

**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 4th Industrial Revolution (4IR) and Digitalization

- The **4th Industrial Revolution** (4IR) by **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.
 - = combination of digital technologies with diverse technologies
 - **Combination** (convergence) of **multiple** technologies in a novel way and a shift from simple digitization that characterized the 3IR (EPO 2017; Kagermann et al. 2013; Schwab 2016)

1st Wave of Digitalization = application of digital tech in ICT sector

2nd 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 2nd Wave of digitalization Mass production (1.0/2.0) -> Automation (3.0) -> Smart Factory (4.0)



EWA development Industrie 1.0 to 4.0



1966

Industrie 1.0/2.0

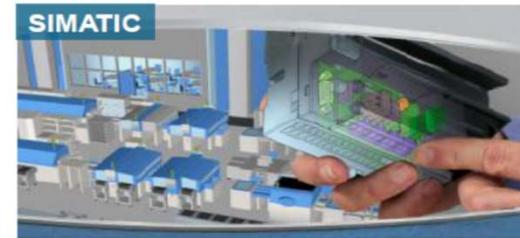
- Mechanical production lines
- Mass production
- Manual drawings



1995

Industrie 3.0

- Automated production
- Lean production
- Intranet and Internet



2015

On the way to Industrie 4.0

- Digital Product Lifecycle
- Horizontal and vertical integration
- Identification and history for all elements

제조업 4.0 등장/추진 이유/배경 = 독일 고임금. 인구감소노동력부족, 경쟁력 상실 -> 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; 4th 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

to Fly on a Balloon (=Leapfrogging)

when the Ladder is Kicked Away”

(Lee, 2019, Art of Economic Catch-up, CUP)

-> 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

1) Compared with the Path of the Incumbent (Lee and Lim 2001)

- a) Stage-skipping in a given trajectory
- b) Path-creating into a new trajectory
- cf) Path-following Catch-up

2) Two variations of Path-creating Leapfrogging (Lee and Ki 2017)

- a) Follow-on Innovation-based Leapfrogging
- b) Radical innovation-based Leapfrogging

