Trade and Innovation in Global Networks - Industrial Policy Lessons from Asia

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Storyline

1. What does the literature tell us about gains from trade for innovation?
2. Capturing innovation gains – Diverse experiences in Asian countries
3. Policy implications and unresolved issues

1. What does the literature tell us about gains from trade for innovation? Established wisdom

Trade enhances innovation and hence growth of GDP and employment through …

1. **imports, FDI and licensing**
   - absorption of foreign technology & intangible knowledge as a source of product & process innovation
2. **Learning-by- exporting**
3. **Competition**
   - may reduce monopoly rents from innovation
   - pressure to increase productivity

Established Wisdom - Policy Prescriptions

For a country's innovation capacity to benefit from trade, the following policies must be in place:

- **Trade liberalization** → tariff reduction lowers import prices; improves market access for exporters; enhances competition
- Effective **intellectual property legislation & enforcement** is necessary to enable knowledge diffusion & external knowledge sourcing

→ But is that really enough?!! → What lessons can be drawn from Asian experiences?

New approaches

- Feenstra, Robert, 1998, “Integration of Trade and Disintegration of production (offshore outsourcing)”
- Branstetter, Lee, 2006, “Is FDI a Channel of Knowledge Spillovers?”
- Baldwin, Robert, 2013, “The new relevance of FDI: The GVC Perspective”

New approaches

Feenstra , Robert 1998 "Integration of Trade and Disintegration of Production in the Global Economy"

Gains from trade are increasingly shaped by globalization of production (offshore outsourcing)

- In addition to traditional gains from increased specialization, trade in intermediates leads to efficiency gains
- Distribution of gains: Does globalization of production make factor-price equalization more or less likely?
- ➢ *The position of low-skilled workers in the industrial countries is worsened by the complementary combination of globalization and new technology.*

Branstetter, Lee, 2006, Is FDI a Channel of Knowledge Spillovers?

- FDI is an alternate, potentially equally important channel for the mediation of knowledge spillovers.
- Using an original firm-level panel data set on Japanese firms' FDI in the U.S. and their innovative activity, B. documents that FDI increases the flow of knowledge spillovers both from and to the investing Japanese firms.

New approaches - Baldwin's "Trade-investment-services-IP nexus"

Baldwin, Robert, 2013,"The New relevance of FDI: The GVC Perspective" (p.13)

"The information and communication technology revolution has internationalized supply chains, which has created a tight supply-side linkage between trade and FDI: the "trade-investment-service-IP nexus". Today's international commerce comprises complex, two-way flows of goods, services, people, ideas and investments in physical, human and knowledge capital — in addition to trade in raw materials and final goods.... As a result, trade and investment are neither complements nor substitutes — they are simply two facets of a single economic activity: international production sharing."

Will network integration foster or impede innovation?

- Network flagships transfer both explicit and tacit knowledge to local suppliers through formal and informal mechanisms
- This is necessary to upgrade the local suppliers' technical and managerial skills so that they can meet the flagships' specifications
- Once a network supplier successfully upgrades its capabilities, this creates an incentive for flagships to transfer more sophisticated knowledge, including engineering, product and process development"
- This process is NOT automatic → To stay on the GPN, local suppliers must constantly upgrade their capabilities
- **Upgrade or perish!!**

Ernst and Linsu KIM (Research Policy, 2002)

