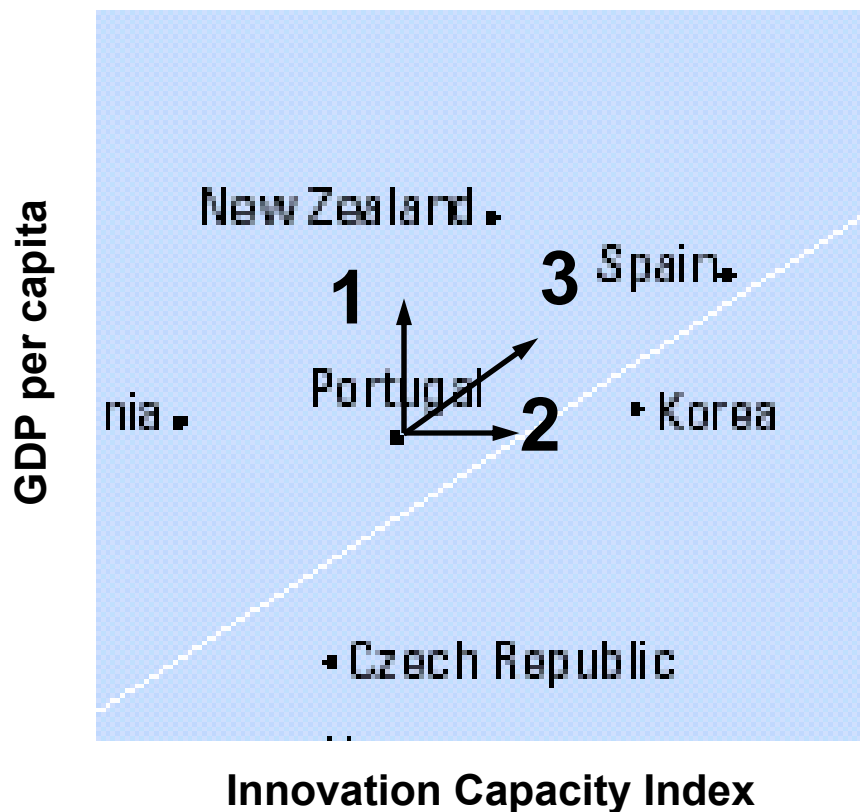
Life Sciences Research and Biotechnology



