

Technological Catch-up in China: A Comparison with Korea

(with Gao Xudong & Li Xibao
in Tsinghua Univ. China):

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Motivations and Goals

- To sort out similarities and difference of Chinese catching up model from that of neighboring Asian economies,
 - in particular, Korean model of catch-up in Lee and Lim (2001) from 6 sectors in Korea.
- To identify common, effective catch-up policies generalizable across east Asian economies of China, Korea and Taiwan
- as well as point out the China-specific factors for more or less successful catch-up in diverse sectors in China.

1) Why Korea and China?

Because exceptional success in latecomer catch-up in a certain size economy

2) Why the 5 sectors in China?

Telecom equipment & systems

Mobile phones

Automobiles

IC chips

Machine tool

=> Similar sectors in Lee and Lim (2001 RP)
on Korea

Record of Catch-up in Market shares in 5 Sectors (and How to explain these?)

1) Cell phone: Very dynamic:

- - quick catch-up, some retreat, and recently re-catch-up

2) Telecommunication system:

initially slow catch-up through path-following;

then a rapid catch-up with leapfrogging at later stage.

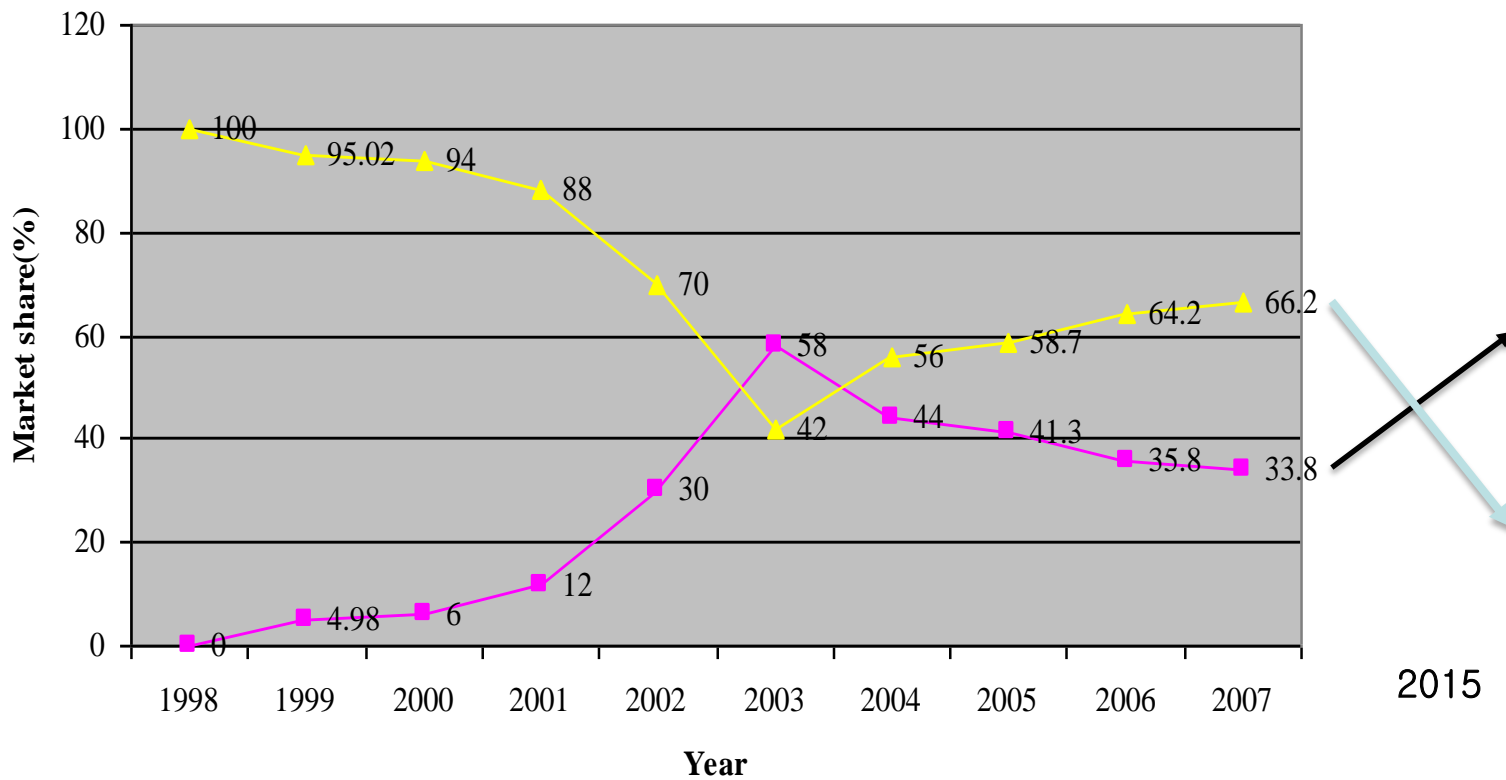
3) Automobile sector:

steady catch-up with medium speed or slower than that of the IT

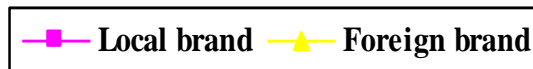
4) Machine tool: steady and slow catch-up.

