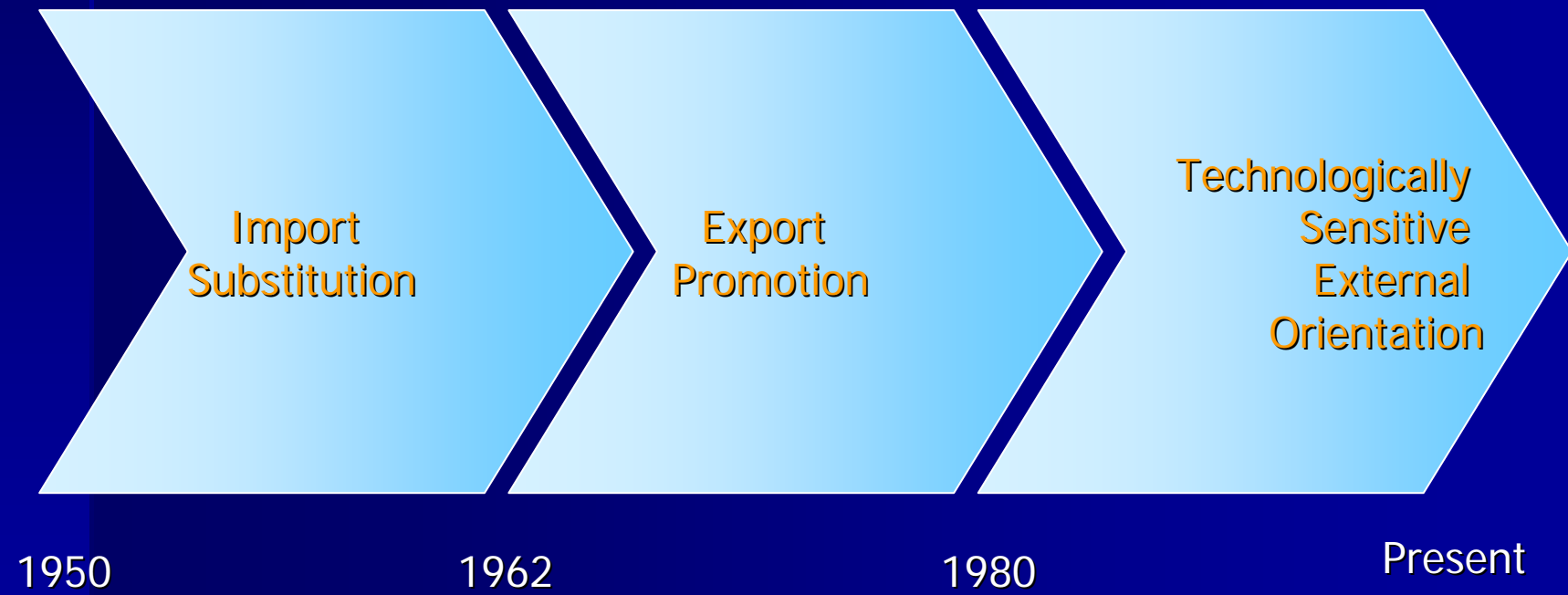


A Unique Style of Innovation

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The Taiwanese Growth Process



- **Import Substitution Phase 1950-1962**

- Labor-Intensive Industries
 - Food & Textile
- Publicly Owned Enterprises Dominated
 - 56.2% of Total Industrial Value-Added (Hou & San 1993)

- **Export Promotion Phase 1962-1980**

- Labor-Intensive Industries (Food & Textile)
- 1970s: Capital Intensive Heavy Industries
 - Petroleum, Chemical, Iron & Steel
- Policies to Export Labor-Intensive Manufactured Goods
- SME Flourished
- Publicly-Owned Enterprises as Upstream Suppliers

Technologically Sensitive External Orientation Phase 1980-

- 1980s: Capital Intensive Heavy Industries
 - Petroleum, Chemical, Iron & Steel
- 1990s: IT & Electronics
- Industrial Technology Research Institute (ITRI)
- Hsinchu Science-based Industrial Park
- Innovation Policy:
 - Offsetting Techno-insufficiency of The Private Sectors
- FDI Policy: Encouraging Technology Diffusion
 - E.g. Labor Mobility
- Moving Production Plans to China
 - Amount of Bilateral Trade btw Taiwan & China Surpassed That btw Taiwan & US since 2002
 - Continue Competing on Low Cost Production

