Sharing Knowledge, Sharing the Future

글로벌 지식공유 포럼

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Science, Technology, and Innovation Capacity-Building for Industrialization

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1. Introduction

1. Introduction

- Empirical evidence abounds in support of the critical role of science, technology and innovation (STI) in social and economic development of countries

- Due to the relationship between STI capacity and development, international development institutions have great concerns for STI capacity-building in developing countries, but it seems the effectiveness of their programs for STI capacity-building in developing countries falls short of their concerns for it.

- The Objective: To articulate the Korean experience in building STI capacity for industrialization.
  - How Korea has been able to build its STI capacity?
  - How Korea's approach differs from those of other countries?
  - Any lessons and/or policy implications?

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2. STI and STI Capacity

2. STI and STI Capacity

2-1. Concept of STI

- Two major reasons that undercut the effectiveness of STI capacity-building programs:
  - Misunderstanding on the notion of STI, and
  - Separation of STI capacity-building programs from specific development programs, for which the capacity would be used.

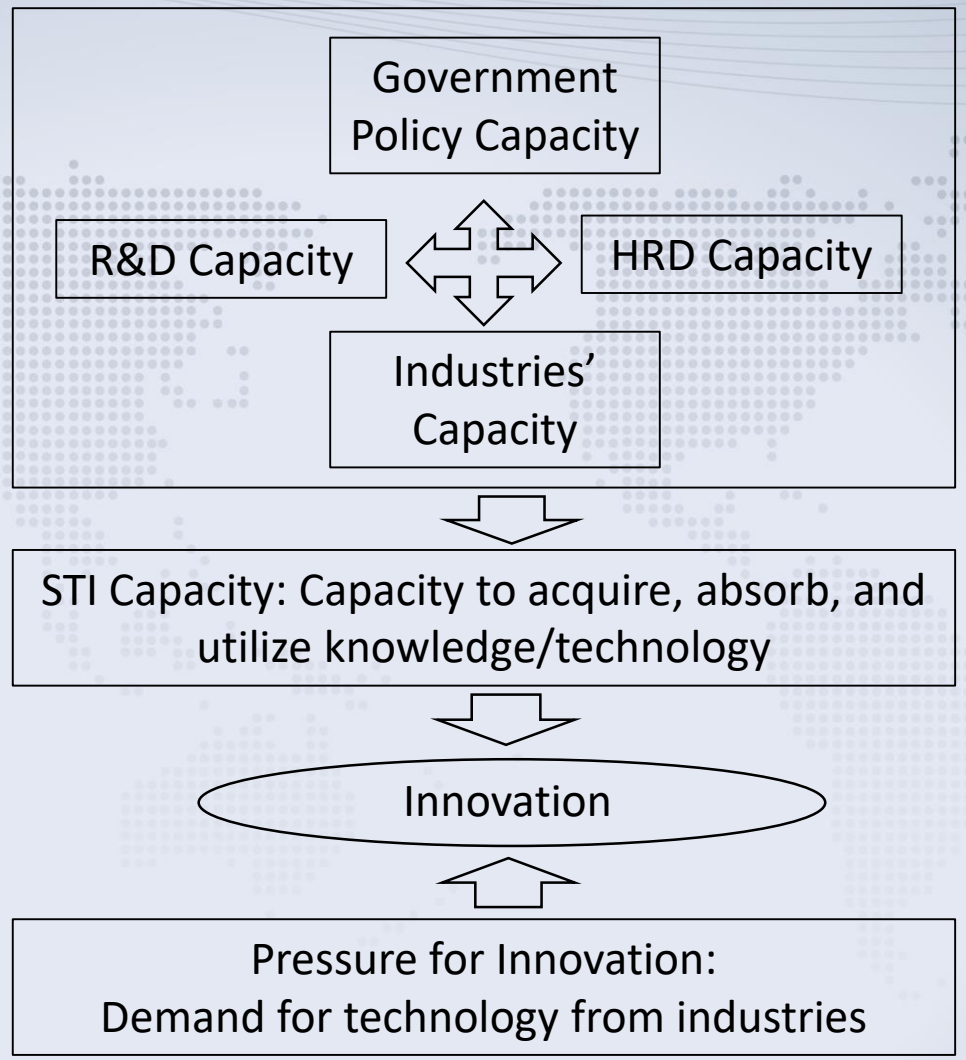
- What is STI: Concept of STI relevant for developing countries
  - Literally, science, technology and innovation -- Very often, people tend to relate STI to the discovery of new knowledge and equate STI capacity to R&D capability.
  - But what really matters to developing countries is the capacity to access, acquire, absorb and utilize knowledge/technologies that already exist…
  - For developing countries, the priority is on how to translate the existing knowledge/technologies into social and economic values.

