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Formation of Automotive Manufacturing Clusters in Thailand

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Abstract: *The development of the local supplier base and the formation of industrial clusters are important for industries, especially the automotive industry. This study focuses on local supplier development and the formation of automotive clusters in Thailand. Using the Thailand Automotive Industry Directory 2014, the study investigates the type of parts produced by the respective suppliers, as well as the geographical distribution of suppliers in the automotive clusters. The study finds that the number of firms producing each type of parts is different, depending on the ownership structure. Also, the location of automotive establishments has changed over time, reflecting the changes in location advantages of the respective regions as well as government policy.*

Keywords: Automotive industry, industrial cluster, Location of firms

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1. Introduction

The local supplier base in Southeast Asia is relatively weak in comparison with that in northeast Asian countries such as China, Japan, and Korea. As discussed in this study, the development of the local supplier base and the formation of industrial clusters are crucial for industries, especially the automotive industry. However, empirical evidence is still lacking due to a lack of appropriate data. This study focuses on local supplier development and the formation of automotive clusters in Thailand.

The formation of industrial clusters affects the industrial development of a country in significant ways.

First, industrial linkages tend to promote structural transformation, which leads to industrial diversification and upgrading. Since Albert O. Hirschman published a seminal book on economic development strategy (Hirschman, 1958), industrial linkages have become the focal point of industrial development. In particular, the backward linkages play a critical role by inducing demand for upstream activities, thus stimulating industrial development in the sequence from downstream final assembly to first-tier parts suppliers and then to second and lower-tier suppliers. Furthermore, the production of related industries, including mining, basic materials, machinery, and services would be stimulated by the advancement of downstream activities.

Second, the development of upstream industries and the formation of domestic linkages increase the share of domestic content and decrease dependency on imported inputs. This process contributes to reducing the trade deficits faced by many developing countries.

Third, the development of domestic upstream industries increases the competitiveness of downstream industries by delivering parts and components at a lower cost, within a shorter time, and with more flexibility.[1] Moreover, if the upstream and downstream industries are jointly located within industrial clusters, frequent communication and information exchanges may stimulate innovation (Porter, 1990).

Finally, industrial linkages create an important channel for technology transfer. In particular, the formation of backward linkages promotes knowledge and technology spillover from foreign-affiliated firms to local suppliers (Javorcik, 2004; Blalock and Gertler, 2008).

Due to the above-mentioned benefits to industrial development, many developing countries have tried to develop the automotive industry by adopting a protective policy. However, only a few developing countries have succeeded in forming industrial clusters and gaining competitiveness in international markets. Thailand is one of the few such examples. As discussed below, Thailand adopted an import-substitution policy for the automotive industry in the early 1960s. Since then, Thailand has attracted a large number of automotive manufacturers, especially from Japan. At the same time, the local content requirements (LCRs) helped local suppliers participate in the automotive value chain and they now constitute an essential part of the local supplier network.

It is therefore important to explore how the automotive supplier base was formed in Thailand. In particular, it is important to examine how local suppliers were involved

[1] Due to these effects (i.e. 'forward linkage effects'), the downstream industries (e.g. automotive assemblers) are attracted to a country or region where the upstream industries (e.g. parts suppliers) are located. On the other hand, upstream industries are attracted to a country or a region where downstream industries are located because the latter provide intermediate demand for the former (i.e. 'backward linkage effects'). Note that both the forward and backward linkage effects cumulatively promote the formation of industrial clusters and increase the competitiveness of industries (Krugman and Venables 1995; Puga 1999).

in the formation of the automotive clusters. This study – using data derived from the Thailand Automotive Industry Directory 2014 – addresses this issue from the following aspects.

First, this study investigates the types of parts produced by local suppliers. The study focuses on (1) ownership structure and period of establishment; (2) types of parts and period of establishment; and (3) the relationship between the types of parts and ownership structure.

Second, the study focuses on the geographical distribution of suppliers in the automotive clusters. In particular, it examines (1) the year of establishment of suppliers by location; (2) the relationship between location and ownership structure; and (3) the relationship between location and the types of parts.

This paper is composed of the following sections. First, the paper explains the data used for the analysis. Second, it provides the outline of the Thai automotive industry from a historical perspective. Third, it discusses the process of the formation of the local supplier base from a technological capability viewpoint. Fourth, it discusses the location of parts suppliers in the context of the formation of industrial clusters. Finally, the paper concludes with important findings and suggestions.

2. Data

This paper compiled data on automotive firms in Thailand in terms of 1) geographical location; 2) year of establishment; 3) ownership types; and 4) types of parts produced. This shows the evolution of the industry over the course of economic development in the past 50 years. To accomplish this, we utilised data from the Thailand

Automotive Industry Directory 2014. This directory contains information about the automotive-related companies that belong to four main associations, namely: the Thai Auto-Parts Manufacturers Association, the Thai Automotive Industry Association, the Automotive Industry Club, and the Auto Parts Industry Club (these clubs are under the Federation of Thai Industries). The directory includes data from about 1,954 firms. As far as we know, this is the first attempt to compile and update data from several sources in order to analyse the historical development of the automotive industry in Thailand.

However, the information that we analysed was not complete. For instance, there were only 1,400 firms in the directory that specified their year of establishment. In addition, the directory had no information about the ownership structure of each firm. Only the addresses of the firms were complete, and this was useful to track the firms' location. Therefore, we needed to compile other fields of information from other sources. Some firms had websites, so we searched each of them and updated the missing fields required for our analysis, i.e. the year of establishment, ownership structure, types of parts, and the main products.

For the ownership structure, we utilised information from the database published online in the Thailand Automotive Institute website.[2] For ownership, we classified firms according to the nationality of ownership: 1) Thai firm (T), refers to a firm with Thai share larger than 80 percent; 2) joint venture (JV), refers to a firm with Thai share between 20 and 80 percent; and 3) foreign (F), refers to a firm with Thai share less than 20 percent.

[2] Based on our interview with the Thai Automotive Industry (TAI), the database had been compiled and updated but the number of entries is less than the number in the directory. In addition, the TAI database contained information about the ownership structure, i.e. the share of ownership by nationality. This information is the same as the business registration information at the Ministry of Commerce.

There were about 225 categories of parts and/or activities that each firm can specify as their main product types. The three main group classifications were: automotive-related, motorcycle-related, and service-related. We inputted the data and classified the parts into smaller groups of parts.[3] There were 19 groups of parts, as follows: 1) engine; 2) drive train; 3) suspension/steering/wheel and tire; 4) axle/brake/body control; 5) body and exterior; 6) interior; 7) climate control; 8) driving support and security; 9) electronic/electrical parts; 10) small/general parts; 11) categories by production process; 12) clean energy system; 13) motorcycle parts; 14) automobile assembly; 15) agricultural machinery and other transport machinery; 16) chemical, oil, lubricant, paint, etc.; 17) accessories; 18) service (trading, logistics, trade show, training, etc.); and 19) machine tools, jigs and fixtures, moulds and dies, etc.

According to our best knowledge, this data set is the latest update and includes almost all the key firms in the Thai automotive industry. However, some limitations remain. The data is a snapshot of the firms that exist at the time of writing this paper, and assumes the information in the directory has been updated regularly. Thus, this data set cannot detect the actual evolution of firms from the past, whether they may have been operating in the past but no longer exist now. In addition, the information about the main business or main parts produced concerns the firms' current production. Thus, we must be careful when interpreting the evolutionary result of a firm's establishment and the type of parts available in each period. We should also note that the information

[3] We followed the auto parts classification at www.marklines.com, which classifies parts into 13 main, second, and third categories. Each category consisted of several parts/components and sub-components. We then compared and matched the type of main products from the Thailand Automotive Industry Directory 2014. However, we had to create some more categories of parts that were not in the list of the auto parts classification. They were automobile assembly, agricultural machinery and other transport machinery; chemical, oil, lubricant, paint, etc.; accessories; service (trading, logistics, trade show, training, etc.); and machine tools, jigs and fixtures, moulds and dies, etc.

disclosed in the directory is on a voluntary basis. Firms can decide what information they would like to disclose to the industry and business. It is not a survey with complete data, but rather a format of information sharing on a business basis.

3. Historical Development of the Thai Automotive Industry

The Thai automotive industry has developed over 5 decades, and the process has been more rapid since 2000. This is in line with the dynamic growth of the Thai economy. Car manufacturers, predominantly foreign-owned firms, had installed capacity of million units. Production of cars and commercial vehicles reached 2.45 million units in 2012, but decreased to 1.88 million units in 2014 (Figure 1). The Thai automotive sector is one of the few examples of a developing country that has achieved this level of development. Previous studies have argued that Thailand's impressive development was a result of government incentives and trade protection for domestic producers (Kohpaiboon, 2006, 2009; Techakanont and Charoenporn, 2011). This section will explain and discuss the role of the government's policies that encouraged multinational enterprises, especially Japanese carmakers, to expand and deepen their operations in Thailand.

Historically, the automotive sector was promoted in line with the country's import substitution policy. In 1961, only 525 cars were produced locally, while domestic sales totalled 6,080 units. From 1970 to the mid-1980s, the domestic market expanded along with the production volume, when the government changed the policy from import substitution to a more rationalised policy promoting domestic auto parts production. The production volume and localisation ratio has been growing since the 1990s due to

two major reasons: the appreciation of the Japanese yen in 1985, and the commitment of the Thai government to liberalise the automotive sector. This significantly transformed the Thai automotive sector from a highly protected to a more liberalised industry (Poapongsakorn and Techakanont, 2008). In particular, the abolition of the LCR regulation in 2000 significantly transformed the sector to become a more liberalised sector.

