

# Measuring technology catching up of automotive industry in Thailand by text mining of patent information

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## Abstract

**Purpose** – This study endeavor aims to investigate the extent to which the Thai automotive industry has achieved technological parity with multinational firms operating within the nation.

**Design/methodology/approach** – The methodology used in this study uses text mining techniques applied to patent titles and abstracts. This approach facilitates the creation of a vector space representation of the patents. Patents are categorized according to applicant nationality (Thai or foreign) and submission time, differentiating between base and follow-on patents. The Foreign Effect Index quantifies the influence exerted by foreign patents on a specific patent, while the Local Impact Index measures the influence of a given patent on other related Thai patents.

**Findings** – The analysis reveals an evolving trend characterized by a decreasing foreign effect on Thai patents over time. This suggests a diminishing reliance on foreign technology for advancements. Conversely, an increasing local impact of Thai patents is observed, indicating a growing influence of domestic innovations on subsequent Thai patents. These findings collectively suggest discernible progress in the technological catching-up process within the Thai automotive industry.

**Research limitations/implications** – This study's reliance on patent data constitutes a limitation, as it potentially excludes other relevant sources of innovation, such as trade secrets. Furthermore, the generalizability of the findings may be constrained to other industries or national contexts beyond the Thai automotive sector.

**Originality/value** – The originality and value of this study lie in its innovative methodological approach to measuring technology catching-up. By using text mining techniques on patent data, this research overcomes the limitations inherent in traditional methodologies that rely solely on patent citation analysis, which are less viable in contexts such as Thailand where citation data is limited. Furthermore, the introduction of novel patent quality indicators, reflecting technology cumulativeness and impact within the technology content space, constitutes a significant contribution. These metrics offer valuable insights into the dynamics of innovation, knowledge transfer and the role of foreign patents in fostering technological advancements within the Thai automotive industry.

**Keywords** Technology catching up, Thailand, patent analysis, text mining

**Paper type** Research paper



## 1. Introduction

The automotive industry in Thailand holds a prominent position within the country's economy, often referred to as the "Detroit of Asia". Over the years, Thailand has attracted significant investments from multinational firms in this sector, establishing itself as a major manufacturing and export hub for automobiles and automotive components (Kohpaiboon, 2008; Techakanont, 2011). However, the extent to which the local industry has been able to catch up with multinational firms in terms of technological advancements is a crucial aspect to investigate (Abhinorasaeth, 2007; Intarakumnerd, 2010).

Traditionally, measuring technology spillovers and the level of technological catching up has relied on patent citation analysis (Alcacer and Gittelman, 2006). By examining the citations of patents, researchers can assess the extent to which knowledge and technology flow from one firm to another, indicating the level of technology transfer and adoption within an industry such as automobiles (Intarakumnerd and Charoenporn, 2015). However, in the case of Thailand, the patent data available do not include citation information, posing a challenge to the conventional approach.

To overcome this limitation, we use an innovative text mining approach to analyze patent information from the Department of Intellectual Property (DIP) in Thailand. Text mining enables us to extract valuable insights from the content of patent documents, providing a means to measure the technological relationship and similarity between patents (Motohashi and Zhu, 2020). By comparing the text similarity of patents filed by local firms and multinational corporations, we can gain a deeper understanding of the technology catching up process within the Thai automotive industry.

It is important to note that although comprehensive patent information is available through databases such as PATSTAT (Kang and Tarasconi, 2016), encompassing major patent offices worldwide, there are certain countries where complete patent application data is absent. Thailand falls into this category, lacking domestic patent information within the PATSTAT database (Motohashi, 2020). Therefore, our study bridges this data gap by directly obtaining patent information from the DIP, enabling a comprehensive analysis of the Thai automotive industry's patent landscape.

While there have been empirical studies on Thailand's industrial competitiveness, the overall picture regarding the country's ability to catch up technologically has been rather bleak. By conducting a detailed analysis of patent content and quality, our research aims to provide complementary information to the DIP's existing patent statistics reports (Department of Intellectual Property, M. of C. T, 2019). This approach allows us to further understand the nature of technological catching up among local players in the automotive industry.

