

Invention, productivity and the future of East Asia's innovation systems

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Japan was once regarded as an innovation superstar...

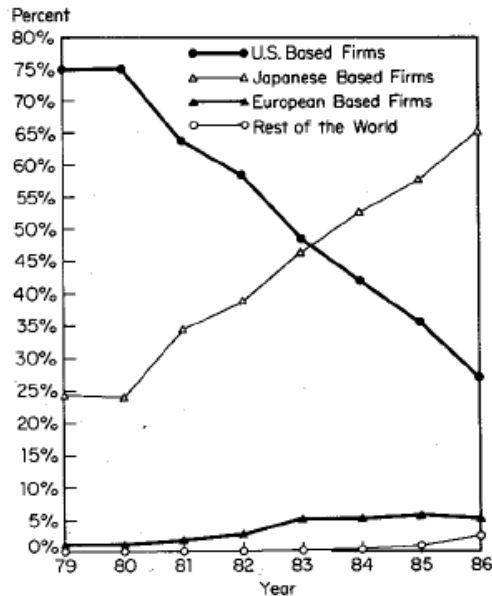
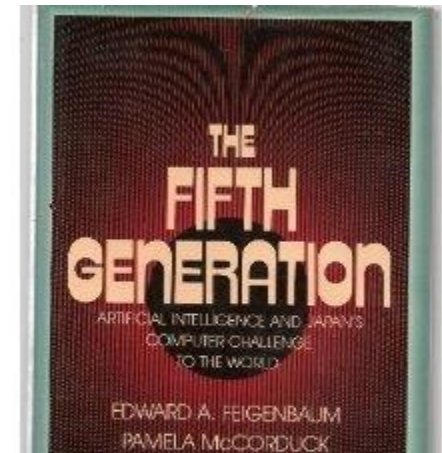
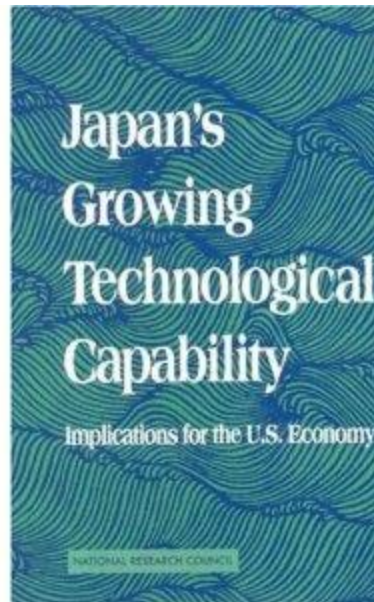
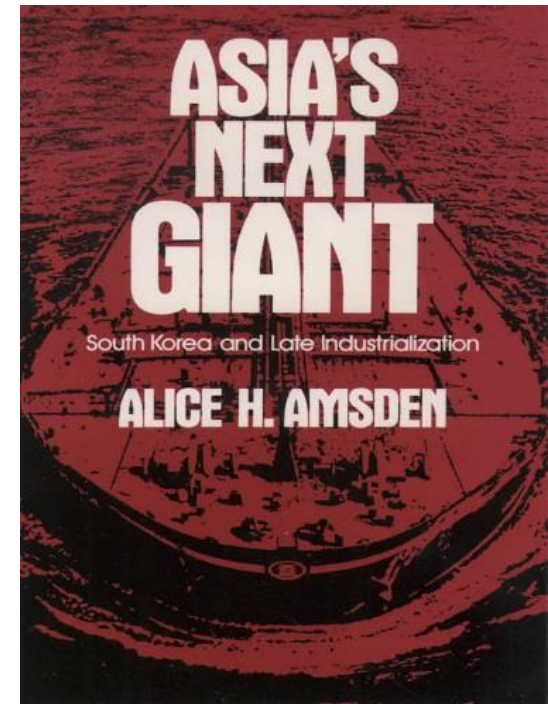
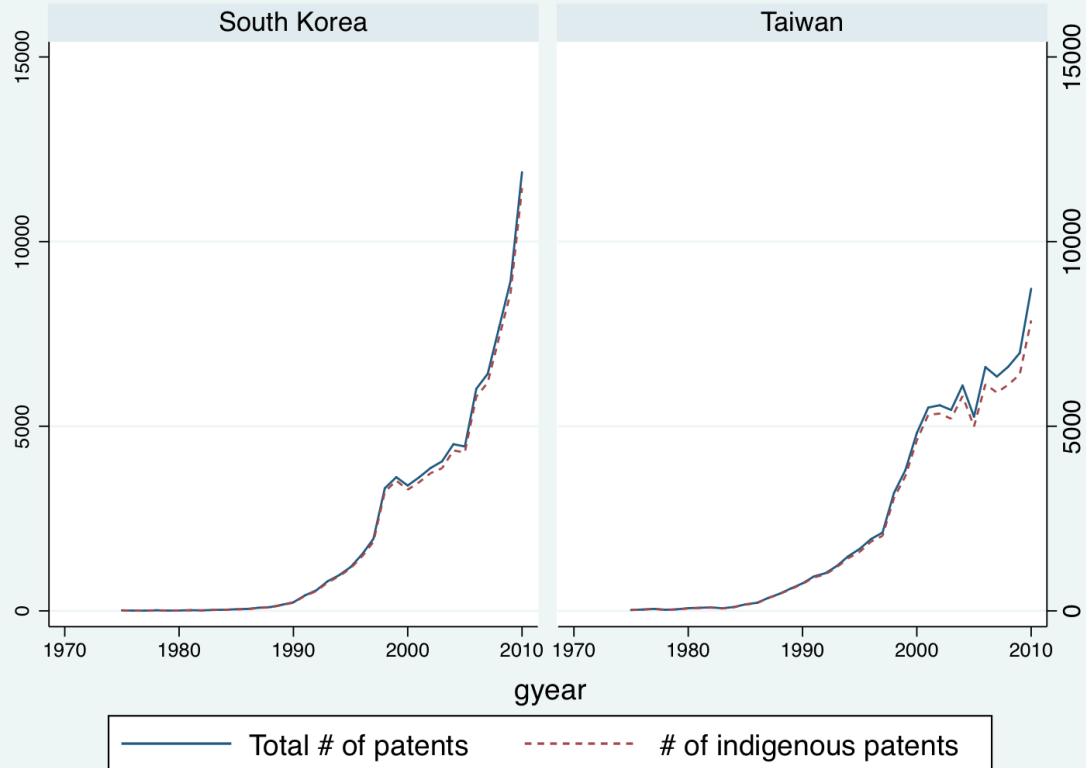


FIGURE 2.6
Memory Products: World Market Share
(Percentage of world shipments)
SOURCE: Dataquest