The critical importance of Absorptive Capacity

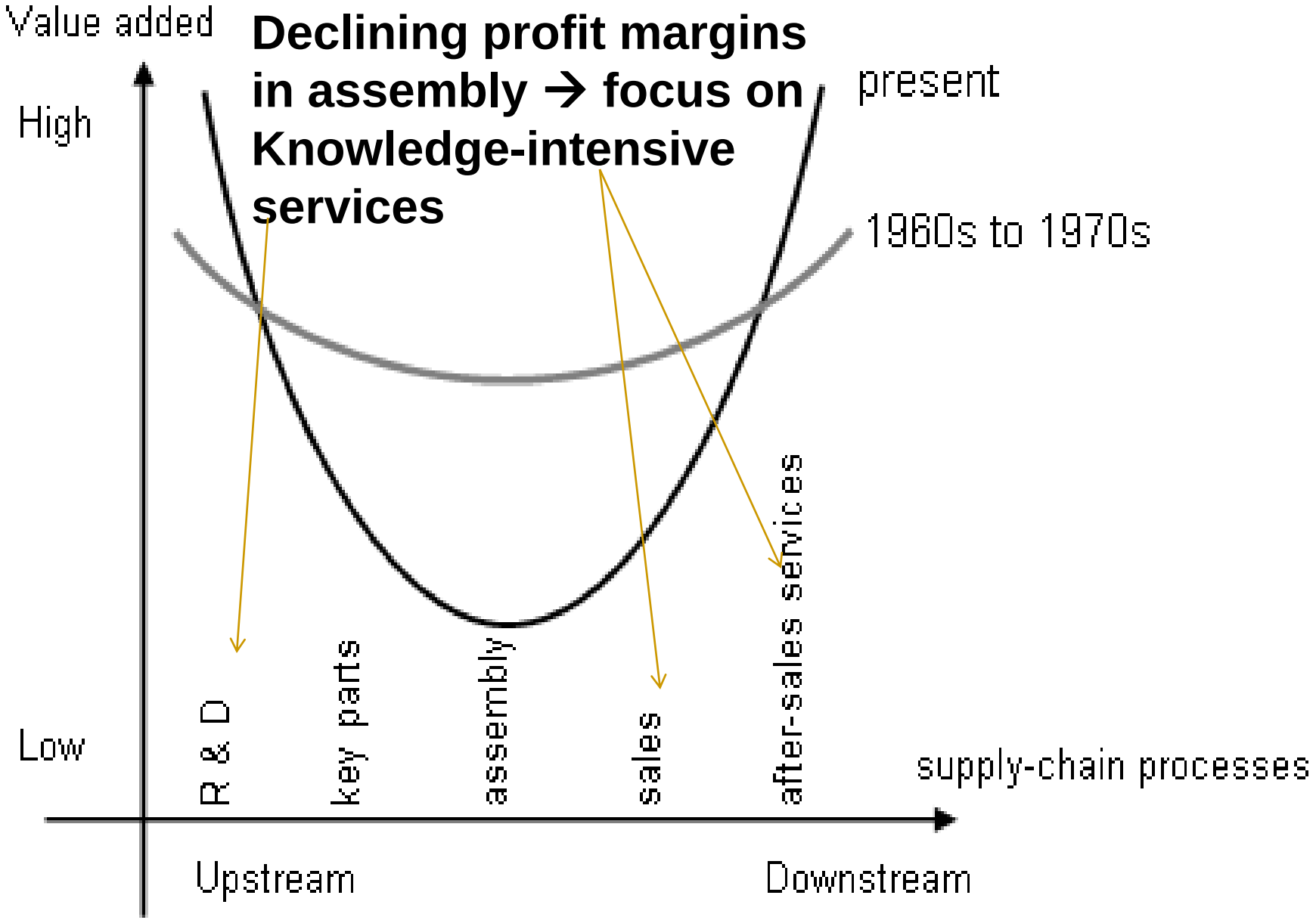
- R&D is critical to strengthen the ability of firms "to recognise the value of new external information, assimilate it, and apply it… to do something quite different"*.
- The requirements for absorptive capacity evolve over time, as a country or a firm moves up from catching-up to upgrading and leadership strategies of innovation.
- **Precisely what type of innovation strategy is needed when & where?**

