



Catch-up Cycles & Changes in Industry Leadership

**Windows of opportunity and responses of firms and countries
in the evolution of sectoral systems**

Keun Lee & Franco Malerba
Research Policy 46 (2017) 338–351

Summary by Chi Nguyen



Content

1. Introduction
2. The Phenomenon
3. Theoretical Framework
4. Empirical Evidences in 6 Industries
5. Concluding Remarks



Catch-up Cycles

Phenomenon: changes in industry leadership and successive catch-up cycles

- Incumbent fails to maintain its superiority in technology, production and marketing
- Allowing a latecomer to catch-up with the incumbent
- The latecomer that has gain leadership will relinquish its position to a new latecomer

Research Questions:

- 1) How is the catch-up cycle characterized?
- 2) How does it occur?
- 3) How do latecomers catch up with incumbents and acquire industrial leadership?



Some Definitions

Catch-up	<p>the process of <u>closing the gap in global market shares</u> between firms in leading countries and firms in latecomer countries</p> <ul style="list-style-type: none">• diverge from the practices of pioneering firms and countries
Leadership	<p>the position of a country that has achieved a <u>commanding position in a specific industry</u> based on its share in the global market and its superiority in technology, production, or marketing</p>
Latecomer/ emerging countries	<p>firms share a common context related to the national or local networks, infrastructure, university system, human capital, financial organization, and institutions and policies of the country</p>



More Definitions

Sectoral system: consist of regimes of knowledge and technologies, demand conditions, actors and networks, and institutions (Malerba, 2002, 2004)

Windows of opportunity: discontinuities in the dynamics of a sectoral system

- (Perez and Soete, 1988) role of the rise of new techno-economic paradigms in the leapfrogging of latecomers who take advantage of a new paradigm and overtake incumbents

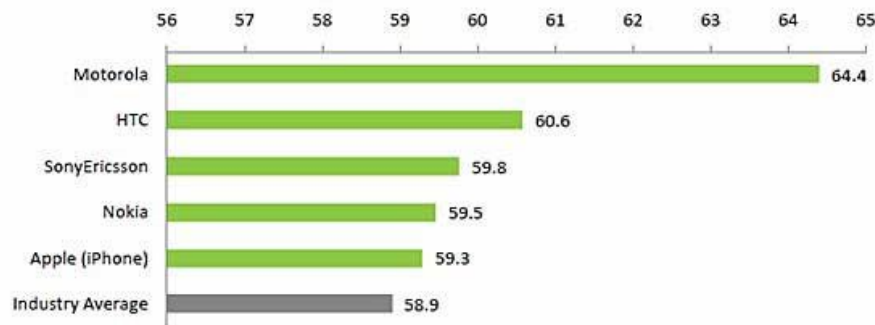
Technological windows	changes in technology	e.g., Korea vs. Japan in consumer electronics
Demand windows	a new types of demand, a major shake-up in local demand or a business cycles	e.g., increase demand in China, new set of consumers in India
Institutional windows	open through public intervention in the industry or through drastic changes in institutional conditions	e.g., high-tech industries in Korea and Taiwan, telecommunications industry in China, pharmaceutical industries in India

Technological windows

changes in technology

e.g., Korea vs. Japan in consumer electronics

Mobile Phone Brand of the Year Rankings



Other Mobile Phone Brands in Study (Alphabetical)
Blackberry, Kyocera, Pantech

2011 Harris Poll EquiTrend®

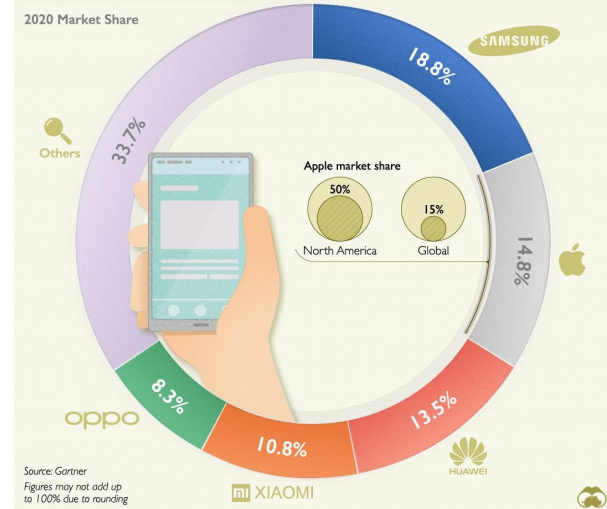
Top 10 Global Mobile Phone Brands 1993-2020 | The Rankings

<https://www.youtube.com/watch?v=zhqeWMvvvYM>

The Biggest Smartphone Brands Worldwide

Here's a look at the top 5 smartphone brands, based on 2020 unit sales.

