



[ INTERNATIONAL SYMPOSIUM 2019: The Challenges of Technology and Economic Catching-Up in Emerging Economies, July 3-4, 2019 ]

DGA Auditorium UNICAMP, Brazil

# **Middle Innovation Trap: Capability Transition Failure and Stalled Economic Growth**

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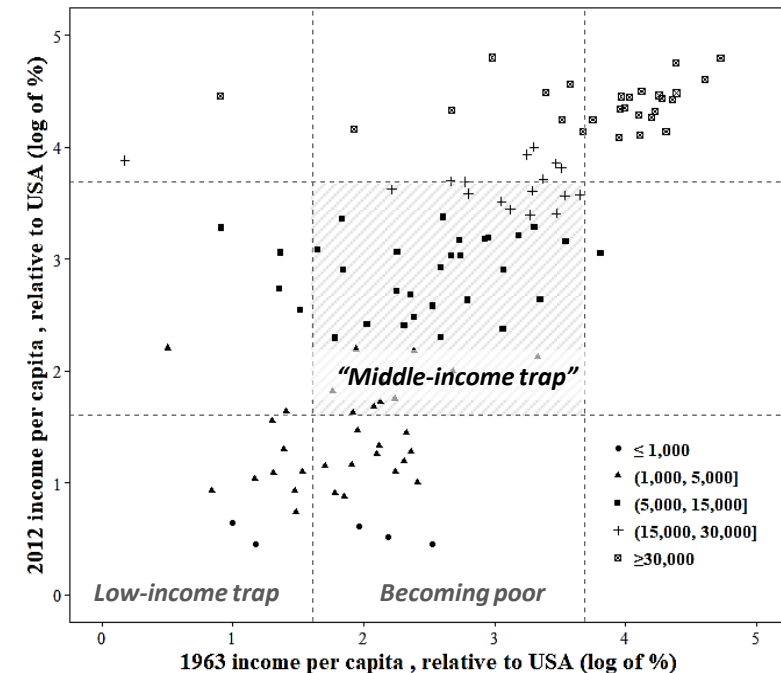
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- 1. Introduction**
- 2. Two types of technological capabilities and their distinct characteristics: An conceptual framework**
- 3. Development pattern of the two technological capabilities: An empirical evidence**
- 4. Middle innovation trap and transition**
- 5. Innovation policies and commons for successful transition**



# Long-run economic growth in emerging economies

- Emerging economies' growth and development through technological progress
  - From **catching up** with the leading countries to **moving forward** by one's own upgrading
- The middle-income trap as a stylized fact
  - Diminishing the latecomer's advantage in most middle-income countries (stalled economic growth)
  - **Uphill struggle** to further promote economic growth through technological innovation

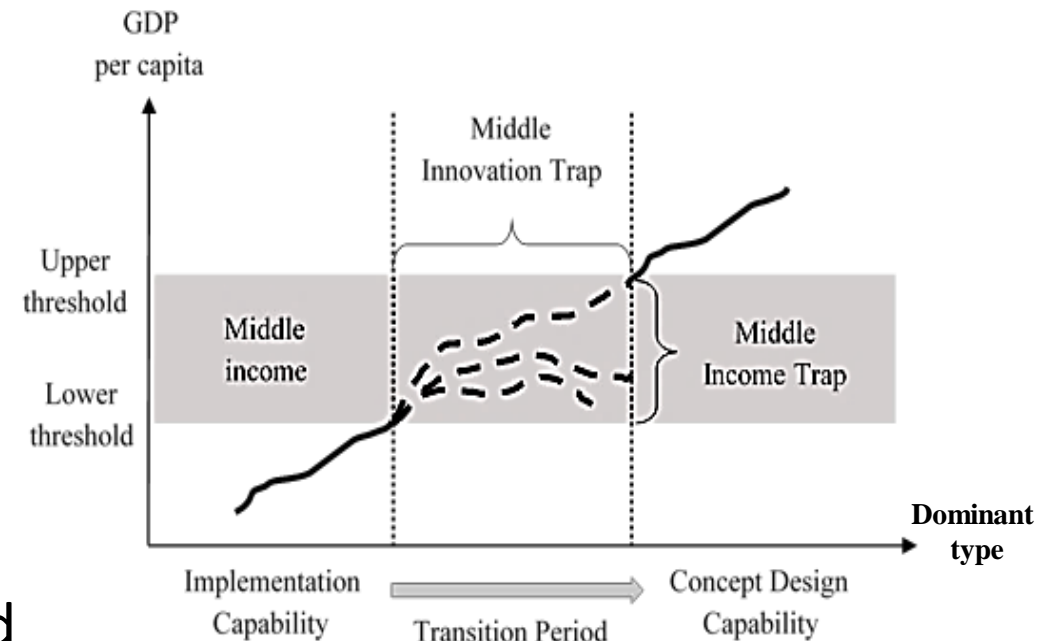


Source: Author's elaboration, using the data, PWT version 9.0 based on Agenor et al. (2012)

▲ Example of illustrating the middle-income trap and other lack of growth

## Stalled economic growth and capability transition failure

- The need for the middle-income trap revisited, from the perspective of **technological capabilities**
  - Based on our concept, i.e., *implementation capability* and *concept design capability*
  - “**Middle Innovation Trap**” as capability transition failure
- The objective of this chapter is...
  - To demonstrate two types of capabilities and their transition
  - To identify the bottleneck in capability transition
  - To suggest a way to overcome the risk of the middle innovation trap



Source: Lee et al. (2019)

▲ Stylized development process based on the transition of technological capabilities



- 2. Two types of technological capabilities and their distinct characteristics: An conceptual framework**
  - 2.1. The need for two different capabilities in long-run economic growth
  - 2.2. The characteristics of implementation capability and design capability
- 3. Development pattern of the two technological capabilities: An empirical evidence**
  - 3.1. Measuring two technological capabilities
  - 3.2. Dynamics of the two technological capabilities along with a long-run economic growth



## **4. Middle innovation trap and transition**

4.1. Middle innovation trap and growth stall

4.2. The reasons for transition failure (institutional rigidity, path dependency)

## **5. Innovation commons to facilitate the transition from implementation to concept design capability**

5.1. A strong advanced manufacturing capability as a platform for trial and error

5.2. Learning capability to nurture professionals

5.3. Socio-cultural institutions to favor the accumulation of trial and error

5.4. Consistent and coherent innovation policy to lead change



## **Two types of technological capabilities and their distinct characteristics**

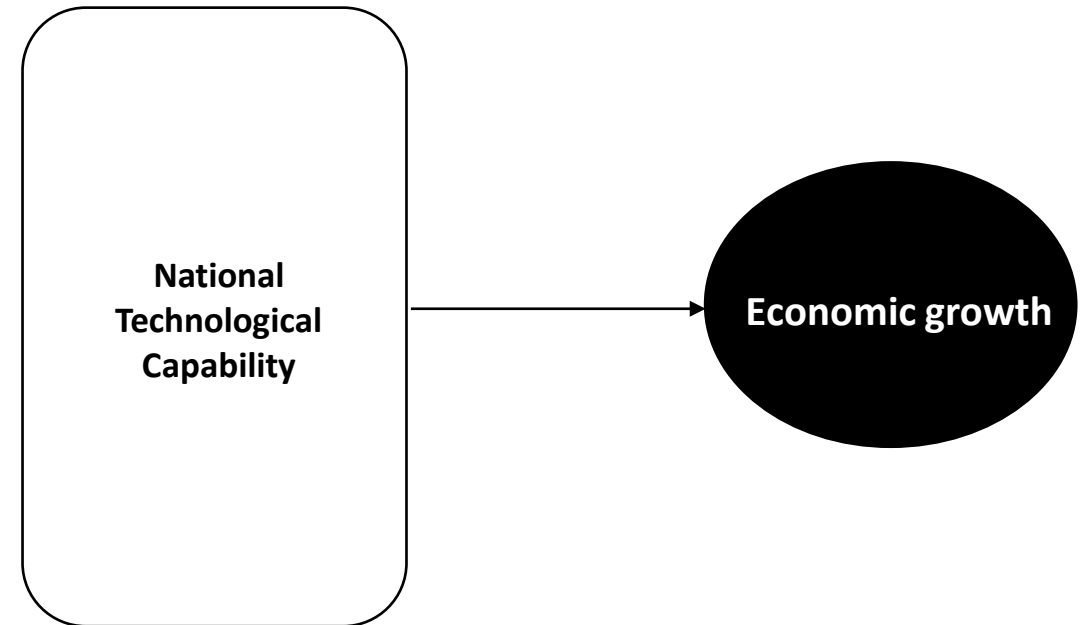
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: An conceptual framework



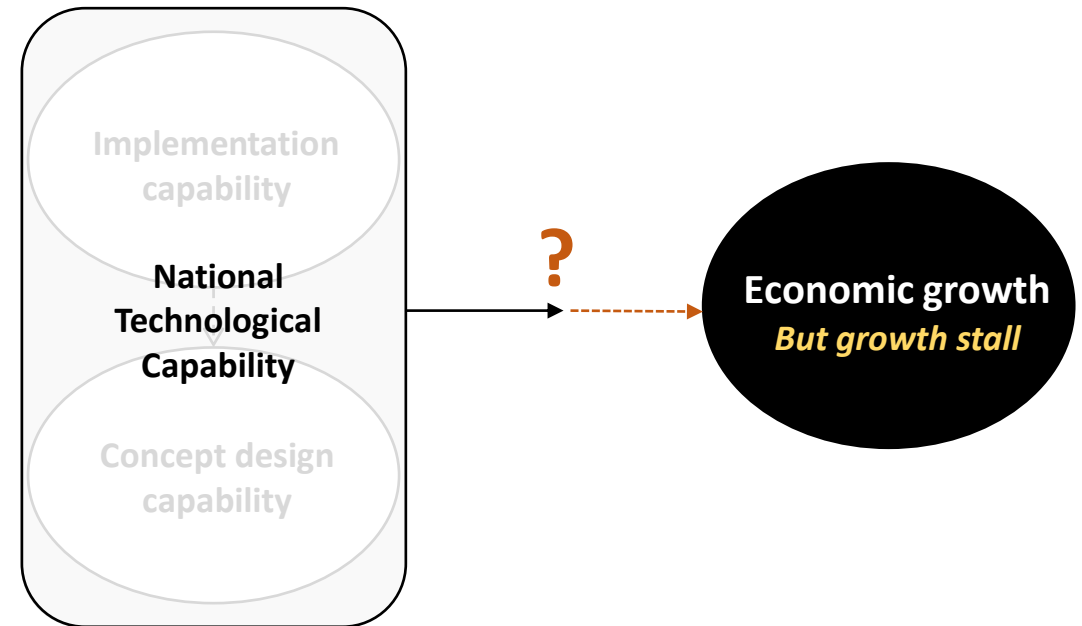
# Economic growth and capability literature

