The Impact of Japan-China's FDI on the Change in Thailand's Industrial Structure

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Abstract

This study analyzed Thailand's statistical data from 2003 to 2023 using multiple regression analysis to assess the impact of Japanese and Chinese foreign direct investment (FDI) on changes in Thailand's industrial structure. To address the issue of multicollinearity among the variables, ridge regression was used. The ridge regression results indicated that Japan's FDI, China's FDI, research and development (R&D) expenditures, and Thailand's labor force are significant determinants of industrial structure changes. Notably, Japan's FDI has a stronger impact than China's, while R&D expenses contribute the most to the industrial structure's transformation. In contrast, Thailand's labor force exerts a significant negative effect on the adjustment of the industrial structure. These results suggested that fostering innovation through increased R&D investment is crucial for advancing Thailand's industrial structure. Furthermore, while leveraging FDI, can drive structural upgrades, addressing challenges within the domestic labor market should be a priority. Policymakers must adopt a balanced approach to maximize the benefits of FDI and R&D while enhancing the capabilities of the local labor force to ensure sustainable industrial transformation.

Keywords: Foreign Direct Investment (FDI), Industrial structure changes, Thailand, Multiple regression analysis
JEL Classification Code: F21; C20; L52

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1.Introduction

According to the World Bank, Thailand has the second-largest GDP and the fourth-largest GDP per capita among the countries in the Association of Southeast Asian Nations (ASEAN). In the early 1990s, Thailand experienced robust economic growth, with its GDP increasing at an average rate of 8% per year. This growth was fueled by market liberalization, industrialization, and a rising influx of foreign direct investment (FDI). FDI played a crucial role during this period, as international investors were attracted to Thailand's competitive advantages, including its strategic location in Southeast Asia, relatively low labor costs, and favorable business environment. These factors helped stimulate manufacturing, exports, and infrastructure development, propelling Thailand's economic expansion. However, following the Asian financial crisis of 1998, which briefly disrupted Thailand's economic progress, FDI played a pivotal role in driving Thailand's recovery during the early 2000s. FDI flowed into pivotal industries such as automotive, electronics, and petrochemicals, helping to rejuvenate the economy and achieve an impressive annual growth rate of 5-6% throughout the decade. Even as Thailand's growth slowed to an average annual rate of around 3% since the 2010s, FDI has continued to support the economy by enabling technological advancements and infrastructure improvements. FDI has facilitated the modernization of Thailand's traditional industries and spurred innovation in high-value sectors.

Therefore, FDI has been a significant driver of Thailand's economic growth, playing a crucial role in advancing industrial development, generating employment, and facilitating the transfer of technology and expertise. In particular, Thailand has become an increasingly attractive destination for foreign investors since the 1990s, offering a strategic location in Southeast Asia, a relatively low-cost workforce, and incentives for foreign companies to set up operations in the country. Key sectors that have benefited from FDI include automotive, electronics, petrochemicals, and tourism. By the end of 2023, Thailand's total FDI reached US$290,870 million, making it the second-largest recipient of FDI among ASEAN countries, trailing only Singapore. Japan has been Thailand's largest source of FDI for decades, fostering a strong and stable economic partnership characterized by advanced technology transfer and deep integration into Thailand's industrial ecosystem. Historically, Japanese FDI has been concentrated in manufacturing, particularly in the automotive and electronics sectors, which serve as the backbone of Thailand's industrial base. In contrast, Chinese FDI in Thailand, while a more recent phenomenon, has grown rapidly, driving development across diverse sectors. These FDI increasingly focus on labor-intensive manufacturing, infrastructure development, and real estate. Both Japanese and Chinese FDI, attracted by Thailand's strategic location, skilled workforce, and favorable economic policies, have significantly influenced Thailand's economy, and contributed to the transformation of its industrial structure. Therefore, by examining the sectoral priorities of Japanese and Chinese FDI in Thailand, this study seeks to provide a comprehensive understanding of how these FDI drive Thailand's industrial development, highlighting the crucial role that both Japanese and Chinese FDI play in Thailand's industrial transformation and economic diversification.

Previous research has highlighted the qualitative impact of Japanese and Chinese FDI on changes in Thailand's industrial structure. Qiuli (2006) highlighted those shifts in the primary investment sectors of Japan's FDI has played a crucial role in driving the transformation of Thailand's industrial structure. Nokita (2012, 2018) examined the current trends in Japanese FDI in Thailand, observing that it predominantly focuses on the manufacturing sector. The growth of Japan's FDI has positively influenced Thailand's industrial transformation and trade dynamics. Similarly, Hao, et al. (2024) noted that the steady expansion of Chinese enterprises' FDI in Thailand, alongside intensifying competition in the domestic market, has significantly contributed to changes in Thailand's industrial structure. Anwei (2024) emphasized that China's FDI has supported Thailand's economic growth, extended its

industrial chain, and fostered interactions with related industries, thereby accelerating the transformation of its industrial structure.

Despite extensive qualitative research on the influence of Japanese and Chinese FDI on Thailand's industrial structure, there is a notable lack of quantitative studies examining the specific extent through which FDI from these countries impacts Thailand's industrial transformation. Most existing studies focus on descriptive analyses, leaving an empirical void in understanding the direct and measurable contributions of Japanese and Chinese FDI to Thailand's industrial evolution. This study seeks to address existing gaps by employing multiple regression analysis to conduct a quantitative evaluation of the impact of Japanese and Chinese FDI on Thailand's industrial structure. Through the utilization of macroeconomic data, it provides a novel contribution to the literature by offering precise, data-driven insights into the relationship between FDI and industrial development in Thailand. The findings of this study aim to enhance the understanding of the comparative effects of Japanese and Chinese FDI, elucidating their distinct roles in shaping Thailand's industrial composition.

Thailand is an essential partner in its global supply chain for Japan, particularly in the automotive and electronics sectors. Understanding the impact of Japanese FDI helps Japan refine its investment strategies to maintain competitiveness and foster sustainable growth in host countries. Similarly, Chinese FDI in ASEAN is growing rapidly, and understanding its influence on Thailand offers valuable insights into the effectiveness of China's "Going Global" strategy and Belt and Road Initiative (BRI) in advancing regional connectivity and industrial integration. Moreover, understanding the role of Japanese and Chinese FDI in Thailand is crucial for formulating policies that promote technology transfer, skill development, and industrial diversification. The findings of the study hold significant implications for policymakers across all three countries. They offer strategic guidance on optimizing FDI policies, enhancing economic and diplomatic ties, and assisting Thailand in addressing critical challenges such as sectoral disparities, dependency on foreign capital, and the uneven allocation of industrial benefits.

