



## Review Article

# What is next in Asian Catch-up - A Technological View

Do Huyen Trang\*

*VNU University of Social Sciences and Humanities, 336 Nguyen Trai, Thanh Xuan, Hanoi*

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**Abstract:** The world has witnessed the rise of less developed economies in catching up with or, sometimes, over taking industrialised countries. This has shown in narrowing the gap in growth and development indicators such as productivity, national income, market share and technological capability. They can be countries that were defeated in wars like Germany, Japan, or even the United States during 1950s, or it can be countries that historically and politically less developed in terms of industrialisation like South Korea (hereinafter Korea), Singapore, Taiwan, etc. or lately China, India, Brazil. After the first and the second wave of the successful catch-up, questions have been posed on who among the lagging behind can possibly move to more advanced position in the technological development ladder.

*Keywords:* Technological catch-up, follower, forerunner, leader.

## 1. Introduction

The world has witnessed the phenomenon of less developed economies catching up with or, sometimes, overtaking industrialized countries. Since 19<sup>th</sup> century, the first wave of catching up happened when Germany and the United States, and later Japan caught up with the forerunners. The second wave took place after World War II, when Newly Industrialized Economies (NIEs) – Hong Kong, Singapore, South Korea (hereinafter Korea), and Taiwan - caught up with

Japan and other Western economies [1-6]. The third catch-up wave started since 1980s, when some BRICs countries – China, Brazil, India – caught up with Korea or Japan [7-13] (Figure 1).

Catching up takes place at different levels. At the country level, latecomer countries may catch up in some sectors and not in others [14]. Lee & Lim (2001) affirmed the same by investigating the diversity of Korean industries in catching up, and concluded that while some industries have achieved a remarkable catching up, others may face serious difficulties in doing

\* Corresponding author.

*E-mail address:* [trangdh@vnu.edu.vn](mailto:trangdh@vnu.edu.vn)

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so [4]. The successful industries are different from country to country. They are semiconductor, electronic industries in Korea, telecommunication manufacturing industry in China, pharmaceutical and software industries in India, agro-food industry in Brazil. Therefore, in addition to studies that investigate the catch-up phenomenon of above mentioned countries, which means the national level of catch-up, there are substreams in the literature focusing at the regional level [2, 3, 15-17], sectoral level [14, 18], or industrial level [19-20]. In catch-up, there are latecomers that shorted the gaps with forerunners in aspects including productivity, national income, market share, capability, etc., of which technological catch-up appears to be an emerging topic aligned with the rise of technological leaps.

Southeast Asia, as a region, including countries such as Thailand, Malaysia, Indonesia, the Philippines, and Vietnam, is considered representing the next wave of catch-up, following BRICS countries – Brazil, Russia, India, China, and South Africa. The location gives those ASEAN countries advantages. Hobday (1995) suggested that Vietnam, together with other ASEAN neighbors like Malaysia or Indonesia, can form a low-end manufacturing and lower production cost region, turning the region into the next catching-up latecomer. Since then, there can be seen potential results in terms of technological catch-up, and some countries indeed had been succeeded in certain industries and firms, for example automobile component industry in Thailand, and electronics in Malaysia [21]. Those that strike the weaving into story of the technological catch-up waves.

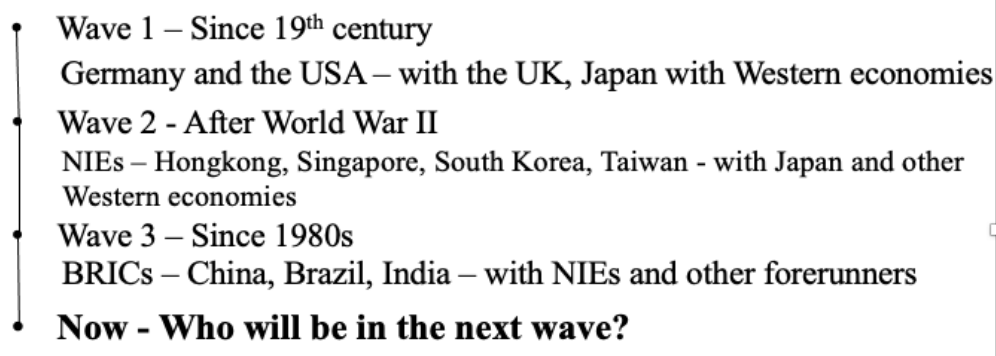


Figure 1. Timeline of Catch-up waves worldwide in comparison with Asian waves (Source: author compilation).