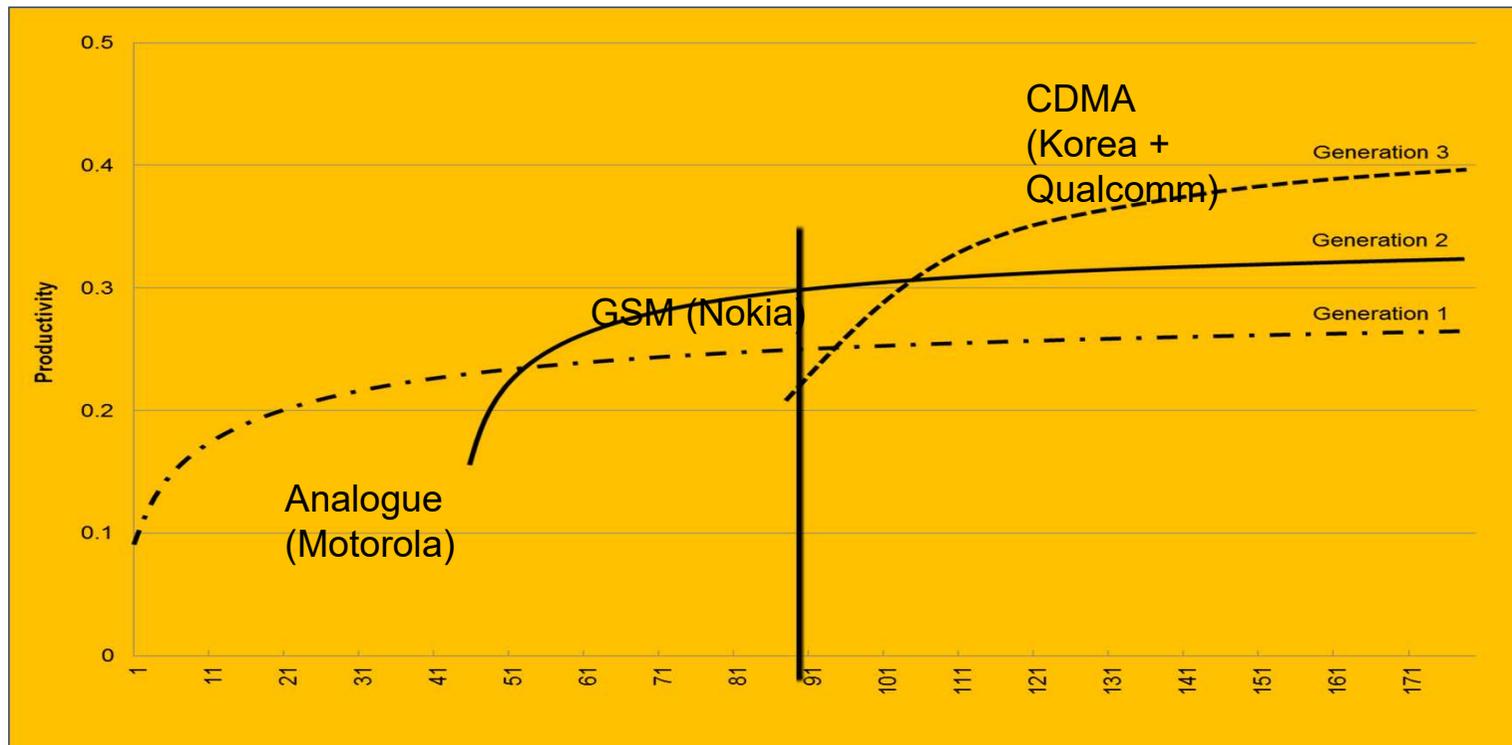
3) Inter- vs. Intra-sectoral leapfrogging (Lee 2019)

- a) Intra-sector (across generations of tech; less risky)
- b) Inter-sector (cf. Long jump across prod space; more risky)

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)

=> **Lee & Malerba, *Research Policy* 2017: Catch-up Cycles & Changes in the Industry Leadership:**
roles of the diverse Windows of opportunity;

- 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) 4th 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) Kenya: M-Pesa (mobile banking); M-copa (Solar energy for rural)