According to Poapongsakorn and Techakanont (2008) and Techakanont (2011), the severe shrinkage of the domestic demand due to the 1997 Asian Financial Crisis has forced the manufacturers to adopt export strategy. It seems that the economic crisis aftermath has been a key factor in transforming Thailand to be a production and export base for several carmakers. For instance, in 2002, Toyota announced that Thailand was chosen as part of its global production network for the Innovative International Multi-purpose Vehicle (IMV) project launched in 2004. The success of this project encouraged Toyota to continue and launch the IMV2 (Hilux, REVO) in 2015.[4]

Annual production capacity expanded considerably after 2000, reaching 2 million units in 2010 and 2.8 million units in 2015 (Table 1). Production in 2007 reached 1,301,849 units, with total exports of 690,100 units (Figure 1). This marked an important milestone for the Thai automotive sector because exports exceeded the domestic volume. At that time, Thailand's automotive sector became a fully export-oriented industry, indicating that Thai-made vehicles could achieve international quality standards at competitive prices.

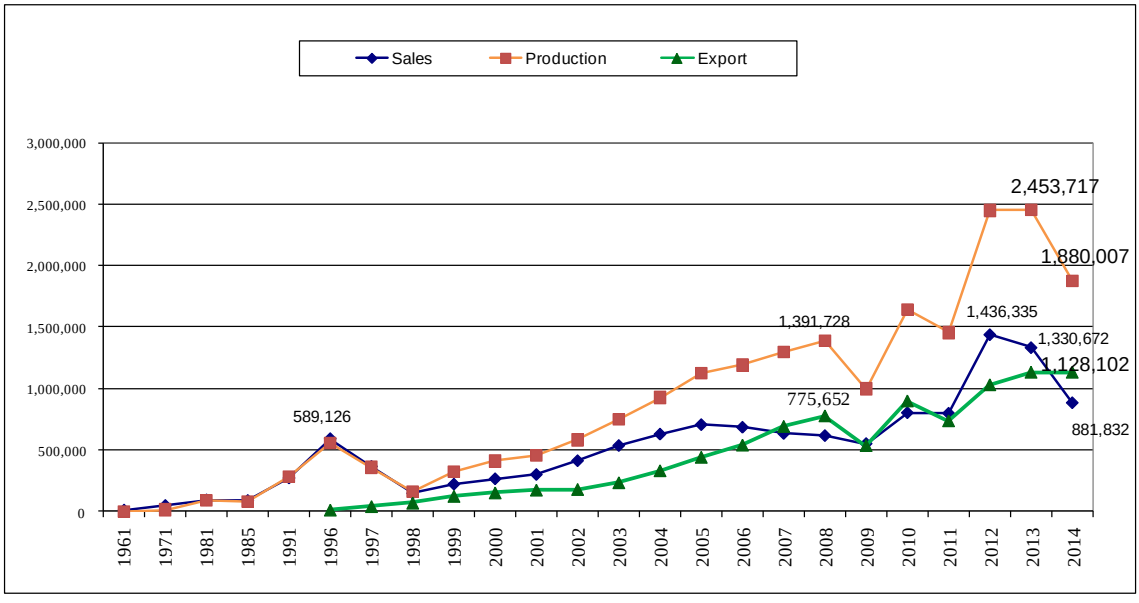
[4] From http://wardsauto.com/technology/toyota-taps-thailand-new-gen-hilux-pickup-launch

Table 1. Production Capacity (Units) of Assemblers in Thailand (1985–2015)

	1985	1994	1999	2005	2010	2015
Toyota	40,800	135,000	200,000	350,000	600,000	750,000
Mitsubishi	n.a.	126,600	174,400	170,200	200,000	450,000
Isuzu	30,000	83,200	140,600	200,000	220,000	338,000
General Motor	n.a.	n.a.	40,000	100,000	160,000	180,000
Auto Alliance Thailand	n.a.	8,400	135,000	135,000	275,000	250,000
Nissan	n.a.	96,500	113,100	102,000	200,000	370,000
Honda	n.a.	39,000	70,000	120,000	240,000	280,000
Hino	9,600	24,000	9,600	28,800	28,800	27,000
DaimlerChrysler	n.a.	4,600	14,900	16,300	16,300	n.a.
YMC Assembly	6,000	14,000	12,000	12,000	12,000	n.a.
Volvo (Thai Swedish Assembly)	3,000	7,000	6,000	10,000	10,000	15,000
BMW	n.a.	n.a.	n.a.	10,000	10,000	8,500
Tata Motors	n.a.	n.a.	n.a.	n.a.	35,000	15,780
Ford	n.a.	n.a.	n.a.	n.a.	n.a.	150,000
SAIC Motor-CP	n.a.	n.a.	n.a.	n.a.	n.a.	12,000
FUSO	n.a.	n.a.	n.a.	n.a.	n.a.	6,000
Scania	n.a.	n.a.	n.a.	n.a.	n.a.	720
United Motors	n.a.	n.a.	n.a.	n.a.	n.a.	5,300
Total	89,400	538,300	915,600	1,254,300	2,007,100	2,846,280

n.a. = not applicable.
Source: Compiled by the authors from various sources, mainly from the Thai Automotive Industry Association, Thailand Automotive Institute, Bank of Thailand, Ministry of Industry, and information received from companies.

Figure 1. Thailand Production, Sales, and Exports of Automobiles (1961–2014)



Source: Federation of Thai Industries, The Thai Automotive Industry Association.

4. Formation of Automotive Clusters

This section explains the evolution of the automotive manufacturing clusters in Thailand. We show evidences of the Board of Investment (BOI) incentives, the LCRs, the development of the road network, and industrial estate (IE) in the Eastern Seaboard region. This point will be analysed and confirmed in the next sections.

Past researches have documented and discussed the evolution of the industry. For instance, Poapongsakorn and Techakanont (2008) and Techakanont (2011) argued that government policies were successful in promoting the industry through a series of protective and supportive policies, particularly between 1970 and 1999. The Japanese assemblers that tried to adjust and comply with the higher policy requirements have played a crucial role in the development of automobile production and in supporting industries in Thailand. This section will also discuss the role of government policy in the establishment of the parts suppliers in Thailand.

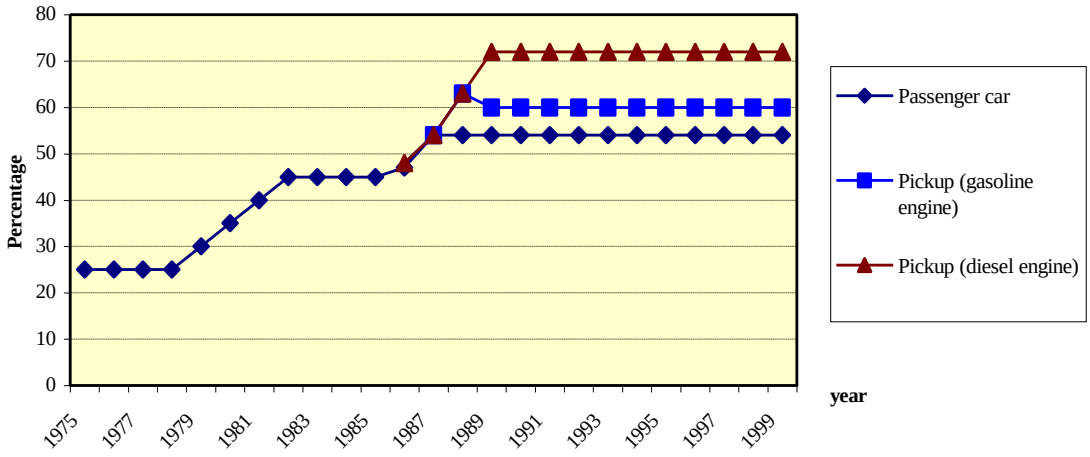
Thailand's automotive industry has developed since the 1960s, and the stages of development can be divided into four periods:

1. initial stage of import substitution (1960–1975)
2. early stage of localisation (1976–1985)
3. second stage of policy rationalisation and export promotion (1986–1999)
4. global and regional manufacturing hub in East Asia (2000 onwards).

Before 1961, all cars were imported. Then, foreign car assemblers entered Thailand and started business by supplying the domestic market due to the protective trade policy. The operation involved assembling complete knock-down (CKD) kits comprised of imported parts. There was little or virtually no backward linkage. In the 1970s, the

government shifted the industrial and trade policy regime towards a more rationalised approach. The LCR regulation was implemented from 1975 to 1999, requiring car assemblers to purchase parts locally. The government clearly specified the LCR target that the assemblers had to achieve for specific types of vehicles (passenger cars and pickups). The LCR is shown in Figure 2. The manufacturers responded by expanding their in-house production and reduced the reliance on imported CKD parts. Accordingly, the automotive parts industry started to emerge in the second period (1975–1985). Car manufacturers not only expanded their in-house production but they also invited their suppliers in Japan to invest in Thailand or to conclude technical assistance agreements with the Thai suppliers.