2-2. STI Capacity

- To translate an idea or technology into actual value, for which the society is willing to pay, it requires capacities that go far beyond what scientists and engineers can provide.
- So, STI capacity refers to the capabilities of a society or nation not just to create new knowledge or access the stock of knowledge but also to facilitate interactions among the players in the processes of the transforming new or existing knowledge into social and economic values.
- STI capacity of a society: Combined capacities of the innovation players:
  - **Government**: **STI policy capacity** to formulate and implement STI policy and programs and to provide infrastructure required for knowledge creation and/or diffusion
  - **R&D capacity** to generate new knowledge or to digest and modify existing knowledge for local uses
  - **HRD capacity** to nurture manpower with creativity and entrepreneurship
  - **Industries**: **capacity** to access, absorb, and translate technologies into market value

When and how innovation takes place in the real world?

When **pressures** for innovation can be met by the society's innovation **capacity**



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3. STI Capacities of Developing Countries

- An assessment based on the review of the STI capacities of developing countries in six regions (Southeast Asia, Central Asia, Sub-Saharan Africa, MENA, Latin America, Eastern Europe)

3-1. STI policy capacity:

Many countries, in particular, those with short history of STI, are very weak in STI policy capacity

- Lack of STI statistical and information system,
- Weak of capability to identify policy issues,
- Weak organizational apparatus to formulate and implement policy measures to respond to the issues identified,
- Most of all, political will or commitment to the promotion of STI as a key policy strategy –
- Most of the countries have not been able to integrate STI policy into national development policy
- Poor in STI infrastructure, both physical and institutional.

3-2. Orientation of the STI system:

Excessive orientation toward science and research for knowledge creation that require huge resources and long-term political commitment that are well beyond the capabilities of developing countries.

3-3. Resource constraints:

- Vast majority of the countries suffer serious lack of STI resources – financial, human and network resources.
- Many countries neither allocate sufficient resources for the future (R&D and education) nor offer incentives for private sectors to invest in innovation and human resource development.

3-4. Industrial STI capacity:

- For different reasons, many countries have not been able to develop industrial STI capacity.
- African and Southeast Asian countries have not been able to build up industrial STI capacity because they have just begun industrialization.
- MENA countries have had long interactions with European countries, but it seems STI has not been policy priority in many of the countries in the region.
- Most of the countries in Latin America and the Caribbean are blessed with rich natural resources and therefore have not been pressed for innovation.
- Central Asian and Eastern European countries have yet to complete the transition toward a market system and therefore industries in the region have not had time to develop STI capacity.
- Commonality: Weak systems linkage

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4. STI Capacity-Building for Industrialization: Korean Experience

4-1. Initial Setting

- The state of STI in Korea in the early 1960s can be summed up as the following:
  - No market pressure for innovation and
  - Lack of STI capacity in both public and private sectors
  - Overwhelmed by the series of political turmoil that followed the independence – ideological conflicts, division of the country, the Korean War, etc. – Korea could not afford to think about development, not to mention S&T.
  - Fortunately, however, Korea had a workforce with a level of education that was higher than its income indicated. Korea's workforce had an average education of 4.98 years in 1960 which was as high as that expected of a country twice as wealthy as it was in those days (1960) (Cohen and Soto, 2001).
  - Under such a setting, Korea launched the drive for industrialization in 1962, which generated huge demand for technology and innovation

4-2. Korean Strategy

- **Capacity-building led by the government**
  - Strengthen policy capacity to lead and orchestrate the efforts for STI capacity-building
- **STI capacity-building geared to industrialization**
  - Public R&D capacity to help industries identify, acquire, and assimilate foreign technologies for industrial development
  - Develop the capacity of educational institutions to meet the changing and increasing demand for skills
  - Provision of policy incentives to promote STI activities in the private sectors
- Promote the demand and/or generate pressure for innovation in the private sectors through industrial development policy and policy incentives

