UNICAMP/InSySPo Conference

TRANSITIONS WITH NON-TECHNICAL CAPABILITIES IN KOREA

2019.07.

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Contents

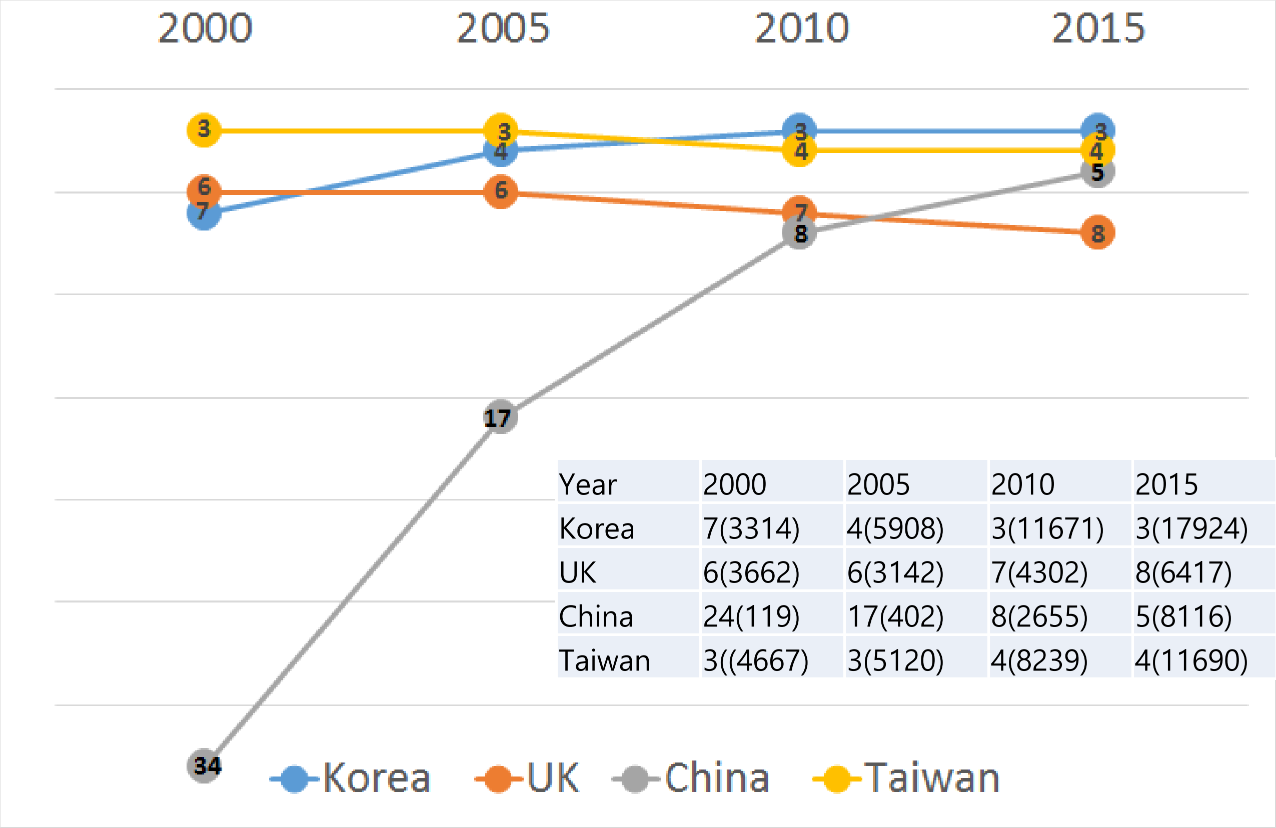
I. Embarkation: cross cutting questions

1. How latecomer countries develop technological capabilities and non-technological capabilities?
2. What are the key stylized challenges during the transition, upgrading and post-catching up period?

