Supplier networks at the integrated peripheries of the automobile industry: the case of keiretsu suppliers in Thailand

David Guerrero, Hidekazu Itoh, Guanie Lim, Petronille Harnay, Guillaume Corre

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Abstract

The formation of supplier networks at the integrated peripheries is a complex process and results from variegated strategies adopted by firms seeking to adapt to the specificities of each host state. This study aims to provide a preliminary explanation of these patterns by focusing on the case of tier 1 suppliers serving Japanese car manufacturers in Thailand. The empirical data, which captures supply relationships for five different car parts and components, was analyzed using a network visualization method. Our initial findings provide insights into how the supply networks vary across car manufacturers and countries and suggest some of the conditions at the integrated peripheries which can enable suppliers to expand their client portfolio to gain scale. The paper also discusses how the integrated periphery framework intersects with the *keiretsu* networks of Japanese car manufacturers.

Keywords: automobile industry, Thailand, integrated periphery, supply network, global production networks, spatial division of labor.

1.Introduction

During the last decades there have been major changes in the geography of the global automobile industry. Nowadays, the traditional core areas of US, Western Europe and Japan, only contribute marginally to the growth of the global production of cars, parts and components. These core areas are characterized by high levels of domestic ownership and control, domestic global assembly firms, high levels of spending in research and development (R&D), production of sophisticated parts and components, as well as high labor costs and productivity levels (Pavlinek, 2018). Outside of the core, the "integrated peripheries" are mostly distinguishable by their lower production costs and can be of two types (Chanaron, 2004, Mordue and Sweeney, 2020). The first type corresponds to countries at the vicinity of core areas, strongly export-oriented and with low levels of domestic ownership. Mexico, Turkey, or Poland clearly fall within this category (Lampon et al, 2021, Domanski et al, 2017). A second type of integrated periphery includes countries with large domestic markets and homegrown car manufacturers and suppliers such as India and China, which have been recently considered both as "core" and as "integrated peripheries" (Mordue and Sweeney, 2020).

Other integrated peripheries, such as Thailand, are difficult to categorize, because they combine several attributes of each one of the two types mentioned above. The kingdom is currently the 10th

largest automobile producer at global scale and the first in the Association of Southeast Asian Nations (ASEAN), with 1.7 million vehicles in 2021 (OICA, 2022). Although the Japanese FDI was critical in the growth of automobile production, it was not the only factor of success (Guiheux and Lecler, 2002, Bell and Monaco, 2020). Thailand implemented a series of industrial policies to stimulate the development of the automobile sector with active state intervention since the 1960s (Natsuda et al, 2022). More recently the automobile industry was identified by the government as one of the key areas to promote innovation and higher value-added activities in its latest 'Thailand 4.0' strategy (Chiengkul 2019). The focus on the automobile industry is understandable. Several major automobile Transnational Companies (TNCs), mostly from Japan and Europe, use Thailand as their production base in ASEAN. Although Thai firms have deepened their technological base, largely from collaborating with Japanese TNCs, there is something of a dearth of homegrown tier 1 suppliers. Amongst the tier-1 suppliers based in Thailand, 58% are foreign majority firms or wholly foreign owned and only 23% were fully Thai-owned (Fourin, 2017, cited by Natsuda et al, 2022). Multiple accounts have been put forward, covering primarily innovation policy (Intarakumnerd and Chaoroenporn 2013) and political economy (Doner 1991; Doner and Wad 2014). However, relatively few have dealt with the production networks and industrial organization linking the TNCs and their suppliers. The paper fills this intellectual lacuna, analyzing the ways in which the Japanese TNCs coordinate their tier 1 suppliers in Thailand, and how they shape development outcomes.

More prosaically, this paper asks the following questions: How have the various Japanese automobile firms organized their sourcing in Thailand? How (and to what extent) do manufacturers and their suppliers conform to pre-existing business relations in their home market of Japan? Are there patterns that are peculiar to specific manufacturers and/or components? What implications can countries from integrated peripheries draw to better tap into the upgrading opportunities offered by the embedding of automobile TNCs and their production networks? Two key arguments are put forward here. Firstly, we argue that Japanese car manufacturers predominantly adopt a follow sourcing strategy, bringing the same tier 1 suppliers they use in their Japanese home market to Thailand. It is likely that they are reproducing the traditional *keiretsu* grouping, in which long-term preferential relationships are favored, to maintain quality and reduce the risk of disruption in the context of the uncertainty that prevails in developing countries. Secondly, the paper illustrates distinct sourcing patterns for five bulky, relatively costly, parts and components (i.e. seats, seatbelts, tires, windows and radiator grilles). Multidimensional Scaling (MDS) is used to visualize the relationships between car manufacturers and suppliers. This method places firms in an abstract 2 dimension space according to the number and diversity of their relationships. These sourcing trends apply to all the Japanese car manufacturers.

The next section unpacks the literature covering the automobile industry, focusing especially on global value chains (GVCs)/global production networks (GPNs) and on the concept of "integrated peripheries". The paper then presents the area of study and provides an analysis of the sourcing patterns of Japanese automobile TNCs. Subsequently, it discusses the findings in relation to the existing body of scholarship. Major points of discussion include the equity ownership interconnecting the Japanese TNCs and their component suppliers, locational considerations, and other industry-specific challenges. The penultimate section concludes with a summary of the main arguments and research findings. It also suggests potential areas for future research.

2.Literature Review

There has been a copious amount of literature analyzing the automobile industry, especially its development outside the traditional core regions. Within the context of economic and technological catch-up, two widely applied approaches – GVC/GPN and spatial divisions of labor– have generated particularly useful insights. In the mid-1990s, it was relatively common for GVC/GPN researchers to adopt a firm-centric standpoint when analyzing the production networks of various commodities, ranging from agri-food products (e.g., Dolan and Humphrey 2000; Gibbon 2001) to automobiles (e.g., Doner et al. 2004). The main thesis was that economic upgrading can occur essentially in four ways: intra-chain or functional upgrading (moving up the same value chain/production network from a more marginal to a more secure position by offering more functions), product upgrading (producing more sophisticated goods with higher unit prices), process upgrading (adopting more efficient manufacturing processes), and inter-chain upgrading (moving from one industry to another) (Humphrey and Schmitz, 2001). Subsequent GVC/GPN research has delineated a more nuanced approach for unpacking upgrading opportunities. In their study on the impacts of the German firm BMW in Thailand, Coe et al. (2004) argued that Thailand's upgrading trajectory depends just as much on interfirm exchanges as regional and local institutions and their policies (see also Doner et al. 2021; Yeung 2009). To this end, Yeung (2016) argued that (developing) states can form strategic couplings with lead firms (usually from the advanced economies) to pursue industrial expansion and technological upgrading within their respective territories.