Outline

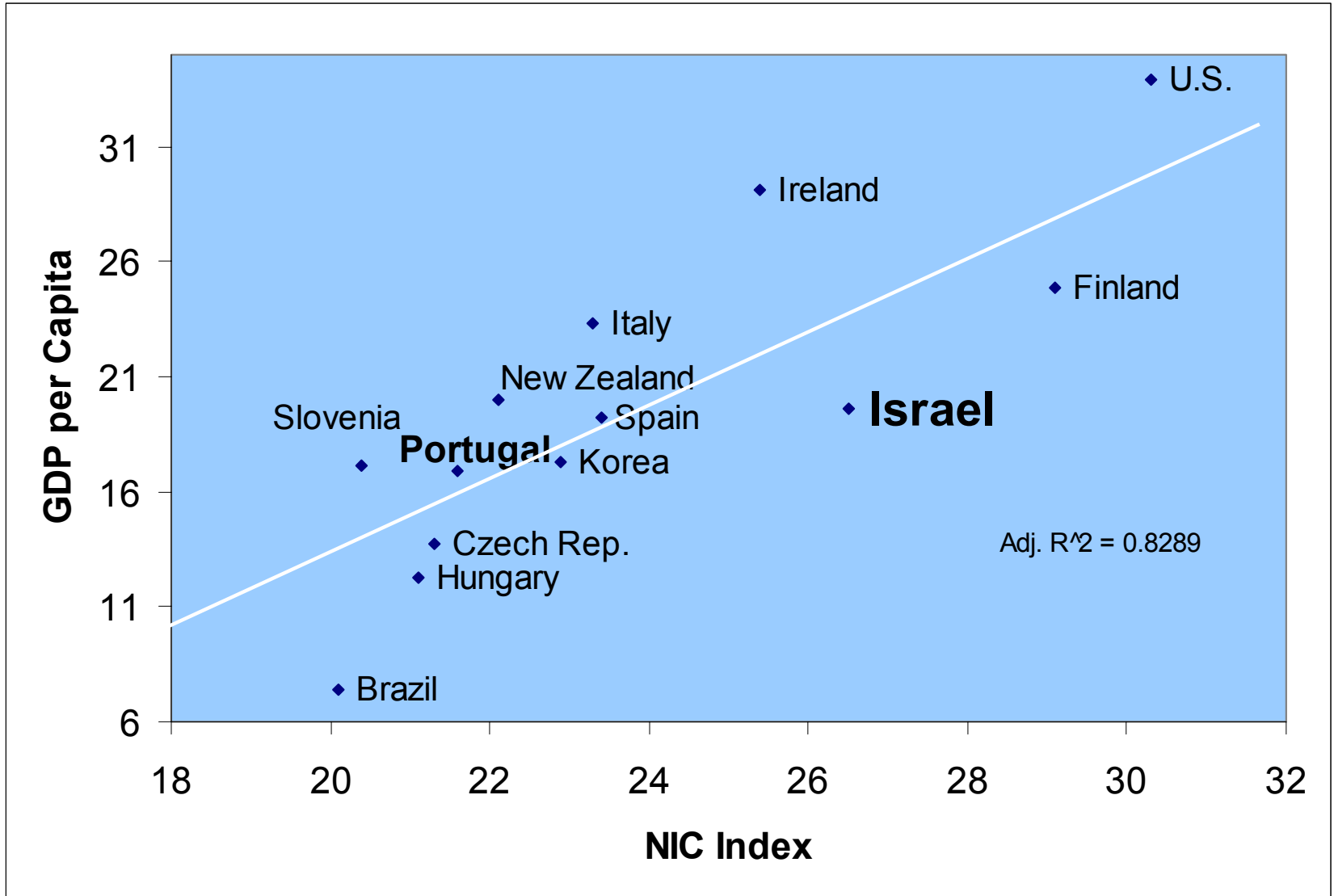
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Competitiveness Strategies: Innovation-Driven or GDP-Driven?