Through our investigation, we seek to identify and evaluate the relative technological importance of domestic firms in comparison to multinational corporations operating in Thailand's automotive sector. Moreover, we propose new indicators of patent quality that take into account technology cumulativeness and impact, considering the surrounding patents within the technology content space. By focusing on specific areas such as engine and power train technology, our analysis sheds light on the specific domains where technological catching up is evident.

In summary, this paper presents an innovative approach to measuring the technology catching up of the Thai automotive industry with multinational firms. By leveraging text mining techniques on patent information from the DIP, we overcome the absence of citation data and gain valuable insights into the technological relationships and advancements within the industry. This research serves as a complement to existing patent statistics reports, providing a comprehensive understanding of the technological catching up process among local players in Thailand's automotive sector.

## 2. Data source

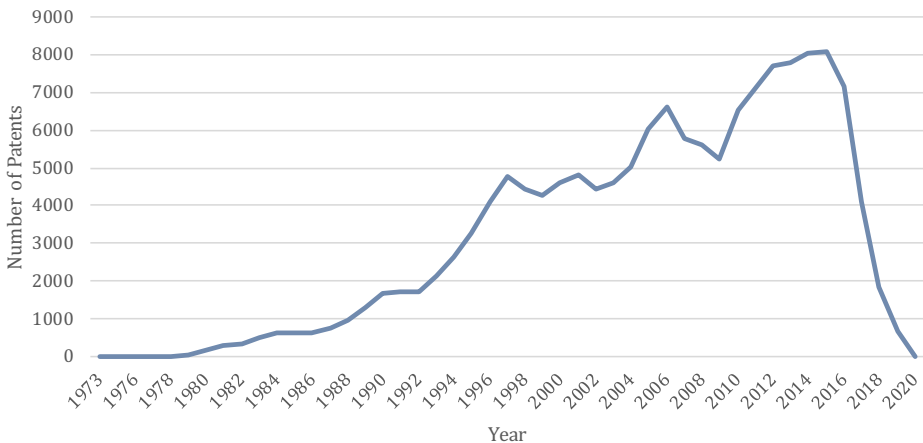
In this study, we use a data set comprising Thai patent information to measure the technology catching up of the automotive industry in Thailand through the application of text mining techniques. However, the data set presents some challenges related to spelling variations in the names of applicants. To address this issue, we undertake a harmonization process for applicant names and subsequently categorize the applicants into appropriate groups. Our analysis is based on the vector representation of patent titles and abstracts, which enables us to explore the technology movement in Thailand effectively.

We collected a total of 148,773 Thai patents from two main sources: the website of the DIP (Department of Intellectual Property, 2025), which is under the Ministry of Commerce, Thailand, and the ASEAN Patentscope (ASEAN PATENTSCOPE, 2025) provided by the ASEAN Intellectual Property Portal. These patents were collected in September 2020. The distribution of patents in our data set is depicted in Figure 1 below.

To ensure relevance and focus, we narrowed down the data set by selecting patents falling under specific categories as described by the Japan Patent Office (2017). The selection was carried out using text matching techniques, where we identified related technical keywords in the titles and abstracts of the patents falling within the desired categories. As a result, we obtained a subset of 12,544 patents specifically related to the automotive industry. The distribution of automotive patents by year is illustrated in Figure 2.

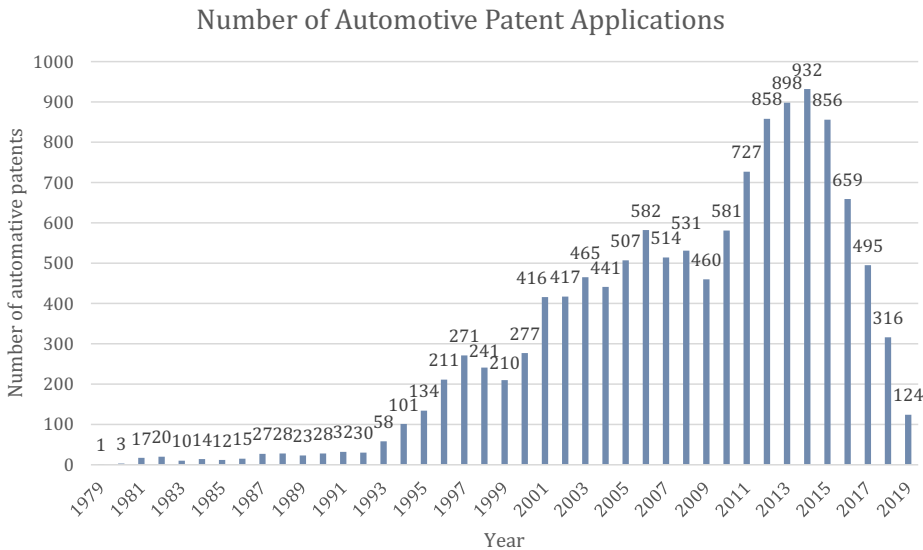
To determine the nationality and type of each applicant, we considered both the name and address information. However, we encountered challenges due to the patent registration process being conducted in Thai language, with no standardized translation from foreign names to Thai. Consequently, the same applicant could be registered under multiple different Thai spelling variations. To overcome this obstacle and ensure accurate analysis of applicant numbers and categories, we performed a harmonization process on the applicant names.