* Cohen and Levinthal, 1990

Innovations differ – complexity & capability requirements

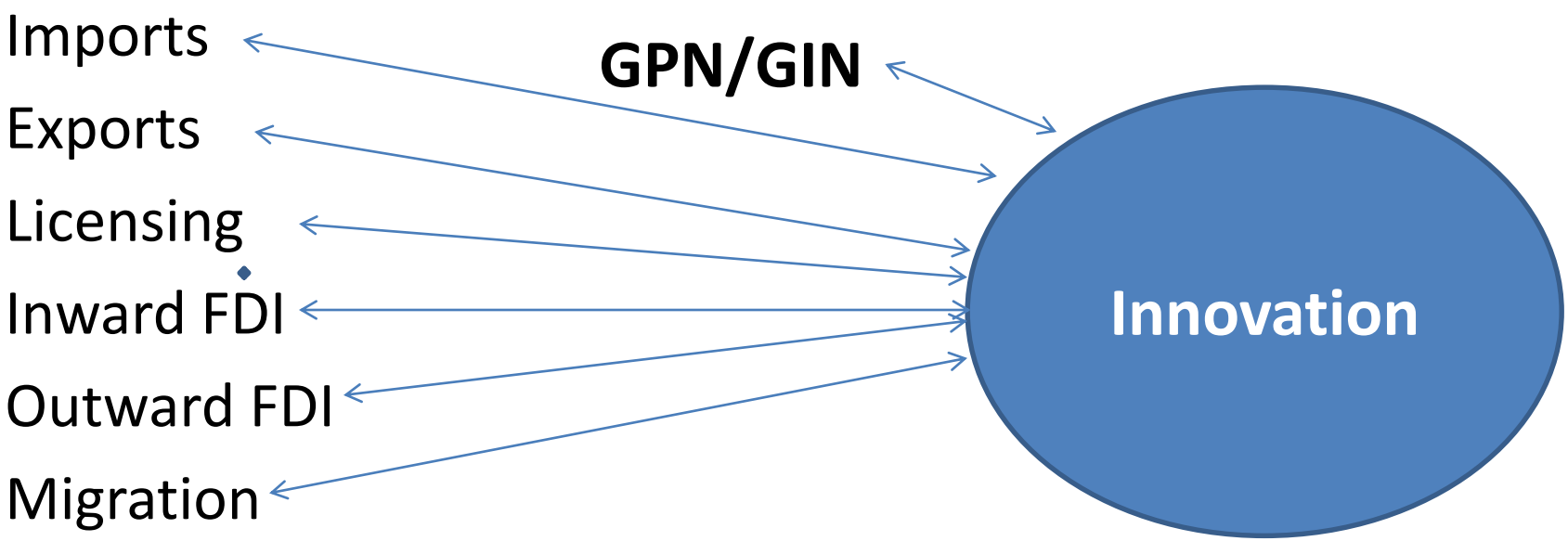
Architecture	Components: unchanged	Components: changed
changed	**Architectural** Cost-saving disruptive technologies that recombine existing components *Internet; Cloud computing; smart phones; iPad*	**Radical** Paradigm-shifting enabling technologies *Parallel programming* *Exascale HPC; biochips*
unchanged	**Incremental** •add new product features •cost-saving processes •Combine scaling-up & product diversification (“*mass customization*”) •Transition to next technology cycle	**Modular** *Graphic processors* *Li-ion battery cells* *Multicore processors* *Integrated photonic devices*

Henderson and Clark, 1990; Ernst, 2009 & 2014


Value added
Declining profit margins in assembly → focus on Knowledge-intensive services
present
High
1960s to 1970s
Low
R & D
key parts
assembly
sales
after-sales services
supply-chain processes
Upstream
Downstream

RIETI, 2004

Trade, FDI and innovation – two-way interactions



→How does trade, FDI, tech licensing, GPN/GIN integration affect technology diffusion; price effects; competition; scale economies; learning; capabilities; spillovers; forward & backward linkages?

← How does innovation capacity shape trade, FDI, tech licensing agreements, position in GPN/GIN, approach to trade agreements?

2. Capturing innovation gains – Asian experiences

- Development indicators (per capita GDI; labor costs)
- Diverse development models
- First generation NIEs – Korea, Taiwan → combine selective liberalization with some sort of industrial policy
- The “middle income trap” – Malaysia
- India is struggling in electronics manufacturing
- China – what is different?

Development indicators - per capita GDI [US-$]

Country	2010	2013
Singapore	44,790	54,040
South Korea	21,320	25,920
Taiwan	18,488	20,295
Malaysia	8,150	10,430
Mexico	**8,730**	**9,940**
China	4,240	6,560
Indonesia	2,500	3,580
India	1,290	1,570

Taiwan , IMF World Economic Outlook, October 2014

All other countries, http://data.worldbank.org/indicator/NY.GNP.PCAP.CD, Atlas method