- Literature review on long-run economic growth, growth slowdowns, and technological capability development
  - To highlight **the importance of intrinsic technological capabilities** for catching-up and moving forward

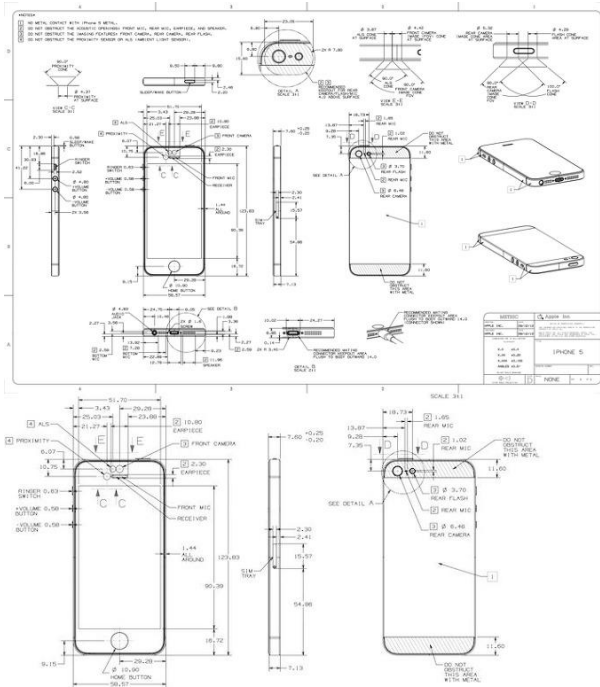


# Economic growth and capability literature

- Literature review on long-run economic growth, growth slowdowns, and technological capability development
  - To highlight the importance of intrinsic technological capabilities for catching-up and moving forward
  - To argue **the need for effective technological capabilities by income level**



# Two capabilities



**(Unique)  
Design  
Capability**



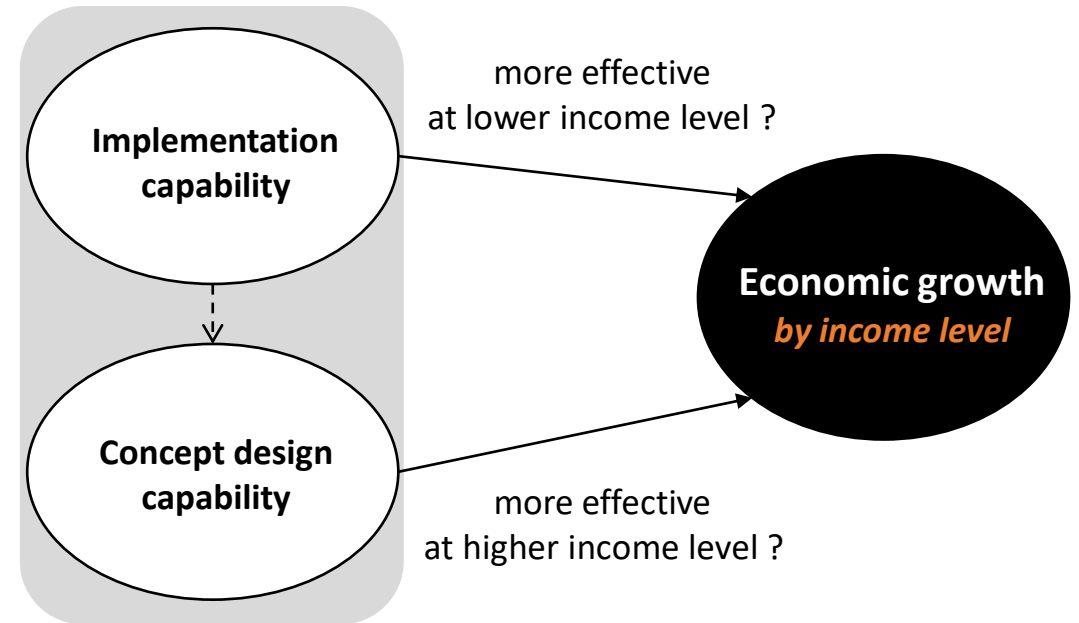
**(Excellent)  
Implementation  
Capability**



**(Innovative)  
Product**

## Our conceptual framework

- Our conceptual framework explaining national technological capability by means of **implementation capability** and **design capability**
  - The differences between the two technological capabilities (key aspects and effects)
  - e.g. the knowledge management literature (explicit vs. tacit)
  - e.g. the organizational learning literature (exploitation vs. exploration)



## Our conceptual framework

- The distinction of technological capabilities in Lee et al. (2019)
  - **Concept design capability** (hereafter design capability) to create new blueprints, business models, or standard levels of new products or services by defining new specifications or functions.
  - **Implementation capability** to actualize a given design of products or services and attain proficiency in production and operations.

**Table 1.** Key characteristics of implementation and design capabilities

Feature	Implementation capability	Design capability	References
Mode of expression (Knowledge contents)	Explicit (Know-how)	Tacit (Know-why)	Polanyi (1958), Bell and Pavitt (1993), Nonaka and Takeuchi (1995)
Performance criteria	Efficiency	Differentiation	
Strategy to nurture	Learning-by-doing with the accumulation of repetitive execution	Learning-by-building with the accumulation of creative trial and error	March (1991), Katila and Ahuja (2002), Zollo and Winter (2002)
Time and cost for learning	Low to medium (relatively easy, via exploitation)	Medium to high (relatively difficult, via exploration)	



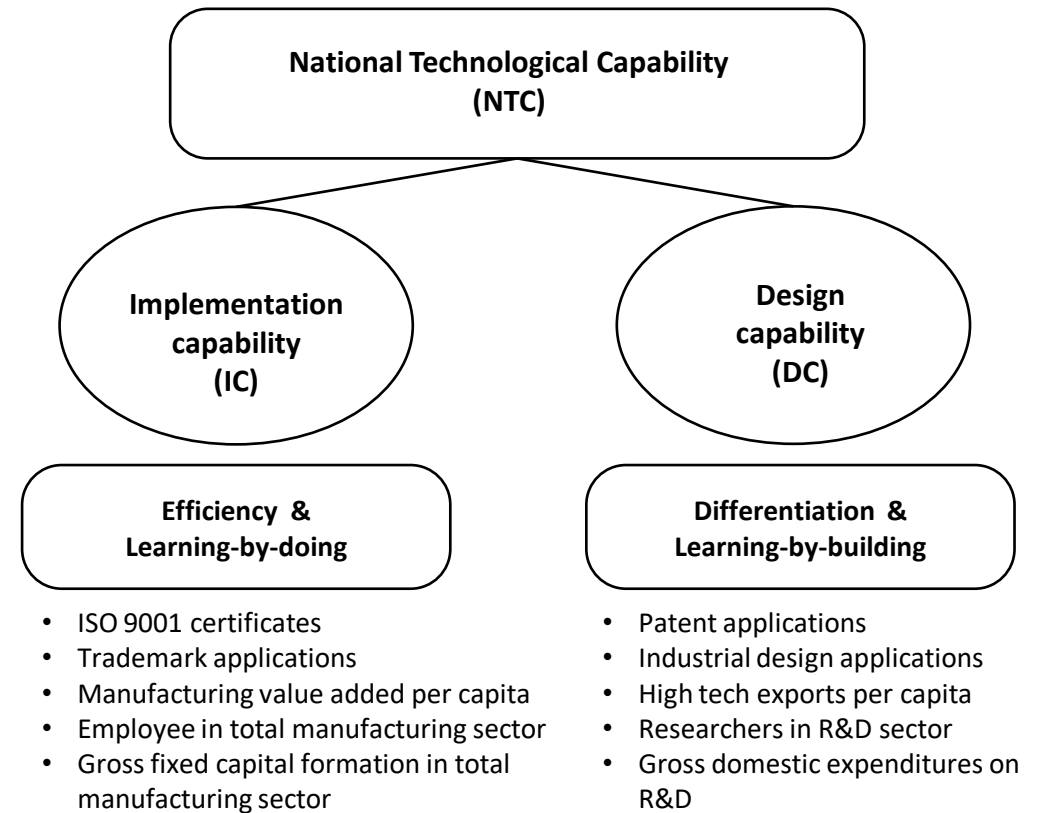
## Development pattern of the two technological capabilities

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: An empirical evidence

# Measuring two technological capabilities

- A composite index methodology with multifaceted aspects
  - Improving *efficiencies* in actualizing a given design or *differentiating* new concept designs from existing ones
  - *Repeated practice* to adapt and assimilate technological knowledge at production sites (i.e., learning-by-doing) or *creative trial and error* to combine and build new technological knowledge in pursuit of new designs (i.e., learning-by-building)



**Figure 1.** The analytical framework for measuring national technological capability (NTC) with two components, implementation capability (IC) and design capability (DC)