4-3. Policy Capacity

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- STI information system

Statistics	Year launched	Publisher	Remarks
Survey of Technical Manpower	1961	EPB	Single year
R&D Survey of Korea	1963	EPB/MOST	Annual
Intellectual Property Statistics	1976	KIPO	Annual
Technology Foresight	1993	MOST	Every 5 years
R&D Survey of Korea (Frascati Manual)	1996	MOST	Annual
Korea Innovation Survey (Oslo Manual)	1996	STEPI	Biennial
Public Understanding of Science	2000	KFASC	Biennial
Technology Trade Statistics	2001	MOST	Annual
National Technology Information Service	2005	MOST	Portal

- Analytical capacity: KIST/Policy center (1966); STEPI(1987)
- Capacity to formulate and implement policy: MOST (1967) spun off from EPB
  - Transfer of planning capacity from EPB to MOST
  - Linkage of STI policy to national development plan
  - Access to resources (budget) plus broader policy perspective
  - STI infrastructure – legal, institutional, ….

4-4. R&D Capacity

- R&D system: Institution building
  - Korea Institute of Science and Technology, launched in 1966 as *an industrial R&D center* to support industrialization
  - GRI for each of the strategic areas to support the development of heavy chemical industries
  - Development of the Daedeok Science Town to accommodate the GRIs and industrial R&D centers
- R&D funds
  - Setting numerical target for R&D investments (GERD/GDP)

Year	1976	1981	1986	1991	1996	2012	2014
Target	1.0	1.5	2.0	3.0	3.5	5.0	5.0
Actual	0.42	0.92	1.50	1.74	2.34	4.03	4.29

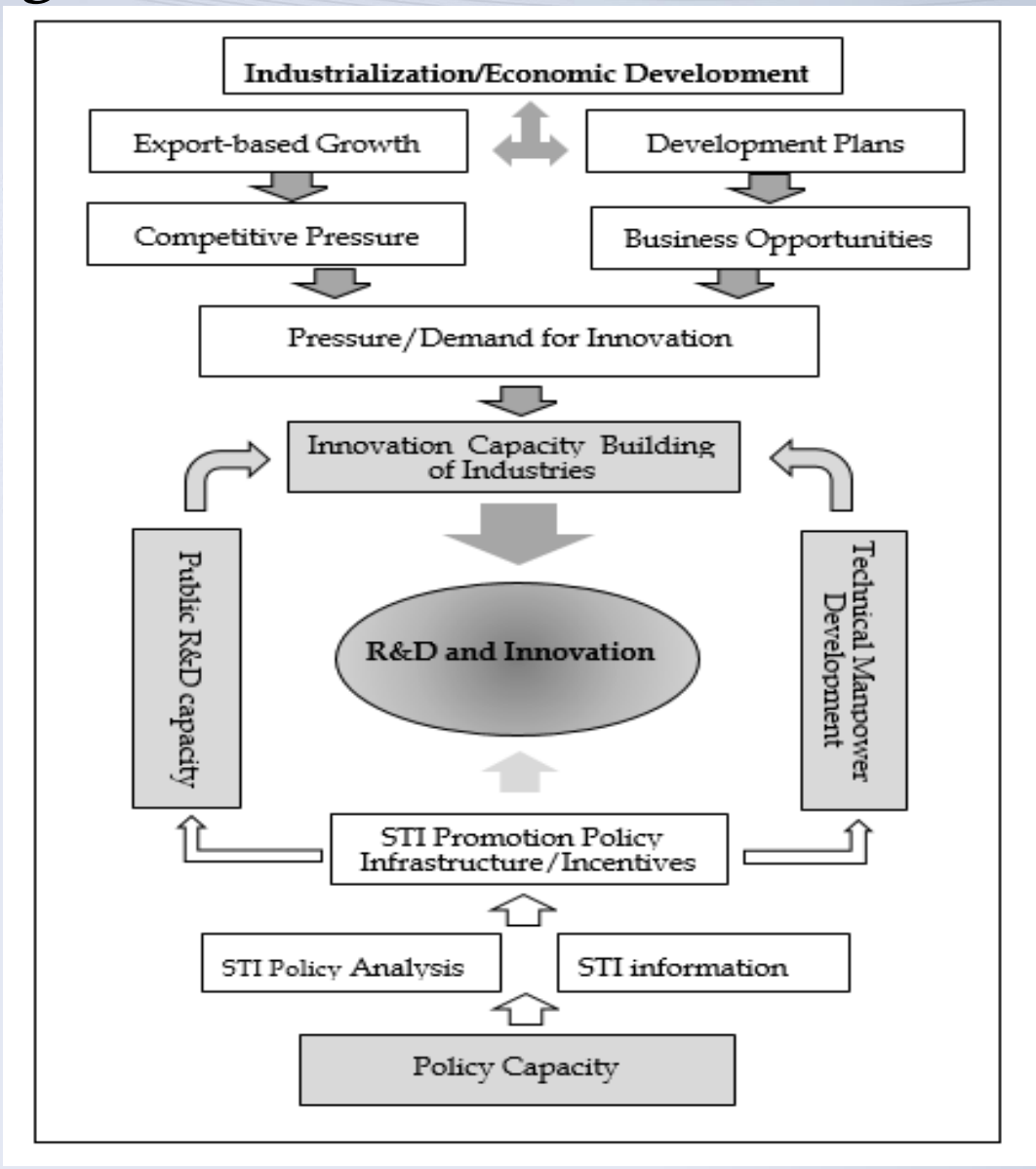
- R&D manpower
  - Short-term strategy: Attract ethnic Korea scientists and engineers from abroad – to staff KIST, GRIs, etc.
  - Create new graduate education system to produce high-caliber R&D manpower – KAIST (As of 2015, KAIST produced 10,000 PhDs in S&E)

