

Measuring Productivity-Enhancing Effects of Patent Information Policy

Findings from Patents-by-Industry Data in Korea

Sanghoon Ahn

Head, Public Investment Evaluation Division

Korea Development Institute (KDI)

C O N T E N T S



Why Korea?

Entry and Growth of SMEs in Korean Manufacturing

Innovation and Productivity Growth

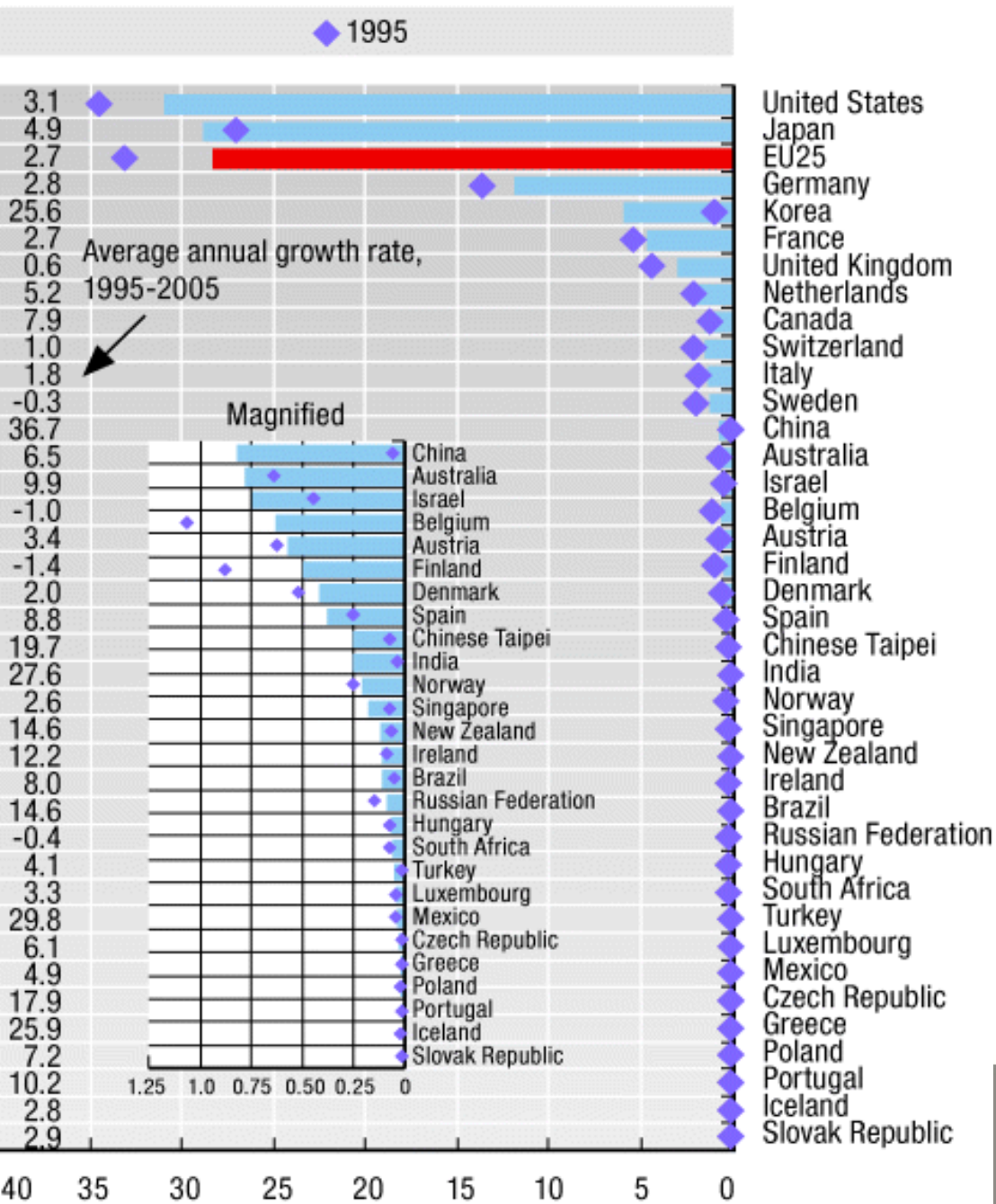
Patent Information Policy and Patent Applications

Patent Information Policy Expenditures and Job Creation

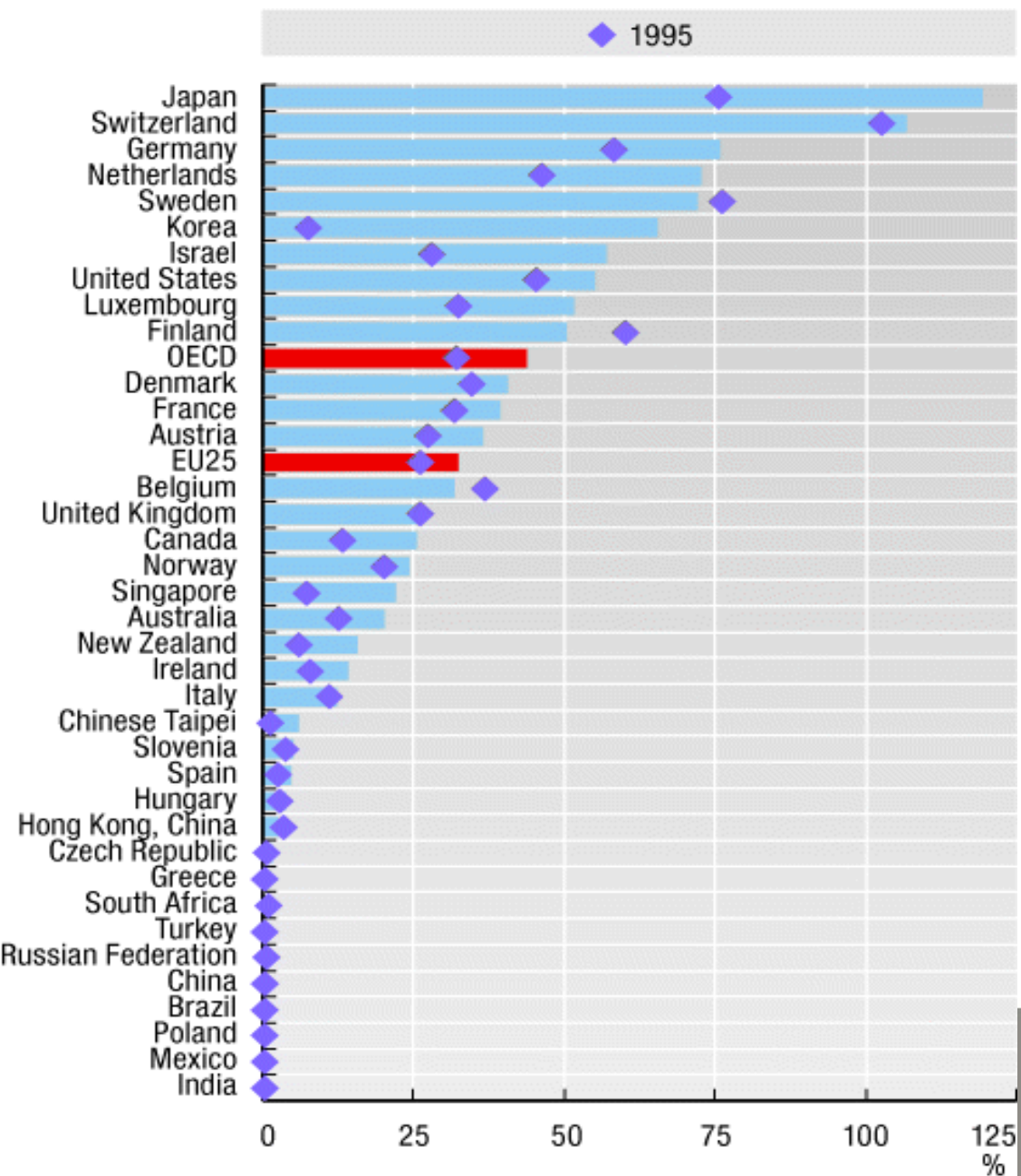
Part-00

| Why Korea?