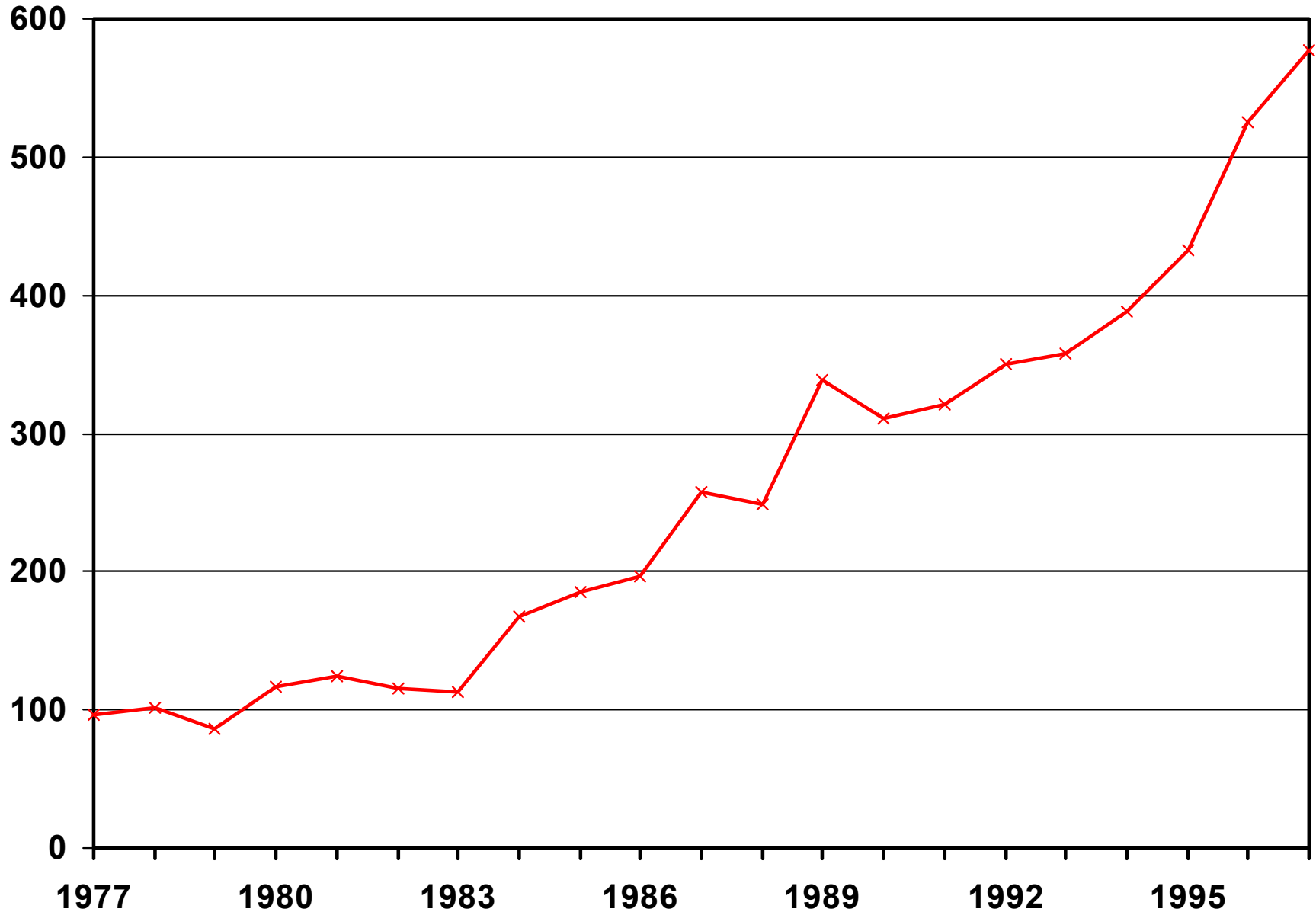


1. Focus on GDP growth through typical '80 – '90 growth strategy....
2. Or focus on building the capacity for world-class innovation, that leads to...
3. Sustainable GDP growth through innovation
 - New Products / Services
 - New Processes
 - New Systems

The Israeli Experience



Israel Has Experienced an International Patenting Surge...



...Driven By High & Growing Innovative Capacity

Common Innovation Infrastructure

- R&D expenditures & human capital
 - R&D expenditure **grows 14%** per year.
- Policy & Resource Commitments
 - **Encouragement** of Industrial R&D
 - Grants which share R&D costs for projects that lead to **know-how, processes or systems.**
 - International Cooperation
 - Encouragement of **joint** R&D, manufacturing and marketing.

• Cluster-Specific Environment for Innovation

- The Incubators Program
 - Support tech entrepreneurs at the *earliest* stages.

• Quality of Linkages

- The Magnet Program
 - Support **consortia** of industrial firms and academic institutions
 - Focus on *pre-competitive* technologies.

Israeli Economic Performance

Performance Indicators by Type of Sector

Annualized rates of change, 1995 - 98

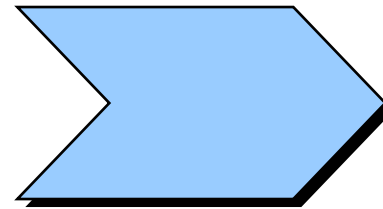
Indicator	Period	Sector		
		Advanced	Mixed	Traditional
<i>Production</i>	<i>1995-96</i>	8.0	6.3	5.9
	<i>1997-98</i>	6.0	0.3	-1.8
<i>Labor Productivity</i>	<i>1995-96</i>	3.5	2.4	4.2
	<i>1997-98</i>	4.5	0.6	2.2
<i>Capital Stock</i>	<i>1995-96</i>	10.7	6.4	9.7
	<i>1997-98</i>	10.0	6.1	6.8
<i>Exports</i>	<i>1995-96</i>	9.0	10.5	2.7
	<i>1997-98</i>	18.5	3.0	-1.4

Source: Bank of Israel, Annual Report for 1998, table B 10 (page 56).