## 2. Asian Technological Catch-up

### 2.1. First Asian Wave – Asian Tigers

The catch-up phenomenon can be traced back far in the history when the USA and some European countries with the UK leading position – gained as a consequence of the First Industrial Revolution during the 19<sup>th</sup> century. Later on, Japan performed a rapid catch-up with Westerners in terms of productivity [22]. Much of the third quarter of the 20<sup>th</sup> century witnessed

drastic growth of few developing countries through the technological catch-up process [1]. The significant growth of the Asian tigers or “the East Asian miracle” featuring Korea, Singapore, Taiwan and Hongkong who had made it possible through the technology-based capability building process, sharing common as well as diverse characteristics.

At country level, researchers assured the vital position of technological capability in technological catch-up. Apart from that common finding, decisive factors to technological catch-

up processes were proved to be country-wise, especially in different contexts of developed and developing countries, which led to the latter trying to create alike macro environment conditions to the former. For example, according to World Bank put the focal on building stable macro environment following export-oriented growth model. Besides, disparities were identified such as social and political factors. According to Kim, Korea focused in building process capability in the initial stage, imitating to master sophisticated products, promote the development chaebols, and create crises [1]. Singapore used government facilitation to multinational corporations (MNCs) as the engine to the economy. Taiwan in the mean time, build an small medium enterprises (SMEs)-based-economy, using bottom up approach [21].

As these countries reached the final stage in the catch-up process, they are able to compete with technology frontier at the global market, moving from follower to leader in some industries or sectors. This stage has been termed “transition to leadership” of Asian NIEs catch-up [15-16, 23-24], where innovative capability accumulation has posed a great challenge. Even in this trend, countries showed different characteristics and path. The difference in NIEs’ catch-up lead to the idea that maybe different paths for different countries is necessary and that catch-up is basically country and industry-driven phenomenon. The first catch-up tier’s experience has suggested that rather than copying from the lessons, latercomers should learn from analysing the disparities, because it was these disparities that explain the differences in catch-up speed and success and failure of countries.

## 2.2. Second Asian Wave – China and India

After the NIEs successful catch-up, other emerging followers tended to continue challenging forerunners or leaders in respected industries or sectors, of which dramatic growths were spotted in BRICs countries, particularly, leaders of this group – China and India. As

widely accepted claim by Goldman Sach “Dreaming with BRICs”, by 2040, China will be the largest economy and India will be the third largest, surpassing even Japan, Germany, France and the UK. A large part of this succeed is coming from the rapid technological catch-up of China and India.

Although the US, the EU and Japan are still the leaders in most technology intensive industries currently given their technological capability stock, Asian economies are just behind the established incumbents in these areas. Not only followers from the first tier, the second Asian tier leading by China and India have rapidly enhanced their own technological capabilities, catching up with or even leapfrogging over these established incumbents from advanced countries in certain fields and industries.

In the case of China, the record of economic growth has no precedent in history, while its technological progression is at an alarming rate to even the world’s leader, with many technological capability indicators are just behind, sometimes even surpass the US. What contributed to the striking technological catch-up of China to name a few infused growth models of Japan, Korea, Taiwan, the bargaining power to gain technology and spillover effects from MNCs which was called “trade market to technology, and the role of government [25]. Multiple approaches to achieved technological catch-up have been documented. For instance, collaborating to take advantage from spillover effect [26], developing indigenous capabilities [27], merger and acquisition with foreign firm with technology, patent citation as a guard to innovation capability [6, 19, 28-30]. Successful stories among all catch-up industries can be semiconductor; mobiphones and automobiles, of which telecom equipment seems to be the fastest and strongest catch-up industry of China, with the phenomenal success of Huawei. Most recently, Huawei of China emerged as a leader in the telecommunications equipment industry, surpassing Ericsson and Cisco Systems in sales.

