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Upgrading in Global Value Chains: the Cases of High, Mid and Low Technology Sectors in Thailand

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Abstract This paper highlights how Thailand upgrades its positions in global value chains in high-tech, mid-tech and low-tech industries represented by electronics, automotive and frozen seafood, respectively. In the electronics industry, there are not many capable firms in the upstream segment like semiconductors. Nevertheless, transnational corporations in segment like hard disk drive began to invest in process R&D and collaborate more with local suppliers, universities and public research institutes in human resource and technological development. In the automotive industry, several Japanese car manufacturers such as Toyota, Honda, Nissan, and Isuzu set up R&D/Technical centres in Thailand since 2000s. This prompted Japanese and local part suppliers to also invest more in engineering, design and development activities. Some local universities offer as well engineering programmes specifically targeting the automotive industry. In the frozen seafood industry, several Thai firms have developed new ready-to-eat products, own brands and international distribution networks. They started to become transnational corporations investing in both developing and developed countries.

Keywords Industrial upgrading, global value chain, Thailand, automotive, electronics, seafood

I. Introduction

In the past 40 years, Thailand has both achieved consistently high GDP growth rates of approximately 7% per annum and has significantly diversified its economy. The contribution of the agriculture sector to GDP has been significantly reduced from 44% in 1951 to 11% in 2014, while the share of manufacturing increased markedly from 13% to 26% over the same period. Nonetheless, in terms of exports, while the role of primary products has fallen in relation to that of manufacturing, agriculture has diversified remarkably, as Thailand has become one of the world's largest exporters of a wide range of primary products, namely rice, rubber, sugar, cassava, prawns, canned

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pineapple, soy, and frozen sugar. Coincidentally, the growth and diversification of manufactured exports, in sectors ranging from textiles, to automobiles and parts, to electronic and electrical components, has also been remarkable. For example, the shares of exports of electronic/electrical and automotive products increased from 0.04 and 0.25 in the year 1970 to 25.20 and 6.68 in the year 2006, respectively (Yusuf and Nabeshima, 2009). Thailand's economic status upgraded from low-income country to upper-middle-income country since 2003. There are several factors contributing to this success: investment in physical infrastructure and expansion of school and university enrolment, prudent macroeconomic management, and early adoption of export and foreign direct investment promotion policies (World Bank, 1993).

Nonetheless, some scholars such as Yoshihara Kunio (1988) strongly questioned the sustainability of Thailand's economic prosperity. He describes the Thai economy as 'Ersatz Capitalism'. Unlike Western countries, Japan and first-tier East Asian Newly Industrialized economies, the Thai economy grew by overcoming bottlenecks with foreign technology and capital without making serious efforts to increase its own saving and upgrade technology. He believed that this type of capitalism could not keep expanding. Kunio's prediction came true. The country experienced a major economic crisis in 1997. The economic growth rates have decreased substantially to 3-4 % per year on average. The country's once labour-intensive and prominent sectors like textile, garment, toys and shoe has lost their competitive advantages to lower-wage countries. These triggered growing concerns among Thai policymakers and the general public that Thailand is in the middle-income trap[1].

More precisely, the worry is about the limited intensity of technology development in industry, which has contributed to that competitive weakness. This has been revealed in a number of key indicators, both at the macro level in trade performance and overall competitiveness rankings, and at the firm level. At the macro level, although Thailand's economic growth rate in the past 40 years has been rather notable, this has been attained largely by exploitation of factor inputs. The clear indication is very low growth rate of Total Factor Productivity (TFP). TFP's growth explains other reasons for a country's economic growth beyond the growth of capital, labour and land. Apart from education and other social capital and institutional factors, TFP includes progress of science and technology and innovation. Even in the period of high

[1] By analyzing historical income transitions, the threshold number of years for a country to be in the middle-income trap is calculated. This cut-off is the median number of years that countries spent in the lower middle-income and in the upper middle-income groups. Threshold of 14 years to cross the upper middle-income to high income (USD5,000 to USD11,750) has been calculated (Felipe, *et.al*., 2012).

growth between 1987 and1995 when the economy in general grew at a rate of almost 10%, the TFP growth rate was only around 1.5% (NESDB, 2007).

At the firm level, R&D and Innovation Community Surveys can demonstrate the passive learning of Thai firms and their concomitant low level of technological and innovative capabilities of firms. The surveys have been carried out by the National Science and Technology Development Agency (NSTDA) and, later, the National Science Technology and Innovation Policy Office. R&D surveys were undertaken every year, but the innovation surveys were conducted in the year 2003, 2008, 2011, and 2014. The number of R&D-performing and innovating firms both in manufacturing and service sectors were 27% and 23%, respectively in the year 2014 (Table 1). This shows moderate improvement in innovation performance of firms in Thailand, which correspond to the positive changes after the Financial Crisis in 1997 as will be explained below.

Table 1 R&D-performing and innovating firms in Thailand's innovation surveys

	2003	2008	2011	2014
R&D-performing firms	6.0%	2.43%	7.96%	27%
Innovating firms	5.8%	4.24%	20.73%	23%

Source: Reports on R&D/Innovation Surveys Year 2003, 2008 by National Science and Technology Development Agency (NSTDA) and R&D/ Innovation Surveys Year 2011 and 2014 by National Science, Technology, and Innovation Policy Office

After the economic crisis in 1997, there were a few interesting positive changes in industrial sectors in Thailand:

(a) Several large conglomerates such as the CP Group and Siam Cement Group increased their R&D activities. One large conglomerate alone invested 500 million Baht on R&D in 1999. This is because the crisis made executives of those companies thinks that the long-term survival depends on deepening their technological and innovative capabilities. They could not simply rely on importing off-the-shelf technologies and knowledge necessary for simple production as before.