2020 Market Share



Demand windows

a new types of demand, a major shake-up in local demand or a business cycles

e.g., increase demand in China, new set of consumers in India

BUSINESS

China's Giant Market for Really Tiny Cars

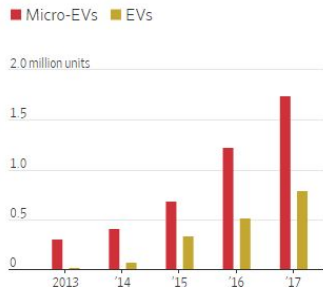
Supersmall electric vehicles are taking over roads in some parts of China—no driver's license needed

Chinese £3,200 budget electric car takes on Tesla

By Justin Harper
Business reporter, BBC News
© 25 February 2021

Small Success

In China demand for micro-EVs is significantly outstripping demand for full-size electric vehicles.

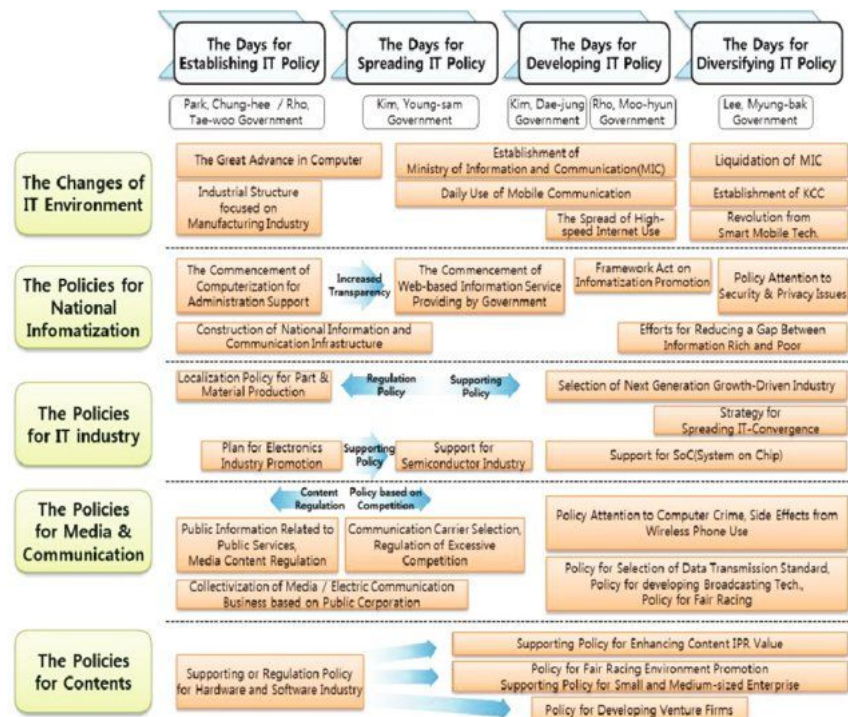


Note: 2017 micro-EV sales figure is an industry estimate
Sources: China Association of Automobile Manufacturers (EV); ResearchInChina (micro-EV)



Source: [WSJ](#), [BBC](#)

Institutional windows	open through public intervention in the industry or through drastic changes in institutional conditions	e.g., high-tech industries in Korea and Taiwan, telecommunications industry in China, pharmaceutical industries in India
-----------------------	---------------------------------------------------------------------------------------------------------	--------------------------------------------------------------------------------------------------------------------------



Source: Yeo et al. (2014)

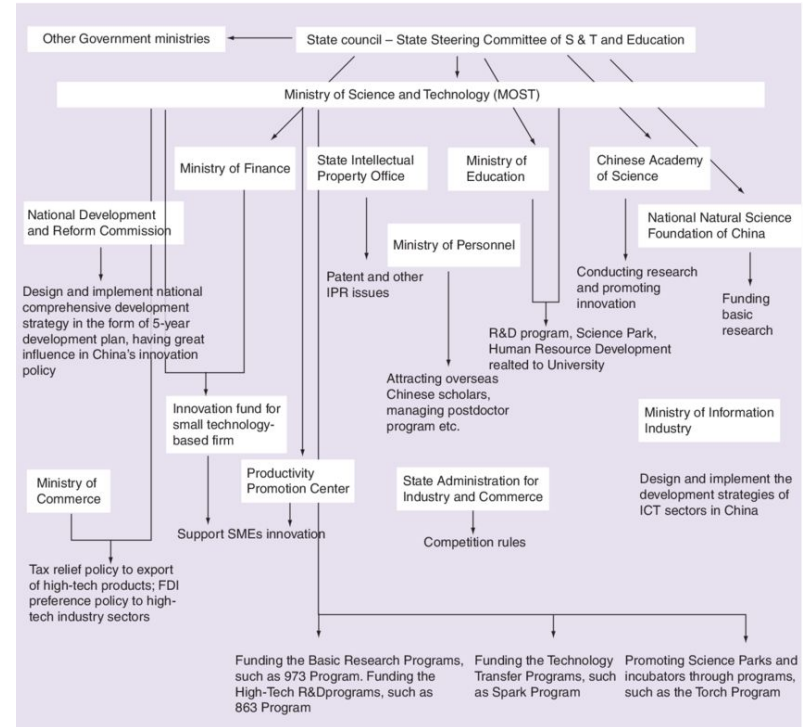
Institutional/Public Policy windows

open through public intervention in the industry or through drastic changes in institutional conditions

e.g., high-tech industries in Korea and Taiwan, telecommunications industry in China, pharmaceutical industries in India

