Digitalization and Greening as Windows of Opportunity for Leapfrogging, Re-/near-shoring and New Growth: A Schumpeterian Perspective

Keun Lee (www.keunlee.com)
Distinguished Professor, Economics, Seoul Nat’l University;
Editor, Research Policy;
Vice-Chairman, NEAC (Nat’l Economic Advisory Council) for the President of Korea
the 4\textsuperscript{th} Industrial Revolution (4IR) and Digitalization

- The 4\textsuperscript{th} Industrial Revolution (4IR) by \textbf{Klaus Schwab} (at WEF, 2016)
  - The new waves of innovations using new technologies, such as 3D printing, Internet of things (IoT), artificial intelligence (AI), big data, cloud computing et al.
  - \textit{combination of digital technologies} with diverse technologies
  - \textbf{Combination} (convergence) of \textbf{multiple} technologies in a novel way and a shift from simple digitization that characterized the 3IR (EPO 2017; Kagermann et al. 2013; Schwab 2016)

1\textsuperscript{st} Wave of Digitalization = application of digital tech in ICT sector
2\textsuperscript{nd} Wave of Digitalization (4IR; Ind. 4.0) = digitalization of all sectors by new combination of digital tech with diverse domain technologies

=> Leading to both process and production innovation
More Possibility of Leapfrogging with 2\textsuperscript{nd} Wave of digitalization
Mass production (1.0/2.0) \rightarrow Automation (3.0) \rightarrow Smart Factory (4.0)

제조업 4.0등장/추진 이유/배경 = 독일 고임금. 인구감소노동력부족, 경쟁력 상실 \rightarrow 현 한국과 비슷
Schumpeterian Concepts (Perez and Soete 1988): Leapfrogging and the ‘windows of opportunity’

Emerging technological paradigms = a window of opportunity for the latecomer, To bypassing existing technologies and to leapfrog to new technologies To start from the same points as the incumbents

Def) Leapfrogging = latecomers doing something new, often ahead of the forerunners (and thereby leap over the incumbent)

Why Opportunity?

1) low entry barriers in terms of IPRs; (knowledge in public domain; no established market leaders).

2) Incumbent trap: locked into the current existing technologies; eg) Motorola: analogue-based cell phones cf) digital phone Nokia. eg) 3IR (digital technology) = window of opp. For Korea to catch up with Japan
Challenge aspect of 4IR for Emerging Economies

1) With automation, low-cost labour is less effective strategy to attract manufacturing investment

2) A trend towards re-shoring of manufacturing back to the rich world (eg Apple in the US and Adidas making shoes in Germany)

3) GVC or global supply chains to become flatter: (leave less room for some intermediate producers)

Now, for Emerging economies; 4\textsuperscript{th} industrial revolution

= might not be a window of opportunity
but a window of further falling behind (destruction)
to be stuck in the middle-income trap (digital divide).
Latecomers can still catch up with their forerunners by taking detours (e.g., capability building) and then flying on a balloon (leapfrogging), out of windows of opportunity, even when the ladder to rich economy is kicked way,
Leapfrogging, Why and for What?

Why need it?
- as you get closer to frontier, difficult to expect tech. transfer from the incumbent
- detours are not enough to bring in radical changes in industrial leadership

• 2 benefits from Leapfrogging

1) A way to overcome IPR barriers,
   - no need to rely on IPR held by the incumbents
   - IPR tend to reside in public domains (academia) during the transition period;
     or no dominant IPR holders

2) A way to avoid direct competition with incumbent
   by entering new markets ahead of incumbents
## Variations of Technological Leapfrogging

<table>
<thead>
<tr>
<th>1) Compared with the Path of the Incumbent (Lee and Lim 2001)</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) Stage-skipping in a given trajectory</td>
</tr>
<tr>
<td>b) Path-creating into a new trajectory</td>
</tr>
<tr>
<td>cf) Path-following Catch-up</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>2) Two variations of Path-creating Leapfrogging (Lee and Ki 2017)</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) Follow-on Innovation-based Leapfrogging</td>
</tr>
<tr>
<td>b) Radical innovation-based Leapfrogging</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>3) Inter- vs. Intra-sectoral leapfrogging (Lee 2019)</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) Intra-sector (across generations of tech; less risky)</td>
</tr>
<tr>
<td>b) Inter-sector (cf. Long jump across prod space; more risky)</td>
</tr>
</tbody>
</table>