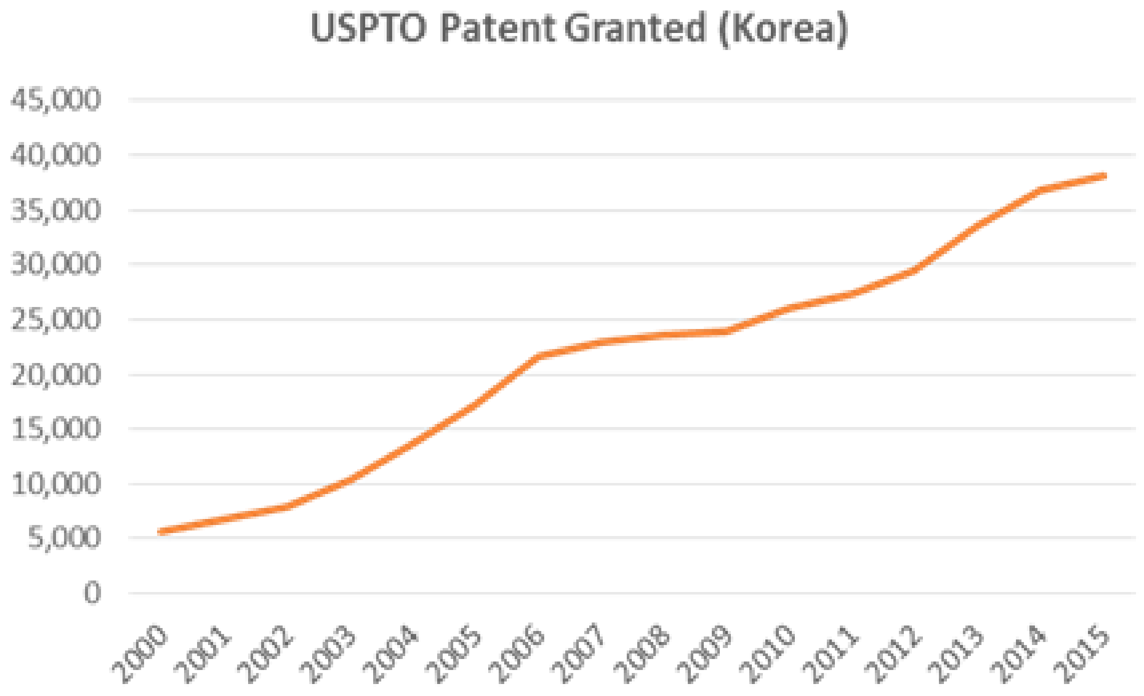
I. Evidence: Pros and Cons

Increase in patenting activities by Chaebol: from six in 2007 to 11 organisaitons in 2017(Among top 100 IPO)

❶ Samsung Group(3), LG Group(4), Hyundai Motors(1), SKH(1), ETRI
❷ Samsung Group contribution:54%, ❸ SEC contribution:36%



Year	2000	2005	2010	2015
Korea	7(3314)	4(5908)	3(11671)	3(17924)
UK	6(3662)	6(3142)	7(4302)	8(6417)
China	24(119)	17(402)	8(2655)	5(8116)
Taiwan	3((4667)	3(5120)	4(8239)	4(11690)



USPTO ALL TECHNOLOGIES REPORT(2015)

I. Evidence: Pros and Cons

The patterns of accumulation of knowledge production in Korea gradually evolved from engineering to scientific activities