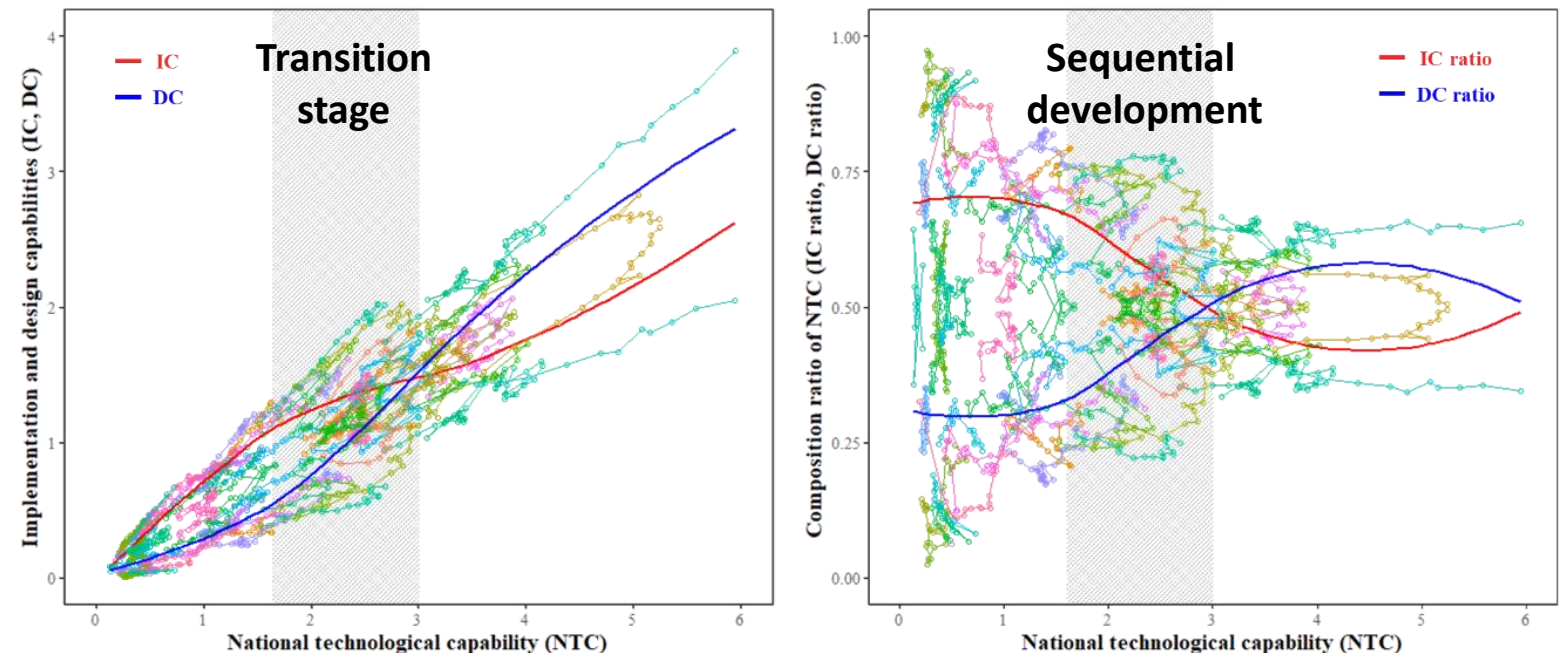
## Development pattern of two technological capabilities

- **Implication 1.** The existence of **the transition stage** in the capability dynamics: the *vigorous changes* in the dominant type of national technological capability
- **Implication 2.** **The sequential pattern** from the implementation-based to the design-based capability

Notes:

1. The left panel shows the development trajectory of each country based on the index score per se, with the representative trend line of its typical pattern.
2. The right panel represents the same data but is based on the composition ratio of the total index score.

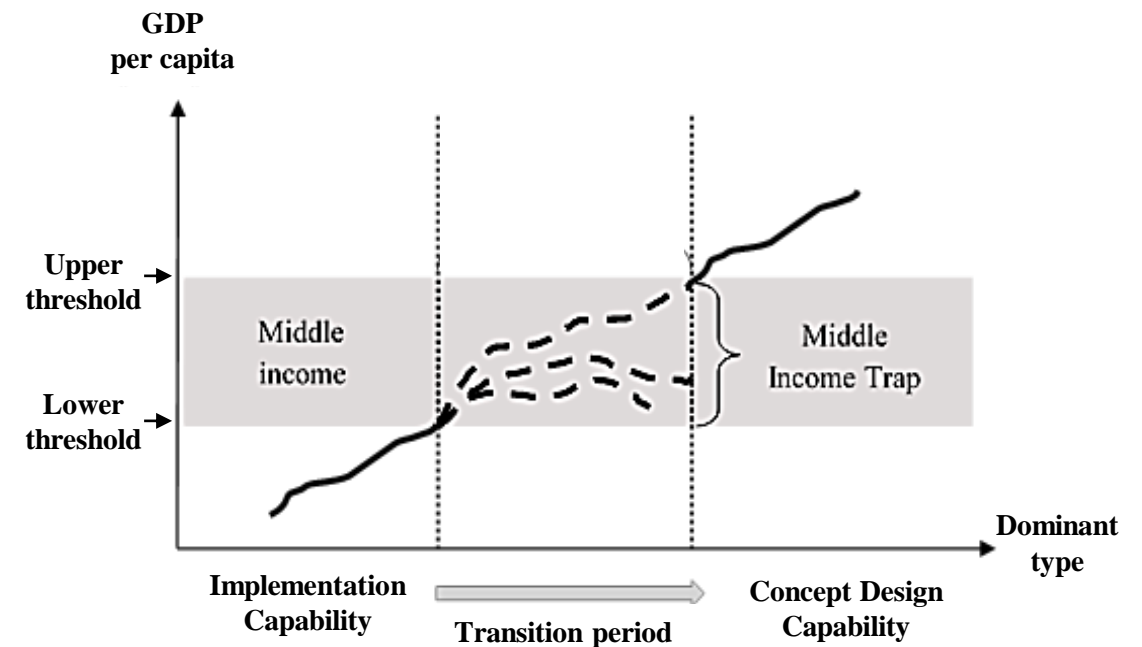
**Figure 2.** The development pattern of implementation capability and design capability (97 countries for 1996-2016)





# The process of economic growth revisited

- How does the **typical pattern** of technological capability development correspond with the long-term process of **economic growth**?
  - Conceptual description  
: the typical process of economic growth driven by technological capability development



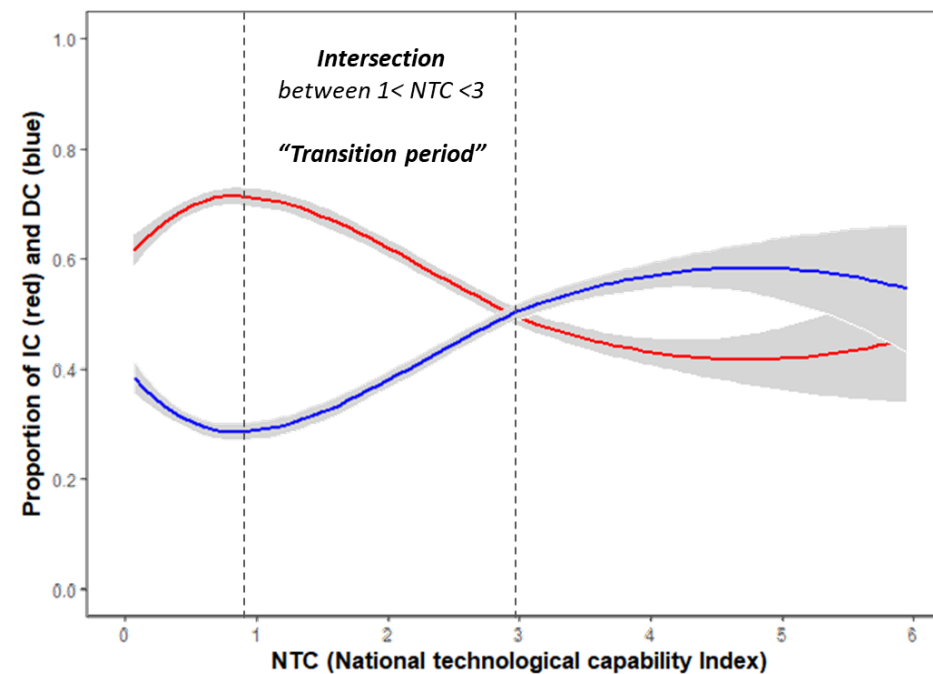
Source: Lee et al. (2019)

## III. Empirical evidences

### 2. Development pattern of technological capabilities, from implementation to design capability

- Results (cont'd)

- The sequential development pattern from implementation to design, based on the **proportions** to NTC