Product Innovation VS. Process Innovation

- Abundance of Experienced Engineers
 - Returned Migration
- Active in Patenting Activities
- Development-Focused R&D

Selected CIS Indicators: Taiwan

Input indicators		Output indicators					
ININT2K	RDINT2K	TURNIN	TURNMAR	INPDT	NTTM	INPCS	INNO
2.8%	1.3%	11.7%	6.0%	20.0%	*	31.0%	40.0%

*ININT2K: Innovation Intensity in year 2000; RDINT2K: R&D Intensity in year 2000; TURNIN: Turnover due to 'new to the firm' products; TURNMAR: Turnover due to 'new to the market' products; INPDT: Introduction of 'new to the firm' products; NTTM: Introduction of "new to the market" products; INPCS: Introduction of new processes; INNO: Innovating firms. Reference year: 2000.

Sources: Pierre Bitard (2003) data from Eurostat NewCronos3 ; Taiwan's Technology Innovation Survey [TTIS-1] (2003) ; the source of RDIN2K in Taiwan is from *Indicators of Science and Technology Republic of China*. (2001).

Selected CIS Indicators: Manufacturing VS. Service Sectors

	Input indicators		Output indicators					
	ININT2K	RDINT2K	TURNIN	TURNMAR	INPDT	NTTM	INPCS	INNO
Manuf.	4.1%	1.2%	17.9%	7.0%	25.0%	*	35.0%	45.0%
Serv.	1.8%	--	6.9%	5.4%	17.0%	*	28.0%	37.0%

*ININT2K: Innovation Intensity in year 2000; RDINT2K: R&D Intensity in year 2000; TURNIN: Turnover due to 'new to the firm' products; TURNMAR: Turnover due to 'new to the market' products; INPDT: Introduction of 'new to the firm' products; NTTM: Introduction of "new to the market" products; INPCS: Introduction of new processes; INNO: Innovating firms. Reference year: 2000.

Sources: Pierre Bitard (2003) data from Eurostat NewCronos3 ; TTIS-1 (2003)

Source of RDIN2K in Taiwan is from *Indicators of Science and Technology Republic of China*. (2001).

Selected CIS Indicators of Manufacturing & Service Sectors in Taiwan

	ININT2K	RDIN2K	INPDT	INPCS	INNO
Manufacturing industry	4.1%	1.23%	25.0%	35.0%	45.0%
Food, Beverages & Tobacco	2.2%	0.36%	<u>28.0%</u>	<u>46.0%</u>	<u>50.0%</u>
Textiles, Wearing Apparel, Fur & Leather	<u>4.8%</u>	0.40%	18.0%	34.0%	41.0%
Wood, Paper, Printing, Publishing	4.3%	0.13%	12.0%	33.0%	39.0%
Coke, Petroleum, Nuclear Fuel, Chemicals & Products, Rubber & Plastics	2.5%	<u>0.71%</u>	<u>30.0%</u>	<u>37.0%</u>	<u>48.0%</u>
Non-Metallic Mineral Products	2.5%	0.24%	20.0%	35.0%	40.0%
Basic Metals	1.9%	0.17%	12.0%	32.0%	38.0%
Fabricated Metal products	3.3%	0.22%	25.0%	32.0%	43.0%
Machinery Equipment, Instruments & Transport Equipment	<u>5.2%</u>	<u>2.06%</u>	<u>36.0%</u>	<u>37.0%</u>	<u>52.0%</u>
Furniture, Other Manufacturing nec	<u>5.7%</u>	<u>0.47%</u>	25.0%	33.0%	43.0%
Service industry	1.8%	--	17.0%	28.0%	37.0%
Wholesale, Ret.Trad., Mot.Veh. Repair etc	1.3%	--	12.0%	29.0%	32.0%
Hotel & Restaurants	1.8%	--	18.0%	29.0%	31.0%
Transport & storage	1.0%	--	15.0%	26.0%	35.0%
Communications	<u>6.6%</u>	--	<u>43.0%</u>	29.0%	43.0%
Financ. Intermediation (inc. Insur.)	1.9%	--	<u>36.0%</u>	<u>39.0%</u>	<u>53.0%</u>
Real Estate, renting & Busin. Activ.	<u>4.0%</u>	--	<u>20.0%</u>	<u>33.0%</u>	<u>41.0%</u>
Comm., Soc. & Pers. Serv. Activ., etc	1.1%	--	<u>36.0%</u>	<u>50.0%</u>	<u>61.0%</u>
Total	2.8%	1.25%	20.0%	31.0%	40.0%