By addressing these data preprocessing challenges, we aim to provide reliable and insightful analysis of the technology catching up of the automotive industry in Thailand based on the extracted patent information.



Source(s): Figure by authors

Figure 1. Number of patent applications by year



**Source(s):** Figure by authors

**Figure 2.** Number of automotive patent applications by year

### 3. Name harmonization

The primary objective of name harmonization in this study is to ensure the accurate identification of patent applicants, thereby avoiding any misidentification of the same entity due to variations in Thai spelling for the retrieved Thai patents from both the DIP and ASEAN Patentscope. The complexity arises when some foreign names can be translated into several different Thai spellings, leading to potential discrepancies in applicant identities when relying solely on the original spelling.

To achieve effective harmonization, we have found that using the official English names proves to be the most reliable approach. Official English names are generally consistent and unaffected by the variations found in Thai spelling. As a valuable resource, we leverage the English names available from previous works for the purpose of translation in our study.

It is important to note that certain individual names may lack an English translation, but if these names consistently appear in the same spelling, we consider them as the same entity and retain their original spelling without translation, as it ensures accuracy in the identification process.

The majority of name translations are derived from the data provided in previous works. We map our data to the Thai patent scope data using the main ID and the applicant's sequence. If both parameters match, the corresponding row receives an English translation. However, since not all rows in the previous works have translations available, not all data points in our data set will be translated.

To further enhance the translation process, we manually translate the names of applicants with the most significant number of patents. Given their substantial patent submissions, we use the translated names from these applicants to extend translations to all their patents, improving the comprehensiveness of the data set.

In instances where no translated name is available from the previous works, we conduct a thorough search for potential translations on the Thai Patent Scope. If an English name

associated with the same entity is found, it is used for harmonization. Alternatively, we resort to conducting searches on reputable sources such as Google or official websites like bloomberg.com or IP Australia to identify possible translations and finalize the harmonization process.

#### 4. Applicant categorization

The process of applicant categorization involves classifying each applicant into one of the following types: individual, firm, university or institution. To achieve this, specific terms associated with each category are collected. For example, for firms, terms like “Company” “Company” (“บริษัท”), “Corporation” (“ CORPORATION”) and “Kabushiki gaisha” (“ ค้า มู ชี กิ ไคชะ”) are gathered. For individuals, terms such as “Mr” (“ นาย”) and “Professor” (“ ศาส ตรา จาร ป”) are included. For institutions, the term “Institute” (“ สถาบัน”) is considered, and for universities, the term “University” (“ มหาวิทยาลัย”) is taken into account. is taken into account. These terms are then transformed into regular expression patterns to accommodate possible spelling variations.

The applicant categorization process proceeds with a boolean search using the compiled regular expression patterns. Four boolean variables are created for the categories: firm, individual, institution and university. When an applicant’s name matches any of the terms within a specific category, the corresponding boolean variable for that category is set to 1. For example, if the applicant’s name is “Thammasat University”, the firm boolean variable will have a value of 0, the individual boolean variable will be 0 and the institution boolean variable will be 1.

In addition to the type of applicants, we further divide them into either foreign or Thai entities based on their addresses. This determination is made using information from the province and district (“Amphoe”) fields. If there is no Thai region name in the address, the foreign boolean variable is set to 1; otherwise, it is set to 0.