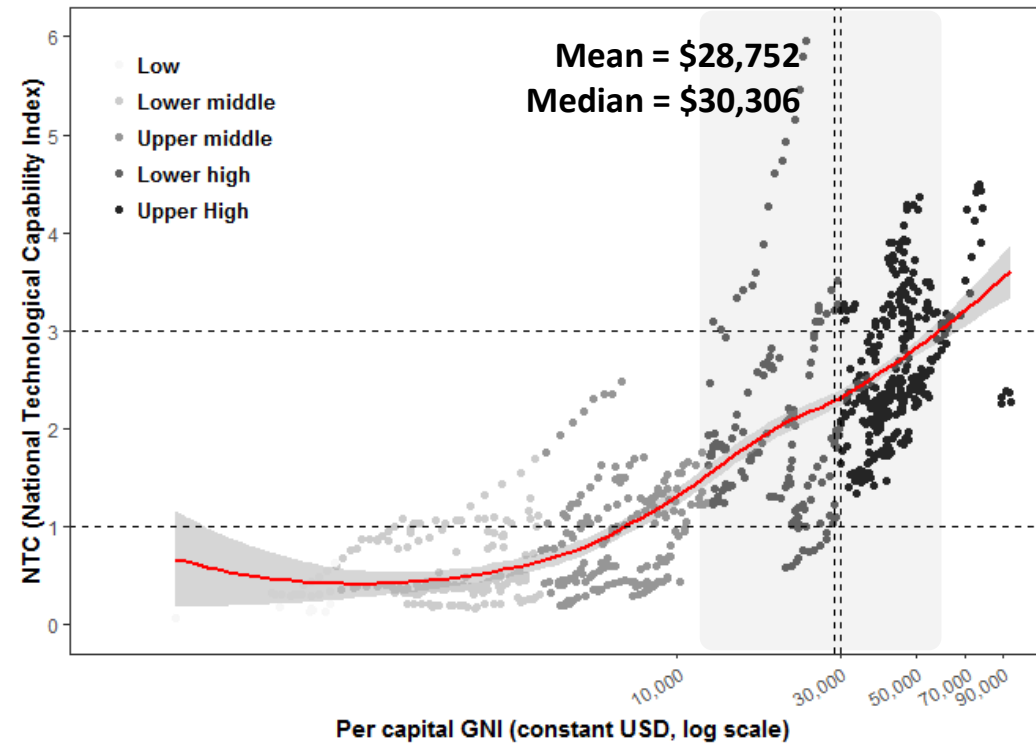
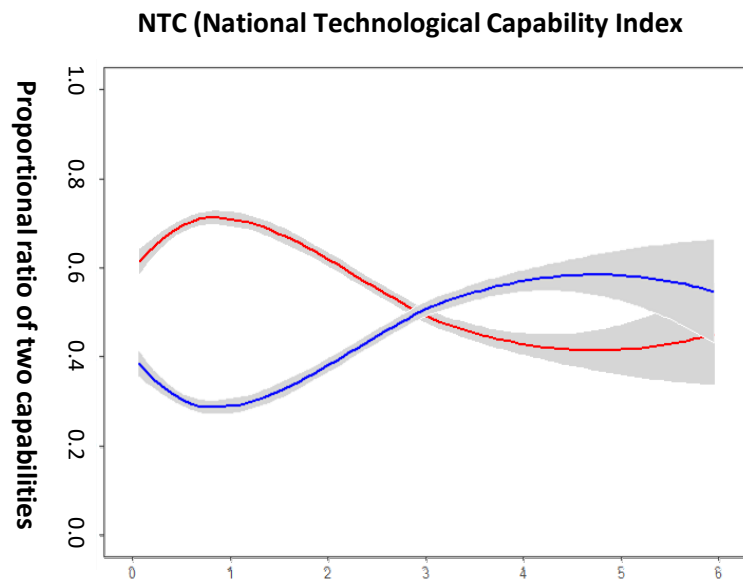
**Figure 3.** Development pattern of implementation capability(left, red) and design capability(right, blue) as the NTC index increases based on the proportions to NIC, colored according to the classification of income groups

## III. Empirical evidences

### 2. Development pattern of technological capabilities, from implementation to design capability

- Results (cont'd)

- Transformation of *'the transition period'* from the capability-ratio domain to the income-capability domain

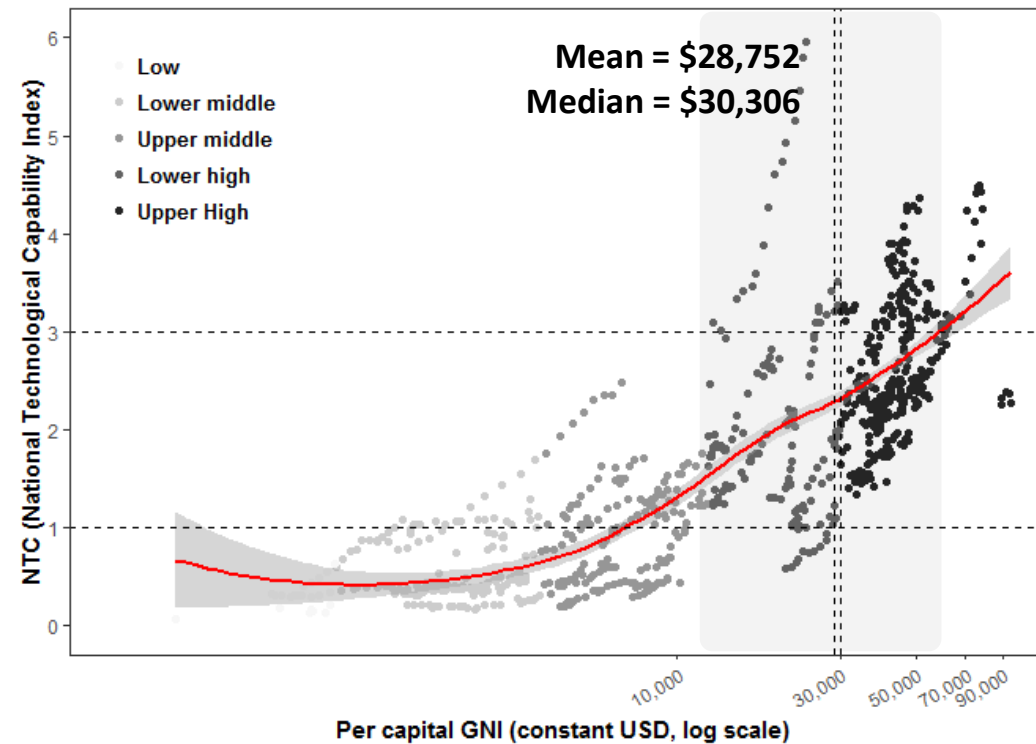
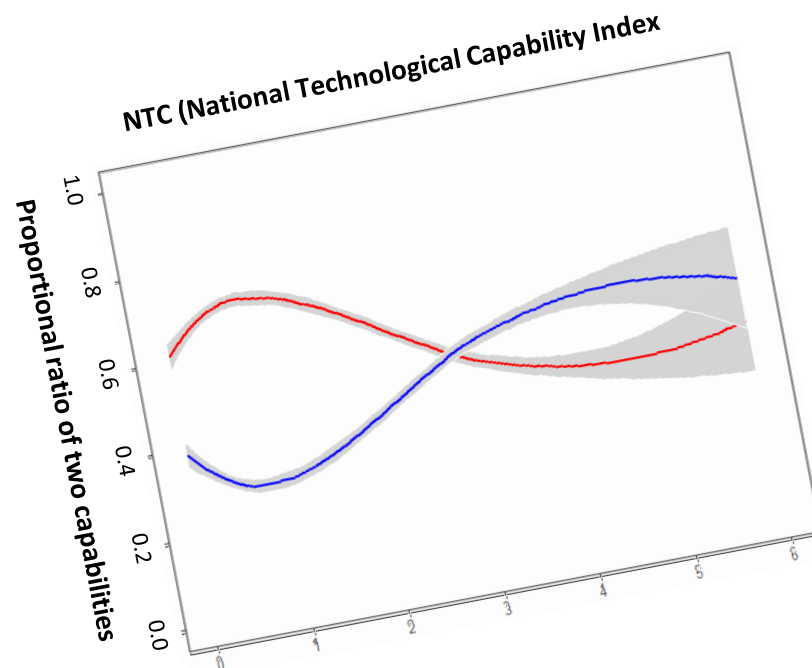


## III. Empirical evidences

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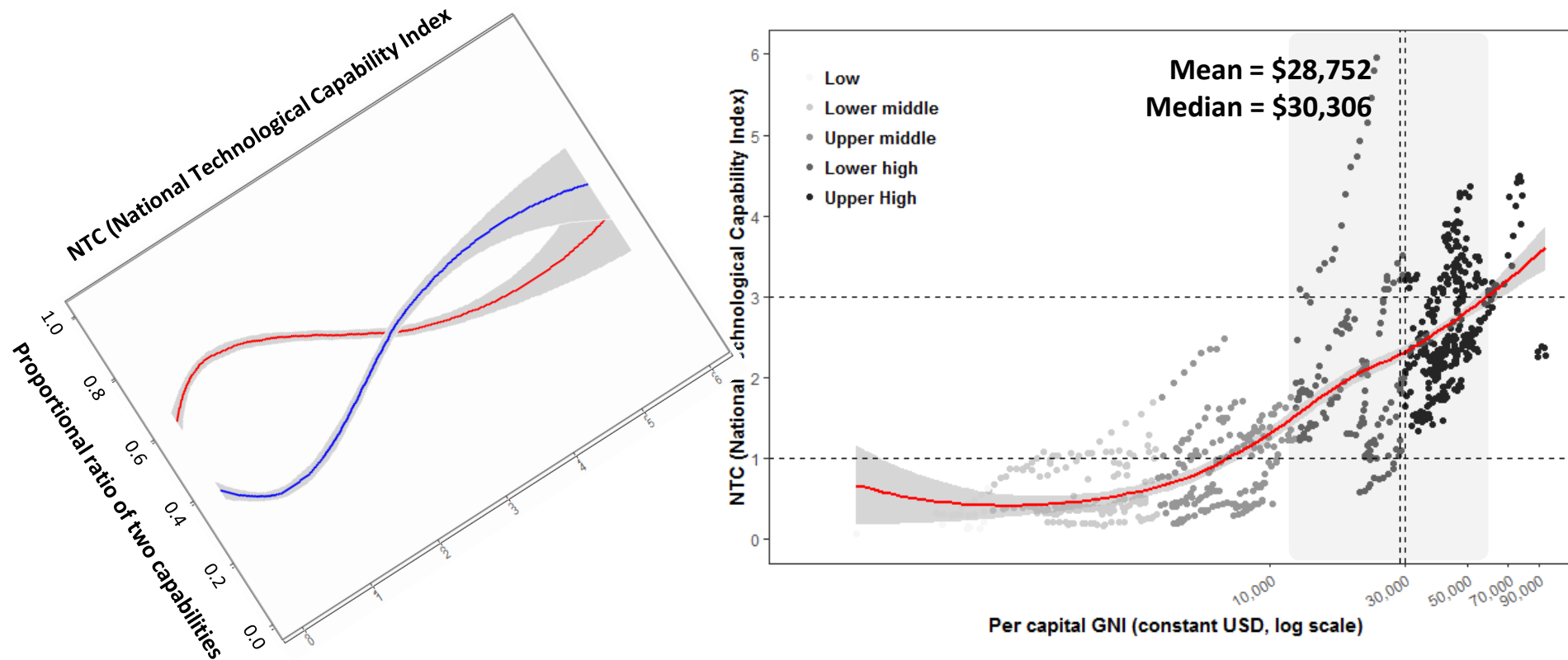