4-5. Industries' Innovation Capacity

- **Stimulation of learning**
  - Stimulation of technological learning: Export-performance based incentives
  - Policy incentives for technological learning
  - GRIs to assist technological learning
- **Promotion of industrial R&D**
  - Incentives for industrial R&D – Tax, financial, etc.
  - Export-based development → Exposure to international market competition → R&D and innovation
  - Structural transformation toward high-tech industries
- **Technical manpower**
  - Technical high School and Technical Junior College system (1960-70s)
  - In-plant technical training programs (mandatory for companies employing 300 or more workers)
  - National Technical Qualification Act (1973): classified and defined technical qualifications in accordance with the contents and levels of the technical competences based on the technical requirements of industries.

STI Capacity-Building: Korean Way

- **STI Capacity-Building for Industrialization**
  - Government-led
  - Industries have been induced to build innovation capacity in order to reap the opportunities offered by the industrial development projects and export-based incentive system.



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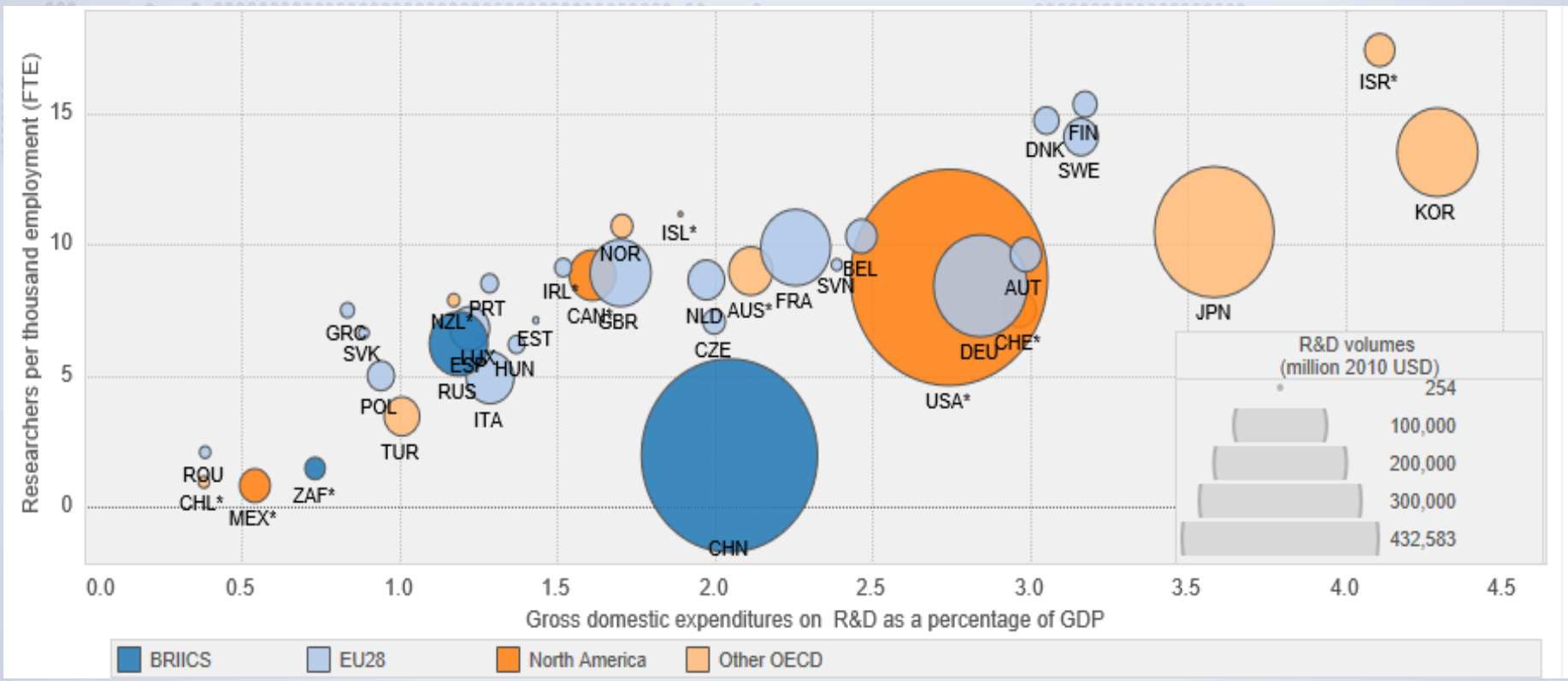
5. Achievements and Issues