5) Semiconductor : most modest catch-up so far.

Market Shares in Mobile Phone Markets in China; Foreign vs. Indigenous (TCL, Bird, Renovo)



Data source: CCID&MII



Market shares of Indigenous makers
in Automobile sector in China:
=> Steady but no rapid catch-up

	Shares of Domestic Brands	
Year	Passenger Cars	Sedans
2007	40.5	26.4
2008	39.9	25.9
2009	44.3	29.7
2010	45.6	30.9
2011	42.2	29.1
2012	41.9	28.4
2013	40.3	27.5

Top 10 Semiconductor Suppliers in China Market (Roh and Lee 2015)

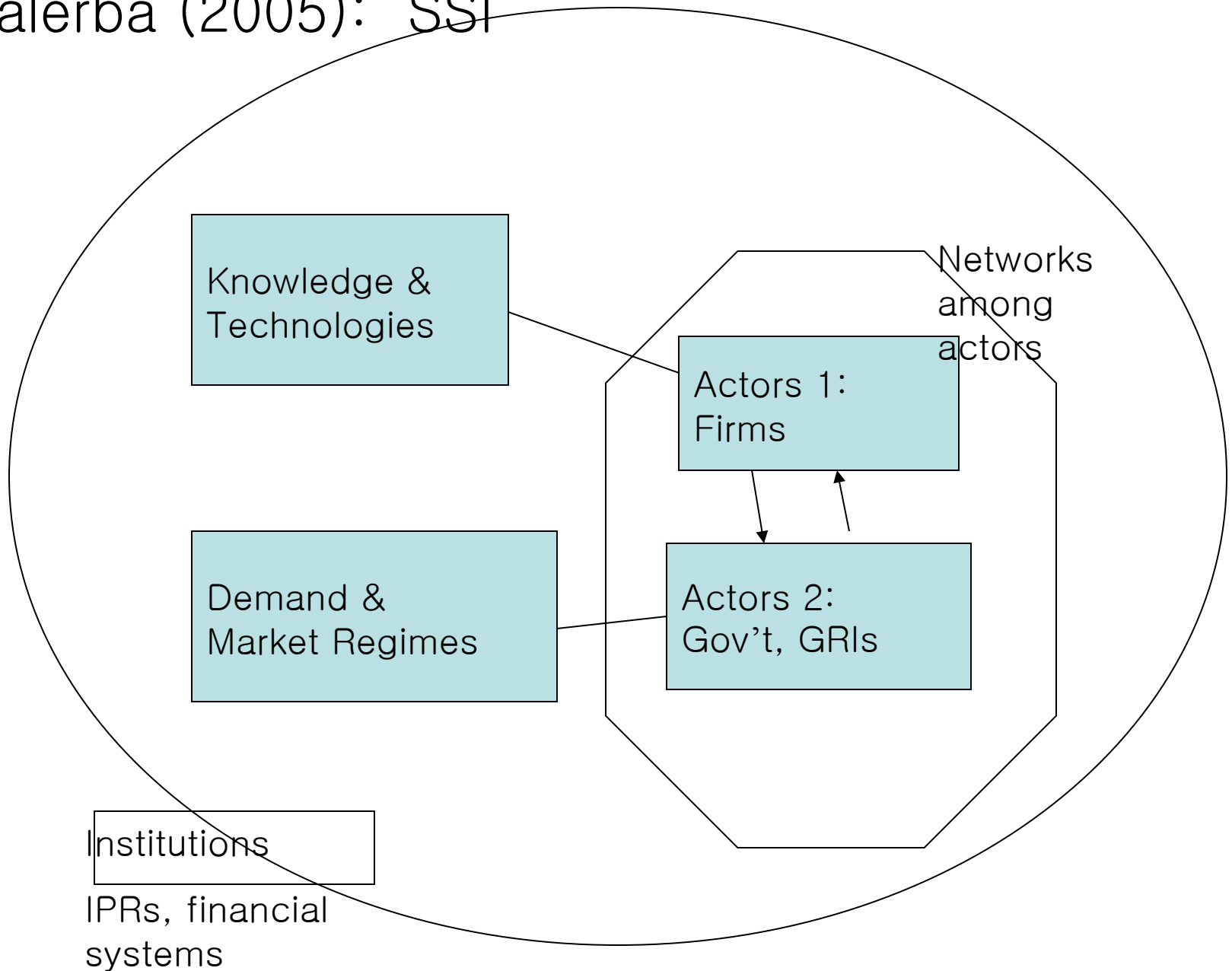
=> no catch up by China

Rank		Company	Revenue in USD million			Market share
2012	2013		2012	2013	%Change	
1	1	Intel	25,076	24,941	-0.5	13.8
2	2	Samsung	11,450	13,723	19.9	7.8
5	3	SK-Hynix	5,108	7,230	41.5	4.0