The resulting boolean variables are then transformed into distinct applicant categories: Thai Firm, Thai Institute, Thai University, Thai Individual, Foreign Firm, Foreign Institute, Foreign University and Foreign Individual. There may be cases where 153 applicants have no category assigned due to missing address information. To resolve this, these cases are manually reviewed and corrected based on the search results from reliable sources, such as Google.

By conducting this applicant categorization process, we ensure that each applicant is accurately classified, allowing for a more comprehensive analysis of the technology catching up in the automotive industry in Thailand based on distinct applicant types and nationalities.

#### 5. Descriptive statistics

In total, the data set consists of 12,544 patents, comprising 11,418 invention patents and 1,126 petty patents. These patents are further classified into 7 subcategories, namely “engine and powertrain”, “tire”, “interior accessories”, “electric vehicles”, “battery”, “position control system” and “motorcycles”, following the categories defined in [Table 1 \(Japan Patent Office, 2017\)](#). The distribution of patent counts across each category is presented in [Figure 3](#)

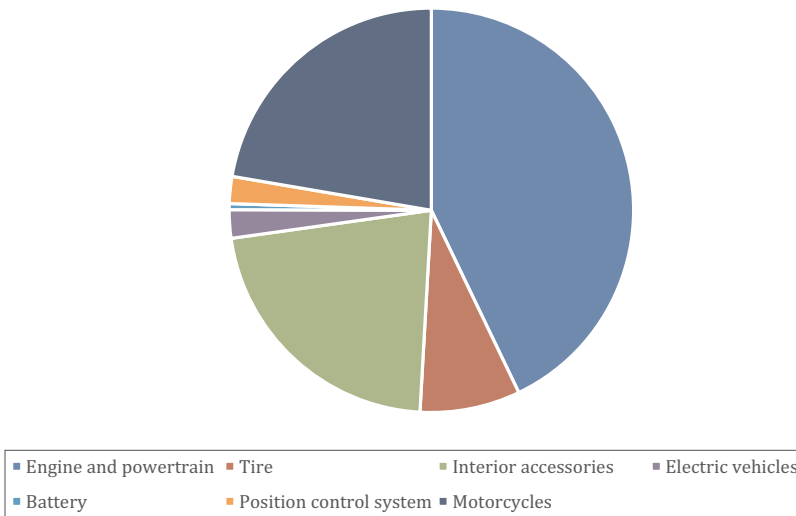
There are 1,781 automotive-related Thai patents, with 63 patents in English and 1,718 patents in Thai. These patents are submitted by different types of applicants: 582 patents by Thai firms, 1,317 patents by Thai individuals, 219 patents by Thai institutes and 82 patents by Thai universities. Additionally, there are 10,319 automotive-related foreign patents. On average, there are 1.123 applicants per patent, with Thai patents having a slightly higher average of 1.231 applicants compared to the average of 1.104 applicants per foreign patent. The distribution of patents by the application year is presented in [Figure 4](#).

**Table 1.** Conditions for separate the patents into the category

Technology category	IPC/CPC	And contains words
Engine and powertrain	F16C	VEHICL+ or CAR or CARS or AUTOMOB+ or AUTOMOTIVE or AUTOCAR or AUTOCARS or MOTORCAR or MOTORCARS or TRANSMISSION or ENGINE+ or TIRE or TIRES or WHEEL+ or HUB(W)BEARING+
Tire	F01B, F01C, F01L, F01M, F01N, F01P, F02B, F02D, F02F, F02G, F02M, F02N, F02P, F16H, B60T, F16D, B62D, B60G	
Interior accessories	B60C	
Electric vehicles	B60R, B60J, B60H	
Battery	B60K, B60L	
	H01M	VEHICL+ or CAR or CARS or AUTOMOB+ or AUTOMOTIVE or AUTOCAR or AUTOCARS or MOTORCAR or MOTORCARS or AUTO or AUTOS or VAN or VANS or TRUCK or TRUCKS or BUS or BUSES or WAGON or WAGONS or TRANSPORTATION or TRAILER+ or CAB or CABS
Position control system	G08G	
Motorcycles	B62H, B62J, B62K, B62L, B62M	