(b) A number of smaller companies increased their technological efforts by cooperating with universities to improve existing and develop new products and processes.

(c) Several components suppliers in the electronics and automobile industries were forced by their TNCs customers/partners to enhance their efforts to improve product design and production efficiency.

(d) There were young emerging start-ups relying on their own creativity, design, engineering or R&D activities. Entrepreneurs who had acquired a strong technological background, while studying or working abroad, founded these companies. Many of them are "fabless" companies (Intarakumnerd, Chairatana and Tangjitpiboon, 2002). Nonetheless, the pool of potential entrepreneurs is still small, as the rate of enterprise creation per population is rather low. Scientists, engineers or managers tend to work in public agencies or large businesses.

Similarly, the financial crisis has led to some changes in government policies. The new policy initiatives pay much more intention to developing indigenous technological and innovative capabilities. The Board of Investment (BOI), for instance, has launched a special investment package promoting "Skill, Technology and Innovation or STI." Firms can enjoy one or two extra years of tax incentives if they achieve the following activities in the first three years: investing on R&D or designing at least 1-2% of their sales, hiring scientists or engineers with at least a bachelor's degree for at least 5% of their staff, paying for training of their staffs at least one percent of their total payroll, and paying at least one percent of total payroll on training employees of their local suppliers.

In addition, the National Science, Technology and Innovation Act, considered as the 'basic law' on science, technology and innovation, was enacted in 2008 to provide a framework for public and private sector institutions to strengthen the nation's STI capabilities.

Capabilities to be strengthened include S&T manpower, S&T infrastructure, public awareness of S&T, and S&T management and administration systems. The new law also emphasizes the creation and commercialization of intellectual property rights. According to the law, a new supra-ministerial structure - the National Science, Technology and Innovation Policy Committee - has been established, to be chaired by the Prime Minister. Members of the Policy Committee include ministers from key ministries relevant to science, technology and innovation, together with respected resource persons. Since 2009, after the Abisit Government, government policies to promote a 'creative economy' based on creativity, talent and the unique culture of Thai people (the so-called 'Thainess') was initiated. Policy-makers pay a lot of attention to 'creative industries' like Thai food, Thai craft, Thai massage and spa, Thai films, Thai multimedia software and so on. In 2016, Thailand 4.0 Plan was introduced. It aims to change the country into becoming a value-based and innovation-driven economy by emphasising the promotion of technology, creativity, and innovation in focused industries.

Subsequently, the Law on National Competitive Enhancement for Targeted Industries was enacted. The act aims at promoting investments that are in line

with Thailand 4.0. Incentives are given to promoted projects of the targeted industries. Remarkably, apart from tax incentives, the Fund for Enhancement of Competitiveness for Targeted Industries was established with the government seed money of US$ 285 million for investment projects engaged in research and development or human resource development in specific areas.

This paper attempts to analyse whether Thailand is still 'Ersatz Capitalism' without adequate progress in technological upgrading by examining the development of technological capabilities[2] of firms in three leading industrial sectors: electronics, automotive, and food. These three industries were selected, as they represent high-tech, mid-tech and low-tech industries, respectively[3]. They were top three export products exporter in the country. In 2014, electronics products contributed 15% of total export, followed by automotive products (14%), and agro manufacturing products (12%) (Intarakumnerd et al., 2016). Also major innovation took place in those three sectors, especially in the past ten years. This will be discussed extensively in the following sections.

To analyse these three sectors, the sectoral innovation system (SIS) concept will be adopted as an analytical framework. "Sectoral Innovation System Concept pays attention to the nature, structure, organisation and dynamics of innovation and production in sectors. According to Malerba (2002), "A sector is a set of activities that are unified by some linked product groups for a given or emerging demand and that share some common knowledge. Firms in a sector have some commonalities and at the same time are heterogeneous in terms of learning processes and capabilities. There are key elements in a sectoral system of innovation: firms, other actors (such as suppliers, users, universities, financial institutions, government agencies, trade unions or technical associations), networks, demands, institutions, and knowledge base".

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[2] Technological capabilities are defined as "resources needed to generate and manage technological change. These include skills, knowledge, and experience as well as the particular kinds of institutional structures and linkages necessary to produce inputs for technical change. They also distinguish between "depths" of technological capabilities. A basic level of capabilities permits only minor and incremental technical change, whereas technological capabilities at the intermediate and advanced levels, may result in more substantial, novel and ambitious change" (Bell and Pavitt, 1995).

[3] The OECD (2003) has developed a classification of industries. The industries are classified based on the importance of their expenditures on research and development relative to their gross output and value added. Examples of *high-technology* industries are aircraft, computers, communication equipment, and pharmaceuticals; *medium- technology* includes motor vehicles, rubber, plastics, basic metals and ship construction; *low-technology* industries include food processing, textiles, clothing and footwear.

II. Technological Upgrading in the Thai Electronic Sector

Thailand is one of major manufacturing bases of the global electronics industry. At present, there are 2,034 firms in Thai electrical and electronic (E&E) industry. The majority of firms are small and medium sized enterprises (1,354 and 387, respectively) with a substantial representation of transnational corporations (TNCs) in both assemblies and part supplying domains (Thai EEI, 2012). The TNCs (293 firms) dominate the assembly activity with an extensive control over supply chain of parts and components (see Table 2). Central and Eastern regions of Thailand are among the most favourable locations for the industry, following by Northeastern and Northern regions.