4	4	Toshiba	5,152	5,886	14.2	3.3
3	5	TI	5,398	5,650	3.8	3.1
10	6	Qualcomm	3,171	4,658	46.9	2.6
6	7	ST	4,359	4,546	4.3	2.5
7	8	AMD	4,219	4,050	-4.0	2.2
8	9	Freescale	3,561	3,958	11.1	2.2
9	10	Renesas	3,260	3,008	-7.7	1.7

Theoretical Origins and Framework

- Sectoral systems of innovation (SSI) framework of Marlerba (2002; 2004) that has evolved from the NIS literature
- Catch-up = explained as interaction of technological regime and responses by the actors (latecomers and incumbents)
- but introduce some modification of the framework to the context of China ,
- as a modification of Lee & Lim (2001) model or Mu and Lee (2005) model.

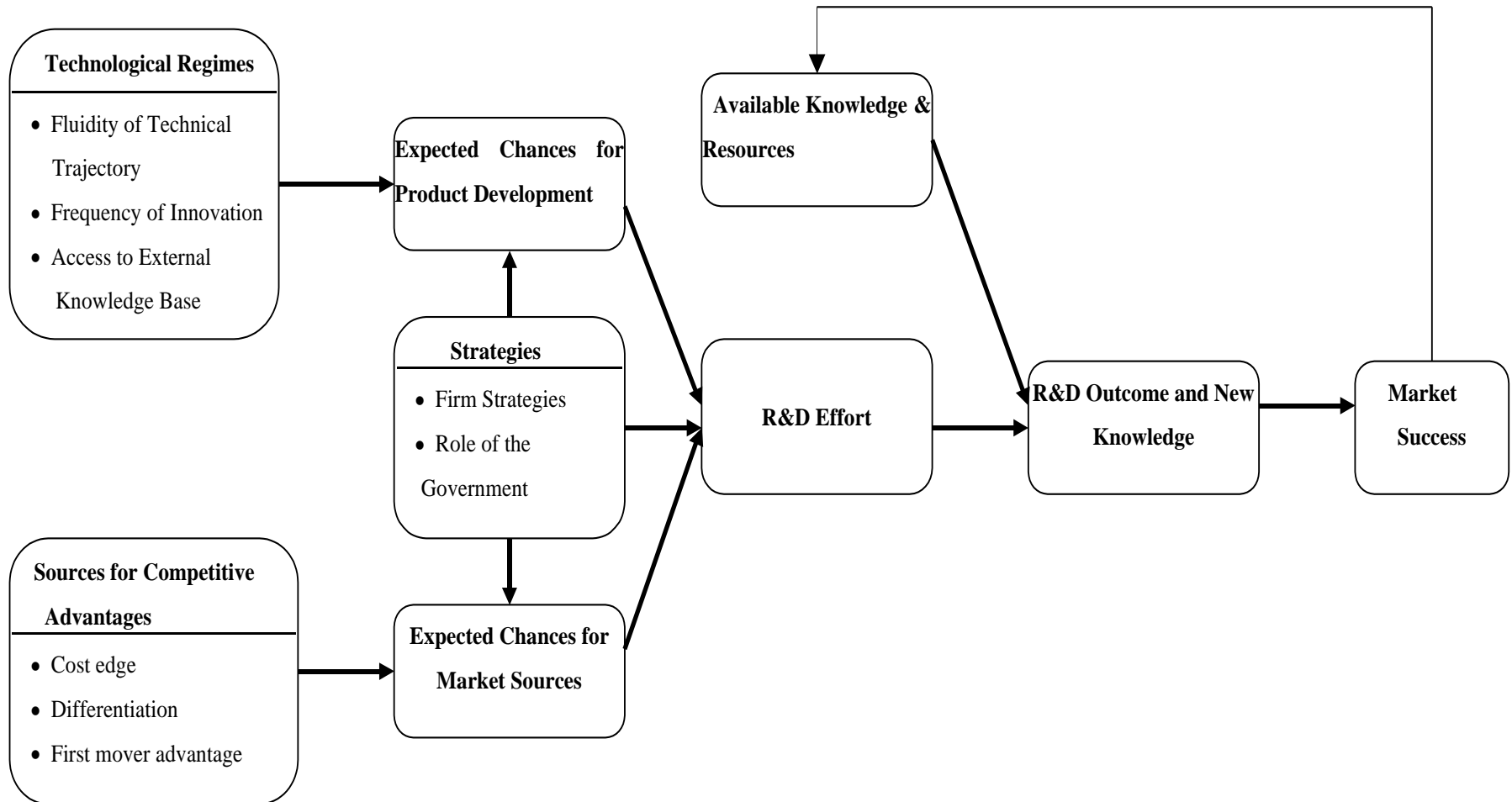
Malerba (2005): SSI



Model of Tech. and Market Catch-up (6 sector in Korea)