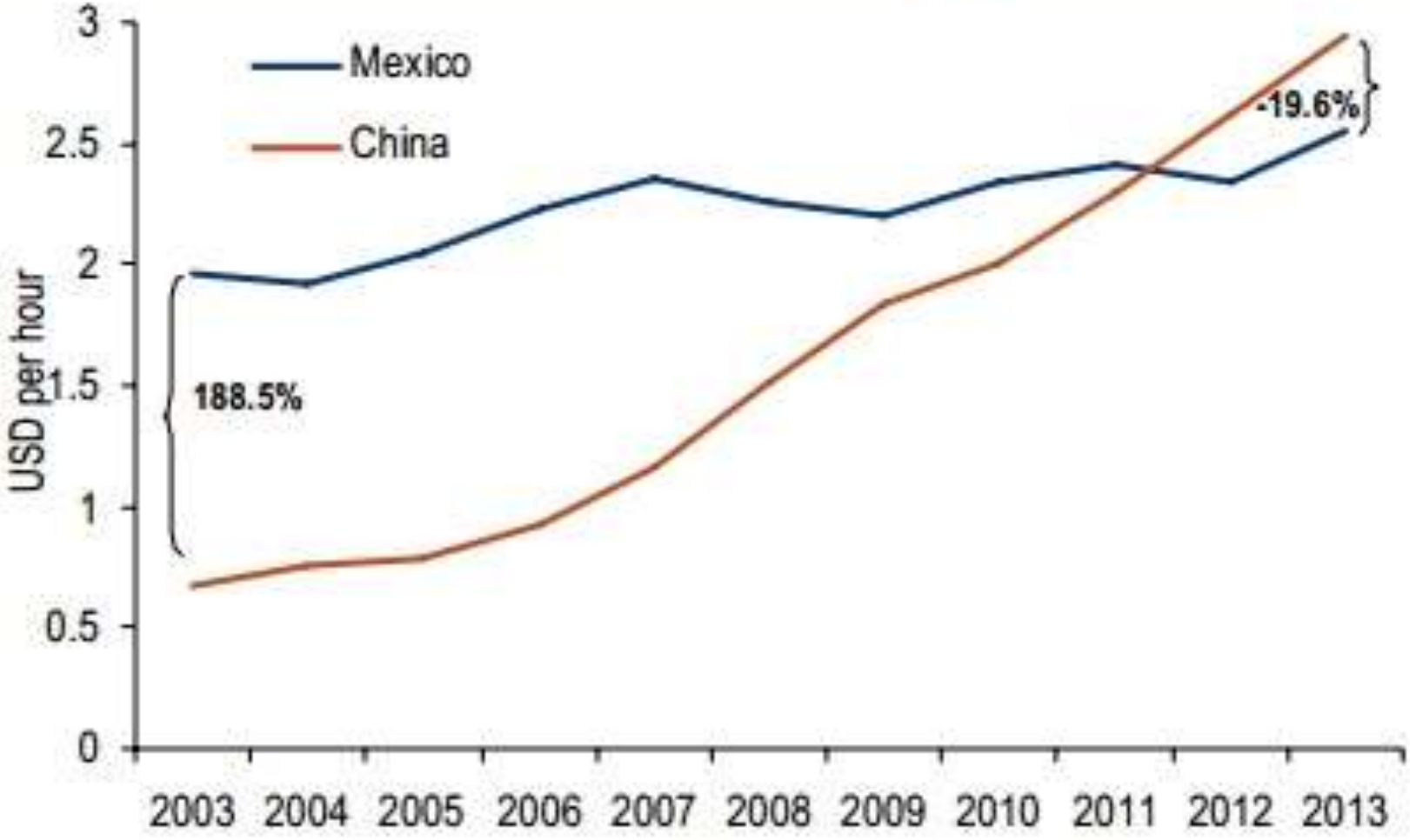
Development indicators - labor costs

Country	Average minimum annual salary (worker, Intl. $)	Average mandatory welfare (% against salary)	Total labor cost (Intl. $)
Bangladesh	798	n/a	798
Cambodia	672	n/a	672
China 3	1,500	50	2,250
India	857	10	943
Indonesia	1,027	6	1,089
Laos	1,057	9.5	1,157
Malaysia 1	4,735	23	5,824
Mongolia	2,004	n/a	2,004
Myanmar	401	n/a	401
Nepal	1,889	n/a	1,889
Pakistan	984	7	1,052
Philippines 4	2,053	9.4	2,246
Sri Lanka	1,619	n/a	1,619
Thailand 2	2,293	6.9	2,451
Vietnam	1,002	15	1,152