Main Actors of Innovation

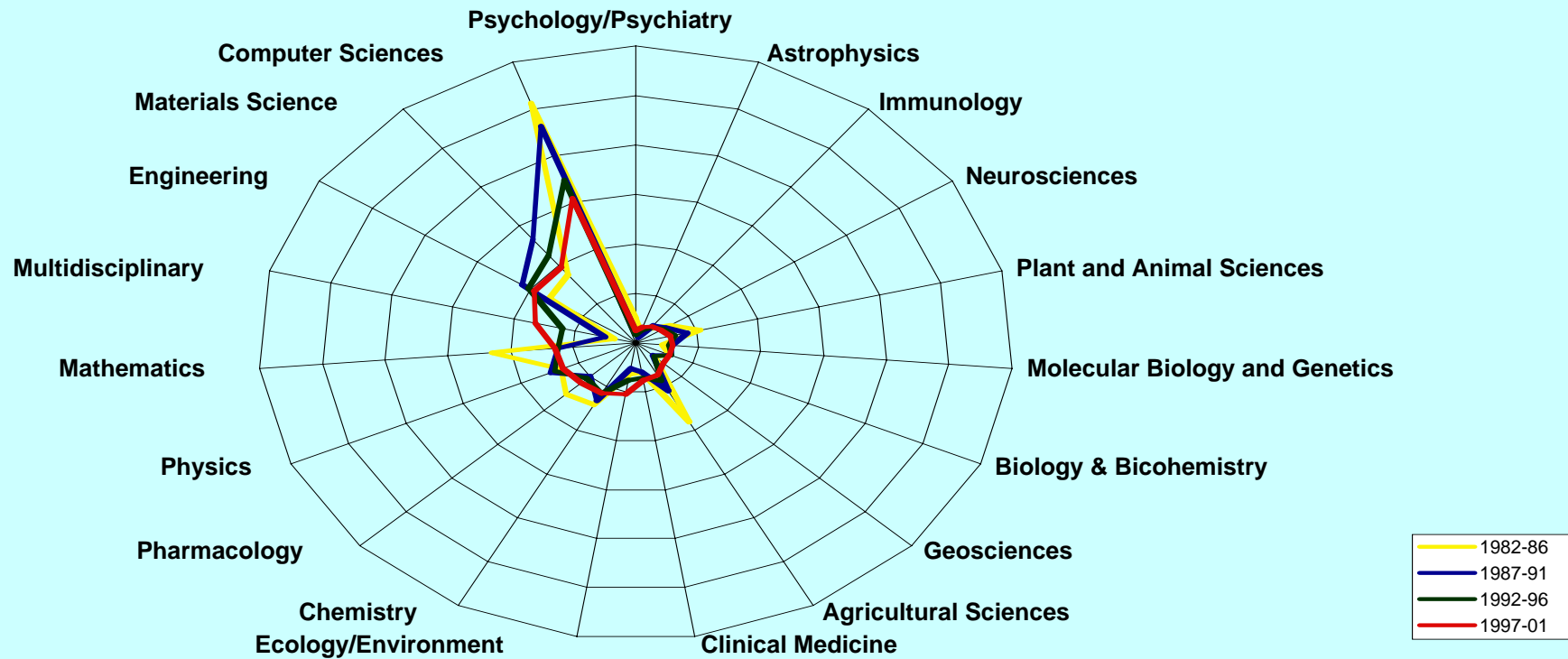
- Lead State Agencies
 - STAG, CEPD, MOEA, NSC....
- Firms
 - Network of SMEs (core-satellite system)
 - TNCs -> market demand & technological learning
- Research Organizations
 - ITRI, CSIST, ...
- Venture Financing
 - VC & Angels