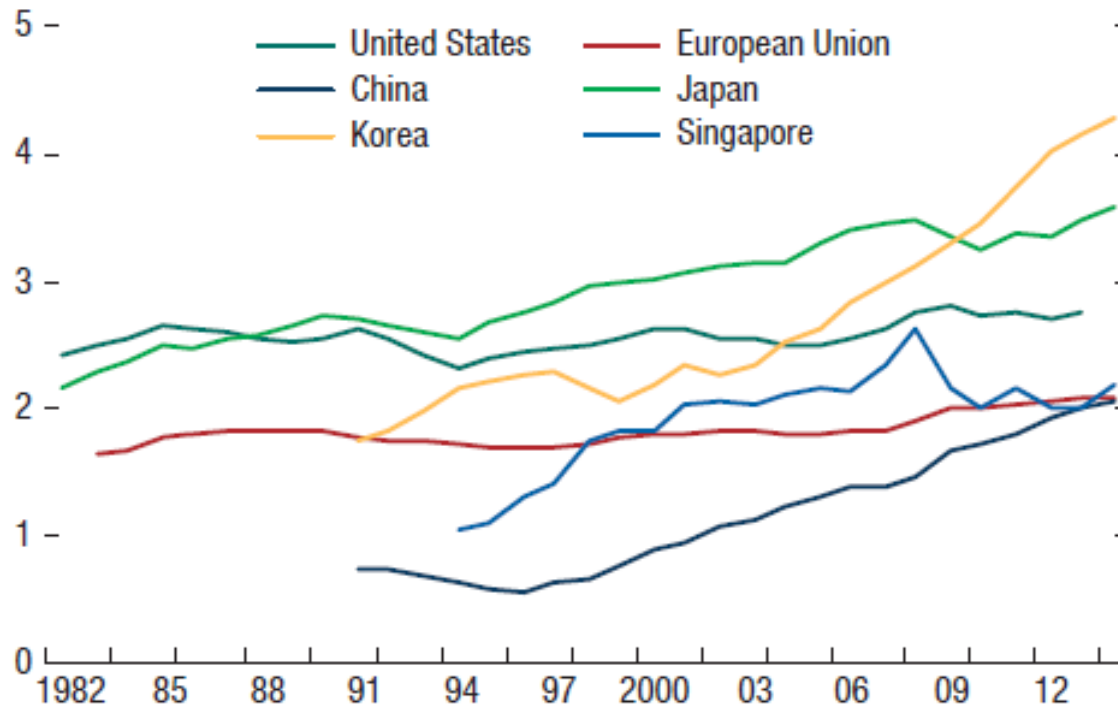
With South Korea (and Taiwan) following rapidly in its footsteps...



Today, Japan and South Korea lead the industrialized world in R&D investment...

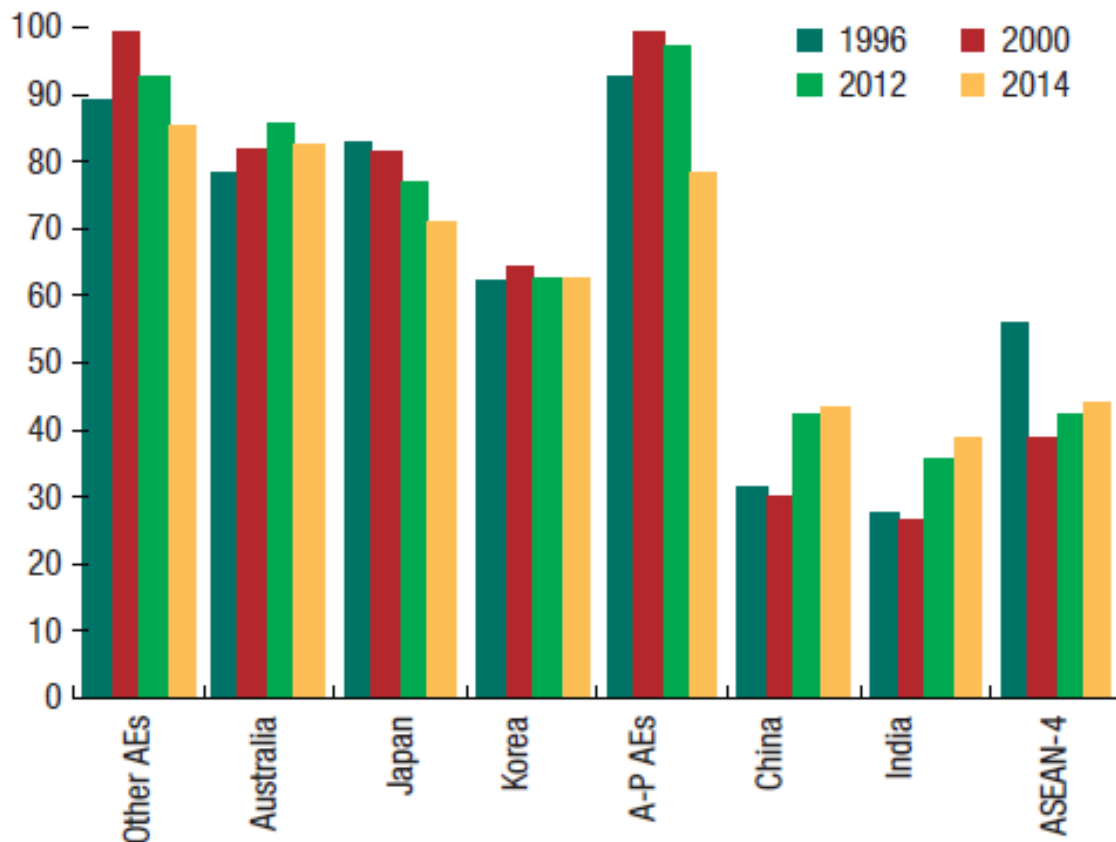
Figure 3.7. Expenditures on Research and Development