5-1. Korea: A New Global Player in STI

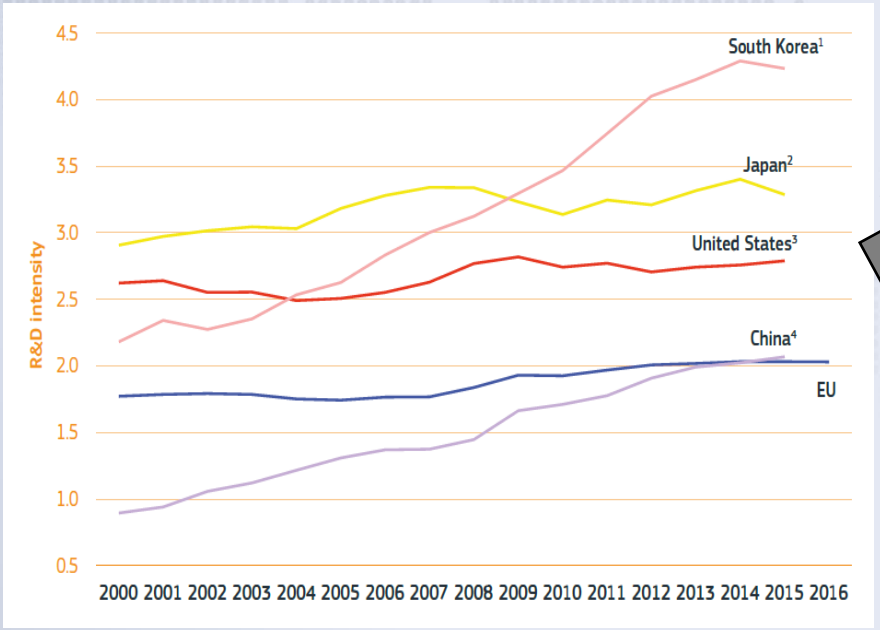
- 6th largest investor in R&D in the world - 3rd largest in Asia
- One of the countries with largest number of researchers per unit of employment
- Largest share of R&D performed by industries