Table 2 Structure of Thai electrical and electronic industry

	Assemblers	Part Suppliers
Local firms	43%	60%
Foreign/ Joint venture	57%	40%
Total	100%	100%

Source: Thai Electrical and Electronics Institute

After the financial crisis, total exports of electrical and electronic products increased drastically from US$23 billion in 2000 to US$45 billion in 2014. Most of international trade in this sector are in intermediate goods, i.e., electrical and electronics parts and components. According to Thai Electrical and Electronics Institute, the workforce for the E&E industry has increased from around 300,000 in 2001 to 400,000 in 2011 with an observable representation of migrant workers from Cambodia, Laos, and Myanmar. By 2016, Thai Ministry of Labour also projected that the workforce in this sector will be stable, while the jobs in automotive, petrochemical, chemical, and plastic will be the first three fastest growing sectors.

Subsidiaries of transnational corporations in Thailand has achieved a considerable technical acquisition and upgrading since the 1980s, while R&D activities for new product or process innovation still mainly conducted outside Thailand (Hobday and Rush, 2007). Research and innovation activities in large Thai firms are not quite high, but have also increased, especially on IC and appliance designs (Intarakumnerd, Chairatana and Chayanajit, 2016). Most of SMEs in the electronics industry are original equipment manufacturers (OEMs) for transnational corporations. A number of firms having innovation are low. Among those firms, process innovation is higher than production innovation, and a number of innovative Thai own firms is more or less the same as the number of innovative joint ventures (with foreign partners). On expenditure for

innovation-related activities, these innovating firms spent much more on acquisition of machinery and external knowledge than internal R&D. This reflects the nature of latecomer firms that most of knowledge for their innovations come from outside. They learned from knowledge already generated elsewhere. But they also simultaneously made their own effort on internal R&D to generate their own innovations and to increase the capacity for absorbing such external knowledge.

A leading subsector in electronics industry in Thailand is hard disk drive (HDD). Thailand has been one of the largest manufacturing bases of hard disk drive in the world. In 2012, it held approximately 40% market share of global HDD market accounting approximately for 577 million units of shipments. It employs more than 200,000 workers. The two global leaders, namely Seagate and Western Digital, dominate the sector; nonetheless, there are more than 50 part producers. Most of the first-tier part makers that supply critical parts to Seagate and Western Digital are foreign-owned firms or joint venture dominated by foreign partners. These manufacturers and part makers are located in rather close geographical area in the central and northeastern regions. Together, these companies organize a remarkable cluster and, according to a comprehensive study by AIT/Asia Policy Research (2003), display strengths in investment, process development and industrial engineering. Notwithstanding this growth, the industry has shown important weaknesses. They were significantly weaker capabilities in product engineering and innovation (than in process engineering), even though US TNCs seem to have gone further in building these capabilities in their subsidiaries in Thailand than their non-US counterparts. The industry's domestic value added is still quite low at 31%, though value-added in hard disk drives is already high in relation to the average of the overall Thai electronics sector.

Recently, the two both Seagate and Western Digital started activities beyond assembling in Thailand, namely process engineering and process R&D. Why was the hard disk drive sub-sector more successful than others in electronics industry? To a large extent, this is due to industry-wide efforts to boost up technological capabilities and infrastructure and human resources from private sector as well as a few government agencies during the past 15 years. In August 2004, IDEMA, an industrial association for HDD firms, worked with NSTDA, a leading local research institute, to set up a cluster management organization. Its steering committee comprises CEOs of the four TNCs, local research institutes and representatives of key governmental organizations like the Board of Investment (BOI). The organization, which was later named 'Hard Disk Drive Institute' (HDDI), was led by a technopreneur-cum-university professor who used to work for the industry. This institute initiated future projects focusing on upgrading capabilities of the whole industry in Thailand like joint training programmes and collaborative R&D projects. The

focuses of the training courses are skills and knowledge critically needed for technology upgrading.

After the project started, Thai engineers and researchers, not only those employed by TNCs, have been sent for training at the headquarters of TNCs like Western Digital in the US, up to 1.5 years. After coming back, they diffused what they had learnt by organizing training courses for other Thai engineers and researchers. They also helped TNCs set up R&D laboratory in Thailand. This was the first step to change Thailand from just production base to R&D base of TNCs, even though initially their R&D was aimed at upgrading the production process rather than developing any new product. In addition, by the financial support and coordination of HDDI, industry/university cooperative research centres specialised in HDD component, HDD advanced manufacturing, and data storage technology and applications have been set up in three leading universities, namely, Konkaen University, King Mongkut's Institute of Technology Ladkrabang, and King Mongkut's University of Technology Thonburi. These centres created research networks of professors and researchers in these specific fields. HDDI provided research funding through these centres. Industrial relevance is the prime concern of their research. Before submission, all the research proposals have to be certified by private companies. HDDI is also trying to assist Thai suppliers (mostly SMEs) to be able to participate in the global value chain of TNCs. It provides training courses for Thai firms who previously failed to be suppliers of TNCs.

The courses focus on critical skills such as automation processes to meet TNC's requirements. To summarise, HDDI tried to enhanced spillover impacts from TNCs and absorptive capacities of Thai firms and non-firm actors. The role of HDDI as an 'intermediary' facilitating interaction and collective learning in the HDD sector is very remarkable and very much different from other sectors. Some relationships between TNCs and Thai universities have also transformed from short-term, technologically unsophisticated and personal-based relations to longer-term, technologically advanced and institutional ones. For instance, Western Digital worked with Suranaree University to design a new curriculum for an engineering bachelor-degree programme focusing on HDD technologies.