(Lee & Lim 2001; with 730 google citations so far)

Figure 1. Model of Technological and Market Catch-Up



3 Patterns of Technological Catch-up (Lee & Lim 2001)

Path of the Forerunner : stage A --> stage B --> stage C --> stage D

Path-Following Catch-up : stage A --> stage B --> stage C --> stage D

eg. PC, some consumer goods, and Machine Tools

Stage-skipping Catch-up (leap-frogging I) :

stage A -----> stage C --> stage D

eg. Hyunda's fuel-injection engine (cf. carburetor engine)

Samsung' 64 K D-Ram production technology; 256 K D-ram design technology

Telephone switch in in China

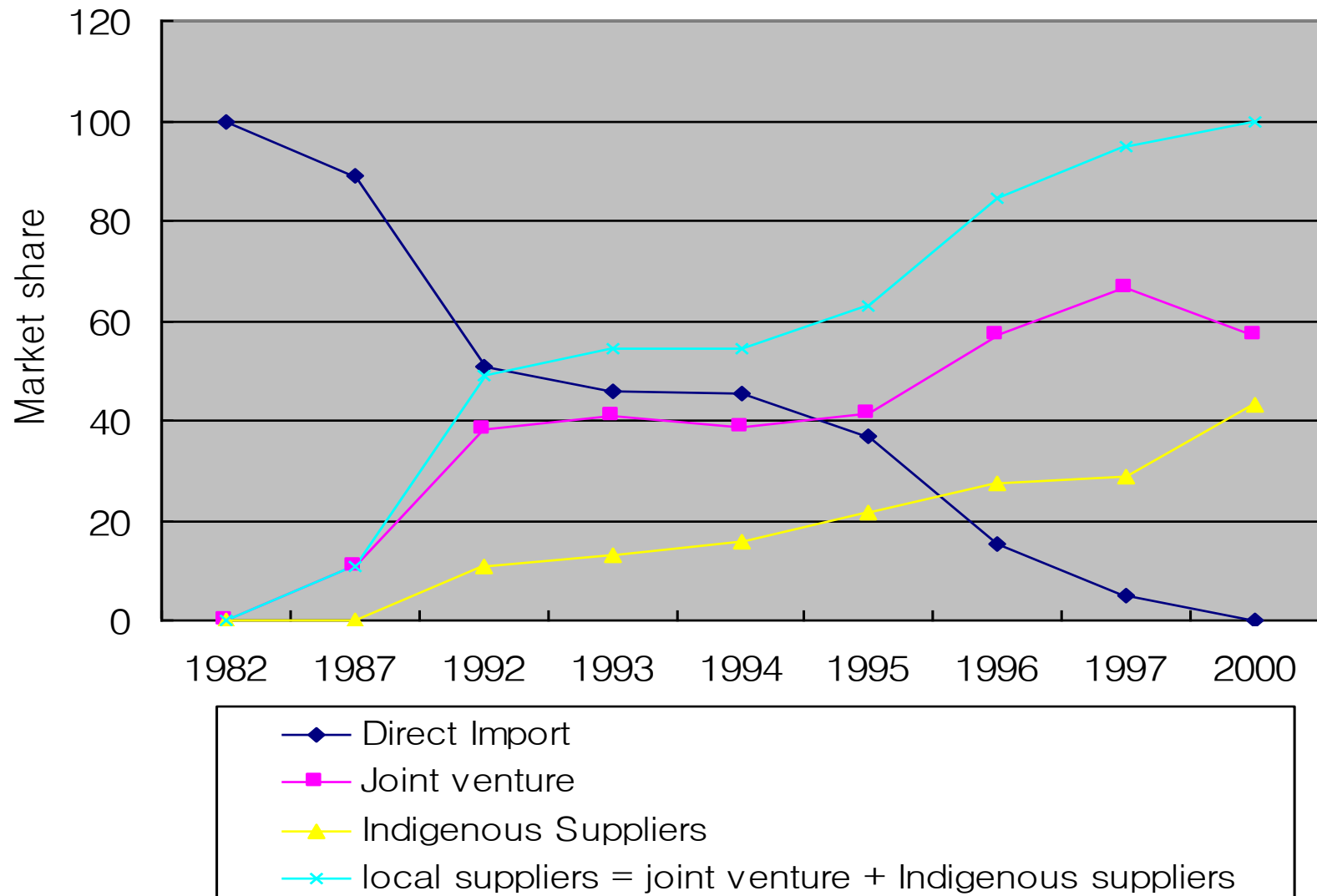
Path-Creating Catch-up (leap-frogging II)

stage A --> stage B --> stage C' --> stage D'

eg. CDMA development, digital TV

(Notes: C and C', represent competin technologies.)

