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Is the Fourth Industrial Revolution a window of opportunity for upgrading or reinforcing the middle-income trap? Asian model of development in Southeast Asia

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ABSTRACT
This paper focuses on the cases of Malaysia and Thailand and investigates the possibility of upgrading these countries from the middle-income trap and the possible roles of the 4th Industrial Revolution (4IR) in this process. The 4IR may induce firms to introduce factory automation to facilitate upgrade into higher segments with local spillovers. A key factor for this positive scenario is local institutions facilitating the training and upskilling of their local workforce. By contrast, increased problems are expected for other countries with the mid-range level of wages and mid-level of educated population, and firms in these economies mostly execute labor-intensive production and are likely to be substituted by additional factory automations or their multinational firms may move to neighboring countries for low wages.

Policy Highlights
- Impacts of the 4th Industrial Revolution (4IR) may vary, depending on countries’ resource endowments and the level and nature of human capital.
- Given the rising wages, the electronic cluster of Malaysia and auto cluster of Thailand are taking 4IR as a window of opportunity to move into higher end segments of the GVC.
- Key enabling factors in this upgrading include local public-private institutions involving training, reskilling, and upskilling of local workforce.
- The comprehensiveness and across-the-board nature of the 4IR requires policy response from multi-ministries with a central coordination, for instance, by the prime minister’s office.

1. Introduction
Manufacturing is a critical part of the Asian model of development. The so-called four Asian tigers, such as South Korea and Taiwan, led the East Asian miracle (World Bank 1993). The economies in Southeast Asia, such as Thailand and Malaysia, pursued a similar strategy but with less success. They encountered difficulties, such as rise in wages, but their products remain in the low-end segment, which has been associated with the term, the middle-income trap.
(MIT) (Lee 2013); a country is considered stuck in the trap if its per capita GDP of a country remains within the 20% to 40% level (upper middle-income level) of the US for several decades.

However, with the arrival of the Fourth Industrial Revolution (4IR), the question is whether the next generation of less-developed economies can use export-based manufacturing as a path to prosperity. According to Schwab (2016), the 4IR refers to the new wave of innovations that use several technologies that comprise 3D printing, Internet of things, artificial intelligence (AI), smart cars, big data, and on-demand economy (sharing economy). The existing mode of economic catch-up will encounter many challenges with the arrival of the 4IR. First, the 4IR is rewriting the rules of manufacturing because low-cost labor is not an effective strategy for attracting manufacturing investment as the cost of automation plummets. Second, the 4IR facilitates the start of a trend toward reshoring manufacturing back to the rich world (e.g. Adidas in Germany). Third, global supply chains are expected to become flat.

The response of Southeast Asian economies to these challenges will determine their economic future. Currently, not the latecomers but advanced economies tend to initiate most of the 4IR technologies; moreover, the response of latecomer economies, particularly ASEAN countries, has been perceived as slow or in small scales (ILO 2016a). Given this background, the possibility of 4IR becoming a window for the advancement of ASEAN economies must be explored along with how they should prepare for the 4IR to avoid being stuck in the MIT.

This study deals with cases of Southeast Asian economies in investigating the possibility of upgrading in these economies to get out of the MIT and the possible roles of the 4IR on this process. However, the 4IR is narrowly defined in this study given that the scope of the 4IR is broad. The concept of Industry 3.0 (automation) and Industry 4.0 (smart factory) would be more relevant in this context because it relates to manufacturing. Typical Southeast Asian factories are at the Industry 2.0 stage or mass production stage; thus, even the automation (Industry 3.0) has not attained considerable progress, let alone transformation into a smart factory or Industry 4.0 (ILO 2016a, 4; ILO 2016b, 3). The 4IR can expedite the transition from mass production to automation or leapfrogging into the smart factory. Thus, this study deals with the issue of automation and upgrading in terms of the GVC (global value chains).

The countries in the region have varied levels of industrialization. At one end, Malaysia and Thailand are reasonably sophisticated, especially in areas such as electronics, automotive, and food processing. At the other end, Cambodia and Myanmar remain largely agricultural economies with their manufacturing sectors dominated by low-end goods, such as textiles. Thus, this study starts from a broad perspective on the region to reflect its heterogeneity and then focuses on the relatively developed economies of Thailand and Malaysia. These two economies are in the upper-middle-income stage wherein the issue of the MIT is more acute compared with others at low- or lower-middle-income stages. In particular, case studies on specific areas are conducted, such as the electronic cluster in Penang, Malaysia, and automobile cluster in Thailand.

2. Theoretical perspectives and research framework

2.1. National innovation systems and windows of opportunity

A theoretical departing point for this research is the Schumpeterian concept called the innovation systems (Lundvall 1992). Innovation systems involve the relationship among the
actors involved in creating, diffusing, and utilizing knowledge and innovations. The innovation systems can be discussed at several levels, including nations, sectors, sub-national regions/clusters, and firms. The effectiveness of the innovation system of each nation or sector will determine their innovative and economic performance. In this perspective, a wrong response to new innovations can be considered a sign of system failure (Lee and Malerba 2017).