### III. Empirical evidences

#### 2. Development pattern of technological capabilities, from implementation to design capability

- Results (cont'd)

- Transformation of 'the transition period' from the capability-ratio domain to the income-capability domain

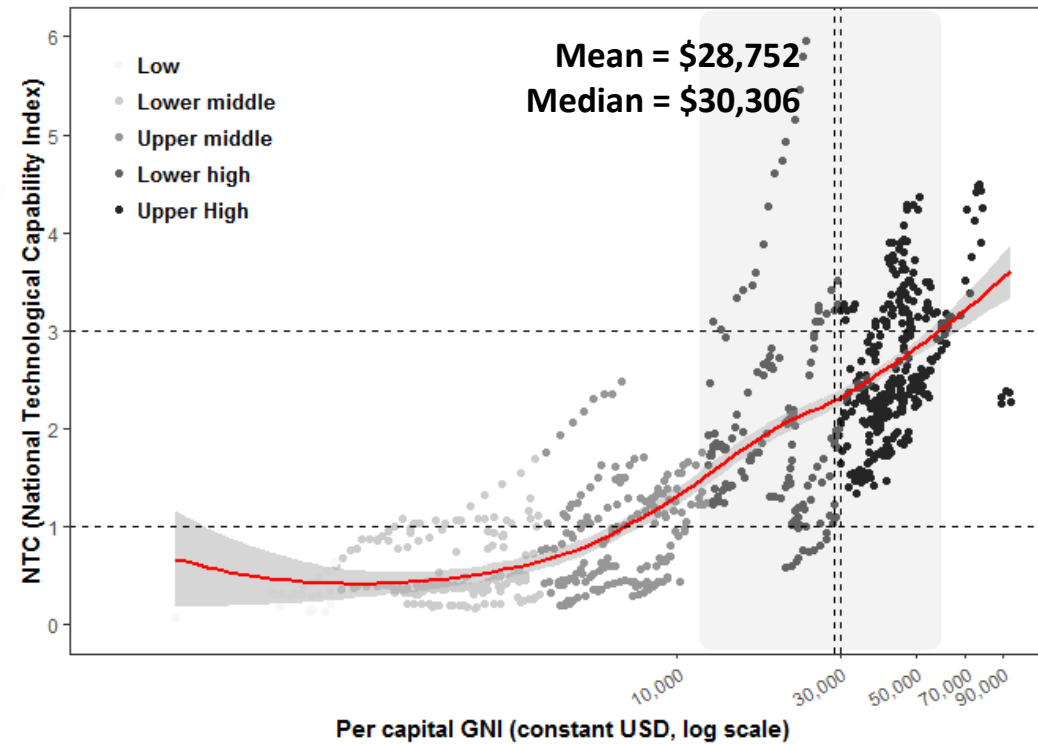
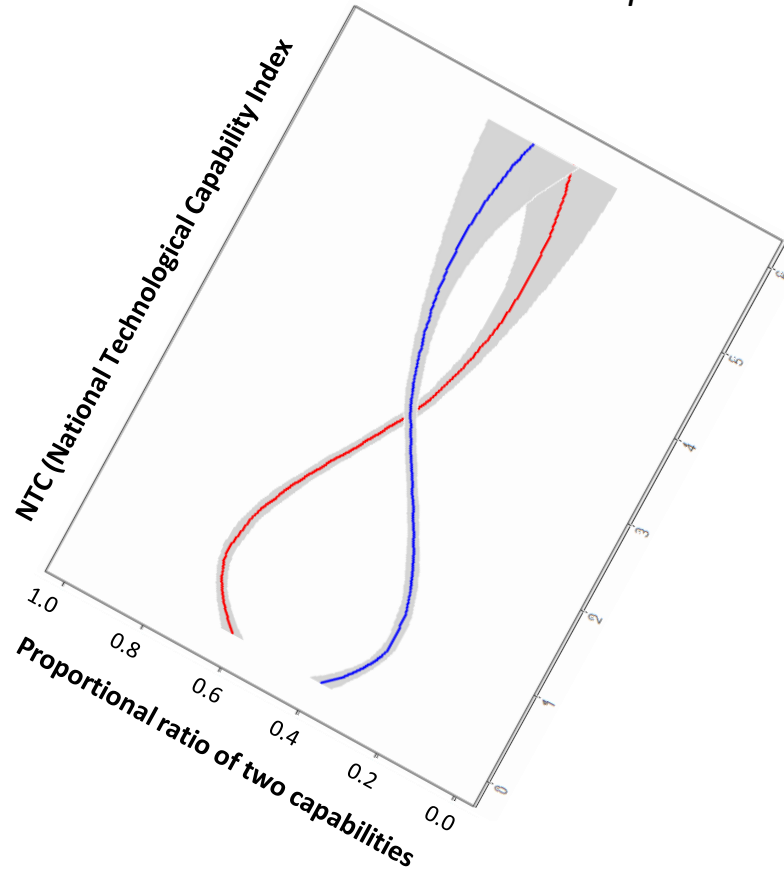


### III. Empirical evidences

#### 2. Development pattern of technological capabilities, from implementation to design capability

- Results (cont'd)

- Transformation of 'the transition period' from the capability-ratio domain to the income-capability domain

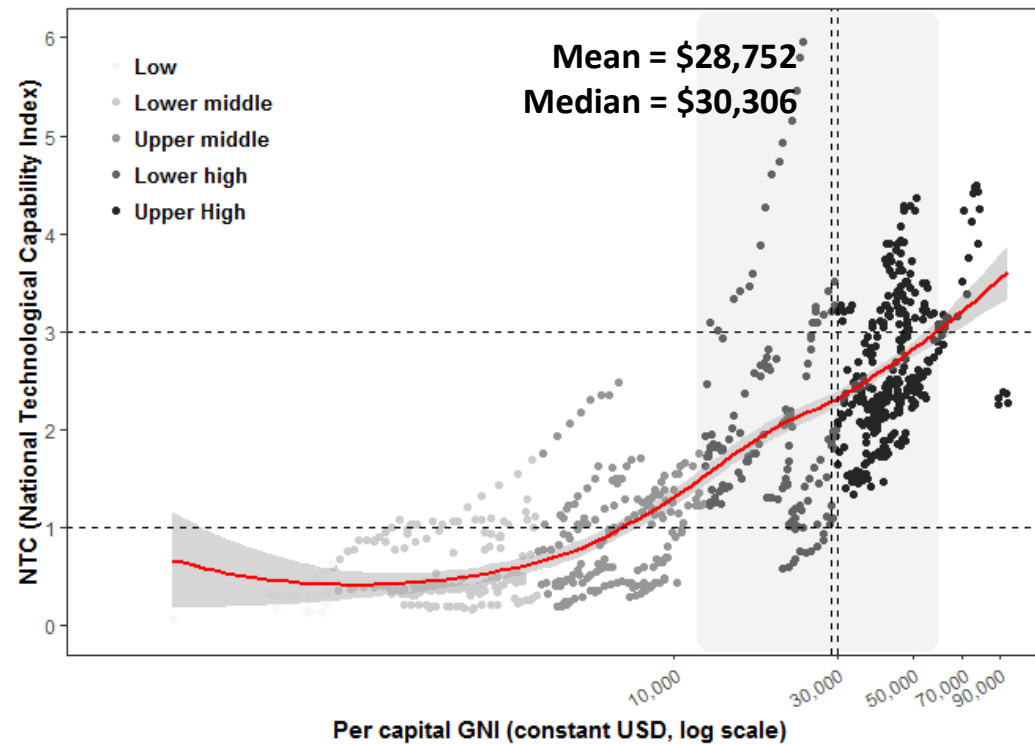
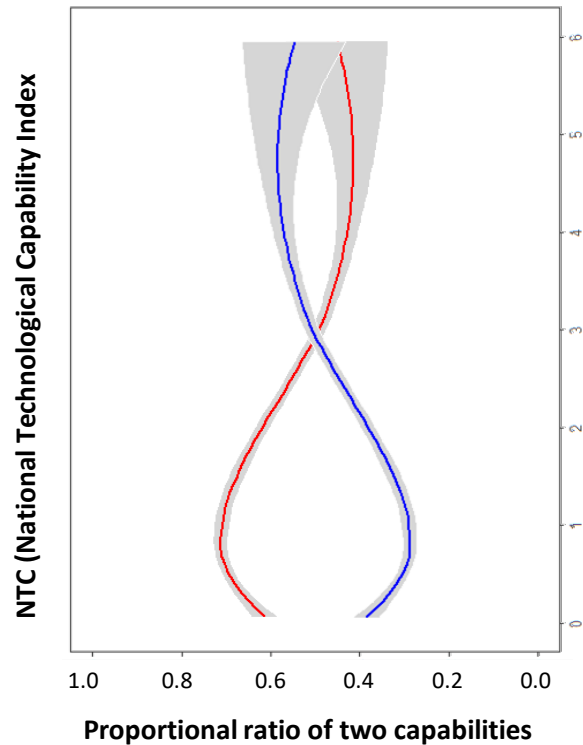


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- Results (cont'd)