KDI

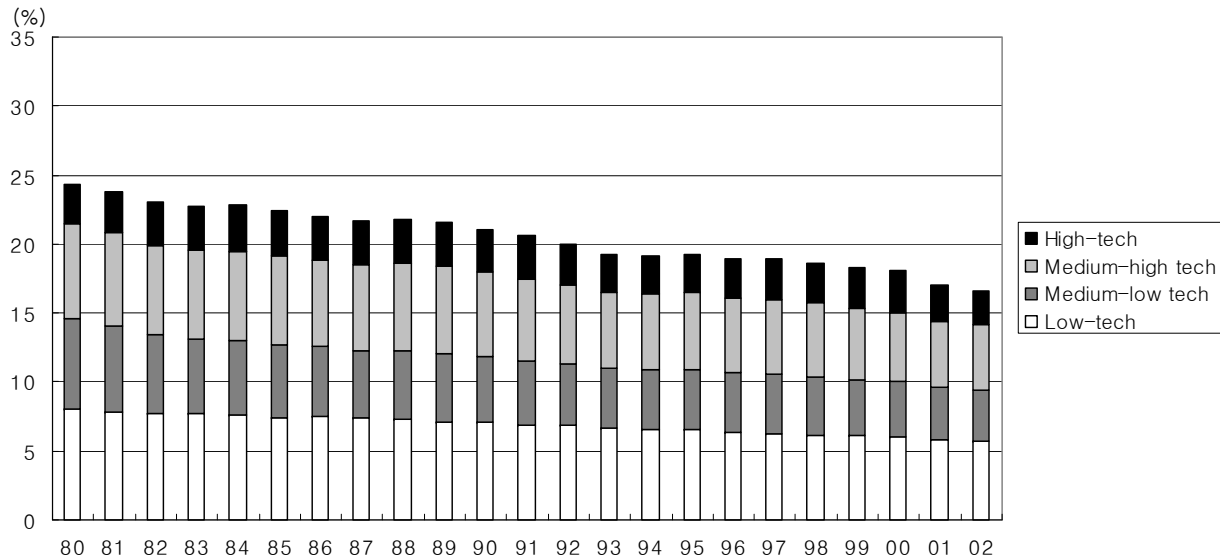


Source: OECD STI Scoreboard 2007

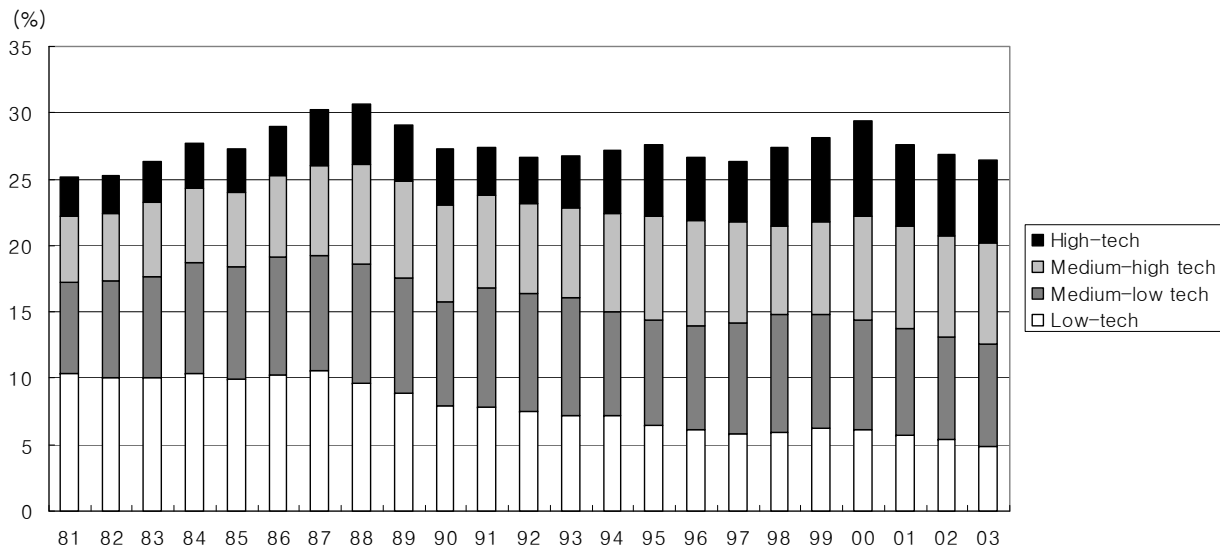


Source: OECD STI Scoreboard 2007

Trend in value-added share of manufacturing industry (by technology level)



G7



Korea

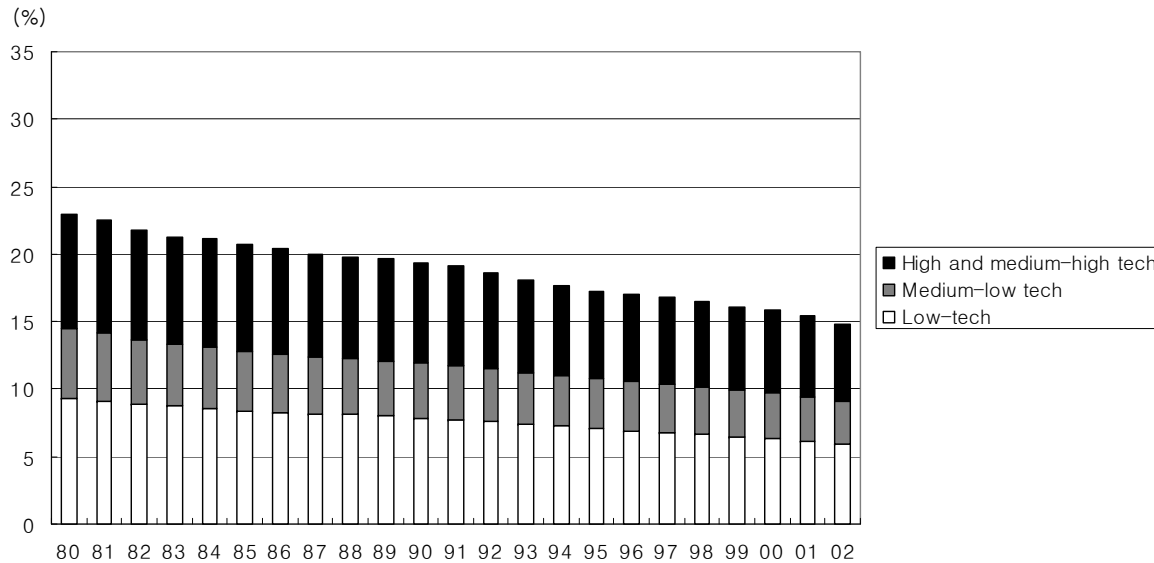
Source: *OECD STAN Indicators database, 2005*

Korea's Leading Think Tank

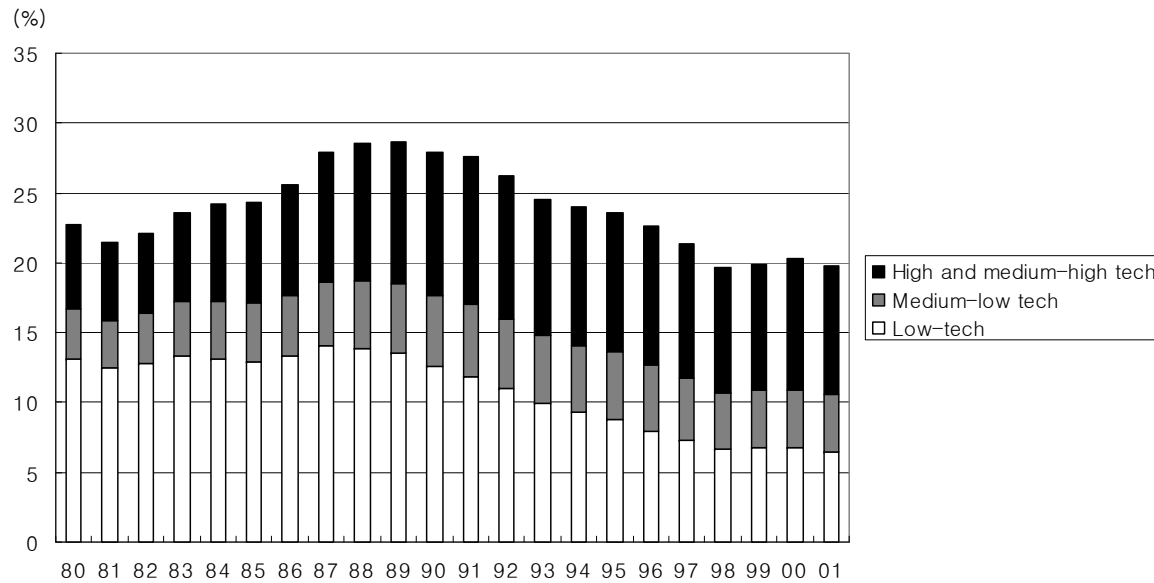
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Trend in employment share of manufacturing industry (by technology level)

G7

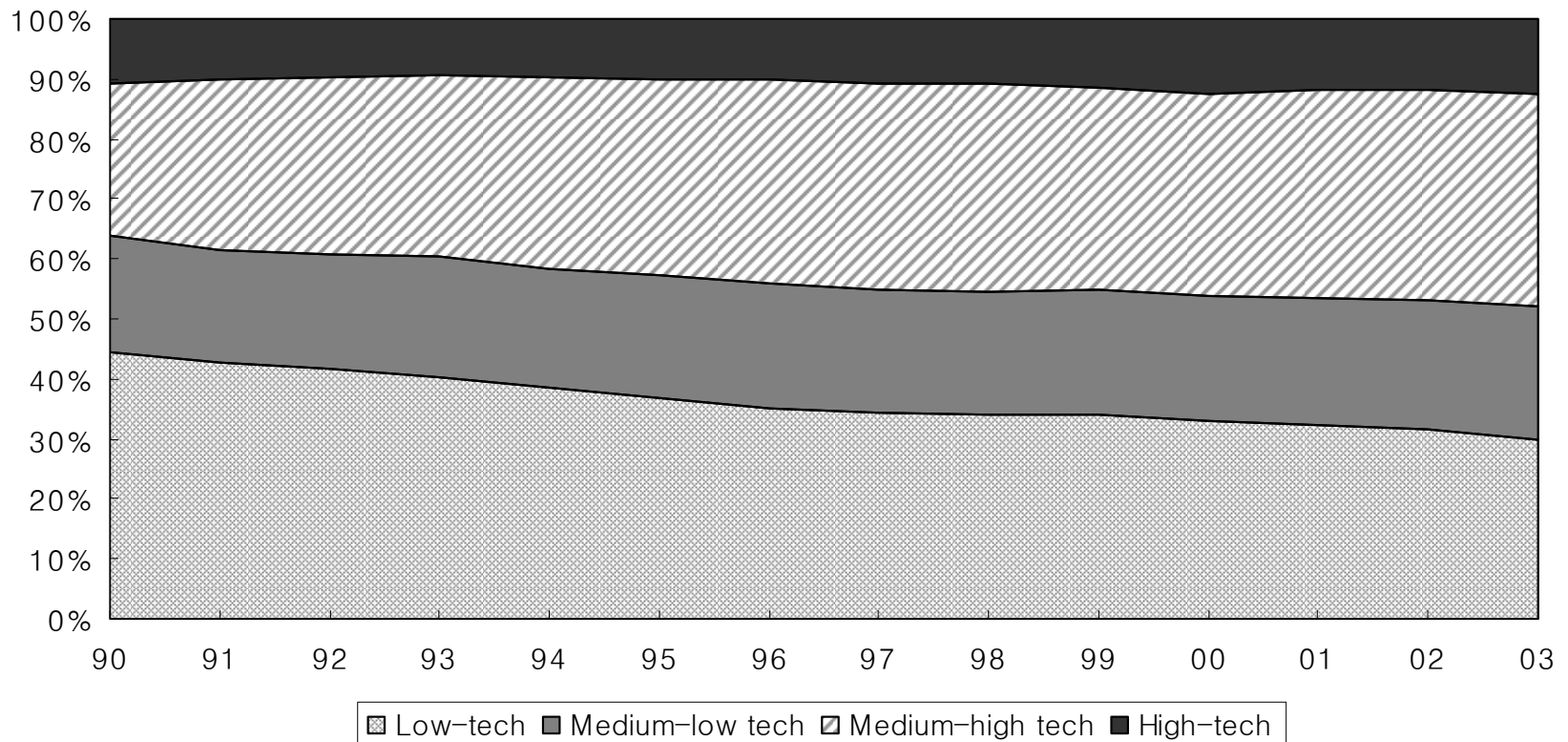


Korea



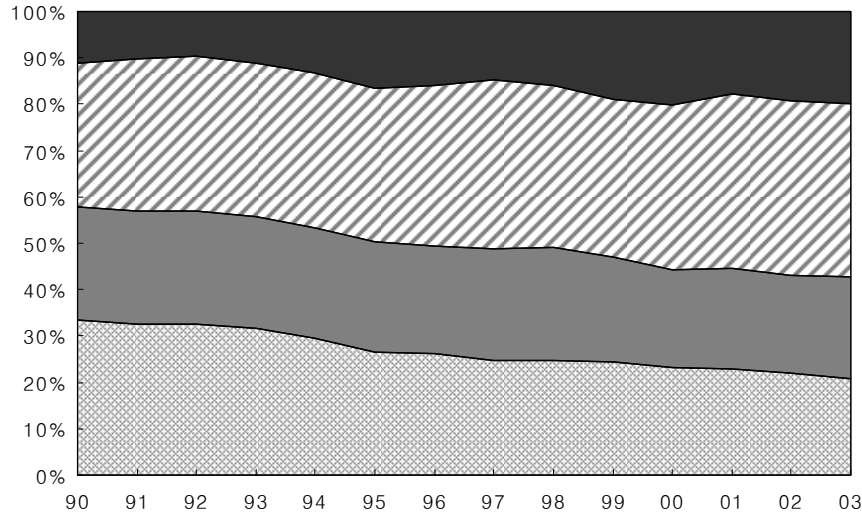
Source: OECD STAN Indicators database, 2005