Funding Sources at Different Stages of Enterprise Development in Taiwan

Development Stage	Type of Funding Required	Source of Funds					
		Government	Commercial Banks	Special Banks	Capital Markets	VC Companies	Individual Investors
Planning	Seed capital	X					X
Establishment	Funding for establishment and expansion funding	X		X		X	X
Mass production	Working capital and expansion funding	X	X	X		X	X
Expansion	Expansion funding		X	X		X	X
Maturity	Mature funding		X		X		X
Reorganization	Reorganization funding	X	X		X		X

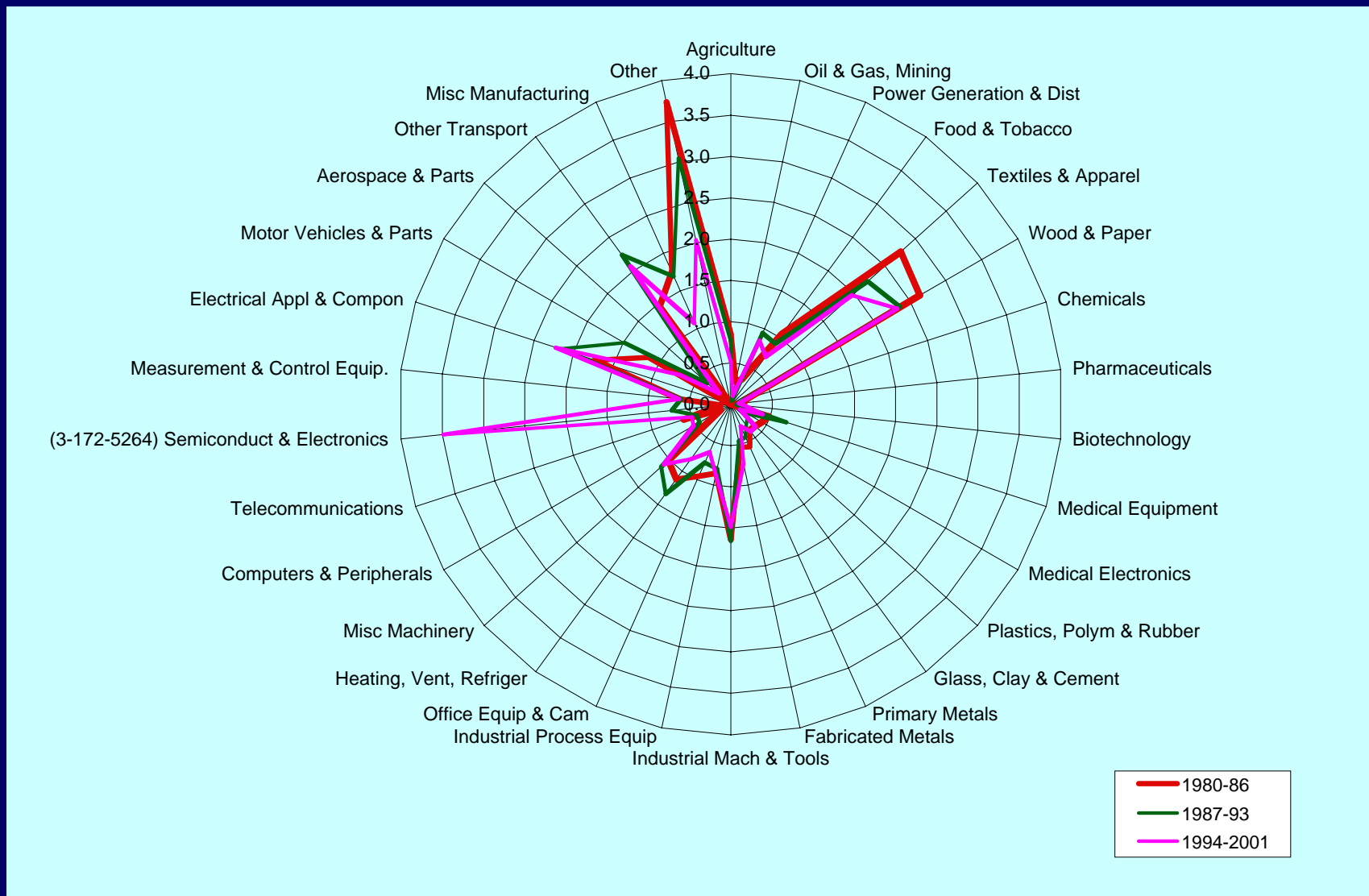
Source: Yang (2002).