The two related sub-concepts in the framework are leapfrogging and “windows of opportunity.” Perez and Soete (1988) propose that emerging technological paradigms may serve as a window of opportunity for the latecomer to leapfrog into new technologies. The replacement of analog technology by digital technology since the 1990s (the Third Industrial Revolution) served as a window for Korea and Taiwan (Lee and Malerba 2017). Similarly, the 4IR can be a window for the next tier of Asian economies. However, coordinated and strategic responses are needed to realize these potentials.

2.2. From double dividends to diverse risk in Southeast Asia

ASEAN economies have been perceived to enjoy the unique advantage of “double dividends,” namely, demographic dividends of young population and the digital dividends of this young population with high extent of digital literacy. However, this cannot be generalized to every country. For instance, Malaysia and Thailand are facing increasing labor shortage, whereas Indonesia and Vietnam tend to enjoy cheaper wages and large young population.

Figure 1 presents the basic heterogeneity in the region regarding the nature of young or aging populations and digital literacy. The two groups, namely, the ones in the upper left (aging and higher literacy) and the others in the lower right (young and lower literacy), have no commonality.

Figure 1. Heterogeneity of the double dividends in Southeast Asia: Internet penetration and the shares of young population in 2015.

Note: The figure is plotted by the authors using data from World Development Indicators of the World Bank.
The upper left group may be classified as the “opportunity” group with a high digital literacy but face the risk of a shrinking young population. This group is close to joining the advanced economies of South Korea or Singapore. This group includes Malaysia, Thailand, and Brunei. Malaysia has Internet users of approximately 71% per 100 people, slightly below that of Singapore (82%). Compared with Malaysia and Brunei, Thailand faces a faster-aging population with a similar level as Singapore but attaining roughly 40% level of digital literacy, which is a bit lower than that of Malaysia. Thailand faces rapidly rising wage rates, which necessitates labor importation from Myanmar. The lower right group of countries attained a lower level of digital literacy but have a higher share of younger population.

In Figure 2 we consider other factors, such as wage rates, educational levels, and market size (size of bubbles in the figure) to assess concretely the status and future scenarios of these economies.

First, Malaysia and Thailand have relatively high wage levels with mid-market size and considerably high levels of educated population. Rising wages occasionally pressure these countries to upgrade their productive capabilities. This limited labor force and rising wage rates are typical symptoms of the MIT because rising wage rates force MNCs to leave Thailand and seek cheap wage-based sites, such as Vietnam and Myanmar, in Asia. Thus, we can state that the 4IR can be a blessing (window of opportunity) for countries that may keep FDI firms by introducing automation or other labor-saving technologies. Other MNCs may still leave Thailand or Malaysia to go back their home countries by adopting the “smart factory” idea.

By contrast, increased problems are expected for the second group of countries, such as Indonesia and the Philippines, which are in the mid-range level of wages and mid-level of educated population. On the one hand, these countries have yet to face labor shortage pressure. Therefore, the economic pressure and policy initiatives to upskill the population may not be easily prioritized in their social–political agendas. A transition toward capitalizing

![Figure 2. Three-factor model plot.](image-url)

Note: The figure is plotted by the authors using data from World Development Indicators of the World Bank and ASEAN Briefing. Data for minimum wages are obtained from [www.aseanbriefing.com/news/2013/04/16/minimum-wage-levels-across-asean.html](http://www.aseanbriefing.com/news/2013/04/16/minimum-wage-levels-across-asean.html).
on a critical mass of trained population who can ride the wave of the 4IR may not proceed promptly in these countries. On the other hand, the possible trend of automation in manufacturing would ultimately affect labor-intensive production. They may lose their competitiveness to other countries because their economies have yet to experience the sticky effect to halt MNCs from relocating abroad. Moreover, some MNCs may relocate their manufacturing operations at low(er) wage economies. One of the possible advantages of Indonesia and the Philippines is their relatively large market size, but the population scattered in different areas (islands) of the nation. Further, the unsophisticated market structure (which is unlikely to demand for high tech products and services) and the existing level of human capital are unlikely to influence multinationals to expand their business. Thus, an enduring effort is necessary in this stage of development to build indigenous capabilities and search for niches for domestic market needs.

The third most backward groups include countries with the lowest level of human capital and wage rates, like Myanmar and Cambodia. Given low their wage rates, these countries may be able to compete even with automation (or cheap machines) and attain competitiveness to fuel their economic growth. Vietnam is between the second and third groups in terms of wage levels and human capital conditions. Vietnam attracts a sizable flow of FDI given its cheap wages and advantageous location. However, wage rates continue to rise owing to the sustained economic growth. Vietnam is estimated to have the highest proportion (70%) of their workforce at the risk of replacement by automation, followed by Indonesia (56%); by contrast, the proportion for Thailand is lower at 44% (ILO 2016b, 14).

In general, the impact of the 4IR depends on the types of segments in the value chain the country’s firms conduct in the GVC. Another consideration is that labor costs are not always the dominant factor in location decisions of FDI firms. For example, Thailand is important for FDI firms in the automobile sector not because of its low labor costs, but because of the size of the local markets and the accumulated stock of middle-level skills. The full play of the 4IR in ASEAN economies will be diverse, depending on the nature of new 4IR-related technologies newly adopted by FDI firms, the relative importance of host countries regarding the size of the local markets, and the nature of the local production cluster/system including the quality of the labor force and the supply network.