Western Digital, then, employs graduates from the programme. In addition, students who studied in the programme received every month 75% of salary of a bachelor-degree graduate since they are in the third year of their educational programme (Intarakumnerd and Chaoreonporn, 2013). There are several collaborative research projects under the three industry/university cooperative research centres supported HDDI, for example, development of an Optical System for Measurement Laser Spot Size Reduction of Flying Height Tester (funded by Seagate), Control and Automation Research Unit (funded by

Seagate), and Development of Algorithm for Read/Write Hard Disk Head Inspection Using Digital Image Processing Phase 2 (funded by Western Digital), Design and Development of Automation Production for Head Stack Assembly (partially funded by Western Digital), and Automation (funded by Seagate).

The most significant contribution was human resource development for the Thai HDD Industry. Between 2006-2009, a network of 15 universities was set up; two testing labs were established; HDD Technology training centre was co-founded between HDDI and Western Digital (with 21,736 headcounts joining the training courses); and 644 scholarships for HDD Technology study were distributed to 202 Bachelor Degree, 412 Master Degree and 30 Ph.D. Degree students. As of September 2014, among those students, there were 517 graduate students; nevertheless, only 144 out of them enter into the HDD industry (Sutthijakra and Intarakumnerd, 2015).

The more success of HDD sub-sector is different from others. Thailand's semiconductor sub-sector, for instance, represents one quarter of total electronics exports. It has also been led by TNCs. Nevertheless, cooperation among semiconductor firms in Thailand has been very limited. The sub-sector is characterised by passive technological learning by companies, though there are a few remarkable firms that had significant attempt in upgrading. There were no specific government policies and effective sector-specific agencies to support the industry.

III. Technological Upgrading in the Thai Automotive Sector

The development of Thai automotive industry started in the early 1960s under an import substitution policy. The government revised the investment promotion law to encourage local automotive assembly. Since the years 2001, the automotive industry has contributed considerably and increasingly on the Thai economy in terms of value added and employment. Thailand is the strongest automotive production base in Southeast Asia, because of a sufficient pool of qualified engineers and technicians, and an extensive supplier network enabling integrated production. The data from National Economic and Social Development Board shows that total labour employed in the auto industry was about 310,000 persons, and the industry is accounted for 7% of the country's total value added in 2011. Companies in the industry can be grouped into three categories, which are 17 care assemblers, approximately 648 first-tier suppliers, and around 1,700 second- and third-tiers suppliers including the supporting companies. Most are small and medium size firms (See Figure 1). Most assemblers are subsidiaries of TNCs. They are led by Japanese TNCs together with the entry of the Big Three US car companies, namely Daimler Chrysler, General Motor (GM) and Ford whose major goal is to produce and export one-ton pickups from Thailand.

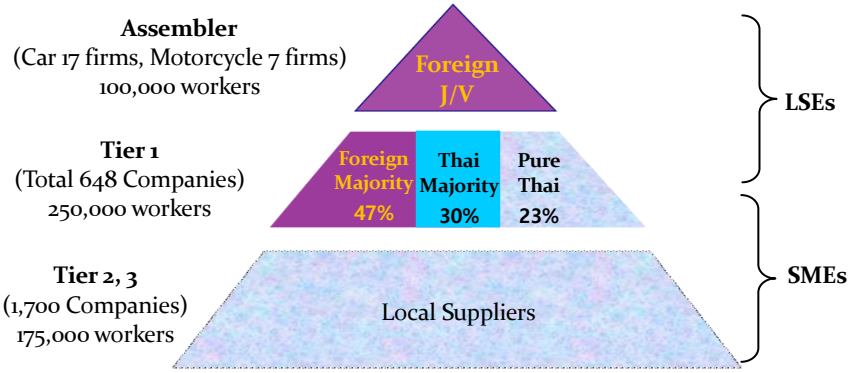

Figure 1 Structure of manufacturers in the automotive industry in Thailand

Source: Thai Automotive Institute (TAI), 2014 Nonetheless, local Thai suppliers are mostly in 'non-functional' parts, for instance, body parts, accessories, whereas foreign suppliers are concentrated in the group of 'functional' parts, demanding higher production and design capabilities to produce, namely, engine, electrical transmission, and suspension parts (See Table 3)

Table 3 Number of automotive OEM part suppliers classified

Group of Part	Thai	Thai Majority	Foreign Majority	Total
Engine Parts	20	8	35	63
Electrical Parts	15	10	27	52
Drive/ Transmission	17	6	29	52
Suspension/ Brake	13	1	21	35
Body Parts	57	17	47	119
Accessories	18	2	19	39
Others	214	24	111	349
Total	354	68	287	709

Source: Thai Automotive Institute (2011)

Before 2000s, these carmakers only had assembly activities, while more sophisticated activities, especially design and R&D, were conducted in their home countries. Since the 2000s, investment strategies of these TNCs began to change, as many firms designated Thailand to be their regional or global export hubs. In order to have better coordination between production phase and development phase, these companies started to invest in Thailand in technologically sophisticated activities more than simple assembly, for example, advanced testing and validation, advanced engineering, and process

and product design. Several large automotive TNCs, especially from Japan, have established technical centres in Thailand. These centres were separated from their normal production plants. They are Toyota Motor Asia Pacific Engineering and Manufacturing Co., Ltd.; Nissan Technical Centre Southeast Asia Co., Ltd.; ISUZU Technical Centre Asia Co., Ltd.; and Honda R&D Asia Pacific Co., Ltd. Initially, the R&D activities of these centres focused on modification of their already designed products to fit local demands and to exploit local advantages. These activities include analysis of suitable local natural raw materials and parts to achieve international standards or the standards of importing countries, especially the European Union's regulations. However, later on, more advanced product design was carried out locally. Nissan, for example, used to carry out only mass production of final products in Thailand. Now its sophisticated activities like clay modelling and vehicle planning and simulation are carried out in its technical centre.