The structure of this study is as follows: Section 1 introduces the research problem and outlines the composition of the paper. Section 2 discusses the trends in Japan's and China's FDI in Thailand and examines the current situation by industry. Section 3 provides a literature review, summarizing previous research on the impact of FDI on changes in a country's industrial structure. Section 4 conducts a multiple regression analysis to assess the impact of Japan's and China's FDI on changes in Thailand's industrial structure. Section 5 explores the causes of this impact and considers how this study differentiates itself from existing research. Section 6 addresses the research limitations. Finally, Section 7 concludes the study by summarizing its findings.

2. Japan-China's FDI in Thailand

2.1. Trends in total Japan-China's FDI in Thailand

As shown in Table 1, FDI flows to Thailand increased significantly during the late 2000s and early 2010s, with notable peaks from major contributors such as Japan, China, Singapore, and the United States. However, these FDI have experienced sharp fluctuations in subsequent years. Despite these fluctuations, countries like Japan, Singapore, and the United States have consistently contributed to FDI, reinforcing Thailand's position as a key destination for investment in ASEAN.

Table 1. FDI Flows from Major Countries to Thailand[2]. (Unit: Millions of US$)

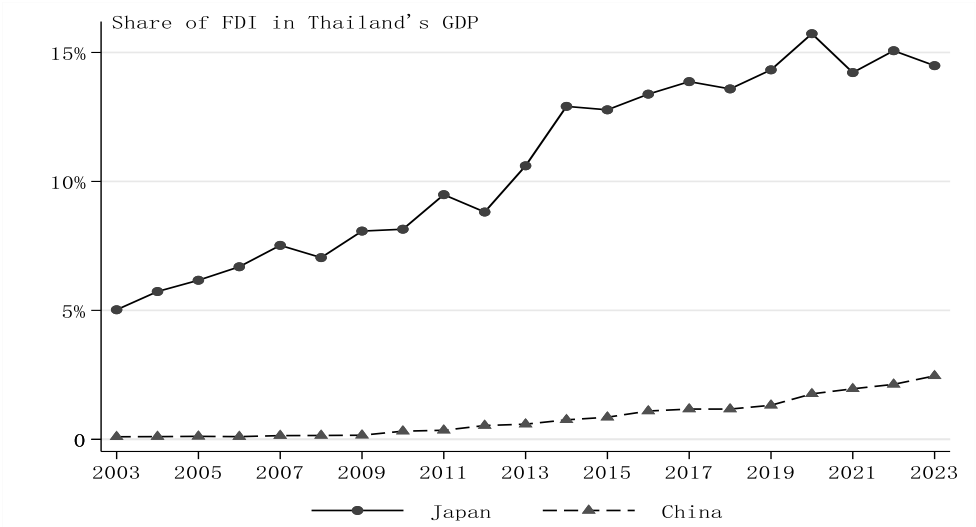
Year	China	Germany	Japan	Malaysia	Singapore	South Korea	Switzerland	United States
2005	46	953	5,070	474	3,892	121	453	3,685
2006	101	1,206	5,407	554	7,945	156	433	2,924
2007	135	1,290	9,174	636	7,085	205	457	4,620
2008	74	472	8,032	475	3,827	183	705	2,318
2009	303	974	10,188	1,520	6,790	545	1,152	3,865
2010	769	377	6,602	605	4,224	272	1,212	2,129
2011	3,503	1,463	11,191	1,777	6,183	1,259	2,292	4,299
2012	5,371	1,503	15,388	2,628	4,602	1,571	3,430	7,271
2013	8,822	1,786	22,515	3,330	5,199	2,653	4,038	6,384
2014	8,795	1,454	12,437	2,963	2,238	2,283	1,724	6,100
2015	6,988	2,224	10,512	2,331	4,068	1,375	1,035	4,637
2016	8,956	3,436	10,456	2,091	3,729	1,387	1,265	3,079
2017	8,142	3,218	9,843	2,157	4,322	1,594	1,900	3,136
2018	8,370	1,845	12,892	1,986	3,854	1,613	1,732	3,819
2019	8,671	1,429	9,302	2,000	8,048	1,774	962	3,577
2020	8,486	1,003	6,470	1,720	4,893	1,205	878	5,981
2021	10,682	1,484	9,031	2,150	5,699	1,785	3,412	5,809
2022	11,372	1,673	10,410	2,260	10,191	1,690	1,808	6,411
2023	13,016	1,489	7,493	1,993	5,444	1,063	1,362	6,208

Source: Bank of Thailand.

Japan has traditionally been the largest source of FDI to Thailand, demonstrating strong and sustained engagement over the years. Japanese FDI peaked prominently in 2013 at $22,515 million. After experiencing a dip in 2015, Japanese FDI fluctuated but remained substantial, reaching $10,410 million in 2022 before declining to $7,493 million in 2023. Meanwhile, China's FDI to Thailand have seen significant growth over the past two decades, rising from just $46 million in 2005 to a record $13.016 billion in 2023. By 2023, China emerged as the largest investor in Thailand, with its FDI surpassing those of Japan. Similarly, Singapore has maintained a significant presence, playing a pivotal role in shaping Thailand's FDI landscape. Early in the period, Singapore's FDI reached a notable peak of $7,945 million in 2006, followed by periods of fluctuation. However, in recent years, Singapore's FDI surged again, with a substantial inflow of $10,191 million recorded in 2022. The United States, while exhibiting moderate levels of investment, has maintained relatively stable FDI flows to Thailand. U.S. FDI peaked at $7,271 million in 2012, and although there have been fluctuations over the years, a notable inflow of $6,208 million was recorded in 2023.

In a nutshell, Japan, China, Singapore, and the United States are the foremost investors in Thailand, each making substantial contributions to Thailand's economic development. These countries have played pivotal roles in driving FDI, thereby solidifying Thailand's position as a prominent investment destination within ASEAN. Additionally, other countries, including Malaysia, Germany, Switzerland, and South Korea, have maintained a consistent presence, contributing to the diversification of FDI and the broadening of Thailand's investment landscape.

[2] Due to the unavailability of FDI flow data before 2005, which hinders the calculation of FDI stock from various countries, Table 1 relies on the FDI flow data published by the Bank of Thailand starting in 2005.



Source: The World Bank Database, the Japan External Trade Organization (JETRO), and the Ministry of Commerce of China (MOFCOM).

Figure 1. Share of Japan and China's FDI Stock in Thailand's GDP[3].