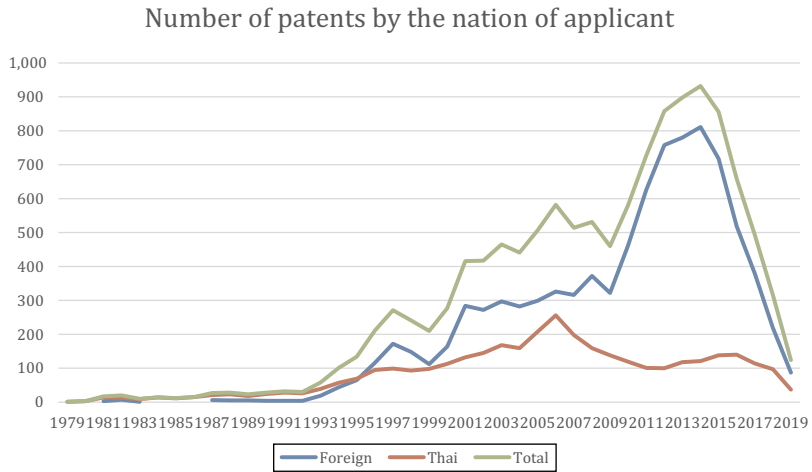
Source(s): Table by authors

Number of Patents



Source(s): Figure by authors

**Figure 3.** Number of patents in each technology category



Source(s): Figure by authors

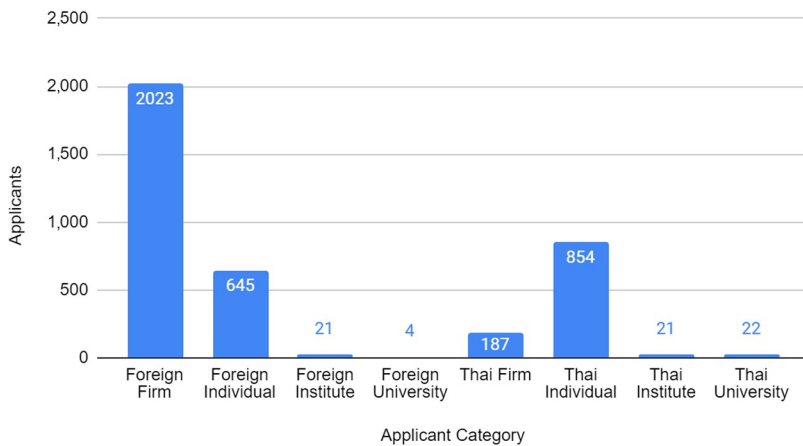
Figure 4. Show the change of number of patents separated by the nation of applicant

Figure 5 illustrates the distribution of the types of applicants, with foreign firms being the main contributors, followed by Thai individuals.

The top 8 patent holders are Japanese companies, as shown in Table 2. The top 20 patent holders consist of 13 Japanese companies, 3 other foreign companies, 2 Thai institutes and 2 Thai companies.

The leading Thai patent holder is the office of the vocational education commission, as presented in Table 3. The top 20 Thai applicants include 2 institutes, 1 university, 8 companies

### Number of Applicants by Applicant Category



Source(s): Figure by authors

Figure 5. The distribution of type of the applicants

**Table 2.** Top 20 applicants for automotive related patents

No.	Applicants	Patents
1	Honda Motor Company	3041
2	Yamaha Motor Company	623
3	Toyota Motor Corporation	601
4	Nissan Motor Company	356
5	Sumitomo Rubber Ind	212
6	Suzuki Motor Corporation	153
7	Keihin Corporation	143
8	Denso Corporation	114
9	Compagnie Generale des Etablissements Michelin	106
10	Michelin Recherche et Technique	104
11	Office of the Vocational Education Commission	98
12	Mitsubishi Electric Corporation	96
13	Vandapac Co Ltd	92
14	NIFCO	85
15	Nissin Kogyo Company	82
16	National Science and Technology Development Agency	81
17	Kubota Corporation	76
18	Nippon Steel Corporation	76
19	NTN Corporation	76
20	Aeroklas Co Ltd	70