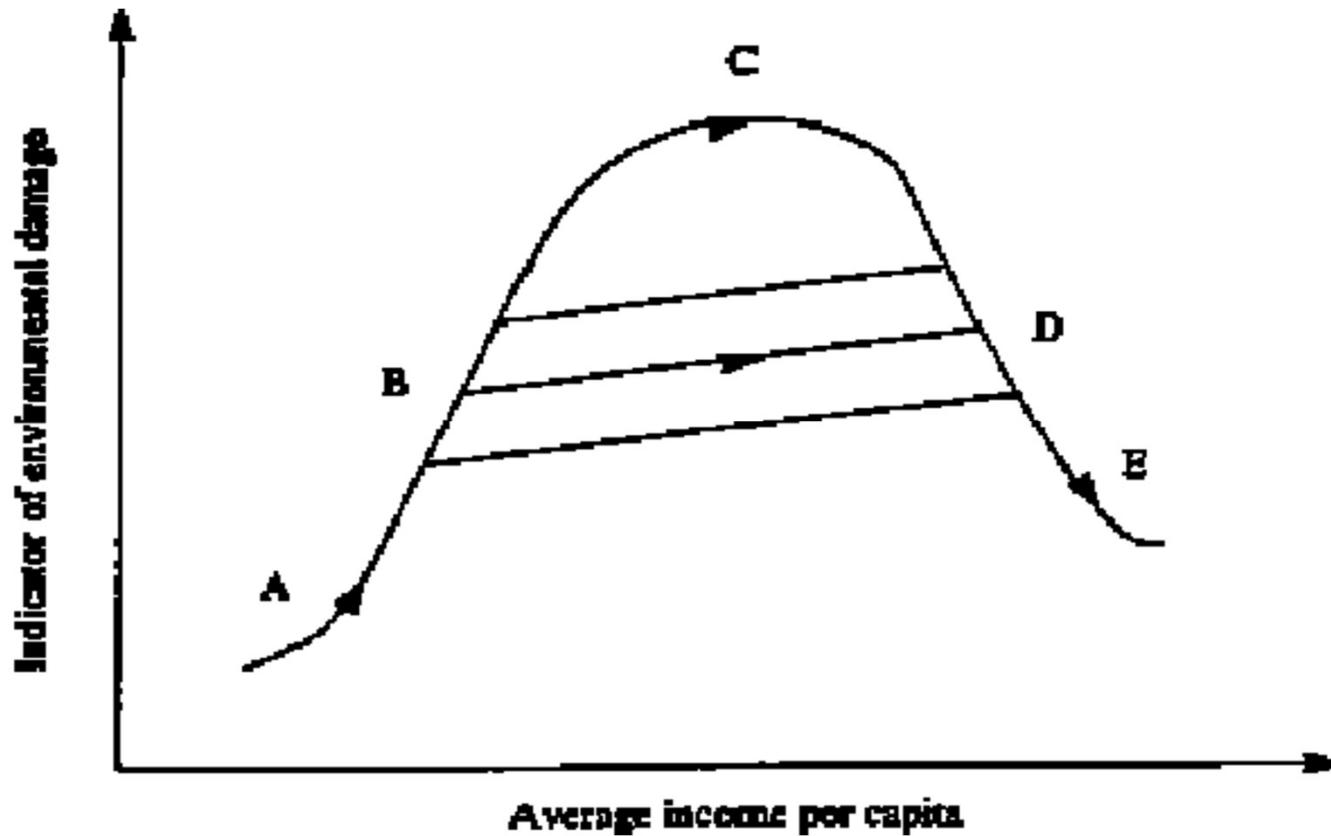
Kenya's M-Kopa Brings power to Rural Africa



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



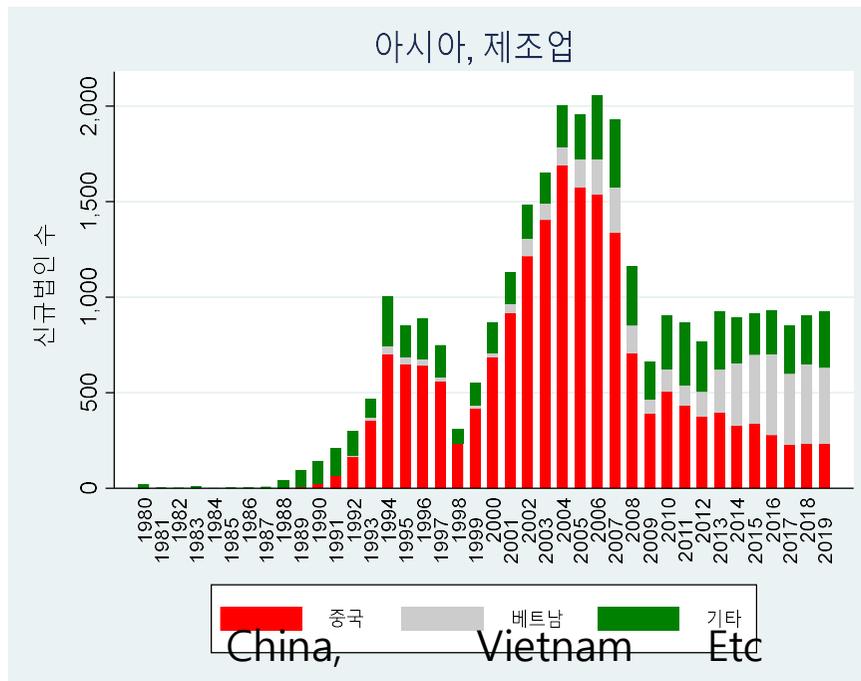
Source: adapted from Assefa (2011)