Similar to Asian forerunners, after narrowed the gap substantially in technological

capabilities, in some sectors, such as the telecommunication manufacturing industry, China, in fact, has been moving to compete at the global technological frontier. Chinese firms in these sectors are experiencing an industrial upgrading - the transition from being technological followers to being technological leaders. Research on this aspect in China has diverted toward two different ends: one stream agreed that multinational firms from China have successfully challenged the dominance of industry incumbents from the developed world in both market share and technological output [e.g., 6, 9, 27]. On the other hand, others have criticised the lacking of original innovation of Chinese firms, showing somehow lacking innovation capabilities, that Chinese still catch-up based on acquiring technologies from industry incumbents [e.g., 31-32].

In India, the most outstanding catch-up industry has to be software service. Software services industry in India is the largest in the developing world and that the leading Indian software firms have been successfully competing against established Western software service firms for over a decade [9]. Not only software, India is also caught up in other sectors and industries, turning Delhi, Mumbai, or Bangalore into manufacturing hubs of the world. Similar to China, different perspectives of India catch-up were well covered by research. Also, many cross countries studies have been conducted to compare the two catch-up cases, from macro to micro levels [7, 8].

There is by now several stories told on the catch-up of the first and second waves of Asian catch-up in various setting. The attention has shifted to the third tier, which included Southeast Asia countries trying to perform some catching up.

### 2.3. *Expected third Asian Wave – Southeast Asia*

Southeast Asia countries had been said to follow industrialisation and export-led models of forerunners, using manufacturing as an engine of growth and development, rapidly shift from agriculture economy to manufacturing based and

export driven economy [33-34]. Due to the relocation of low-cost assembly from the home countries to lower wage locations, previously to China, and now gradually from China to ASEAN countries (Malaysia, Indonesia, Thailand and Vietnam), these countries have experienced rapid growth. It is consistent with OECD and World Bank statement that manufacturing activities in Southeast Asia region are essentially concentrated within 6 key countries: the ASEAN 5 (Singapore, Indonesia, Malaysia, the Philippines, Thailand) plus rapidly rising Vietnam (2015). Over different waves of catch-up, partly as a result of the upgrading of manufacturing skills and capabilities, a significant proportion of world manufacturing and trade shifted from the USA and Europe to the East and South East Asian region [2]. Additionally, due to sharing similar regional location traits and economic regime and trade structure with the NIEs, Southeast Asia region has a strong basis to consider forming the next catch-up wave. However, as learnt from NIEs catch-up experiences, it is almost impossible for any follower to wholly adopt the catch-up models of NIEs without considerable adaptation.

Following Asian NIEs and China and India, ASEAN 4 – Thailand, Malaysia, the Philippines, and Indonesia have been performing catch-up. Among the ASEAN 4, Malaysia is a strong catch-up case. In comparison to other ASEAN countries, Malaysia is one of the highest performers not only in GDP term, but also in potential technology creation. Malaysia has successfully accumulated technological capabilities using credit and trade policies to attract FDI, facilitate resource allocation, together with the national technological development plans that has been enacted since 1960s. The country has been moving toward being able to produce original knowledge, building indigenous capability, with the famous case of electronics [32-36], followed immediately by resource-based industries such as palm oil and natural gas. Where in the former, semiconductors firm started participating in specialised category with higher level

knowledge intensity. However, the number of such firm was still very low. It demonstrates the capability to compete behind the world's frontier of the industry and of Malaysia in general.

Thailand attempted to build its economy on developing and producing higher value-added products since the 1990s, with manufacturing stayed a major sector. In terms of technological progress, it seems that Thai firms have achieved higher productivity without expanding technological capability, where they concentrates in accumulating product and process capabilities through acquisition and assimilation. Overall, ranking of Thailand in the region has remained in the upper part both in economic and technological progression aspects. However, Thai firms demonstrates a great dependence on TNCs where the most sophisticated parts or activities such as design and R&D are sourced in the home country because of innovation capability reason while almost all stage of manufacture activities can be conducted in Thailand [37-39].