In the context of this broader investment trend, the movement of Japanese companies into Southeast Asia aligns with Kaname Akamatsu's "flying geese model[4]". According to this model, Japanese firms initially established a presence in the Four Asian Tigers—Taiwan, South Korea, Hong Kong, and Singapore—before expanding into the ASEAN-4 countries, which include Indonesia, Malaysia, Thailand, and the Philippines. According to Shojiro (1989), Japanese companies in the 1960s, actively invested in Thailand based on joint ventures under the Thai government's import substitution industrialization policy. Zhipeng (1997) noted that there were 122 Chinese companies in Thailand until 1992, with a total investment of only US$130 million. Thailand is the country with the greatest amount of China's FDI in Southeast Asia. However, an examination of the history of FDI in Thailand shows that Japan's FDI in Thailand began earlier than China's.

In addition, Figure 1 provides a comparative analysis of Japan's and China's FDI stock as a percentage of Thailand's GDP. The data indicate that Japan's FDI share is approximately eight times larger than China's, emphasizing a pronounced disparity in scale. The share of Japan's FDI in Thailand's GDP has shown significant growth, rising from 5% in 2003 to

[3] The use of FDI stock, as opposed to FDI flow, is due to the delayed effects of FDI on Thailand's economy. The FDI stock-to-GDP ratio provides a more accurate gauge of FDI's contribution to Thailand's economic development.

[4] Industrialization unfolds in distinct stages, beginning with labor-intensive light industries, followed by capital- and resource-intensive heavy chemical industries. The final stage is characterized by the development of technology-intensive high-tech industries. Each phase demands increasing levels of infrastructure, resources, and technological capabilities, driving economic growth and transformation. Japan was the first country in East Asia to undergo this industrial transformation, setting a precedent for others. The Newly Industrialized Economies (NIEs), including South Korea, Taiwan, Hong Kong, and Singapore, subsequently followed Japan's example, advancing through these stages rapidly in the latter half of the 20th century. Many ASEAN countries, such as Malaysia, Thailand, and Indonesia, began their industrialization processes shortly thereafter, following a similar developmental trajectory. This progression is often metaphorically described as a "flock of geese in flight," with the leading nation paving the way for others to follow.

16% in 2020, nearly tripling over this period. This increase reflects Japan's strengthening economic ties and expanding investment presence in Thailand. However, between 2020 and 2023, Japan's FDI share experienced a slight decline, influenced by the pandemic and other factors. In contrast, the share of China's FDI in Thailand's GDP has grown nearly 25-fold over the same period, from 0.1% in 2003 to 2.5% in 2023. This remarkable growth underscores China's expanding influence and deepening economic ties with Thailand.

2.2. Japan-China's FDI in Thailand by industry

Regarding the specific industries in which Japanese companies invest in Thailand, Qiuli (2006) conducted an overview of Japanese FDI in Thailand and observed that Japanese initial FDI was predominantly focused on manufacturing. During this period, representative industries for FDI included labor-intensive sectors such as textiles and food processing. Over time, Japanese FDI gradually shifted toward technology-intensive manufacturing, exemplified by automobiles, machinery, and precision instruments. In recent years, Japanese FDI in Thailand has further evolved, with a growing presence in the service sector.

Additionally, according to Table 2, the number of Japanese companies investing in various industries in Thailand was 1641 in 2014, 1725 in 2015, 1783 in 2016, 3925 in 2017, and 5856 in 2021. Among them, the number of Japanese companies grew relatively slowly in the early years but suddenly increased significantly in 2017. The data from 2021 also showed a rapid increase in the number of Japanese companies that year. In addition, the number of Japanese companies investing in Thailand's primary sector increased from 4 in 2014 to 9 in 2021. The number of Japanese companies investing in Thailand's secondary sector rose from 895 in 2014 to 6491 in 2021, while the number of Japanese companies investing in Thailand's tertiary sector grew from 749 in 2014 to 7966 in 2021. Therefore, the increase in the number of Japanese companies investing in Thailand's tertiary sector was significantly greater compared to the secondary sector. Judging from the investment of Japanese companies in various industries in Thailand, the primary investment industry in the early years was manufacturing. However, according to 2021 statistics data, Japanese companies investing in Thailand's wholesale and retail trade industries are also increasing rapidly.

Meanwhile, according to a document released by the Thai-Chinese Overseas Chinese Entrepreneurs Association, from 2004 to 2016, 38.6% of China's FDI in Thailand was concentrated in the secondary metal and machinery equipment industry. In comparison, the primary agriculture industry received 18.9%, the chemical industry 12%, mining 10.2%, the electronics and electrical industry 7.1%, the light apparel industry 5.2%, and the tertiary service industry received only 8.5%[5]. China's FDI in Thailand is mainly concentrated in the secondary and primary sectors, and there is a possibility that it is not useful for upgrading Thailand's industrial structure, especially since the light industry and assembly industry, which are labor-intensive and declining industries in China, are important investment industries in Thailand.

[5] http://thcca.org/index.php?route=bossblog/article&blog_article_id=157. "Last accessed on 01-12-2024".

Table 2. Number of Japanese Companies in Thailand by Industry.

	2014	2015	2016	2017	2021
Agriculture, forestry, and fishing	4	2	2	2	13
Mining, quarrying, and gravel collection	1	1	1	3	3
Construction	86	80	83	103	152
Manufacturing	804	840	853	1,587	2,344
Electricity, gas, heat supply, and water supply	5	5	4	14	33
Information and communications	23	17	16	78	209
Transportation and postal services	88	93	96	194	211
Wholesale and retail trade	165	162	156	455	1,486
Financial and Insurance activities	69	70	77	94	91
Real estate and rental activities	26	40	37	75	188
Professional, scientific, and technical activities	1	4	22	94	22
Accommodation and food service activities	53	53	48	51	174
Public administration and entertainment	17	18	16	36	110
Education	4	7	6	18	55
Human health and social work activities	5	5	4	7	24
Other services activities	289	254	296	266	741
Unclassifiable industries	1	74	66	848	0
Total number of companies	1,641	1,725	1,783	3,925	5,856

Source: Ministry of Foreign Affairs of Japan.

Table 3. Comparative Analysis of Japanese and Chinese FDI in Thailand.

	Japanese FDI	Chinese FDI
Timing	Early investment in the 1970s, with a matured focus on high-value industries by the 2000s	Rapid growth since the 2000s, with a shift to mid- to high-tech manufacturing and real estate after 2019
Industry Focus	High-tech manufacturing, such as automotive, and a growing service sector	Initially focused on resource-intensive sectors; recent emphasis on labor-intensive and mid-tech manufacturing
Differences	Strong focus on technology-intensive sectors with high economic value	Resource-driven investments with incremental technology transfer
Impact on Thailand's Economy	A strong emphasis on service industries and a significant role in industrial upgrading	Limited investment in the service sector, with a focus remaining on manufacturing. The emphasis on labor-intensive industries slows industrial upgrading

Source: Author's compilation.

