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Technology Fields of Automotive Parts Suppliers in Aichi Prefecture, Japan

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Abstract: The global automotive industry is at a crossroads due to the unique structural changes driven by digitalization and electrification. The emergency of electric vehicles will decrease the number of parts and components necessary to build any given vehicle, leading to significant adverse impacts on existing automotive parts suppliers. Automotive parts suppliers are among the most competitive manufacturers of any kind in Japan and should have sufficient capacity for innovation and change to allow them to implement strategies necessary to maintain themselves, although not all of them may continue in their current lines of business. How much have the automotive parts suppliers prepared themselves for this structural change in their industry? How can they survive and in which business fields? This study observes recent patent data in an effort to understand technological competencies and potential future business fields for Japanese automotive and vehicle parts manufacturers. The patent data show a range of diversified technologies related to automotive parts industries, which should allow automotive parts suppliers to use their current technologies to develop new products for new vehicles, secure margins from the matured traditional market of automotive parts and spare parts, or enter growing new markets in non-automotive industries such as medical equipment, primary products, and other products and services that support people’s daily life. These findings from Japan will provide business and policy implications for securing the economic and environmental sustainability of local

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automotive parts suppliers in developing countries without endogenous automotive original equipment manufacturers (OEMs).
Keywords: Patent; technological diversification; automobile; supplier; Japan

1. Introduction

The automotive industry is in the process of radical structural change leading ultimately toward electrification and digitalization that will influence various firms in the automotive and related industries. In particular, the transition to battery electric vehicles (BEVs) will cause a considerable negative impact on traditional automotive parts suppliers by halving the number of automotive parts used for a typical vehicle from around 30,000 pieces for an internal combustion engine (ICE) vehicle. This structural change will also bring new business opportunities for automotive parts suppliers and vendors in other industries.

The development of the BEV market is led primarily by Chinese and European automotive OEMs (i.e., carmakers) with strong support from governments providing physical and institutional infrastructure and subsidies to accelerate the change. Their technological focus on BEVs is motivated by various elements including political factors such as the increasing public interest in climate change and commercial considerations, including efforts to gain competitive advantages over major vehicle producing countries and automotive OEMs.

Japanese automotive OEMs have been ahead of the market in the development of the technologies necessary for BEVs and other electric vehicles (xEV) such as fuel cell electric vehicle (FCEV). Some of them addressed pioneering challenges to commercialize BEVs, including introducing i-MiEV by Mitsubishi in July 2010 and the Leaf by Nissan in December 2010. Toyota has been advanced in the development of FCEVs, as demonstrated by the launch of Mirai in December 2014. However, Japanese OEMs had been slow at promoting BEVs and FCEVs as their main products to Japanese consumers when the Government of Japan had not as yet encouraged a policy to promote BEVs and FCEVs.

One of the reasons for this Japanese stance was the widespread proliferation of fuel-efficient hybrid electric vehicles. The other issue was Japan's lack of a comprehensive decarbonization policy. Further, the Japan Automobile Manufacturer Association estimates a reduction of 700,000 to one million jobs in the automotive and related industries that currently employ 5.5 million people if a BEV promotion policy were implemented without a national decarbonization policy that will mitigate negative impacts on exports of vehicles from Japan by reducing carbon emissions during the entire life cycle of vehicles including manufacturing of parts and automobiles.

This business environment surrounding the Japanese automotive industry has changed with the policy speech in October 2020 by the Prime Minister Suga declaring the challenge of achieving carbon neutrality by 2050. In January 2021, he set a target of phase-out of ICE vehicle sales by 2035. Following these policy changes, Honda announced in April 2021 its aim for 100% BEV sales by 2040, whereas Toyota released in December 2021 its BEV strategy and plan to roll out 30 BEV models by 2030. These movements were enough to convince Japanese automotive parts suppliers of a future increase in demand for parts and components for BEVs and other EVs in Japan. As a result, the problem for automotive parts suppliers became not considering whether or not xEV should be promoted in Japan but rather preparing for the coming changes in the Japanese automotive parts market.