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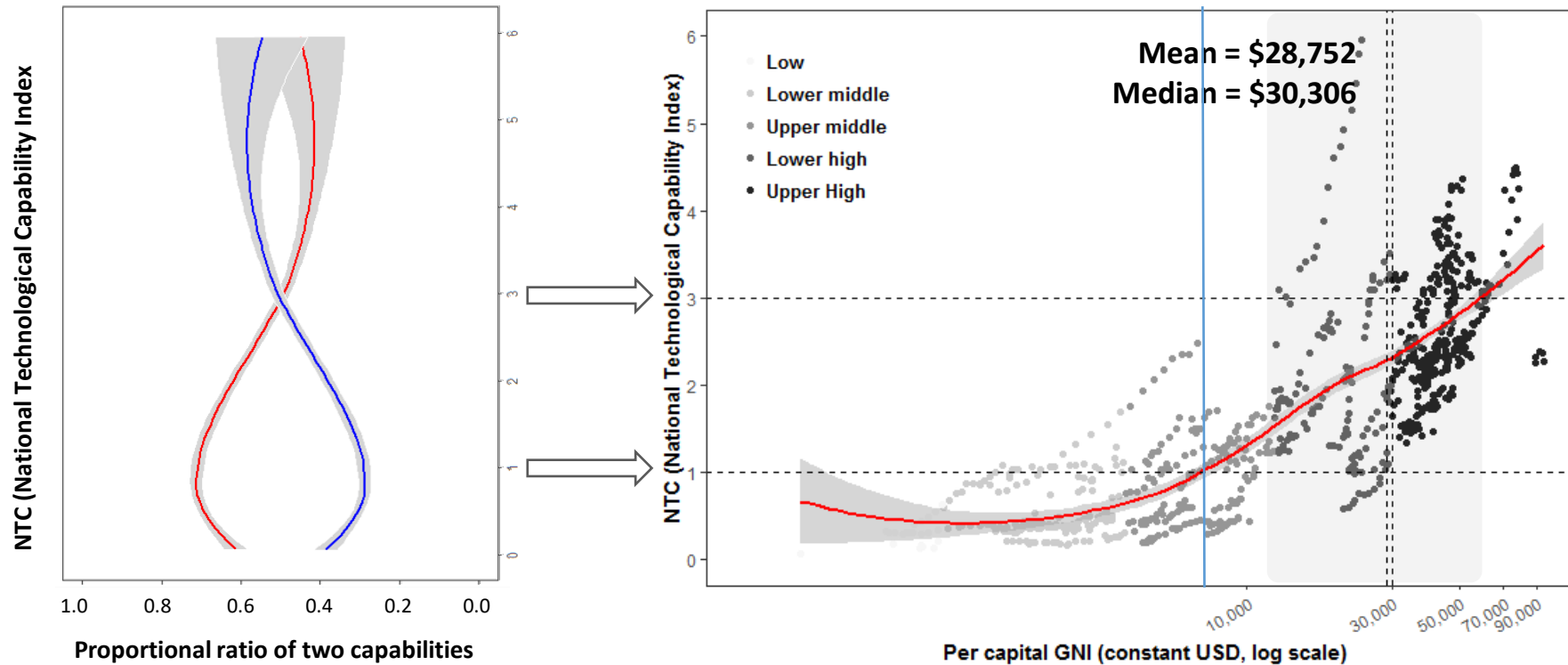


### III. Empirical evidences

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- Results (cont'd)

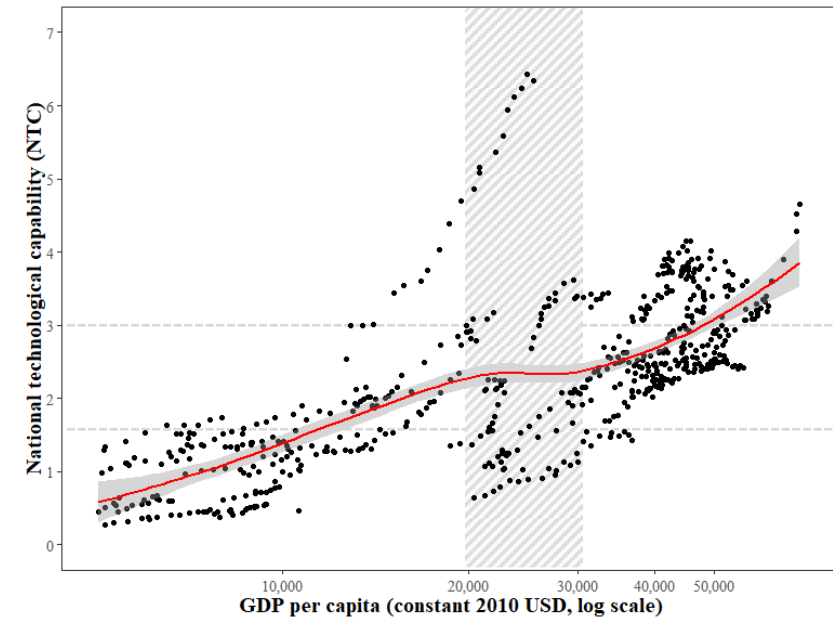
- Transformation of 'the transition period' from the capability-ratio domain to the income-capability domain





# The process of economic growth revisited

- How does the **typical pattern** of technological capability development correspond with the long-term process of **economic growth**?
  - Empirical description  
: the nonlinear feature of the per capita income dynamics<sup>1</sup>



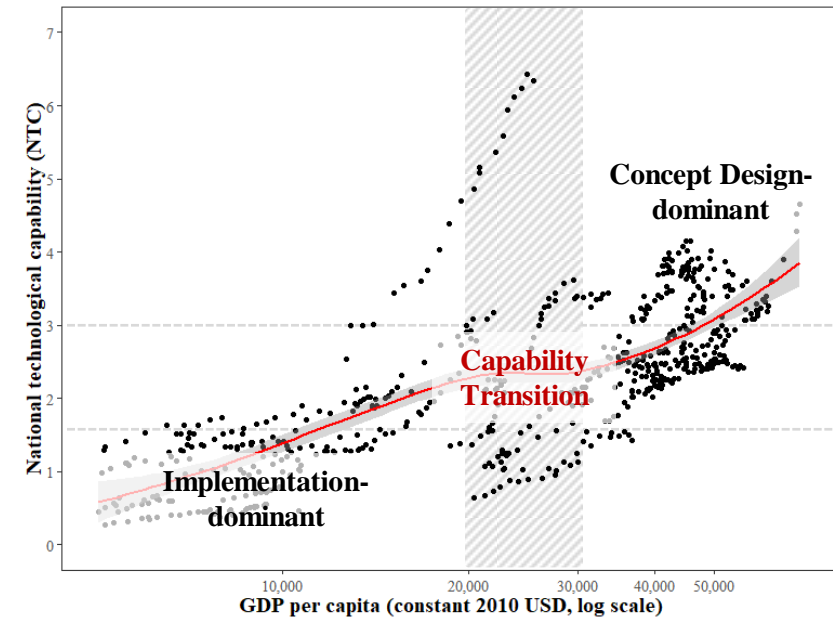
**Figure 3.** The overall index of national technological capability as per capita income increases

Notes:

1. In this study, the per capita income level refers to the log of gross domestic product (GDP) per capita in constant 2010 US\$, with data collected from the World Bank.

# The process of economic growth revisited

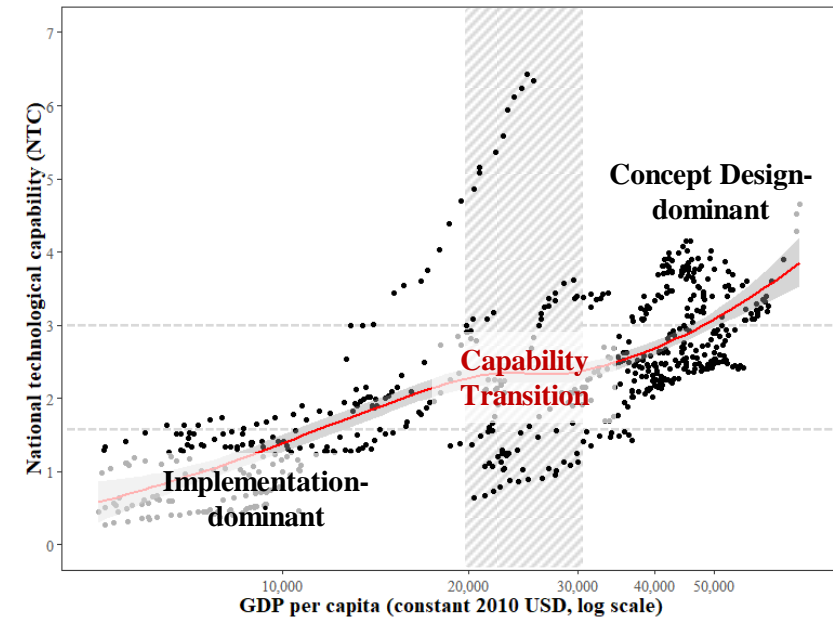
- How does the typical pattern of technological capability development correspond with the long-term process of economic growth?
  - Empirical description : the nonlinearity corresponding with **the sequential development** of national technological capability



**Figure 3.** The overall index of national technological capability as per capita income increases

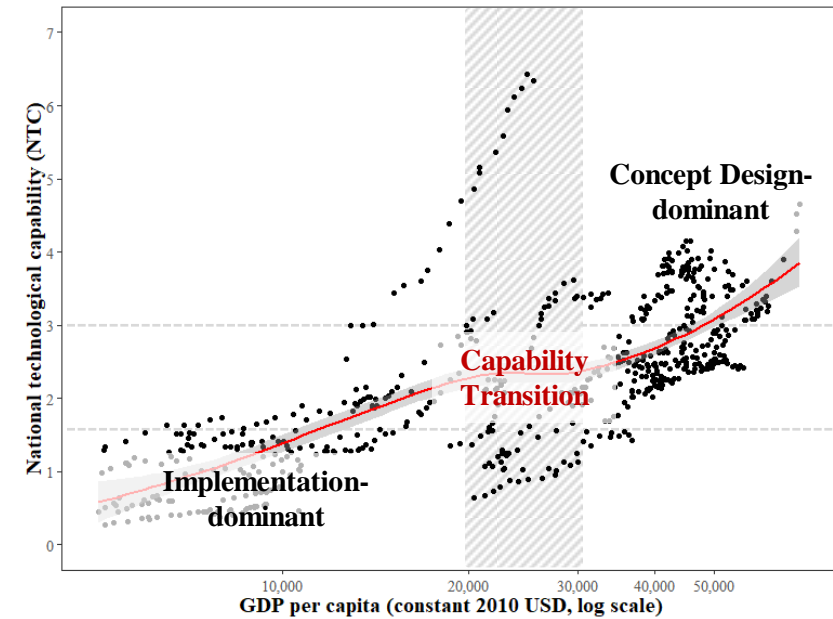
## The process of economic growth revisited

- **Implication 3.** The dynamic correlation between the transition dynamics of technological capability and the cause of the middle-income trap or post-middle-income trap  
  
i.e. “ Successfully securing design capability through the transition stage is a *sufficient condition* to overcome the middle-income trap.”