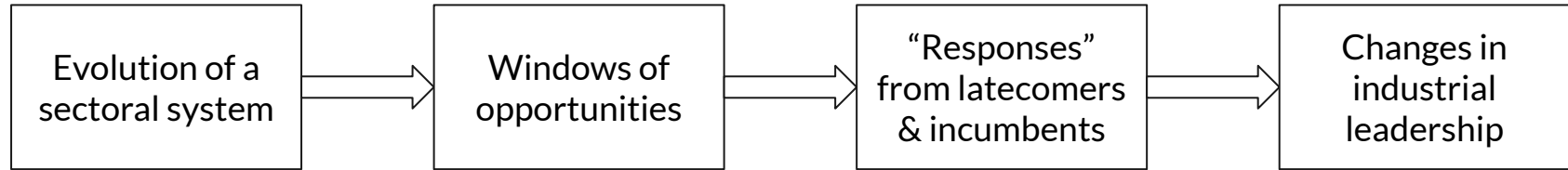
Program	Initiating year	Objective
Key Technology R&D Program	1983	Concentrate resources on key and common technologies needed for industrial upgrading and socially sustainable development
State Key Laboratories Program	1984	Support selected laboratories at public or private facilities
Spark Program	1986	Support technology transfer to rural areas
National Natural Science Foundation of China	1986	Support basic research through directing funding of projects
High Technology R&D Program	1986	Enhance China's international competitiveness and its capability in high-technology R&D
National New Product Program	1988	Compile the annual list of new and high-technology products and fund those products selectively through grants and interest subsidy
Torch Program	1988	Support high-technology industry sector development through setting up science parks and incubators, funding projects and training
Key Basic Science R&D Program	1997	Support basic science research
Innovation Fund for Small Technology Based Firms	1999	Support the establishment of new technology-based firms

R&D: Research and development.
Data from [7].



Source: Salter et al. (2006)

Arguments



- Diverse combinations of windows of opportunity and responses from incumbents and latecomers determine the pattern of successive catch-ups that will most likely emerge in a sector.
- Catch-up cycles may significantly differ across sectors in terms of the characteristics, frequency, and actors (firms/countries) involved because of the possible differences in the characteristics of a sectoral system and its evolution.

The Framework of Catch-up Cycles



Fig. 1. Leading Country A.

Global Leadership: firms of country A rising market share from A_0 to A_1

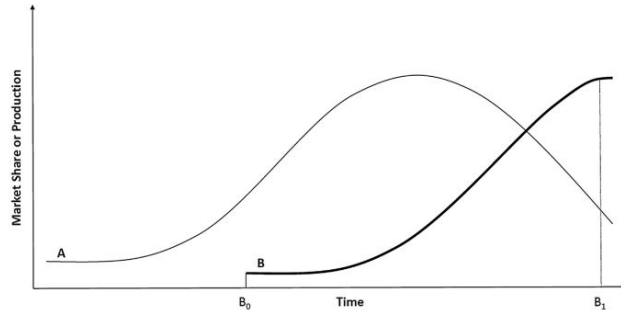


Fig. 2. Latecomer Country B.

Standard Catch-up Cycle: latecomer country B enter and starts production at B_0 then achieved the position of leadership at time B_1

The Framework of Catch-up Cycles

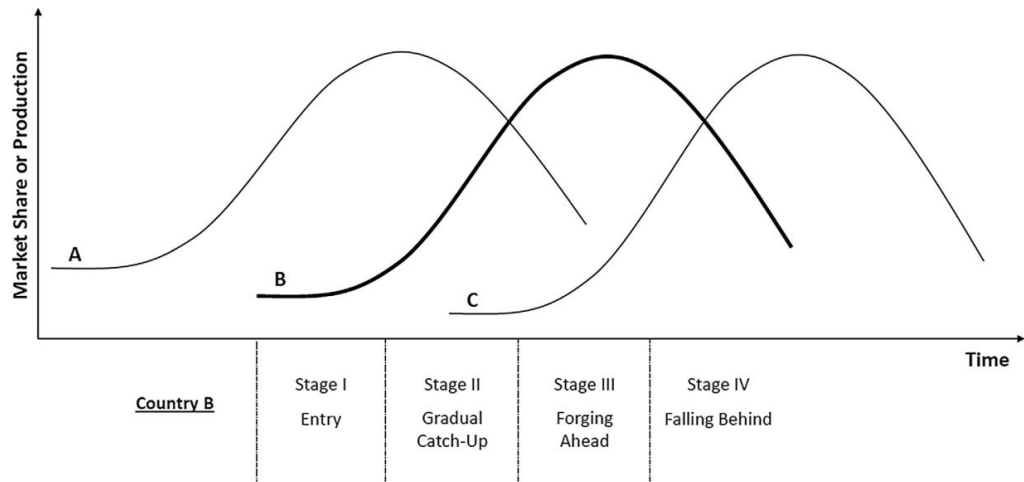


Fig. 3. Stages in Industry Catch-Up Cycle.