Although vehicle electrification will reduce the number of required automotive parts and therefore create a greater impact on automotive parts suppliers than on automotive OEMs, attention had been focused mainly on automotive OEMs and new entrants into the automotive industry from other industries. Governments must also consider business strategy and supporting policy for automotive parts suppliers to facilitate the transition from ICE to BEV. Future alternatives to ICE-related products will depend on the technologies and other resources that automotive parts suppliers have.

To consider the possible alternative business fields available for Japanese automotive parts manufacturers, this study used patent data to observe technology fields that Japanese firms have already developed. The preliminary findings suggest technology fields of Japanese automotive parts manufacturers are not limited to those categorized as vehicles but cover a wide range of industries, including agriculture and medical equipment.

The structure of this paper is as follows. Section 2 explains the data and methods used for this study. Section 3 reports descriptive statistics. Section 4 summarizes and concludes with an attempt to derive business and policy implications for developing countries for the material reviewed.

2. The Data and Method

This study uses the Bureau van Dijk Orbis Intellectual Property (Orbis IP) database. The primary benefit of using Orbis IP is that the database contains information related to intellectual property in English applied to data in various countries, categorized by different patent classification systems. This database also includes information on firms from different countries, which contains location, activity, financial information, and so on. Those patent and firm information can be linked to the patent data, although this study does not use identifiable firm information.

In a preliminary analysis of intellectual property in the automotive parts industry, this study focuses on automobile and parts manufacturers in Aichi prefecture, Japan. Aichi prefecture is the manufacturing center of the Chubu region, the third largest business district and one of the largest automotive clusters in Japan. Toyota and its suppliers concentrate their mother factories in Aichi prefecture. Toyota and many of its Tier 1 suppliers also place research and development (R&D) functions in this prefecture.

The author downloaded patent data from the Orbis IP database on October 1, 2021, defining the sampling frame as those firms in Aichi categorized as the North American Industry Classification System (NAICS) 2017 code 3363 (motor vehicle parts manufacturing), which can include automotive OEMs producing automotive parts and components in-house. Then, the downloaded data were limited to those containing the patents published at the patent offices in Japan and current owner names. The data excluded the patents of the years 2020 and 2021 because only 119 patents (186 observations if owners for co-owned patents were accounted) fell into these priority years. As a result, the author obtained 73,342 observations, or 45,864 patents held by a total of 73,342 owners, for data analysis. Because the objective of this study is to observe potential new technological portfolios and fields for automotive parts manufacturers, the analysis in the following section is based on either the total number of patents (=45,864) or the total number of observations or patent owners (=73,342). Co-owned patents have multiple observations; therefore, the ratio between the number of observations and patents (=73,342/45,864=1.6) means the number of owners per patent, which also suggests the number of co-inventors[1].

[1] Co-owners of a patent identified in this dataset is limited to those in Aichi prefecture. In other word, a patent in this dataset can be held by owners/an owner in Aichi with those in other

To identify potential new business fields for automotive parts suppliers from the technological competence suggested by the patent information in the dataset, this study used the concordance table to link the International Patent Classification (IPC) with technology fields (Schmoch, 2008).