As for part suppliers, College of Management, Mahidol University (2006) has carried out a comprehensive research based on adaptation of technological capability framework developed by Bell and Pavitt (1995). The study examines technological capabilities of six groups of automotive component suppliers, namely, suspension and brake, interior, exterior, engine, electronic, and drive transmission. The result illustrates that, on average, component suppliers in Thailand could be grouped into two categories based on level of technological capabilities. Firms in suspension and brake, interior and exterior had relatively higher capabilities. They have abilities to compete regionally and globally. The other three in engine, electronics and drive transmission components have lesser capabilities, since their principal technologies are more refined and required intrinsic knowledge of TNCs. Interestingly, the study illustrates that Thai-owned firms had higher capabilities than foreign-owned firms or joint ventures in terms of making investment decision, product development, linkages with customers and markets, linkages with supporting institutes, where as foreign-owned firms had higher capabilities in project management, quality control, and linkages with materials and technology suppliers.

The reason why Thai-owned firms had higher technological capabilities than foreign counterparts in some areas is that Thai firms needed to make their own investment decision, carried out product development activities by themselves, and collaborate more with local research and supporting institutions in order to be able to compete with foreign competitors. They could not rely on technology supply and technical assistance from parent companies like foreign-owned makers or joint ventures. For instance, Daisin, a majority Thai owned supplier, managed to stay on as first tier suppliers for several decades. The company was founded in 1979 to produce aluminium-casting parts for the automotive industry as a joint venture with Nissin Koygo Co., Ltd (Thai

partner being a larger shareholder with 67% ownership). The company employed a retired Japanese engineer. This engineer assisted the firm to upgrade its production capability and negotiating with Nissin to considerably lower its royalty fees. Subsequently, the firm also accessed external knowledge besides partnership with Nissin by employing other Japanese technical consultants to assist in upgrading its own design capability. Finally, the firm was able to suggest the new design for a hand brake and a new lighting system to their customers (Japanese carmakers). On the other hand, foreign part makers' investment strategies had to be in accordance with their parents' strategies, and most of product development activities were done in parent companies or headquarters.

The success of the Thai automotive industry in terms of production expansion, and, to a lesser extent, technological upgrading can be partly attributed to government policies. The automotive industry in Thailand began in the early 1960s under the regime of import substitution and a revision of the country's investment promotion law to attract automotive assembly to Thailand. During 1961-1969, nine assembly plants were established as joint ventures between foreign carmakers and local partners. To increase investments in the local production of automotive parts, in 1969 the government issued a minimum local content requirement of 25% on automotive assembly. Before the implementation of the local content requirements, some Japanese parts-makers had already invested in Thailand to produce spare parts. Completely knock down (CKD) of both passenger and commercial cars were imported from Japan to be assembled locally. After the requirement was initiated, car-makers had to purchase locally. Nevertheless, Japanese carmakers could not depend on Thai-owned firms, and they asked affiliated automotive-parts suppliers from Japan to set up plants in Thailand and supply to them.

In the late 1970s, with a goal to lower the trade deficit and boost the industry, a localization policy was articulated. On top of import bans and raising tariff rates on CKD and complete built unit (CBU), the Thai government restricted the number of automotive models and increased the local content requirement from 25% to 50% for passenger cars. Since the Thai automotive industry suffered from low demand in the early 1980s, the carmakers preferred to produce automobiles themselves to utilize their excess production capacity. To further enhance the development of the automotive parts locally, the government increased the local content requirement to 54% for passenger cars and 60-72% for pick-up trucks. This policy gave rise to new investment in automotive parts. It also helped the transfer of technology to the Thai automotive industry.

In the late 1980s, the appreciation of the Japanese Yen raised the cost of key automotive parts imported from Japan. The Yen appreciation triggered the

relocation of Japanese parts producers to Thailand so as to reduce production costs. There was a massive increase in FDI inflows, and the enhanced degree of TNCs participation in the Thai automotive industry for both carmakers and parts suppliers. To follow their customers, Japanese parts suppliers established new factories for supplying new and more sophisticated parts. In the middle of 1990s, the Thai government also designated one-ton pick-up trucks as 'product champion'. Tax incentives and other promotions were specially initiated, leading to notable investment and then exports on this product. Thailand has become the second biggest production site of pick-up trucks after the US.

Thailand had an economic crisis in 1997. To assist affected companies enhance their liquidity, the Board of Investment eliminated the limits on foreign shareholding in November 1997. Before, the policy demanded the majority share ownership to be possessed by a Thai national. Many investors, typically Japanese, benefitted from this new initiative. From November 1997 to September 2000, foreign partners in 164 automotive firms have transformed shareholding structure from minor to majority shareholders (Charoenporn, 2001). FDI inflows in the Thai automotive industry were higher after the 1997 financial crisis and reached the record high by 2007.

In the late 2000s, economical and ecology-friendly car or 'eco-car' was designated as the second product champion. Very preferential incentives conditioned on producing four out of five engine components locally, would be given to interested carmakers. This new product champion is a part of Master Plan for Automotive Industry (2012-2016), which aims to establish Thailand as a global green production base. Consequently, Thailand has turned out to be the centre of eco-car production in Asia. Nissan's March and Honda's Brio, for example, have been produced and exported to the global market.