The proportion of knowledge production increased from 2% to 3%

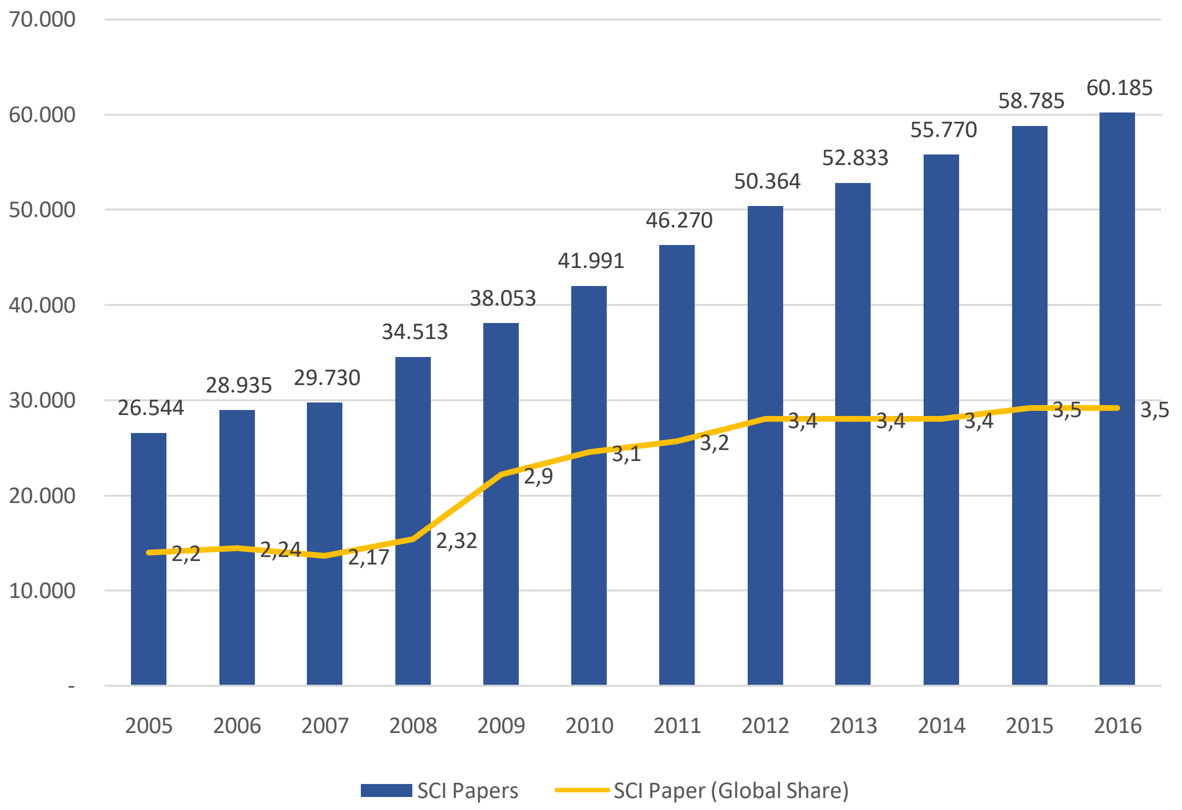


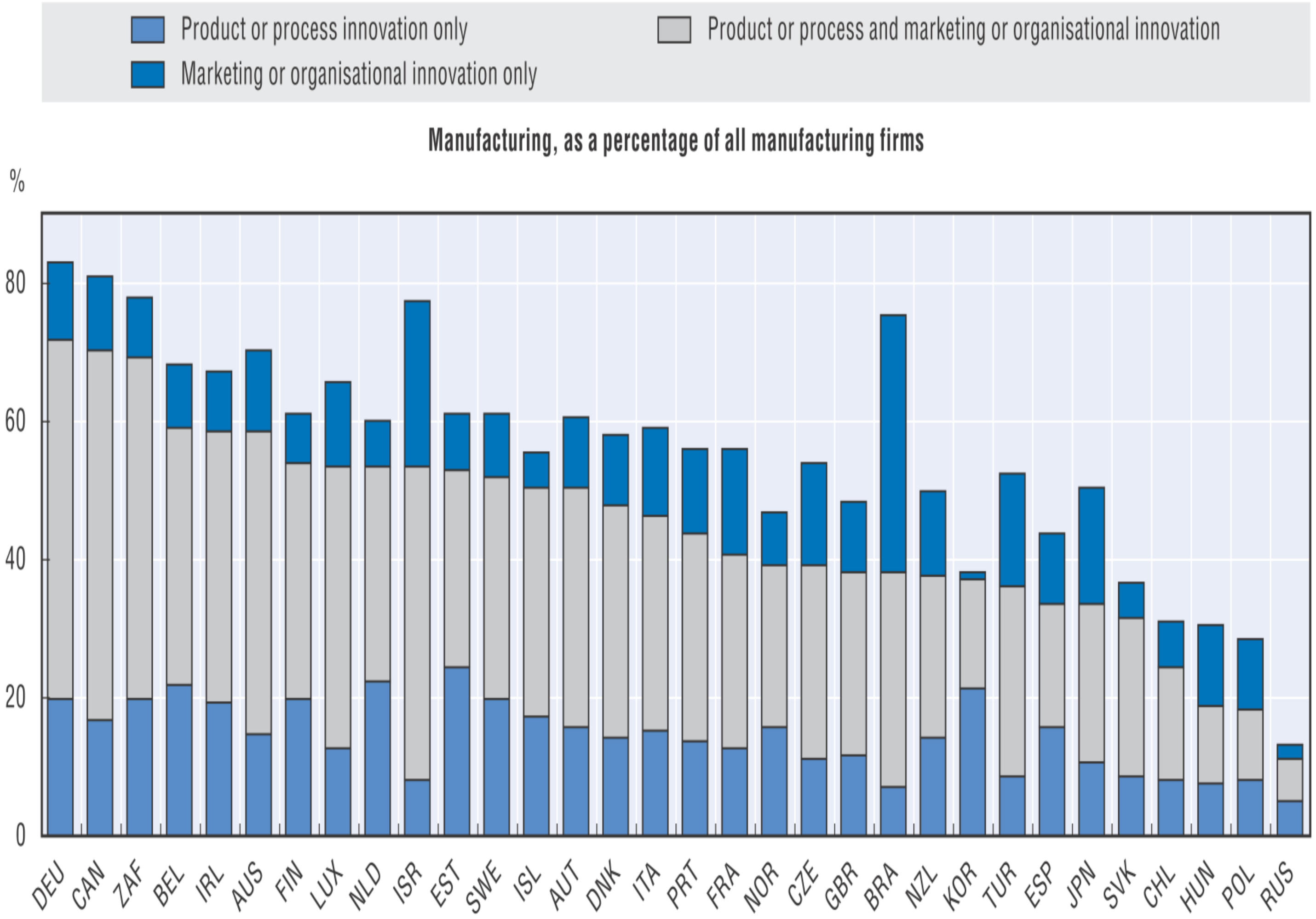
Table 6 Korea's Global Rank of knowledge production by the academic discipline

	2000	2005	2007
Engineering			
IT and communication sys	5	3	4
Electrical and electronics Eng	8	4	5
Material science and Eng	7	6	5
Mechanical engineering	7	6	6
Metallurgy	5	7	6
Engineering Mgt/General	10	8	7
Civil Eng	12	7	8
Nuclear Eng	7	8	8
Aerospace Engineering	9	7	10
Science			
Chemical engineering	8	10	9
Chemistry	9	9	9
Physics	14	13	9
App phy./Conden. Matter/mat. Sci	9	8	7
Optics and Acoustics	13	11	10
Medicine and pharmacology			
Biotech and applied microbiology	7	5	6
Pharmacology/Toxicology	12	6	7
Otolaryngology	17	9	6
General/Internal Medicine	13	10	8
Radiology, Nuclear Med., Imaging	9	9	8

Source: MEST (2008)

I. Evidence: Pros and Cons

Figure 2.6. **Innovation in manufacturing and services, 2008-10**



Box 2.1. **OECD definitions of innovation**

The current edition of the *Oslo Manual* identifies four types of innovation:

- **Product innovation:** The introduction of a good or service that is new or significantly improved with respect to its characteristics or intended uses. This includes significant improvements in technical specifications, components and materials, incorporated software, user friendliness, or other functional characteristics.
- **Process innovation:** The implementation of a new or significantly improved production or delivery method. This includes significant changes in techniques, equipment and/or software.
- **Marketing innovation:** The implementation of a new marketing method involving significant changes in product design or packaging, product placement, product promotion, or pricing.
- **Organisational innovation:** The implementation of a new organisational method in the firm's business practices, workplace organisation or external relations.