Multinational firms in ASEAN countries have four options for transitioning to the era of the 4IR.

1. Stay in the same location but adopt new automation technologies to stay competitive.
2. Return to their home country by embracing full scale 4IR-type radical innovation.
3. Move to a neighboring country with lower wage rates.
4. Stay in the same location but diversify by embracing new 4IR technologies in new businesses.

2.3. Selection of cases for investigation

Two countries and their associated sectors have emerged with some commitment to capitalize on technologies under Industry 4.0. Two sectors are the electronic sector in Penang of Malaysia and the automobile cluster in a bigger Bangkok area of Thailand. These two sectors are highlighted as they witnessed some economic spillover effects to
their respective local economies and have been consistent in upgrading their industrial technologies. In the following sections, each case will be discussed. The discussion of the two cases is first based on our review of literature, which are then validated with interviews. In Penang, the positions of interviewees ranged from policy advisors to Penang state government officials, the Vice President of CREST (an industrial research conglomerate in Penang), the CEO of PSDC (a joint industrial driven training academy) and senior engineers in multinational firms in Penang. In Bangkok, we interviewed the presidents of the Thai Automotive Institute (TAI), Thai Electrical, and Electrical and Electronics Institute (EEI), Thai Autoparts Manufacturers Association (TAMA), and executives of automotive part manufacturers.

3. Upgrading and getting out of MIT in Penang, Malaysia

3.1. Economy of Malaysia and Penang

The Malaysian economy has changed remarkably from an economy that depends on agricultural and primary commodities exports to an economy that appropriates multi-sectors for growth. From 1960s to early 1990s, Malaysia has attracted many MNCs which contributed to job creations, technology transfer, and backward linkages to local SMEs (Thiruchelvam, Ng, and Wong 2013). Industrial policy is also implemented in early 1980s to develop indigenous firms that can operate in high capital and heavy industries (Rasiah 2010; Rasiah, Shan, and Salih 2017). Although Malaysia witnessed relatively mixed results of local firms in performing their operations, some managed to graduate from the infant industrial protection and expanded toward the exporting market.

Penang in Malaysia has long been recognized as a productive cluster hosting MNCs in electronic parts and components. MNCs operations in Penang started since 1972 when a free trade zone was launched, offering incentives, such as low-cost wages and tax haven. MNCs have also been instrumental in developing new niches and economic growth of Penang (Ari and Figueiredo, 2004).

Penang has now reached the level of GDP per capita (PPP), much higher than the average Malaysia. We can argue that Penang has already overcome the MIT as its income level has reached over 50% to that of the US and is now even close to the level of South Korea (Figure 3). Although Penang faced negative growth rate due to the 2008 global financial crisis, it recovered in 2010 and achieved 7.73% in 2015 (Table 1), while the rest of Malaysia witnessed a declined growth rate in the same year. The manufacturing and services are the core sectors propelling the growth. Penang has still kept a relatively high share of manufacturing in GDP of 44.5% on average since 2010.

Penang has also maintained a low unemployment rate, from 2.5% in quarter 1 of 2009 to slightly above 1.5 in quarter 1 of 2016. The total employed population in 2015 is 834,100.\(^1\) The share for a high-skilled worker is 29.2, mid-skilled worker is 31.7, and low-skilled worker is 39.7. In 2015, roughly 18,725 new jobs are created in Penang. The share of the MNCs in the total investment has ranged from 60% to 70% from 2014 to 2015, with ups and downs but no clear trend of decline (see Figure 4).

In summary, Penang has evolved from a labor-intensive manufacturing toward a cluster that provides software, engineering design, R&D, and industrial system-
based services, whereas the low value-added manufacturing operations are ending. Notably, the new cycle of development is emerging, and Penang has diversified to high value-added servicing industries, such as medical tourism, education, shared service center, and R&D (Penang Economic Indicators, 2015:10–15).

What follows highlights the dynamic evolution of the MNCs and local spin-off in Penang.

### 3.2. Co-evolution of MNCs and local spin-offs

Dominant products produced in Penang have six types: land mobile radios; information technology; industrial, scientific, and medical equipment; auto equipment and components; lighting; broadcast; and household appliances. Penang witnessed downsizing of MNC manufacturing operation and M&A among multinationals to rationalize their resources and reduce redundancies over the past few years. An example

![Figure 3. Per capita GDP as % of the US (PPP) of selected economies, 2000–2015.](image)

Note: The figure is plotted by the authors using data from World Development Indicators of the World Bank and Department of Statistics of Malaysia.