1. Gross Expenditures on R&D
(Percent of GDP)



Yet these investments have not yielded commensurate productivity gains

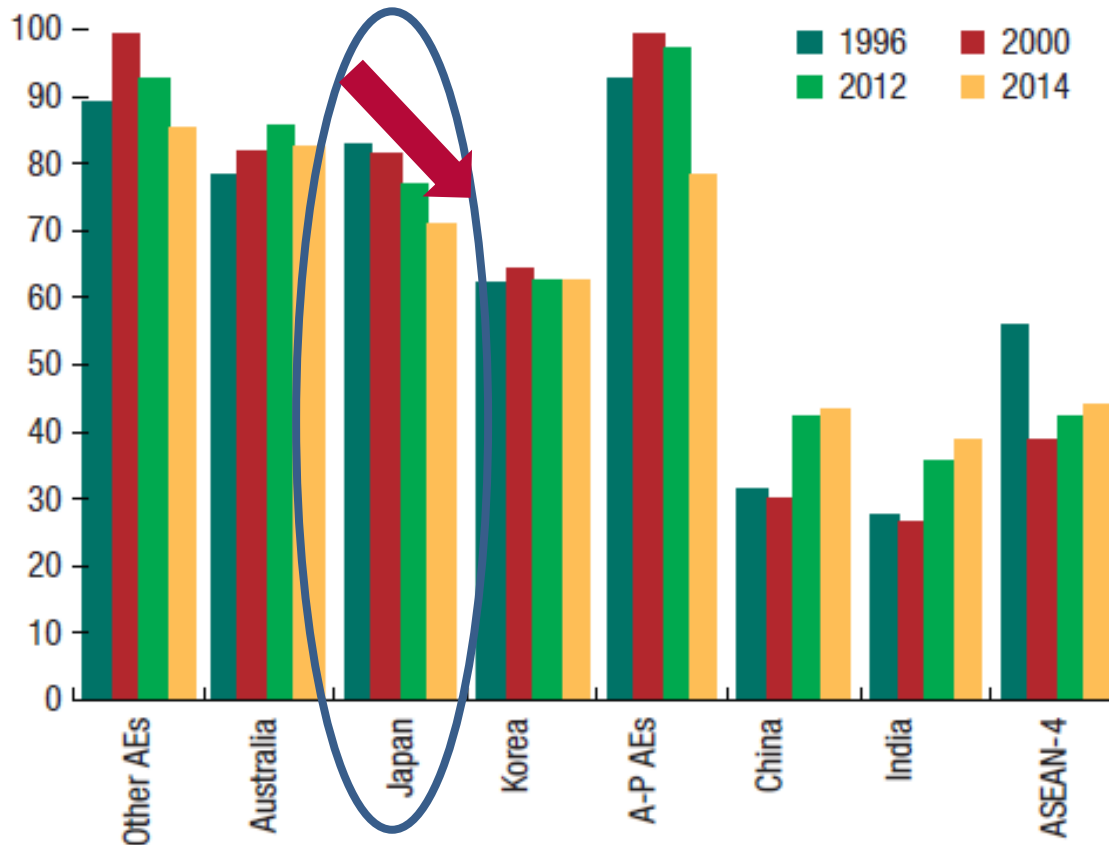
Figure 3.3. Total Factor Productivity Gaps
(Current purchasing power parity, United States = 100)



Source: IMF (2017)

Japan's aggregate TFP has fallen substantially relative to the U.S...

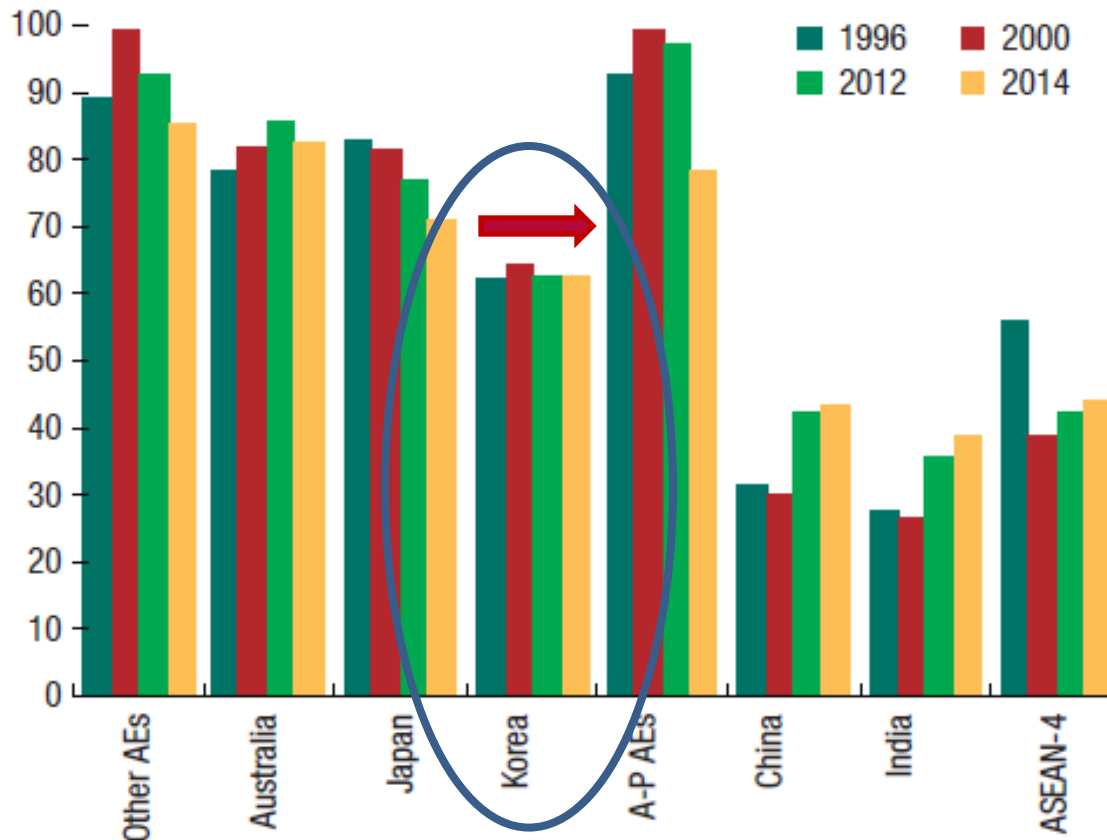
Figure 3.3. Total Factor Productivity Gaps
(Current purchasing power parity, United States = 100)



Source: IMF (2017)

And South Korea has shown almost zero TFP convergence over 20 years...

Figure 3.3. Total Factor Productivity Gaps
(Current purchasing power parity, United States = 100)