Source: OECD-Eurostat (2005), *Oslo Manual – Guidelines for Collecting and Interpreting Innovation Data, 3rd Edition*, OECD Publishing, Paris, *http://dx.doi.org/10.1787/9789264013100-en*.

Source: OECD (2013a), *Science, Technology and Industry Scoreboard 2013*, OECD Publishing, Paris, *http://dx.doi.org/10.1787/sti_scoreboard-2013-en*.

I. Key characteristics of KIS during catch-up and transition

Photo: AAMC Survey 2011 (Medical Simulation In Medical Education)

1. Reverse Product Life Cycle (Process to Product innovation)
2. Predictable technology cycle(Memory, LCD)
3. Knowledge production: From engineering to Science
4. From industry specialization to diversity (System and BioPharma)
5. From technological capability to innovation/non-technological capabilities

II. Non technological capabilities

Management literature: Administrative(Evan, 1966) Organisaitonal(Damapour, 1991, Teece, 1997), Managing (Hamel, 2006), Marketing(Johne, 1999)

Organisational and marketing (OECD, 2005:2018; Mothe and Nguyen-Thi, 2010)

Technological capability literature: non-technological(R&D) or non-R&D innovation such as marketing, administrative, logistics, and financial activities, in association with the accumulation of technological capabilities for production and innovation activities (Bell, 2009; Bell and Figueiredo, 2013)

A brief summary of definitions of different types of non-technological innovation along with their authors.

Term	Meaning or definition	Representative authors
Administrative innovation	Technical (new products, processes or services) vs. administrative innovation (new policies of recruitment, allocation of resources, and the structuring of tasks, authority and rewards—*organizational level*, but content-wise related to administrative practices at lower levels)	Evan (1966),Daft (1978), Kimberly and Evanisko (1981)
Organizational innovation	Individual characteristics, such as sex, age, and personal attitudes, administrative positions and roles, structural characteristics of the organization, such as size and complexity, environmental input from the community and other organizations. Later on: non-technical process and service innovations.	Baldridge and Burnham (1975), Damanpour and Evan (1984), Damanpour (1991), Armbruster et al. (2008)
Management innovation	How companies organize, lead, allocate resources, plan, hire, motivate—a holistic view; what managers are and do; organizational structures (structural innovation), management techniques and marketing concepts/strategies—in line with CIS	Hamel (2006), Mol and Birkinshaw (2009)
Marketing innovation	Innovation in marketing—creating, communicating, delivering, and exchanging offerings that have value for customers; as opposed to product and process innovation	Simmonds and Smith (1968), Johne (1999)
Non-technological process innovation	Focused on *how* (a form of innovation, not a type)—process innovation = a set of activities to produce output	Papinniemi (1999), Krause, Gebert, & Kearney (2007), Lambertini and Mantovani (2009)
Ancillary innovation	Organization-environment boundary innovations or cross-organizational innovations	Damanpour (1987), Tether and Tajar (2008)
Open innovation	The use of purposive inflows and outflows of knowledge to accelerate internal innovation and expand the markets for external use of innovation (also technological innovation), respectively	Chesbrough (2007), Vanhaverbeke, Van de Vrande, & Chesbrough (2008)
Strategic innovation	Business process improvement; marketing, licensing, adoption/generation	Kodama (2004), Afuah (2010)
Business model innovation	Innovation in strategic choices, value network, creating value, and capturing value; innovation in the way a company does business, what is its source of competitive advantage, how it transcends traditional firm boundaries	Zott and Amit (2008), Teece (2010)
Green or eco-innovations	Innovations aimed at producing solutions with lower negative environmental impact than relevant alternatives; they may be technological or non-technological (organizational, institutional or marketing-based)	Schiederig et al. (2012)
Non-technological innovation	Non-technical product and process innovation: organizational (implementation of innovative organizational concepts: structural vs. procedural; intra vs. inter-organizational; business processes or organizational structures) and marketing	OECD – Community Innovation Survey (OSLO Manual, 2005), Barañano (2003), Schmidt and Rammer (2007); Mothe and Thi (2010)

Approach

R-Product life cycle (Kim, 1997)

- Fluid
- Transition
- Specific

COPS

Non-technological capabilities

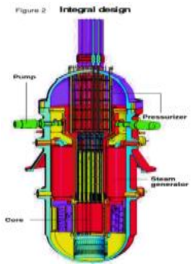
Transition

- Intra firm
- Inter-firm

Small Nuclear Reactor Dev.

Large Nuclear Reactor Cons.

High Speed Train Cons.



World first development and received Standard Design Approval

Modification of exiting reactor, architectural innovation, and export to UAE

Nation first High Speed construction

What are the phase specific non-technological challenges in CoPS(Davies, 1997)?