Employment share of industries within manufacturing industry (by technology level)

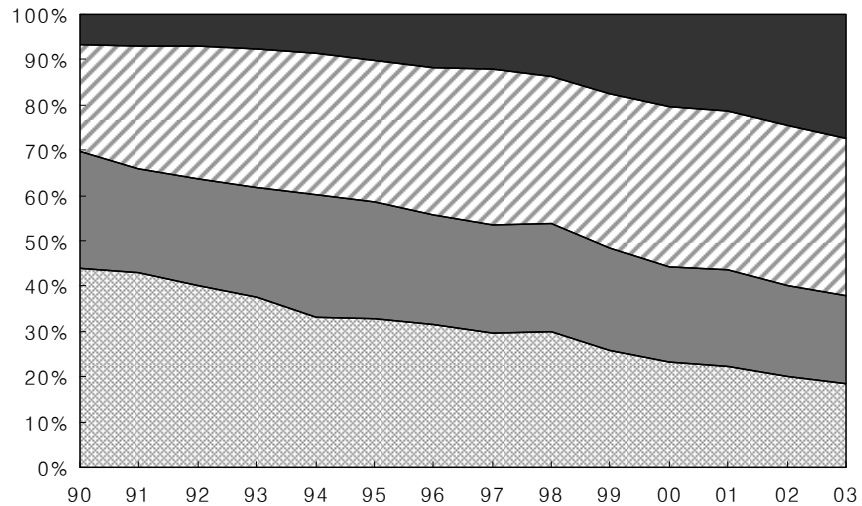


Author's calculation based on the micro-data of
Annual Survey on Mining and Manufacturing, National Statistics Office

Value-added share of industries within manufacturing industry (by technology level)

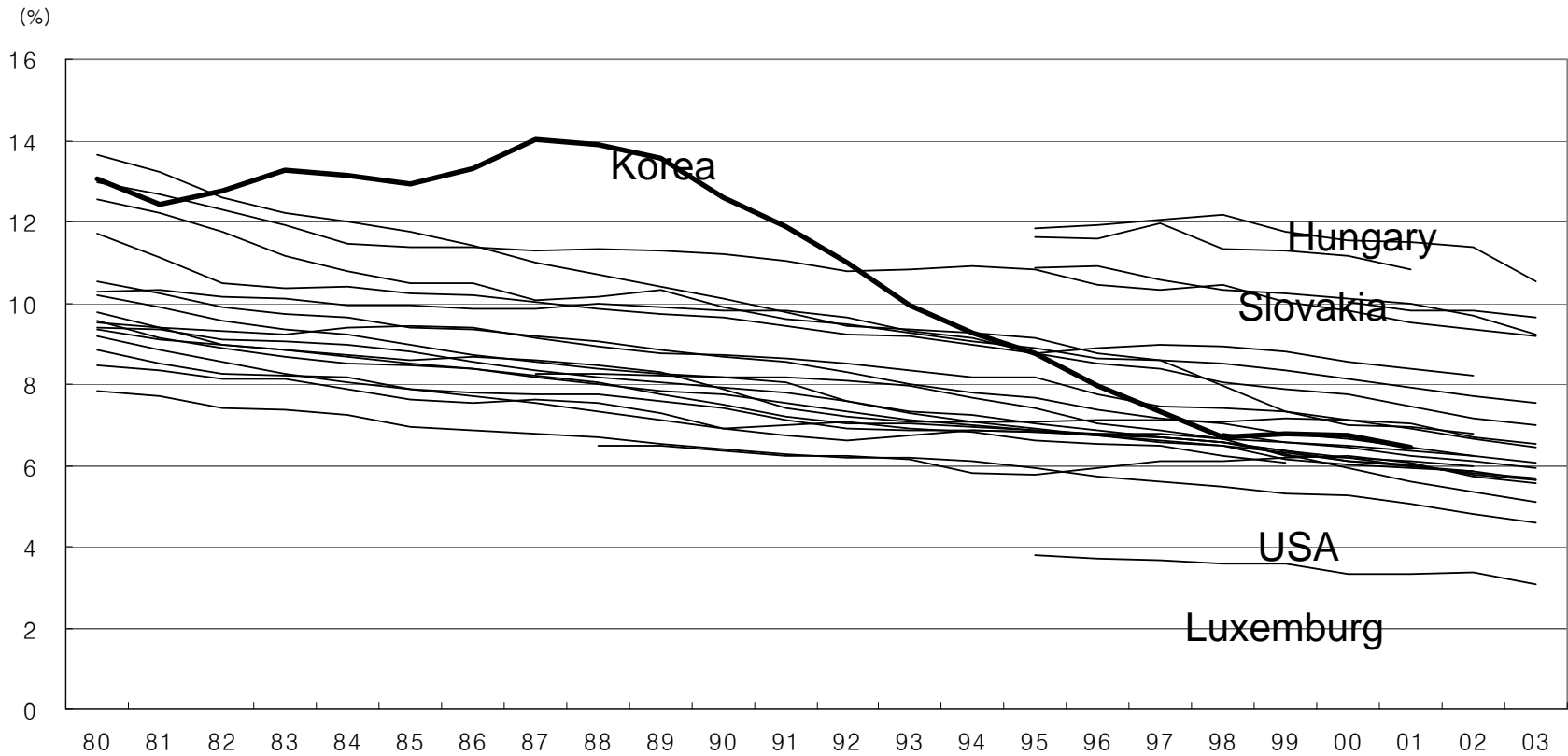


**Nominal
Value-added**



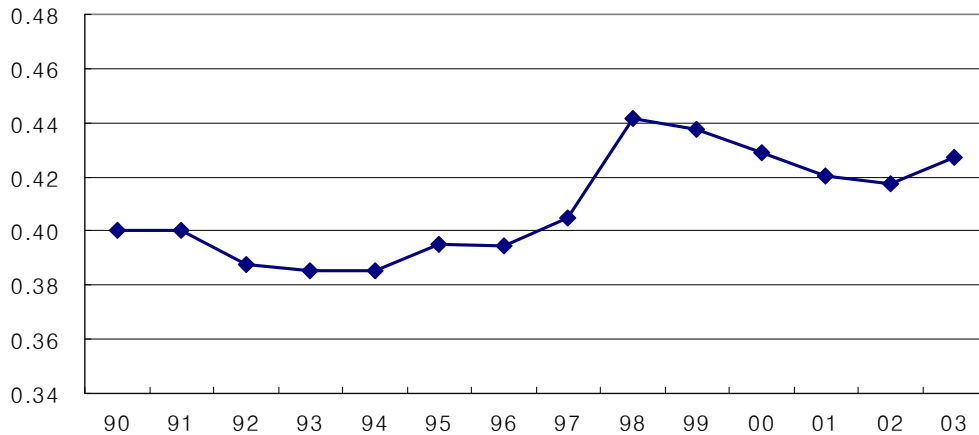
**Real
Value-added**

Trend in employment share of OECD countries by sector: Low-tech manufacturing industry