Entry	latecomer attempts to <u>enter an industry</u> and <u>overcome its disadvantages</u> by utilizing macro factors, such as low factor costs
Gradual catching-up	in terms of <u>market shares</u> , usually based on cost advantages, investments, learning, and gradual <u>accumulation of capabilities</u>
Forging ahead	achieved the position of <u>leadership</u> based on the opening of <u>windows of opportunity</u> and effective <u>responses</u> to those windows, often associated with the decline of incumbent
Falling behind	new leader B tends to decline with the rise of new challenger C

[1] Aborted Catch-up

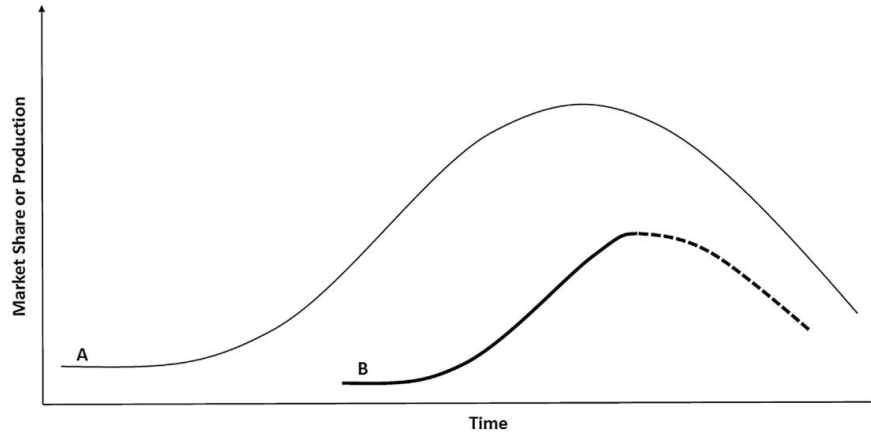


Fig. 4. Aborted Catch Up Cycle.

Catching-up effort fails to generate a consistent gradual catch-up and the stage of forging ahead.

- Inability to learn and generate upgrades in value-added products
- Lack of an effective and articulated system that supports firms in their catching up, particularly at the time of arrival of new technologies or the opening of new markets
- Example: software industry in Ireland catching up to US (Mani, 2013)

[2] Persistent Leadership

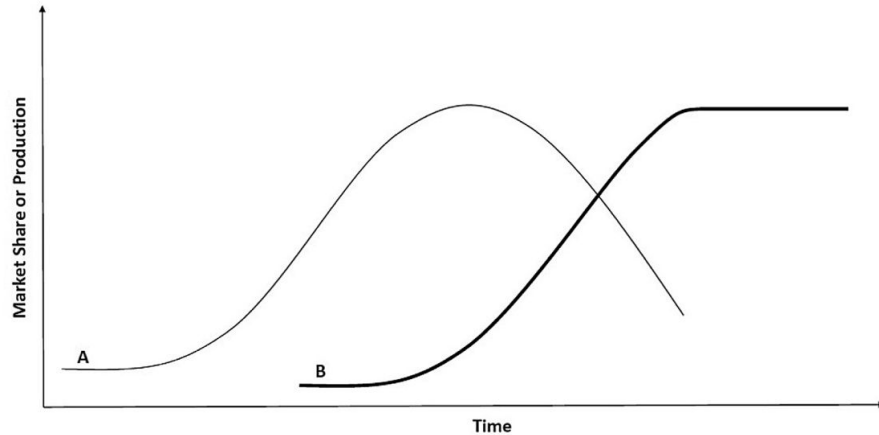


Fig. 5. Persistency of Leadership.

The leader continues to stay on top and maintains its position for a long time.