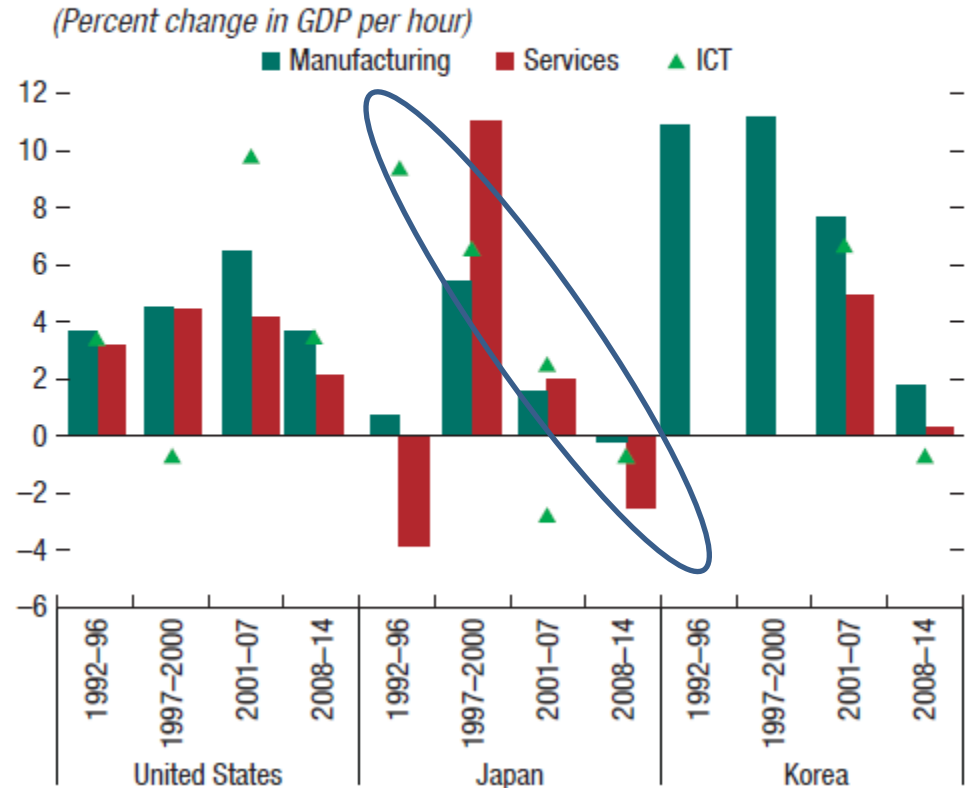


Source: IMF (2017)

Japan has seen its once-vaunted ICT industries' productivity growth slide into negative territory...

Figure 3.4. Sector-Level Labor Productivity Growth

1. Period Averages for Selected Industries in the United States, Japan, and Korea
(Percent change in GDP per hour)



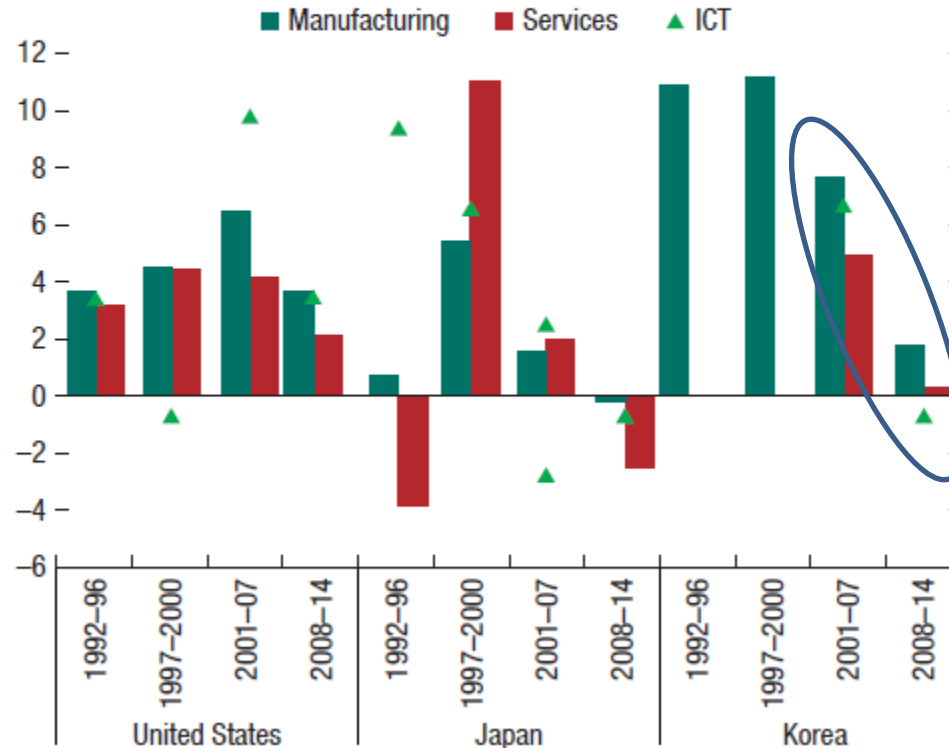
Source: IMF (2017)

And so has South Korea...

Figure 3.4. Sector-Level Labor Productivity Growth

1. Period Averages for Selected Industries in the United States, Japan, and Korea

(Percent change in GDP per hour)



Why does the productivity of R&D seem to have fallen in these two countries?

These nations are stuck with “innovation systems” that are poorly adapted to their current circumstances...

- These nations followed a technological development trajectory with some common features.**
- That trajectory led these nations to specialize in a particular “style” of R&D that was appropriate to the circumstances of their high-growth eras...**
- Government policies in these countries exacerbated the concentration of R&D resources in certain sets of activities and organizations.**
- When circumstances changed, innovation systems in these countries struggled to adapt, and research productivity appears to have fallen.**

Even in its 1980s heyday, astute observers noted distinctive features of Japan's innovation system...

United States	Japan
Basic research	Applied development
Software	Hardware
Fundamental new products	Miniaturization
High-technology systems	Process equipment and technology
New industry creation	Product variety
Advanced development	Process engineering

Source: Henry Riggs, Professor of Industrial Engineering, Stanford University, reproduced from Okimoto and Rohlen, 1988.

These features reflected Japan's internal and external conditions...

- Japan's exchange rate did not fully reflect its rising productivity in the late 1960s, 1970s, and 1980s...
- Providing Japanese firms with a growing cost/price advantage in global markets...
- And incentivizing Japanese firms to focus on process engineering and cost-reducing, incremental R&D.
- A relatively weak patent regime limited the returns to fundamental innovation...
- And a university system that lagged the West in basic scientific research limited the capacity of firms to engage in fundamental innovation.



Exchange rate, intellectual property, and education policy choices reinforced a "*pro-incrementalist bias*" in Japanese R&D

And the distribution of Japan's R&D resources across organizations and sectors...

- A lifetime employment system tended to concentrate engineering talent in large, established firms.
- A highly regulated financial system limited the provision of capital to risky new entrants.
- Domestic incumbents exercised substantial influence over a fragmented retail sector (an effort abetted by weak antitrust policy), limiting the access of domestic and foreign entrants to Japanese customers well into the 1990s...
- And government policies limited FDI (and therefore the entrance of foreign multinationals with different R&D strengths and styles) through the end of the 1970s.
- Modest “industrial policies” tended to reinforce established incumbents



FDI, antitrust, and financial policy choices reinforced a “*pro-incumbent bias*” in Japanese R&D