Malaysia and Thailand shared similarities in the catch-up pattern with Singapore, due to the large extent that they all relied on FDI and MNCs for growing, and both are now facing the same problem of being stuck at the current level of technological capabilities due to limited development of indigenous capacity [21].

In the middle-income group, Indonesia was once perceived to be a second-tier Asian tiger however, be affected by the financial crisis and just recently made the way back. The pulp and paper industry was one of the most dynamic industries as Indonesia emerged as one of the world's major producers and exporters of paper products. With the aim of being leading pulp and paper exporter, this learning by exporting approach has helped Indonesia move closer to the frontier. However, indigenous capability shows no sign of expanding as the industry remains highly dependent on imported technologies [41-43].

The case of the Philippines however didn't show a positive technological catch-up with the downtrend in a number of science and

technology development indicators, explaining why it has been lagged behind in catching up.

### 3. Summary

In sum, the technological catch-up stories of the first and second Asian waves has glamorised the prospects of the next emerging followers from the continent – ASEAN countries. As Malaysia and Thailand are considered two fast followers, competing just behind the frontier, Indonesia is also fast keeping up, other ASEAN members according to ADB and GII reports are improving in innovation indicators, there are evidence ground to believe in the speedy movement of Southeast Asia countries towards competing with forerunners and leaders of the world. However, there also exists a great reliance of domestic firms on foreign source of technology and knowledge, proving the impossibility in generating radical innovation, but incremental innovative activities instead. Together with the movement of capitals to South Asian and Africa, in the circumstance where low-wage production upon great population has no longer an absolute advantage in Southeast Asia region, it might be hard to comment on who would be the next Asian catch-up.

### References

- [1] L. Kim, *Imitation to Innovation: The Dynamics of Korea's Technological Learning*, Boston: Harvard Business School Press, 1997.
- [2] M. Hobday, *East Asian Latecomer Firms: Learning the Technology of Electronics*. *World Development*, Vol. 23, No. 7, 1995, pp. 1171.
- [3] M. Hobday, *Latecomer Catch-Up Strategies in Electronics: Samsung of Korea and ACER of Taiwan*. *Asia Pacific Business Review*, Vol. 4, No. 2-3, 1998, pp. 48-83, <https://doi.org/10.1080/13602389812331288364>.
- [4] K. Lee, C. Lim, *Technological Regimes, Catching-up and Leapfrogging: Findings from the Korean Industries*. *Research Policy*, Vol. 30, No. 3, 2001, pp. 459-483, [https://doi.org/10.1016/S0048-7333\(00\)00088-3](https://doi.org/10.1016/S0048-7333(00)00088-3).