In a similar vein, Fujita (2013) investigated the Vietnamese motorcycle manufacturing industry in the aftermath of the Southeast Asian country's 1986 *doi moi* (renovation) program to reform its former command and control economy. She found that the economic liberalization efforts have led to the introduction of two distinct industrial organizations into Vietnam, from Japan and China respectively (Fujita 2013). Centered around Honda, Yamaha, Suzuki, and Kawasaki, the Japanese production system emphasized long-term, trust-based TNC-supplier relationship, which promoted skills formation to manufacture increasingly sophisticated products. However, this form of technology

transfer occurred too slowly for the Vietnamese policymakers' liking (Fujita 2013; Ngo 2017). Chinese TNCs were subsequently welcomed in the late 1990s, with the latter forming multiple collaborations with Vietnamese assemblers to market motorcycles to the increasingly urbanized consumers. Unlike their Japanese counterparts, the Chinese motorcycle TNCs relied mainly on arm's-length transactions that valued price-based competition over product quality, which lead to a surfeit of cheap (albeit poorly manufactured) motorcycles and components in the ensuing years (see also Lim 2020).

The institution of *keiretsu* is key for understanding the relationships between Japanese car manufacturers and their suppliers. There are two major types of *keiretsu*: horizontal (financial) and vertical (industrial). In this study we refer exclusively to vertical *keiretsu*, in which a car manufacturer develops deep relationships with key suppliers. Aoki and Lennerfors (2013) considered that vertical *keiretsu* in the automobile industry involve four main dimensions: long-standing relationships (eventually through cross-shareholding), some degree of exclusiveness, governance mechanism (e.g. ambiguity in the contract terms) and support systems (supplier development programs and suppliers' clubs). During the last decades there have been pressures on Japanese car manufacturers to abandon *keiretsu* ties so as to promote competition between tier-1 suppliers. However, *keiretsu* remain under new forms, in which "competition-based elements and more open support systems have been added to earlier governance mechanisms such as power and security" (Aoki and Lennerfors, 2013, p.70). A recent study has shown that inter-*keiretsu* relationships have become more important, and that diversified supply networks may have a positive influence on firms' productivity (Todo et al., 2016, cited by Tomeczek, 2022). When expanding to Thailand and other South East-Asian countries, Japanese car manufacturers have established their own supply networks. While the overseas affiliates of their home-based *keiretsu* part suppliers provide the most sophisticated parts and components, Thai suppliers are confined to less technologically sophisticated ones (Interakumnerd and Charoenporn, 2015, Sadoi, 2010). Despite this apparent replication of networks, the purchasing policies of Japanese car manufacturers in Thailand have been considered as less restrictive to *keiretsu* suppliers than in Japan (Guiheux and Lecler, 2000). Indeed, some of the *keiretsu* suppliers of Toyota in Thailand supply parts to Nissan and vice-versa. Whether this openness in purchasing policies results mainly from the small size of the automotive markets in Southeast Asia or from a hypothetical specificity of *keiretsu* in Thailand remains open to discussion (Hatch, 2005, Itoh et al., 2019).

Even among Japanese car manufacturers, there is some variety in logistics management styles. Itoh and Guerrero (2020) have explained the differing ways by which two automobile manufacturers organize the shipping of their Japan-based components to their overseas assembly plants. Both the studied TNCs use parts consolidation centers (PCCs) which are cross-docking facilities, to sort and

pack components depending on their final destinations. In one case, the PCCs are deeply integrated within the firm's global production system, providing the flexibility that is needed to respond to changes in market conditions. In contrast, the other Japanese firm sees and deploys its PCCs simply as transfer points, generating little added value for its operations. This also means that different (Japanese) TNCs create different pathways for growth, not least when they invest and establish overseas facilities. Adding to the complexity are the challenges involved in transferring such management styles to the host economies. The variety of institutional regimes means that the upgrading avenues for the host economies are dependent on factors ranging from (dis)economies of scale and the resilience and cost-efficiency ratio of supplier networks, to government policies. In particular, Coe (2020) underlined the imperative to focus on the logistics dynamics undergirding the related production networks. Amongst other things, he advocated paying more attention to the politics and power relations inherent to logistics development.

Notwithstanding the above insights, GVC/GPN studies tend to be undertaken at a fairly granular level. Their firm-centric focus has also inadvertently led to an overemphasis on the business strategies of one or several lead firms (in this paper, brand name car manufacturers). As alluded to earlier, much is still unknown about the dynamics interlinking automobile TNCs and their tier 1 suppliers as well as the wider institutional context. This is even more the case when we consider the peculiarities of each automobile component. One simple explanation is that a more technologically sophisticated component will likely stimulate a more complex production architecture compared to a simpler component, resulting in varied upgrading avenues. However, technology is only part of the upgrading potential. In this paper we propose a less systematic explanation, stressing on other aspects such as the level of standardization of parts and components, their bulkiness, and the minimum efficient scale needed for their local production.

Within the context of GVC/GPN literature, a number of studies, mostly focused on Europe and North America categorized nations according to their positions in the International Division of Labor (IDL). The underlying idea is that capital accumulation at global level results from appropriation of surplus from the producers of low-profit goods at peripheral nations, by the producers of high-profit goods from core nations (Hopkins and Wallerstein, 1986). This process has been captured by Harvey (2014) through the concept of spatiotemporal fix: capitalist firms invest their surplus capital in more profitable locations to "fix" (temporarily) the declining profitability in the existing locations. More recently, Pavlinek (2018) considered the integrated peripheries of the automotive industry as a form of spatiotemporal fix. From this perspective, integrated peripheries are relatively low cost locations geographically adjacent to core markets, and mostly lacking of strategic functions such as research and development, strategic decision making, and finance. In the case of Europe and North America,

automobile TNCs lobbied for the geographic expansion of regional integration to establish production in low cost areas (Carrillo et al., 2004). But domestic suppliers in integrated peripheries remain contractually highly dependent on foreign firms and are eventually "locked" into simple and low value added activities (Pavlinek, 2018, Mordue and Sweeney, 2020, Doner and Wad, 2014). Therefore integrated peripheries articulate into automobile GPN through structural coupling, "which is the least advantageous and dependent mode of integration" (Pavlinek, 2018, p. 160). Most of the studies aiming to categorize nations as core or integrated peripheries have focused on the cases of North America and Europe (see, for example, the recent works of Mordue and Sweeney, 2020 and Pavlinek, 2022). The ways in which integrated peripheries from other parts of the World, engage into the Global Production Networks of car manufacturers, have attracted less attention. In this study we aim to contribute to this literature by examining how the GPNs of core-based car manufacturers develop in a type of integrated periphery in ASEAN which is not adjacent to a core market. A further question arises over how the integrated periphery framework intersects with the institution of *keiretsu*.