IMF WORLD ECONOMIC OUTLOOK DATABASE, OCTOBER 2010

China's hourly wages exceed Mexico's

Chart 1: Mexico has overturned China's hourly wages



Source: BofA Merrill Lynch Global Research, Banxico, INEGI, International Labor Organization, China NBS
Own estimates for China since 2009 and for Mexico in 2013

China vs. Mexico labor costs

- 2013: Average hourly wages were almost 20% lower in Mexico than China, whereas in 2003 Mexican wages were 188 % more costly (Bank of America Merrill Lynch, 2013)
- Demographics: Mexico's economically active population will grow by 20 percent from 2010 to 2020, compared to a 2.9 percent increase in China over the same period (ILO proj., 2013)

Strategies	Definition	Capabilities	Comments
<u>Catching-up</u> VN; Indonesia India (el mfg); Mal (el mfg)	• enter after growth stage • lower-cost producer	• operational •assimilate & improve foreign tech's	• decreasing returns • razor-thin margins
<u>Fast-Follower</u> Tw (PC; handsets) China (global electronics factory) © Dieter Ernst	• enter early during growth stage • quick market response & scale-up • flexible production system •cost control	• process development • prototype development •System integration	• footloose investment • weak marketing skills • where to move to? (paradigm shift)

Strategies	Definition	Capabilities	Comments
<u>Technology Diversification</u> China (internet services; budget smart phones; HS-Train) Tw (IC design) Korea (smart phones; CE; car)	• recombine (mostly known) technologies to create new products & services • economics of scope (technology)	• applied research •international knowledge sourcing •build on proven capabilities •IPs	• higher margins & reduced uncertainty • new opportunities (vertical specialization in GPNs/GINs) • latecomer advantages
<u>Technology Leader</u> China(HPC; BGI; mobile comm's; satellite & spacecraft; nanomaterials) Korea (IC fab) Tw (IC foundry services)	• sets standard during introduction of new products/service	• basic research • pure science • defining standards •superior IPs	• higher margins •strong entry deterrents • high cost (R&D; regulations) •lower-cost imitators •"disruptive technologies"

Asian development models –current status

Indonesia and less so Malaysia – stuck in "middle income trap", this constrains transition beyond catching-up

Korea & Taiwan – in core industries, transition from fast-follower to technology diversification, but limited inroads into technology leadership

China – has mostly moved beyond catching-up, and is primarily active as a fast-follower. However, its size allows it to bear the huge investments needed to move into technology diversification, and into some areas of technology leadership.

Singapore – Located on one of the busiest sea trading routes, this small city state is the Asian Headquarters' hub for MNCs, and can afford to pursue highly selective niche strategies in both technology diversification and leadership.

The Korea conundrum

- Industrial policy fosters rapid expansion of manufacturing exports based on imported technology & on “octopus-like diversification”
- Vertical integration within conglomerates (“Chaebol”) and their dedicated supplier networks
- Truncated development of innovative start-up companies (chaebol recruit & retain top talent; start-ups as “mini-chaebol”)
- Weak linkages between private sector and universities & GRIs
- Services account for 50% of GDP and 60% of employment, but contribute little to productivity growth (except for some Internet services)
- Korea remains “sandwiched” between China’s lower -cost catching-up from below, and technology leadership strategies from above, i.e. the US, Japan, and EU.

Apple ←→ Samsung ←→ Xiaomi, Lenovo, Huawei, ZTE, Oppo

Ernst, D. 1994, What are the Limits to the Korean Model?; Cowhey, P. & S. Haggard, 2014, US-Korea Business Council White paper

How viable is Taiwan's ODM model?

- Rapid expansion of electronics manufacturing exports through deep integration into corporate production networks & informal knowledge networks
- One-stop provision of OEM & ODM services which combine low-cost production and quick response to changes in markets and technology
- Offshore outsourcing to China (manufacturing and R&D) creates serious hollowing-out pressures for local industry
- Considerable progress in product development & electronic design, but restricted to incremental innovation → weak branding power
- ITRI provides basic and applied research support & coordination
- ODM model is highly vulnerable to "IP barriers" imposed by strategic patenting → *Apple litigation against HTC*

Ernst, D. 2010, Upgrading through innovation in a small network economy; Ernst, D., 2013, Industrial Upgrading through Low-cost and fast Innovation – Taiwan's Experience