**Figure 3.** The overall index of national technological capability as per capita income increases

- **Implementation capability is the necessary condition**
- **Design capability is the sufficient condition**



**Figure 3.** The overall index of national technological capability as per capita income increases

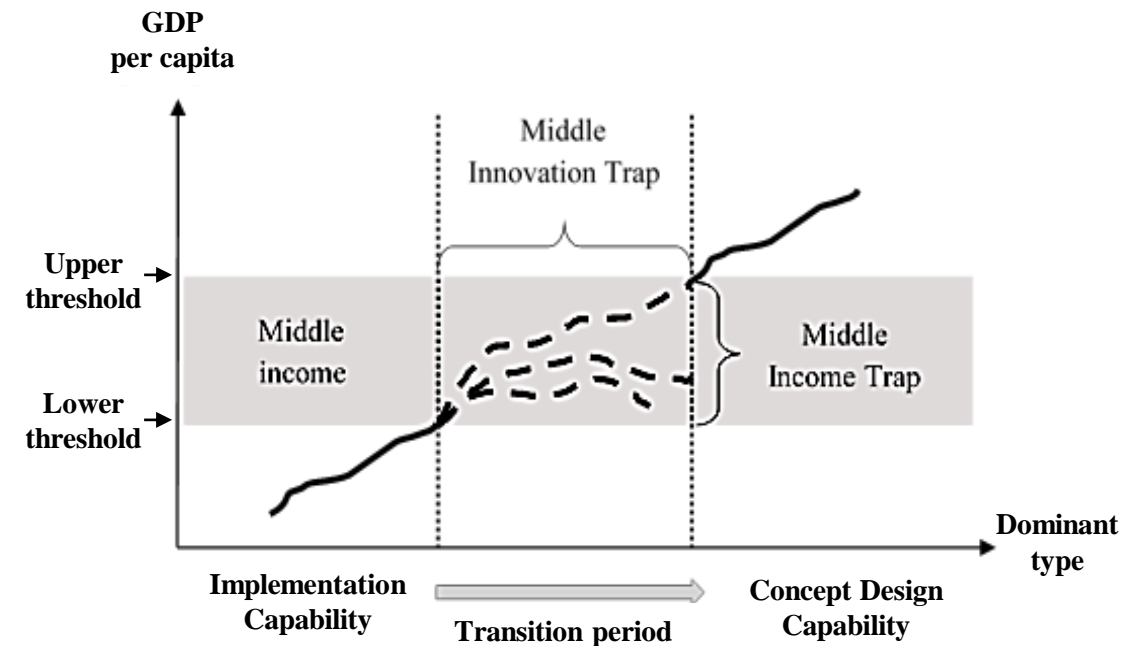


## Middle innovation trap and transition failure

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# Growth stall and capability transition failure

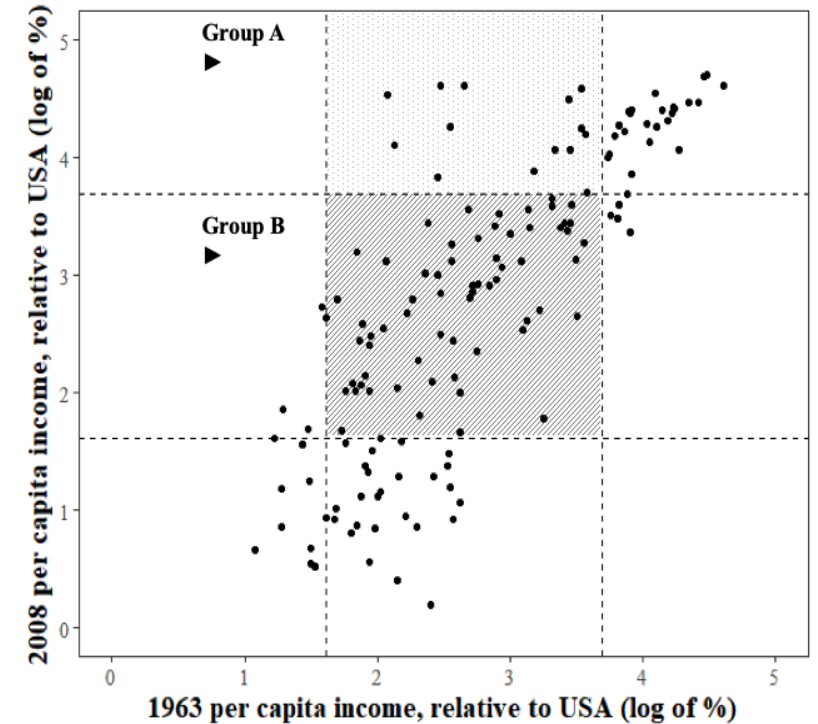
- According to Lee et al (2019), the middle-income trap is...
  - Growth stall in most middle-income countries due to capability transition failure
  - i.e. “the middle-innovation trap” to describe a fundamental cause



Source: Lee et al. (2019)

## Middle innovation trap: Demonstration

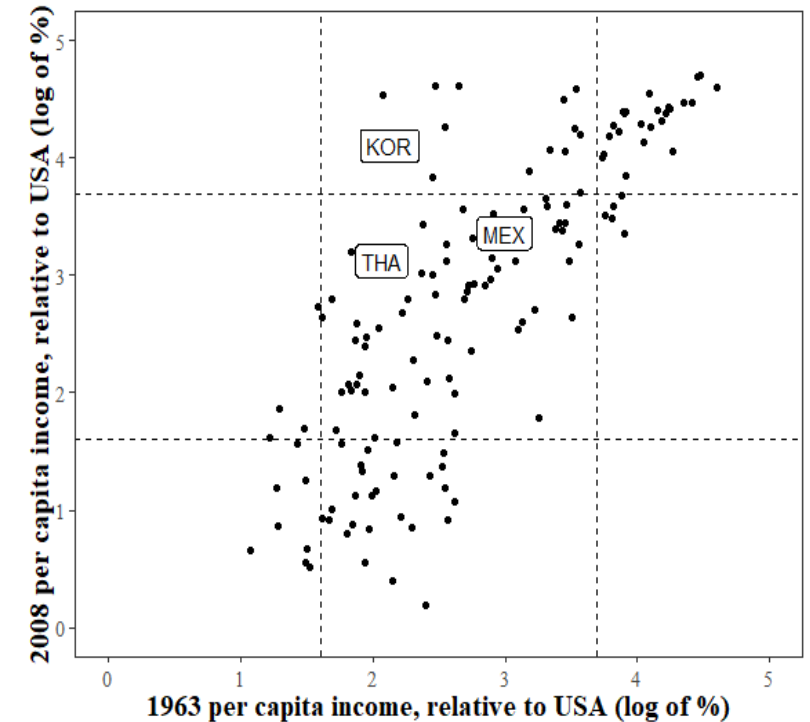
- **Step 1.** Divide the group of countries
  - **Group A** : Countries that have grown into high-income countries in 2008,
  - **Group B** : Countries that could not escape from the middle-income trap for 45 years,



**Figure 4.** The distribution of countries by 1963 per capita income and 2008 per capita income

## Middle innovation trap: Demonstration

- **Step 1.** Divide the group of countries
  - **Group A :** Countries that have grown into high-income countries in 2008, e.g. Korea (KOR)
  - **Group B :** Countries that could not escape from the middle-income trap for 45 years, e.g. Thailand (THA) and Mexico (MEX)

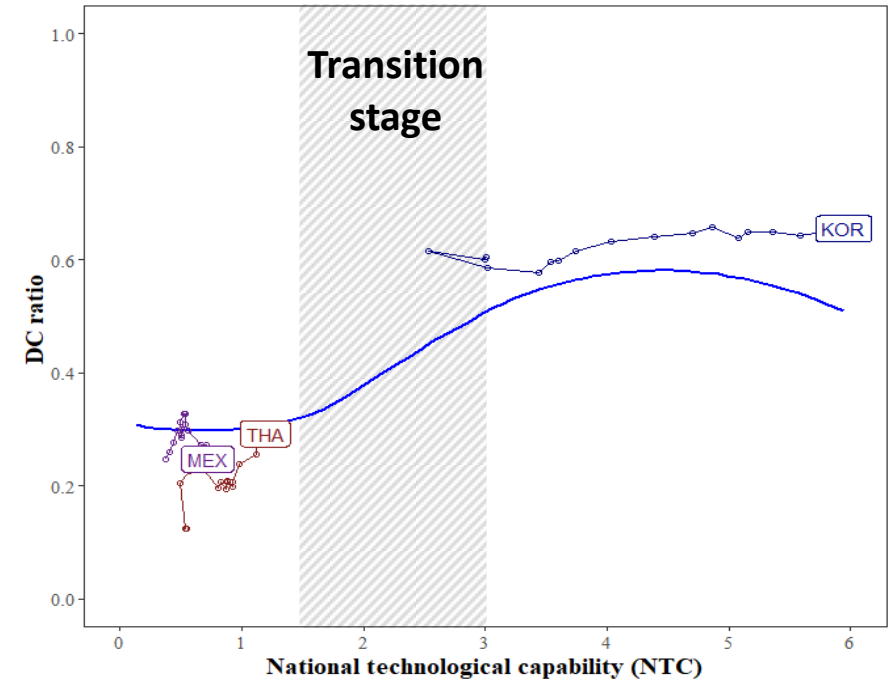


**Figure 4.** The distribution of countries by 1963 per capita income and 2008 per capita income



## Middle innovation trap: Demonstration

- **Step 2.** Check the % of concept design capability to national technology capability (DC ratio)
  - To distinguish countries in Group A (KOR) and Group B (THA, MEX), concerning whether a country has undergone the capability transition stage or not