Our framework is illustrated in Figure 1. It proposes that the globalization/regionalization strategies of automobile TNCs are related to the capacity of suppliers to follow them into new countries and the liberalization of policy by a host state. For example, the factor endowments of the host state (e.g. its market size and labor discipline) can only be properly harnessed when they are aligned with the commercial goals of the automobile TNCs and their suppliers. It is important to make it clear that the attributes outlined in Figure 1 are theoretical ideal types and serve primarily as heuristic devices, as real-life dynamics differ substantially across time and space. Nevertheless, Figure 1 can potentially provide the reader with a better understanding of how multiple interest groups and their interactions shape long-term industrial development.

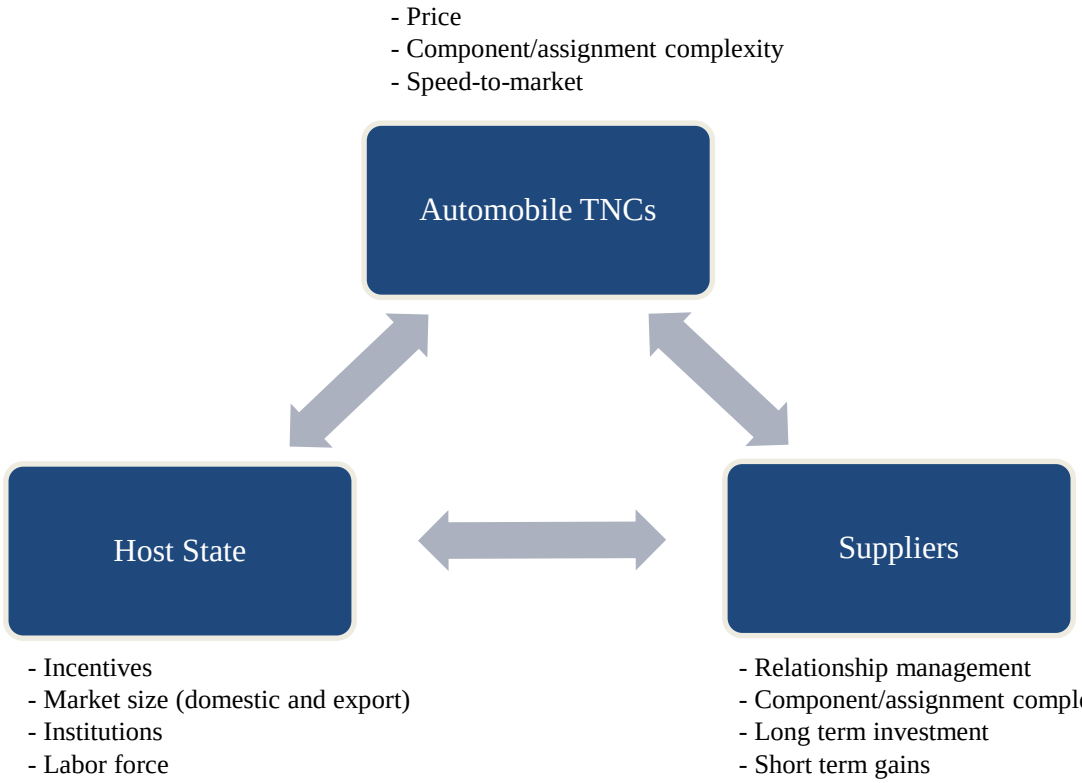


FIGURE 1. FRAMEWORK FOR THE STUDY OF SUPPLY NETWORKS IN THAILAND

3. Area of study: Trade, production and location of firms

Although the automotive industry was present in Thailand since the 1960s, production volumes remained modest until the late 1980s. The industry reached a significant peak in the mid-1990s (half million) and mostly during the 2000s and 2010s. As shown by the Figure 2, during the last three decades the growth has been considerable[1]. The Asian financial crisis (1997-1998) was a turning point for the automotive industry, and production levels felt dramatically.

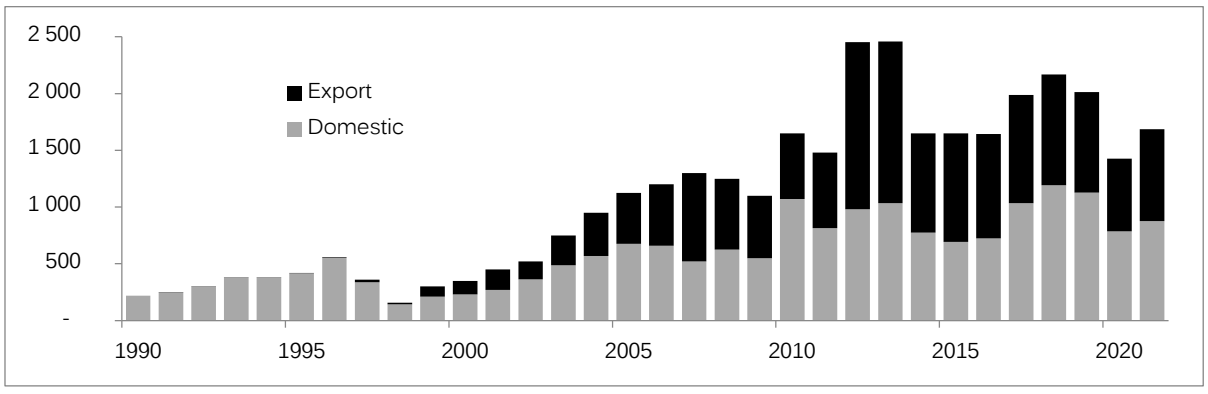


FIGURE 2. VEHICLE PRODUCTION IN THAILAND, THAILAND AUTOMOTIVE INSTITUTE, 2005, 2021.

[1] This growth was interrupted by the Asian financial crisis (1998), the global financial crisis (2009), floods (2011), political conflict (2014) and by Covid-19 pandemics (2020).