Figure 2. Local Content Requirement in Automobile Assembly (1975–1999)



Source: Wattanasiritham 2000, Figure 2.1, page 23.

As reported by Poapongsakorn and Techakanont (2008), in the 1970s, the automobile and auto parts producers located their plants in industrial estates in Bangkok and its vicinity, especially Samut Prakan province. An agglomeration of firms involved

in the automotive industry developed mostly in Bangkok and nearby vicinity.[5] From end of the 1970s to the early 1990s, the Thai government implemented several policies promoting the industrial sector, especially regional development. The BOI incentives were revised and privileges were granted to firms according to their location in three General Industrial Zones (Table 2). Industrial estates and a developed infrastructure were important for multinational enterprises when choosing a location for a new plant.

The Eastern Seaboard Development (ESB) Plan, initiated in the mid-1980s, reflected the Thai government's intention to establish industrial clusters in three eastern provinces (Chachoengsao, Chonburi, and Rayong). Consequently, the east region became the second largest manufacturing sector after Bangkok. The largest sub-sector is refined petroleum products, followed by the automotive, petrochemical, and machinery sub-sectors, respectively. However, later, the auto industry expanded and agglomerated in the east region.

During the 1980s, there were two important changes in the landscape of the Thai automotive industry. First, the appreciation of the Japanese yen generated the relocation of auto parts firms from Japan to Southeast Asia, including Thailand. Second, the LCR was revised, and the requirements went beyond the assembly of automobiles (Figure 2). The policymakers imposed further restrictions, such as local sourcing of certain compulsory parts, including radiators, batteries, exhaust pipes, and parts for diesel engines. In particular, localisation for diesel engines was imposed in 1989 at 20 percent, with the ratio set to increase to 70 percent by 1996. As a result, the establishment of auto parts firms surged significantly, covering a wide range of parts from simple to high technology parts. According to Wattanasiritham (2000), three engine assemblers under

[5]The result of the location of firms is presented in the next section.

Table 2. Investors' Privileges in Accordance with the Board of Investment and the Industrial Estates Authority of Thailand for Location in Three General Industrial Zones

	Zone 1	Zone 2	Zone 3
Corporate Income Taxes	100% exemption for 3 years	100% exemption for 7 years if location is in IE	100% exemption for 8 years + 50% reduction for a further 5 years
Duties on Capital Goods (Machinery, Parts etc.)	Pay 50%	Pay 50%	Free
Duties on Imported Raw Material	Exemption for 1 year if exports are at least 30%	Exemption for 1 year if exports are at least 30%	5 years exampation if exports are at least 30%; pay 25% for 5 years for domestics sales
VAT, Excise Tas, Surcharge (BOI), Import and Export Duty (IEAT)	Normal rates	Normal rates	Normal rates
Transportation, Electricity, Water	Not applicable	Normal rates	Double deduction from tax income for 10 years
Infrastructure Facilities	Not applicable	Not applicable	Deduction from taxable income 25%

BOI = Board of Investment, IEAT = Industrial Estates Authority of Thailand, VAT= value-added tax.
Source: Poapongsakorn and Techakanont (2008), Table 7.11, page 239.

the BOI diesel engine project, namely Isuzu Engine Manufacturing (Thailand), Siam Toyota Manufacturing, and Thai Automotive Industry, initiated cooperative production of five compulsory parts. Isuzu Engine Manufacturing (Thailand) was responsible for forging crankshafts and connecting rods; Siam Toyota Manufacturing for casting cylinder blocks; and Thai Automotive Industry for casting cylinder heads. This shows the success of the rationalising policy to promote and upgrade the automotive supplier industries.

From 2000 onwards, Thailand gradually became the production and export base for several carmakers. However, this was traced back to the commitment of the Thai government to liberalise the industry. In particular, the LCR regulation was abolished in 2000. In addition, the Asian Financial Crisis in 1997–1998 made Japanese carmakers export from Thailand, and this was an important milestone for the industry. In addition, the production structure of automobiles in Thailand has gradually shifted to more small and energy-efficient passenger vehicles since late 2000. This was called the 'Eco-car' programme. In 2004, the Thai government enacted the Eco-car programme that focused

on stimulating the production of energy-efficient passenger vehicles in Thailand, with significant benefit for the much higher passenger vehicle tariff. The investment programme is now in the second phase, and about 10 carmakers have submitted applications to BOI by 31 March 2014. They must start production within 2019.[6]

5. Establishment of Automotive Firms

The discussion thus far has shed some light on the evolution of the industry over five decades. In the four periods of development, the government's policy has clearly and gradually developed the domestic production of automobiles and parts. During the second and third periods, the government implemented a rationalisation policy to create backward linkages and increase the technological level of auto parts made in Thailand. This section will display the evolution of automotive firms' establishment in Thailand, according to the four periods classified earlier.

There were 1,952 firms involved in the automotive industry, based on the data from the Thailand Automotive Industry Directory 2014. Updated from various sources, the data set contains 1,650 firms with the establishment year and main products/activities produced, and only 1,013 firms with complete ownership structure. As shown in Table 3 below, a small number of firms were established in the first (1961–1975) and second (1976–1985) periods. The number increased sharply in the third (1986–1999) period,

[6] In addition to the production capacity requirement, the second phase requires higher standards and localisation of engine parts to qualify for tax exemption. For instance, fuel efficiency must be increased from 5 litres/ 100 km to 4.3 litres/ 100 km in the first phase; and vehicles must be environmentally friendly (Euro 5), emitting no more than 100 grams of CO_2 per km, and adhere to the impact-protection standards set by UNECE Reg. 94 and Reg. 95. The programme set a clear target to promote production of higher quality and technology advanced products in Thailand. For instance, four out of five key components of the engine (cylinder head, cylinder block, crankshaft, camshaft, and connecting rod) must be procured locally.

and approximately 50 percent of the current firms in this industry were established during that period (885 out of 1,650 firms). After 2000, the number of new establishments declined but still remained high. Regarding firm ownership, the share of establishment by foreign and joint venture firms noticeably increased in the third and fourth periods. This is because of the appreciation of the Japanese yen in 1985 and the relaxation on foreign ownership by BOI after the financial crisis in 1997 (Poapongsakorn and Techakanont, 2008). When looking in detail at the nationality of the firms in the database, we found the dominant role of Japanese-related companies in the industry. There were about 67 percent Japanese firms in the foreign category and about 85 percent in the joint venture category (both Thai majority and Japanese majority).

Table 3. Ownership Structure and Period of Establishment[a]

	Largest Shareholder	-1960	1961-75	1976-85	1986-99	2000-14	Total
Thai firm	Thai	8	69	97	297	102	573
Joint Venture	Thai	3	11	12	73	17	116
	Japanese	1	8	5	45	14	73
	Others	0	3	1	5	4	13
	Total	4	22	18	123	35	202
Foreign Firm	Japanese	0	9	4	115	33	161
	Others	0	5	2	48	22	77
	Total	0	14	6	163	55	238
Not Specified		11	56	71	302	197	637
Total		23	161	192	885	389	1650

[a] The ownership structure of firms was determined as follows:

Ownership Structure	Share of Thai Investors	Largest Sharehodler
Thai Firm	80 < <=100	Thai
Joint Venture	20<= <=80	Thai
Joint Venture	20<= <=80	Japanese
Joint Venture	20<= <=80	Others
Foreign Firm	0<= <20	Japanese
Foreign Firm	0<= <20	Others

Source: Calculated from Thailand Automotive Industry Directory 2014.

Regarding the types of parts available in Thailand, the data we compiled is shown in Table 4 and Table 5 below. In Table 4, we showed the types of parts and the establishment year of the companies in the database. As each firm can specify more than one product/service, the numbers of products/services recorded in Tables 4 and 5 were much greater than the number of firms recorded in Table 3. We reported the chronological establishment of parts manufactures in Thailand based on this database. It should be noted that Thailand has producers in all types of parts but the category of clean energy system (fuel cell and drive train system).

From 1975 to 1999, the Thai government had implemented several rationalised policies such as the LCR, raised import duty, and banned imports in order to protect and promote the domestic production of parts and components. The regulation became stricter and heightened in the third period (1986 to 1999), especially the localisation of engine parts. Noticeably, more than 75 percent of the automotive parts produced in Thailand emerged after 1986. The peak of establishment was between 1986 and 1999.

Three main reasons account for this. First, the increasing trend of trade liberalisation and the yen's appreciation caused Japanese firms to relocate their production to lower cost countries in Southeast Asia, including Thailand. Second, the more intensive LCR for both vehicle manufacturing and engine parts led to more investments in Thailand. Third, the Thai automotive industry surged significantly in the first half of the 1990s, combined with the commitment to liberalise the industry by abolishing the LCR regulation in 2000. After the industry restructured and recovered from the financial crisis, Thailand became the key global production base for pickup trucks with the number of establishments remaining at high level. Thus, this can be evidence of the success of the rationalising policy, paving the way for promoting and

upgrading the industries to international level.

As shown in Table 4, the top five auto parts produced in Thailand are: 1) support activities (metal forming, plastic moulding, rubber parts, surface treatments); 2) motorcycle parts; 3) engines and engine parts; 4) small and general parts (fastener/connector, pipe/hose, bush/seal, fabric, and components); and 5) body and exterior parts (i.e. body panel, frame, body reinforcement, bumper, door, hood, trunk, window, mirror).