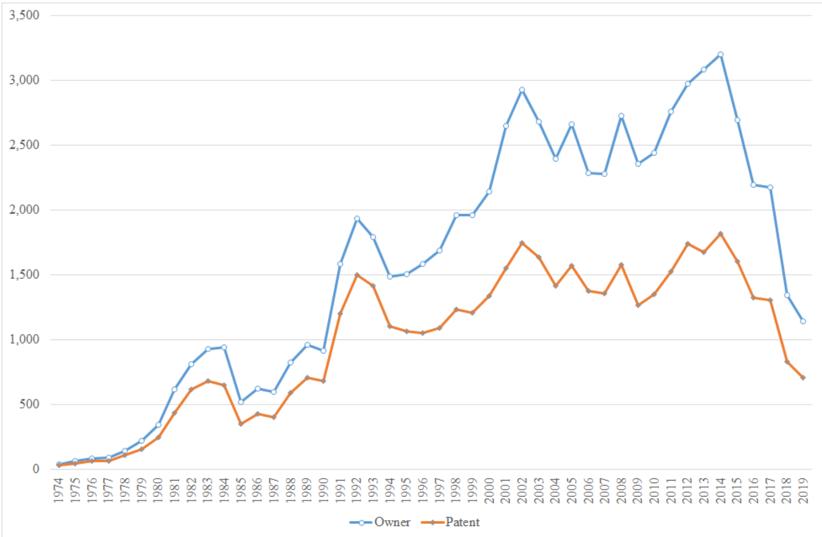
3. Results

3.1 Patents published by year

The dataset comprises the total number of 73,342 owners for the 45,864 patents owned by automotive parts manufacturers in Aichi prefecture. Figure 2.1 illustrates the total number of patent owners by priority year, obtained by converting the priority date into the year. This figure had reached over 1,500 by 1991. After reaching over 2,000 in 2000, the number fluctuated but maintained this level by 2017. During the 2000s, the maximum number of 3,202 was recorded in 2014.

The total number of patents had increased to over 1,000 in 1991 and reached the maximum number of 1,816 in 2014. Like the number of patent owners, this number experienced fluctuations but maintained this level beyond 1,000 by 2017.

Figure 2.1: Total number of patent owners and patents by priority year



Source: Created by the author from the Orbis IP database.

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prefectures.

3.2 Leading patent owners

The patent owners in the dataset include automotive OEMs (i.e., Daihatsu, Hino, Honda, Mazda, Mitsubishi, Nissan, Subaru/Fuji Heavy Industries, Suzuki, and Toyota) in Aichi prefecture that produce parts and components, although this study focuses more closely on pure parts suppliers in the same prefecture. Non-OEM parts manufacturers, specializing in automotive parts, account for 92.6% of the total number of observations (i.e., 67,906 of 73,342 observations), whereas the OEMs account for only 7.4% (5,436). Non-OEM parts manufacturers hold 43,707 patents, comprising 95.3% of the total patents. This means that these figures for the OEMs are 2,157 and 4.7%, respectively.

Table 2.1 shows that Denso and Aisin group are the top patent owners in Aichi prefecture. As Denso holds a 75% stake in Nippon Soken[2], Denso group accounts for one-quarter of the total observations. Although Aisin group's presence is not obvious because Aisin Seiki[3] ranks ninth in the list, the table includes Aisin's group firms, including Advics[4] and Shiroki[5] in the top five. By adding Aisin Chemical, Aisin Takaoka, and Hosei Brake Industry[6], six Aisin group-affiliated companies are among the top 15 companies.

Among the automotive OEMs, Toyota occupied a dominant position in its home prefecture, having 4,652 observations or 6.3% of the total observations. This figure for Toyota does not include its group companies, such as Toyota Central R&D Labs and Toyota Auto Body. However, as Table 2.1 shows, most of the leading patent owning companies are owned by Toyota or Toyota group-affiliated suppliers, including Araco, a Toyota Boshoku affiliated company.

[2] Toyota holds the rest of 25% stake in Nippon Soken.
[3] Aisin Seiki and Aisin AW merged to form Aisin Corporation on April 1, 2021.
[4] Advics was founded by Aisin Seiki, Denso, Sumitomo Electric, and Toyota in 2001. The share-holding ratio is Aisin Seiki (51%), Denso (34%), Sumitomo Electric (6%), and Toyota (9%) as of October 31, 2016 (Advics press release on November 17, 2016).
[5] Shiroki became a wholly-=owned subsidiary of Aisin Seiki on April 1, 2016.
[6] The share-holding ratio in Hosei Brake Industry is Advics (50.1%), Aisin Seiki (26.5%), and Toyota (23.4%) as of February 28, 2018 (Advics press release on February 28, 2018).