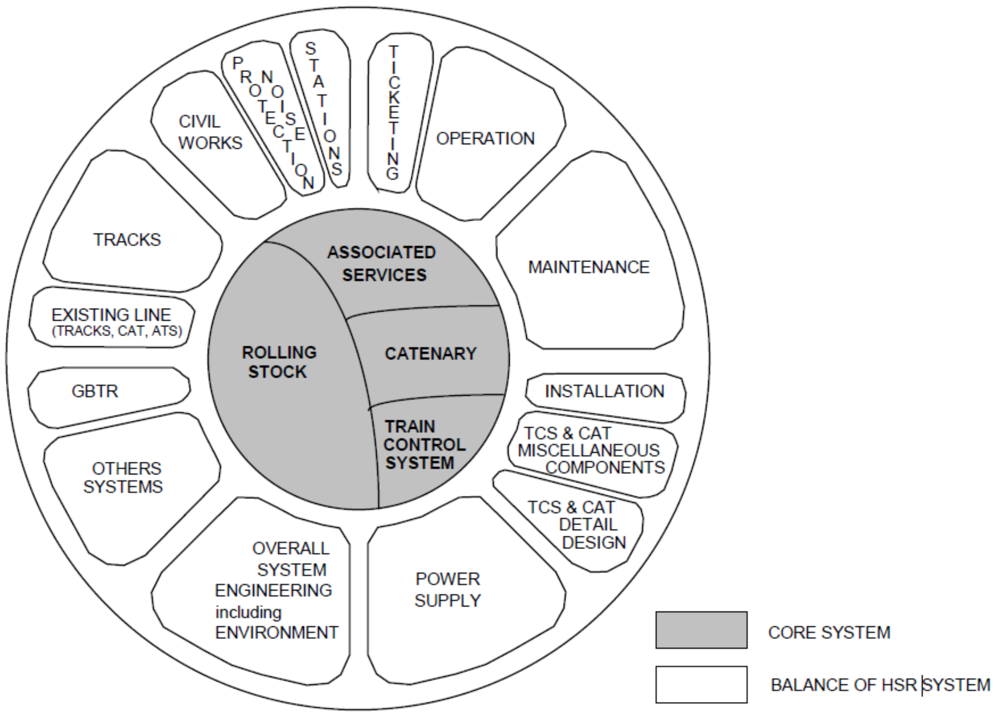
① Why projects suffer from enormous delays?

② How non-tech capabilities contributes project(product) completion(success)?

II. cases: High Speed Train(KTX (1))

Table 3 Hyundai Rotem's KTX Development

Project	Content
KTX I	Signed supply contract and technology transfer agreement with Alstom in 1994: 46 trains (920 rolling stocks), max speed 300km/h Delivered in 2003
HSR-350X	Launched self-development in 1997: max speed 350km/h Applied technology to KTXII (KTX-Sancheon) in 2006
KTX-Sancheon	Signed supply contract in 2006 and applied HSR-350X technology: 240 units Delivered in 2010: five years for KTXII delivery compared to 10 years for delivery of KTX I
HEMU	Launched independent development in 2007: max speed 440km/h Target completion in 2012



P Plan

1. Core technology transfer from France
2. Utilization of complementary asset (Subway, Motor way)
3. Construction order: railroad and track separation
4. new organizational set-up(KRNA, Rail. Net. Authority)

II. cases: High Speed Train(KTX (2))

C
Challenges

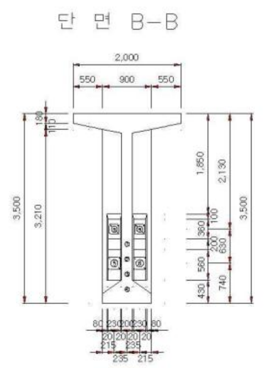
Specific | **Organizational innovation**

❶ **Design of CoPS construction:** core vs system design (later faced with integration design alteration)

❷ **Methods of building bridge deck(Beam or Box type):** user vs consultancy (later faced with knowledge gap)

❸ **Construction:** general rail construction vs High speed(later faced with integration problem among signal, track, tunnel, railroad etc

❹ **Train system management:** operators vs network construction (later faced with operational efficiency)



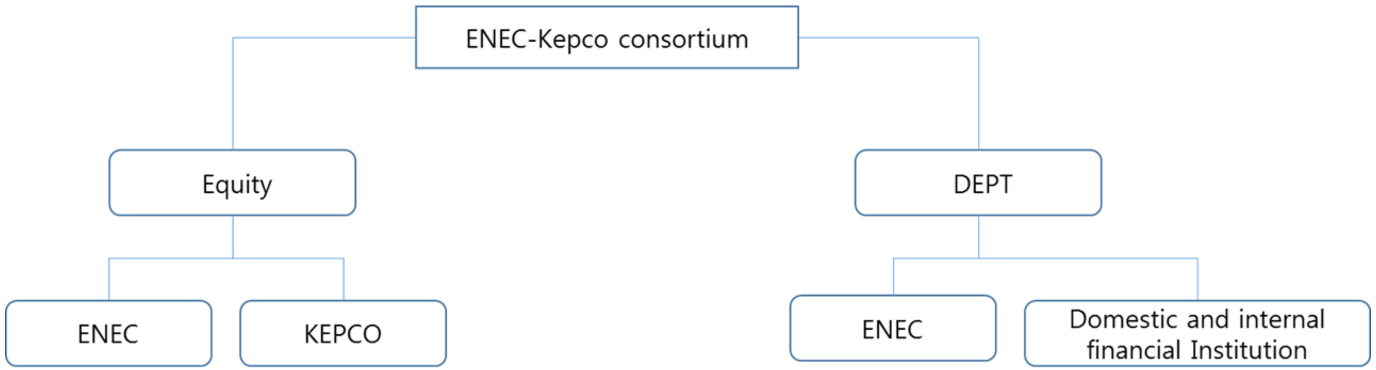
II. cases: Large Nuclear Reactor Export (1)

The Advanced Power Reactor 1400 MWe (APR1400) is a standard evolutionary Advanced Light Water Reactor (ALWR) and developed in 2002.