Digitalization also shape GVC
in post-Pandemic era

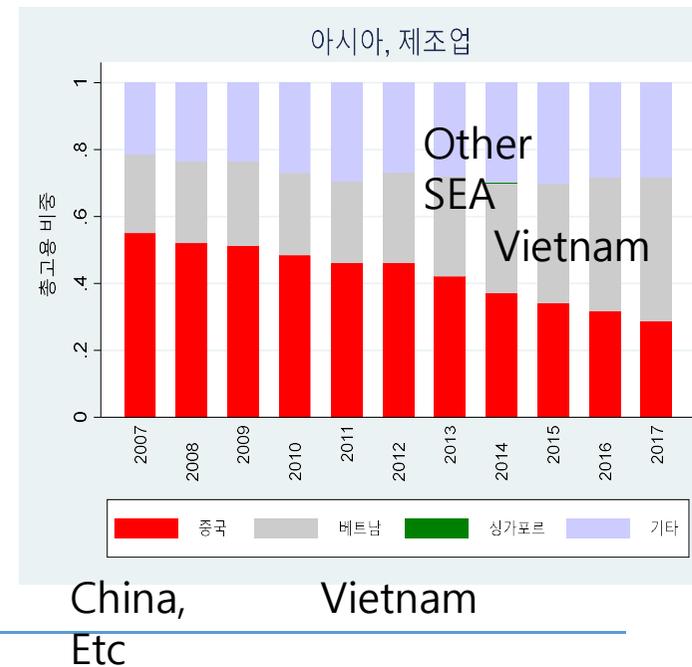
and thus affect Reshoring and nearshoring

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)

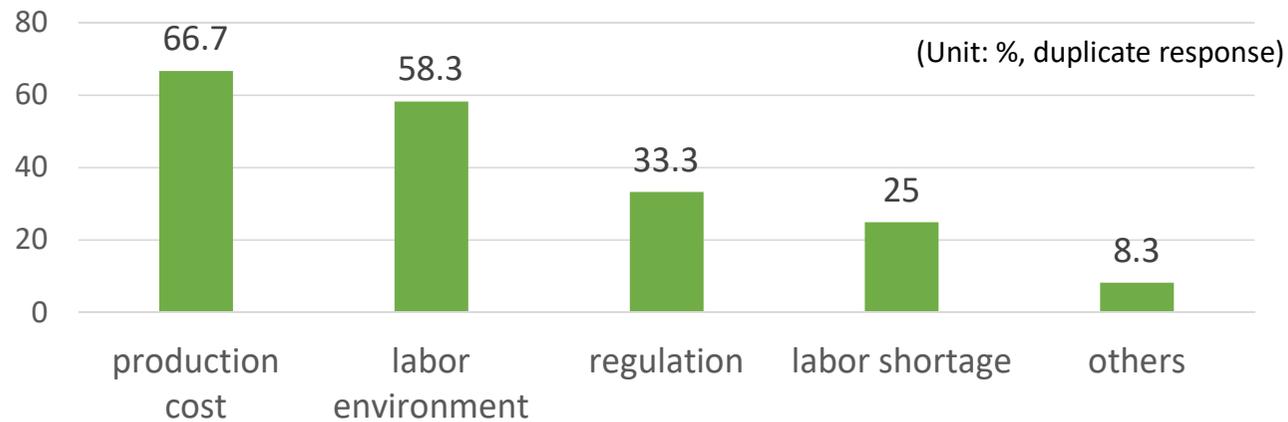
3) Remaining case of Chinese firms investing in Korea
or other firm investing in Mexico or E Europe:
due to rising wages in China