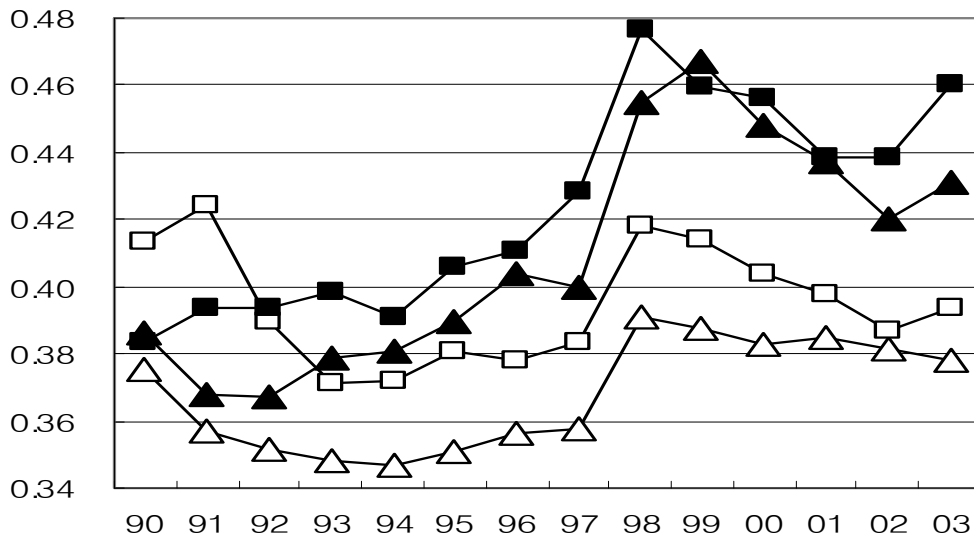


Source: *OECD STAN Indicators database, 2005*

Trend in inequality of labor productivity (Gini Coefficient) by firm



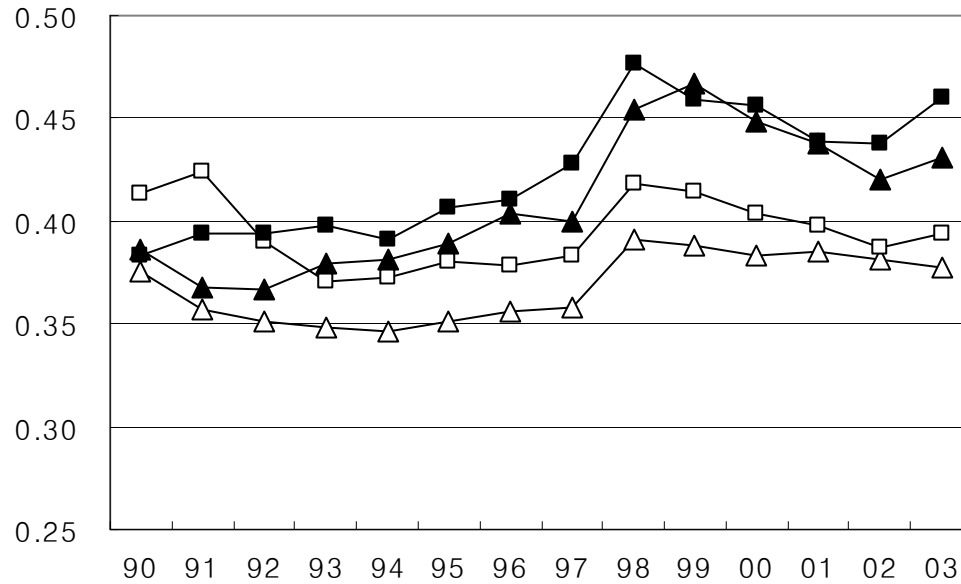
Manufacturing industry



by technology level

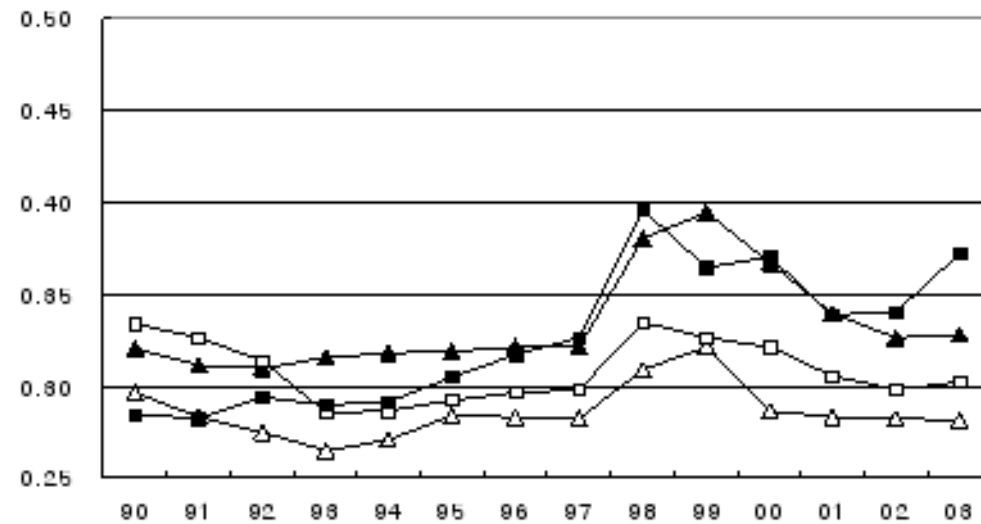
- ▲ High-tech
- △ Medium-high tech
- Medium-low tech
- Low-tech

Comparison of inequality index and bipolarization index (manufacturing industry)



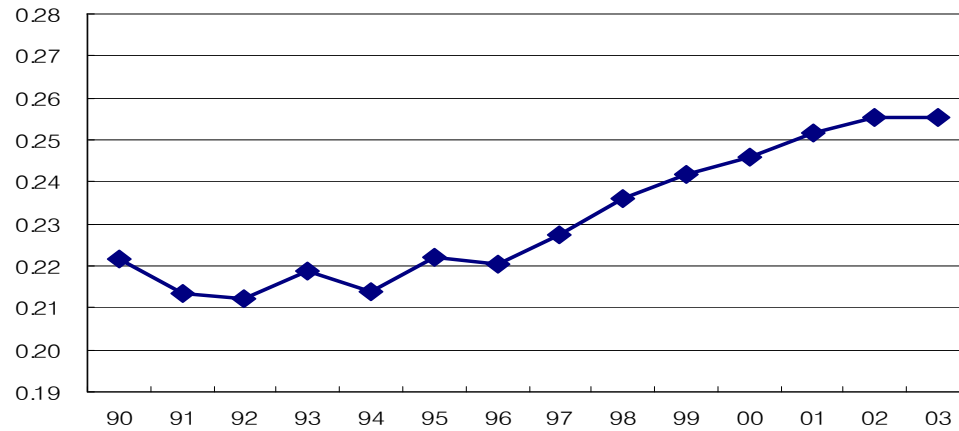
**Inequality index
(Gini Coefficient)**

- ▲ High-tech
- △ Medium-high tech
- Medium-low tech
- Low-tech

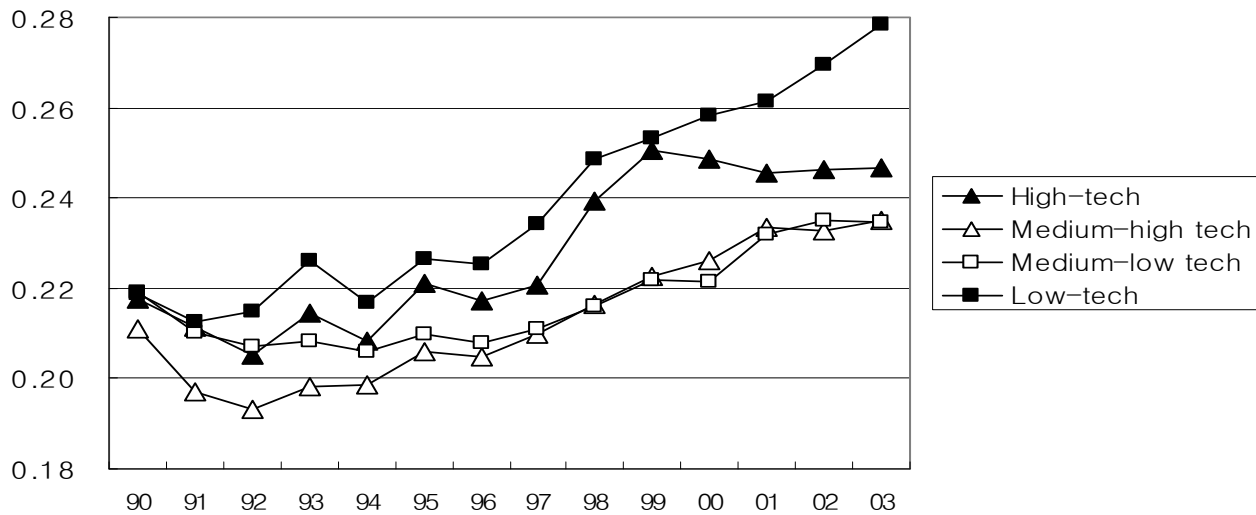


**Bipolarization index
(Wolfson Index)**

Trend in inequality of average wage (Gini Coefficient) by firm

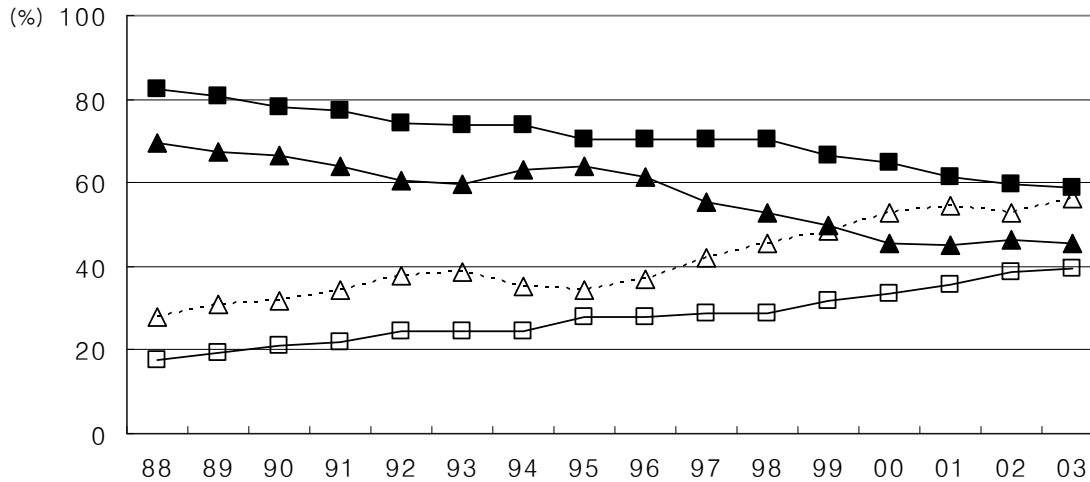


Manufacturing industry

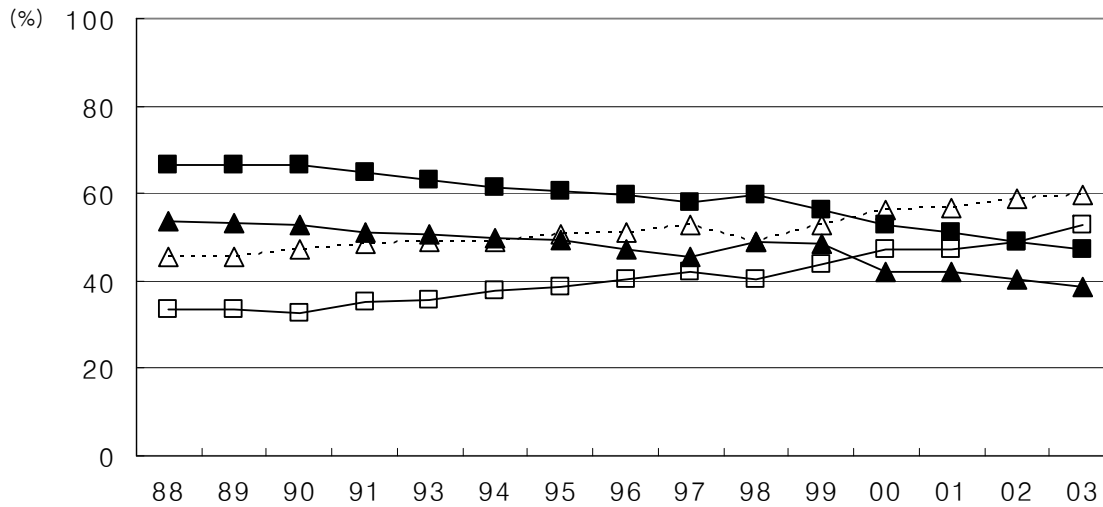


by technology level

Trend in import share of final and intermediate goods by region



Korea



Japan

- Intermediate goods from non-OECD countries
- Intermediate goods from OECD countries
- △--- Final goods from non-OECD countries
- ▲— Final goods from OECD countries