Evolution of Scientific Areas in Taiwan



Source: Wang, K., et al., (2003) Intensities of Scientific Performance: Publication and Citation at a Macro and Sectoral Level of All the Nine Countries, (version of 2003-11-20), paper presented at ESF/Eurocores Taipei Workshop.

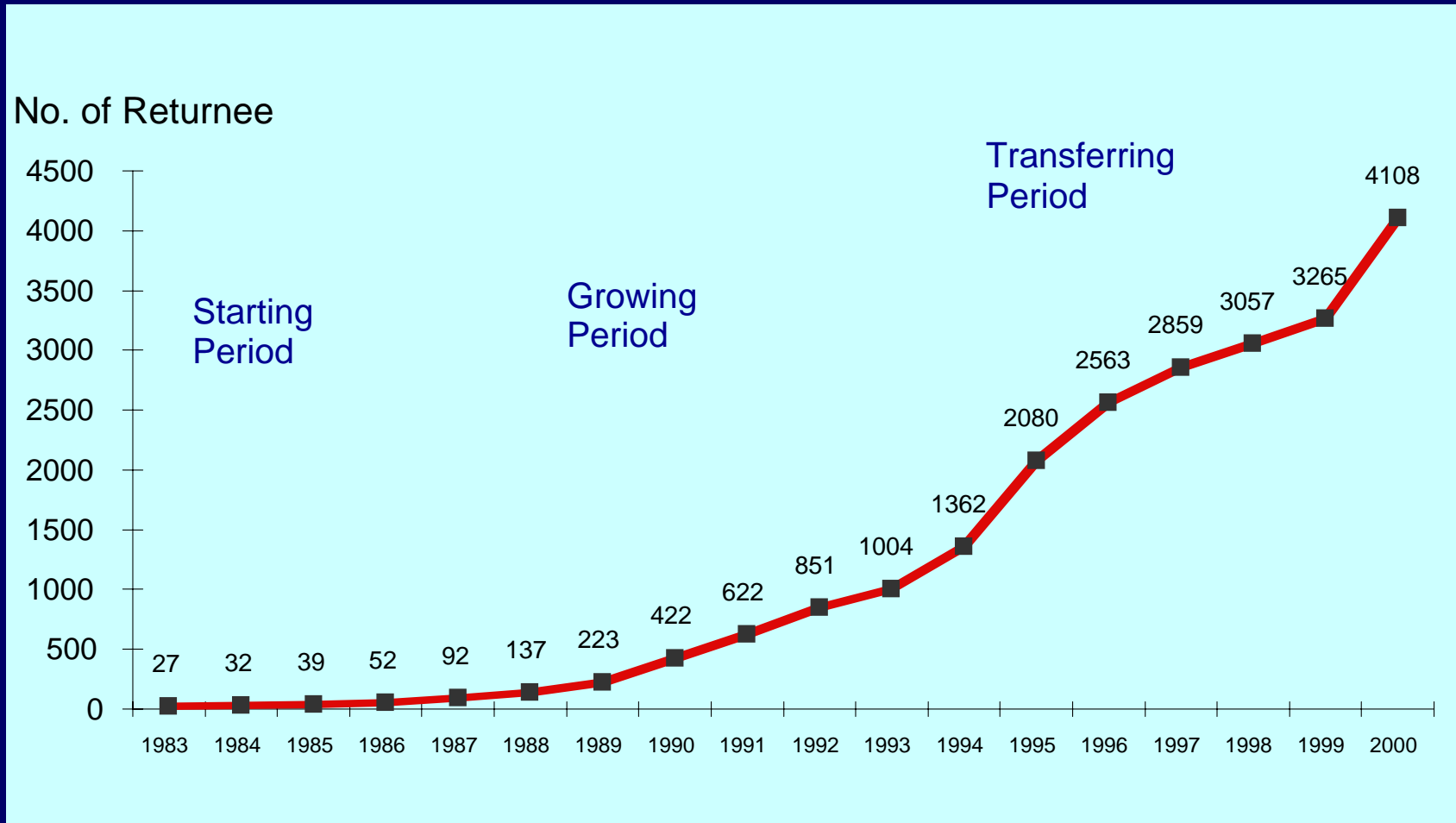
Patent Specialization Pattern of Taiwan



Source: Balaguer, A., et al., (2004). *STIC Eurocores Working Paper Series - Technological Specialization in Small and Open Economies*, Taipei: STIC-NSC.

Improvement of The Manpower Profile

Number of Returnees in Hsinchu Science Industrial Park



Source: Science Park Administration.

Public Policies & Institutions

- Development of Domestic Technology Capability
- Importation of Foreign Technologies
- Mechanisms for Technology Diffusion
- Assistance to The Development of Products
- Financial & Tax Benefit Policies
- Development of Science Parks & R&D Centers

Strength & Weakness of The Taiwanese System

■ Advantages

- Advanced & Sophisticated Industrial Customers
- Vertically Integrated Industrial System
- Effective Mechanism for Diffusion and Learning
- Incremental Innovation in High Tech Manufacturing
- Knowledge & Skills on Production Network Management

■ Mismatches

- Weakness in Critical Areas of Innovation Infrastructure
- Lack of Production Innovation Capability
- Weak Basic/ Long-Term Research
- R&D Efforts in Advanced Sectors May Be Overly Exaggerated
- Low R&D Intensity in Non-Electronics Industries
- Weak Legal Framework for R&D Collaboration
- Slow Transformation of The Common Innovation Infrastructure