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



But, since 2019; the no of reshoring kept increasing

2012	2013	2014	2015	2016	2017	2018	2019	2020	Total
-	-	20	3	12	4	9	16	16	80

Reshoring after the Covid-19: two types in Korea; getting possible with digitalization

	Definition	Cases	Needed Intervention
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

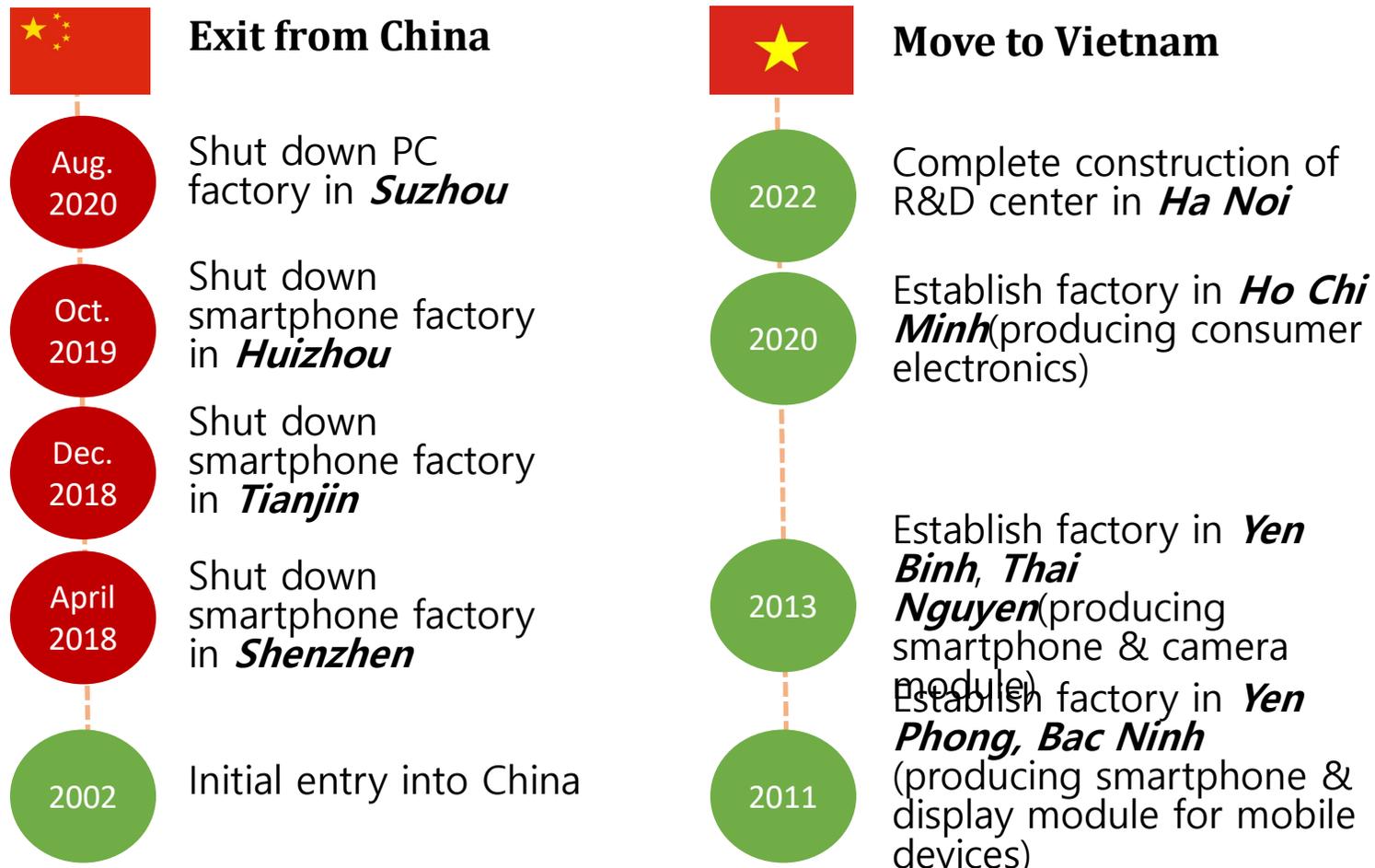
Nearshoring as an alternative of reshoring