- The leader both invests to cope with new technologies or demand conditions and is able to adapt to a drastically changing environment.
- Example: memory chip and camera industries in Korea and Japan (Shin, 2017; Kang and Song, 2017)

[3] Coexistence of the old and the new leaders

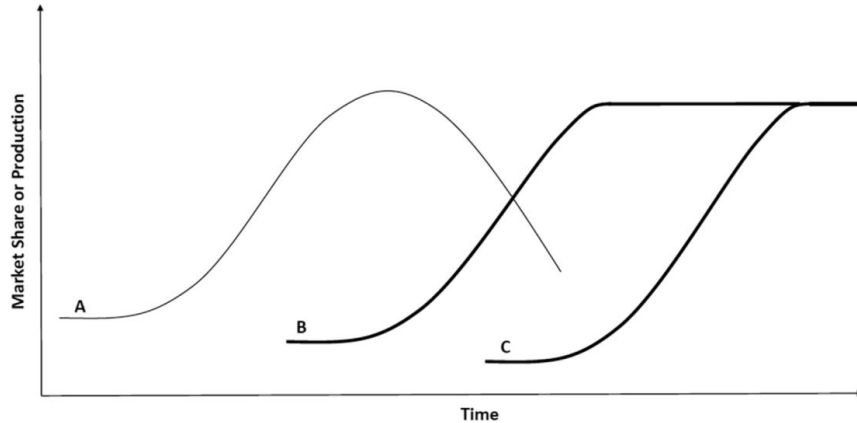
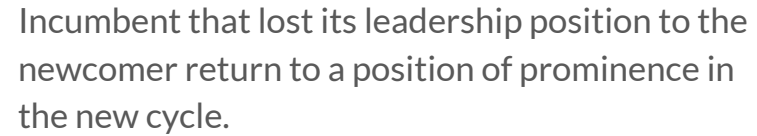


Fig. 6. Coexistence of leadership.

Latecomer country reaches a leadership position, but shares this position with the new leader.

- Example: automobile and wine industries (Morrison and Rabellotti, 2017)



- Fig. 7. Return of Old Leadership.**



Catch-up Cycles in Industries and Changes in Industrial Leadership

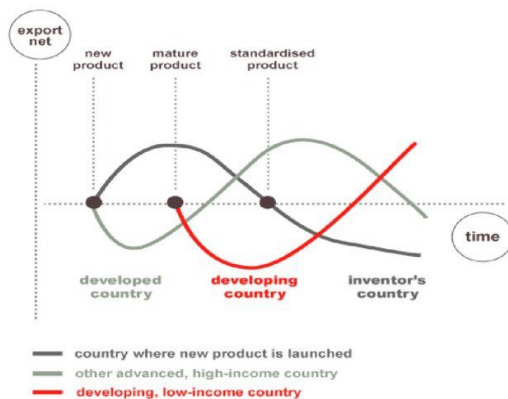
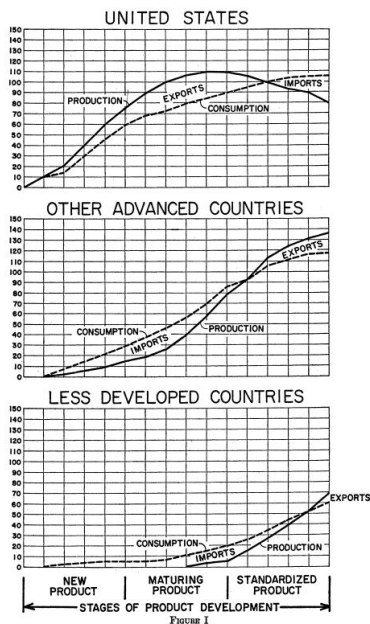
Product Life
Cycle

Sectoral
Systems

Catch-up Cycles

3. Theoretical Framework

Theory: Product Life Cycle



Source: Vernon (1966), Egu (2016)

Product Life Cycle: cost of production is a critical factor of comparative advantage → shift in production sites from developed to developing countries → location of production of established goods is eventually moved from developed countries to developing countries

Criticism (Mowery and Nelson, 1999)

- Only applicable to products rather than industry
- Only focuses on imitation and entry, without the later stages
- Does not account for changes in industrial leadership → leadership always remains in advanced countries

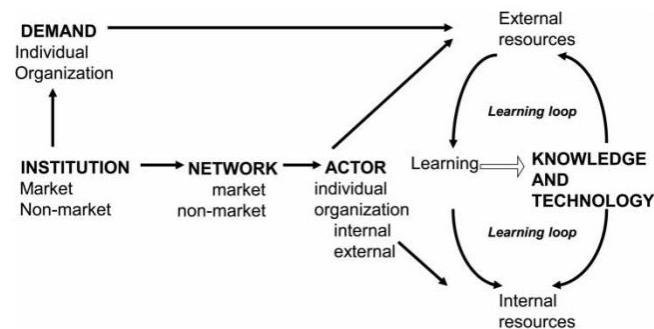
Catch-up cycles: not only the production sites but also the leadership position could move to developing countries

Theory: Catch-up cycles in sectoral systems

Sectoral innovation system (Malerba, 2002, 2004)

- Firms are a part of systems that comprise other actors and institutions.
- Firms in industries learn and accumulate capabilities in systems including knowledge and technologies, demand conditions, other actors, and institutions.
- Sectoral systems evolve over time through co-evolutionary processes in their elements (Nelson, 1994; Malerba and Adams, 2013)

Criticism: previous studies did not examine catch-up cycles using a long-term and multi-country comparative perspective



Source: Aminullah and Adnan (2012), adapted from Malerba (2002)



Theory: Early stages of catch-up

Entry and initial growth

- Associated with 3 main factors
 - (1) Initial conditions: presence of factor endowments, natural resources, culture, the extent of inequality, historical legacies, legal institutions, industrial structure, and entrepreneurship (Fagerberg, 1988)
 - (2) Macro factors: such as low labour costs
 - (3) Sectoral and national system factors: public policy, financial organizations, etc.
- These factors alone cannot enable latecomers to achieve world leadership.