Together with the above government policies, Thailand Automotive Institute (TAI) was set up in 1998 with a goal of enhancing collaboration between the government and private firms for the increase of competitiveness of the Thai automotive industry. Thus, TAI is a sector-specific promotional and intermediary agency for the automotive industry. In terms of administration, TAI is not a part of the national bureaucracy but comes under the Industry Development Foundation under the Ministry of Industry. Hence, the administration is relatively flexible. It is not under the rules and regulations of the standard government agencies and state-own enterprises. TAI's governing committee, led by the Permanent Secretary of Industry, is composed of representatives from the government and private sector, and academics.

The institute gathers and analyses data, information and related situations, which are used as supporting data for recommendation, guidance and warning to the private sector, or directly and indirectly related organisations in the automotive industry. The most significant study carried out by TAI is the

Master Plan for Thai Automotive Industry. Up to now, TAI has been commissioned by the Office of Industrial Economics under the Ministry of Industry to write two master plans for the industry. The first master plan covers 2002-2006, and the second one covers 2007-2011. For TAI, building capabilities of local parts manufacturers is very important. TAI has a database of 2000 part manufacturers. TAI provides consultancy and testing services through its testing centre in Bang Pu, close to Bangkok, to these firms. Most of its testing activities are to prove if components and parts produced by these firms are up to international standards (therefore, qualifying to export or being purchased by TNCs). This job is very crucial to Thai part manufacturers, which do not have expensive and sophisticated testing facilities inside the companies. However, because of lack of budget and personnel, it cannot perform this job adequately.

The most outstanding programme is The Automotive Human Resource Development Programme (AHRDP) conducted in the period of 2006-2011. It was a joint cooperation between Thailand and Japan. Besides TAI, Federal of Thai Industries was an important player in the programme. Japan International Cooperation Agency (JICA), Japan External Trade Organization (JETRO) and Japanese Chamber of Commerce (JCC) were key players from the Japanese side. To improve the capability of local auto part manufacturers through enhancing abilities of Thai automotive workforce is the objective of this programme. Graduates of the programme were expected to be able to train other people in their firms or supplier partners. Four leading Japanese TNCs provided training experts and course materials in their specialized areas. They are Toyota (Toyota Production System), Honda (mould and die Technology), Nissan (scheme of skill improvement), and Denso (manufacturing skill and mind management).

The training content covers all aspects including theoretical knowledge, practical skills, and working practices. Thai university professors taught more theoretical subjects. The auto part manufacturers (foreign owned, joint venture, or local firms) sent their qualified technicians and engineers to be trainees in the programme. Executives of these firms were demanded to illustrate their commitment by sharing their knowledge and skills. They had to open up their factories for trainees from other firms to visit. This is an outstanding programme. It has created a pool of talented trainers and has increased awareness of the significance of human resource development in the industry. Nevertheless, consequences in terms of the genuine upgrading of Thai automotive workforce are not clear. Some firms, especially larger ones, set up training centres or training courses after joining AHRDP. Smaller companies were less willing to do so.

IV. Technological Upgrading in the Thai Frozen Seafood Sector

Thailand has attained the position of one of the largest and most advanced producers and exporters of processed food products. Its agricultural traditions and abundance of natural resources, in conjunction with substantial investments in international quality standards, technology, and food safety R&D, aided Thailand to become the sole net food exporter in Asia. In 2010, Thailand's export-oriented food industry generated $27 billion - an upsurge of 30% from 2007. Thailand steadily ranks as not only a key food producer regionally, but also globally. Thailand leads a number of food export sectors, ranking first in the world for cassava and tapioca, canned pineapples and seafood products (Board of Investment, 2012).

In the seafood industry in particular, Thailand is one of the key players in the market. In 2012, the value of fish exports reached 264.4 billion Baht (US$8.8 billion). This makes Thailand the 3rd largest fish exporter behind China and Norway. Thailand is also an important market in Asia. Its imports were around 100 billion Baht (US$3.3 billion) in 2012. During the 2000s, there has been a substantial expansion in the frozen shrimp and cephalopods processing and tuna canneries. Thailand is the world's largest producer and exporter of canned tuna and shrimp.

There are three levels of the value chain of the seafood industry.

A) Upstream: sourcing and production of raw materials, which can come from the sea or farming.
B) Midstream: post harvesting, sales, transportation, and early processing.
C) Downstream: processing, product development, freezing, and exporting.

Compared to chilled or frozen seafood, processed seafood has a higher value added per one kilogramme. Over 90 % of Thai seafood products are exported. The major parts of these exports are chilled or frozen shrimp. More than 90 % of Thai exports are original equipment manufacturers (OEMs) for foreign customers. Though increase substantially, Thai-owned brands are still far fewer than OEMs. After the 2010s, Thai seafood products experienced competition from lower-cost countries like Vietnam and Indonesia. Branded and more sophisticated products are progressively vital for the future survival of Thai firms. Non-tariff barriers in the form of increased food-safety standards in developed countries are also a major problem for these companies. They have to improve their product quality to fit increasingly demanding standards. Chilled or frozen shrimp, and chilled or frozen fish are two main market segments in the Thai seafood industry. Both heavily rely on semi-skilled labour and low technology. Over 85 % of raw materials in the shrimp industry are from farming. However, most of the raw materials for the fish industry are caught from the waters inside and outside Thailand.

Different from electronics and automotive industries, the frozen seafood industry is led by locally-owned firms. There are two types of seafood firms: large firms and SMEs. Large firms sell in both domestic and export markets.