Table 2.1: Top 15 patent owners

Rank	Name	Freq.	Percent (1)	Percent (2)
1	Denso	10,884	15.0	23.7
2	Nippon Soken	7,618	10.5	16.6
3	Advics	4,751	6.6	10.4
4	Toyota	4,652	6.4	10.1
5	Shiroki	3,691	5.1	8.0
6	Araco	3,370	4.7	7.3
7	Aichi Machine Industry	2,683	3.7	5.8
8	Toyota Central R&D Labs	2,637	3.6	5.7
9	Aisin Seiki	2,267	3.1	4.9
10	Aisin Chemical	1,642	2.3	3.6
11	Aisin Takaoka	1,510	2.1	3.3
12	Sango	1,215	1.7	2.6
13	Hayashi Telempu	1,015	1.4	2.2
14	Toyoda Iron Works	897	1.2	2.0
15	Hosei Brake Industry	875	1.2	1.9

Note: Percent (1) is based on the total number of owners (=73,342 observations). Percent (2) is based on the total number of patents (45,864 patents).

Source: Created by the author from the Orbis IP database.

3.3 Technological fields

Table 2.2 summarizes the data by IPC section, which is the largest category of the classification system shown in the first digit of the IPC code. Table 2.2 lists the data in terms of the number of observations (freq. (1)) and patents (freq. (2)), while the following paragraphs in this subsection discuss primarily the number of observations.

Section B (performing operations; transporting) accounts for 38.0% of the total observations. Section B includes a subsection for transportation that contains the class (i.e., IPC 3-digit) for vehicles in general (B60) and its subclasses associated with vehicles. Following Section B, the second important category is Section F (mechanical engineering; lighting; heating; weapons; blasting), which constitutes 23.2% of the dataset. Section F contains the subsection for engines or pumps, and the class (F02) and its subclasses associated with internal combustion engines. As the sampling procedure for this study limited firms to those classified as engaged in motor vehicle parts manufacturing, it is reasonable for these two sections to constitute a significant percentage of the data studied.

The shares for Sections B and F are followed by Sections H (electricity) and G (physics). Among classes in Section H, important IPC classes are H01 (basic electric elements), which includes subclasses related to semiconductor devices (H01L) and batteries (H01M), H02 (generation, conversion, or distribution of electric power), and H04 (electric communication technique). The patents designated as Section G can be used for various purposes. For example, instruments and systems for measurement and testing, assigned to G01 (measuring; testing), will be necessary for ICE vehicles. At the same time, this section also contains classes for key technologies for the future automotive industry such as G05 (controlling; regulating), G06 (computing; calculating or counting), and G08 (signaling). The significance of Sections H and G is that they reflect competition in the development of technologies for connected, autonomous driving, shared, electrified (CASE) vehicles.

Considering vehicle interiors and exteriors will make it simple to recognize that automotive parts suppliers have patents based on material sciences, such as chemistry and metallurgy (Section C) and those related to fabrics (Section D), compared to Sections A (human necessities) and E (fixed constructions). The IPC codes for Section A suggest that the patents for Section A will be related to car interiors only if the technologies were actually developed for such vehicles. Section E has several technological fields related to automobiles, such as E05 (locks; keys; window or door fittings; safes).

Table 2.2 also presents the ratio between the total number of patent owners and the total number of observations, or the number of owners per patent. This information indicates the extent of co-ownership. This ratio for Sections G and H is higher than the ratio based on the total number of observations and patents (1.6), suggesting collaborations with more inventors to promote electrification and digitalization.

Table 2.3 is based on the data from Table 2.2 but rearranged by priority year to show shares (%) for the IPC section in each period. Table 2.3 shows the observations for Section G and H increasing, while those for Sections A, B and C decreased. The increase in share for Section H was accelerated in the 2010–2014 period to reach 20%, reflecting private efforts for a technological consolidation to prepare for digital transformation in the automotive industry. In this situation, the traditional technology fields such as Section B and F kept significant shares, suggesting the continuing importance of fundamental automotive technologies.