Catch-up in Telephone Switch Market in China (1982-2000): Birth of Huawei (Mu and Lee 2005 RP)



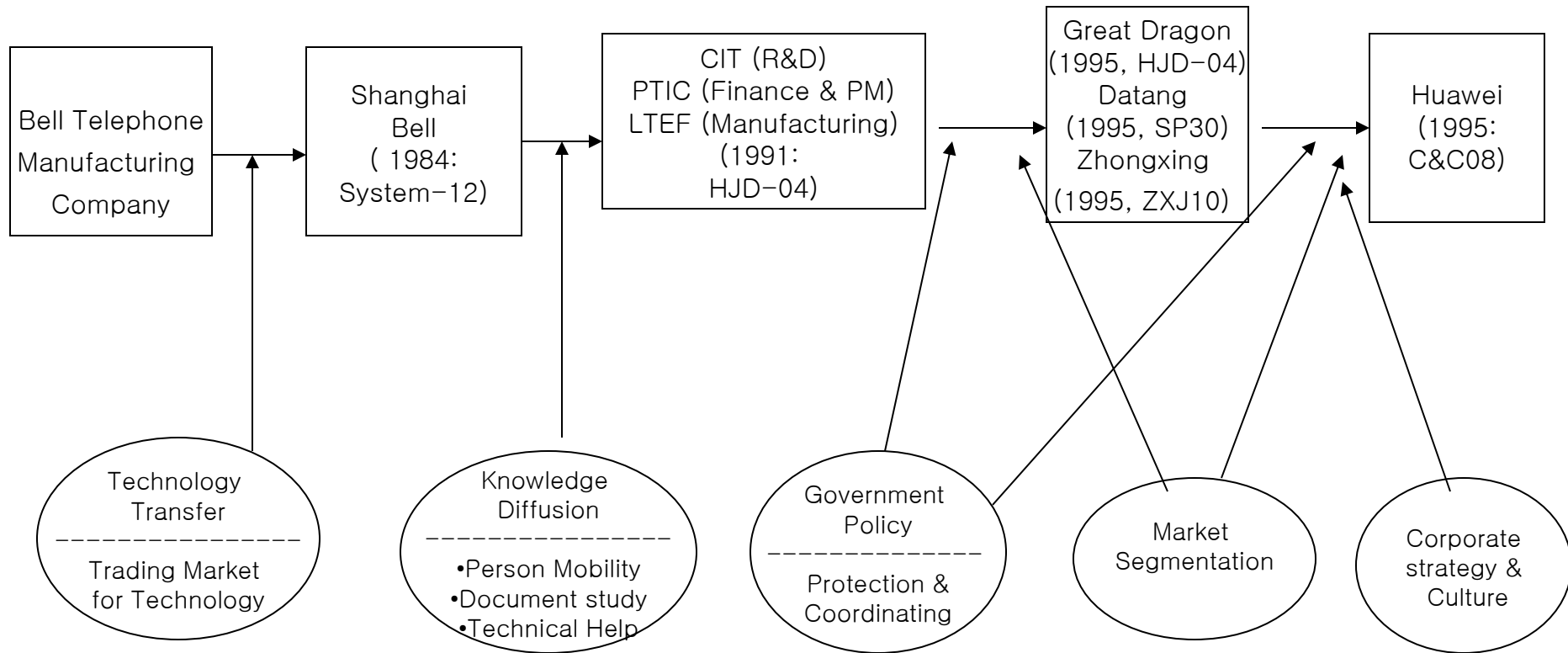
Knowledge Diffusion, Market Segmentation & Technological Catchup : a stage-skipping under predictable regime