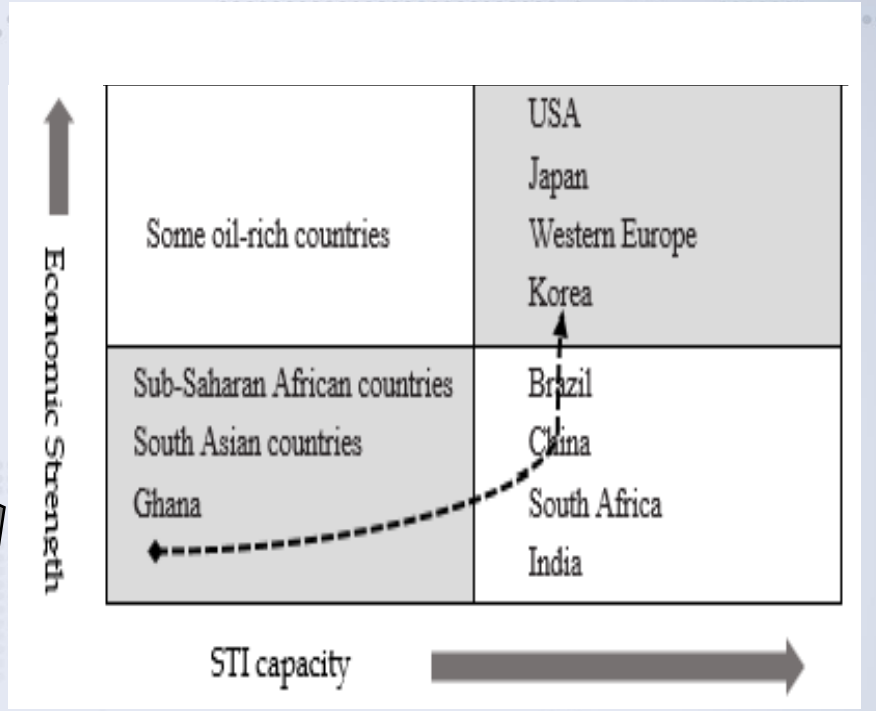
5-2. Economic Transformation:

From being one of the poorest countries to being a new industrialized economy

GERD/GDP



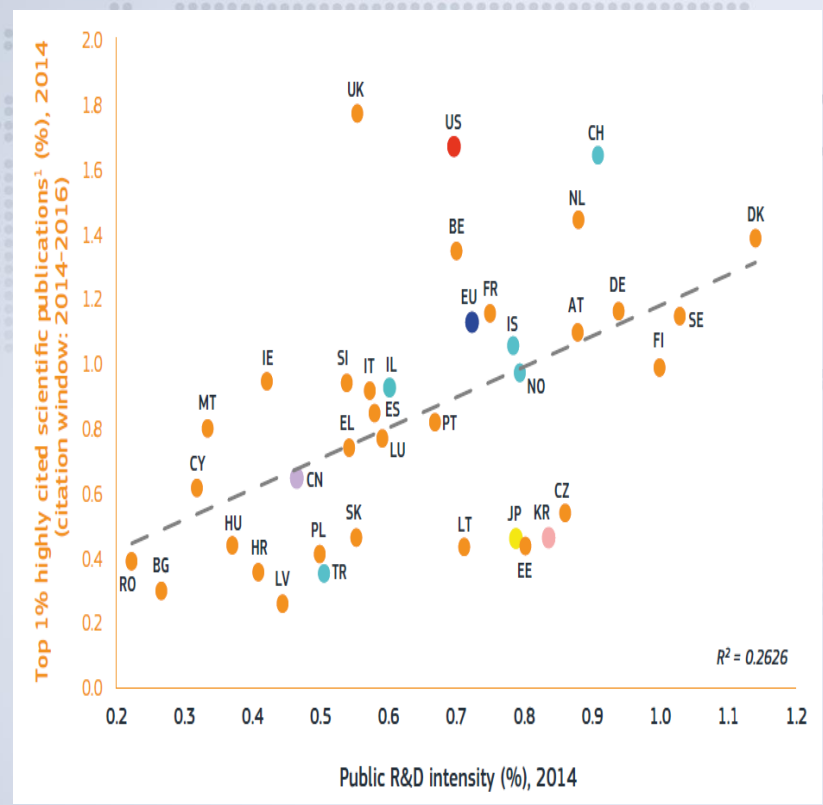
Source: EU(2018)