Theory: Early stages of catch-up

Gradual catch-up

- Associated with learning and building of capability (Bell and Pavitt, 1993; Kim, 1997; Lall, 2001)
 - high-quality human capital from advanced educational organizations
 - public research organizations,
 - networks of related firms
 - vertical links with suppliers and users.
- Latecomers firms gradually accumulate production capabilities via learning-by-doing, then move up the quality ladder of products and technologies.



Theory: Later stages of catch-up

To enable a latercomer to forge ahead, change must occur in global leadership from the incumbent to the latecomer accompanied by a decline of the incumbent.

Windows of
Opportunity

Responses of
latecomers and
incumbents



Windows of opportunity

- An industry experiences changes in one or more of the basic components of the sectoral system.
- These experiences open up a window of opportunity for the forging ahead of the latecomer.

Technological windows	New technology or radical innovation	“Incumbent trap”: company may adopt a cautious attitude with respect to the new emerging technology due to high degree of uncertainty
Demand windows	Creation of new demands, rapid growth of domestic demands, abrupt changes in market demands	<ul style="list-style-type: none">• Leaders do not respond to new demand because they are successful within their existing markets and customers• Growth of domestic demand is not satisfied by exports from leading countries or by the local production of multinational corporations.• During business cycles, a mismatch occurs between the dynamics of investment and production vs. dynamics of market demand → require strategic choices about timing and capacity
Institutional windows	open through public intervention or drastic changes in institutional conditions	Government creates an asymmetric environment in which incumbent firms (often foreign) are in a disadvantageous position (in terms of taxation, entry restrictions or marketing restrictions) at least in the domestic market of a country



Responses to Windows of Opportunity

Success of latecomers associated with

- high levels of learning and of absorptive technological and marketing capabilities
- other supporting actors, networks, and institutions
 - effective institutional setting in terms of public policy and regulation
 - a strong university and public research system, supply of advanced human capital
 - presence of networks of suppliers and collaborating firms
 - availability of finance for innovation.



Responses to Windows of Opportunity

Latecomers

Firm level

- identify and commit to the opportunity that has opened up
- continue to strengthen efforts to learn and innovate.
- effectively focus on specific areas of technology or segments of demand
- timing of investment and access to new knowledge and technology are key

Sectoral level

- public policy often supports the efforts of firms.
- R&D funding of the government must also change in terms of the scale and quality of support
- provided.
- financing of new initiatives be readily accessible for university research and education program
- realignment of other institutions, such as regulation and standardization

Incumbents

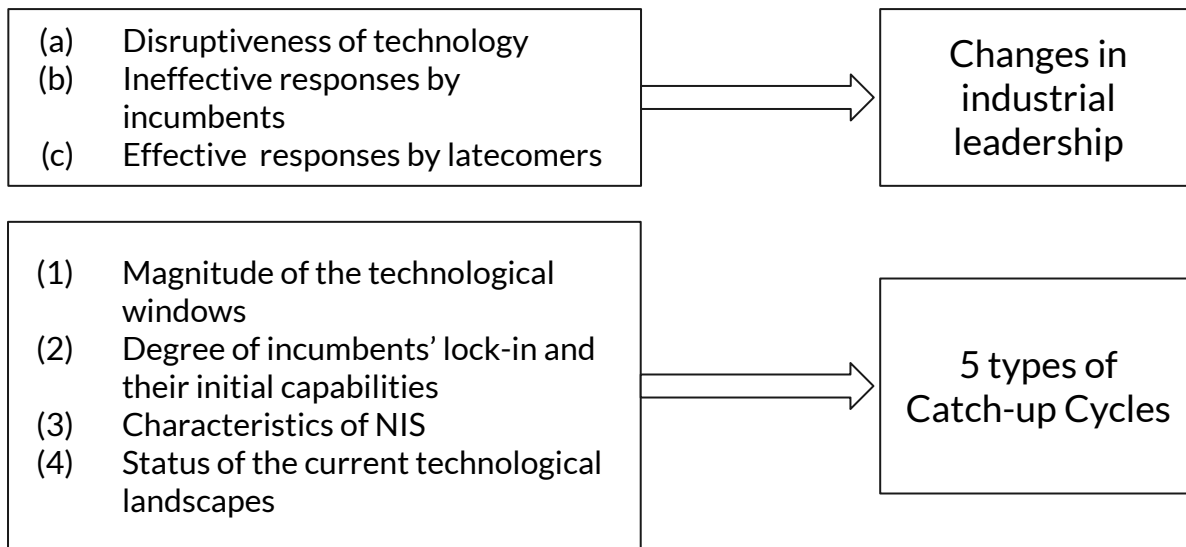
Firm level

- tend to be complacent with their current success, causing them to neglect new technologies, disruptive innovations, new types of demand, and/or growing markets
- fall into a lock-in trap of sticking to old technology while delaying the adoption of new ones
- disruptive innovation (Adner, 2002), innovator's dilemma (Christensen, 1997)