Most are still OEMs. They sell their products under the brand names of large domestic supermarkets and foreign customers. Nonetheless, some of them became own-brand manufacturers (OBMs). Many of the large firms have acquired know-how from abroad through joint ventures. They are, for example, CP Group, Thai Union Frozen, Surapon Food, Pacific Fish Processing (PFP), S&P, and Prantalay. They have full or partial vertical integration, as they accomplish several activities in the value chain from farming to marketing and distribution. They either have their own farms or are established contracted-farming with local farmers. By doing this, they can have confidence that they can procure sufficient high-quality raw materials. The local farmers are provided with larvae, necessary materials, and technical support. Some companies have their own large fishing fleets for sea catching. The CP Group possesses several distribution outlets like Seven-Eleven and Lotus department stores in China. S&P, another firm, was initially a Thai-food chain-restaurant business. It diversified to produce packaged ready-to-eat food for the ordinary customers under its own brand names. Firms like CP Group and Thai Union Frozen became transnational corporations. CP group invested in more than 20 countries. Thai Union Frozen set up their own subsidiaries in Indonesia, Papua New Guinea, and Vietnam, and took over leading food-processing manufacturers in US, Canada and France. Apart from accessing to markets, the reason for the two firms to invest in other developing countries is to exploit exiting capabilities already developed at home. Their reason to invest in developed countries is to tap into advanced knowledge, international brands and extensive distribution networks. Nonetheless, these Thai firms still heavily rely on OEM/ODM markets. The ratio of ODM to OEM products of these firms is around 1:1.

Most companies set up their own R&D departments to perform product and process innovations. Food technologists and engineers are key human resources for upgrading existing production processes and design new ones. Interestingly, since the 2010s, the R&D departments also recruited locally and foreign-trained graduates in home economics and food chefs. They worked with food scientists and engineers to develop ready-to-eat and ready-to-cook new recipes. Some firms have extended their R&D undertakings by establishing culinary development centres to vigorously develop new processes and products with their customers, whom the companies consider as the most significant source of knowledge. The marketing departments also work closely with the R&D departments. Their aims are to learn what new products the customers need, and to convince them that the firms' new products meet their needs. Linkages with domestic and overseas customers are

important channels for learning about preferred technologies, packaging styles, foreign-market regulations, and tastes.

Remarkably, there was also an emergence of fusion food. They were creative mixtures of different cuisines. Beyond that, new products were the outcomes of convergences of several knowledge disciplines and business approaches. Scientific disciplines include new freezing, chilling and food packaging technologies, and better food logistics. Artistic disciplines cover innovative and delicious recipes, nice-looking packaging, and appealing product storylines. Required services span from retailing practices in supermarkets, convenience stores, to advertising. Process-innovations to enhance productivity, safety, and traceability were also evident.

Moreover, collaborations between large firms and universities have turn out to be more and more significant since 2000s. These collaborations take several patterns, namely, joint- or contracted- research to develop new products, personnel training, and student internship. Faculty of Agro-Industry of Kasetsart University, for instance, provides courses in production processes, product development and marketing. It also had contracted research with large firms on raw materials analysis, production process improvement, and product development.

The majority of SMEs in the industry are family-own firms. They rely on imported technologies. There are very limited R&D activities. They lack efficient energy and waste management systems. They can only perform minor adaptations to imported machinery and equipment. SMEs quality control systems are executed only to the extent needed to pass minimum certification requirements, not for continuous improvement as experienced in large firms.

In terms of policies, generally, Thai government's policies and the agencies in charge of supporting the industry are not very effective, and coordination among these organizations is rather poor. The clearest evidence of this is in 2015 the European Commission threatened Thailand with a trade sanction if the country did not take action on illegal fishing. EU excused that Thailand has failed to certify the origin and legality of its fish exports to the EU. Still, some agencies assisting the seafood industry perform rather well. Some have played vital roles in upgrading the industry.

The main agency responsible for the devising and execution of policies to support the seafood industry, from the fishing and farming stage to the processing stage is the Fisheries Department. It conducts R&D and transfers knowledge to farmers and, to lesser extent, SMEs. Another important activity is providing quality certification to aquatic farms and their products. It was a champion in introducing and promoting quality control and traceability systems to fish and shrimp farms all over Thailand. Chemical residuals in the seafood products were markedly lower as a consequence. This enabled Thai products to meet the standards of importers from developed countries.

The National Bureau of Agricultural Commodity and Food Standards (ACFS) is another important organization. It enforces standards along the whole food-supply chain in order to control agricultural food production and processing. It is also an accrediting certification-body for agricultural commodities and foods.

It represents Thailand in negotiating with international partners, especially on the issues related to the non-tariff barriers to trade.

The National Food Institute (NFI) was found in 1996, under the Ministry of Industry, as a food sector-specific promoting agency. It provides laboratory services for chemical, microbiological, and physical testing, and consulting services related to the adoption of hazard analysis and critical control point (HACCP) practices. It conducts training seminars and workshops, especially those related to international trade. It also publishes papers on food safety and quality. As an intermediary, NFI brokers collaborations between companies, SMEs in particular, and food industry experts who can offer research and training. It has leveraged resources from other government agencies to assist the capability development of firms. The NFI conducted studies related to policy and strategic plans for the government, especially first and second Food Industry Master Plan in 2002 and 2008 respectively. Later it also formulated a strategic plan for the halal-food business.