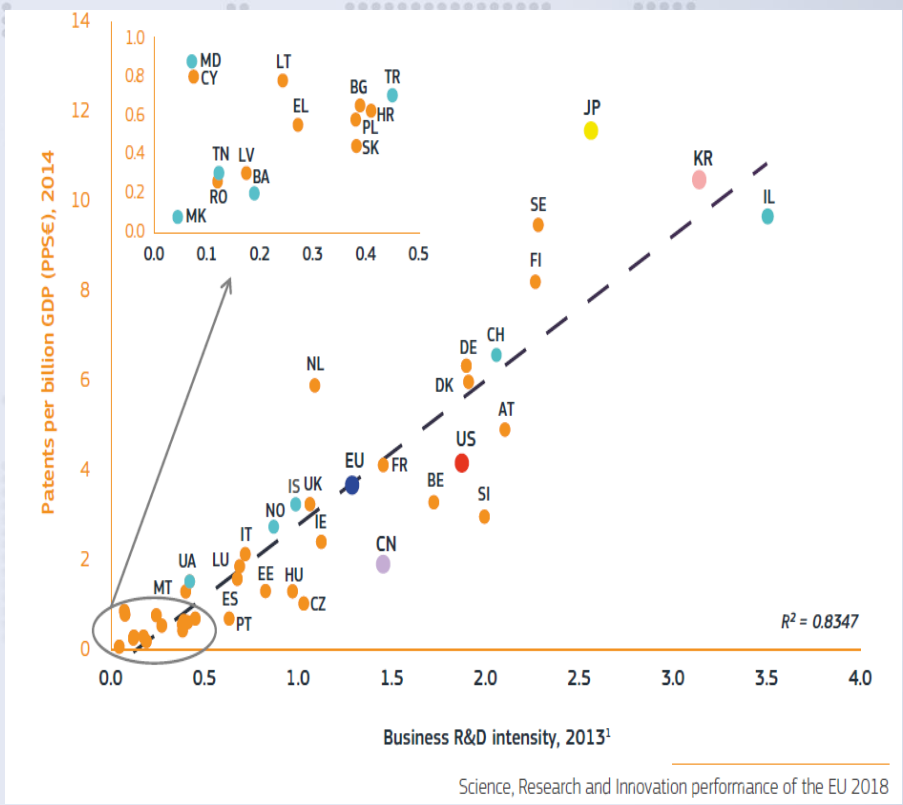


Source: Watkins and Ehst (2008)

5-3. STI Performance

- In terms of scientific knowledge creation, Korea is below average, while in patenting, it belongs to the leading group – The result of "technology first, science later" policy.





Science, Research and Innovation performance of the EU 2018

5-4. Success Factors

(1) STI capacity-building geared to industrial development – Practical approach;
(2) The existence of relatively well-educated workforce made capacity-building efforts more effective and easier.
(3) STI has been blessed with strong supports from both the political leaders of all political orientations and the general public;
(4) Effective use of ODA for STI capacity-building in the early stages of development: KIST and KAIS, major STI institutions in Korea, are the beneficiaries of ODA programs;
(5) Most of all, the mutuality of STI capacity-building efforts and industrial development strategy have made both of the two successful.

5-5. Challenges

Despite the achievements, some of the success factors are becoming barriers to further growth:

(1) Pragmatic approach to building STI capacity → serious imbalance in capability between industrial technology and basic science.
(2) HRD capacity for fast follower strategy → Focused on producing fast learners, and neglected creativity education
(3) The strategic industry-targeting policy → Dominance of large enterprises in industrial innovation system, creating another imbalance
(4) Role of government in STI: The government has been a dominant player in STI capacity-building and made positive contributions to STI development. However, negative fallouts have become visible:
   - Bureaucrats tend to believe government can and should remain the dominant player as they have been so far.
   - Private sectors tend to look to the government for solutions to whatever problems they face in the market.

A big question: "Is Korea going to be a prisoner of its own success?"

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6. Conclusion: Policy Suggestions

Policy Suggestions

- **For Korea**
  - The current STI capacity is what was built for industrialization through technological catching-up, and thus can no longer serve as a vehicle toward an innovation–based economy.
  - Transformative reforms are required in R&D and educational systems, and in particular, in the institutional system that governs the inter-relationships between and among the innovation players..
  - Most of all, the role of the government needs to be redefined.
- **For Developing Countries**
  - **More attention should be given to STI policy capacity**: Even though many developing countries are eager to develop STI capacity to support industrialization and economic development, in many cases, they lack STI policy capacity to formulate and implement STI capacity-building programs.
  - Not being an issue of imminent concern of the society, it requires **long-term political supports** to develop STI capability.
- **For the KSP**
  - In order to make KSP meaningful, it is critical to choose issues for consultation that are likely to be put into policy actions.
  - One way of doing this may be to conduct a joint pre-study for the identification of topics for policy consultation instead of simply collecting demand sheets from partner countries.

Thank you