Globalization & Taiwan

- Role of Foreign MNCs
- Outward Globalization VS. Inward Globalization
- Rise of China
- Human Resource Mobility
- Region-Specific Strategies

Comparison of BERD AS A Percentage of GDP

	1999	2000	2001	2002	95'-02' AGR(%)
Japan	2.10	2.12	2.26	2.32	4.0
Korea	1.76	1.96	2.23	2.18	7.3
Taiwan	1.31	1.30	1.37	1.43	8.4
Singapore	1.20	1.17	1.33	1.32	13.6

Source: OECD, Main Science and Technology Indicators 2004/1, May 2004.

Structure of BERD (1995 vs. 2001)

	Total Manufactur.		Hi-Tech Manufacturing											
			Hi-Tech total		Pharm.		OA & comput.		Electronic		Aerospace		Instrument	
	1995	2001	1995	2001	1995	2001	1995	2001	1995	2001	1995	2001	1995	2001
(%)														
TWN	97.1	92.4	51.0	66.0	1.2	1.1	15.8	18.2	3.8	43.7	0.1	0.7	1.5	2.3
JPN	96.2	90.6	37.8	40.5	6.8	7.1	9.0	13.0	17.5	15.3	0.7	0.8	3.8	4.3
SKO	83.3	82.8	37.0	51.4	1.4	2.2	1.8	7.8	31.6	36.2	1.5	3.8	0.7	1.4

Source: Wu, R.I. and Lin, H.Y., (2004) "Mapping Taiwan's competitiveness of R&D and Innovation," International Conference on 2004 Industrial Technology Innovation: Growth Engines of the Innovation-driven Economy. August 19-20, Taipei.

Structure of BERD by Fund Source – 2002

(%)	Government	Business enterprise	Abroad	Other national resource
Japan	0.97	97.91	0.49	0.63
Taiwan	1.71	98.24	0.01	0.44
Korea	6.40	93.02	0.50	0.08
Singapore	8.72	79.45	11.37	0.46

Source: Wu, R.I. and Lin, H.Y., (2004) "Mapping Taiwan's competitiveness of R&D and Innovation," International Conference on 2004 Industrial Technology Innovation: Growth Engines of the Innovation-driven Economy. August 19-20, Taipei.