Taiwan's ODM model truncates innovation

- Relentless pressure by global brand marketers to reduce cost and time-to-market → decreasing returns (profits; jobs) → constrains investment in R&D, intellectual property creation and branding.
- Heavy reliance on foreign technology →hefty patent licensing fees ('patent trap')
- No exposure to final customers → constrains system knowledge
- Incremental innovation limits product development & capacity to shape technology roadmaps and standards

➢ ***The new strategy – provide "integrated solutions" thru low-cost and fast innovation within domestic & global innovation networks.***

Ernst, D., 2010, Upgrading through innovation in a small network economy; Ernst, D., 2013, Industrial Upgrading through Low-cost and fast Innovation – Taiwan's Experience

Taiwan's U.S. patent data

While Taiwan's international patent filings have grown rapidly, the quality of Taiwan's patents remains low (patent citation; science linkages)

- Sixth largest patenting economy (after France & Korea) → China,incl Hong Kong #12, ahead of Australia & israel
- Low quality (patent citation; science linkage)
- Weak bargaining power (cross- licensing; patent swapping)
- TSMC, Hon Hai and ITRI dominate Taiwan's most influential patents

http://www.uspto.gov/web/offices/ac/ido/oeip/taf/cst_utl.htm

The "middle income trap" - Malaysia

a) Eroding competitive advantage

- 60 percent of value-added produced in Malaysia is ultimately consumed by foreigners
- Lead export industry (electronics) in structural decline
- Low share of value-added in exports, due to limited domestic linkages

b) Innovation barriers

- Underinvestment/disinvestment in innovation infrastructure (education; vocational training; R&D)
- Weak industry-university linkages reflect shortcomings of industry structure & business model

Malaysia 2013 p.c. GNI =$10,430; Mexico = $ 9,940(World Bank,Atlas method)

Ernst, D., 2015, The role of innovation for Malaysia's economic development

The misery of Malaysia's electronics exports…

- Their GDP share fell from 38% (2002) to 18% (2013).
- Their share in M's exports declined from 62% (2000) to 37% (2013) ←→ Share of commodities rose from 13 to 22%. → But: Electronics remains the largest export category by value
- Their global market share fell from 5.25% to 3.74%
- Low contribution of domestic intermediates to electronics exports (7%) ←→ Korea (31%)
- MNCs source < 40% of their inputs from domestic firms ←→ Vietnam (46%), China (82%)

Malaysia's competitiveness crisis in a nutshell

All three actors are under pressure

- ***Workers*** ← low minimum wage vs rising cost of living(housing); low cost immigrant labor =ca 1/3 of M's total workforce
- ***Firms*** ← 1. persistent Crony capitalism 2. financialization (lax regulation of financial sector, tax preferences for investors and real estate has resulted in underinvestment in productive assets and R&D)
- ***Public institutions*** ← Under-investment in basic & applied research ← negative side effects of NEP ← weak enforcement of regulations
- ***How to break out of this vicious circle? Is streamlining of procedures (PEMANDU) enough?***

Why India struggles in the electronics industry

1. India's thriving chip design clusters remain disconnected from domestic market & electronics production

2. Integration into GPNs for electronics manufacturing is VERY limited:

- FDI in India's electronics industry has been extremely low – electronics ranks 26 out of 64 sectors in terms of the cumulative FDI received since 2000.
- US & Japanese MNCs play no role in India's electronics industry → US FDI is focused on offshore IT services & IC design; Japanese FDI is focused on the car industry*.
- *This very low global network integration cuts India's electronics firms off from global knowledge sources, setting it apart from China*

Ernst, D. 2014, Upgrading India's Electronics Industry

*UN-ESCAP , 2011, India: A New Player in Asian Production Networks

China's strengths

Innovation push: Massive investments in the country's R&D infrastructure & higher education have been fast-tracking the speed of learning & capability development. → Since 2000, China has increased R&D spending roughly 10% each year.

High GPN integration: Two-thirds of China's production of goods & services are intermediates, which is substantially higher than the world average*

High GIN integration: China is the largest "net importer" of R&D, and it is the third most important offshore R&D location (after the US and UK) of the 300 top R&D spending multinationals**.