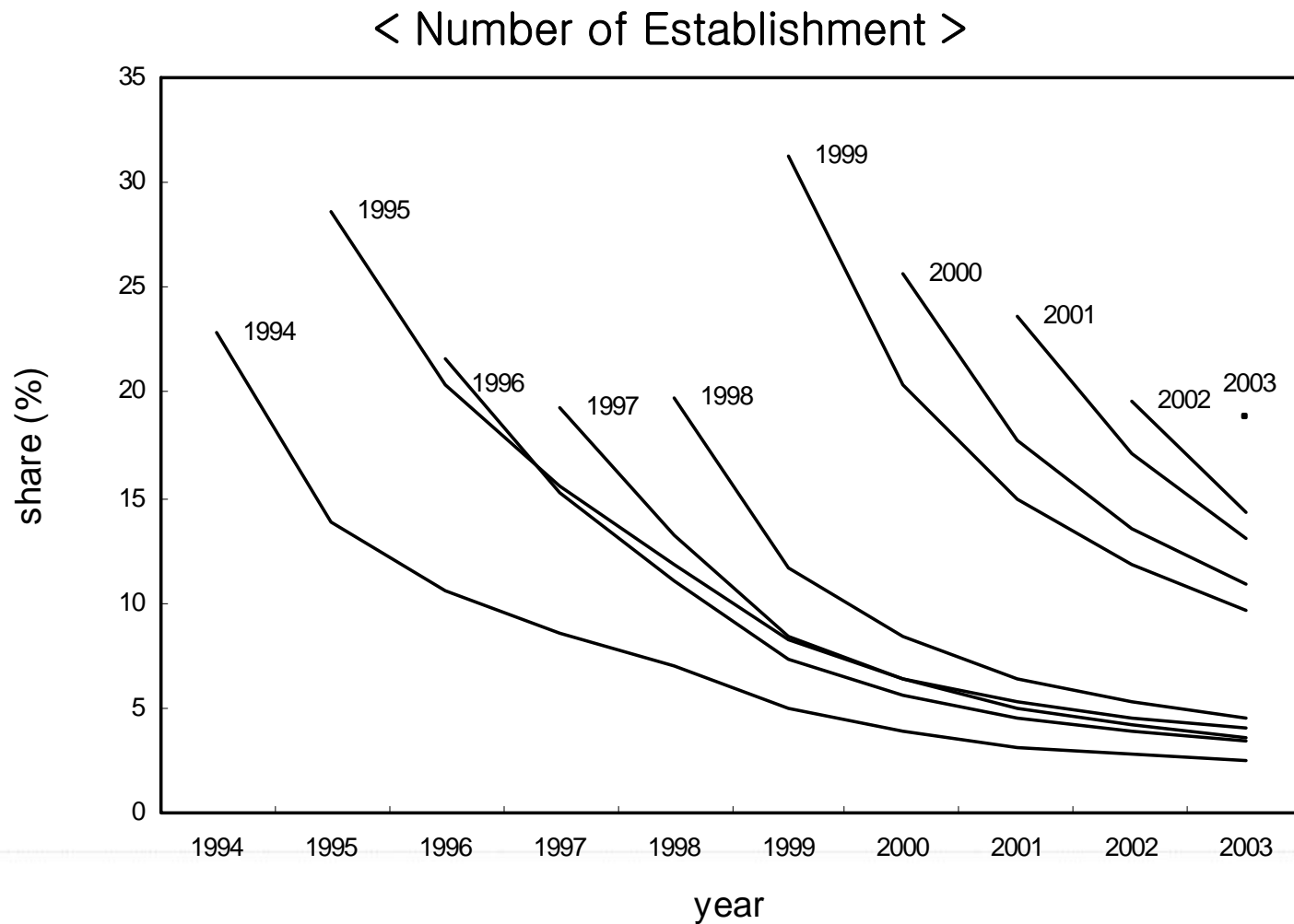
Source: Pain (2006)

Part-01

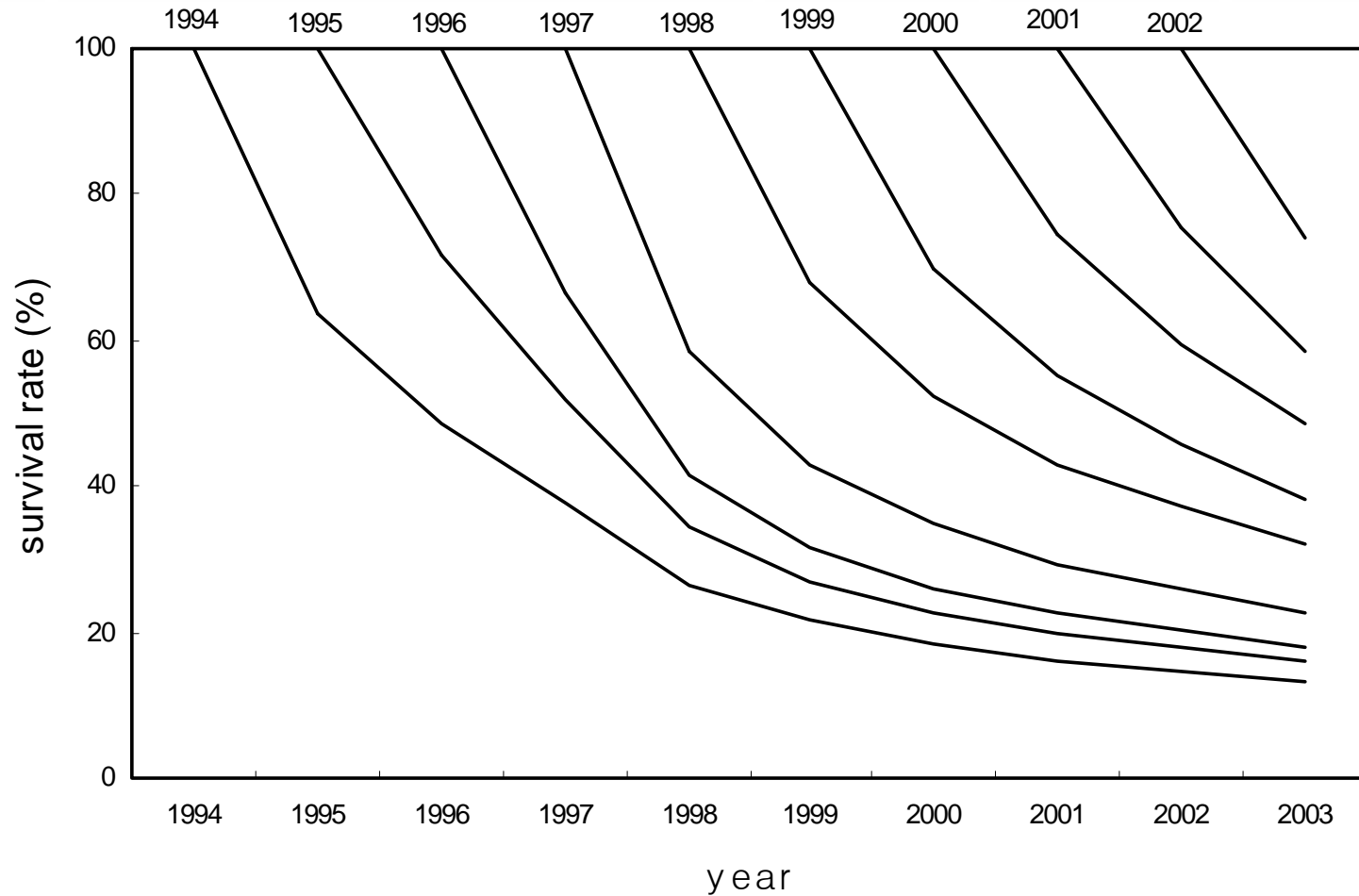
Entry and Growth of SMEs
in Korean Manufacturing