Table 2.2: Patents by IPC section

Section	Description	Freq. (1)	Percent (1)	Freq. (2)	Percent (2)	Co-owned
A	Human necessities	3,695	5.0	2,883	6.3	1.3
B	Performing operations; transporting	27,896	38.0	19,009	41.5	1.5
C	Chemistry; metallurgy	3,708	5.1	2,143	4.7	1.7
D	Textiles; paper	330	0.5	210	0.5	1.6
E	Fixed constructions	3,533	4.8	2,399	5.2	1.5
F	Mechanical engineering; lighting; heating; weapons; blasting	17,006	23.2	10,702	23.3	1.6
G	Physics	7,824	10.7	3,970	8.7	2.0
H	Electricity	9,350	12.8	4,548	9.9	2.1
Total		73,342	100.0	45,864	100.0	1.6

Note: Freq. (1) and Percent (1) are based on the total number of owners. Freq. (2) and Percent (2) are based on the total number of patents. Co-owned= Freq. (1)/ Freq. (2).

Source: Created by the author from the Orbis IP database.

Table 2.3: Patent owners by IPC section and priority year (%)

Section	–1980	1990–1994	1995–1999	2000–2004	2005–2009	2010–2014	2015–2019	Total
A	9.1	9.5	7.5	5.6	3.3	1.6	2.5	5.0
B	43.4	47.1	38.8	38.9	36.6	31.1	36.9	38.0
C	9.3	5.6	5.1	4.9	4.6	4.4	2.8	5.1
D	0.9	0.7	0.7	0.6	0.1	0.2	0.3	0.4
E	5.3	3.9	6.3	5.6	5.0	4.2	3.4	4.8
F	22.3	24.1	24.3	22.6	24.5	24.1	19.9	23.2
G	6.5	5.9	9.1	10.3	12.6	12.9	14.1	10.7
H	3.2	3.3	8.2	11.6	13.3	21.4	20.0	12.7
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Note: Percentage of the total observation for each period.

Source: Created by the author from the Orbis IP database.

3.4 Technology fields of firms specialized in automotive parts

Table 2.4 summarizes the number of observations (i.e., patent owners) and patent fields by section (IPC 1-digit). The owners were divided into automotive OEMs, and non-OEM manufacturers specialized in parts suppliers. To break down the number of fields, the various patents were classified with the IPC 4-digit codes.

The data show that non-OEMs cover broader technological fields than OEMs for all sections. In particular, automotive OEMs make less investment in technologies for Sections A (Human necessities), D (Textiles; paper), and E (Fixed constructions). Automotive OEMs cover only seven fields for Section A, four fields for Section D, and six fields for Section E.

To enable the reader to see more details of technology characteristics owned by automotive OEMs and parts manufacturers, Table 2.5 classified the patents into 35 technology fields by using the IPC-based technology classification proposed by Schmoch (2008).

Table 2.4: Patents by IPC section and priority year

	Observations			Fields	
Section	Non-OEM	OEM	Total	Non-OEM	OEM
A	3,597	98	3,695	59	7
B	25,429	2,467	27,896	133	61
C	3,399	309	3,708	55	21
D	318	12	330	27	4
E	3,385	148	3,533	29	6
F	15,807	1,199	17,006	73	31
G	7,354	470	7,824	54	30
H	8,617	733	9,350	43	23
Total	67,906	5,436	73,342	473	183

Note: Observations are the number of observations, and fields are the number of subclasses (IPC 4 digit) for each Section (IPC 1 digit).

Source: Created by the author from the Orbis IP database.

This table reveals that Japanese OEMs have not developed high scientific competencies in chemistry. In particular, no OEMs own patents classified in the fields of analysis of biological materials, organic fine chemistry, food chemistry, and micro-structural and nanotechnology. Automotive OEMs also rely on suppliers' capabilities especially in basic communication processes and IT methods for management. As the numbers of observations for automotive OEMs on audio-visual technology, telecommunications, and digital communication are small, carmakers will not usually have a strong technological foundation in electrical engineering that will contain key technologies for electrification and digitalization of vehicles.

Table 2.6 is based on the same data as Table 2.5 but uses only the data for the patents published from 2015 to 2019. This table clarifies the recent technology focus for automotive OEMs in such fields as transport and semiconductors. On the other hand, the field related to engines, pumps, and turbines has decreased in importance, reflecting the transition toward electrified vehicles.