*Baldwin and Lopez-Gonzales 2013 ** Ernst, 2011 Testimony to US-China Economic& Security Commission

Demand Pull from mobile devices

China as lead market has…

- three times as many mobile handset subscribers as in the US (> 1 bn to 331.6m)
- 22% of global smart phone market (US=16%)

China as co-shaper of mobile telecom standards

- Both TD-SCDMA and TD-LTE standards have fostered the development of technical capabilities in Greater China IC design companies (MTK; SPRD; RDA)

→ As a result, global device vendors & leading IC companies are all searching for ways to ensure long-term access to the China market.

- Global market share of mobile phones produced in China has almost doubled from 44% (2008) to 81% (2013) *

* CSIA, MIIT, Gartner

Beijing Genomics Institute (BGI) – a new technology platform leadership strategy?

- Use > 150 imported state-of-the-art sequencing machines to build a huge library based on the DNA of many millions of people
- Use this library as a springboard for new drug discoveries, advanced genetic research and a transformation of public health policy
- Use venture capital funding from Gates Foundation, Sequoia Capital, etc. instead of Government funding

http://www.genomics.cn/en/index

China's challenges - External

- MNCs dominate operating systems for mobile phones (Google, Apple) and PCs (Wintel)
- Technology export restrictions on leading-edge technology slow-down the pace of catching-up [Wassenaar Agreement]
- Leading global players control essential patents and standards
- Global strategic patenting strategies constrain catching-up in innovation

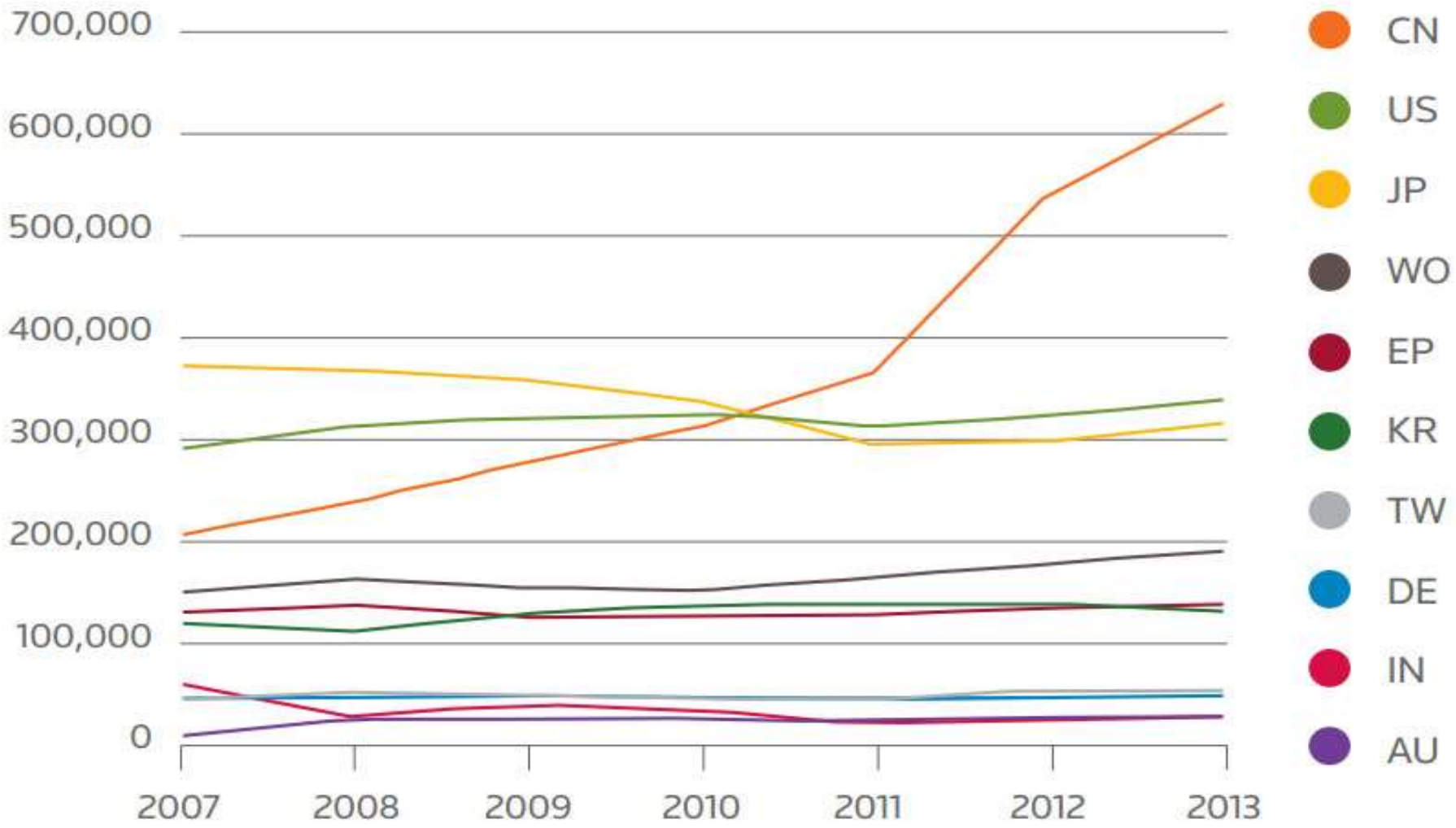
Ernst, 2011, Indigenous Innovation and Globalization: The Challenge for China's Standardization Strategy