In the 2000s the Thai government introduced a series of industrial policies focused on the automotive industry, promoting product champions. Thailand became more export oriented, and became a regional base for the production of pick-up trucks. Tax exemptions were provided for foreign car manufacturers and suppliers, and some of them relocated their pick-up truck production and some related R&D functions in the early 2000s (Natsuda et al. , 2022). As a result, exports of new cars and commercial vehicles increased significantly during the 2000 and until the mid 2010s (Figure 3a) while imports remained relatively low. The main export markets are ASEAN for cars and Oceania for commercial vehicles (mostly pick-up trucks). Other important destinations are Africa & the Middle East, and the EU (Figures 3b and 3c).

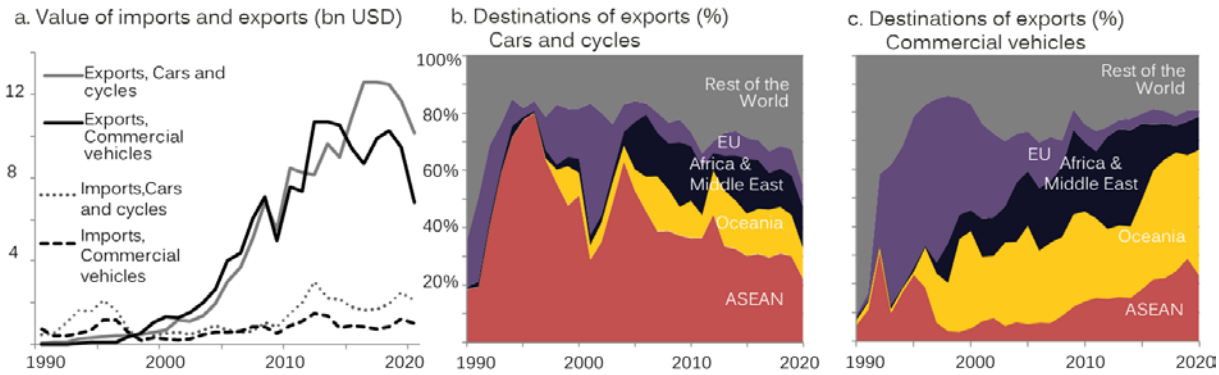


FIGURE 3. INTERNATIONAL TRADE OF THAILAND. CARS AND CYCLES, COMMERCIAL VEHICLES, CHELEM, 2022

To assemble cars and commercial vehicles in Thailand, car manufacturers import parts and components. Thai-based suppliers also export parts and components to other countries. The trade of parts has increased significantly between 2000 and 2014, following the trend of vehicle production. The main country of origin of parts is Japan, although its share has decreased from 80% in 1990 to less than 40% in 2020 (Figure 4b). The main destination of the parts exported by Thailand is ASEAN (Figure 4c).

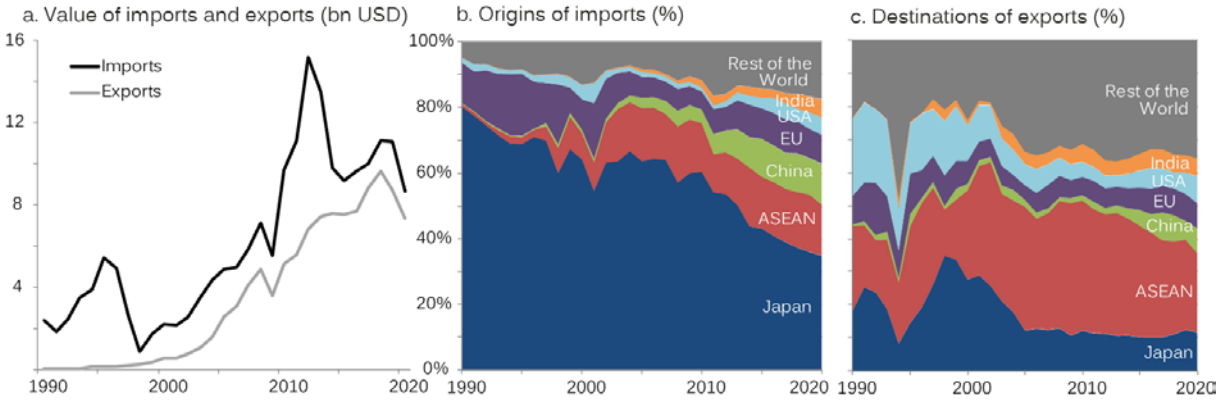


FIGURE 4. INTERNATIONAL TRADE OF THAILAND. VEHICLE COMPONENTS (CHELEM, 2022)

In Thailand car manufacturers and suppliers are concentrated in a relatively small area around the ports of Bangkok and Laem Chabang, where the domestic and international accessibility is the highest (Figure 5). The first phase of development took place in the 1960s and 1970s around the port of Bangkok. Several car manufacturers set up assembly factories in Samut Prakan and parts manufacturers subsequently located in the same province or in the surroundings of Bangkok. A second phase took place after the Asian financial crisis in 1997. Toyota and other car manufacturers decided to use Thailand as a base for exports in the ASEAN (Kuroiwa et al, 2022, Lecler, 2002). The development of the deep-sea port of Laem Chabang and tax incentives attracted export-oriented firms to the provinces of Chonburi and Rayong (Coe et al,.2004, Lecler, 2002).

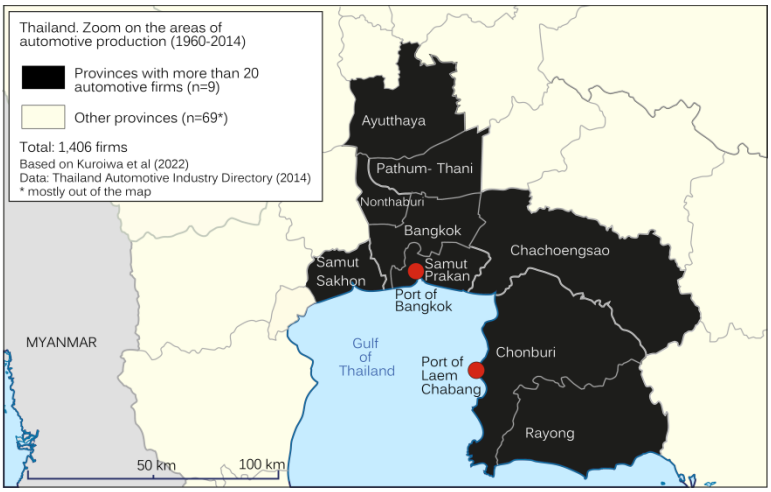


FIGURE 5. AREA OF AUTOMOTIVE PRODUCTION (OWN REALIZATION BASED ON KUROIWA ET AL., 2022)

This short historical background showed the progression of production and trade, as well as the different stages in the installation of car manufacturers and suppliers in Thailand. To disclose the dynamic links between both types of firms, we examine the production architecture of different parts and components.