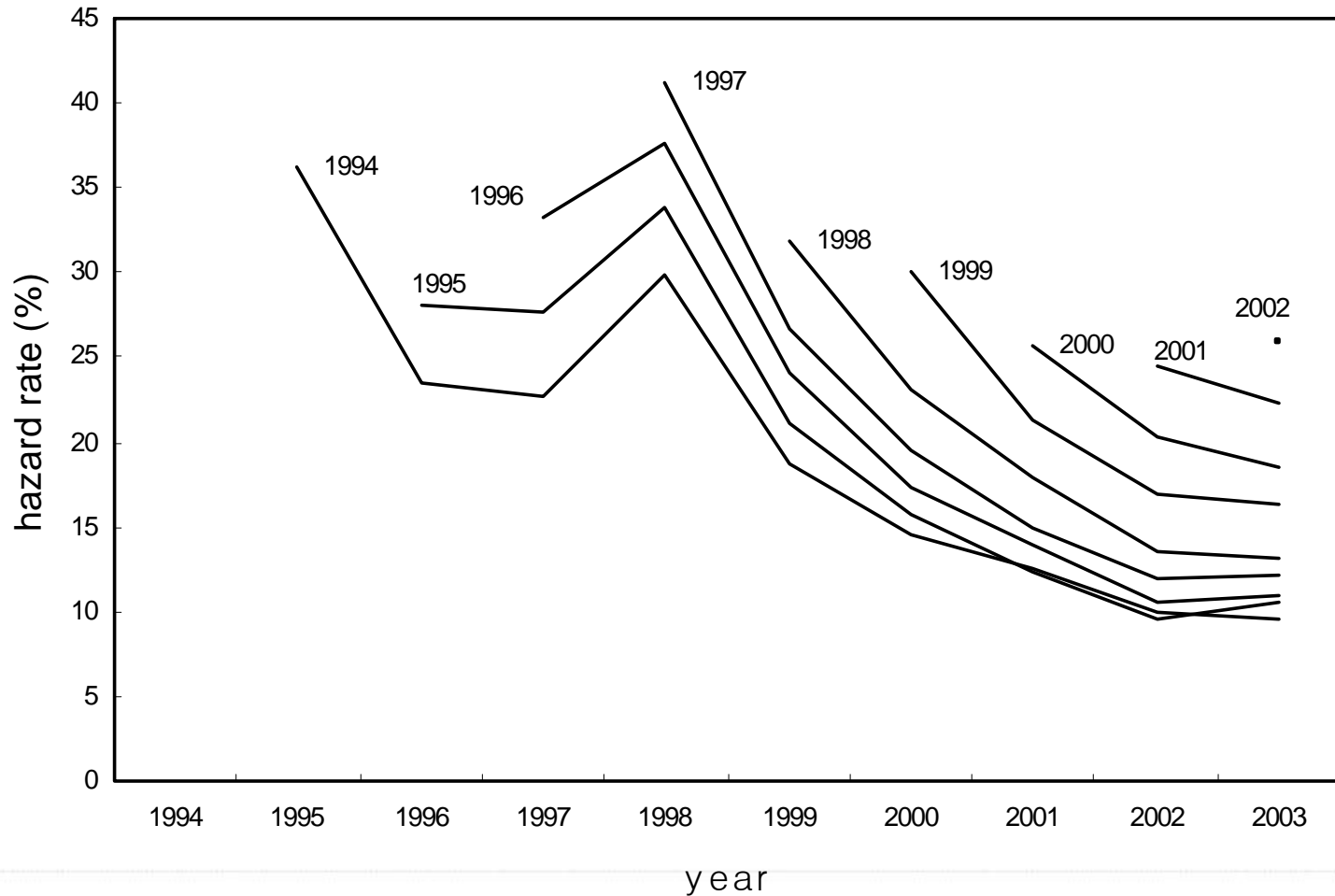
Share of Entry Cohorts



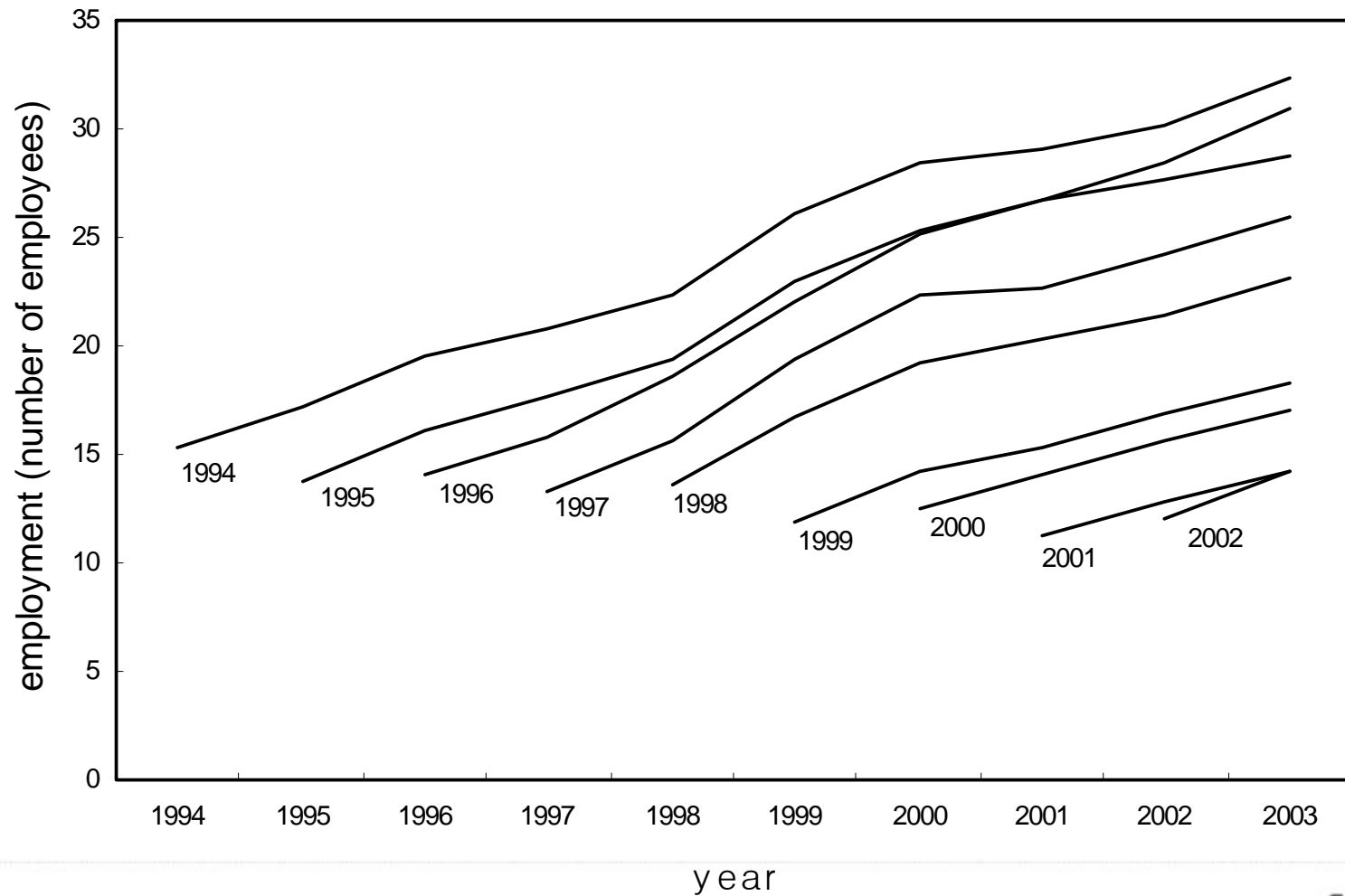
Survival Rate of Entry Cohorts



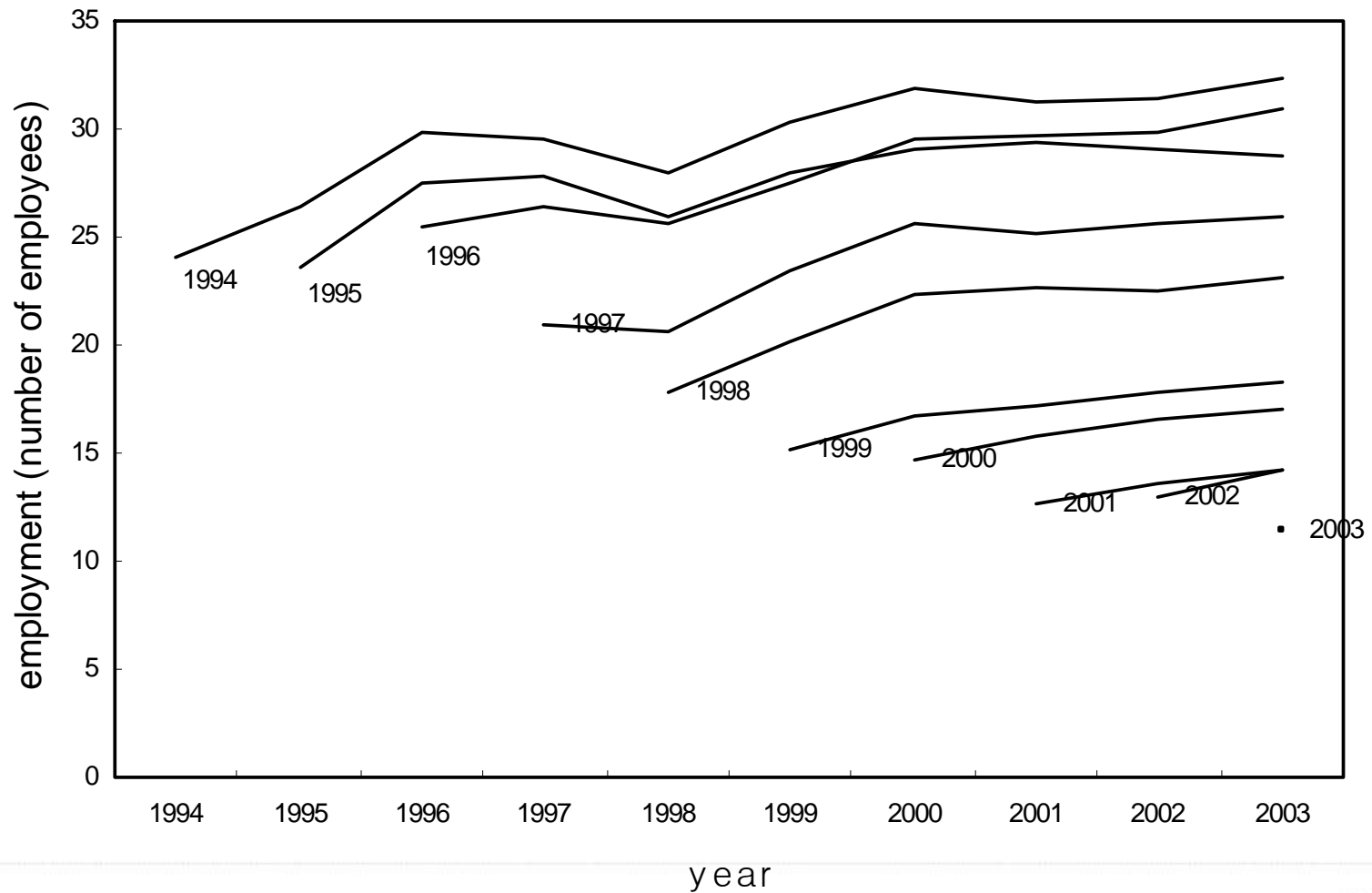
Hazard Rate of Entry Cohorts



Average Size by Entry Cohort 1



Average Size by Entry Cohort 2

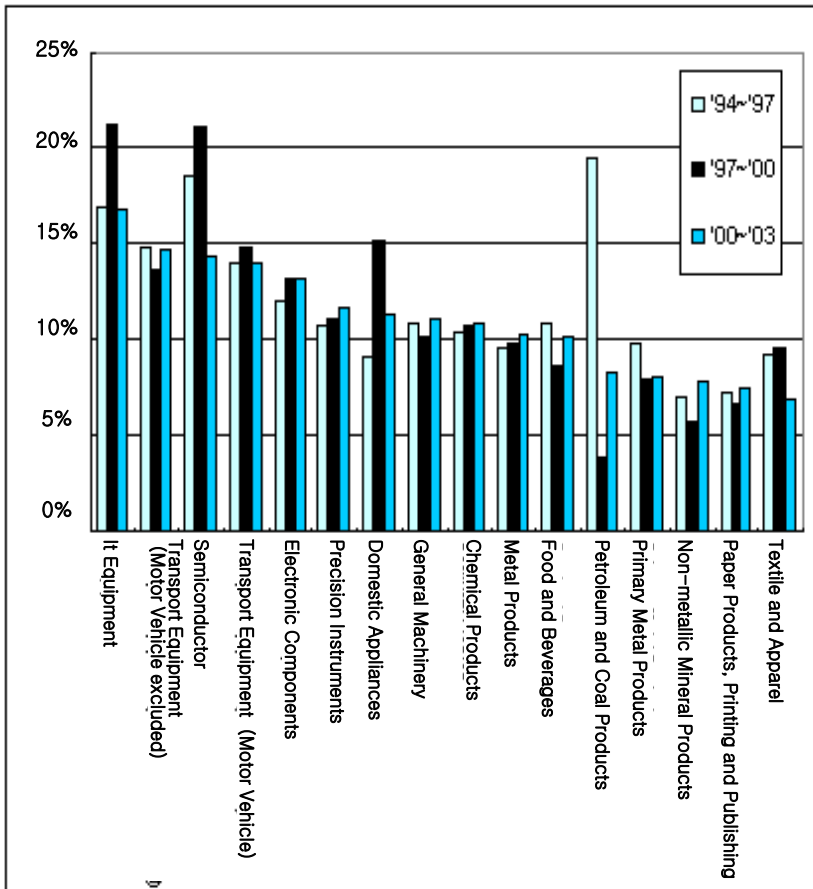


Defining High-growth SMEs

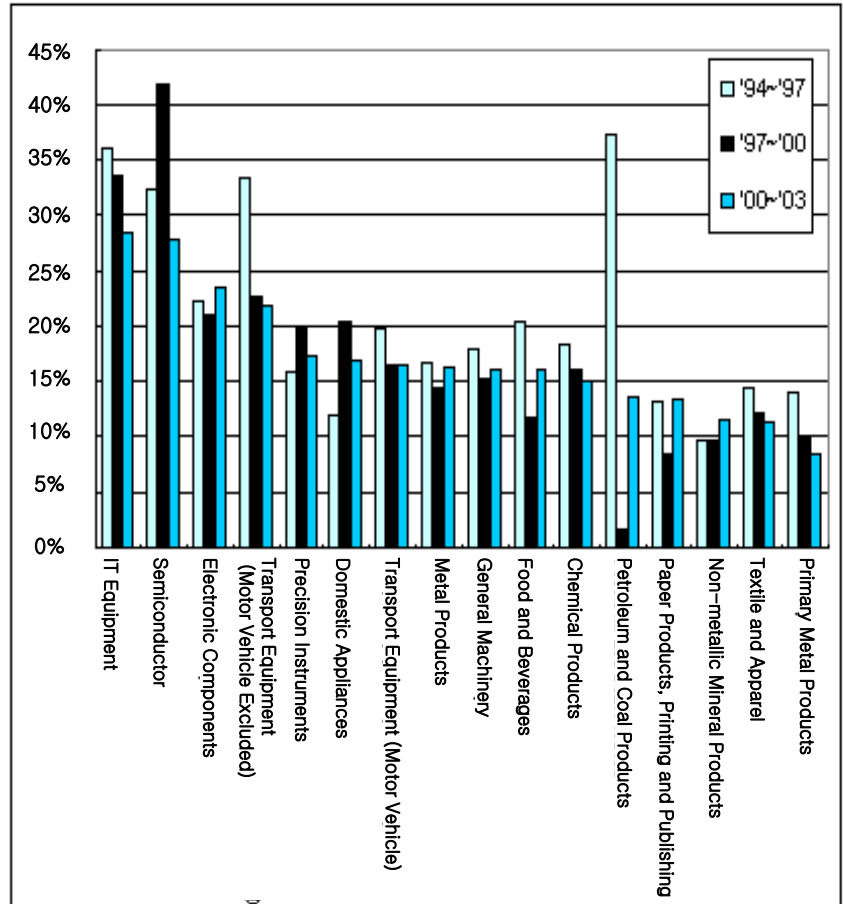
- To identify high-growth SMEs with top 10% growth rate
 - ✓ 4,444 plants in the period of 1994-1997 (top 9.90%)
 - ✓ 4,355 plants in the period of 1997-2000 (top 9.99%)
 - ✓ 5,864 plants in the period of 2000-2003 (top 9.98%)

Share of High-Growth SMEs by Industry

< Number of Establishment >

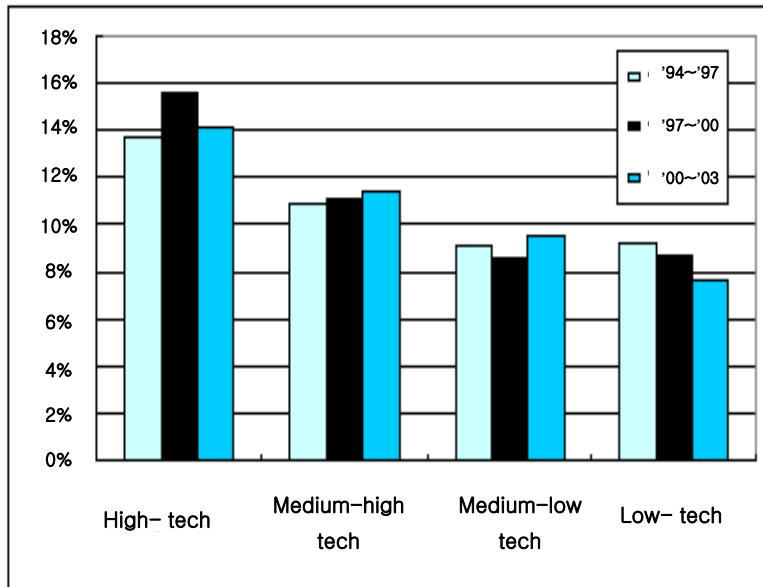


< Employment >

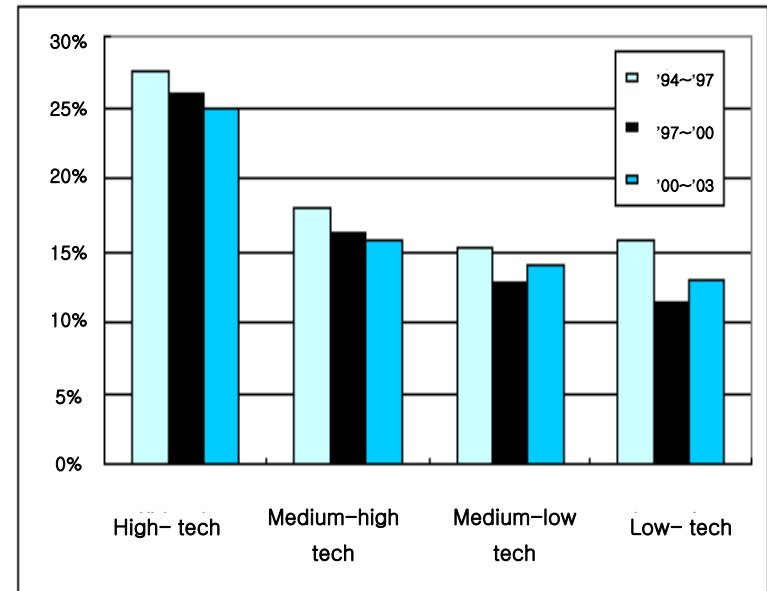


High-Growth SMEs by Technology Level

< Number of Establishment >



< Employment >



Characteristics of High-Growth SMEs

Dependent Variables \ Explanatory Variables	Total Factor Productivity (TFP)	Proportion of Non-production workers	R &D Intensity	Export Intensity
High-growth dummy	0.02153* (6.61)	0.05728* (6.30)	0.00230* (4.40)	0.00572* (3.06)
Constant term	0.55193* (20.33)	0.34352* (25.38)	0.00154 (1.57)	0.03564* (11.49)
Industry dummy	included	included	included	included
Year dummy	included	included	included	included
number of observations	104,966	146,167	147,238	88,465
Adj. R ²	0.06581	0.01843	0.00422	0.03993

Note: Inside of () are t-ratios corrected for heteroskedasticity