Table 4. Types of Parts and Period of Establishment

	-1960	1961-75	1976-85	1986-99	2000-14	Total
Engine	9	58	51	253	89	460
Drive Train	1	7	11	52	29	100
Suspension / Steering / Wheel and Tire	4	22	40	110	48	224
Axle/Brake/Body Control	1	19	28	125	53	226
Body and Exterior	4	35	47	170	78	334
Interior	1	15	23	94	49	182
Climate Control	3	11	22	68	25	129
Driving Support and Security	0	2	6	22	7	37
Electronics/Electric Parts	1	11	17	95	26	150
Small/General Parts	4	39	52	199	77	371
Supporting Activities, Categorised by Production Process	3	41	61	260	124	489
Clean Energy System	0	0	0	0	0	0
Motorcycle Parts	5	44	67	263	94	473
Automobile Assembly	4	8	1	18	9	40
Agricultural Machinery and Other Transport Machinery	3	16	22	44	29	114
Chemical, Oil, Lubricant, Paint, et cetra	2	18	17	61	25	123
Accessories	0	13	16	61	28	118
Services (Trading, Logistics, Trade S	6	35	32	154	107	334
Machine Tools, Jigs and Fixtures, Mo	1	9	19	68	36	133
Total	52	403	532	2117	933	4037

Source: Calculated from Thailand Automotive Industry Directory 2014.

Table 5 shows that the number of firms producing each category is different. For foreign firms, about 70 percent are Japanese firms specialising in engine parts, support activities, motorcycle parts, small and general parts, and body and exterior parts. For joint venture firms, they specialise in motorcycle parts, engine parts, support activities, small and general parts, and body and exterior parts. However, considering the types of ownership in detail, the Japanese joint ventures seem to be more specialised in engine parts, while Thai-dominated joint venture firms specialise in motorcycle parts. In the last category, Thai firms specialise in motorcycle parts, engine parts, support activities, body and exterior parts, and small and general parts.

Table 5. Types of Parts and Ownership Structure

	Thai Firm	Joint Venture				Foreign Firm			Not Specfied	Total
		Thai	Japanese	Others	Total	Japanese	Others	Total		
Engine	228	42	25	5	72	47	24	71	89	460
Drive Train	46	12	6	1	19	11	7	18	17	100
Suspension / Steering / Wheel and Tire	114	22	8	2	32	21	12	33	45	224
Axle/Brake/Body Control	118	23	14	1	38	19	19	38	32	226
Body and Exterior	179	29	12	5	46	31	22	53	56	334
Interior	93	19	12	3	34	15	13	28	27	182
Climate Control	67	17	4	2	23	11	10	21	18	129
Driving Support and Security	10	4	1	1	6	6	6	12	9	37
Electronics/Electric Parts	60	26	4	3	33	17	14	31	26	150
Small/General Parts	177	36	11	4	51	34	19	53	90	371
Supporting Activities, Categorised by Production Process	198	45	16	3	64	53	14	67	160	489
Clean Energy System	0	0	0	0	0	0	0	0	0	0
Motorcycle Parts	231	49	24	2	75	45	16	61	106	473
Automobile Assembly	10	6	3	2	11	2	4	6	13	40
Agricultural Machinery and Other Transport Machinery	56	5	0	2	7	2	5	7	44	114
Chemical, Oil, Lubricant, Paint, et cetra	29	6	4	1	11	10	7	17	66	123
Accessories	46	15	2	1	18	12	6	18	36	118
Services (Trading, Logistics, Trade Show, Training, et cetr	85	18	4	0	22	13	9	22	205	334
Machine Tools, Jigs and Fixtures, Moulds and Dies, et cetr	56	11	0	2	13	5	4	9	55	133
Total	1803	385	150	40	575	354	211	565	1094	4037

Source: Calculated from Thailand Automotive Industry Directory 2014.

Since the database could reveal only the business areas and types of parts produced, we are unable to specify differences in the level of technology of each part produced by ownership. However, the foreign firms tend to produce higher technology parts than the Thai firms because almost all important parts such as engine and precision parts are usually manufactured by Japanese firms. In particular, the localisation policy on engine parts during the 1990s had forced Japanese firms to invest in engine parts production in Thailand (Wattanasiritham, 2000). This required additional investment in ancillary activities such as casting, forging, and machining. The key automobile parts are produced by foreign firms, and the Thai firms play a support role, i.e. second or third tier in the supply chain. It is also possible that they are independent and not in the automotive supply chain. This should be a topic for further study in the future.

6. Location of Automotive Firms

Location of firms

Table 6 shows the number of establishments by province for all automotive firms. The table covers all the provinces where auto firms have been established until 2014. It shows that before 1960, only Bangkok and Samut Prakan had a small number of establishments, with the exception of one establishment in Nakhon Ratchasima.

During 1961–1975, the number of establishments started to rise in Bangkok Metropolitan region – which comprises Bangkok and its vicinity, including Samut Prakan, Patum Thani, Samut Sakhon, Nakhon Pathom, and Nonthaburi – and in the central and east regions. In addition, Samut Sakhon and Chonburi – neighbouring provinces to Bangkok and Samut Prakan respectively – exceeded 10 establishments. Note that during the above-mentioned period, the automotive firms decided to invest in

Table 6. Locations of Establishments by Province

	-1960	1961-75	1976-85	1986-99	2000-14	Total
Bangkok	18	75	102	293	133	621
Samut Prakan	4	41	47	159	82	333
Patum Thani		6	7	55	30	98
Samut Sakhon		12	10	49	10	81
Nakhon Pathom		5	7	22	5	39
Nonthaburi			1	12	2	15
Vicinity	4	64	72	297	129	566
Ayutthaya		3	1	41	14	59
Prachin Buri				11	4	15
Saraburi		1	1	9		11
Ratchaburi			2	3	3	8
Suphan Buri				2	1	3
Nakhon Nayok				1		1
Samut Songkram				1		1
Sing Buri				1		1
Kanchanaburi		1				1
Central	0	5	4	69	22	100
Chachoengsao		2	3	49	13	67
Chonburi		11	9	80	53	153
Rayong		3		73	33	109
East	0	16	12	202	99	329
Nakhon Ratchasima	1		1	14	5	21
Nong Khai			1	1		2
Udon Thani		1		1		2
Khon Kaen				1		1
Northeast	1	1	2	17	5	26
Lamphun				2	1	3
Phitsanulok				1		1
North				3	1	4
Songkhla				4		4
South				4		4
Total	23	161	192	885	389	1650

Source: Calculated from Thailand Automotive Industry Directory 2014.

Thailand to cope with the import substitution policy. The firms also chose the metropolitan area because it was the only area where infrastructure facilities, including industrial estates, and access to local markets could attract investors. For instance, Toyota, Isuzu, Hino, and Nissan set up assembly factories in Samut Prakan in the 1960s through

to the 1970s. Simultaneously, parts manufacturing factories were established in nearby vicinities.

During 1975–1985, the trend of the previous period continued, but it was supplemented by the introduction of the local content policy in 1975. This made it necessary for assemblers to either increase in-house production or to invite foreign parts suppliers to invest in Thailand, or provide technological assistance to local suppliers. Among them, in-house production was still prevalent. Consequently, the total number of establishments increased to 192 during this period.

A rapid change occurred during 1986–1999. First, investments from Japan surged, and automotive production started to pick up. As a result, the number of firms established during this period – particularly foreign firms and joint ventures – increased very rapidly. Moreover, increased congestion and local scarcity of land raised land prices and other operating costs in the metropolitan area. Such a change in the investment environment forced the firms to spread to the provinces surrounding Bangkok and Samut Prakan such as Patum Thani, Samut Sakhon, Nakhon Pathom, Chachoengsao, and Ayutthaya.

Simultaneously, as discussed in Section 4, infrastructure development, as well as investment incentives provided by the government's zoning policy, increased the location advantage of the east region. Also, the number of firms established in the east region increased very sharply.

The number of firms also increased in provinces in the northeast, north, and south regions. Nakhon Rachasima achieved the greatest number of firms among these regions. Other provinces that had more than one firm were the commercial or industrial centres in the respective regions such as Lamphun in the north and Songkhla in the south.

During 2000–2014, the number of establishments declined, although still maintaining a relatively high level. The trend in various provinces was similar, with a notable exception of the east region, in particular Chonburi and Rayong, which continued to have a large influx of new firms. The key factor behind this change was the increased export orientation of the Thai automotive industry, particularly after the Asian Financial Crisis in 1997.

As suggested by spatial economics, trade liberalisation and economic integration may decrease the location advantage of the metropolitan area[8], while increasing the location advantage of frontier regions – such as port cities or border regions – which have superior access to international markets. A notable example is the east region where, after the Laem Chabang Port was opened in 1991, Chonburi and Rayong became a frontier region for international trade. As a result, Mitsubishi set up an assembly factory in Chonburi in 1992, followed by Ford–Mazda, and General Motors, which established factories in Rayong in 1998 and 2000 respectively.[9]

In sum, trade liberalisation, infrastructure development, and tax incentives increased the location advantages of the east region. Moreover, the Asian Financial Crisis was a turning point that increased the export orientation of the Thai automotive industry and enhanced the location advantages of the east region. As a result, this attracted a large

[8]During the period of import substitution, both intermediate inputs and markets were provided by the metropolitan area where suppliers and consumers resided. Thus, the metropolitan area was the best location for import-substitution firms. However, once the market is opened to international trade, the metropolitan area loses such advantages, while the frontier region becomes more attractive, especially for export-oriented firms, owing to good access to imported inputs as well as international markets (Hanson, 1993; Fujita, Krugman, and Venables, 1999).