![Table 1. Growth rate of per capita GDP of selected economies and Penang, 2006–2015.](table)

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</thead>
<tbody>
<tr>
<td>Indonesia</td>
<td>6.82%</td>
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<td>6.27%</td>
<td>3.89%</td>
<td>5.77%</td>
<td>6.50%</td>
<td>6.17%</td>
<td>5.56%</td>
<td>5.27%</td>
<td>4.44%</td>
</tr>
<tr>
<td>Malaysia</td>
<td>6.45%</td>
<td>9.40%</td>
<td>3.42%</td>
<td>−3.55%</td>
<td>6.12%</td>
<td>5.45%</td>
<td>5.44%</td>
<td>4.56%</td>
<td>5.96%</td>
<td>4.40%</td>
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<tr>
<td>Thailand</td>
<td>7.01%</td>
<td>7.09%</td>
<td>3.08%</td>
<td>−0.44%</td>
<td>7.66%</td>
<td>2.37%</td>
<td>8.01%</td>
<td>3.78%</td>
<td>2.26%</td>
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<tr>
<td>S. Korea</td>
<td>6.35%</td>
<td>7.21%</td>
<td>2.95%</td>
<td>−1.15%</td>
<td>6.80%</td>
<td>2.75%</td>
<td>2.78%</td>
<td>1.81%</td>
<td>3.07%</td>
<td>2.28%</td>
</tr>
<tr>
<td>Penang</td>
<td>6.94%</td>
<td>6.27%</td>
<td>−2.29%</td>
<td>−5.73%</td>
<td>4.60%</td>
<td>2.37%</td>
<td>5.11%</td>
<td>5.16%</td>
<td>7.67%</td>
<td>7.73%</td>
</tr>
<tr>
<td>USA</td>
<td>4.59%</td>
<td>3.38%</td>
<td>0.70%</td>
<td>−2.98%</td>
<td>2.84%</td>
<td>2.83%</td>
<td>3.21%</td>
<td>2.50%</td>
<td>3.28%</td>
<td>2.81%</td>
</tr>
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</table>

Note: Data are compiled from World Development Indicators of the World Bank and Department of Statistics of Malaysia.
is the consolidation initiatives by US-based Amphenol and Hitachi Global Storage Technologies (HGST). Moreover, firms in Penang are planning their exit policy. From January 2015 and June 2017, 6,136 employees are estimated to be affected by such changes. Multinationals, such as Seagate Technology and Fairchild are among the exit companies that may lead to high level of employee retrenchment. These groups of firms are seen as one that moved their low value-added operation to lower wages countries. Moreover, multinationals, such as Intel, reduced its investment in low value-adding operation and committed to R&D, prototyping, and shared servicing center in Penang.

However, many MNCs maintained certain operations in Penang, as they are provided with strong supply chains to produce state-of-the-art technologies and services. Further, a new cycle of firms is observed to emerge and perform high value-added activities. These firms include Kerry Logistic, Boston Scientific, Jinko Solar, Bosch Car Multimedia, HP Inc., and Atotech. In addition, existing firms in Penang, such as Toshiba Medical, Osram, Paramit, Linear Tech, Jabil, and KLS MARTIN, expanded their businesses between January 2015 and June 2017 for high value-added activities. Companies, like Agilent, operate in Penang for high valued engineering tasks, such as prototyping and services, and Motorola executes full cycle of engineering operation for its telecommunication business, from research and design to prototyping, production, and ultimately engineering services. As estimated, the entry of new firms and the expansion of existing ones will create 8,625 new jobs. The creation of new jobs will offset losses from the downsizing of MNCs.2

Noteworthy, local firms that define niches and new industries for Penang are emerging. Local firms are committed to advance their high value-added activities in Penang. These firms include Vitrox (a spin-off from HP producing automated machine inspection vision system), Globetronics (a spin-off from Intel providing semiconductor process services), and EngTek (from a humble workshop in 1970s providing services to MNCs to producing hard disk drive components, precision tooling).
In summary, many MNCs, such as Intel and Motorola, have decided to stay in Penang while intensifying their high value-added services and expanding toward full cycle of engineering operation, whereas many spin-off firms are seen keen on appropriating the supply chain network and potentials of complementary of Penang in developing niches under Industry 4.0.

In the next section, we discuss key local institutions that have facilitated upgrading of value-chains in MNCs and emergence of locally owned companies with many of them as spin-off from the MNCs.

### 3.3. Key enabling institutions

The success of Penang can be attributed to its consistent commitment in upgrading of research infrastructure, social capital, and state-of-the-art skills useful in GVCs. Two key institutions can be noted. The one is the Penang Skill Development Centre (PSDC), and the other is the CREST, namely, the Penang R&D consortium.

PSDC is an agency established to cultivate skills for productive activities of the blue collar working population. Established in 1969, Penang Development Centre (PDC) was a state agency that helped Penang attain industrial park development and employment creation, and cooperated with MNCs, such as HP, Intel, and Motorola. They together founded PSDC in 1989, a non-profit institution that provides technical knowledge and training program to technicians and engineers in the industrial park. The center has an established industrial network and knowledge base and can provide specialized knowledge useful for advanced industrial operation. Approximately 200 company members of PSDC contribute to its technical knowledge base and enjoy the benefits of ensuring a stable supply of manpower. PSDC also hosts a number of laboratories for shared services to its members. In 2016, PSDC has trained and certified 7,048 individuals as skilled workers in the industrial park, a ratio of 35 workers per company in Penang.