Apart from government agencies, the Thai Frozen Foods Association (TFFA) also plays important roles. With more than 200 members in processing and exporting of frozen foods, the association is a non-profit organization started in 1968. Almost all of the members are Thai-owned firms. The TFFA encourages entrepreneurship in the frozen food industry. It delivers consulting services. It promotes information exchange and trust building among its members. It acts as a mediator when there are conflicts among its members, or between members and outsiders. One of the most remarkable achievements is an establishment of an endowment fund to be used to ward off short-term common challenges such as anti-dumping measures imposed by importing countries. It also works with government departments responsible for the industry. In short, it was effective in developing 'club goods'. This is quite exceptional for Thai industrial associations.

However, it has not been able to convince its members to collaborate in longer-term issues related to overall technological upgrading of the sector (Intarakumnerd and Charoenporn, 2013). Though the roles of the above-mentioned public and private-sector agencies do not directly contribute to innovation which mainly done by firms themselves, it helped to increase the capacities and skills of the industry's manpower, build trust among actors leading to better knowledge diffusion and cooperation, and enhance regulatory environment which pressure firms to innovate.

V. Conclusion

The Thai manufacturing industry, in general, is technologically weak. Though direct causal effect cannot be drawn, the financial crisis in 1997 somewhat contributed to atmospheric changes both in government policies as well as behaviour of firms. It is like a wake-up call that doing things in usual ways is no longer sustainable. Several large Thai-own business groups, for example, the CP amplified their R&D activities. A number of smaller companies increased their technological efforts by working with universities to improve their production efficiency and develop new products. Several subcontracting suppliers in the automobile and electronics industries were pressured by their TNCs customers/partners to upgrade their product designs and improve production efficiency. There were emerging young start-ups exploiting their own design, engineering or R&D activities. New government policy initiative paid much more attention to deepening indigenous technological and innovative capabilities.

Detailed analysis of three leading sectors also indicates positive changes, though we cannot draw direct causal effects from the financial crisis in 1997. In general, large firms (both TNCs and local ones) illustrate significantly bigger scale of technological and innovative capability enhancement than SMEs. In electronics industry, especially in hard disk drive sub-sector, TNCs began to invest in process R&D and collaborate more with local suppliers, universities and public research institutes in human resource and technological development. In automotive industry, several Japanese auto manufacturers such as Toyota, Honda, Nissan, Isuzu set up R&D/Technical centres in Thailand since 2000s.

This prompted Japanese and local part suppliers to also invest more in engineering, design and development activities. Some local universities also offer engineering programmes specifically targeting the automotive industry. In the frozen seafood industry, several Thai firms have developed new ready-to-eat products, own brands and international distribution networks. Some started to become transnational corporations investing in both developing and developed countries.

Two common factors contribute to qualified successes in technological upgrading and innovation in the three sectors.

First, availability of leading firms, which can stimulate, inspire, or even pressure other firms, especially smaller ones, in the industries to upgrade their technological capabilities. Transnational corporations like Seagate and Western Digital in hard disk drive industry, Toyota, Honda and other carmakers in automotive industry, CP Group, and Thai Union Frozen in frozen seafood industry are examples. Part suppliers, especially local ones, which wanted to engage or keep their businesses with transnational corporations in hard disk drive and automotive industries had to upgrade their capabilities along with the upgrading in products and processes of TNCs in those sectors.

CP and Thai Union Frozen, on the other hand, inspired other smaller Thai firms to upgrade technologically and develop their own brands and international distribution channels.

Second, government policies targeted specific sectors play significant roles in the technological upgrading of firms in particular sectors. The provision of finance, physical infrastructures, regulations, industrial standards, scientific knowledge and services like consultancies and testing catering for specific industries are necessary. General government supports are not enough. What have been highlighted here is the role of 'sector-specific' agencies which have like *intermediaries* linking firms to each other, especially large (TNCs and big domestic firms), linking firms to other actors in the sectors like government authorities, universities, public research institutes and so on. These intermediary organizations can be private sector ones like IDEMA (in hard disk drive industry), Thailand Frozen Food Association in the frozen seafood industry or government-linked agencies like Thailand Automotive Institute (TAI), Hard Disk Drive Institute (HDDI), and National Food Institute (NFI). Strengthening roles and underlying capacities of these intermediaries should be a subject for policy concern.

The roles of intermediaries were largely ignored in the innovation system literature. Intermediary organizations can facilitate innovation processes by performing activities that bridge user needs and the supply side with respect to many areas, including technology, skill and human resources, financial support, business and innovation strategy, knowledge about new technology, implementation, and other matters. (Dodgson and Bessant, 1996). Howells (2006) defined four roles of the intermediary that include acting in the following capacities: (1) consultant, supplying information and advice in the recognition, acquisition and utilisation of the related knowledge and technological capabilities, (2) broker, brokering a transaction between two or more parties, (3) mediator, being an independent 'third party' assisting two organizations to form a mutually beneficial cooperation, and (4) resource provider, securing access to funding and other material support for the innovation outcomes of such cooperation. In our study, HDDI, TAI and NFI perform their roles as consultants, brokers, and resource providers in sectoral innovation systems of hard disk drive, automotive and seafood industries respectively.

To summarize, the ersatz capitalism traits of the Thai economy may somewhat have changed after almost thirty years after Yoshihara Kunio wrote a book in 1988. The Thai economy no longer solely relies on foreign capital and technology without increasing indigenous technological and innovative capabilities at least in certain industrial sectors of its economy. Nonetheless, his notion on ersatz quality of Thai industrial development cannot be totally dismissed, as, even in these sectors, many local SMEs are still weak in terms of technological capabilities and innovation.

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