In contrast to the automobile producing industry, the technology fields covered by the automotive parts industry are still broad. They have been developing technologies in the fields that will not necessarily be related directly to the automotive industry, such as medical, bio, food, and other chemistry.

In fact, it is possible to find that automotive suppliers did or tried to develop new business fields such as medical (e.g., Hamada in Hiroshima prefecture, Kyowa Fine-Tech in Okayama prefecture, Tokai Buhin Kogyo in Shizuoka prefecture), agriculture (Denso, Toyoda Iron Works in Aichi prefecture), forestry (Oozugiken in Kumamoto prefecture), and aquaculture (e.g., NGK Spark Plug). In Shizuoka prefecture, AOI Forum promotes an AOI project to apply advanced technologies in agriculture, food, and health. The members of the forum include Tokai Buhin Kogyo and other automotive suppliers in this prefecture.

Table 2.5: Patents by 35 technology fields

Field No.	Field	Non-OEM	OEM	Total
1	Electrical machinery, apparatus, energy	4,788	362	5,150
2	Audio-visual technology	621	10	631
3	Telecommunications	1,007	13	1,020
4	Digital communication	251	16	267
5	Basic communication processes	322	1	323
6	Computer technology	909	120	1,029
7	IT methods for management	47	3	50
8	Semiconductors	1,834	339	2,173
9	Optics	520	6	526
10	Measurement	4,465	236	4,701
11	Analysis of biological materials	25	0	25
12	Control	918	77	995
13	Medical technology	710	6	716
14	Organic fine chemistry	144	0	144
15	Biotechnology	205	1	206
16	Pharmaceuticals	23	0	23
17	Macromolecular chemistry, polymers	399	34	433
18	Food chemistry	272	0	272
19	Basic materials chemistry	917	128	1,045
20	Materials, metallurgy	1,786	128	1,914
21	Surface technology, coating	1,259	119	1,378
22	Micro-structural and nanotechnology	12	0	12
23	Chemical engineering	961	16	977
24	Environmental technology	1,569	191	1,760
25	Handling	1,099	49	1,148
26	Machine tools	3,073	282	3,355
27	Engines, pumps, turbines	7,114	456	7,570
28	Textile and paper machines	394	6	400
29	Other special machines	2,600	136	2,736
30	Thermal processes and apparatus	1,212	21	1,233
31	Mechanical elements	6,399	561	6,960
32	Transport	16,155	1,860	18,015
33	Furniture, games	1,871	88	1,959
34	Other consumer goods	645	23	668
35	Civil engineering	3,380	148	3,528
Total		67,906	5,436	73,342

Source: Created by the author from the Orbis IP database and Table 2 in Schmoch (2008).

Table 2.6: Patents by 35 technology fields published in 2015–2019

Field No.	Field	Non-OEM	OEM	Total
1	Electrical machinery, apparatus, energy	981	40	1,021
2	Audio-visual technology	49	0	49
3	Telecommunications	98	0	98
4	Digital communication	29	0	29
5	Basic communication processes	52	0	52
6	Computer technology	168	9	177
7	IT methods for management	22	0	22
8	Semiconductors	529	151	680
9	Optics	101	2	103
10	Measurement	762	15	777
11	Analysis of biological materials	4	0	4
12	Control	153	0	153
13	Medical technology	84	1	85
14	Organic fine chemistry	41	0	41
15	Biotechnology	14	0	14
16	Pharmaceuticals	7	0	7
17	Macromolecular chemistry, polymers	21	1	22
18	Food chemistry	4	0	4
19	Basic materials chemistry	54	6	60
20	Materials, metallurgy	133	18	151
21	Surface technology, coating	91	3	94
22	Micro-structural and nanotechnology	8	0	8
23	Chemical engineering	50	0	50
24	Environmental technology	180	30	210
25	Handling	76	4	80
26	Machine tools	344	19	363
27	Engines, pumps, turbines	682	28	710
28	Textile and paper machines	39	1	40
29	Other special machines	247	55	302
30	Thermal processes and apparatus	148	2	150
31	Mechanical elements	874	60	934
32	Transport	2,311	303	2,614
33	Furniture, games	77	1	78
34	Other consumer goods	41	0	41
35	Civil engineering	323	6	329
Total		8,797	755	9,552

Source: Created by the author from the Orbis IP database and Table 2 in Schmoch (2008).