Sectoral level: delayed responses

- education may be locked-in to old technologies
- finance may be too short-sighted and directed towards funding existing technologies
- regulations may be too stringent with respect to novelty
- public policy may be myopic and tend to support low-risk R&D projects only

The Formal Model



5 Types of Catch-up Models

Standard cycle	a clear change in the market leadership occurs	
Aborted cycle	limited rise of the market share of late entrants	associated with a window of limited size, which does not allow late entrants to gain the necessary momentum and keep pace with the leaders
Persistence of leadership	incumbent maintains its leadership	enabled by lesser lock-ins of incumbents with respect to new technological windows, which allow them to respond promptly to technological discontinuities
Return of old leadership	the old incumbent's return to leadership after losing its position to a latecomer	attributed to an increase in the average level of capabilities that incumbent firms are endowed with at their inception and from the strength of the NIS of the incumbent
Coexistence of leadership	coexistence of leadership between incumbents and latecomers	achieved by introducing discontinuities of a smaller size and decreasing returns to technological investments, something which is typical of traditional industries

4. Empirical Evidences

The Cases

Table 1
Events of Leadership Change and Persistence in Six Sectors.

Events/ Time	Mobile Phone	Memory	Camera	Jet	Steel	Wine
Event (I) Time Main actors	1998 USA (Motorola) → Finland (Nokia)	1982 USA → Japan	Mid-1960s Germany → Japan	1995 Netherlands (Fokker) → Canada (Bombardier)	1980 USA → Japan	Mid-1990s Old World (France, Italy, etc.) → New World (USA, Australia, etc.)
Event (II) Time Main actors	2012 Finland (Nokia) → South Korea (Samsung)	1993 Japan → South Korea (Samsung)	1980s–2010s No change (Japan was the persistent leader despite the development of digital SLR camera.)	2005 Canada (Bombardier) → Brazil (Embraer)	1998 Japan (Nippon Steel) → South Korea (POSCO)	Mid-2000s Return of Old World
Event (III) Time Main actors		1993–2016 No Change (South Korea was the persistent leader.)	Mid-2010s Change likely with substantial rise of new entrants			
No. of EVENTS	2	3	3	2	2	2

Case 1: The Mobile Phone Industry

Leadership changes

1998
USA (Motorola) →
Finland (Nokia)

2012
Finland (Nokia) →
South Korea
(Samsung)



Windows of opportunity

- Technological change: shift of operating system from Nokia's Symbian to Google's Android OS with custom-built to support the touch interface
- Demand change: rapid increase in individual phone users, rise in demand for touch interface
- Institutional change: EU's support for GSM standards, US's support for multiple standard

Responses by actor: Nokia trap-like behavior of sticking to the old OS and hesitation to launch smartphones

4. Empirical Evidences

Case 2: The Memory Industry

Leadership changes

1982
USA → Japan

1993
Japan → South
Korea (Samsung)

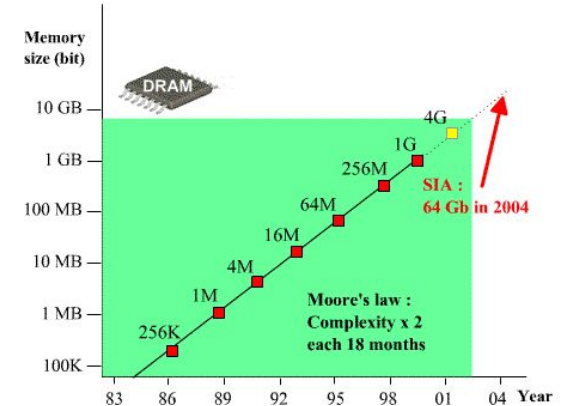
1993–2016
No Change (South
Korea was the
persistent leader.)

Windows of opportunity

- Technological change: generation changes of product developed every 3 to 4 years
- Demand change: larger investment by late entrants for next generation of technology
- Institutional change: government support in Japan and Korea, 1986 Semiconductor Trade Agreement between US and Japan

Responses by actor:

- 2 changes: Japan catch-up as the trajectory moved from 1K to 4K, Korea when 4M to 16M generations
- Persistence of Korean firms: capability expansion of incumbents, new technological developments that favored incumbent leaders (economy of scope in DRAM and flash memory)



DRAM Roadmap
Source: INSA Toulouse

4. Empirical Evidences

Case 3: The Camera Industry

Leadership changes

Mid-1960s

Germany → Japan

1980s–2010s

No change (Japan was the persistent leader despite the development of digital SLR camera.)