Furthermore, Xuechun (2016) pointed out that from 2004 to 2014, China's FDI in Thailand was primarily concentrated in metal products and machinery equipment, agriculture, chemical products and the paper industry, minerals and ceramic products, services, electrical and electronic products, light industry, the textile industry, and other sectors. Hao, et al. (2024) noted that China's net FDI in Thailand's manufacturing, finance, insurance activities, and real estate was substantial from 2015 to 2022. From 2019 to 2022, China's investment primarily flowed into Thailand's manufacturing sector, focusing on mid-range and high-end technology manufacturing industries. Additionally, Anwei (2024) noted that due to Thailand's large domestic market, Chinese manufacturing companies motivated by market development are predominantly white goods companies. In recent years, given Thailand's relatively complete automotive industry chain, strong production capacity, and large market potential, China's automotive-related industries have also begun to gradually enter the Thai market.

In summary, Japanese and Chinese FDI have influenced Thailand's industrial structure in distinct ways, each contributing differently to its economic transformation. Japanese FDI initially targeted labor-intensive manufacturing industries such as textiles and food processing, laying the foundation for Thailand's industrial development. Over time, it shifted to technology-intensive sectors, including automobiles, machinery, and precision instruments, driving Thailand's industrial upgrading. By 2021, Japanese FDI included 6,491 companies in the secondary sector and 7,966 in the tertiary sector, with significant contributions to the growth of the automotive and service industries, enhancing Thailand's global competitiveness. In contrast, Chinese FDI from 2004 to 2016 was predominantly focused on primary and secondary industries, such as metals, machinery, chemicals, and agriculture, with a strong emphasis on labor-intensive investments. More recently, there has been a gradual shift toward mid- to high-tech manufacturing and real estate, along with increased participation in Thailand's automotive sector. However, progress in the service sector remains limited. While these FDI have bolstered Thailand's industrial capacity, their impact on technology transfer and the promotion of high-value industries has been less pronounced compared to Japanese.

In general, Japanese FDI has been instrumental in advancing the industrial upgrading of Thailand and enhancing the sophistication of its supply chains, thereby facilitating Thailand's transition toward a service-oriented and technology-driven economy. In contrast, while Chinese FDI has expanded and diversified in recent years, it continues to prioritize resource- and labor-intensive industries, thereby limiting its impact on Thailand's shift toward an innovation-driven economy.

3. Literature review

A representative prior study examining the relationship between inward FDI and the transformation of industrial structure in the host country is Chenery, et al. (1986). According to Chenery, et al. (1986), FDI can provide the development funds necessary for the economic advancement of developing countries. It can also introduce advanced technology to these countries, affecting their economic growth and the transformation of their industrial structures. Wang, and Blomström (1992) examined the impact of FDI on the productivity of Mexican companies and found a positive correlation between the share of foreign investment in an industry and the increase in productivity of companies. In other words, FDI promotes the upgrading of Mexico's industrial structure. Paus (2005) also examined the relationship between inward FDI and the adjustment of industrial structure in the Czech Republic. Foreign companies promote the upgrading of the industrial structure of the host country mainly through economic and industrial relations with the host country. Barrios, et al. (2005) used the case of Ireland to create an econometric model to examine the relationship between

inward FDI, multinational corporations, and companies in the host country and emphasized that inward FDI and the competition and externalities of multinational corporations affect the growth of companies in the host country. Chakraborty, and Chandana (2008) used Granger causality analysis to examine the relationship between inward FDI by foreign companies and the industrial structure of India. They found that inward FDI supported the development of the manufacturing industry but did not affect the growth of the primary sector of agriculture and the tertiary sector of services. Qiong, and Minyu (2013) examined the relationship between the increase in inward FDI and the upgrading of China's industrial structure and found that government policies to attract foreign capital and the upgrading of China's industrial structure and found that government policies to attract foreign capital and the improvement of the investment environment are important in determining whether inward FDI can promote the upgrading of industrial structure. Zheng (2019) used regression analysis to examine the relationship between Japan's FDI and China's industrial structure, pointing out that Japan's FDI is helpful for the change in China's industrial structure.

Additionally, Milner, et al. (2006), starting from a micro perspective, used data at the Japanese company level to quantitatively analyze how industrial collaboration among Japanese companies in Thailand affects Japanese FDI. They found that Japanese companies invested overseas together with their trading partners to protect their supply networks for intermediate goods and parts to existing trading partners, and thus Japanese companies became industrial clusters in specific industries in the host country.

In summary, FDI primarily affects the change in the host country's industrial structure through two channels: direct industrial transfer and indirect technology spillover effects. Industrial transfer can quickly help the host country establish a complete production system, directly promoting the change in its industrial structure. Meanwhile, the technology spillover effect accelerates the host country's industrial technological innovation through indirect channels such as human resource flow between foreign and domestic enterprises, market competition, and technical assistance, thereby driving the change in the host country's industrial structure.

Building on the theoretical foundation and empirical evidence presented in the literature, this study further investigates the specific impacts of Japanese and Chinese FDI on changes in Thailand's industrial structure. As highlighted in previous studies, FDI can play a critical role in transforming the industrial structure of host countries by fostering technological innovation and promoting industrial upgrading. For instance, Japanese FDI is closely linked to the development of industrial clusters and technological advancements. As highlighted by Milner, et al. (2006), Japanese firms often invest in clusters to safeguard supply chains and foster robust industrial ecosystems. Similarly, Chinese FDI, with its emphasis on labor-intensive industries, drives industrial structural changes in host countries by addressing critical industrial gaps. Considering these insights, this study proposes the following hypotheses:

Hypothesis 1: Japanese FDI positively influences the upgrading of Thailand's industrial structure, particularly by fostering technological innovation and supporting the development of industrial clusters.

Hypothesis 2: Chinese FDI positively influences the upgrading of Thailand's industrial structure, particularly in labor-intensive industries.

This study aims to shed light on how Japanese and Chinese FDI influence changes in Thailand's industrial structure by examining these hypotheses.

4. Model and data

4.1 The indicator of the change in industrial structure

Petty-Clark's law, which states that workers shift from primary to secondary and from secondary to tertiary sectors as the economy grows, explains the change or sophistication of industrial structure. Previous studies have used various methods to calculate the sophistication of industrial structures. Hoffmann (1931) proposed a law of evolution (sophistication) of industrial structure during the industrialization of a country or region. He collected time-series data on the economic development of 20 countries and introduced the proportion between the consumer goods sector and the capital goods sector in the manufacturing industry (Hoffmann's ratio). Hoffmann explained that as industrialization progresses, Hoffmann's ratio gradually decreases, and when the ratio reaches 1 or less, it signifies industrialization. Some previous studies have used Hoffmann's ratio to consider the sophistication of industrial structures. However, Yuichi (1965) questioned the criteria Hoffmann (1931) used to divide industries into two sectors. S argued that the consumer goods and capital goods sectors in Hoffmann's ratio used the light and heavy industries and pointed out the inadequacy of Hoffmann's ratio. In other words, Hoffmann's method for classifying at least 75% of the output of the consumer goods industry and the investment goods industry is ambiguous, and the consumer goods industry and the investment goods industry are substituted for the light industry sector and the heavy industry sector. Thus, this study does not use the method of Hoffmann (1931).