Knowledge Investment of GDP in 2000

%	R&D	Software	HE	Total	AGR% (1992-2000)
Korea	2.7	0.5	2.3	5.4	..
Japan	3.0	1.1	0.6	4.7	3.4
Taiwan (2000)	2.1	0.6	1.3	3.9	..
Taiwan (2001)	2.2	0.9	1.9	4.9	..

*HE-Higher Education

Source: Wu, R.I. and Lin, H.Y., (2004) "Mapping Taiwan's competitiveness of R&D and Innovation," International Conference on 2004 Industrial Technology Innovation: Growth Engines of the Innovation-driven Economy. August 19-20, Taipei.

Total Public Expenditure on Education as A Percentage of GDP (1995, 2000)

		%	Taiwan	Japan	Korea	OECD mean
2000	All levels (%)		4.3	3.6	4.3	5.2
	Tertiary education (%)		0.7	0.5	0.7	1.2
1995	All levels (%)		5.5	3.6	...	5.4

Note: 1. In Taiwan, expenditures on educational administration and social education are not included after year 2000.

2. Subsidies on private sector are included in Taiwan.

Source: 1. OECD (2002, 2003), Education at a Glance OECD Indicators, 2003, Tab. B4.1; 2002, Tab. B3.1)

2. Department of Statistics, Ministry of Education (2003), Educational Indicators: An International Comparison, Tab. 4-3.

Tertiary Graduates, by Field of Study & Level of Education (2000)

	Edu.	Art	Social S.	Services	Engin.	Agr.	Health	Life S.	Physics	Math.	Comp.	N
Taiwan	7.2	10.3	26.9	1	23.9	3.4	7.3	4.2	1.2	2.6	6.3	5.7
Japan	6.3	18.1	37.2	x(12)	21.3	3.4	5.2	4.4	x(8)	x(8)	x(8)	4
Korea	5.6	20.9	22.8	2.5	27.4	3.2	6.6	2.1	4.4	2.1	2.4	a
OECD mean	13.2	12.3	33.5	33.5	13.2	2.3	11.5	3.1	3	1.1	3.1	0.9

Note: 1 Edu-Education; Art- Humanities and arts; Social S.-Social sciences, business and Law; Engin.-Engineering, manufacturing and construction; Agr.-Agriculture; Health-Health and welfare; Life S.-Life Science; Physics-Physical science; Math.-Mathematics and statistics; Comp.-Computing; N-Not known or unspecified.

2x indicates that data are included in another column. The column reference is shown in brackets after "x". e.g., x(2) means that data are included in column 2.

Source: 1. Department of Statistics, Ministry of Education (2003), Educational Indicators: An International Comparison, Tab. 3-3, p.35.

2. OECD (2002), Education at a Glance, Tab. A4.1

Summary of Taiwanese Scientific Performance within Asian 4

Scientific area	Specialization rate	Growth rate	Scientific impact
Electronics and information technology			
Materials Science	High	High	Competitive(2)
Physics	High	High	Fairly Competitive(1)
Electrical Engineering	High	Medium	Fairly Competitive(1)
Mechanical Engineering	High	High	Competitive(2)
Computer Science	High	High	Fairly Competitive(1)
Pharmaceutics and medical technology			
Biomedical Sciences	High	High	Weak(3)
Basic Life Sciences	High	Medium	Competitive(2)
Clinical Medicine	High	High	Weak(3)
Pharmacology	Medium	High	Fairly competitive(1)
Chemicals and chemical technology			
Chemistry	High	High	Fairly Competitive(1)
Chemical Engineering	Medium	Medium	Competitive(2)
Fuels and Energy	Low	High	Weak(3)
Food technology, biotechnology and environmental technology			
Environmental Sciences	Medium	High	Competitive(2)
Food Science and Agriculture	Medium	Medium	Weak(3)

Conclusion: A Regional Perspective

- Offering Taiwan's Unique Process Innovation
- Combining Strengths of Others
 - Japan's Advanced Research & Development
 - Korea's Strong Corporations
 - Singapore's Financial/ Service Specializations
 - China's Cost Advantage & Market Share
- Better Flow & Exchange of Technology
- Promoting A More Innovative, Collaborative Asia-Pacific Economy