**Figure 5.** The ratio of concept design capability to national technological capability

## Middle innovation trap: Demonstration

- **Step 3.** Compare the capability development trajectories for three countries, i.e. KOR, THA, and MEX

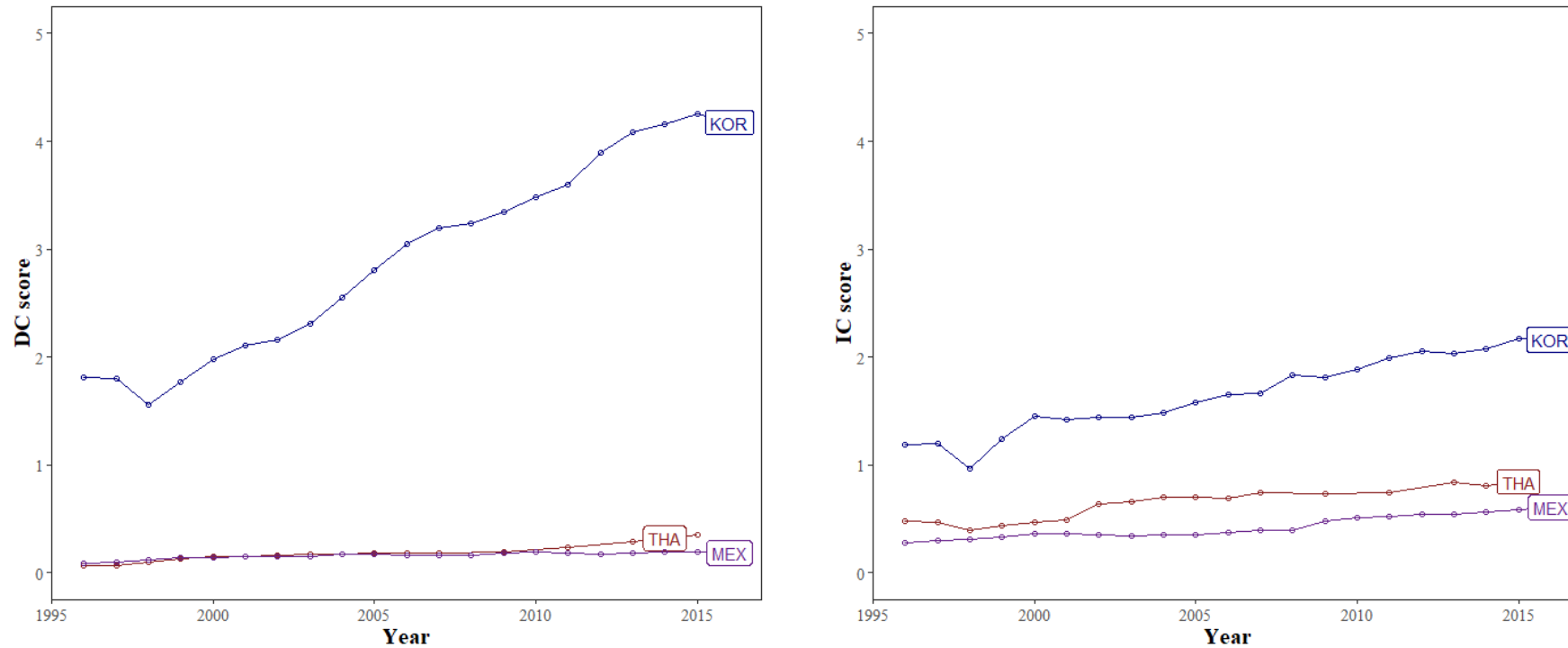
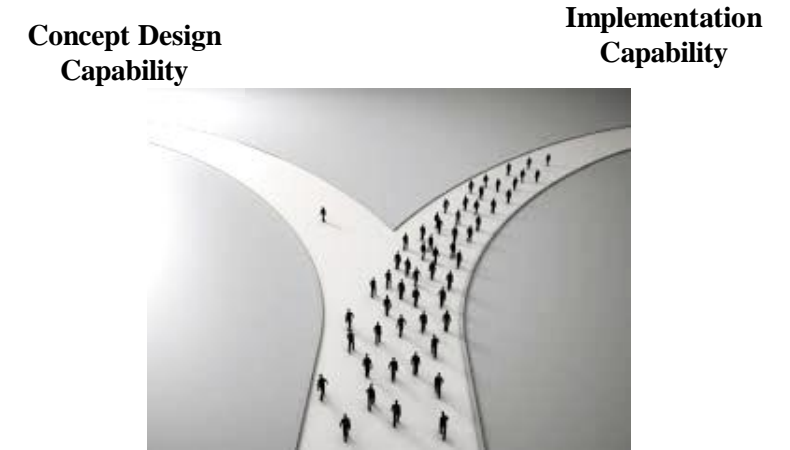


Figure 6. Development pattern of concept design capability (left) and implementation capability (right)

# The reasons for transition failure

- Two main reasons for the difficulties in capability transition
  - **First**, institutional rigidity, from the innovation system perspective
  - **Second**, path dependency, in terms of the inertia investing more on implementation



**Table 1.** Key characteristics of implementation and design capabilities

Feature	Implementation capability	Design capability	References
Mode of expression (Knowledge contents)	Explicit (Know-how)	Tacit (Know-why)	Polanyi (1958), Bell and Pavitt (1993), Nonaka and Takeuchi (1995)
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Strategy to nurture	Learning-by-doing with the accumulation of repetitive execution	Learning-by-building with the accumulation of creative trial and error	March (1991), Katila and Ahuja (2002), Zollo and Winter (2002)
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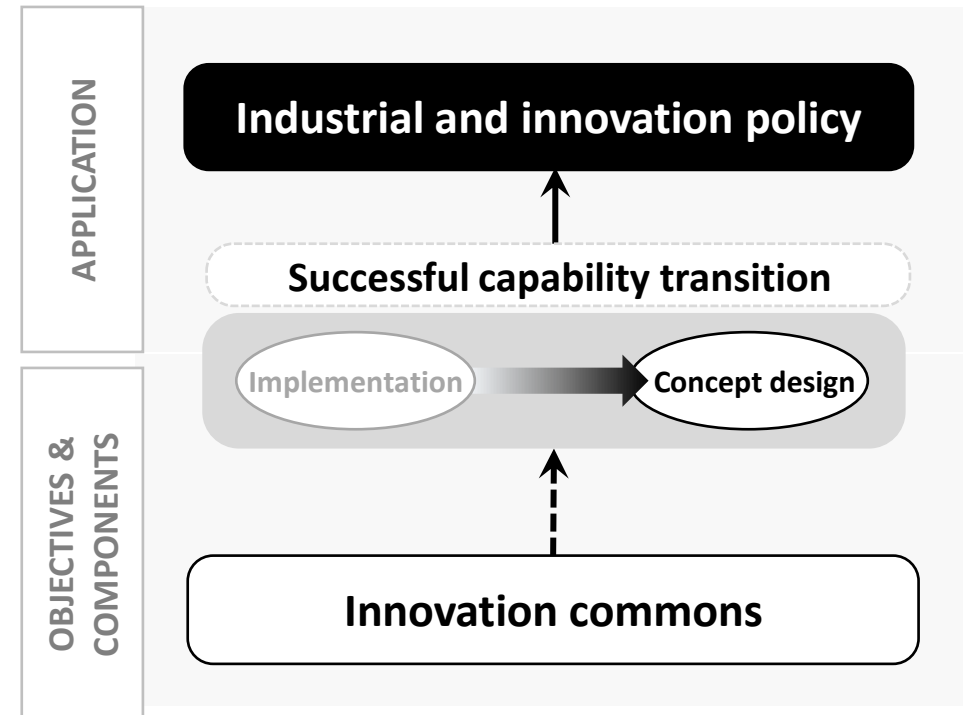
1 2 3 4 5

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**Innovation commons to facilitate the transition  
from implementation to concept design capability**

## Policies and platform to facilitate successful transition

- The concept “innovation commons” to nurture the key components of the coherent innovation systems, according to the evolutionary process of concept design capability
  - Basic objectives
    - : Challenging vision-setting
    - : Networking
    - : Accumulating trial and error



# Innovation Policy Agenda for Design Capability

- Regulatory Sandbox to support innovative trail-and-errors (Jan. 10, 2019)



## Innovation Policy Agenda for Design Capability

- Finance sector reform toward innovation friendly and patient capital system to support trial and error of industry (May 7, 2019)



## Innovation Policy Agenda for Design Capability

- Public Procurement for Innovation (PPI) to support the proof of the initial design concepts (July 2, 2019)







## Innovation Policy Agenda for Design Capability

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- Venture capital reform focusing on scale up (March 6, 2019)
- R&D system for private companies from supply driven to demand based (expected on Sep. 2019)

## Innovation Commons to make smooth transition

- Manufacturing Renaissance as the physical platform to test prototype designs (June 19, 2019)
- Education reform toward life-long learning



**Remarks by President Moon Jae-in at  
Manufacturing Renaissance Vision  
Declaration Ceremony**

June 19, 2019

Share  



## Socio-cultural institutions

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- An accumulation-oriented culture and leadership to recognize and trust trial and error in the long run
- Promoting new attempts based on the principle of negative regulation
- Timely analyzing the causes of regulation failure and resolving the problem  
e.g. the immunity of regulatory practitioners
- Evaluating and monitoring policy program to value long-term performance rather than short-term quantitative goals



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