■ 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

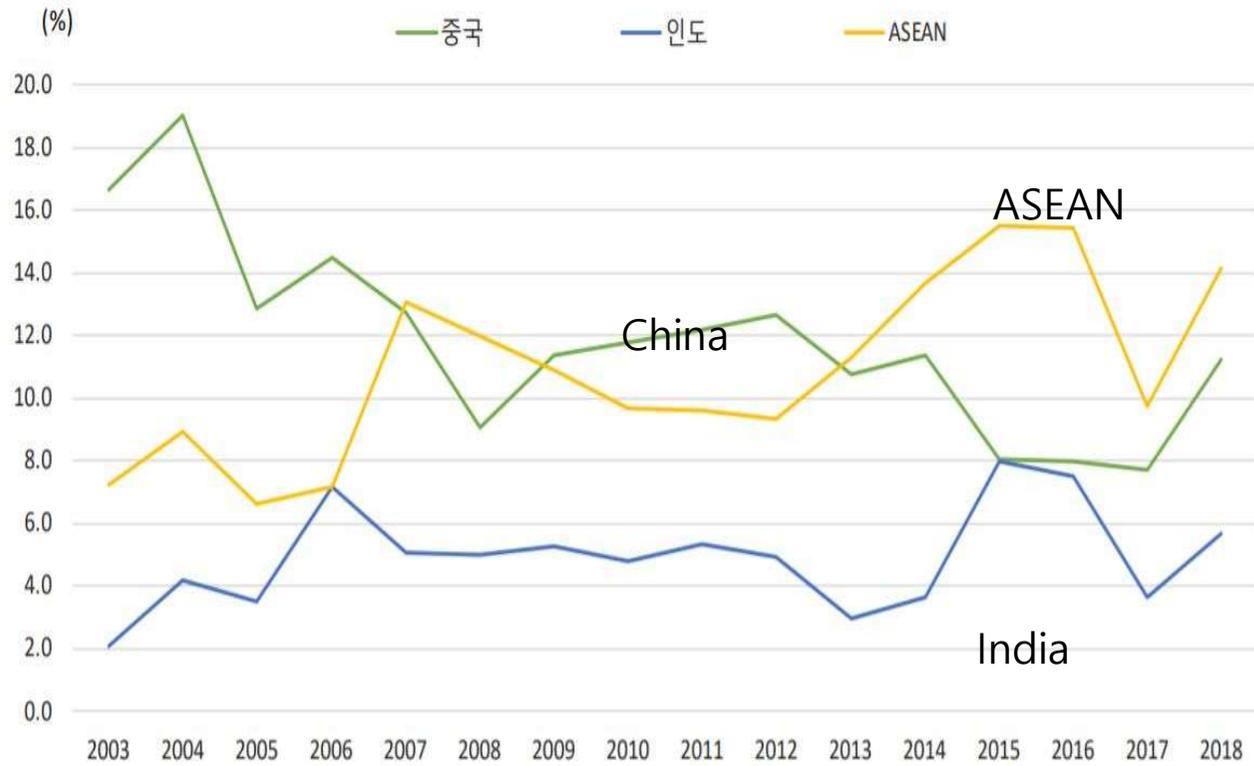
Korean cases of nearshoring: Samsung

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