Leapfrogging in GVC: OEM to OBM (cf) via ODM
Risk and Potentials of Leapfrogging across generations

1) Path-following = entry with oldest generation tech (1G)
2) Stage-skipping = entry by up-to-date generation 2 Tech
3) Path-creating /leapfrogging = entry by generation 3 technology;
   eg) Samsung skipped generation 1 and 2 but jumped generation 3 using Public-private joint R&D to share risks
Pre-conditions and Risks for Leapfrogging:

1) **Leapfrogging vs. Long jump (Hidalgo 2017) in product space**;
   -- intra- and inter-sector leapfrogging
   the latter (intra-sector) leapfrogging is a jump not to different sectors/spaces
   but to different generations of technologies within the same sectors;

   • So, less difficult than long jumps to different, unrelated sectors
   But need to have built up, sector-specific capabilities
   In other words, You got to have strong “Wings” to fly
   ; otherwise, you might fall through the ‘windows’, rather than fly.

   cf) Product space literature: less concern for entry barrier and competition upon entry:
   not all the neighboring spaces are feasible to enter; => entry possibility: short cycle matter;
   - Leapfrogging = another way of avoiding competition with incumbent

2) **Need to take care of the 2 Risks (Lee et al 2005).**
   A) risk of choice among alternative technologies;
   B) existence of initial markets
   => government activism is called for, unless you have patient capital (Mazukato)
When to try leapfrogging; not everyday but on a good weather

- As we cannot fly balloons everyday
  but have to wait for a good weather (window of opportunity);
- leapfrogging; a higher chance for success when there emerged disruptive innovations;
- otherwise, the incumbents would prevail under the existing paradigm
  eg) change from Analogue to digital technology:
    window for Korea to leap over Japan: eg HD TV (Japan) to digital TV (Korea)
Q: Why higher chance for success?
  1) everybody is beginner, starting at the same start line
  2) some incumbent fall into the trap /lock-in with current technologies, rather than bother to
     switch to new ones (given their superiority/productivity with current technologies)

   -- not only tech. window but demand and gov’t windows
Different Leapfrogging for Different Types of Firms: Startup vs. Incumbents (Leader, follower, laggards)

a) startups typically try path-creating leapfrogging (or follow-on innovation, or business model innovation)

b) follower with some experiences and absorptive capacity; likely to meet preconditions; thus can try stage-skipping but with risks in mind (so need P-P joint R&D; gov’t support)

c) laggard should first build capability (taking detours) and try to upgrade by moving into higher ends segment of GVC --taking 3 detours: imitation (loose IPR), building local values chains (not GVC); and getting into short cycle tech. (not long cycle)

=> latecomers’ advantage 2.0 = Trying new Bus. Model innovation adopting 4IR tech without paying for R&D cf) latecomer advantage 1.0 = Installing mature fixed capital at lower costs without paying for R&D
Two aspects of incumbent trap/WoO and Policy framework

a) Traditional aspects: advanced economies vs. Emerging Economies  
   (the former into incumbent trap/lock-in with old tech)

b) New aspect:
   WoO for Startups/new entrants vs. incumbent firms in EEs  
   (the latter into incumbent trap or lock-in/ complacent)

* Policy framework: Vertical (target sector/firms) vs horizontal intervention  
  new digital infrastructure = (public) clouds, big data;  
  online, hi-tech & hi-touch education system for upskilling of labor force;  
  mobile banking and crowd funding;  
  cf) 3IR era = high speed internet
eFish = A Start-up in Indonesia: Using IoT for fish farming (feeding)

- Founded in 2013, eFishery is one of the first “fishtech” start-ups in Indonesia.
- It provides an IoT solution for fish and shrimp farming businesses.
  - feeding costs account for around 80 per cent of total expenses;
  - feeding is inefficiently carried out by unskilled labour

- eFish created a device that enables automated feeding of stock in fish farms, which results in reducing feeding costs, better feed performance, fish growth, water quality
  - reduce the amount of feed used by farmers by around 21 per cent.