The enduring costs of a “pro-incumbent” bias



Clay Christensen



Steven Klepper,
1951-2015

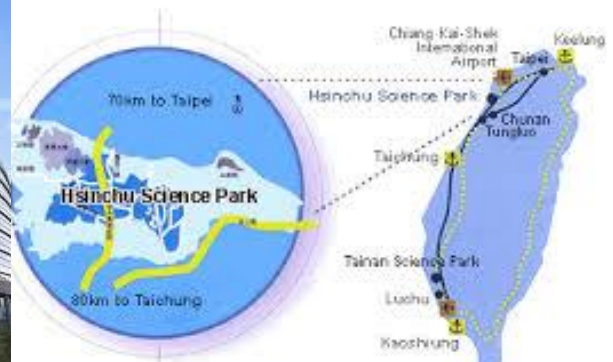
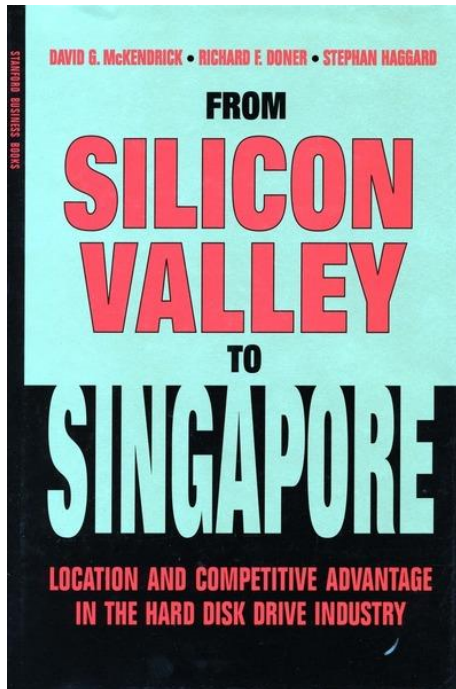
- Incumbents face a “double bind” when engaging in fundamental innovation
- The creation of nearly every new industry is characterized by widespread entry of new firms and wide-ranging experimentation with fundamentally different technologies and product concepts...
- The set of contestants widens as talented entrepreneurs “spin off” from the early successful entrants to test ideas not supported by their employers
- Out of this ferment, a group of champions with the best ideas emerges...
- Economies with a strong pro-incumbent bias impede this process and retard the birth of new industries.

Wage increases and yen appreciation undermined Japan's position as a low-cost production site...



Source: Bank of Japan. The real effective exchange rate is a weighted average of the yen's value against 25 major currencies.

And lower-cost Asian countries acquired advanced manufacturing capabilities...

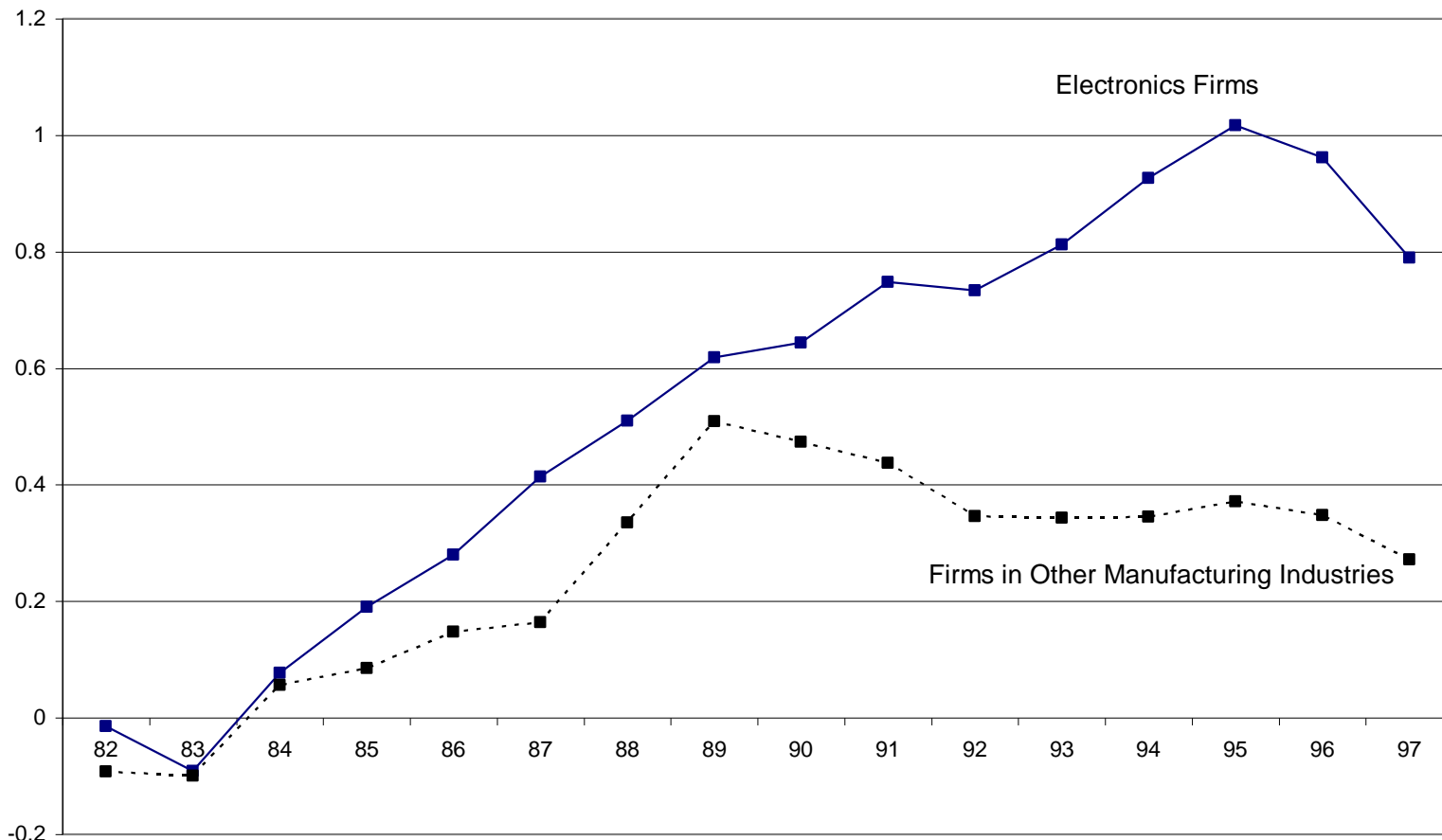


The world changed, and Japan had to change its approach to R&D...

- **A loss of manufacturing competitiveness forced a change in the structure of Japanese R&D spending**
 - Japan was “squeezed” between Silicon Valley and cheaper Asian nations.
 - So, Japanese firms invested billions of yen in central R&D laboratories pursuing more technologically ambitious product innovation programs.
 - The Japanese government sought to reengineer Japan’s R&D policy regime, making it more like the U.S.
 - But after decades spent honing to perfection a different approach to R&D, Japanese firms struggled to adapt to their new circumstances and strategies.
 - The technology-intensive startups that were redefining the IT world in the U.S. were nearly absent in Japan.
 - R&D productivity stagnated or declined, and policy reforms did not have the desired impact.