4. Data

The main source we used to analyze the relationships between tier 1 suppliers and car manufacturers was the Marklines database[2]. The data it contains was collected from questionnaires that are sent to about 40,000 automotive suppliers and it is primarily used by its member firms to search for suppliers. Each record in the database corresponds to a supply relationship for a certain part or component for a certain vehicle model. MarkLines updates the database each time an automaker introduces a new model or changes an assembly location. Therefore, while the database by MarkLines is not suitable for analyzing

[2] Marklines https://www.marklines.com/en/

time-series changes, it offers the advantage of always having the most up-to-date supplier information. Because of such characteristics, we extracted and used data for the past five years. In other words, we are considering the averaged situation over a five-year period between 2017 and 2021.

Our initial sample contained 53,000 records relating to more than 20 different categories of car parts and components. A component usually refers to a complex item which is complete in itself, consisting in several parts. For example, while a seat is a component (ex. metal structure, foam, etc.), a tire is just a part of the wheel (component). For the sake of simplicity, we focused on five car components and parts, which reflected the variety of delivery conditions. The capacity to ensure deliveries of parts on times is crucial in supplier selection by car manufacturers, especially in developing countries. To make the selection of parts categories, we considered several characteristics that have already been recognized as relevant for logistics (Van Egeraat and Jacobson, 2005): volume, cost, variety, frequency and distance.

The selected parts were seats, safety belts, windows, tires and radiator grilles. Table 1 shows some general characteristics of the selected parts and components from a logistics perspective. Seats, for example, are bulky, costly, diverse and generally delivered to assembly plants in modules[3]. On the contrary, safety belts are relatively cheap, less diverse, and delivered in large batches of discrete components over longer distances. For the five components considered in the case of Thailand, there were about 1 600 records between 2007 and 2021, of which about a half corresponded to the period 2017-2021.

Type of part	Volume	Cost	Variety	Frequency of deliveries	Distant sourcing
Seats	Very high	High	High	High	No
Seat belts	Low	Low	Medium	Low	Yes/No
Glass windows	High	Medium	Low	High	No
Tires	High	Medium	Medium	Medium	Yes
Radiator grilles	Medium	Low	Low	Low	No

[3] A module is a set of parts or components working as a small subsystem that can be designed independently (Carliss et al. 1997)

TABLE 1 CHARACTERISTICS OF THE SELECTED COMPONENTS FROM A LOGISTICS PERSPECTIVE

The database does not provide information on the number of parts or components supplied. To overcome this limitation we weighted the supplying relationships by the production volumes of each vehicle model. We therefore considered supplying relationships from two perspectives (Figure 7). The first related to the total number of relationships, based on the total number of vehicle models. The second estimated the volumes involved by weighting the number of models by the production volume for each model. To gain a better understanding of supplying relationships, we collected complementary data from the same database on the main shareholders of each supplier, which could be considered to be a third perspective. Given the importance of Japanese car manufacturers in Thailand, the supplying relationships were systematically compared with those observed in Japan to examine differences and similarities, and if possible see if follow sourcing applies (Humphrey 2003). The characteristics of the automotive industry in both countries are very different in terms of size, their respective positions in the value chain, and their growth rates over the past three decades. The recent work of Pollio and Rubini (2021) and Itoh et al. (2019) provide a detailed presentation of the automotive industry in Thailand.

5. The varied networks of Japanese car manufacturers in Thailand

The representation of the relationships between car manufacturers and tier 1 suppliers was carried out done using Multi-Dimensional Scaling (MDS). This so-called dimension-reduction technique places firms (here, car manufacturers and suppliers) in an abstract n-dimensional space based on the differences (or similarities) between the entities in question (Kruskal and Wish, 1978). Proximities between firms have a meaning which can be interpreted, contrarily to other visualization methods such as Sankey charts. The metric used for MDS is the number of vehicle models for which a supplier provides a certain part to a certain car manufacturer.

Figure 6 shows a diagrammatic representation of the main types of relationships. The most frequent is single sourcing, with one supplier providing a certain part for most of the models made by a certain car manufacturer. The second type of relationship is multi-supplier, when a car manufacturer makes use of several suppliers none of which is dominant. In general, this type of relationship occurs when the car manufacturer aims to promote competition between its suppliers, to reduce the risks of disruption, and/or to expand the range of

options it proposes to its customers. The third case is when one supplier provides components for several car manufacturers. This usually happens when the supplier has some experience in the country, and expands its client portfolio to achieve scale economies in manufacturing and/or to improve its technical capabilities (Itoh et al. 2019). This list of relationships is not exhaustive. Sometimes car manufacturers encourage collaboration between their tier 1 suppliers, resulting in lateral links[4], but this is clearly beyond the scope of the current analysis.

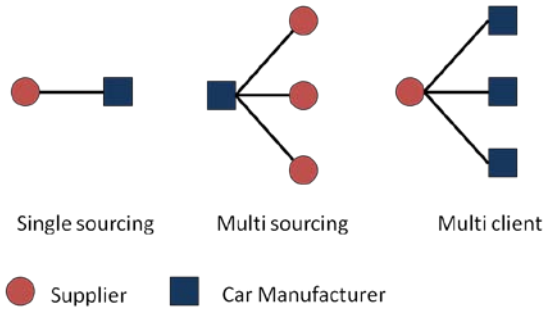


FIGURE 6. MAIN TYPES OF RELATIONSHIPS

This diagram reflects the strength and diversity of relationships, based on the number of vehicle models for which a supplier provides components to a car manufacturer. However, while many of the vehicle models are assembled in small series, few of them are top sellers. In Thailand, this applies, for example, to a handful of pick-up truck models produced in tens, or even hundreds, of thousands, each year. Since volumes are suggestive of market power, a second type of representation was created in which the links were weighted by the number of vehicles assembled. Figure 7 shows the two types of representation. While the diagram on the left (A: Links) shows the position of firms within business networks, that on the right (B: Sales) highlights firms' market power.