PSDC plays a significant role in the process of developing competencies for technologies under Industry 4.0. The agency is endowed with resources from the government to empower working population in Penang and elsewhere with knowledge useful to develop niches under Industry 4.0. Training programs are provided to develop competencies for Industry 4.0. These include I4.0: the idea, architecture, demand, and approach; Embedded Systems for IoT; Cloud Architectures & Technologies; Cybersecurity Fundamentals for Industry 4.0; Big Data: Methods and Solutions; and The Robot Operating System.

CREST, namely, the Penang R&D consortium, was established in 1999 to host multinationals and local firms, universities, and research institute to perform research and provide research training for talented individuals to achieve critical mass of skilled human workforce. The CREST formed research areas that explicitly define domains of Industry 4.0. The consortium provides scholarships, grants and research supports to interested individuals seeking to advance their academic qualification (MSc or PhD). In addition, to establish a network that is productive for Industry 4.0, the consortium now creates a collaborative scheme to promote co-patenting activities among its members.

The state government has also acknowledged the issue of brain drain, for instance, from Penang to Kuala Lumpur or Singapore, and thus, initiated a number of programs to reverse the phenomenon. This includes providing scholarship (Penang Future Foundation) to those aiming to pursue a higher degree of education in which the
attainable knowledge will bridge the gap of industrial knowledge (that are needed in Penang) and develop areas that may bring potential growth and development in Penang. A state agency, namely, Penang Career Assistance and Talent Centre, is established to coordinate and inform talents regarding the needs and knowledge gaps of industries. The state government also offers space for talented young people to perform start-up businesses, such as creative animation services and APP development. Talented Singaporeans moved to Penang as they sought to enjoy the low cost of living.

In sum, the government in Penang is actively involved in productive networking between local firms and multinationals. The public-private networking is sought initially to address basic infrastructure issues, such as power and water supply and movement of workers, and then has evolved to stimulate value-added activities and promote upgrading via delivering specialized and generic training programs. The network has been instrumental for technological deepening as the government can identify sources of partnerships for different upgrading programs (Rasiah, Shan, and Salih 2017, 299–302).

According to the interviews, industrial stakeholders believe that along with existing supply chain and network, Industry 4.0 will provide a window of opportunity for further upgrading and development in Penang. As noted by an ILO study on the electronic sector in ASEAN, robotic automation in this sector occurs in the form of collaborative robots to perform repetitive, high-precision, and difficult tasks. Such robots tend not replace but aid high-skilled workers (ILO 2016d). Moreover, the IoT is regarded as offering an important growth opportunity for electronic firms; for instance, IoT presents exciting possibilities for enterprises to improve their efficiency in almost every sector because the connection of disparate operations, synchronize machines, and generate insightful data is enabled. The observation of ILO indicates an opportunity because the region’s electronic sector and subsectors possess a formidable and established nexus of producers and suppliers and demand for IoT devices and components produced in the region will increase. We view such process as productive, leading firms to produce critical mass of agents that can perform for technologies of Industry 4.0.

4. Possibility of upgrading in Thai automotive sector

4.1. Thai economy

Moving from a low-income country to a lower middle-income country in the early of 1970s, Thailand has joined the ranks of the upper-middle-income countries since 2005. Thailand started the industrialization with import-substitution strategy in the 1960s, and then shifted to export-orientation strategy since the mid of 1970s. Given advantages of rich natural resources, low labor cost, and macroeconomic stability, Thailand has attracted investment from MNCs, particularly Japanese enterprises, which has become an important driver for economic growth. The export-orientation strategy has led Thailand to participate in the GVCs, particularly in the areas of automobiles and electronics. Therefore, Thailand’s economy has been restructured significantly. The GDP share of the agricultural sector decreased from 31.1% in the 1960s to 12.3% in the early half of 2010s, while the manufacturing sector increased from 22.8% in the 1960s to 42.8% in the early half of 2010s.3

Between 1987 and 1996, Thailand enjoyed the economic expansion with GDP growth averaging around 9.5% per year. This economic expansion merited political stability,
a business-friendly regulatory environment, a large domestic market, open access to foreign investment, and great participation in regional value chains. When the Asian financial crisis broke out in 1997, Thailand faced an unprecedented contraction. Since then, a series of unfortunate events hit Thailand’s economy and slowed down the pace of recovery, i.e. the political unrest in 2006, the global financial crisis in 2008, the global demand slump in 2009, and the massive flooding in 2011. Those events dampened investors’ confidence and affected the domestic demand and growth performance. Consequently, the GDP growth dropped to an average of 3.9% during 2000–2014.