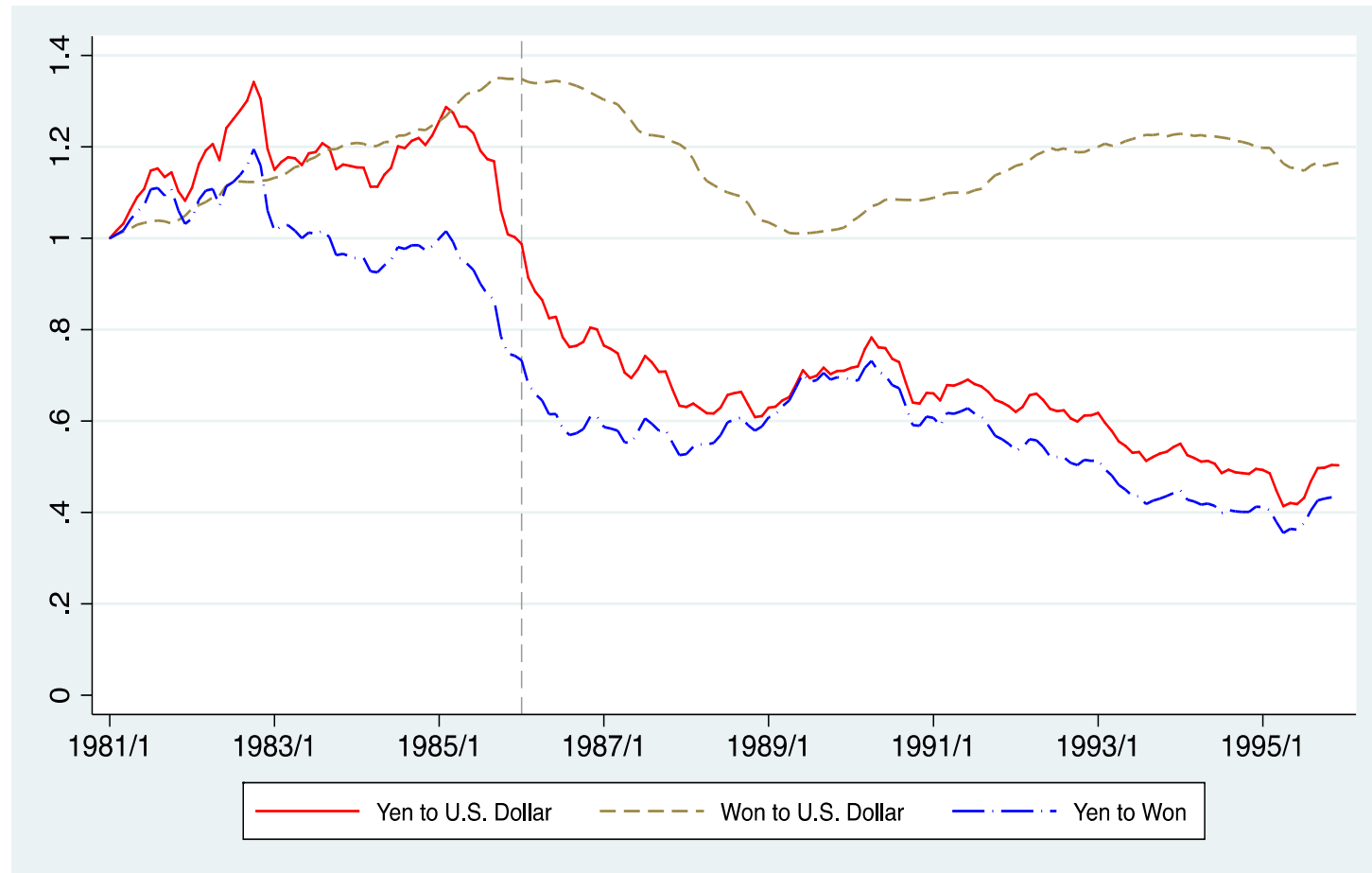
Japanese research productivity began to fade in the 1990s...

Divergence in R&D Productivity Growth after 1989
Electronics Firms vs. Other Manufacturing Industries



Source: Branstetter and Nakamura (2003)

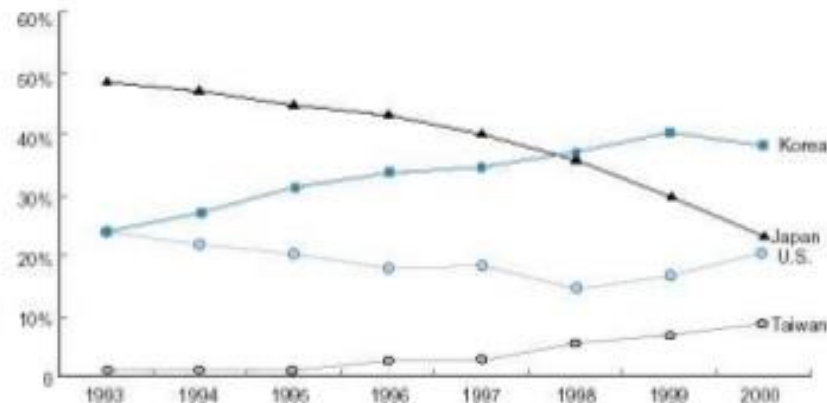
The appreciation of the Japanese yen created an opening for Korean and Taiwanese companies...



Source: Branstetter and Kwon (Working paper, 2017)

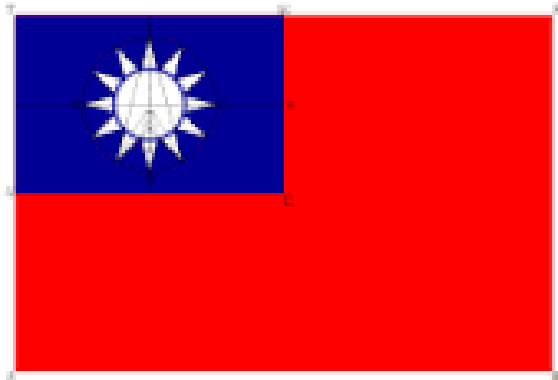
To pursue the same “incremental” innovation strategy against Japan that Japan had employed against the U.S.

Global Market Share by Countries, DRAM Sector



- (Source: Dataquest, May 2001)
- www.american.edu

South Korea and Taiwan inherited many of Japan's pro-incrementalist policies



- Both nations inherited Japan's weak patent system, and reformed it late, under U.S. pressure...
- Both nations inherited Japan's education system, with its strengths and weaknesses...
- Both nations tended to resist the appreciation of their currencies, as Japan did.
- This policy mix may have worked, as in Japan, to "bias" Taiwanese and South Korea firms in favor of incremental innovation and process engineering.

The legacy of Park Chung-Hee's heavy-handed industrial policy left Korea with an extreme version of pro-incumbent bias...