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

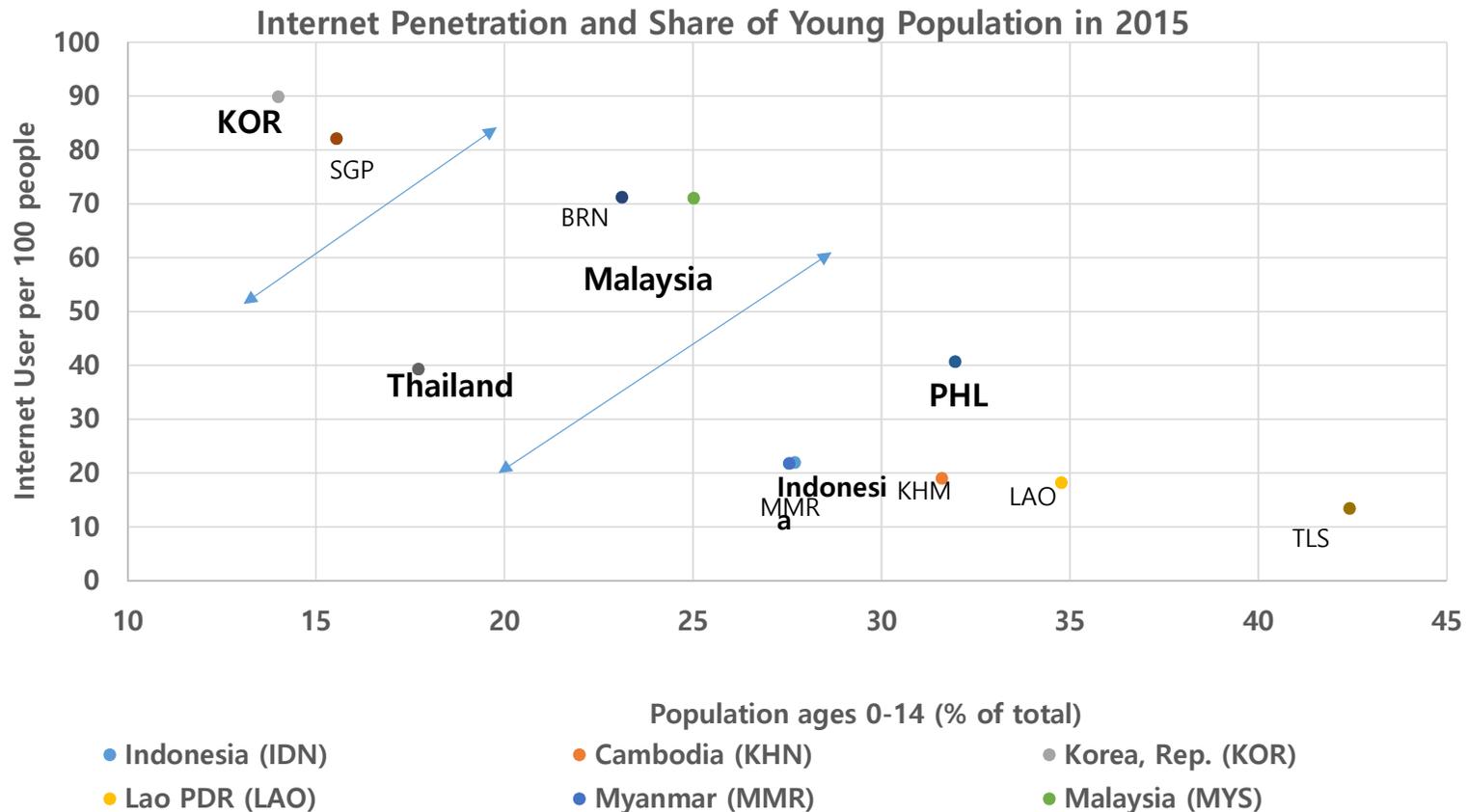


Implications for Southeast Asia (SEA): New Opportunity for onshoring/nearshoring

- 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