[9]It is important to note that the assemblers that set up factories in Rayong or Laem Chabang are highly export-oriented, while Honda, which established a factory in Ayuthaya, has a lower dependency on exports (Kuroiwa, Bhandhubanyong, and Yamada, 2015).

number of parts suppliers – especially foreign suppliers as discussed in the next section – so that competitive automotive clusters were formed in this region.

Ownership structure and locations of firms

In the following, we investigate the location choices of firms from different viewpoints. First, the location choices were examined from the viewpoint of ownership structure because location patterns may differ depending on the ownership structure.

All firms: Figures 3.1a and 3.1b show clearly that until the mid-1980s, Bangkok and its vicinity had the dominant share of the number of establishments. Establishments in the east and central regions started to increase substantially after the mid-1980s.

Thai firms*:* A similar trend can be observed in Figures 3.2a and 3.2b, but the share of the east and central regions has been consistently lower than other regions, implying that Thai firms were more inclined to locate in Bangkok and its vicinity.

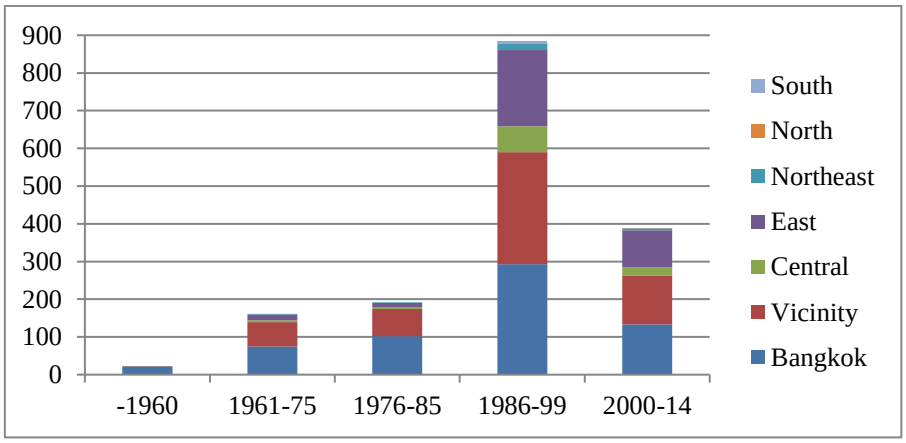
Joint ventures: Figures 3.3a and 3.3b demonstrate that Thai joint venture firms show a similar trend to that of Thai firms, which reveals a dominant share of Bangkok and its vicinity. On the other hand, Figures 3.4a and 3.4b indicate an opposite trend, demonstrating that Japanese joint ventures – where Japanese were the largest shareholders – heavily concentrated investments in the east and central regions after 1986. Other joint ventures had a smaller number of establishments and indicated a trend in between the Thai and Japanese joint ventures after 1986 (Figures 3.5a and 3.5b).

Foreign firms: Figures 3.6 and 3.7 show clearly that foreign firms, particularly Japanese firms, are more inclined to choose the east and central regions. A similar trend can be observed in foreign firms of other nationalities, although to a lesser extent.

In sum, foreign firms, especially Japanese firms and its joint ventures, were more sensitive to the change in location advantages after the Asian Financial Crisis – i.e. the

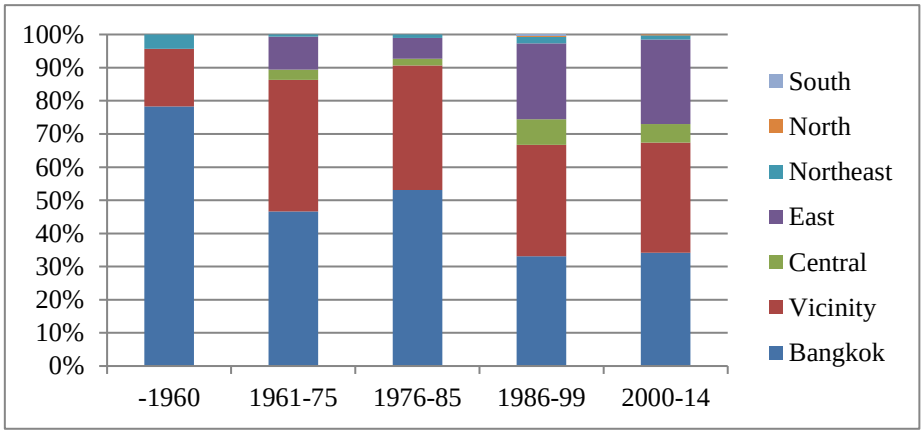
increased location advantages of a frontier region especially, in the Laem Chabang Port vicinity – while Thai firms and its joint ventures were still inclined to locate in Bangkok and its vicinity.

Figure 3.1a. Number of Establishments by Region: All Firms



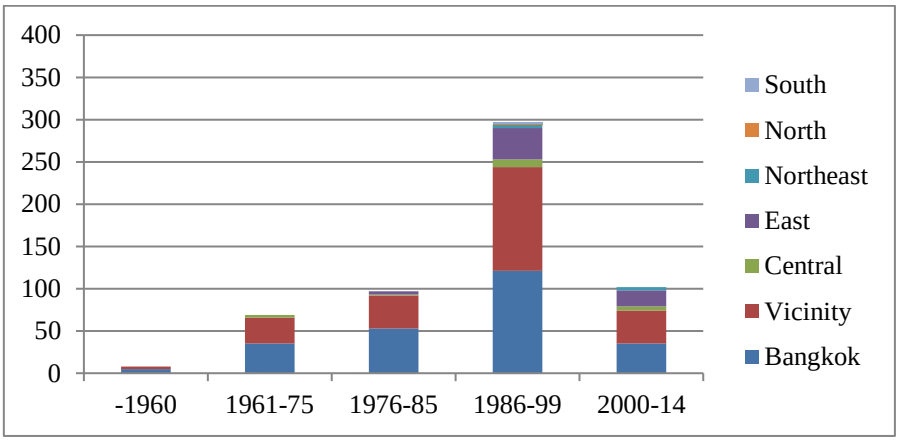
Source: Calculated from Thailand Automotive Industry Directory 2014.

Figure 3.1b. Share of Establishments by Region: All Firms



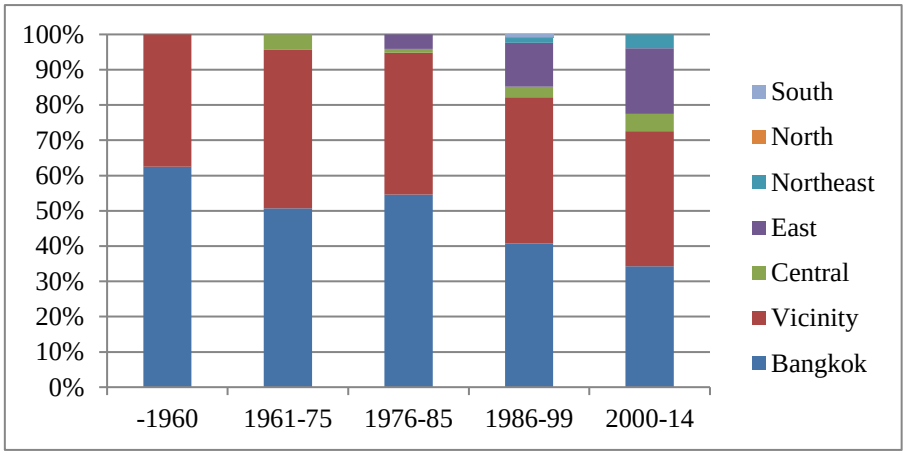
Source: Calculated from Thailand Automotive Industry Directory 2014.

Figure 3.2a. Number of Establishments by Region: Thai Firms



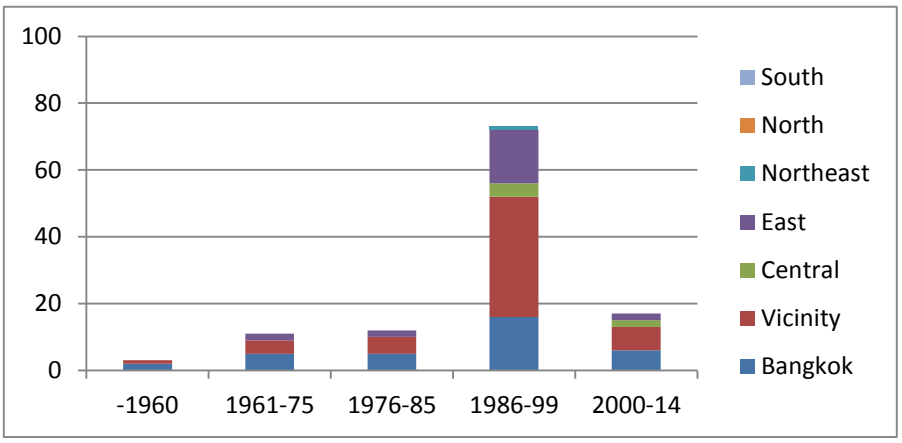
Source: Calculated from Thailand Automotive Industry Directory 2014.