Labor force has also been restructured. Presently, Thailand apparently faces labor shortage, particularly, skilled workers. One of the factors causing a labor shortage in the industry is the rapid demographic change. The proportion of people aged over 60 has more than doubled during 1975 to 2007, from roughly 5% to 11% of the population (or 7.2 million people). The decline in the share of the working-age population will open an economic growth gap that automation can potentially fill. Another factor to consider is the wage increase. The government raised the daily minimum wage to 300 baht in seven provinces in 2012 and nationwide in 2013, which meant 85% rise in labor costs to certain firms; the minimum wage increased by over 60% during the past decade from 184 Thai Baht (THB) in 2006 to THB215 in 2011 and then to THB300 in 2013 (ILO 2016c, 9). This brought about adverse effects on labor-intensive industries and SMEs. Consequently, many labor-intensive firms have turned to migrant labors, for instance, from Myanmar. Enhancing worker productivity and more automation seem to be the long-term solutions to restructure labor market, particularly regarding the lack of qualified workers.

To prepare Thailand for entering the 4IR, the Prime Minister, General Prayut Chan-o-cha, has announced the development policy, known as “Thailand 4.0,” which aims at the transition from a productivity-driven to innovation-driven economy. Thailand 4.0 is to enhance the country into a high-income country by promoting a knowledge-based economy. Ten future industries have been identified for promotion, such as next-generation automotive, smart electronics, and robotics. Additionally, major investments in infrastructure are underway, including the Eastern Economic Corridor (EEC). The EEC is to be a new growth hub, which is a part of the ADB’s Greater Mekong Sub-region (GMS) project, covering Rayong, Chonburi, and Chachoengsao provinces where automobile cluster is located.

4.2. Automobile cluster in Thailand

The automotive industry in Thailand started in the early 1960s under an import substitution policy. It has contributed increasingly to the Thai economy in terms of value added and employment, especially since 2001. Given a pool of qualified engineers and technicians and an extensive supplier network enabling integrated production, Thailand is clearly the strongest automotive production base in Southeast Asia. Data from National Economic and Social Development Board show that total labor employed in the auto industry was nearly 310,000 persons, and the industry accounted for 7% of Thailand’s total value added in 2011.

Currently, firms in the industry can be classified into three groups, namely, 17 car assemblers, approximately 648 first-tier suppliers around 1,700, second- and third-tier suppliers that include supporting companies. Most of them are SMEs (Figure 5). Most
Assemblers are subsidiaries of MNCs. They are dominated by Japanese MNCs and the entry of three large US car companies, namely, Daimler Chrysler, General Motor, and Ford who primarily produce and export one-ton pickups from Thailand. Indigenous Thai suppliers used to be mainly in “non-functional” parts, such as body parts, accessories, and other parts, while foreign suppliers are concentrated in the group of “functional” parts, requiring high manufacturing and design capabilities to produce parts, such as engine, electrical transmission, and suspension parts.

Before 2000s, these carmakers only executed productions in Thailand, while sophisticated activities, like design and R&D, were done in their home countries. Since the 2000s, MNCs’ investment strategies have changed, designating Thailand to be their regional export hubs. They began investing more sophisticated activities beyond simple assembly, such as advanced engineering, process and product design, and advanced testing and validation, to have good coordination between production phase and development phase. Several major MNCs (mostly Japanese) have established technical centers in Thailand, in addition to their normal production plants (e.g. Toyota Motor Asia Pacific Engineering and Manufacturing Co., Ltd.; Nissan Technical Center Southeast Asia Co., Ltd.; ISUZU Technical Center Asia Co., Ltd.; Honda R&D Asia Pacific Co., Ltd.). The R&D activities of these companies focused on modification of products to fit local demands and to exploit local advantages, such as analysis of appropriate local natural raw materials and parts to meet international standards, or the standards of importing countries. Thus, a trend exists that more advanced product designs will be carried out here. For example, Nissan, which is used to implement only mass production of final products in Thailand, is now performing sophisticated activities, like clay modeling and vehicle planning and simulation, in its technical center.

This trend of increasing level of activities in the Thai auto sector is also accompanied by the rapid growth of domestic value-added in that sector, as shown by Figure 6. The domestic value-added by the auto sector in Thailand has increased from a mere 1 billion in the late 1990s (or at the peak of the Asian financial crisis) to nearly 10 billion by the early 2010s, and used to be smaller than, but surpassed, those by Malaysia or Taiwan in 2005. Even if one considers price changes, this 10-fold increase
must be an impressive growth. In exports, Thailand far exceeded other countries in the region, exporting more than 25 billion US dollars in 2015, compared with less than 5 billion dollars each by others in the region (ILO 2016c).

4.3. Upgrading, upskilling, and current challenges in the cluster

The growth of the Thai automotive industry in production and technological upgrading can be partly attributed to government policies (Baldwin 2016). To boost investments in the domestic production of automotive parts, the Thai government imposed a local content requirement of 25% on automotive assembly in 1969. Before the local content requirements, Japanese part makers already entered Thailand to produce spare parts. New vehicles (both passenger cars and commercial vehicles) were purchased through the completely knocked down (CKD) imports from Japan. After the requirement was enacted, car makers started purchasing locally. However, Japanese carmakers could not rely entirely on locally owned Thai firms. Thus, they requested Japanese automotive parts suppliers to build plants and supply locally.