In addition, Wei, and Dong (2011), Chen, et al. (2020) used Deyun (2008)'s Industrial Structure Level Coefficient to calculate the changing of industrial structure. The equation for the Industrial Structure Level Coefficient R is as follows:

$$R = \sum_{i=1}^{3} i \cdot Y_i = Y_1 \cdot 1 + Y_2 \cdot 2 + Y_3 \cdot 3 \qquad (1)$$

Where i is 1, 2, 3.

The value of R ranges from 1 to 3. The higher the result of R, the higher the level of the changing of industrial structure. However, Deyun (2008) does not provide a detailed explanation of the weighting of each industry in the Industrial Structure Level Coefficient, making it unclear. Thus, this study does not use Deyun (2008)'s Industrial Structure Level Coefficient.

In addition, Hiroshi, and Matsumoto (2000) proposed σ to measure the change in industrial structure. The calculation of the indicator σ is as follows:

$$\sigma = \left(\sqrt{\sum_{i=1}^{n}\left(w_i^{t_2} - w_i^{t_1}\right)^2}\right)/T \qquad (2)$$

Where w_i^t is the proportion of industry i in period t to total production.

T is $t_2 - t_1$.

t_1 represents the initial period for evaluating industrial changes.

t_2 represents the final period for evaluating industrial changes.

σ reflects the change in the industrial structure, such as industrial decline.

However, Hiroshi, and Matsumoto (2000) are unclear about how to choose period T, making the use of σ unclear, so this study will refer to the measure of the change in industrial structure by Hiroshi, and Matsumoto (2000) but does not use it.

On the other hand, some previous studies focused on one economic indicator of economic activity and considered the advancement of industrial structure from the change in the ratio of the employees in each sector or the change in the proportion of each sector in GDP. For example, Clark (1941) used the ratio of the number of employees in each sector to

the total number of employees, and Cunhui, et al. (2011) used the ratio of the tertiary sector to the secondary sector to consider the change in industrial structure. Zheng (2019) considered the change in industrial structure using the ratio of the total amount of the secondary sector and the tertiary sector to GDP.

Based on the methods of the above previous studies, the indicator of the change in industrial structure in this study refers to Petty-Clark's law, which presented the three-industry structure, and the calculation method of Cunhui, et al. (2011) of the ratio of the total amount of the tertiary sector to the total amount of the secondary sector, which can clearly reflect the shift of workers from the primary industry to the secondary sector and from the secondary sector to the tertiary sector due to economic growth. Therefore, this study uses the calculation method of the ratio of the total amount of the tertiary sector to the total amount of the secondary sector[6].

4.2. Model and data

To mitigate endogeneity bias from omitted variables, this study incorporates widely used control variables drawn from prior research on industrial structure changes. Shasha (2021) highlighted that demand, driven by economic development, serves as a significant force behind industrial upgrading. Similarly, Feng, and Yanhua (2023) emphasized that the level of economic development impacts production efficiency, which in turn determines the extent of industrial structure upgrading. Furthermore, Jianmin, et al. (2017) noted that both economic development and fixed asset investments significantly impact the process of upgrading industrial structures. Additionally, Ning, and Zuankuo (2021) demonstrated that technological innovation has a direct and positive effect on industrial structure upgrading. Lee (2009) found that trade generates an agglomeration effect within the manufacturing industry, further promoting industrial structure advancements. Moreover, Shasha (2021) also observed that the quality and quantity of labor directly influence economic output, underscoring the labor force's critical role in driving industrial upgrading.

Based on these insights, this study utilizes GDP per capita, fixed asset investments, trade, R&D expenditures, and labor force size as control variables. Accordingly, the multiple regression analysis equation for this study is as follows:

$$\begin{aligned} lnIndustrial\_structure_t = \alpha_0 + \beta_1 lnJPFDI_t + \beta_2 lnCNFDI_t + \beta_3 lnGDP\_per\_capita_t \\ \beta_4 lnDomestic\_investment_t + \beta_5 lnR\&D_t + \beta_6 lnTrade_t + \\ \beta_7 lnLabor\_force_t + \varepsilon_t \end{aligned} \quad (3)$$

where α_0 is the constant term.

β_i are the coefficients.

ε_t is the error term.

t is the year.

Industrial_structure is the industry structure changing coefficient, which is the ratio of the total amount of the tertiary sector to the secondary sector.

JPFDI is the total amount of Japan's FDI in Thailand.

CNFDI is the total amount of China's FDI in Thailand.

GDP_per_capita is the GDP per capita of Thailand.

Domestic_investment is the gross fixed asset investment in Thailand, which means the total amount of domestic investment in Thailand.

R&D is the research and development (R&D) in Thailand.

Trade is the total amount of exports and imports in Thailand.

[6] The primary sector includes agriculture, forestry, and fishing. The secondary sector includes mining, manufacturing, construction, public utilities, and gas and electricity supply. The tertiary sector refers to all industries other than the primary and secondary industries.

Labor_force is the labor force of Thailand.

The data used is obtained from The World Bank, the Ministry of Commerce of China, and the Japan External Trade Organization (JETRO). Regarding the data period, this study uses statistical data from Thailand from 2003 to 2023[7]. In addition, in order to reduce the impact of heteroscedasticity and outliers in the model, the selected variables are transformed by taking natural logarithms. The descriptive statistics for each variable are shown in Table 4.

From Table 5, the correlation coefficients of several variables are all large, indicating a strong correlation between them. Therefore, it is highly likely that multicollinearity exists among these variables. Table 6 also shows the variance inflation factor (VIF) of the multiple regression analysis model. The VIFs of these variables exceed 10, indicating significant multicollinearity, which causes instability in the ordinary least squares (OLS) estimates. To address this issue, this study utilizes ridge regression[8], a technique designed to handle multicollinearity by adding a penalty term to the regression equation. This penalty shrinks the coefficients, reducing their variability and improving model stability. As a result, ridge regression effectively addresses multicollinearity while preserving predictive accuracy.

Table 4. Descriptive Statistics.