Figure 3.2b. Share of Establishments by Region: Thai Firms



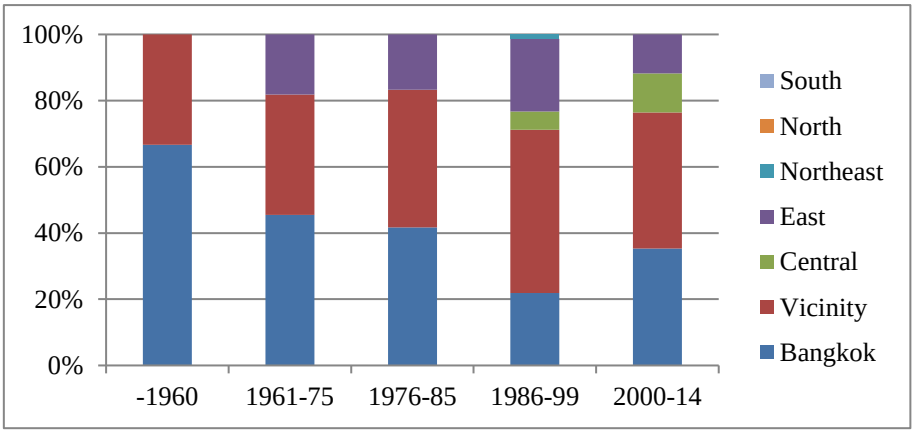
Source: Calculated from Thailand Automotive Industry Directory 2014.

Figure 3.3a. Number of Establishments by Region: Joint Ventures (Thai)



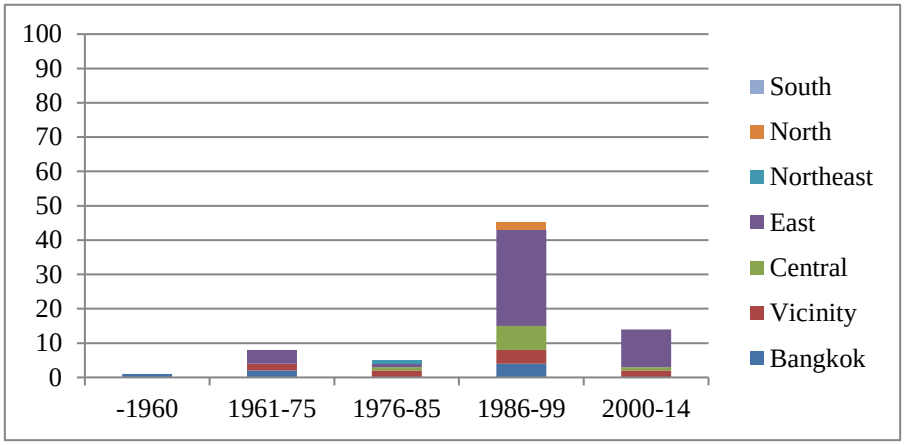
Source: Calculated from Thailand Automotive Industry Directory 2014.

Figure 3.3b. Share of Establishments by Region: Joint Ventures (Thai)



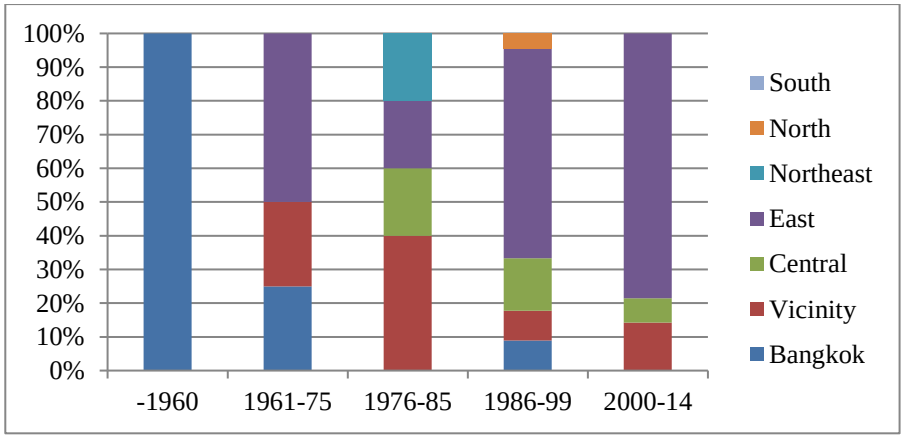
Source: Calculated from Thailand Automotive Industry Directory 2014.

Figure 3.4a. Number of Establishments by Region: Joint Ventures (Japanese)



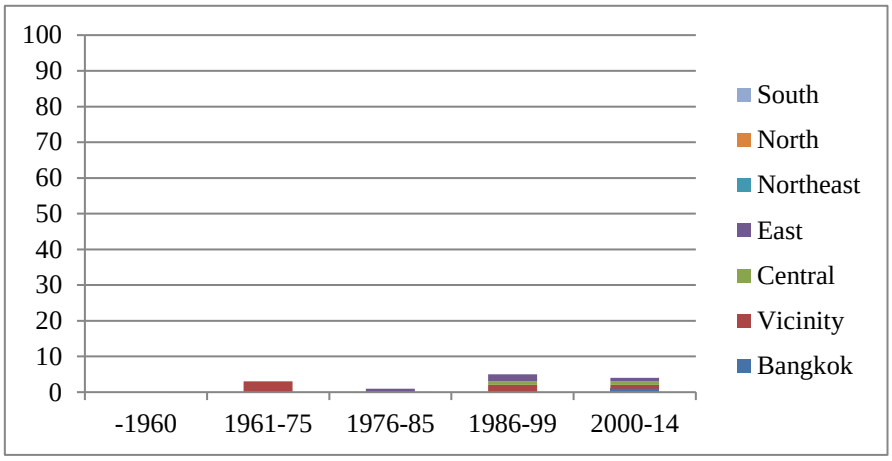
Source: Calculated from Thailand Automotive Industry Directory 2014.

Figure 3.4b. Share of Establishments by Region: Joint Ventures (Japanese)



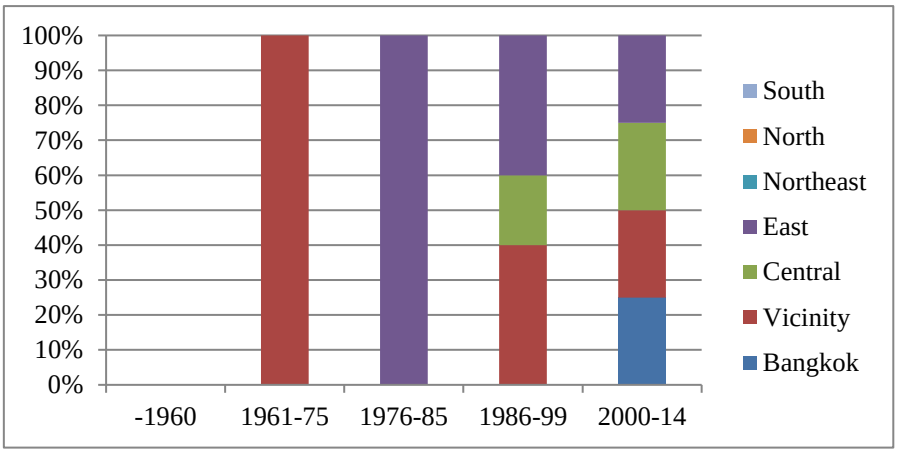
Source: Calculated from Thailand Automotive Industry Directory 2014.

Figure 3.5a. Number of Establishments by Region: Joint Ventures (Others)



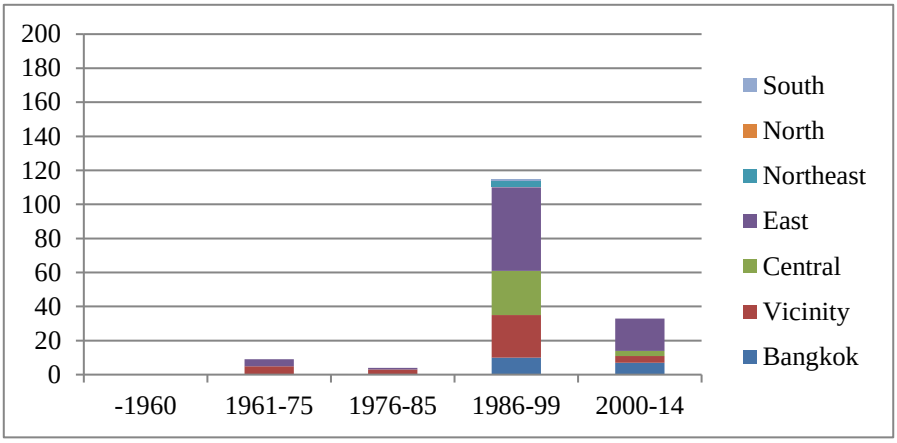
Source: Calculated from Thailand Automotive Industry Directory 2014.