4. Conclusion

The patent data compiled for this study demonstrated that the automotive parts industry is based on varieties of scientific and technology fields related to electrical engineering, measurement, chemistry, and mechanical engineering, in addition to sophisticated manufacturing management practices. This situation implies high technology potentials for automotive parts suppliers to develop new products for the automotive industry or to diversify their businesses entirely away from the automotive field. However, at the firm level, individual suppliers must focus on particular technology fields. Therefore, it will be necessary, especially for SMEs, to collaborate among themselves to turn the potential into the reality.

4.1 Implications for developing countries

The ongoing electrification of vehicles will create both opportunities and threats for automotive parts suppliers not only in Japan and other developed countries but also in developing countries due to the global movement toward decarbonization and promotion of BEVs. However, automotive suppliers have advanced manufacturing techniques and know-how which can be applied to newly growing industries. Developing countries producing automobiles and parts can consider new and different roles for the automotive and related industries in multiple policy goals to balance decarbonization with development of new industries and promote structural changes with minimized transition costs.

Findings from this study suggest that technologies developed and used by automotive part suppliers can be applied to various products. Such industries include primary products and the manufacturing of processed products where indigenous firms in developing countries have comparative advantages. Medical and health-related businesses were the other fields exemplified as opening to the automotive industry. Such direction of business diversification, in tandem with the servitization of the automotive industry to support a broad range of people’s daily activities, will be consistent with the strategies of some automotive OEMs, linking automotive and related businesses with urban development, such as Vinfast, a new entrant in the automotive industry originally from the real estate business in Viet Nam and Toyota’s development of Woven City in Shizuoka prefecture for conducting experiments.

Although many automotive parts manufacturers have broad technological capabilities, it is costly for SME suppliers to take the necessary measures to respond to the expected radical structural changes in the automotive industry. Firms need to have persuasive perspectives of future society and markets that encourage these firms in those perspectives, secure a certain transition period, and receive policy supports. These are policy areas where governments in developing countries can play key roles.

4.2 Limitations

This study features various technical and non-technical limitations. First, the data used for this study only covered patents owned by firms in Aichi prefecture, although the same data for firms in all prefectures is available. This limitation means this study is preliminary. This limited data use also causes constraints in identifying patent co-owners in other industries and other prefectures. Second, the analysis in this paper is based only on observations of data classified with IPC codes and does not use rich text data in patents and company information available from various sources. It will be necessary to observe and analyze the data more carefully to make the findings and implications more credible. Third, in combination with the patent data analysis, a case study of firms, especially manufacturers of engines and engine parts, will be necessary to understand how suppliers respond to electrification. Fourth, a comprehensive study on business diversification in the automotive industry will be useful to link the findings from the patent data to business reality.

A future extension of this study will link the patent data used for this study with the firm-level data on automotive parts suppliers to conduct rigorous statistical analyses. National and international comparisons also remain for future research.

Reference

Publications

Schmoch, U. (2008). Concept of a technology classification for country comparison. Final Report to the World Intellectual Property Organization (WIPO). https://www.wipo.int/edocs/mdocs/classifications/en/ipc_ce_41/ipc_ce_41_5-annex1.pdf (accessed on April 15, 2025).

WIPO (2020). Guide to the International Patent Classification (2020). Geneva: World Intellectual Property Organization. DOI: 10.34667/tind.42002 https://www.wipo.int/publications/en/series/index.jsp?id=183 (accessed on February 26, 2022).

WIPO Websites

IPC concordance table. https://www.wipo.int/ipstats/en/ (accessed on April 23, 2025)

IPC publication. https://ipcpub.wipo.int/ (accessed on February 22, 2022)