	Model	Capacity	Cost($/Kwe)
Korea	APR1400	1343	1556
France	EPR	1600	5383
Japan	ABWR	1330	3009

Source: OECD/ IEA(2010)

In 2009 South Korean consortium had been awarded a contract worth some $20bn to build four nuclear power plants in the United Arab Emirates.



1. Korea EXIM credit loan arrangement (10bn)
2. KEPCO led construction consortium
3. Learning by construction and operational asset
4. Proven technology based
5. Financing experience/capability

II. cases: Large Nuclear Reactor Export (2)

	Total design	sys. Design	equipt. design	equipment	BOP Balance of Plant	Fuel	Maintenance
Westinghouse (USA)		√	√	√		√	√
AREVA NP (FRANCE)	√	√	√	√	√	√	√
GE/Toshiba Hitachi	√	√	√	√	√	√	√
Korea	ENC	ENC	Doosan	Doosan	Doosan	NEF	KPS

Source: KEEI(2009)

C
Challenges

Transition

Organisational and Financial innovation

❶ **Construction Eco-system:** Horizontal vs Vertical (later faced with integration cost, decision process delay)

❷ **Project financing:** difficulties with finding the right equity partners / EPC contractors with financial capability (strong balance sheets) and credit support appetite

❸ **Financial Institution:** delayed credit control innovation(credit ceiling) by the government

❹ **Financing management:** KEPCO has amended the range of the target return rate, and the arbitrage settlement details

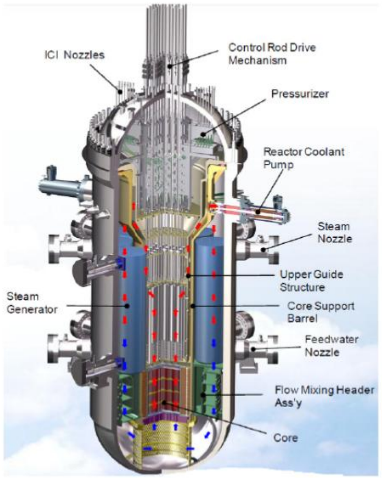
II. cases: Small Nuclear Development (1)

SMART project was conducted between 1997 and 2002 as a national R&D project to develop small- and medium-sized nuclear reactor by the Korea Atomic Energy Research Institute

	Product development
02-06	-Design, construction, license for P65 Model -Apply SDA and drop SDA application process
09-11	-Design, construction, license for 330 Model -Proven technology base design alteration -SDA approval
2012	-SDA approval

Korea made effort to export it's domestically designed rector

Legal and procedural issues recognized by regulatory agencies and developers



P
Plan

1. Innovative design and material=new regulation
2. Joint study with developer and regulators on Pre-application Safety Review(PSR)
3. Amendment of Korean Nuclear Act
4. Proven technology based regulatory framework

II. cases: Small Nuclear Development (2)

C

Challenges

Table 6
Technology upgrading and regulatory innovation.

	Product characteristics and case	Factor contribution
Success in regulatory innovation	- Incremental innovation - APR1400	- Platform based regulatory innovation
Failure in regulatory innovation	- Radical innovation - SMART, KSTAR	- Regulatory lock-in - Recognition - Regulation dilemma

Choung and Hwang (2018)

Fluid | **Regulatory innovation**

❶ **Developer: new regulatory development requires organizational recognition, appropriate guidelines, preparation(later drop out approval process)**

❷ **Developer: High level(innovative) design specification requires stable data provision (reference data) on nuclear reactor**

❸ **Regulator: Past routine function brought difficulties in creating new regulatory guidelines (from examination to creation)**

I. Conclusion: findings

From selected case studies identified the number of experience-related challenges in the area of product development ranging from the specific to the fluid phases of the product lifecycle

Table 5. Latecomers Challenge in non-technological capabilities

Innovation activities		Product Life cycle Phase		
		Fluid Phase	Transitional Phase	Specific Phase
	Firm's activities	-Perception of regulation by developers -Capability of creating new regulations and technical service by regulatory agency	Project financing capability	Organisational capabilities
	Inter-firm activities	Joint regulatory development between developer and regulators	Transition to global business oriented structure	Inter – organisational set-up

I. Conclusion: Discussion (1)

- PF as an efficient entry mode for large investments in high risk environments.
- What are the effective financial financing strategy we well as how firms orchestrates complementary risk strategies
- Reg. innovation may play critical role for upgrading
- Problems: persistence of catch-up routine(technology and organization)
- How to build non-technological capabilities and their critical elements