Variable	Units	Obs.	Mean	Std.Dev.	Min	Max
Industrial structure	-	21	1.47	0.17	1.24	1.78
JPFDI	Million US$	21	43,761.44	25,151.50	7,649.71	78,715.84
CNFDI	Million US$	21	3,836.16	3,944.60	150.77	12,670.00
GDP per capita	US$	21	5,359.54	1,631.92	2,350.85	7,628.58
Domestic investment	Million US$	21	60,745.55	23,836.08	19,683.10	92,297.22
R&D[9]	Million US$	21	2,591.36	2,038.61	631.82	5,735.89
Trade	Million US$	21	466,599.37	143,905.95	177,700.54	665,067.02
Labor force	Million People	21	39.67	1.16	36.73	41.20

Source: Author's calculations.

[7] Detailed data on China's FDI by country were not released until 2003.

[8] Ridge regression analysis is a type of regularized regression that addresses the issue of multicollinearity between variables by adding a regularization term. The OLS regression's coefficient β is $\beta = [x^T x]^{-1} x^T y$. The ridge regression analysis' coefficient β(k) is $\beta(k) = [x^T x + k\boldsymbol{I}]^{-1} x^T y$ and is obtained by adding the identity matrix $\boldsymbol{I}$, multiplied by the regularization term k (a scalar value that controls the amount of regularization applied to the regression model), adding the determinant of the coefficient β of OLS regression. When k = 0, the ridge regression analysis' coefficient β(k) is the same as the coefficient β of the OLS regression. When the regularization term r k changes, it can address the multicollinearity problem of the OLS model.

[9] The gross expenditures on R&D in Thailand for 2022 and 2023 have not yet been published. Therefore, this study uses the percentage of R&D expenditure relative to GDP from 2021 as a reference for estimating the gross expenditures on R&D for 2022 and 2023.

Table 5. Matrix of Correlation Coefficients.

	Industrial structure	JPFDI	CNFDI	GDP per capita	Domestic investment	R&D	Trade	Labor force
Industrial structure	1							
JPFDI	0.89	1						
CNFDI	0.90	0.91	1					
GDP per capita	0.77	0.96	0.83	1				
Domestic investment	0.79	0.97	0.86	0.99	1			
R&D	0.94	0.96	0.96	0.87	0.89	1		
Trade	0.65	0.89	0.78	0.96	0.94	0.77	1	
Labor force	0.42	0.72	0.59	0.84	0.83	0.56	0.91	1

Source: Author's calculations.

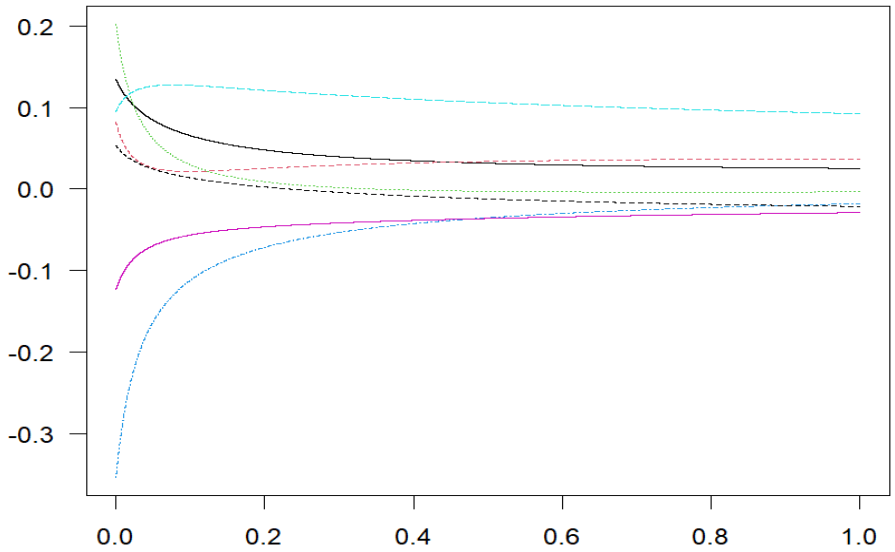
4.3. Basic results

Figure 2 shows the trajectory of the ridge regression analysis. Looking at the trajectory of each variable in the figure 2, the estimated coefficient of each variable becomes stable when the regularization term k = 0.3063. Therefore, the regularization term k of the ridge regression analysis in this study is selected to k = 0.3063, and the result of the ridge regression analysis is summarized in Table 7.

Table 6. Results of VIF.

	VIF
lnJPFDI	116.45
lnCNFDI	139.07
lnGDP_per_capita	268.27
lnDomestic_investment	347.93
lnR&D	59.99
lnTrade	60.90
lnLabor_force	19.02

Source: Author's calculations.



Source: Author's calculations.

Figure 2. Trajectory of Ridge Regression Analysis.

The ridge regression analysis results presented in Table 7 highlight the significance of several variables, including *JPFDI*, *CNFDI*, *R&D*, and *Labor_force*, in explaining Thailand's industrial structure. The adjusted R-squared value of 0.7541 suggests that these variables effectively account for variations in the industrial structure. The analysis specifically shows that both Japanese and Chinese FDI have a positive impact on Thailand's industrial structure. A one-unit increase in Japanese FDI raises Thailand's industrial structure by 0.0253 units, while a one-unit increase in Chinese FDI raises it by 0.0198 units. This shows that Japanese FDI has a larger impact than Chinese FDI.

Moreover, R&D expenditures have the largest positive effect, with a one-unit increase resulting in 0.0617 units rise in the industrial structure. Thailand's economy has traditionally relied heavily on manufacturing and export sectors. However, R&D can lead to advancements in areas such as electronics, automotive, and manufacturing, contributing to the development of new products, services, and processes that strengthen Thailand's industrial structure. Additionally, R&D drives innovation and supports the growth of high-tech industries, which helps diversify Thailand's industrial base.

Table 7. Results of Ridge Regression Analysis[10].

	Coefficient	Standard Error	P-values
lnJPFDI	0.0253***	0.0059	0.0008
lnCNFDI	0.0198***	0.0034	0.0000
lnGDP_per_capita	0.0132	0.0126	0.3151
lnDomestic_investment	0.0074	0.0082	0.3877
lnR&D	0.0617***	0.0091	0.0000
lnTrade	-0.0264	0.0174	0.1534
lnLabor_force	-0.7490***	0.3019	0.0276
Constant	2.4123**	1.1194	0.0505

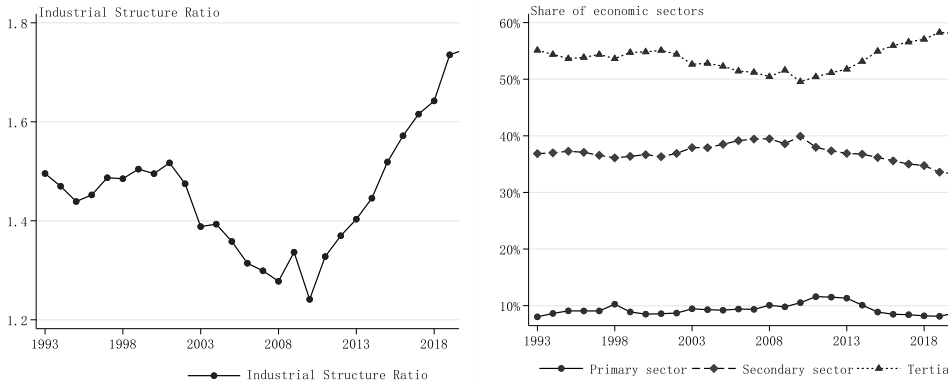
Note: ***, ** and * denote 1%, 5%, and 10% significance levels, respectively.
Source: Author's calculations.