Trajectory of
Telephone

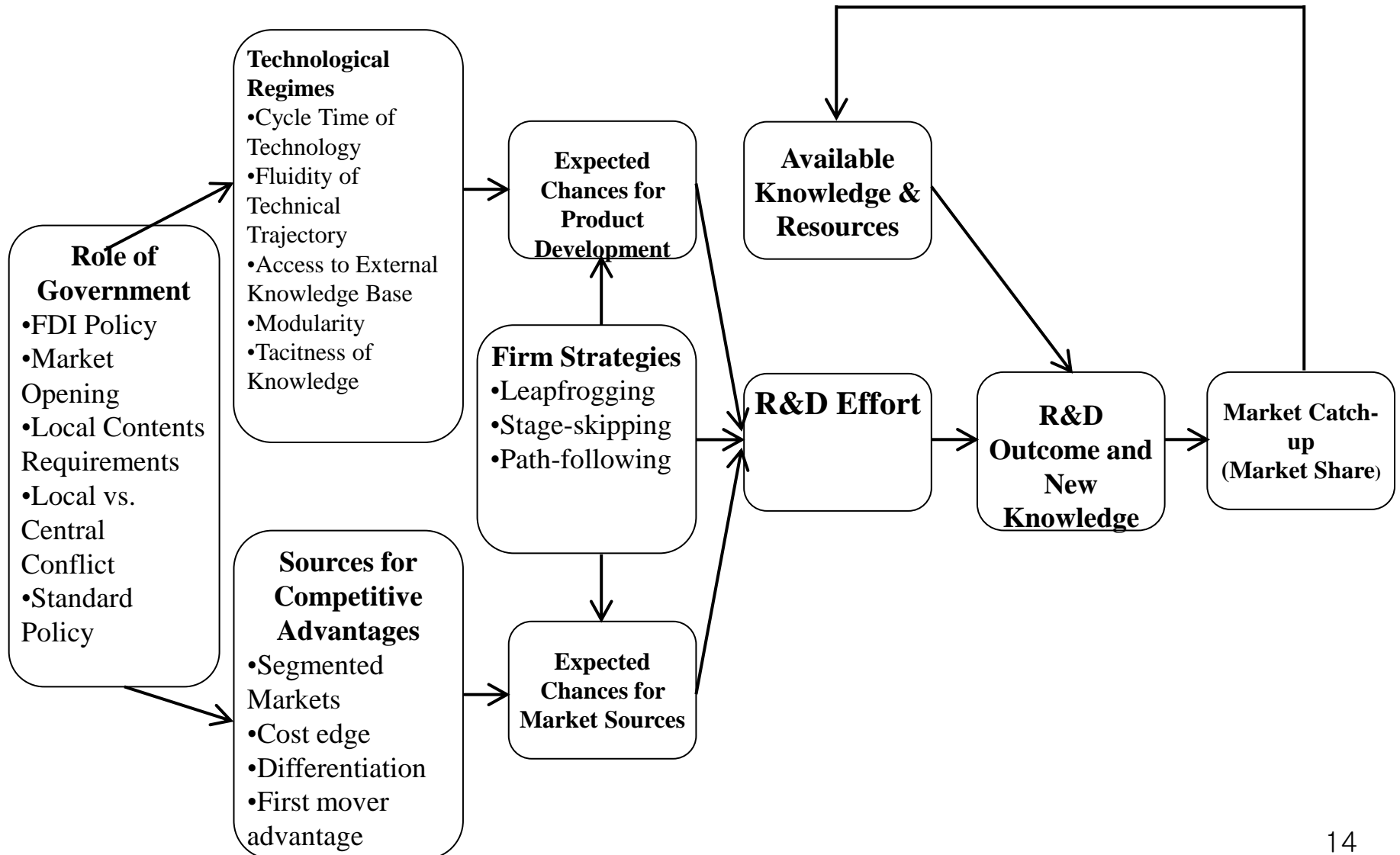
Foreign Path: Manual → Step-by-step → Crossbar → Analogue electronic → Digital SPC

Switch
Technology :

Chinese Path: Manual → Step-by-step → Crossbar → -----→ Digital SPC



Modified Model of Technological and Market Catch-Up in China



SSI (Tech Regimes) and Catch-up in Autos and Cell Phones in China

	Automobiles	Mobile Phones
A. Tech/Knowledge Regimes		
Embodied technical change	High	Low
Modularity	Medium	High
Knowledge Access	High	High
Tacitness	High	Low
Frequency of Innovation	Low	High
B. Elements important for Catch-up Performance		
Entry and early Stages	Embodied Tech. Change	Modularity
Later Stages or Longer Term	Tacitness	Frequent innovation
C. Critical Capability for Long Term		
	Integration Capability based on key components	innovation capability to meet changing market demands