- Ranked first in start-up competitions. Raised 5.2 million$ in total funding.
  - to become a platform: connects the entire ecosystem of fish farming

- Impact on Indonesia’s aquaculture industry;
  -- help enhance the lives of more than 3.3 million Indonesian fish farmers;
  - 3.3 million fishponds and 2.7 million fish farms: big industry;
Diverse Cases of Leapfrogging with digitalization
New Waves of Paradigm Shift = Best Time for Leapfrogging

1) New Energy Revolution (Renewable Energies) to replace fossil-fuel
2) 4\textsuperscript{th} Industrial Revolution = Digitalization and Fusion of Technologies (IT, BT, NT,)

-> already happening;
  "former latecomers are no more latecomers"

eg) 1) Solar thermal heating in China
- Rural area bypassed the stage of gas or electricity based heating but solar thermal heating.

2) Bio-Ethanol and Bio-Diesel in Brazil (EMBRAPA: soils suitable for sugar cane cultivation

3) Keyna: M-Pesa (mobile banking); M-copa (Solar energy for rural)
Kenya’s M-Kopa Brings power to Rural Africa
Kenya’s M-Kopa Brings power to Rural Africa

- Solar energy products that are both **accessible** and **affordable** to off-grid African homes
- **Pay-as-you-go** model (spinoff from the famous M-PESA);
- Leapfrog over kerosene-based to solar lightening

- **M-Kopa IV Solar System** = a new combinations of:
  - 8-Watt Solar Panel
  - Control Unit
  - 2 LED bulbs
  - Rechargeable Radio & Flashlight

- To **purchase** the system:
  - Deposit of 3,500 KES (~$35 USD)
  - Daily payment of 50 KES (~$0.43 USD) for a year
  - Total: 21,750 KES (~$192 USD) to own system
Stage-skipping and Leapfrogging in the Environmental Kuznets Curve

Source: adapted from Assefa (2011)
Digitalization also shape GVC in post-Pandemic era and thus affect Reshoring and nearshoring
Three factors determining GVC in Asia: Digitalization, US-China Conflict, and Covid-19
=> De-globalization ->reshoring/nearshoring

- US-China trade conflicts (tariffs against China):
  = push factor for trade/FDI diversion
  (out of China to Southeast Asia: nearshoring, or onshoring; also rising wages and competition in China)

- Digitalization (automation, smart factory)
  = enabling factor for reshoring back home
Changing Locations of Korean FDI in Asia: from China to Vietnam and others; + some reshoring

No of FDI cases, 1980-2019

Share in Employment

출처: 수출입은행 해외직접투자 통계 자료 이용 박지형/안재빈 계산; https://stats.koreaexim.go.kr/main.do
Exit from China: rise of local firms’ competitiveness; rising wages
=> Many case of nearshoring and reshoring

1) 19 cases of nearshoring to SEA (south east Asia):
   mostly due to the US-China Conflicts

   eg) Sharp (Japan) : LCD screen subject to the US tariffs;
       moving factory from China to Vietnam

2) 8 cases of reshoring back to home:
   owing to incentives for reshoring; smart factory; near to markets
   Eg) Intel: owing to reshoring incentives (corporate taxes)

3) Remaining case of Chinese firms investing in Korea
   or other firm investing in Mexico or E Europe:
   due to rising wages in China
Cases of Disruption by Covid 19: auto sector in Korea

- Eg) Hyundai Motors:
  - Wiring harness = an assembly of electric cables that transmits all the necessary information for cars to function.
  - Most of the car manufacturers in Korea used to have their wiring harnesses produced in factories that are located in China;
  - as the Covid-19 struck China, wiring harness factories in China had to shut down.
  - Consequently, car factories couldn’t operate since wiring harnesses are necessary for earlier processes of car production;

⇒ Now being reshored back to Korea,
  by policy initiatives combined with digitalization
  (a package combining reshoring incentives + digitalization)
Korean firms cases of reshoring now increasing

- Earlier Survey results: Reasons of being reluctant to reshoring

![Bar chart showing reasons for reluctance to reshoring]

But, since 2019; the no of reshoring kept increasing

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>-</td>
<td>-</td>
<td>20</td>
<td>3</td>
<td>12</td>
<td>4</td>
<td>9</td>
<td>16</td>
<td>16</td>
<td>80</td>
</tr>
</tbody>
</table>
Reshoring after the Covid-19: two types in Korea; getting possible with digitalization