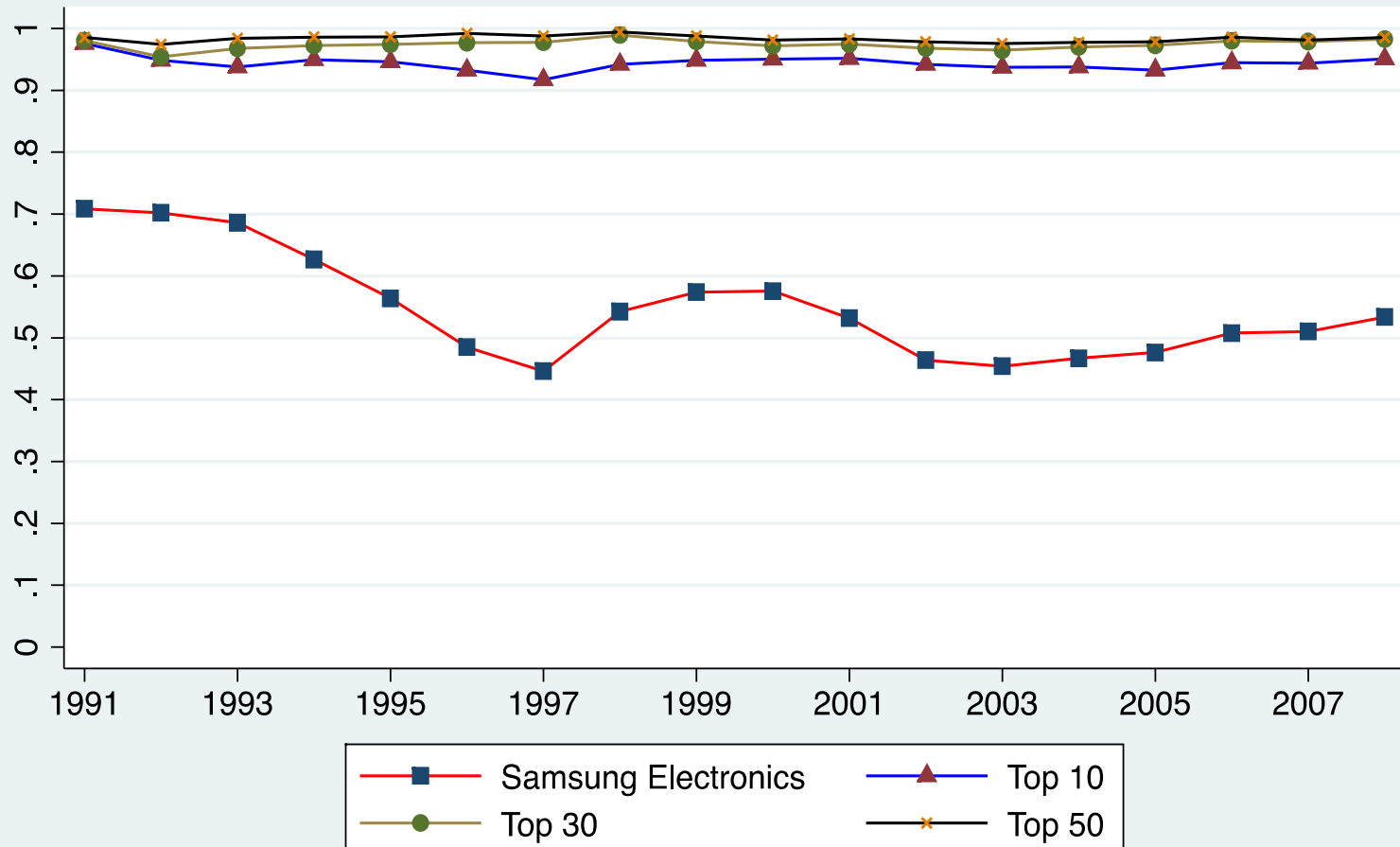


Park Chung-Hee
Ruler of South Korea
1965-1979

- Distorted capital markets showered low-cost funding on favored chaebol groups.
- Heavy-handed licensing requirements and other interventions limited the ability of other firms to expand.
- Long after President Park's assassination, Korea retains a uniquely high degree of industrial concentration whose roots lie in the policy regime of the Park era.
- Even today, Korean policymakers and economists worry about the ill effects of chaebol predominance...

Pro-incumbent bias in the “Republic of Samsung”