**Source(s):** Table by authors**Table 3.** Top 20 Thai applicants for automotive related patent

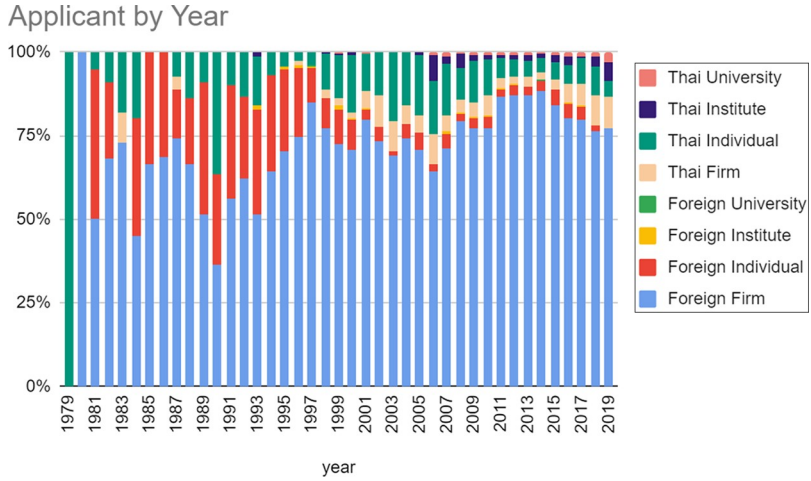
No	Applicant	Patent
1	Office of the Vocational Education Commission	98
2	Vandapac Co Ltd	92
3	National Science and Technology Development Agency	81
4	Aeroklas Co Ltd	70
5	Sak chomchuen	49
6	Kamol kanjarniti	45
7	Isuzu Motors (Thailand) Co Ltd	29
8	Wairote janyongwuorakul	28
9	Monchai wongkasemsombat	23
10	King Mongkut's University of Technology north Bangkok	22
11	Siam Kubota Corporation Co Ltd	18
12	Vachira kaewkunlabut	17
13	Nipat pinamorn	14
14	CPF (Thailand) PCL	13
15	Theerapong khamraktrakul	13
16	Somchai tiamsiriwat	12
17	Aeroflex Company Limited	11
18	PTT PCL	11
19	Solex International (Thailand) Co., Ltd	11
20	Nichakorn atichartsrisakul	11
20	Natawat leelasritham	11

**Source(s):** Table by authors

and 10 individuals. Notably, there are 5 applicants with 11 patents, and all the individuals in this group are company owners or managers.

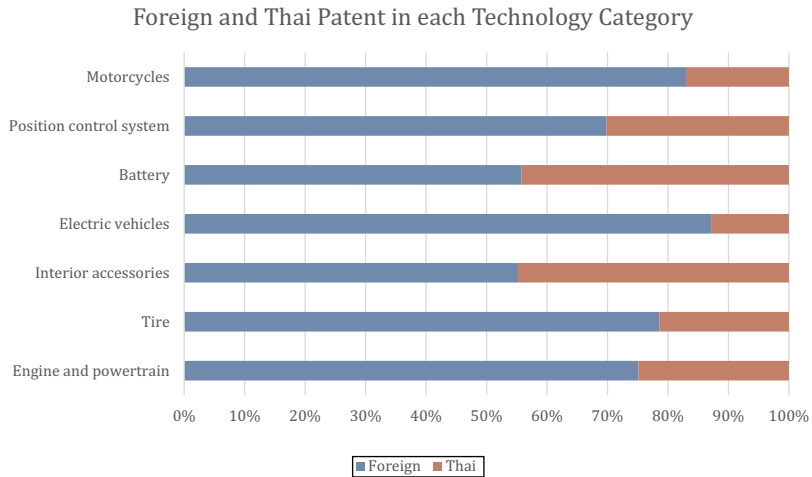
The distribution of applicants' types varies each year, with foreign firms consistently being the largest group, as depicted in Figure 6.

Finally, the share of domestic applicants differs depending on the type of technology. Figure 7 illustrates the comparison between the share of domestic patents (all applicants are Thai) represented in red and foreign patents in blue. While foreign patents dominate in all



Source(s): Figure by authors

Figure 6. Change of the shares of each applicant type



Source(s): Figure by authors

Figure 7. Comparing share of foreign and Thai patent in each technology category

technology categories, Battery and Interior Accessories show a higher share of Thai patents compared to other categories.