<table>
<thead>
<tr>
<th></th>
<th>Definition</th>
<th>Cases</th>
<th>Needed Intervention</th>
</tr>
</thead>
</table>
| 1 | Reshoring by flattening of GVC; domesticizing a segment in GVC by process innovation; From foreign processing & domestic assembly to domestic processing & assembly. | Aju Steel  
Solgent  
(virus testing kit)  
OTOS (PAPR)  
Mask factories | Financial Assistance plus Technical Assistance (help from gov’t agency and other firms/experts) |
| 2 | Reshoring accompanied by: large scale automation of manufacturing process or smart factorization. | G&G Enterprise  
(apparel)  
Treksta (Shoes)  
Hyundai Mobis | Financial Assistance + technical help |

Many SMEs capability too low to do this themselves  
- Room for Improvement but they don’t know how to do it => need for help
Nearshoring as an alternative of reshoring

- Nearshoring?
  - The practice of transferring a business operation to a nearby country, especially in preference to a more distant one
  - Practice of locating a business to places with better business conditions even if they are not the nearest countries
  - Some Korean firms adopted nearshoring rather than reshoring by moving their factories and facilities from China to Southeast Asian countries (e.g., Vietnam, Indonesia, Philippine and Cambodia) and India

* Samsung: moved all final assembly out of China to SEA but kept only three intermediate parts (memory chips, electric batteries, and MLCC);
  - Eg) M/S of cell phone in China: 20% in 2010s to 0.5% in 2020
Korean cases of nearshoring: Samsung

- Samsung is producing almost 60% of the smartphone in Vietnam

### Exit from China
- Aug. 2020: Shut down PC factory in *Suzhou*
- Oct. 2019: Shut down smartphone factory in *Huizhou*
- Dec. 2018: Shut down smartphone factory in *Tianjin*
- April 2018: Shut down smartphone factory in *Shenzhen*
- 2002: Initial entry into China

### Move to Vietnam
- 2011: Establish factory in *Yen Phong, Bac Ninh* (producing smartphone & display module for mobile devices)
- 2013: Establish factory in *Yen Binh, Thai Nguyen* (producing smartphone & camera module)
- 2020: Establish factory in *Ho Chi Minh* (producing consumer electronics)
- 2022: Complete construction of R&D center in *Ha Noi*

*Source: Lee, Hyuntai and Jung, Dosook (2020); Financial News (news article on 6 April 2016)*
% Shares in total Green field FDI to Emerging Economies:
ASEAN > China, India
Implications for Southeast Asia (SEA): New Opportunity for onshoring/nearshoring

• China exodus
  = new opportunity for SEA to overcome the challenges posed by 4IR to keep onshoring (existing FDI) or attract new nearshoring out of China

cf) The Earlier Challenges from the 4iR
1) With automation, low-cost labour is less effective strategy to attract manufacturing investment
2) A trend towards re-shoring of manufacturing back to the rich world (eg Apple in the US and Adidas making shoes in Germany)

• But grabbing this new opportunity requires upgrade human capital; reskilling/up skilling
But, ASEANs are heterogenous: -> Diverse Risk and Opportunities;

ey) Malaysia, Thailand = labor shortage;
Indonesia, Vietnam = large young populations.

Source: (Lee et al 2019)
Three factor model (Lee et al. 2019): Minimum wage, college education, and Market (GDP) size (in circles)
Two Groups:
Onshoring group vs. Nearshoring Group

1) Onshoring for Group 1 (Thailand, Malaysia):

   : High Wage, High Skilled/Internet, big GDP

=> Keep existing FDI by upskilling + digital transformation (4IR)

• Opportunity (and pressure) to upgrade embracing 4IR/digitalization utilizing both domestic and regional (ASEAN) markets

2) New Nearshoring for Group 2 (Vietnam, Indonesia, Philippines):

-- Med. Wage, med skilled, med/big GDP

   but, should upgrade human capital
   and build up domestic value chains to hold factories;
   or to develop more niches in diverse sectors
Concluding Remarks:

• 3 factors shaping GVC since the Pandemic:
  - US-China conflicts
  - Digitalization (factory)
  - Covid-19 and moves for resilient GVC

• Consequences: Re-shoring and nearshoring/onshoring

• It depends on the responses and readiness:
  eg) upskilling and re-skilling human capital
  Introduction of digital factory system
  Financial incentives/market (VC)
  and diverse Public-private partnership
Thank you!

Visit www.KeunLee.com for more!