However, Thailand's labor force has a significant negative effect. For every unit increase in the labor force, Thailand's industrial structure decreases by 0.749 units, suggesting that a growing labor force may hinder the adjustment of the industrial structure. Thailand's industrial structure has traditionally relied on labor-intensive manufacturing sectors. A labor force dependent on these low-skill industries has hindered the development of high-tech sectors, slowing industrial transformation. Additionally, the lack of necessary skills and education within the labor force has impeded the growth of more sophisticated industries, limiting changes to Thailand's industrial structure.

In this context, Figure 3.a serves to underscore these trends by illustrating the evolution of Thailand's industrial structure ratio over the period from 1993 to 2023, highlighting significant shifts in the composition of Thailand's economy. The ratio, initially documented as 1.496 in 1993, decreased to 1.388 in 2003 and further declined to 1.278 by 2008, reflecting a relative expansion of the secondary sector compared to the tertiary sector. However, from 2009 onward, the ratio demonstrated a consistent upward trend, peaking at 1.742 in 2020 and reaching its highest value of 1.780 in 2023, signifying a more pronounced growth of the tertiary sector relative to the secondary sector. Similarly, Figure 3.b illustrates the significant transformation of Thailand's industrial structure over the period from 1993 to 2023. The primary sector, including agriculture, forestry, and resource extraction, decreased from 8.03% of GDP in 1993 to 8.57% in 2023, reflecting a reduced reliance on agriculture and a shift toward industrial and service-based activities. The secondary sector, which includes manufacturing, construction, and energy, remained significant but declined from 36.85% in 1993 to 32.89% in 2023, as the economy shifted towards services. The tertiary sector, encompassing services like finance, tourism, trade, and IT, grew from 55.12% in 1993 to 58.54% in 2023, marking Thailand's transition to a service-driven, knowledge-based economy. Both Figures 3.a and 3.b highlights the overarching trend of Thailand's economic transition from agriculture and manufacturing to a more service-oriented economy. These

[10] This study utilized ridge regression to address multicollinearity issues and investigate the effects of explanatory variables on the target variable. Including a regularization term (k) in ridge regression reduces the variance of the coefficients but introduces bias, rendering traditional statistical inference methods inapplicable. To evaluate the importance of variables, this study approximated P-values using a pseudo-t-test. These P-values, derived from ridge regression coefficients and their standard errors, serve as reference indicators but are not directly comparable to the significance levels obtained from OLS regression. Nonetheless, a comparison between the results of ridge regression and OLS regression demonstrated that the significant conclusions from both methods were largely consistent. This suggests that the ridge regression results in this study possess substantial reference value. Therefore, while the P-values from ridge regression are not strict measures of statistical significance, they can still serve as meaningful reference indicators for assessing the importance of variables.

figures illustrate Thailand's progressive shift away from traditional sectors, such as agriculture and industrial production, toward the expanding and increasingly dominant service sector.



a. Thailand's Industrial Structure Ratio

b. Share of Economic Sectors in Thailand's GDP

Source: The World Bank Database.

Figure 3. Thailand's Industrial Structure Ratio and the Share of Economic Sectors in GDP.

5. Discussion

Through the above analysis, it is found that Japan's and China's FDI has a positive effect on the change in Thailand's industrial structure. This result is the same as the research results of Nokita (2012, 2018) that the growth of Japan's FDI has had a positive impact on the change in Thailand's industrial structure. The results of China's FDI also support the conclusions of Hao, et al. (2024), and Anwei (2024), that China's FDI has had a positive impact on the change in Thailand's industrial structure. Japan's sustained engagement in high-technology sectors, such as automotive manufacturing and electric vehicles (EVs), validates Hypothesis 1 by promoting technological innovation and promoting advanced industrial clusters. This aligns with the hypothesis that Japanese FDI promotes the development of clusters and supports technological progress. Similarly, Hypothesis 2 is affirmed by the growing impact of Chinese FDI in labor-intensive sectors, particularly in manufacturing, which has driven the upgrading of Thailand's industrial structure. As Chinese FDI has largely concentrated on improving production capabilities and infrastructure, they have enhanced Thailand's capacity in sectors traditionally reliant on labor-intensive processes.

Japan's FDI has been a driving force in upgrading Thailand's industrial structure. Following the 1985 Plaza Accord, Japan relocated production to Thailand, initially focusing on labor-intensive sectors like textiles. Over time, Japan transitioned into high-value industries such as automotive manufacturing and EVs, aligning closely with Thailand's industrial development goals. This strategic shift catalyzed Thailand's move from a labor-intensive economy to a more diversified, high-tech industrial base. Japanese FDI has had a significant impact by fostering industrial diversification and creating advanced manufacturing clusters. The automotive and EVs industries have become pillars of Thailand's economy, with Japanese firms integrating local suppliers and introducing cutting-edge technologies. This integration has enhanced Thailand's global competitiveness and strengthened its position within global value chains. Moreover, Japan's contributions go beyond financial investment. It has supported workforce skill development and collaborated on policies like the Eastern Economic Corridor (EEC), reinforcing Thailand's industrial

modernization. In contrast, China's FDI in Thailand, though a more recent development, has positively contributed to the upgrading of Thailand's industrial structure. Accelerating after the 2013 launch of the BRI, China's FDI has largely concentrated on the secondary sector, particularly manufacturing and infrastructure development. These FDI have strengthened Thailand's industrial capacity by addressing critical infrastructure gaps, improving connectivity, and fostering the growth of capital-intensive industries. In addition, Chinese FDI in manufacturing has driven advancements in key sectors such as electronics and machinery, providing technological upgrades and boosting production capabilities. In summary, Japanese and Chinese FDI have collectively strengthened Thailand's industrial structure. Japan's long-term and diversified investments have driven broad-based modernization, while China's focused contributions have addressed critical infrastructure and manufacturing needs, supporting continued growth and regional integration. Both countries have played key roles in Thailand's industrial transformation, each bringing unique strategies and varying levels of impact.