- [5] Q. Mu, K. Lee, Knowledge Diffusion, Market Segmentation and Technological Catch-up: The Case of the Telecommunications Industry in China. *Research Policy*, Vol. 34, No. 6, 2005, pp. 759-783.
- [6] C.-Y. Wu, J. Mathews, Knowledge Flows in the Solar Photovoltaic Industry: Insights From Patenting by Taiwan, Korea, and China, *Research Policy*, Vol. 41, No. 3, 2012, pp. 524.
- [7] M. Sunil, The Dragon vs the Elephant-Comparative Analysis of Innovation Capability in the Telecom Industry of China and India. *Economic and Political Weekly*, Vol. 40, No. 39, 2005.
- [8] OECD, The Information and Communication Technology Sector in India: Performance, Growth and Key Challenges, OECD Publishing, Paris, 2013.
- [9] P. Fan, Catching Up through Developing Innovation Capability: Evidence from China's Telecom-Equipment Industry, *Technovation*, Vol. 26, No. 3, 2006, pp. 359-368, <https://doi.org/10.1016/j.technovation.2004.10.004>.
- [10] P. Fan, Innovation, Globalization, and Catch-Up of Latecomers- Cases of Chinese Telecom Firms. *Environment and Planning, Part A*, Vol. 43, 2010.
- [11] P. Figueiredo, Industrial Policy Changes and Firm-Level Technological Capability Development: Evidence from Northern Brazil. *World Development*, Vol. 36, No. 1, 2008, p. 55.
- [12] P. N. Figueiredo, Learning Processes Features-How Do They Influence Inter-Firm Differences in Technological Capability-Accumulation Paths and Operational Performance Improvements, *International Journal of Technology Management*, Vol. 26, No. 7, 2003, pp. 655-693.
- [13] P. N. Figueiredo, Micro-level Technological Capability Accumulation in Developing Economies: Insights from the Brazilian Sugarcane Ethanol Industry, *Journal of Cleaner Production*, Vol. 167, 2017, pp. 416-431.
- [14] F. Malerba, R. Nelson, Learning and Catching up in Different Sectoral Systems: Evidence from Six Industries, *Industrial and Corporate Change*, Vol. 20, No. 6, 2011, pp. 1645-1675, <https://doi.org/10.1093/icc/dtr062>.
- [15] J. Mathews, Competitive Advantages of the Latecomer Firm: A Resource-Based Account of Industrial Catch-up Strategies. *Asia Pacific Journal of Management*, Vol. 19, No. 4, 2002, pp. 467-488. <https://doi.org/10.1023/A:1020586223665>.
- [16] J. Mathews, Catch-up Strategies and the Latecomer Effect in Industrial Development, *New Political Economy*, Vol. 11, No. 3, 2006, pp.313-335.
- [17] J. Fagerberg, B. Verspagen, Innovation, Growth and Economic Development - Have the Conditions for Catch-up Changed, *International Journal of Technological Learning, Innovation and Development*, 1, 2007, pp.13-33.
- [18] K. Lee, T. Y. Park, R. T. Krishnan, Catching-up or Leapfrogging in the Indian IT Service Sector: Windows of Opportunity, Path-creating, and Moving up the Value Chain. *Development Policy Review*, Vol. 32, No. 4, 2014, pp. 495-518. <https://doi.org/10.1111/dpr.12065>.
- [19] K. Lee, M. Yoon, International, Intra-National and Inter-Firm Knowledge Diffusion and Technological Catch-up: the USA, Japan, Korea and Taiwan in the Memory Chip Industry, *Technology Analysis & Strategic Management*, Vol. 22, No. 5, 2010, pp. 553-570.
- [20] S. Rho, K. Lee, S. H. Kim, Limited Catch-up in China's Semiconductor Industry: A Sectoral Innovation System Perspective, Vol. 6, No. 2, 2015, pp. 147-175, <https://doi.org/10.1177/0976399615590514>.
- [21] C. Wong, K. Goh, Catch-up Industrialization and Growth Trajectory of Science and Technology : A Comparative Study on Asian Economies, 2011.
- [22] J. Fagerberg, M. Godinho, Innovation and Catching-up, in the *Oxford Handbook of Innovation*: Oxford University Press, 2006.
- [23] G. Dutrénit, Building Technological Capabilities in Latecomer Firms: A Review Essay, *Science, Technology and Society*, Vol. 9, No. 2, 2004, pp. 209-241.
- [24] E. Amann, J. Cantwell, Innovative Firms in Emerging Market Countries. Oxford: Oxford University Press, 2012.
- [25] A. G. Z. Hu, G. H. Jefferson, Q. Jinchang, R&D and Technology Transfer: Firm-Level Evidence from Chinese Industry. *Review of Economics and Statistics*, Vol. 87, No. 4, 2005, pp. 780-786, <https://doi.org/10.1162/003465305775098143>.
- [26] X. Gao, Effective Strategies to Catch up in the Era of Globalization - Experiences of Local Chinese Telecom Equipment Firms, *Research Technology Management*, Vol. 54, 2011, pp. 7.
- [27] P. Fan, Catching-up Through Staged Development and Innovation, *Journal of Science and Technology Policy in China*, Vol. 1, No. 1, 2010, pp. 64-91. <https://doi.org/10.1108/17585521011032559>.
- [28] G. H. Joo, X. K. Lee, Samsung's Catch-up with Sony: An Analysis Using US Patent Data, *Journal of the Asia Pacific Economy*, Vol. 15, No. 3, 2010, pp. 271-287, <https://doi.org/10.1080/13547860.2010.494907>.
- [29] C. Tseng, Technology Development and Knowledge Spillover in Africa-evidence Using