Figure 3.5b. Share of Establishments by Region: Joint Ventures (Others)



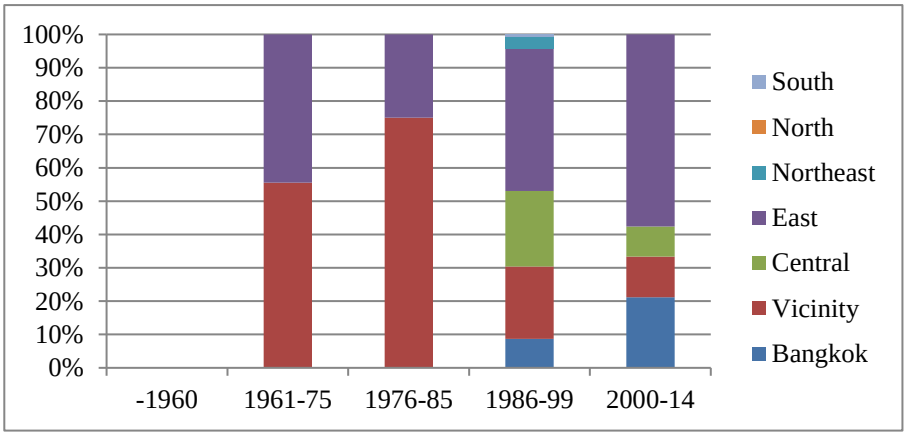
Source: Calculated from Thailand Automotive Industry Directory 2014.

Figure 3.6a. Number of Establishments by Region: Foreign Firms (Japanese)



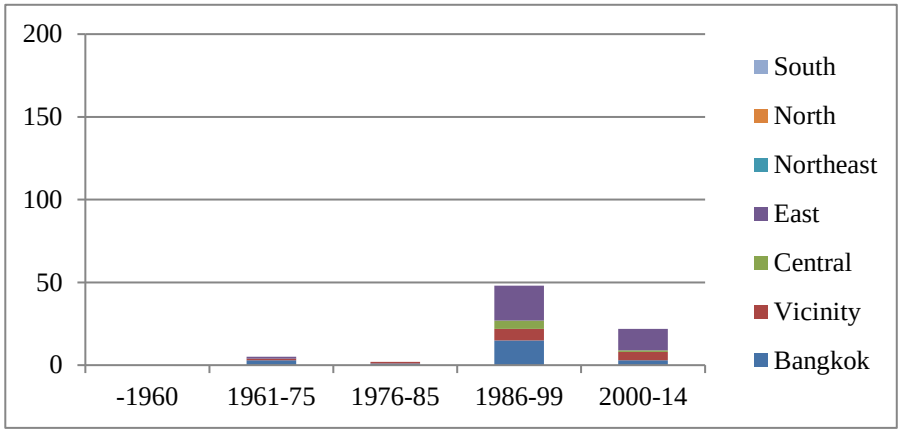
Source: Calculated from Thailand Automotive Industry Directory 2014.

Figure 3.6b. Share of Establishments by Region: Foreign Firms (Japanese)



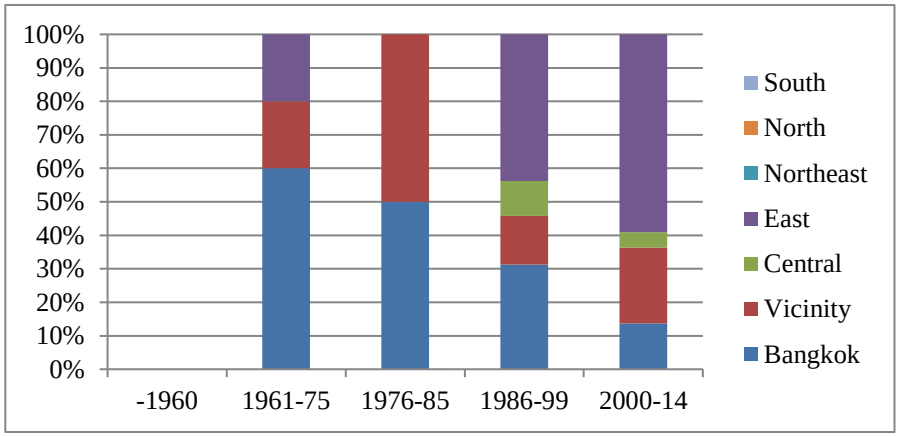
Source: Calculated from Thailand Automotive Industry Directory 2014.

Figure 3.7a. Number of Establishments by Region: Foreign Firms (Others)



Source: Calculated from Thailand Automotive Industry Directory 2014.

Figure 3.7b. Share of Establishments by Region: Foreign Firms (Others)



Source: Calculated from Thailand Automotive Industry Directory 2014.

Types of parts and locations of firms

Table 7 indicates the relationship between firms' location choices and the types of parts (or services) produced by these firms. In total, 4,037 types of parts (and businesses) are recorded in the table. Among the parts and components, engine, drive train, suspension/steering/wheel and tires, axle/brake/body control, driving support and security, and electronic/electrical parts are the key parts affecting the performance and safety of vehicles. Among the key parts, engines involved the largest number of suppliers (460),

Table 7. Number of Firms Producing Specific Types of Parts by Province

	Eng	Dri	Sus	Axl	Bod	Int	Cli	DrS	Ele	Sma	Sup	Mot	Aut	Agr	Che	Acc	Ser	Mac	Total
Bangkok	192	37	89	93	128	55	52	15	54	135	146	149	12	45	54	45	196	53	1550
Samut Prakan	82	15	36	26	62	45	21	3	33	83	126	126	10	21	21	24	50	35	819
Patum Thani	22	4	9	12	23	8	5	2	12	26	29	29	3	5	7	7	18	8	229
Samut Sakhon	22	5	15	16	17	10	10	1	5	28	27	32	2	13	5	7	13	7	235
Nakhon Pathom	9	3	9	10	11	8	4		4	11	7	10		7	4	4	5	4	110
Nonthaburi	2	3	2	2	1	2	1	1	2	4	5	4	1	1	3	1	3	3	41
Vicinity	137	30	71	66	114	73	41	7	56	152	194	201	16	47	40	43	89	57	1434
Ayutthaya	16	3	7	10	11	6	9	3	11	15	25	16	1	4	2	5	10	6	160
Prachin Buri	3	1	1	1	4	1		1	2	1	6	1			1	1			24
Saraburi	4	2	2	2	1	4	2				5	5			3		1	2	33
Ratchaburi	1			1	4	1				2	2	4				1	1		17
Suphan Buri	1	1		1	1	1					1					1	1		8
Nakhon Nayok												1		1					2
Samut Songkram	1		1							1									3
Sing Buri											1	1							2
Kanchanaburi	1	1								1									3
Central	27	8	11	15	21	13	11	4	13	20	40	28	1	5	6	8	13	8	252
Chachoengsao	23	8	14	8	14	12	4	2	6	12	29	20	2	2	3	5	5	5	174
Chonburi	38	12	19	21	30	16	13	3	13	28	53	44	4	9	14	10	20	7	354
Rayong	32	5	14	18	21	11	6	6	7	19	19	19	3	3	4	7	8	2	204
East	93	25	47	47	65	39	23	11	26	59	101	83	9	14	21	22	33	14	732
Nakhon Ratchasima	6		5	5	3	2	2			4	8	6	1	1	2		2	1	48
Nong Khai					1							1							2
Udon Thani	1													1					2
Khon Kaen					1								1	1			1		4
Northeast	7		5	5	5	2	2			4	8	7	2	3	2		3	1	56
Lamphun	3											2							5
Phitsanulok	1								1			1							3
North	4								1			3							8
Songkhla			1		1					1		2							5
South			1		1					1		2							5
Total	460	100	224	226	334	182	129	37	150	371	489	473	40	114	123	118	334	133	4037

Acc = Accessories; Agr = Agricultural machinery and other transport machinery; Aut = Automobile assembly; Axl = Axle/Brake/Body control; Bod = Body and exterior; Che = Chemical, oil, lubricant, paint, etc.; Cli = Climate control; Dri = Drive train; DrS = Driving Support and Security; Ele = Electronics/Electric parts; Eng = Engine; Int = Interior; Mot = Motorcycle parts; Ser = Service (trading, logistics, trade show, training, etc.); Sma = Small/General parts; Sup = Supporting activities, categories by production process; Sus = Suspension/Steering/Wheel and Tire; Mac = Machine tools, jigs and fixtures, moulds and dies, etc.

Source: Calculated from Thailand Automotive Industry Directory 2014.

followed by axles (226) and suspension parts (224).[10] Among other parts, supporting activities, categories by production process (489), motorcycle parts (473), small/general parts (371), body parts (334), and services (334) had a large numbers of suppliers.

Spatial distributions of the types of parts were similar to those of the firms. Bangkok (1,550) had the largest number of parts types, followed by its vicinity (1,434), and the east region (732). However, the shares of regions for the respective parts could be different depending on the characteristics of these parts.