Nurturing Australian Innovative Capacity: An Innovation Policy Agenda

Current Assessment

- Macroeconomic Stability
- Improved Cost / Quality Competitiveness
- Diversifying away from traditional industrial sectors
- Some Examples of Globally Relevant Cluster Development (e.g. Wine and Biotechnology)



**How to Build
Capacity for
World-Class
Innovation?**

Invest in the Common Innovation Infrastructure

- Continue policies encouraging macro stability, growth and effective legal and financial institutions
- Develop and Invest in science and technology **human capital**
 - Potential for substantial increases in scientists & engineers
 - Focus on avoiding “Brain Drain,” particularly for “top tier”
- Strengthen commitment to effective **innovation policy**
 - Openness to international competition and trade
 - Effective protection of intellectual property
 - Tax policy (R&D tax credit)
 - Fiscal policy (Basic Research Investment)
- Substantial education investment **across** society
 - Universal problem-solving skills
 - Maintain access to higher education
 - Sponsorship of postgraduate education opportunity

Encourage Cluster-Based, Export-Led Economic Growth

- Innovation-driven cluster development results from building on **traditional strengths**
 - Traditional sectors can effectively serve as the foundation for innovation-driven **global advantage**
 - Japanese Electronics Cluster
 - Northern Italian Textile Cluster
- Potential number of world-class clusters depends on region size
 - Taiwanese success builds on a **deep** semiconductor cluster
 - Little diversification into biotechnology or even e-business
- Micro-management of commercialization issues hindered by **political pressures and bureaucracy**
- Cluster development should be encouraged which...
 - exploits **local** human resource base
 - are especially **likely** to thrive in the Australian competitive and political environment

















Foster Infrastructure-Cluster Linkages

- Universities Must Continue to Upgrade Their Role as Key Linkages in the Australian innovation system
 - In leading innovator economies, university system provides
 - required training for a technically skilled labor force
 - Undertakes “basic” research investments serving as the **foundation** for a country’s industrial clusters.
 - Though historically isolated from industry and national innovation policy initiatives (relative to the US), Australian universities are playing a key role in one of Australia’s most promising emerging clusters
- Other linking Institutions can serve as **facilitators** of the exchange between the common innovation infrastructure and the innovation-based leadership of national industrial clusters
 - Venture Capital is more than an investment fund
 - Industry Associations can raise the bar through aggressive quality standards and openness to new technologies

Key Lessons

- In a global economy, innovation-based competitiveness provides a **more stable** foundation for productivity growth than low-cost production
- Having secured a position as a leading user of global technology and creating an environment of political stability and regional leadership, Australia has an historic **opportunity** to pursue policies and investments to establish itself as a leading innovator nation
- Australia must build upon a foundation of **openness** to international competition, the **protection** of intellectual property rights, and the enforcement of an **innovation-focused antitrust policy**
- Among the many facets contributing to national innovative capacity, Australia can significantly increase investment in...
 - A **university system** responsive to the science and technology requirements of emerging industrial clusters
 - Incentives for the emergence of **industrial clusters** based on innovation-focused domestic competition
 - Higher education (beyond high school literacy), and, in particular, *incentives* for pursuing **science and technology-based careers** in Australia

The Australian Innovation Policy Agenda

	1980s & 1990s	2000+ ??
Science & Engineering Workforce		 
Educational Investments		 
Nurture Clusters Leveraging Traditional Strength		 
Protection of intellectual property		
Openness to international competition		 
Foster Science & Industry Linkages		 
Upgrading effectiveness of company innovation management		