I. Conclusion: Discussion(2)

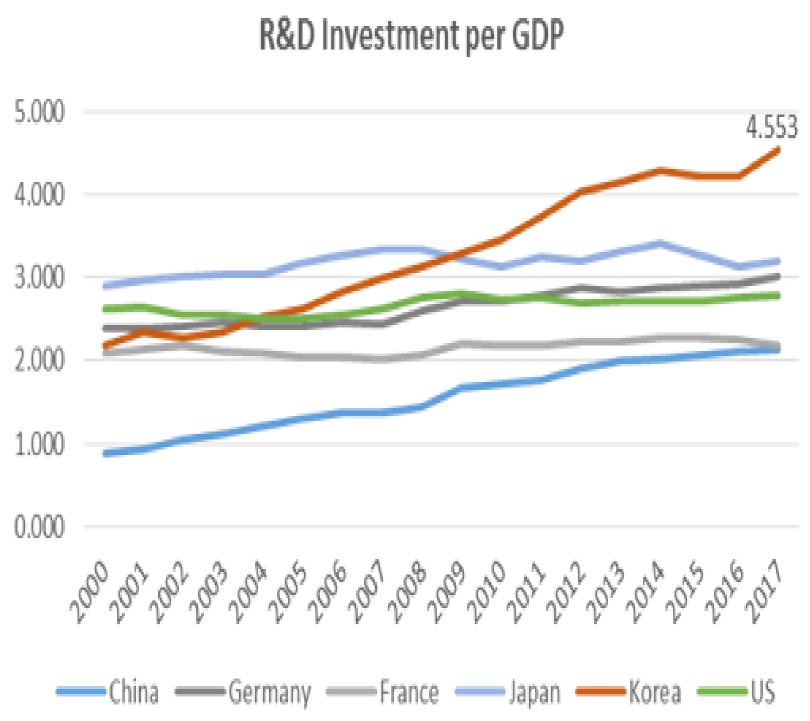
- Transition neither automatic nor easy
- Transitional Product affinity: Mass products(DRAM, LCD) vs CoPS?
- The relationship between equity based and liabilities for latecomer's overseas market creation
- China CoPs and Latecomer CoPs (procurements and financing)
- CoPS transition: middle income matters? Process specialization only?