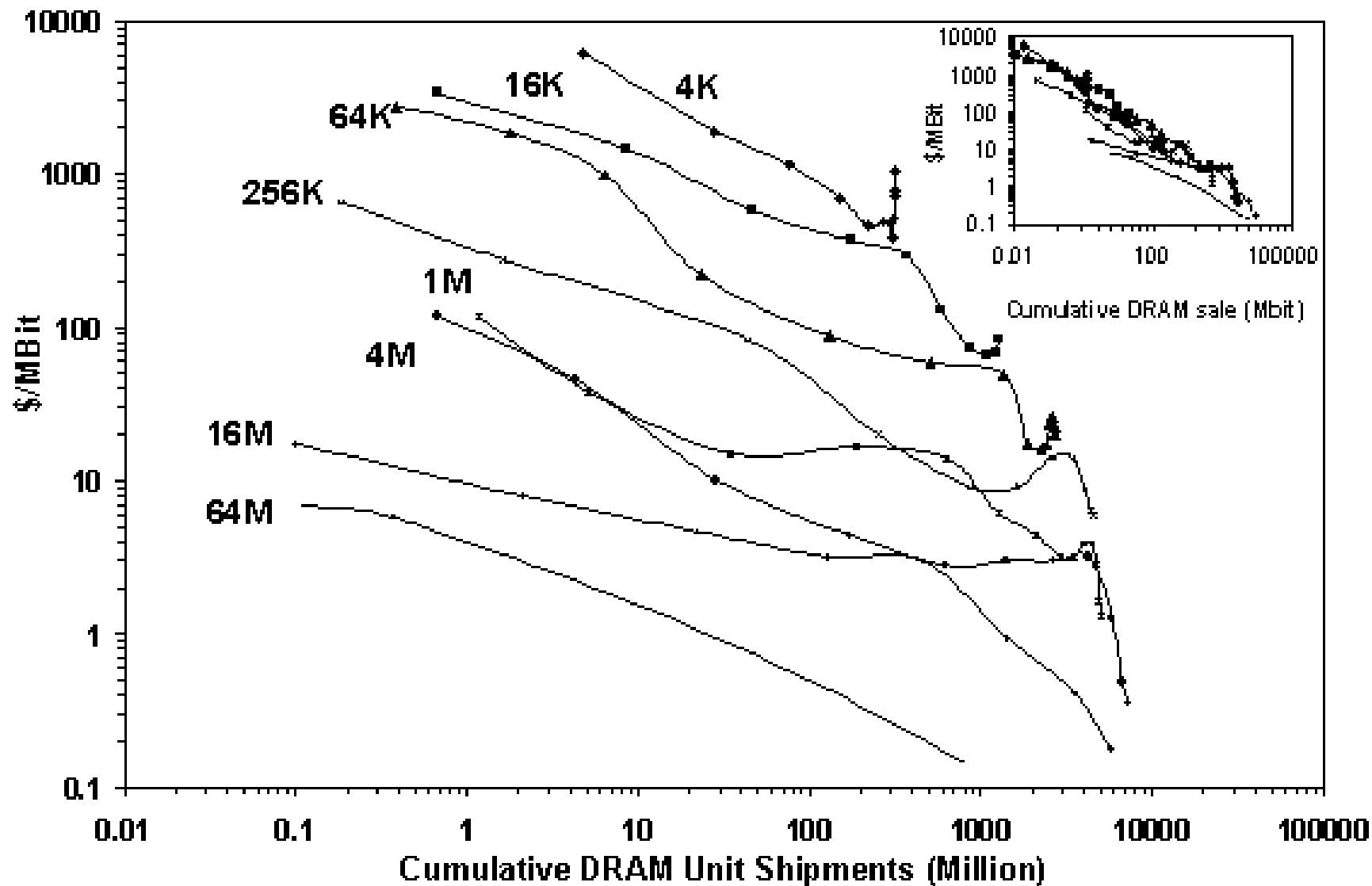
Why: limited Catch-up in memory chips

In catch-up in market shares, the industry still remains limited.

Reasons for limited catch-up:

- 1) **Technology regime: In the semiconductor industry, innovations are frequent and technologies are highly cumulative-> disadvantageous .**
 - 2) **Market for IC chips are not segmented but highly integrated -> no (low-end market) room for the latecomers.
→ difficult to seize the market opportunity through marketing.**
 - 3) Getting worse with the continued increase of the required investment and shortening of life cycles.
 - 4) Western countries restricted transfer of core technologies to China in the past..
- Q) New Window of opportunity?
Intel developed new chips /China acquired some US companies

Rapid generation changes and no coexistence of old and new chips



Comparable finding 1:

From Technological regimes to catch-up

Interface between tech regimes of sector and strategic response by actors as determinants of catch-up;

⇒ **What are the favorable elements of the regime:**

a) higher modularity

(mobile phones vs. machine tools; semi-conductors),

b) shorter cycle time of technologies (mobile phones vs. automobiles),

c) sectors with codifiable (vs. tacit) knowledge

(eg IT vs. autos & machine tools)

⇒ but, still room for strategic intervention by actors;

-> similar the regime leading to different outcomes

(eg. Memory chips in Korea vs China);