Mid-2010s

Change likely with substantial rise of new entrants



History of Camera

<https://www.youtube.com/watch?v=cvy7Qlp4A2k>

Windows of opportunity

- Technological change: emergence of SLR and DSLR camera technology
- Demand change:
 - Event I and II: rising demand during World War II, persisted during post-war in US occupation and the Korean War → basis for mass production and components supplier
 - Event III: user dissatisfaction toward SLR and DSLR

Responses by actor:

- German originally developed SLR technology but Japan adopted, improved, and commercialized the technology
- DSLR was similar to SLR → shift to DSLR technology was a “competence-reinforcing” discontinuity → persistence of Japanese leadership
- Development of mirrorless camera as “competence-destroying” for Japan

4. Empirical Evidences

Case 4: The Steel Industry

Leadership changes

1980
USA → Japan

1998
Japan (Nippon Steel)
→ South Korea
(POSCO)

Event I

Windows of opportunity

- Technological change: basic oxygen furnace (BOF) methods
- Institutional change: Japanese government involved in arranging collective licensing of the new technology for significant royalty fees

Responses by actor

- Japanese firms immediately adopted the BOF methods and improved by follow-on innovations
- US firms fell into incumbent traps by sticking with old methods

Event II

Windows of opportunity

- Technological change: continuous casting (CC) technology
- Demand change: down turn of the steel industry, second oil shock

Responses by actor

- POSCO did not use CC technology but moved successfully in path-following mode of learning based on mature technology imported from Japan → purchase and install state-of-the-art technologies at low price
- Incumbents were less reluctant to sell technologies or to charge low prices

Case 5: The Regional Jet Industry

Leadership changes

1995
Netherlands (Fokker)
→ Canada
(Bombardier)

2005
Canada (Bombardier)
→ Brazil (Embraer)

Windows of opportunity

- Demand change: rapid growth in demand for small jet aircraft (Event I), and to bigger aircraft (Event II)
- Institutional change:
 - Event I: Unionization of US pilots increased demand for smaller aircrafts
 - Event II: the privatization of Embraer, financial and export support schemes offered by the government

Responses by actor: leadership changes as the market shares and institutional supports favors latecomers

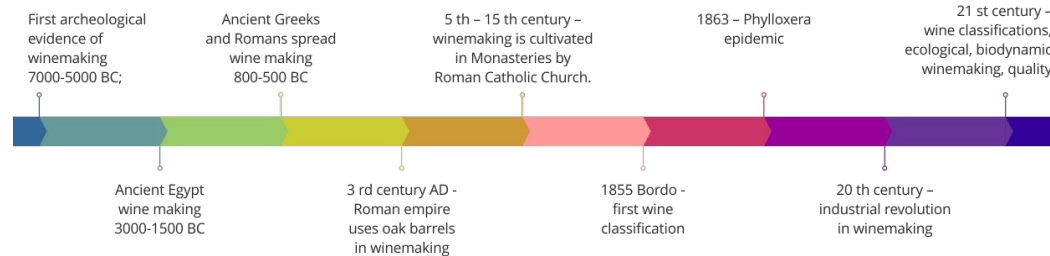
4. Empirical Evidences

Case 6: The Wine Industry

Leadership changes

Mid-1990s
Old World (France,
Italy, etc.) → New
World (USA,
Australia, etc.)

Mid-2000s
Return of Old World



Source: EC

Windows of opportunity

- Radical technological discontinuity did not play any role in opening up windows of opportunity for latecomers.
- Demand change: changing consumer tastes in existing markets, the emergence of new wine-drinking markets, and a major change in the international channels for distribution and marketing
 - Event I: emergence of new, inexperienced consumers from the UK, the US, and Scandinavian countries.
 - Event II: sophisticated and varied wines in new and more traditional markets and an upsurge of the Asian market
- Institutional change: EU subsidy and regulatory controls that locked incumbents into existing products, markets, and technologies (Event I), then reform of the institutional environment (Event II)



Conclusion

Theoretical Contributions

- Offers a framework of catch-up cycle within a sectoral system view (4 stages, 3 windows of opportunities)
- Propose that windows of opportunities at leapfrogging tends to relate to the forging-ahead stage.
- Confirm sectoral heterogeneity in terms of the presence and role of different windows of different sectors and of system responses.

Policy Remarks

- Latecomers must be ready to respond to the opening of window for catch up and they should not waste this opportunity → be prepared to build sector-specific capabilities that support actors, networks, and distributions.
- To avoid middle-income trap, countries should have an agenda centered on building capabilities for creating innovations to seize a window of opportunity, and on the development of a system that is effective in responding to the opening of catch-up opportunities.



Thank You :)