[4] An example of direct links between suppliers is provided by Dyer and Nobeoka (2000) who discussed how Toyota reproduced its supplier network in the U.S. Toyota promotes voluntary learning teams in which suppliers can share production knowledge. *"Each supplier group consists of roughly five to eight suppliers, some of whom use similar production processes (e.g. stamping, welding, painting)"* (p.355).

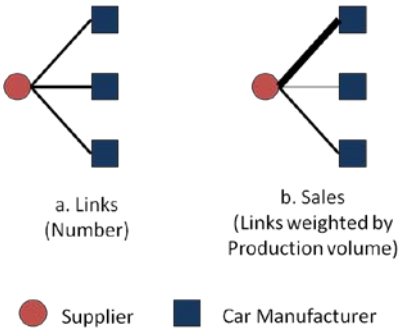


FIGURE 7. TWO COMPLEMENTARY PERSPECTIVES OF SUPPLYING RELATIONSHIPS

The categories covered in this study include five components; *radiator grilles* and *seats*, which are bulky, *window glasses*, which can only be produced efficiently on a large scale, *seat belts*, which are increasingly being procured globally, and *tires*, which offer considerable product differentiation and manufactures' options. Table 2 shows the main characteristics of each category. In both countries, each component is sold in an oligopoly market with the top three suppliers holding about 60% of the market share (see Table 3). By way of a summative conclusion regarding the five different components, we can try to categorize their supply systems based on their complexity (see Table 4). In general, the number of suppliers per car manufacturer is higher in Japan. Due to the nature of the database, the plants where the components are manufactured are not known. Since the number of car manufacturers in each country is almost same, the difference in the number of suppliers is largely due to the differences in the size of the two markets and as well as to the variety of car models and options.

Category	Components
Radiator grille	active grille shutter, grille, front grille, radiator grille etc.
Seat	seat, seat massage system, seat comfort system, arm rest, seat heating, seat table, side panel etc.
Seat belt	seat belt, seat belt airbag, seat belt guide plate, sensor, buckle, remainder system etc.
Window glass	window glass, pillar glass, window seal, window trim, window frame etc.
Tires	tire, tire code, tire module, tire valve, tire valve core etc.

TABLE 2. LISTS OF COMPONENTS

Radiator grille				Seat				Seat belt				Tires			
Japan		Thailand		Japan		Thailand		Japan		Thailand		Japan		Thailand	
Toyoda Gosei	26	Toyoda Gosei	45	Toyota Boshoku	36	Toyota Boshoku	28	Joyson Safety Systems (China)	47	Joyson Safety Systems	33	Bridgestone	35	Sumitomo Rubber Industry	42
Sakae Riken	19	Daido Manu.	23	TACHI-S	15	Adient (Korea)	25	Tokai Rika	20	Tokai Rika (Thai Seat belt)	27	Yokohama Rubber	28	Bridgestone	29
Faltec	13	Daikyo Nishikawa	6	NHK Spring	12	Summit Auto Seats Industry (Thailand)	10	Autoliv (Sweden)	19	Autoliv	19	Sumitomo Rubber Industry	25	Toyo Tire	5
Sankei	8	C.B. Paint	5	Delta Kogyo	8	TS TECH	10	Ashimori Industry	7	Ashimori Industry	9	Toyo Tire	5	Michelin	4
Sankei Giken	7			Fuji seats	7	Delta Thairung	6					Michelin (France)	3	Yokohama Rubber	4
Others	27	Others	21	Others	22	Others	21	Others	7	Others	12	Others	4	Others	16

(Source) Marklines. N.B. No information is available about national and regional market share for "window glass."

TABLE 3. MARKET SHARES OF AUTO-COMPONENTS IN JAPAN AND THAILAND

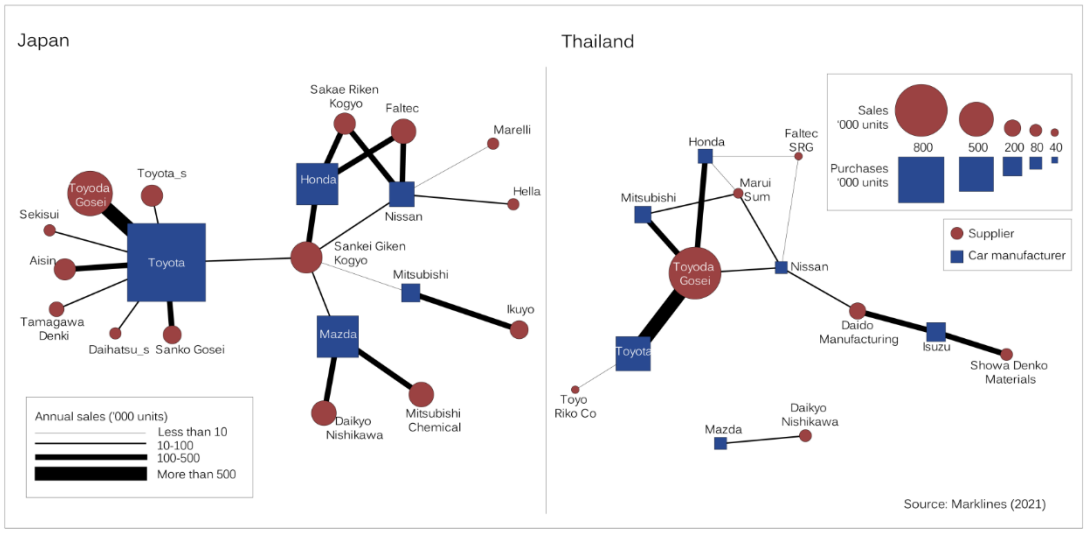


FIGURE 8. SUPPLY NETWORKS OF JAPANESE CAR MANUFACTURERS IN JAPAN AND THAILAND (RADIATOR GRILLE)

The radiator grille brings out major differences between the two countries' supply networks (Figure 8). This component has a dual function: it adds to the car's appearance and conveys air to the engine and radiator. In Japan (left-hand diagram), 15 suppliers are recorded for 5 car manufacturers, each of

the latter having multiple suppliers. The number of suppliers per car manufacturer varies between two for Mitsubishi and seven for Toyota. In Japan, multi-sourcing is the norm. In contrast to this norm, the supplier Sankei Giken Kogyo is in a unique position, being an affiliated (*keiretsu*) supplier to Honda, but also supplying the other car manufacturers. The situation is very different in Thailand (right-hand diagram in Figure 8), where the multi-client relationship is the norm. Only seven suppliers are listed for six car manufacturers. In Thailand, Toyoda Gosei (Toyota's *keiretsu* supplier), has considerably expanded its client portfolio, while keeping Toyota as its main customer[5]. Other suppliers also supply components to multiple car manufacturers, but the volumes are overwhelmingly smaller. Sankei Giken, which is a "multi-client" supplier in Japan, was still in the process of expanding into Thailand at the time of writing this manuscript, so the supply of these components is considered to be limited at this point. When assembly manufacturers are at the stage of entering Thailand's market, they can be expected to have developed a supply system that is different from that in Japan as a result of their dependence on specific suppliers for the procurement of particularly bulky components due to the limited production volume.