Concentration of Patent Grants in a Small Number of Chaebol Groups



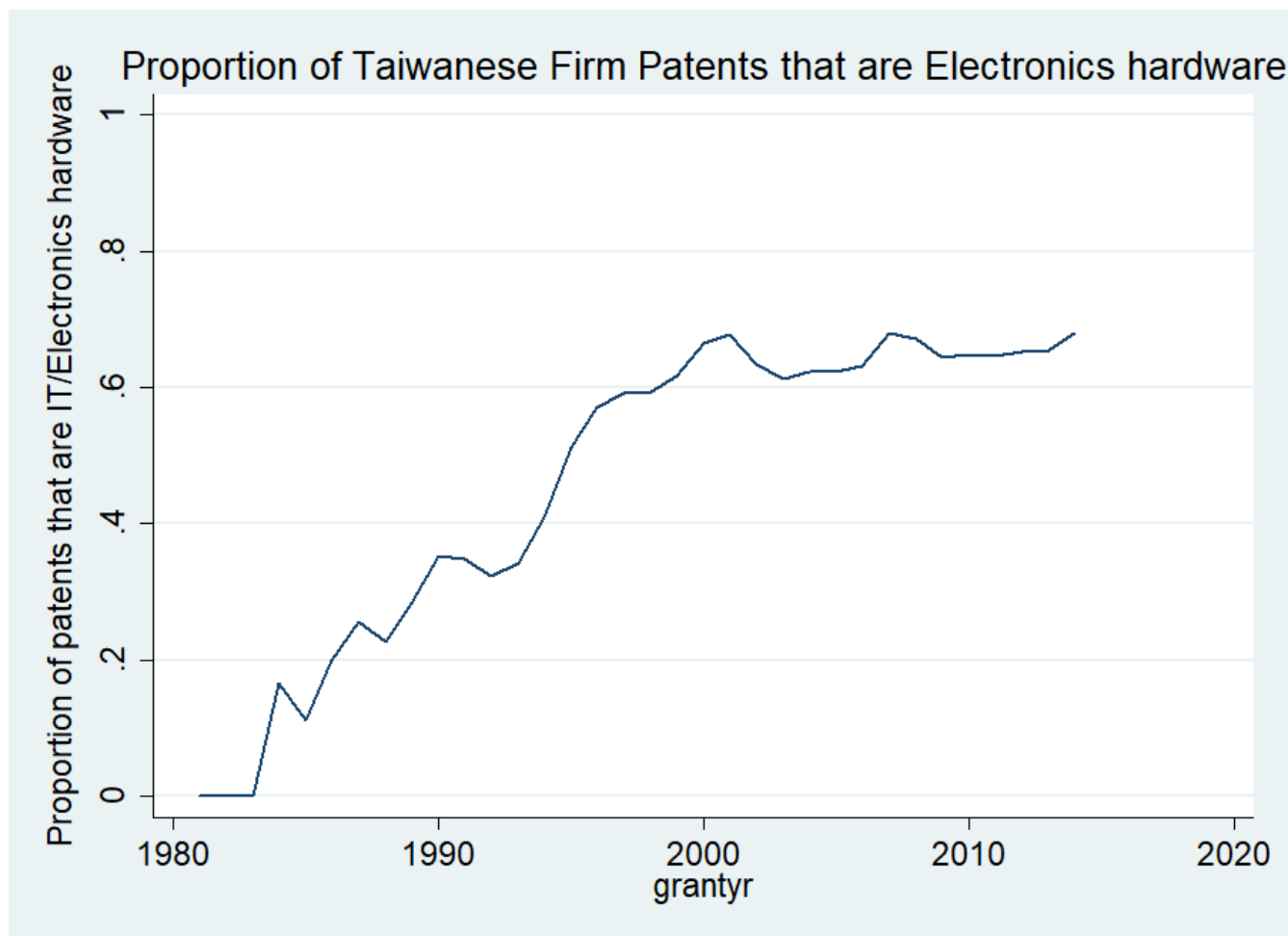
Source: USPTO

Taiwan's pro-incumbent policies took a different form...

- Taiwanese policy distortions did not favor a small number of giant firms, as in Korea...
- And Taiwan's economic landscape features robust entry and exit of SMEs engaged in high-tech activity.
- But Taiwan's industrial policy favored a particular set of industries.
- ITRI and the efforts to create Hsinchu Science Park may have (over)concentrated national innovative talent in IT manufacturing.
- As that activity has moved to the mainland, some Taiwanese firms have struggled to adapt.



(Over)concentration of Taiwanese patenting in one industry...



Source: Branstetter and Chen (2006)

China has done to South Korea and Taiwan what these economies did to Japan...

- **South Korean and Taiwanese innovation capabilities were focused, to a significant extent, on process engineering and process innovation...**
- **But China, a much cheaper production site, has acquired a high level of manufacturing capability.**
- **As manufacturing has shifted to China, Northeast Asia's IT sector has struggled to compete.**

Are nations that refuse to learn from this history doomed to repeat it?

- **China continues to intervene systematically in the allocation of capital across enterprises and industries...**
- **China's financial system is still dominated by state-owned banks, who still appear to favor state-owned enterprises in the allocation of capital.**
- **China has resisted full and fair implementation of its patent and antitrust laws, in order to build up national champions following incrementalist strategies...**
- **China has walled off its digital economy from foreign competition to a degree without precedent or comparison.**
- **Productive multinational R&D and acquisition activity by multinationals in China is subject to a significant degree of government intervention.**

Policy choices have enduring consequences...

Brutus:

There is a tide in the affairs of men.
Which, taken at the flood, leads on to fortune;
Omitted, all the voyage of their life
Is bound in shallows and in miseries.
On such a full sea are we now afloat,
And we must take the current when it serves,
Or lose our ventures.

Julius Caesar Act 4, scene 3, 218–224

Supplemental Slides

Tobin's Q regression results (2007-2016)

Table 2 South Korea's Innovative Resources are Concentrated in Chaebol Firms: Evidence from Tobin's Q Regressions: 2007-2016

InQ	Full Sample	Only Samsung group	Except Samsung group	Except Samsung Electronics	Only Top 30: Sales	Except Top 30: Sales
RD/Assets	0.830*** (0.261)	2.323*** (0.589)	0.743*** (0.282)	0.738*** (0.265)	1.350*** (0.387)	0.793** (0.330)
Industry Dummies	Yes	Yes	Yes	Yes	Yes	Yes
Year Dummies	Yes	Yes	Yes	Yes	Yes	Yes
Number of Obs	762	62	700	752	235	527
Adj R-Squared	0.319	0.697	0.295	0.311	0.527	0.123

This table presents estimates of the stock market's valuation of R&D investment for different groups of South Korean firms, obtained from regression specification (7) in the text. Data are taken from the KLCA database (TS2000 and COINS). Regression estimates suggest that the stock market values R&D undertaken by the Samsung Group far more highly than R&D investment undertaken by other South Korean firms.

Tobin's Q regression results (2009-2016)

Table 3 South Korea's Innovative Resources are Concentrated in Chaebol Firms: Evidence from Tobin's Q Regressions: 2009-2016

InQ	Full Sample	Only Samsung group	Except Samsung group	Except Samsung Electronics	Only Top 30: Sales	Except Top 30: Sales
RD/Assets	0.793*** (0.279)	3.050*** (0.674)	0.700** (0.298)	0.700** (0.283)	1.298*** (0.402)	0.759** (0.354)
Industry Dummies	Yes	Yes	Yes	Yes	Yes	Yes
Year Dummies	Yes	Yes	Yes	Yes	Yes	Yes
Number of Obs	602	49	553	594	192	410
Adj R-Squared	0.331	0.744	0.313	0.322	0.530	0.111

This table presents estimates of the stock market's valuation of R&D investment for different groups of South Korean firms, obtained from regression specification (7) in the text. Data are taken from the KLCA database (TS2000 and COINS). Regression estimates suggest that the stock market values R&D undertaken by the Samsung Group nearly four times more than R&D investment undertaken by all firms other than Samsung Group firms. Since the global financial crisis of 2007-2008 roiled equity markets around the world, regression results reported in this table omit data from those years.

Patent Production Function (1991-2010) : Except Top 30 firms (sales)

Dependent Variable	Number of Patents		Number of Claims		Number of Citations	
	NB: RE	NB: FE	NB: RE	NB: FE	NB: RE	NB: FE
	(1)	(2)	(3)	(4)	(5)	(6)
Log R&D	0.0618*** (0.0161)	0.0493*** (0.0166)	0.0969*** (0.0151)	0.0950*** (0.0156)	0.0782*** (0.0154)	0.0746*** (0.0159)
Industry Dummies	Yes	Yes	Yes	Yes	Yes	Yes
Year Dummies	Yes	Yes	Yes	Yes	Yes	Yes
Number of <u>Obs</u>	1575	1575	1575	1575	1575	1575

Patent Production Function (1991-2010) : Only Top 30 firms (sales)

Dependent Variable	Number of Patents		Number of Claims		Number of Citations	
	NB: RE	NB: FE	NB: RE	NB: FE	NB: RE	NB: FE
	(1)	(2)	(3)	(4)	(5)	(6)
Log R&D	0.119*** (0.0216)	0.111*** (0.0210)	0.202*** (0.0232)	0.187*** (0.0228)	0.177*** (0.0233)	0.164*** (0.0230)
Industry Dummies	Yes	Yes	Yes	Yes	Yes	No
Year Dummies	Yes	Yes	Yes	Yes	Yes	Yes
Number of <u>Obs</u>	521	521	521	521	521	521