*: significant in the level of significance 1%

Part-02

Innovation and Productivity Growth

KDI

Plant-Level Total Factor Productivity

□ Multilateral Index Approach

$$\ln TFP_{it} = (\ln Y_{it} - \overline{\ln Y_t}) + \sum_{\tau=2}^t (\overline{\ln Y_{\tau}} - \overline{\ln Y_{\tau-1}}) \\ - \left\{ \sum_{n=1}^N \frac{1}{2} (\overline{S_{nit}} + \overline{S_{nt}}) (\ln X_{nit} - \overline{\ln X_{nt}}) + \sum_{\tau=2}^t \sum_{n=1}^N \frac{1}{2} (\overline{S_{n\tau}} + \overline{S_{n\tau-1}}) (\ln X_{n\tau} - \overline{\ln X_{n\tau-1}}) \right\}$$

Decomposition of TFP growth rate of manufacturing industry

1.1 Period before Financial Crisis: 1990-1995 (annual average growth rate)

Industry	Within effect	Between effect	Covariance effect	Total effect among stayers	Entry effect	Exit effect	Switch-in effect	Switch-out effect	Net-entry effect	Industry total	Average share	Change in share
	a	b	c	$d=a+b+c$	e	f	g	h	$i=e+f+g+h$	$j=d+i$		
High-tech	0.37%	-0.12%	0.41%	0.66%	0.20%	-0.08%	0.05%	-0.05%	0.12%	0.79%	8.82%	4.21%
Medium-high tech	0.69%	-0.32%	0.30%	0.67%	0.44%	-0.22%	0.36%	-0.13%	0.46%	1.13%	27.31%	7.13%
Medium-low tech	0.22%	-0.48%	0.58%	0.32%	0.19%	-0.22%	0.11%	-0.17%	-0.08%	0.23%	25.82%	0.14%
Low-tech	-0.34%	-0.50%	1.12%	0.28%	0.93%	-1.08%	0.05%	-0.09%	-0.18%	0.10%	38.05%	-11.48%
Weighted average of all industries	0.94%	-1.42%	2.41%	1.93%	1.77%	-1.60%	0.58%	-0.44%	0.31%	2.25%		
Share of each effect in industry's TFP growth	42.00%	-63.10%	107.12%	86.02%	78.67%	-70.99%	25.72%	-19.42%	13.98%	100.0%		