China's domestic innovation barriers reflect its latecomer status

- Fragmented innovation system → inter-agency rivalries
- Quality problems in education; plagiarism in science & derivative research
- Top-down technology leapfrogging that neglects risks of ramping-up complex technology systems in record time
- Public R&D support and procurement privileges SOEs & neglects SMEs
- IPR regime remains weak, despite improvements → disincentives for innovation
- Lists of "indigenous innovation" products used for government procurement focus on *existing* technologies and hence stifle innovation
- Weak complementary capabilities (legal; patent law; standardization; coordination of complex innovation networks; "integrated solutions"; advanced manufacturing)

Ernst, 2011, Indigenous Innovation and Globalization:
The Challenge for China's Standardization Strategy

INVENTION PATENT APPLICATIONS 2007-2013



Source: Derwent World Patents Index® and Thomson Innovation®

Does China's patent boom signal a reduction of China's innovation gap?

- In 2013, China not only passed, but dwarfed the US and Japan in total patent applications
- Domestic patent applications have overtaken foreign applications since 2003 → Chinese nationals account for ¾ of total patent applications with SIPO
- 2011: ¾ of resident applications with SIPO are for lower-quality "Utility Model" (UMP) & Design Patents .
- BUT!! In 2013, resident applications for UMP and Design patents decline significantly ← Government has reduced subsidies for UMP & Design Patent applications.

Thomson Reuters, 2014; SIPO, 2014

3. Policy implications and unresolved issues

- Upgrading through innovation within GPNs & GINs requires an active industrial policy, in coordination with selective trade liberalization and competition policy.
- Different Asian countries face different challenges and hence need to develop their own hybrid policy approaches.

Unintended negative consequences of global network integration

- Foreign affiliates succeed in recruiting the best talent, leaving domestic companies at the sidelines.
- Foreign affiliates are interested primarily in "tapping into the local knowledge base" → This may erode the region's "Industrial Commons"
- Unresolved challenges to Privacy and Cyber-Security

Global network integration may impede innovation

- Chesbrough's **"Modularity trap"**: If a firm focuses too much on developing products within given interface standards, this may erode the firm's system integration capabilities.
- Ernst **"Limits to modularity"**(2005):Demanding *coordination requirements & constraints to interface standardization* hamper innovation in chip design
- Chen and KU **"Pitfalls of modular production"**:
  - Unequal power structure → MNCs resist disruptive innovations by Taiwanese network suppliers
  - Modular networks erode the value "inter-firm relations" (i.e. R&D collaboration among network suppliers)

Industrial policy requires …

- coordination with Trade, FDI and innovation policies.
- Integrated approach to
  - IPR development & protection
  - investment promotion; R&D tax credits; patient innovation funds
  - policies to foster firm-level managerial & technological capabilities
  - Competition policy (see China's Anti-Monopoly policy)
  - standard development & certification;
  - Private-public partnerships (industrial research consortia; university-industry collaborations)
  - trade diplomacy.

Q&A

Unresolved issues

- Who controls patents in global production networks (GPNs)?
- Who appropriates the rents from distributed R&D through GINs ?
- Global Strategic Patenting & the Distribution of Innovation Gains