Comparable findings 2:

double nature of short cycle time or frequent change of tech

- Short cycles sectors give a latecomer better chance for catch-up only for the latecomers with certain level of tech. capabilities;
- Cf) frequent changes in technologies may serve as an additional barrier against catch-up because it might lead to the situation of truncation of learning pointed out by Lall (1992; 2000).
- In cell phones, short cycle time of technologies = sources of windows of opportunity for Chinese firms;
- Cf) in IC manufacturing (esp memory chips) frequent generation changes interfered Chinese catch-up effort against the ever-moving forerunners.
- The difference → level of initial absorptive capacity (or the initial gap) as well as the degree of lateness in entry by the latecomers;
 - Chinese entry into IC chips was far late,, than their entry in mobile phones.
- → consistent with Park and Lee (2006) and Lee (2013: Ch. 4), comparing the East Asia and Latin American firms.

Comparable findings 3a: Potentials and limits of path-following strategy

- In many sectors, initial catch-up start by trying a path-following strategy in low-end segment (low entry barrier)
- for the latecomer firms to succeed require 'space' for initial growth, ;
- Eg 1) low-end segments
(telecom equipment, mobile phones, machines tools),
eg 2) protected market by gov't (telecom equipment).
- In contrast, in the markets with no such segmentation, as in memory chips, latecomers find it difficult to enter:
→ reasons for slow progress of China in memory chip.

Comparable findings 3b: from path-following to leapfrogging at later stage

- In some sectors (eg short cycle technologies), going along path-following strategy would not bring in success but requires leapfrogging;
 - Limit of path-following
 - a) incumbents become reluctant to provide technologies to latecomers who get close to them.
 - b) latecomers always left behind because forerunners keep moving ahead.
- So, try to leapfrogging but it involves risks; might fail.
 - => need gov't sharing risks and funds;
 - eg) Korean memory chips, digital TVs, cell phones
 - also in China: TDSCDMA,

Comparable Finding 4: Importance of indigenous vs. FDI Firms

- eventual success or over-taking requires building capabilities of indigenous firms rather than just FDI.
 - FDI = important channel for learning;
But foreign firms; increasingly reluctant to transfer technology as the latecomers getting close to the frontier.
- Eg) in auto in China and Korea,
 - Geely & Cherry vs. Shanghai Volkswagen & First Auto ;
 - Hyundai motors vs. GM–Daewoo in Korea.

Role of the Government 1: comparable finding 6

- Role of the government; important in some sectors but not in other sectors.

⇒ To find out right forms of activism in diff'nt sector.

1) Local procurement worked in telecom equipment

2) local content requirements worked fine in wind-turbine in China;
cf) many failures in other countries.

3) In high-tech sectors, just licensing or FDI not enough
but requires different mode of intervention

eg) public-private joint R&D;

foreign-domestic joint R&D;

scouting of foreign engineers,

as in the case of mobile phones in China.

Role of the Government 2: China-specific finding: Central vs local government and their consistency

- in automobile sector, there was different emphasis on indigenous vs. FDI firms by center vs. local government.
- Early policy of encouraging JVs with MNEs :
 - slowed down the speed of catching up.
 - b/c 1) MNEs not willing to transfer technology;
 - 2) local firms not motivated to innovate
 - b/c high profits from JVs.
 - > catchup happened only after this policy removed in 2001 or after WTO.
- Inconsistency or conflict among the governments further affected the degrees and modes of access to foreign knowledge and thereby shaped the pattern of catchup.

Conclusion 1: Common, generalizable patterns of Catch-up across China and Korea

- 1) Importance of Indigenous firms rather than relying passively on FDI, which serve mainly as learning channels.
- 2) While the path-following strategy serves as the gradual catch-up of market shares, it alone may not be enough to stage a rapid catch-up or to overtake the incumbents, which requires leapfrogging (path creating).
- 3) Role of the government is important but not always successful, and should be different across sectors;
 - In high-tech sectors, tariff, licensing or FDI may not be effective.
 - Instead, public–private joint R&D or R&D subsidies or grant, as well as foreign–domestic joint R&D and scouting of foreign engineers, may be required

Conclusion 2: China-Specific Factors

***China's difference with Korea can be explained:

A) Huge and segmented market

b) Complex interplay between the central & local gov'ts.

1) Given its huge population, the Chinese are open to foreign capital, can strike a better deal with foreign companies in tech. transfer (“trading market for technology” policy)

2) Segmented nature of China markets with several tiers

= additional benefit for indigenous co/s ;

-- low-end segments as nurturing home (cf: infant industry in Korea)

3) Decentralized nature of China's political system restrained implementation of coordinated industrial policies (Korean style), but government actors experienced overtime learning; eg) telecom

Thank you!

謝謝大家

ありがとう!

Gracias!

Meu Amigo! Obrigado!

감사합니다

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