Decomposition of TFP growth rate of manufacturing industry

1.2 Period including Financial Crisis: 1995-1999 (annual average growth rate)

Industry	Within effect	Between effect	Covariance effect	Total effect among stayers	Entry effect	Exit effect	Switch-in effect	Switch-out effect	Net-entry effect	Industry total	Average share	Change in share
	a	b	c	d=a+b+c	e	f	g	h	i=e+f+g+h	j=d+i		
High-tech	0.14%	-0.35%	0.59%	0.38%	0.36%	-0.05%	0.81%	-0.12%	1.01%	1.39%	14.29%	6.72%
Medium-high tech	-0.02%	-0.33%	0.93%	0.59%	0.38%	-0.22%	0.24%	-0.05%	0.35%	0.94%	32.74%	3.73%
Medium-low tech	-0.98%	-0.19%	0.78%	-0.39%	0.13%	-0.26%	0.18%	-0.08%	-0.03%	-0.41%	24.39%	-3.00%
Low-tech	-1.03%	-0.37%	1.35%	-0.04%	0.35%	-0.61%	0.12%	-0.07%	-0.21%	-0.25%	28.58%	-7.46%
Weighted average of all industries	-1.88%	-1.23%	3.65%	0.54%	1.23%	-1.15%	1.35%	-0.32%	1.12%	1.66%		
Share of each effect in industry's TFP growth	-112.98%	74.22%	219.93%	32.72%	73.86%	-69.04%	81.46%	-19.00%	67.28%	100.0%		

Decomposition of TFP growth rate of manufacturing industry

1.3 Period after Financial Crisis: 1999-2003 (annual average growth rate)

Industry	Within effect	Between effect	Covariance effect	Total effect among stayers	Entry effect	Exit effect	Switch-in effect	Switch-out effect	Net-entry effect	Industry total	Average share	Change in share
	a	b	c	d=a+b+c	e	f	g	h	i=e+f+g+h	j=d+i		
High-tech	2.48%	0.07%	0.17%	2.71%	0.61%	-0.14%	0.19%	-0.07%	0.59%	3.29%	22.82%	10.34%
Medium-high tech	1.42%	-0.75%	1.16%	1.83%	0.40%	-0.15%	0.17%	-0.06%	0.35%	2.18%	34.84%	0.48%
Medium-low tech	0.32%	-0.43%	0.59%	0.48%	0.27%	-0.11%	0.10%	-0.10%	0.16%	0.64%	21.20%	-3.38%
Low-tech	-0.96%	-0.65%	1.12%	-0.50%	0.49%	-0.30%	0.09%	-0.11%	0.17%	-0.33%	21.13%	-7.44%
Weighted average of all industries	3.25%	-1.77%	3.04%	4.52%	1.77%	-0.71%	0.56%	-0.35%	1.27%	5.78%		
Share of each effect in industry's TFP growth	56.25%	30.68%	52.55%	78.12%	30.53%	-12.28%	9.63%	-6.01%	21.88%	100.0%		

Regression for Plant-Level TFP Growth

$$\ln TFP_{i,t+1} - \ln TFP_{i,t} = \beta_0 + \beta_{Plant} \cdot X_{i,t} + \beta_{Industry} \cdot Y_{j,t} + \beta_D \cdot D_t + \varepsilon_{i,t}$$

TFP Growth Regression Results

Explanatory variables	I	II	III	IV
ln(TFP) _{i, t}	-0.18667*** (-405.88)	-0.18668*** (-405.93)	-0.18667*** (-405.88)	-0.18667*** (-405.88)
Non-production to production worker ratio (by plant)	0.01310*** (32.45)	0.01314*** (32.55)	0.01310*** (32.45)	0.01310*** (32.45)
R&D Intensity (by plant)	0.00428*** (3.02)	0.00430*** (3.03)	-0.01915*** (-1.14)	0.00184*** (0.53)
Export Intensity (by plant)	0.00424*** (3.06)	0.00430*** (3.10)	0.00425*** (3.06)	0.00424*** (3.06)
ln(Number of workers)	0.00849*** (25.36)	0.00843*** (25.19)	0.00849*** (25.37)	0.00849*** (25.36)
Non-production to production worker ratio (by industry)	0.02745*** (10.73)	0.02741*** (10.71)	0.02745*** (10.73)	0.02746*** (10.73)
Capital Labor Ratio (by industry)	0.00031*** (46.88)	0.00031*** (46.74)	0.00031*** (46.88)	0.00031*** (46.88)
R&D Intensity (by industry)	1.80791*** (37.99)	0.58761*** (2.74)	1.80738*** (37.98)	1.80630*** (37.92)
Export Intensity (by industry)	0.00676** (2.40)	0.00499** (1.76)	0.00673* (2.39)	0.00676** (2.40)

TFP Growth Regression Results (continued)

설명변수	I	II	III	IV
In(Number of Patent Applications) (by industry)	0.01129*** (39.32)	0.01060*** (34.17)	0.01128*** (39.28)	0.01129*** (39.32)
Industry R&D × Industry Patenting		0.14671*** (5.83)		
Plant R&D × Industry Patenting			0.00299 (1.40)	
Plant R&D × Industry R&D				0.12390 (0.77)
Year dummy	included	included	included	included
Number of observations	438,624	438,624	438,624	438,624
R-sq	0.28544	0.28549	0.28544	0.28544

주: ()안은 t-비율. ***,**,*는 각각 1%, 5%, 10% 수준에서 유의함을 나타냄.

Part-03

Patent Information Policy Expenditures
and Patent Applications



Regression Results for Patent Applications

Explanatory variables	I	II	III	IV
(Budget A + Budget B) t	0.08098*** (12.56)			
(Budget A + Budget B) t-1	0.05450*** (5.52)			
(Budget A) t		0.07866*** (7.98)		
(Budget A) t -1		0.05666*** (3.06)		
(Budget B) t			0.08275*** (12.26)	
(Budget B) t -1			0.05750*** (5.52)	
(Budget C) t				0.08214*** (11.19)
(Budget C) t-1				0.07662*** (9.99)
(Budget C) t-2				0.06303*** (7.98)
(Budget C) t-3				0.06328*** (7.20)

Regression Results for Patent Applications (cont'd)

설명변수	I	II	III	IV
Year dummy	Included	Included	Included	Included
Class dummy	Included	Included	Included	Included
Number of observations	4050	4050	4050	4050
R-sq	0.38536	0.36351	0.38287	0.42638

Part-04

Patent Information Policy Expenditures
and Job Creation



A back-of-the-envelop calculation

- ❑ What if “Budget A” and “Budget B” expenditures keep on increasing by 15% per year maintaining current effectiveness?
 - Patent applications increase by 2.25% per year
 - $0.0809856 + 0.05450 + \dots = 0.15$
 - $15\% \times 0.15 = 2.25\%$
- ❑ Additional increase of patent applications by 2.25%p per year is associated with extra productivity growth by 0.0254%p
 - $2.25\%p \times 0.01129 = 0.0254\%p$
- ❑ 0.0254%p increase of economic growth each year
 - Additional 200+ thousand jobs in 2010 and 600+ thousand jobs in 2015 (compared with the baseline employment projection)

Thank you!

Korea's Leading Think Tank



생산성 증가율의 결정요인 분석 (고기술 및 중고기술 제조업)

설명변수	I	II	III	IV
$\ln(TFP)_{i,t}$	-0.20220*** (-252.64)	-0.20214*** (-253.22)	-0.20219*** (-252.63)	-0.20219*** (-252.61)
업체별 비생산직 종사자 비율	0.01041*** (13.93)	0.01072*** (14.39)	0.01038*** (13.89)	0.01039 (13.91)
업체별 R&D 집약도	0.00188 (1.32)	0.00189 (1.33)	-0.07194*** (-3.54)	-0.00572 (-1.54)
업체별 수출집약도	0.00082 (0.28)	0.00121 (0.42)	0.00083 (0.29)	0.00082 (0.28)
업체 규모	0.00173*** (3.15)	0.00137** (2.49)	0.00173*** (3.15)	0.00173*** (3.14)
산업별 비생산직 종사자 비율	-0.09555*** (-17.01)	-0.08694*** (-15.49)	-0.09534*** (-16.97)	-0.09545*** (-16.99)
산업별 자본장비율	0.00085*** (8.04)	0.00007*** (7.02)	0.00009*** (8.05)	0.00009*** (8.04)
산업별 R&D 집약도	0.49597*** (7.55)	-12.29331*** (-26.07)	0.49521*** (7.54)	0.49032 (7.46)
산업별 수출집약도	0.00767*** (10.43)	0.03310*** (6.70)	0.06651*** (13.87)	0.06659*** (13.88)

생산성 증가율의 결정요인 분석 (고기술 및 중고기술 제조업)(계속)

설명변수	I	II	III	IV
산업별 특허출원	0.00767*** (10.43)	-0.01230*** (-11.89)	0.00755*** (10.26)	0.00767*** (10.42)
산업별 R&D × 산업별 특허출원		1.48937*** (27.39)		
업체별 R&D × 산업별 특허출원			0.00932*** (3.64)	
업체별 R&D × 산업별 R&D				0.37283*** (2.21)
연도더미	포함	포함	포함	포함
관측치수	143340	143340	143340	143340
결정계수	0.32206	0.32558	0.32212	0.32208

주: ()안은 t-비율. ***,**,*는 각각 1%, 5%, 10% 수준에서 유의함을 나타냄.

특허출원 건수의 결정요인 분석 (1990-2006)

설명변수	I	II	III	IV
금년도 (중장기지원예산+단기선정예산)	0.07967*** (12.80)			
전년도 (중장기지원예산+단기선정예산)	0.05207*** (5.41)			
금년도 (중장기기획지원예산)		0.09444*** (8.39)		
전년도 (중장기기획지원예산)		0.05453*** (3.04)		
금년도 (단기선정지원예산)			0.08132*** (12.50)	
전년도 (단기선정지원예산)			0.05549*** (5.47)	
금년도 특허맵사업예산				0.07686*** (10.44)
작년도 특허맵사업예산				0.07154*** (9.29)
재작년도 특허맵사업예산				0.05826*** (7.33)

특허출원 건수의 결정요인 분석 (1990-2006) (계속)

설명변수	I	II	III	IV
재제작년도 특허맵사업예산				0.05904*** (6.67)
상수항	2.66061*** (20.82)	2.68235*** (20.83)	2.65424*** (20.75)	3.69436*** (27.53)
관측치 수	9145	9145	9145	8044
조정된 결정계수	0.37792	0.368141	0.37684	0.38947
결정계수	0.38731	0.37768	0.38624	0.39994