These findings provide valuable insights into the technological landscape of the automotive industry in Thailand, the major players, and the contribution of domestic and foreign applicants in various technology domains.

## 6. Vector space model and finding similar patents by term frequency-inverse document frequency and Gensim library

In this study, we use the Term Frequency-Inverse Document Frequency (TF-IDF) technique to create a vector space representation of the patents' abstracts and titles. TF-IDF calculates the importance of a term within a specific document by considering its frequency in that document (TF) and how widely it appears across all documents (IDF). This scoring mechanism helps us capture the significance of terms in each patent effectively.

The process begins with tokenizing the abstracts using PyThaiNLP (Phatthiyaphaibun *et al.*, 2016) word tokenizer and subsequently removing Thai stop words to ensure more meaningful representations. We then use the popular open-source library, gensim (Řehřek *et al.*, 2011), to generate the TF-IDF vectors for the patents. The TF-IDF vectorization allows us to represent each patent in the vector space, enabling comparison between documents based on cosine similarity, which measures the similarity of vectors. A higher cosine similarity indicates greater similarity between patents, particularly in terms of important words they share.

To identify patents that significantly relate to each other, we establish a criterion based on the top one percent of similar patents. Given that the data set initially consists of 12,544 patents, some of which lack abstracts, we are left with 12,100 patents for analysis. From this subset, we select the 121 most similar patents, determined by the highest cosine similarity scores obtained from the TF-IDF vectorization results, as the related patents.

## 7. Matrices

To analyze the related patents, we categorize them into two distinct groups based on their submission time in comparison to the base patents. The first group (A) comprises patents previously submitted and serves as the base patents, while the second group (B) consists of patents submitted at a later stage, known as follow patents. Additionally, we further divide the related patents based on the nationality of the applicants into (1) Thai patents and (2) foreign patents. This division results in four possible combinations of grouping:

- (1) (A1) Previously submitted Thai patents, referred to as "Thai base".
- (2) (A2) Previously submitted foreign patents, referred to as "foreign base".
- (3) (B1) Later submitted Thai patents, referred to as "Thai follow".
- (4) (B2) Later submitted foreign patents, referred to as "foreign follow".

Furthermore, we create a metric called the "Foreign Effect", calculated as the ratio of foreign base patents (A2) to all base patents (A). This metric illustrates the influence of foreign patents on a specific patent. A higher ratio indicates a greater impact from foreign patents compared to Thai patents.

Additionally, we introduce the "Local Impact" metric, which represents the ratio of Thai follow patents (B1) to all follow patents (B). This metric indicates the effect a specific patent has on other related Thai patents. A higher ratio suggests a stronger influence on other Thai patents.

By using these matrices, we gain insights into the relationship between patents submitted at different times and the impact of Thai and foreign patents on specific inventions and the

broader technological landscape in the automotive industry in Thailand. These analyses help us understand the dynamics of innovation, knowledge transfer and the significance of foreign patents in driving technological advancements within the country.

### 8. The technology catching up analysis using defined metrics

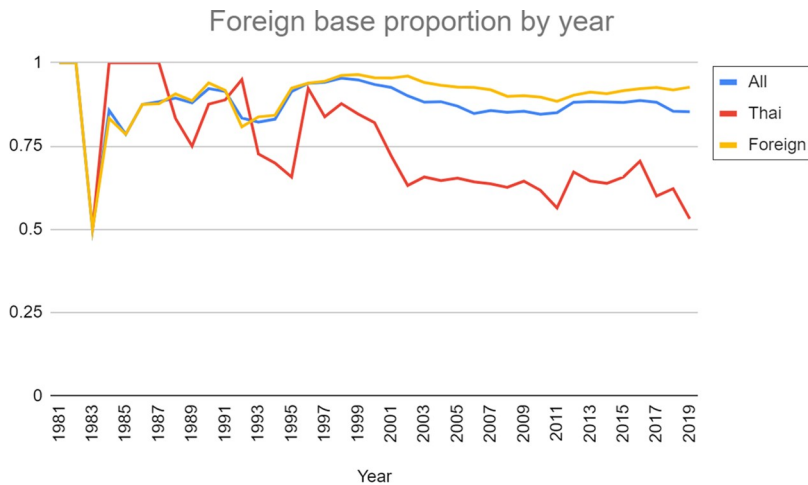
In our analysis of technology catching up, we examine the changes in the average foreign effect index over time for foreign patents, Thai patents and the entire patent data set, as depicted in Figure 8. The graph indicates that following the highest peak observed in 1994, Thai patents experienced a declining average foreign effect index, signifying that they have been influenced less by foreign patents with each passing year.

