6.3. The Japanese Model and Its Challenges

- A catching-up model

- “Japanese spirit and Western technology” (Morishima)

$\rightarrow$ success in exploiting the result of R&D, not in investing in R&D (Freeman 1987)

Initial conditions

(1) moderately backward

- substantial technological catching-up until WW2

  eg 1. building its own aircrafts, battle ships and so on

  eg 2. R&D labs: 349 in 1930 (0.22% of GNP), 711 in 1942 (1% of GNP) (Odagiri & Goto)

- relatively high level of education

(2) legacy from the previous industrial system

: the *zaibatsu* dismantled but the *keiretsu* emerged

- NEC, Toshiba, Hitachi, Mitsubishi …

(3) the national objective re-oriented to 'rich country', giving up 'strong army'

→ the emergence of the 'developmental state'

The electronic industry

- Relatively developed
  - only a small gap in consumer electronics
  → fast adoption of transistor technologies for consumer goods
  - industrial electronics

The electronics industry

- A bigger gap in the computer technology
  "... the earliest research tended to be done, not in the private companies, but rather in government research institutions and universities." (Fransman 1990:13)

Series of catching-up and falling behind in the computer industry

- Rapid catching up with transistor technologies
  - falling behind by US forging ahead with IC technologies
- Catching up with germanium-based ICs
  - falling behind by the introduction silicon-based ICs

Table 2.1. *U.S. Sales of Germanium and Silicon Transistors (Nominal $)*

	Germanium		*Silicon*	
	Units (M)	Average Value ($)	Units (M)	Average Value ($)
1957	27.7	1.85	1.0	17.81
1958	45.0	1.79	2.1	15.57
1959	77.5	1.96	4.8	14.53
1960	119.1	1.70	8.8	11.27
1961	177.9	1.14	13.0	7.48
1962	213.7	0.82	26.6	4.39
1963	249.4	0.69	50.6	2.65
1964	288.8	0.57	118.1	1.46
1965	333.6	0.50	274.5	0.86

Source: EIA (1974, p. 87).

Series of catching-up and falling behind in the computer industry

- Continual frustrations in the computer industry
  - FONTAC Project in 1962
  - Fujitsu, NEC, Oki …
  - conditional loans from MITI

  (not a cooperative research but) “the member companies agree to specialize in selected, non-overlapping areas” (Fransman 1990: 29)

  → IBM’s introduction of its System 360 (based on hybrid ICs) in 1964

Series of catching-up and falling behind in the computer industry

- Fujitsu 370 catching-up with IBM 379 in 1974

  → IBM’s LSI-based PCM (plug-compatible mainframe)

  → even Japan’s dominance in the consumer electronics was threatened

The VLSI Project

(1) Overtaking strategy

- frustrated by failures from catching up efforts with existing technologies in an industry where technological frontier is moving fast
- solution?

$\rightarrow$ investing in the next generation of technologies

cf. Gerschenkronian catching-up

The VLSI Project

(2) Concentration on DRAMs

$\rightarrow$ focusing more on process technologies

cf. more than 1,000 patents produced: improving yield rates and concentrating on the electron-beam lithography

'a more conservative design and ceramic package'

The VLSI Project

(3) cooperative research sponsored by the government

"Japanese producers commercialised 64K DRAM almost at the same time as their U.S. competitors did. By the end of 1981, they captured 70% of the international market for 64K DRAM."

Table 2.9. *Maximum Market Share in DRAMs by American and Japanese Companies, by Device*

Device	Maximum Market Share (%)		
	United States	Japan	
1K	95	5	
4K	83	17	
16K	59	41	1979
64K	29	71	
256K	8	92	1982
1M	4	96	
4M	2	98	

Source: Dataquest, cited in Methé (1991, p 69).

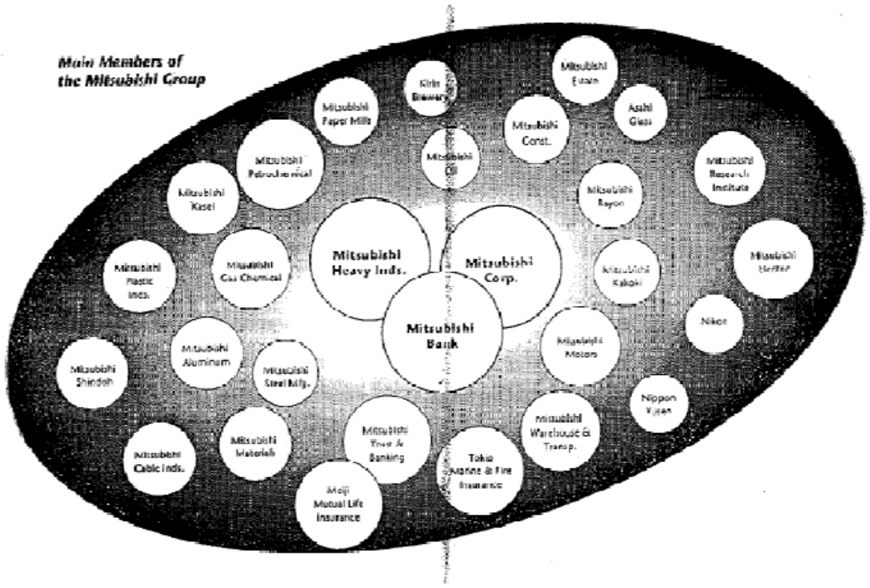
The *Keiretsu*: Main Features

(1) size and diversification

cf. horizontal vs. vertical keiretsu

(2) interlocking through mutual or circular shareholding

: decision-making by 'insiders'



The role of *keiretsu*: diversified electronic firms

(1) stable commitment to investment

"Japanese investment increased more rapidly than that of the U.S. all through the 1970s. Continued capital investment by Japan was most remarkable during the period of recession after the first oil shock. The U.S. semiconductor manufacturers restricted their investments for the development of new technologies and production capacity.