In the late 1970s, a localization policy was formulated with the aim to reduce the trade deficit and boost the industry (Baldwin 2016). In addition, to import bans and raising tariff rates on CKD and complete built units (CBUs), the government limited the number of automotive models and increased the local content requirement from 25% to 50% for passenger cars. To further boost the development of the parts industry, the government raised the local content requirement to 54% for passenger cars and 60% to 72% for pick-up trucks. This policy gave rise to new investments in automotive parts and facilitated the transfer of technology to the Thai automotive industry.
In the late 1980s, the appreciation of the Japanese yen increased the cost of major automotive parts imported from Japan. The yen appreciation triggered the relocation of Japanese parts producers to Thailand to reduce production costs. As indicated by the huge increase in FDI inflows, the degree of MNC involvement in the Thai automotive industry increased for both carmakers and parts suppliers. Japanese part suppliers then established new affiliates to manufacture new and sophisticated parts since the late 1980s when Japan experienced dramatic currency appreciation. In the mid-1990s, the Thai government also assigned one-ton pick-up trucks as the “product champion” for the automotive industry. Tax incentives and other promotions were specially implemented, which led to remarkable investment and subsequent exports of this product. Thus, Thailand has become the second largest production base of pick-up trucks after the US.

After the crisis in 1997, the Board of Investment (BOI) removed the restrictions in foreign shareholding to help affected companies improve their liquidity positions. Prior to this, the policy required that the majority of ownership must be held by a Thai national. Many investors, mostly Japanese, maximized this new policy. From November 1997 to September 2000, foreign partners in 164 automotive firms changed their shareholding structure from minority shares to majority shares (Charoenporn 2001). FDI inflows had thus reached a record high by the late 2000s.

In 2004, the BOI tried to focus on long-term competitiveness of the country, namely, the development of indigenous technological capabilities and human resources. A special investment package that promotes “Skill, Technology, and Innovation” was initiated. Firms can enjoy one or two years extra tax incentives beyond their standard formula when they establish factories in Thailand and perform the following activities in the first three years: spending on R&D or designing at least 1% to 2% of their sales, hiring scientists or engineers with at least a bachelor’s degree in 5% of their workforce, spending on the training of their employees with at least 1% of their total payroll, and spending at least 1% of total payroll on training the personnel of their local suppliers.

The Thailand Automotive Institute (TAI) was established in 1998 as a sector-specific promotional and intermediary agency to strengthen cooperation between the government and private enterprises to enhance the competitiveness of the industry. The TAI is not a part of the national bureaucracy and comes under the Industry Development Foundation established by the Ministry of Industry. The exemption from rules and regulations of the ordinary government agencies indicate that the organization’s administration is relatively flexible. The TAI’s governing committee, which is headed by the Permanent Secretary of Industry, comprises representatives from the government, private sector, and the academia.

The TAI has defined capability building of the parts manufacturers as one of its important tasks. Given its database that includes 2000 parts manufacturing companies, the TAI aims at upgrading the technological capabilities of these companies through consultancy and testing services (through its testing center in Bang Pu, close to Bangkok). Most of TAI’s activities aim to test whether the components and parts produced by these companies are up to international standards (hence, qualifying for export or being part of value chains of MNCs).

Another important institution that helps private firms is the Automotive Human Resource Development Program (AHRDP) established in 2006. This program is a collaboration between Thailand and Japan. The Japanese side is led by the Japan K. LEE ET AL.
International Cooperation Agency, the Japan External Trade Organization, and the Japanese Chamber of Commerce. The program aimed to upgrade the capabilities of local auto part manufacturers. Graduates of the program should be able to train other people in their companies or supplier partners. Four leading Japanese companies participated in the program by providing training experts and course materials in their specialized area: Toyota (Toyota production system), Honda (mold and die technology), Nissan (scheme of skill improvement), and Denso (manufacturing skill and mind management). The training covered theoretical knowledge, hands-on skills, and attitude. Auto part manufacturers (either foreign owned, joint venture, or local firms) were requested to send qualified persons to participate in the program. The AHRDP is a remarkable program as it created a pool of talented trainers although tangible results are rather diverse and vary depending on cases. Other initiatives include the partnerships forged between auto players and government bodies; for instance, the Ministry of Education’s Office of the Vocational Education Commission provides young technicians with internship programs with firms like Isuzu, Toyota, and GM (ILO 2016c, 15).

In terms of automation, Thailand has 2,600 units of industrial robot stock, which is relatively at par with that of Singapore (International Federation of Robotics 2017). This figure is still smaller than that of China (87,000), Korea (41,400), and Japan (38,600). Nonetheless, more than half (51.4%) of the robots are employed in the Thai automotive industry, which is higher than the 36.48% in Japan and 38.65% in Korea. This figure suggests that the automotive industry is leading the automation in the Thai industry. Thailand has roughly 25% robot density in terms of the number of industrial robots per 10,000 employees; this level is higher than that of Mexico, Malaysia, Ireland, or Hong Kong (UNCTAD 2017, Figure 3.5). In terms of the speed of robot installation, Thailand ranks second to China from 2005 to 2014 (UNCTAD 2017: Figure 3.8 in page 53).