Next, we explored the changes in the average local impact index over time for foreign patents, Thai patents and all patents, as shown in Figure 9. The graph highlights an increasing trend in the local impact of Thai patents, indicating that Thai patents have been exerting a stronger influence on later submitted Thai patents.

These metrics and analyses provide valuable insights into the technology catching up phenomenon within the automotive industry in Thailand. The decreasing foreign effect index for Thai patents suggests a potential shift toward greater domestic innovation and reduced reliance on foreign technology. Additionally, the increasing local impact index indicates a growing contribution of Thai patents to subsequent innovations in the country. These trends shed light on the dynamics of knowledge transfer, technological advancements and the overall competitiveness of the automotive sector in Thailand.

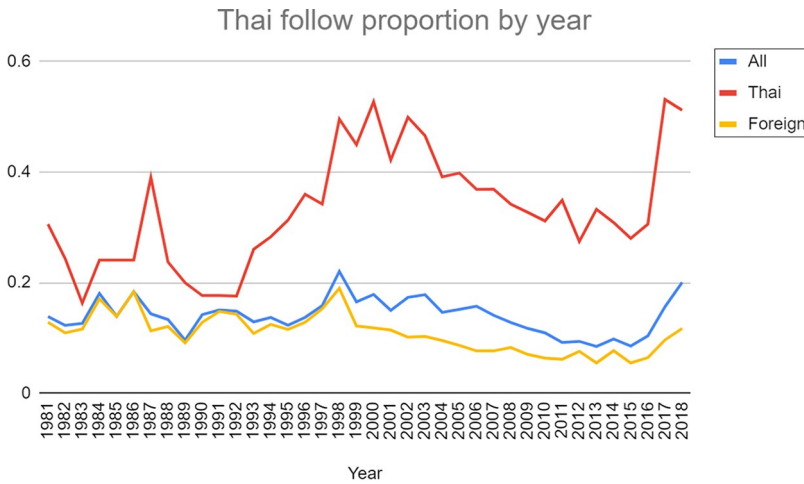
### 9. Discussion

The findings from our analysis provide valuable insights into the technology catching up process within the Thai automotive industry. The decreasing trend in the average Foreign Effect Index suggests that Thai patents are becoming less reliant on foreign patents for



Source(s): Figure by authors

Figure 8. Comparing foreign effect matrix of Thai and foreign patents



Source(s): Figure by authors

Figure 9. Comparing local impact matrix of Thai and foreign patents

technological advancements. This indicates a positive trend of technological development and innovation within the local industry.

The increasing trend in the average Local Impact Index highlights the growing influence of Thai patents on subsequent Thai patents. This suggests a strengthening of the domestic technological ecosystem, where local innovations have a significant impact on further advancements in the industry.

It is important to acknowledge certain limitations of our study. Firstly, our analysis relies solely on published patent data, which may not capture the complete landscape of technological advancements in the industry. The observed decline in patent numbers after 2016 likely reflects the publication lag of recent patent applications still being processed. This dip in published patent counts does not negate our finding of positive technological catching-up trends. Our metrics, calculated from the available published patent data, remain valid indicators of this broader trend, independent of recent publication fluctuations. Other sources of innovation, such as trade secrets or unpublished research, are not considered. Additionally, our study focuses on the automotive industry in Thailand, and the findings may not be directly applicable to other industries or countries.

To further enhance our understanding of the technology catching up process in the Thai automotive industry, future research could incorporate additional data sources such as academic publications, industry reports and collaboration networks. This would provide a more comprehensive analysis of the technology landscape. Additionally, qualitative research methods, such as interviews or surveys, could complement the quantitative analysis by capturing insights from industry experts and key stakeholders.

Overall, our study contributes to the understanding of technological catching up in the Thai automotive industry and provides a foundation for future research in this area.

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