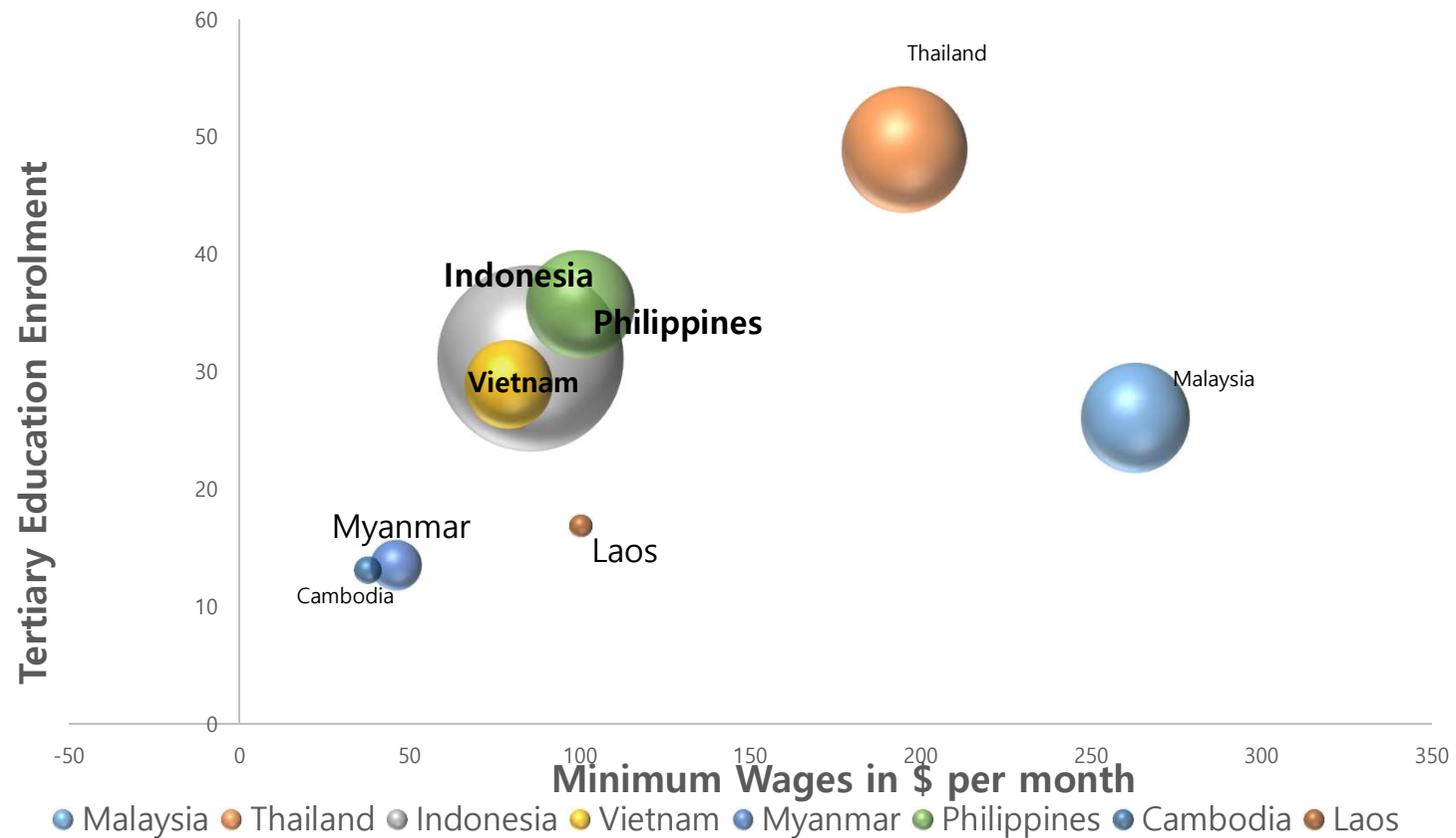
But, ASEANs are heterogenous:-> Diverse Risk and Opportunities;

eg) 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!

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