The eagerness to adopt automation in the Thai auto sector is a response to serious labor shortage. Thai-based auto assemblers and component producers indicated shortages of skilled workers for over a decade (ILO 2016c, 13). For instance, in 2013, an official from the TAI noted that the automotive industry faced a manpower shortage of approximately 900,000 workers (ILO 2016c, 13). The number of Thai auto sector workers peaked at 462,073 in 2014 and then decreased to 412,437 in 2015 and 421,061 in 2016.4

For the Thai auto sector, the challenge comes not from automation but from the increasing “electronification” of automobiles; cars are becoming more electronic than mechanical products. However, as of 2017, the Thai automotive industry still lags in terms of the technologies needed to produce locally high-tech electronic parts, such as advanced sensors and cameras as part of an automatic brake system and lane-keeping system; the industry can only handle simple systems, such as airbag and anti-lock braking (Aimpichaimongkol and Pantaweesak 2017). Further, the arrival of electric vehicle (EV) creates more uncertainty. Cars based on internal combustion engines require 30,000 parts, but an EV only requires 1,500 parts. An estimation is thus that 816 parts manufacturers that employ 326,400 people and 183 firms in supporting industries will be affected (Wongkolkitsilp 2016).

Depending on how the Thai auto sector copes with these problems, a possible risk remains that new production lines for next-generation cars or components may relocate to other countries. For example, the production of the powertrain, chassis, and transmission parts for Toyota Prius (hybrid cars) was performed in Japan, but Toyota also
had assembly lines in Turkey and Thailand. Afterward, Toyota expanded the volume of production in Turkey, whereas the Prius production base in Thailand was shut down in 2015 due to weak domestic demand and dispute with Thai authorities over taxation. This event was a huge loss to Thailand.

In response to the challenges associated with next-generation innovations, the government established the new Super Cluster Investment Packages in 2016. The targeted investment covers advanced technology vehicles, high capacity motorcycles and large bikes, automotive engines, parts with high technology, etc. Several universities and sector-specific institutes were also established to produce engineers and technicians who have adequate skills and knowledge in new technologies, particularly in AI, robotics, and mechatronics. They include Mongkut’s University of Technology Thonburi, Chulalongkorn University, and the Punyapiwat Institute of Management under the CP Group, the largest Thai conglomerate.

5. Summary and concluding remarks

Export-oriented manufacturing is a critical part of the Asian model of development. However, these manufacturing businesses have encountered difficulty from the rising domestic wages while their products remain in the low-end segment. Thus, certain Southeast Asian economies are showing signs of being stuck in the MIT. The arrival of the 4IR is another source of challenges because of the possibility of reshoring factories in the region back to the rich world. This study investigated the possibility of upgrading these economies to emerge from the MIT and the possible impacts of the 4IR on this process.

First, the double dividends of Southeast Asian economies are not uniform across economies in the region, which can be divided into two heterogeneous groups. The first group has an aging population and higher digital literary, and the other with a young population and lower digital literacy. The full impacts of and responses to the 4IR can be discussed by considering other factors, such as the human capital conditions, wage rates, and market sizes of each country.

Second, the 4IR can be a blessing (window of opportunity) for countries like Malaysia and Thailand that are facing labor shortages. This situation may involve the FDI firms that introduce factory automation or other labor-saving technologies headed toward the road of upgrading into higher segments with local spillovers. By contrast, more problems are expected for the second group of countries, like Indonesia and the Philippines, which are among those in the mid-range level of wages and mid-level of educated or skilled population. In these economies, firms mostly execute labor-intensive production and are likely substituted by additional factory automations or the MNCs move to neighboring countries for low wages. The third, most backward group includes countries like Myanmar and Cambodia, with the lowest level of human capital and wage rates that may compete even with automation although low levels of education and infrastructure sound unpromising to attract FDIs.

Third and more importantly, the case studies of the electronic cluster in Malaysia and the automobile cluster in Thailand suggest a positive possibility of upgrading into high-end segments and thus getting out of the MIT. In both cases, a key factor for this positive scenario is the local institutions that enabled training and upskilling of their
local force, with early start or long history going back to the 1960s or 1970s. In Penang, these institutions include the PSCD, a not-for-profit institution to provide technical knowledge, training program to engineers, and the CREST which hosts multinationals and local firms, universities, and research institutes. In the auto cluster in Thailand, the corresponding institutions include the AHRDP, a collaboration between Thailand and Japanese firms to train workers and engineers, in addition to TAI, a sector-specific promotional and intermediary agency.

Thus, whether the 4IR can be a new window of opportunity or sources for further risk for the MIT of the ASEAN depends on each country’s responses and readiness, including digital literacy, skill, and educational level compared with wage rates, population structure, domestic market size, and position in the GVC.

Notes

1. The economic performance figures are sourced from internal report of Penang Institute.
2. The estimated figures for new jobs and job losses from downsizing of multinationals are sourced from an internal report of Penang Institute.
3. All the information in this section is based on an internal report of the National Innovation Agency of Thailand, to which one author belongs to. The report draws on the National Economic and Social Development Board for most of the statistics on the Thai economy.
4. The number used to be on an increasing trend before 2014, with 384,562 in 2013, compared to 287,307 in 2012 and 213,785 in 2011. The data is from the National Economic and Social Development Board of Thailand.

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