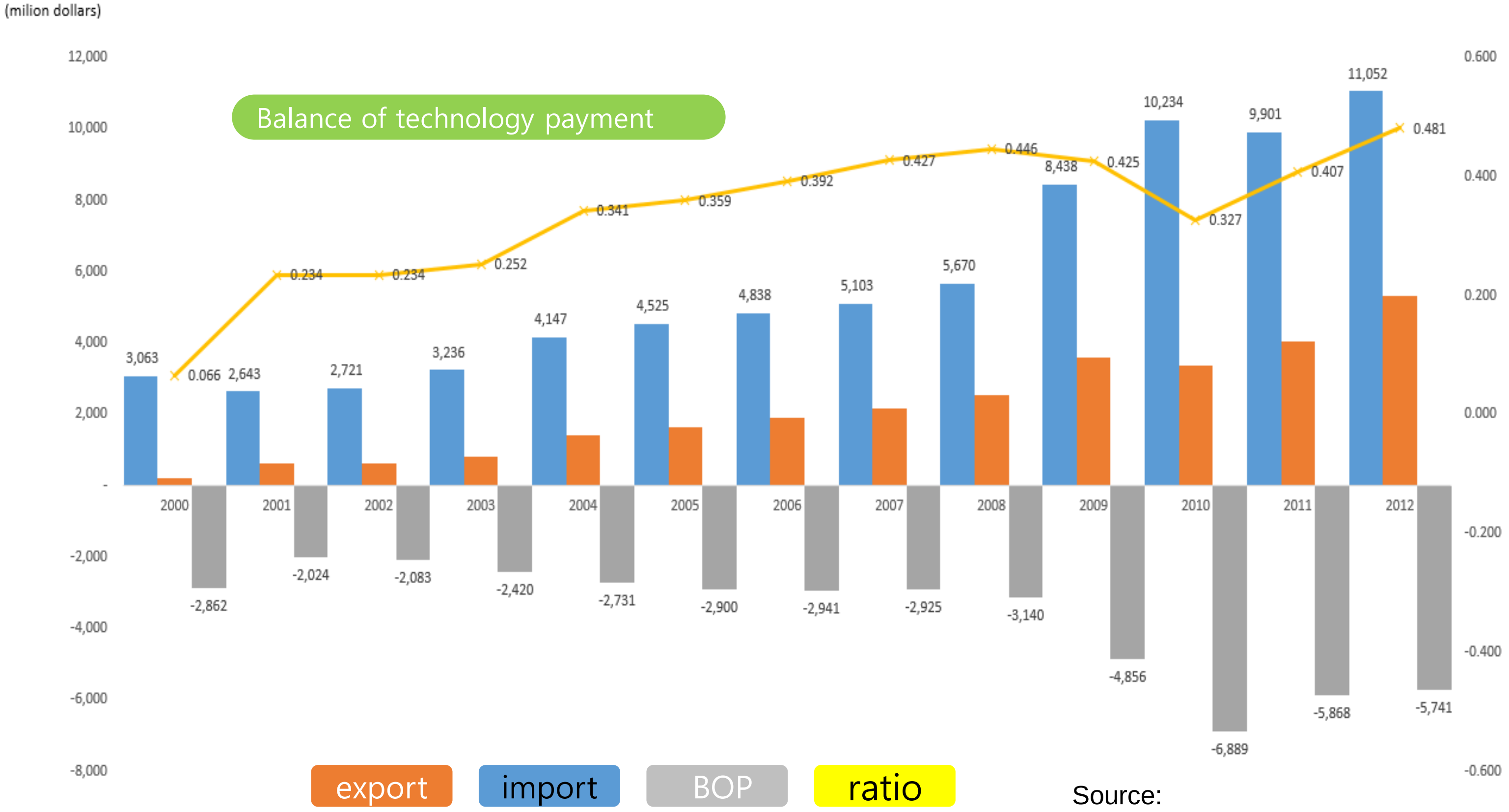
Thank you

Key characteristics of KIS during catch-up

Korean government has played significant role but experiencing the R&D paradox(R&D ↑ technology Import ↑)

Required new forms of Innovation system and technological capabilities (from production to innovation capabilities)





Source:
OECD(2015)

Transition: beyond catch-up(Post catch-up)

Latecomer firms enter the marketplace at all stages of the product life cycle.

Key actors and the relationships among innovators are different in each entry stage (In the fluid stage, the role of the public research institutes.

User–supplier relationships in the cooperative product development are more important (in the transitional stage).

Overarching character of national innovation system	Deepening process innovations	Architectural innovations	Radical innovations
Sources of innovation	– Technological accumulation via imitation of foreign technology, especially in process technologies	– Utilization of institutional assets in large firms – Window of opportunity in new products and new technologies	– Niche-based commercialization of proprietary technology
Intra-firm	– Integration of product and process technology lead to technological accumulation	– Securing a variety of application providers – System-level technology-intensive suppliers	– Absorptive capacity for proprietary technology commercialization
Inter-firm	– Process innovations via joint learning among materials, equipment, and manufacturing	– Joint product development among system vendors and suppliers of materials, components, and equipment	
Public Research Institute and Policy	– Joint learning to reduce imitative learning period – Selection and concentration in strategic areas	– Promotion of technology-intensive SMEs	– Joint development of proprietary technologies with private sector – Lack of institutional assets – Issues in inter-ministerial coordination – Uncertainty of market and technology creation

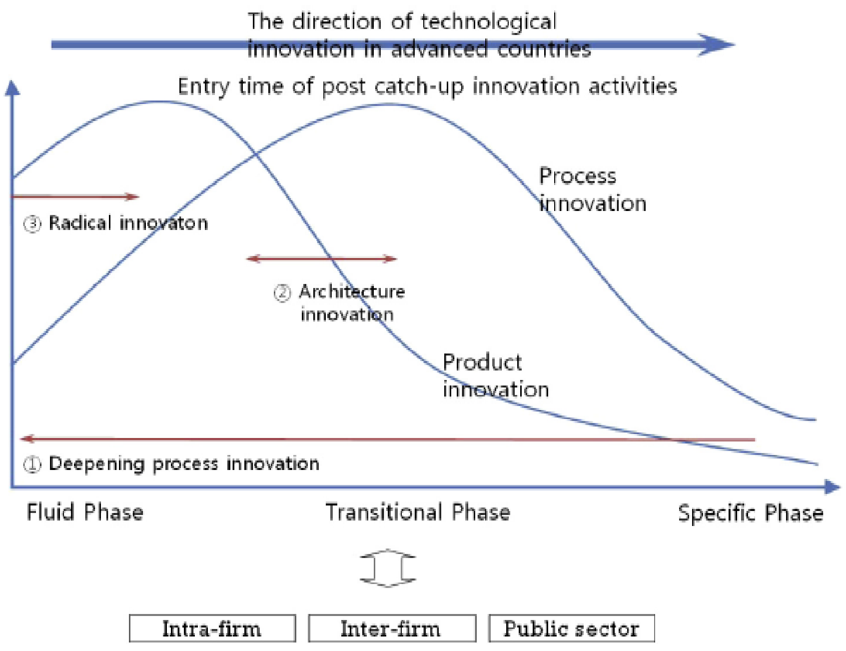


Figure 1. *Coevolution of the reverse product life cycle and a national innovation System.*

Source: Choung et als (2014)

Transition: beyond catch-up(Post catch-up)

The institutional context adapted for catch-up innovation may not evolve adequately rapidly into the new forms required for effectiveness in post catch-up innovation

Rigidities may become a source of lock-in – so contributing an institution-centred source of 'failure in system transition' in the innovation system

Persistent catch-up regime and failure in system transition

	Persisted catch-up regime	System transition Failures
Policy Planning	Technology supply driven planning by single Ministry as a control tower	- Inter-ministerial difficulties - Success in technology development with international standard but failure in market creation
Resource Allocation	PRI driven with manufacturing related large SME participation in national R&D program	- World first technology development - Closed innovation activities resulted in Korean IT Galapagos syndrome
Coordination	Coordination among innovation actors via hierarchical control mechanism	-Conflict and coordination failure between device manufacturer and service provider

Source: choung et als(2016)