By contrast, Japanese producers continued a high rate of investment. Whereas the average ratio of capital spending to sale of the U.S. producers remained only 12% during the period 1973-78, that ratio of the Japanese producers was 17.8% during the same period. In 1983, the 'total capital spending' of Japanese semiconductor makers surpassed that of the U.S. makers" (Shin 1996: 117).

(2) Synergy across sectors

① close and systemic learning-by-using

eg. NEC

"The need for supplying sophisticated ICs for their computer divisions facilitated the development of the semiconductor divisions within the integrated electronics firms. On the other hand, the semiconductor divisions in turn facilitated the development of other divisions" (Shin 1996: 122)

② demand-side promotion

- 21% of SC consumed internally in 1980

The state initiatives

(1) Attempting a catching-up in the high-tech industry from the beginning

- no initiatives from the private sector, but the govt. coordinated and supported it
- reflection of 'moderate backwardness'

cf. Korea, Taiwan and Singapore in the 1960s

The state initiatives

(2) Protection

- computers classified as ‘quota items’

eg. penetration by US firms: only 20% while 98% in US and 78% in Europe

- also due to the Keiretsu grouping

(3) Nearly prohibiting FDI

(4) ‘Buying Japanese’ policy

- JECC (Japan Electronic Computer Company) in 1961

- (2) + (3) + (4)
  → forcing technology licensing
- rapid technological progress and generational changes in the SC industry
  → rapid obsolescence of existing technologies

“One distinctive role of the Japanese protective system in the semiconductor industry was that it was employed as a means of acquiring foreign technologies. As technological progress was rapid in the industry, it was often profitable for the technology originator to license its technology if marketing opportunities for its products are blocked. Japanese tight protection in its domestic market therefore led U.S. semiconductor firms "to license their technology to Japanese firms as a means of generating residual earnings in a market to which access has been difficult at best" (Shin 1996: 119).

(5) coordinated research

- economise R&D resources by reducing duplicative research

→ VLSI project enforced by MITI

TABLE I. MITI Research Projects in Computers, Semiconductors, and Software

Rank	Project		MITI Funding (billion ¥)[a]
**1	Real World Computing	1992–2001	70.0[b]
**2	New Series [computer]	1972–76	57.0
**3	Fifth Generation Computer Systems	1982–93	54.0
**4	Very Large Scale Integration [semiconductor]	1975–80	29.0
5	Pattern Information Processing System [software]	1971–80	22.0
**6	Future Electron Device	1981–2000	17.6[c]
**7	Supercomputer	1981–90	17.5
8	Optoelectronics	1979–85	15.7
**9	SIGMA [software]	1985–89	12.5
**10	High-Speed Computer	1966–71	10.0
11	Interoperable Database Systems	1985–92	7.6
12	FRIEND21 [computer]	1988–94	6.8
13	Software Production Technology Development	1976–81	6.5
14	Japan Software Company	1967–72	3.0
15	Software Module	1973–75	3.0
16	Software Maintenance Engineering Facility	1981–85	3.0
17	New Models for Software Architecture	1991–98	2.0[d]
18	Formal Approach Software Environment Technology	1985–89	2.0
**19	FONTAC [computer]	1962–64	0.4

Source: Ministry of International Trade and Industry.
[a]current yen; [b]projected; [c]1981–1996 only; [d]1991–1996 only; **case studies

(6) technology projection and guidance

- ‘knowledge intensive growth vision’ in 1971
- ‘going all solid state TV’

→ early concentration on and lead in the ICT industry

"In such situation, the important thing is not statistical accuracy, which is in any case spurious, but the identification of main features of the new paradigm and the recognition of its future potential". (Freeman 1987: 77)

Education and training

(1) rapid increase in the number of engineers

- on the per capita basis, 3 times of U.S. and 4 times of U.K. in number of electrical and electronic engineers

Table 14. Electrical and electronic engineering graduates, United States and Japan, 1969–79

	United States		Japan	
	BS only	BS, MS, PhD	BS only	BS, MS, PhD
1969	11 375	16 282	11 035	11 848
1970	11 921	16 944	13 085	13 889
1971	12 145	17 403	14 361	15 165
1972	12 130	17 632	15 020	16 052
1973	11 844	16 815	16 205	17 345
1974	11 347	15 749	16 140	17 419
1975	10 277	14 537	16 662	18 040
1976	9 954	14 380	16 943	18 258
1977	9 837	14 085	17 668	19 257
1978	10 702	14 701	18 308	20 126
1979	12 213	16 093	19 572	21 435

Sources: Engineering Manpower Bulletin (USA); Ministry of Education (Japan), taken from Gregory (1986).

(2) high level of general education

- 95% youngsters have full time education until the age of 18 (U.K. 1/3)
  - → homegeneous workforce
  - → flexibility in incremental innovations

(3) emphasis on on-the-job training