- Patent and Citation Data, *International Journal of Technology Management*, Vol. 45, No. 1-2, 2009.
- [30] M. L. Mancusi, *International Spillovers and Absorptive Capacity- A cross-country, cross-sector analysis based on European patents and citations*. Paper presented at the IDEAS Working Paper Series from RePEc, 2004.
- [31] J. Li, R. Kozhikode, *Developing New Innovation Models: Shifts in the Innovation Landscapes in Emerging Economies and Implications for Global R&D Management*, *J. Int. Manag.*, Vol. 15, No. 3, 2009, pp. 328-339, <https://doi.org/10.1016/j.intman.2008.12.005>.
- [32] X. Fu et al., *The Role of Foreign Technology and Indigenous Innovation in the Emerging Economies: Technological Change and Catching-up*. *World Development*, Vol. 39, No. 7, 2011, pp. 1204-1212.
- [33] OECD, *Innovation in Southeast Asia*, OECD Reviews of Innovation Policy, OECD Publishing, Paris, 2013.
- [34] OECD, *Science, Technology and Innovation in Vietnam*, OECD Publishing, Paris, 2014.
- [35] R. Rasiah, *Exports and Technological Capabilities: A Study of Foreign and Local Firms in the Electronics Industry in Malaysia, the Philippines and Thailand*, *The European Journal of Development Research*, Vol. 16, No. 3, 2004, pp. 587, <https://doi.org/10.1080/0957881042000266633>.
- [36] R. Rasiah, *Technological Intensities and Network Strength: Electronics Firms in East Asia and Southeast Asia Compared*, 2009.
- [37] R. Rasiah, *Are Electronics Firms in Malaysia Catching up in the Technology Ladder?* *Journal of the Asia Pacific Economy*, Vol. 15, No. 3, 2010, pp. 301-319, <https://doi.org/10.1080/13547860.2010.494910>.
- [38] M. Berger, *Upgrading the System of Innovation in Late Industrializing Countries the Role of Transnational Corporations in Thailand's Manufacturing Sector*. (Phd), Kiel University, Germany, 2005.
- [39] M. Hobday, H. Rush, *Upgrading the Technological Capabilities of Foreign Transnational Subsidiaries in Developing Countries: The Case of Electronics in Thailand*, *Research Policy*, Vol. 36, No. 9, 2007, pp. 1335-1356, <https://doi.org/10.1016/j.respol.2007.05.004>.
- [40] P. Intarakumnerd, P. Charoenporn, *The Roles of IPR Regime on Thailand's Technological Catching Up*, 2010.
- [41] R. Reinauer, U. E. Hansen, *Concurrent Changes in Latecomer Capability-Building and Learning: Firm-level Evidence from the Thai Biogas Industry*, *Journal of Cleaner Production*, Vol. 290, 2021, pp. 125783, <https://doi.org/10.1016/j.jclepro.2021.125783>.
- [42] M. V. Dijk, A. Szirmai, *Industrial Policy and Technology Diffusion: Evidence from Paper Making Machinery in Indonesia*. *World Development*, Vol. 34, No. 12, 2006, pp. 2137-2152, <https://doi.org/10.1016/j.worlddev.2006.03.004>.
- [43] M. V. Dijk, A. Szirmai, *The Micro-dynamics of Catch-up in Indonesia Paper Manufacturing*, *The Review of Income and Wealth*, Vol. 57, No. 1, 2011, pp. 61-83, <https://doi.org/10.1111/j.1475-4991.2010.00431.x>.