Category	No. of car manufacturers		No. of suppliers		Features of the supply system	
	Japan	Thail-and	Japan	Thail-and	Japan	Thailand
Radiator grille	5	6	15	7	Multi-sourcing, except Sankei Giken (multi-client)	Multi-client (Toyoda Gosei)
Seat	11	11	30	14	Mostly multi-sourcing, and multi-client (Tachi-S, NHK)	Multi-sourcing, but partially multi-client (e.g. NHK)
Seat belt	12	12	7	6	Mostly multi-client (Joyson, Autivo, Ashimori)	Multi-to-multi combination (multi-sourcing and client)
Window glass	8	12	14	8	Multi-to-multi combination (multi-sourcing and client)	Multi-client (AGC, Saint-Gobain)
Tires	13	14	15	13	Multi-to-multi combination (multi-sourcing and client)	Multi-to-multi combination (multi-sourcing and client)

(Source) Summary by the authors.

TABLE 4. THE MARKET SHARES FOR AUTO-COMPONENTS IN JAPAN AND THAILAND

The characteristics of the supply networks for the other four components are summarized in Table 4. In the case of seats the main type of relationship is "multi-sourcing," but several major suppliers, such as NHK[6], are "multi-client" in both countries. For seat belts, there are only a limited number of suppliers in Thailand, each of which supplies several car manufacturers. In Japan the "multi-client"

[5] Toyota started production in Thailand in 1962 and Toyoda Gosei (Thailand) was established in 1994.
[6] Global market leader for suspension springs

sourcing relationships are slightly different although some of the suppliers are the same as in Thailand. This is not surprising given that most[7] of the seat belts used for car assembly in Japan come from Thailand. In the case of window glasses, the supply market is particularly oligopolistic due to the large investments needed to cover high tooling and set-up costs (Barnes and Kaplinsky, 2000). In Thailand and Japan, each car manufacturer works extensively with at least two suppliers to increase flexibility and reduce bottlenecks (Andrabi et al., 2006). Lastly, for tires, the supplying patterns are similar in Japan and Thailand, with widespread "multi-sourcing" relationships. Tires are not shipped directly to the car manufacturer assembly plant, but they are integrated with wheels in separated plants typically operated by joint venture firms (Collins et al. 1997). As compared to the other four components, economies of scale in tire production are exceptionally large. The priority for car manufacturers seems to be to foster competition between suppliers to save costs and to offer their customers a wider range of options. It is also important to note that the production of tires in Thailand largely exceeds the local demand of car manufacturers. The country is the second largest exporter of tires in the world and leads the upstream production of natural rubber[8] (Ricks and Doner, 2021). Thus, it is apparent that different supply systems have been established depending on the number of component suppliers, their positioning, and the timing of their entry into the market.

6. Discussion: A reproduction of traditional keiretsu grouping overseas?

The analysis of the supplying relationships for the selected components provides some interesting insights from a logistics perspective. For example, in the case of seat belts, car manufacturers usually make use of several suppliers, possibly remote, to stimulate competition between them (Doran, 2003). Since seat belts are relatively compact and standardized, large batches can be delivered over long distances and stored without incurring high logistics costs. On the other hand, seats, which are bulky, costly and varied, are usually produced near the car assembly plants, and produced and delivered on a Just-in-Time basis to minimize stocks. Economies of scale in seat production can only be achieved with large demand. This greatly limits the number of seat suppliers per car assembly factory, and favors long term relationships[9].

[7] About 70%, Trade Statistics of Japan, 2019)

[8] In Thailand, some 1 million families (six million people) are employed in the cultivation and processing of (semi-processed) natural rubber. Rubber is Thailand's largest agricultural export (Ricks and Doner, 2021).

[9] As kindly suggested by one of the two reviewers, it is worth noting that economies of scale in seat production are mainly achieved in the production of components (seat cover, foam, etc.) by a small number of large-scale plants.

Type of part	Most common type relationship	Financial links with car manufacturers	Involvement of local firms as tier 1 suppliers
Seats	Predominantly single sourcing	Strong	Low
Seat belts	Multi-sourcing / Multi-client	Weak	Low
Glass windows	Multi-client	Medium	Medium
Tires	Multi-sourcing / Multi-client	Weak	Medium
Radiator grilles	Multi-sourcing/ Multi-client	Medium	Low

TABLE 5 CHARACTERISTICS OF THE SOURCING RELATIONSHIPS FOR THE SELECTED COMPONENTS

Table 5 summarizes the characteristics of the five components. It shows that in the case of seats it is common for a car manufacturer to work with several suppliers (2-3), with one of them in a favored position in more than 90% of the relationships.