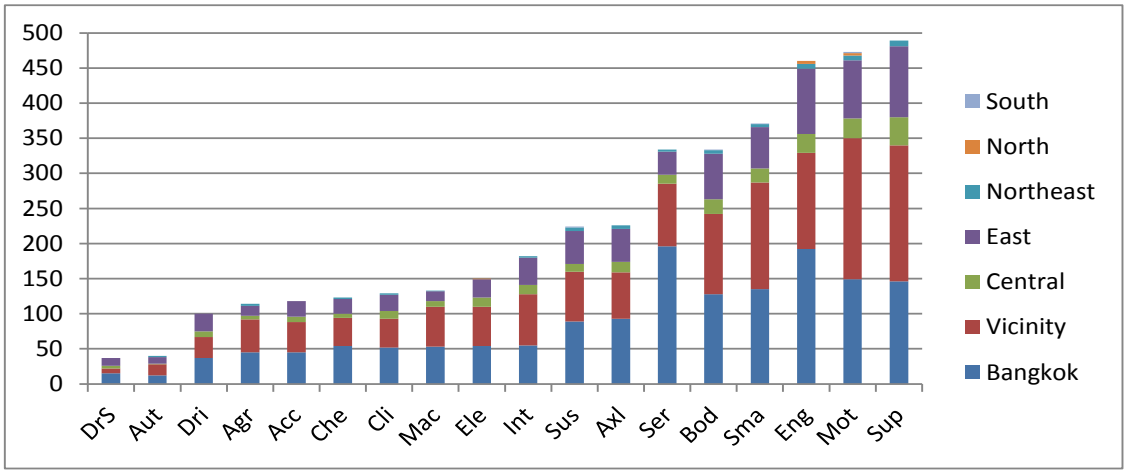
Table 7 shows that services – which include trading, logistics, and trade shows – had the highest number of firms (196) in Bangkok. Furthermore, its share of Bangkok was the highest (59 percent) among all types of parts (Figures 4a and 4b). It is clearly shown that Bangkok specialises in service activities.[11]

Meanwhile, manufacturing activities are dispersed to the neighbouring provinces. For instance, machine tools are largely concentrated in Bangkok and its vicinity, particularly in Samut Prakan. Machine tools include machine tools, jigs and fixtures, moulds, and dies. These machines and equipment are likely to be used not only by the automotive sector but also by other manufacturing industries located in the metropolitan area. Furthermore, the shares of driving support, security and drive train, and automobile assembly were high in the east region and, to a lesser extent, in the central region. Note that the locations of production facilities of these parts were affected by the shifting location advantages of the automobile industry, which raised the benefits of setting up factories in the east region.

[10] As discussed in Section 4, the Government of Thailand started to promote local production of diesel engines and engine parts in 1989, and tried to achieve 70 percent of local content before 1996. It is thus natural that a large number of parts suppliers involved in the production of engines have been established since then.

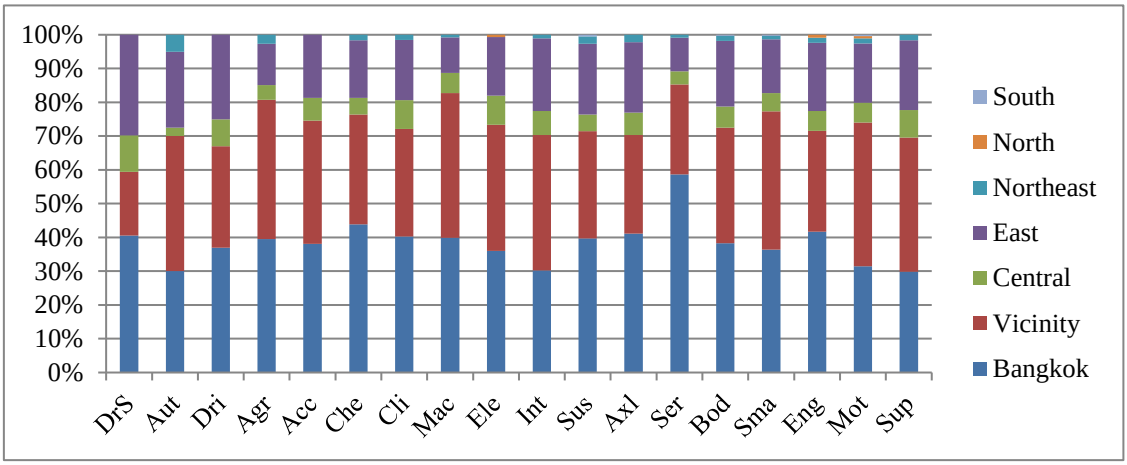
[11] It is also interesting to note that engine parts – one of the most important auto parts – had the second highest number of establishments in Bangkok (192).

Figure 4a. Number of Firms Producing Specific Types of Parts by Region



Acc = Accessories; Agr = Agricultural machinery and other transport machinery; Aut = Automobile assembly; Axl = Axle/Brake/Body control; Bod = Body and exterior; Che = Chemical, oil, lubricant, paint, etc.; Cli = Climate control; Dri = Drive Train; DrS = Driving Support and Security; Ele = Electronics/Electric parts; Eng = Engine; Int = Interior; Mot = Motorcycle parts; Ser = Service (trading, logistics, trade show, training, etc.); Sma = Small/General parts; Sup = Supporting activities, categories by production process; Sus = Suspension/Steering/Wheel and tire; Mac = Machine tools, jigs and fixtures, moulds and dies, etc.
Source: Calculated from Thailand Automotive Industry Directory 2014.

Figure 4b. Share of Firms Producing Specific Types of Parts by Region



Acc = Accessories; Agr = Agricultural machinery and other transport machinery; Aut = Automobile assembly; Axl = Axle/Brake/Body control; Bod = Body and exterior; Che = Chemical, oil, lubricant, paint, etc.; Cli = Climate control; Dri = Drive Train; DrS = Driving Support and Security; Ele = Electronics/Electric parts; Eng = Engine; Int = Interior; Mot = Motorcycle parts; Ser = Service (trading, logistics, trade show, training, etc.); Sma = Small/General parts; Sup = Supporting activities, categories by production process; Sus = Suspension/Steering/Wheel and Tire; Mac = Machine tools, jigs and fixtures, moulds and dies, etc.
Source: Calculated from Thailand Automotive Industry Directory 2014.

Regions remote from the metropolitan area – such as the northeast region, the north region and the south region – have disadvantages in terms of transport costs. Thus, the parts produced in these regions are expected to be neither too heavy nor too bulky. To verify this hypothesis, let us examine Lamphun and Phitsanulok in the north, which produces electronic parts and some engine parts. Electronic parts are relatively light, compact, and high value-added. Thus, the manufacturers of electronic parts can be located in remote provinces. On the other hand, many engine parts are heavy and bulky, but the engine parts produced in Lamphun are oil pumps, water pumps, engine valves, piston rings, piston pins, etc., which are relatively small and light.

There seems to be a clear relationship between the characteristics of parts and location of firms, especially in terms of physical distances. However, further scrutiny would be necessary to investigate such a relationship.

7. Conclusion

The formation of industrial clusters is important in order to improve productivity and competitiveness in international markets. The Thai automotive industry is one of the few such cases where the local supplier base and industrial linkages have been established by the formation of automotive clusters.

To answer the research objectives, this paper compiled data from about 1,954 automotive firms from the Thailand Automotive Industry Directory 2014 and analysed the data in terms of 1) geographical location; 2) year of establishment; 3) ownership type; and 4) types of parts produced. Data showed the evolution of the Thai automotive industry

in Sections 4, 5, and 6 of this paper. In addition, we divided the parts into 19 smaller groups of parts.

As in the case of Thailand's automotive industry, it is clear that the industry has developed because of government intervention. The streamlining policies implemented during the 1970s and 1990s have clearly influenced the development of the industry. The number of establishments surged and the higher degree of the rationalisation policy regarding LCR led to industrial deepening domestically and dynamic competitive advantages.

Our findings confirmed the crucial role of the Japanese assemblers in bringing capital and technology to the host economy. This is due to the fact that the Thai government was aggressive in raising the local content target in the late 1970s onwards, and from the 1990s, implemented a series of gradual steps to liberalise the automotive industry. In addition, it is argued that the Thai government never practices a nationalistic discrimination policy against foreign direct investment (Poapongsakorn and Techakanont, 2008). This is probably the most important factor for foreign firms that consider expanding their operations in Thailand. As confirmed by the findings in Sections 4 and 5, more than 75 percent of automotive parts produced in Thailand emerged after 1986.

In addition, the top five automotive parts produced in Thailand are engine parts, motorcycle parts, support activities (such as forging, metal forming, casting, machining), small and general parts, and body and exterior parts. Nevertheless, it is believed that foreign firms produce higher technology and higher value-added parts. For example, engine parts are produced by Japanese firms or Japanese joint ventures, while Thai firms play a support role such as casting, forging, and machining. The emergence of engine parts production and support industries in the 1990s is believed to be a result of the Thai

government's policy and some external factors (i.e. the yen's appreciation and the trend of trade liberalisation).

During the period of import substitution, the Bangkok Metropolitan region – in particular Bangkok and Samut Prakan – had by far the greatest number of establishments. But, as the number of establishments increased in the metropolitan area, agglomeration diseconomies, such as increased congestions and higher land prices, induced the relocation of production facilities to neighbouring provinces. In particular, the east region has gained location advantages due to the increased export orientation of the Thai automotive industry after the Asian Financial Crisis, and has attracted a large number of foreign suppliers, especially from Japan.

It can be seen that Bangkok specialises in service activities, while manufacturing activities are dispersed to the surrounding provinces. Moreover, provinces remote from the metropolitan area – such as those in the north, northeast, and south regions – have significant disadvantages in terms of transport costs, so that the parts produced in these regions should be neither too heavy nor too bulky. However, further scrutiny would be necessary to investigate such a relationship.

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