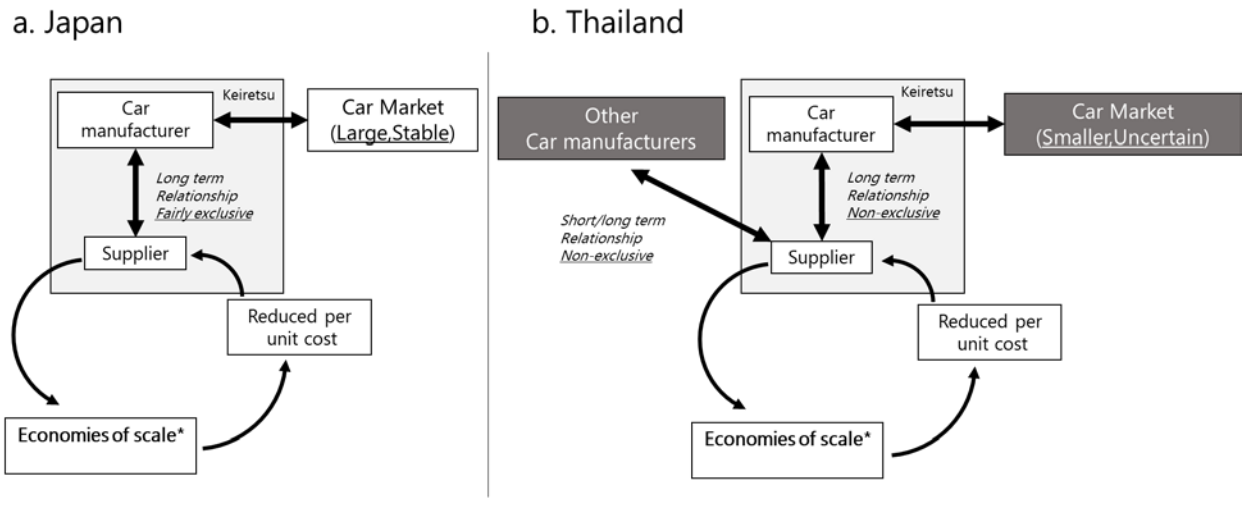
For tires, each car manufacturer sources from many different suppliers, although the top three tire suppliers account for 88% (Japan) and 76% (Thailand), which reflects a highly concentrated market. On one side car manufacturers take advantage of purchasing large volumes to their main tire suppliers. On the other side, alternative suppliers are also selected to reduce their dependence on their main supplier or to provide special options. The cases of seat belts and windows are somewhere in between. In the cases of window glasses and radiator grilles, few large suppliers dominate the market, each selling to a number of car manufacturers (multi-client). Radiator grilles are important elements of differentiation for car manufacturers, they are bulky and difficult to move over long distances, something which favors local production. But at the same time quality requirements and the minimum efficient scale required for production represent important barriers to entry. In the case of seatbelts car manufacturers tend to source from different suppliers, Toyota being an exception.

Despite their specificities, the supplying relationships for the five components considered in this study share some common features. Often the car manufacturers adopt follow sourcing strategies, selecting the same supplier in both the home market and overseas. This relationship often entails financial ties, within the context of the same business group (keiretsu). This pattern seems to be the norm in Japan. In Thailand, *keiretsu* suppliers

develop different production strategies depending on the characteristics of components and the demand from car manufacturers.

In some cases, the traditional exclusive relationship evolves towards a multi-client one (or loose relationship), as witnessed in the case of radiator grilles. Does this imply that the configuration of links result from the level of sophistication of parts and components ? Our results suggest that the determinants may be more diverse and less easy to grasp than it would appear. For the parts and components under study, part suppliers located in Thailand had the possibility of diversifying their client portfolio beyond keiretsu members when production volumes where small in the late 1990s and early 2000s. This early diversification may have been crucial to improve their position and to stay ahead, even after a significant increase in the sizes of domestic and regional markets. We assume that this explanation is partial, and other factors which are beyond our knowledge at the time of writing this paper, may play important roles as well in the increased autonomy obtained by *keiretsu* suppliers in Thailand.

The organizations in the two countries are illustrated in Figure 8. Te relative maturity of Thailand in the automotive production sector and the high density of firms (more than 1400 firms supplying car manufacturers (Kuroiwa et al, 2022) would provide appropriate conditions for keiretsu suppliers to gain room for maneuver.



*Efficient production, easier access to capital, lower purchasing costs, lower logistics costs

FIGURE 8. ORGANIZATION OF KEIRETSU SUPPLIERS IN JAPAN AND THAILAND

If, for some parts and components, *keiretsu* suppliers have managed to diversify their client portfolio in Thailand, it remains unclear what has been the incidence on the country's industrial upgrading, such as for example through the establishment of local R&D facilities or other strategic functions. Studies in other areas outside of the core of automotive industry suggest that most of the strategic functions of suppliers tend to locate close to the headquarters of car manufacturers at the core (Pavlinek and Zenka, 2012, Humphrey, 2003) , even for home-grown suppliers (Mordue and Sweeney, 2020). Furthermore, it remains to be seen if this diversification of suppliers' client portfolios can take place in other countries or regions where component production is less geographically concentrated than in Thailand.

7. Conclusion

The starting point of this paper was the variety of link configurations that may exist between Japanese car manufacturers and their tier 1 Suppliers in Thailand and Japan. The analysis of the supplying relationships based on the Marklines database, coupled with desk research on the Asian automobile industry, provided insights into the positions of *keiretsu* suppliers.

The primary conclusion is that in Thailand, Japanese car manufacturers predominantly adopt follow sourcing, which consists of choosing the same tier 1 suppliers overseas as are used at home. Some may infer that this is a reproduction of the traditional *keiretsu* grouping, in which long-term preferential relationships are favored, to maintain quality and reduce the risk of disruption in the context of the uncertainty that prevails in a developing country such as Thailand. In that respect, the ties between Japanese car manufacturers with their *keiretsu* suppliers in Thailand seem similar to the vertically integrated car manufacturers from Western Europe (Germany) or the United States in their integrated peripheries. However, besides this predominant strategy, the analysis shows a great diversity of situations. In particular, some Japanese suppliers have expanded their client portfolios in Thailand to offset demand weaknesses and instability.

Focusing on the production of five components with different manufacturing processes, the analysis revealed distinct network patterns. The analysis, based on the supply relationships for five different types of parts and components, stresses on the room for action for keiretsu suppliers to diversify their client portfolio beyond their main client. The results show that there is not a simple explanation, either based on the level of sophistication of parts or

minimum efficient scale of production. A multifaceted approach, taking into account the individual characteristics of parts components is therefore necessary, taking into account the number of suppliers and car manufacturers, the market segment, the level of sophistication of production and the involvement domestic firms, amongst other aspects.

For instance, the paper highlights that the choice of Thailand is linked to the fact that most of the suppliers there are geographically concentrated in a few areas. However, this strategy may be less appropriate in other developing regions where component production is more geographically scattered. The adaptations alter the nature of the supply networks, and probably provide greater autonomy from some formerly captive suppliers. These differences may largely be due to transport and logistics issues. This is a hypothesis that we would like to test as part of future work that will be more strongly grounded in fieldwork.

This paper also aims to guide future research that will explore suppliers' strategies, based on interviews with firms or other empirical surveys. It would then explore links with n+1 tier suppliers and neighboring countries (Cambodia, Vietnam, etc.) Therefore, expanding this type of analysis to those countries is a promising avenue for future research.

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