Additionally, R&D expenses are essential for driving innovation, enhancing productivity, and boosting industrial competitiveness, which can lead to the emergence of new sectors and shifts in the industrial structure. In its early development, Thailand advanced technological progress through its "trading market for technology" policy, facilitating the exchange and adoption of innovations. Over time, Thailand has progressively increased R&D investments, enabling the acquisition of advanced technologies that enhance productivity and support the evolution of its industrial structure. However, Thailand still faces challenges with a large pool of low-skilled labor, which has slowed the pace of structural change in the economy. As shown in Figure 3.b, the service sector has emerged as the largest employer, as many individuals moved from agriculture and manufacturing to tourism, retail, and finance jobs. While the secondary sector remains important, it now employs fewer people due to advances in automation and manufacturing efficiency. Recently, the growing influx of Japanese and Chinese FDI, coupled with heightened investment in R&D, has contributed to alleviating the challenges associated with a large low-skilled labor force, thereby supporting Thailand's industrial transformation.

These findings suggest that fostering innovation through increased R&D investment is crucial for advancing Thailand's industrial structure. Furthermore, while utilizing FDI, particularly from Japan, can stimulate structural upgrades, it is essential to prioritize addressing challenges within the domestic labor market, such as skill mismatches and low productivity. Policymakers must adopt a balanced approach to maximize the benefits of FDI and R&D while enhancing the capabilities of the local workforce to ensure sustainable industrial transformation.

6. Limitations

This article has several limitations. Due to data constraints, this study uses statistical data from Thailand between 2003 and 2023, finding that Japan's and China's FDI positively influence changes in Thailand's industrial structure. However, extending the time frame of the data could potentially reveal different impacts of Japan's and China's FDI on the industrial structure. Additionally, the multiple regression model in this study identifies Japan's and China's FDI, Thailand's R&D expenditures, and labor force as key factors driving changes in the industrial structure. However, other factors may also influence these changes, and altering the variables in the regression model could lead to different conclusions. Furthermore, the Japanese and Chinese FDI analyzed in this study represents the total FDI from both countries, without distinguishing by industry. Since the impact of FDI can vary significantly across industries, further research examining Japanese and Chinese FDI by industry would provide valuable insights into its specific effects on changes in Thailand's industrial structure.

7. Conclusion

This study analyzed Thailand's statistical data from 2003 to 2023 using multiple regression analysis to examine the impact of Japanese and Chinese FDI on changes in Thailand's industrial structure. The results indicate that Japanese FDI, Chinese FDI, R&D expenses, and Thailand's labor force are significant factors. Notably, Japanese FDI has a greater impact on Thailand's industrial structure compared to Chinese FDI, while R&D expenses make the largest contribution to these changes. However, Thailand's labor force has a significant negative influence on the adjustment of its industrial structure.

The greater influence of Japanese FDI on Thailand's industrial structure can be attributed to its longer investment period and larger scale compared to Chinese FDI. Over the years, Japanese FDI has targeted key sectors, including automotive manufacturing and related industries, establishing robust industrial clusters that contribute significantly to Thailand's economy. In contrast, Chinese FDI, while growing in recent years, remains smaller in total volume. As a result, its impact on the structural transformation of Thailand's industries has been more modest. However, the cumulative effect of FDI from both Japan and China has been instrumental in shaping Thailand's industrial landscape. FDI from these countries has facilitated the development of mature industrial clusters such as traditional light manufacturing and automotive industries. Furthermore, the recent focus on EVs has spurred innovation and encouraged technological upgrades. These developments align with Thailand's policy efforts, such as the "trading market for technology" policy, aimed at accelerating technological advancement and industrial modernization. Despite these advancements, Thailand faces ongoing challenges due to its large population of low-skilled laborers. This demographic limits the pace and scope of structural transformation by constraining the adoption of advanced technologies and high-value-added industries. However, increased investment in R&D and the influx of Japanese and Chinese FDI have helped mitigate these limitations by fostering productivity and innovation. For example, R&D spending has driven technological upgrades, enabling Thailand to gradually overcome some of the barriers imposed by a low-skilled labor force.

Moving forward, the Thai government should prioritize the development of specialized vocational training programs in collaboration with industries significantly impacted by FDI, including automotive manufacturing, EVs, and electronics. For instance, establishing regional training centers focused on EVs assembly, battery technology, and other emerging fields would directly support Thailand's growing EVs sector. Additionally, to further address the challenges posed by Thailand's large population of low-skilled workers, the government should introduce subsidies or tax incentives for companies that invest in continuous learning and skills development for their employees. This could include funding online training platforms, allowing workers to access training remotely, or offering financial assistance to help workers enroll in technical courses. The government could also sponsor training programs for workers transitioning from traditional industries to emerging sectors. By implementing these initiatives, the Thai government can ensure that its workforce is prepared to meet the demands of an evolving industrial landscape. A highly skilled workforce will not only attract higher-quality FDI but also play a critical role in supporting sustainable industrial growth. Furthermore, it will enhance Thailand's competitiveness in the global economy, positioning Thailand for long-term success as a hub for innovation and advanced manufacturing.

Statements and Declarations:

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Data Availability

The datasets are all publicly available and primarily come from The World Bank Database, the Japan External Trade Organization (JETRO), and the Ministry of Commerce of China (MOFCOM).

Conflict of Interests

The author declares no conflict of interest.

Reference

Anwei, X. (2024). New Motivations, Opportunities, and Challenges for Chinese Manufacturing Enterprises Investing in Southeast Asia. *International Economic Review*, 1-30.

Barrios, S., Görg, H., & Strobl, E. (2005). Foreign direct investment, competition and industrial development in the host country. *European economic review, 49*(7), 1761-1784. https://doi.org/10.1016/j.euroecorev.2004.05.005

Chakraborty, C., & Nunnenkamp, P. (2008). Economic reforms, FDI, and economic growth in India: a sector level analysis. *World development, 36*(7), 1192-1212. https://doi.org/10.1016/j.worlddev.2007.06.014

Chen, H., Pan, J., & Xiao, W. (2020). Chinese outward foreign direct investment and industrial upgrading from the perspective of differences among countries. *China & World Economy*, *28*(3), 1-28. https://doi.org/10.1111/cwe.12330

Chenery, H. B., Robinson, S., Syrquin, M., & Feder, S. (1986). *Industrialization and growth*. Oxford University Press.

Cunhui, G. Ruogu, Z., & Dianfan, Y. (2011). An Empirical Study on the Effects of Industrial Structure on Economic Growth and Fluctuations in China. *Economic Research Journal*, *46*(5), 4-16.

Clark, C. (1940). *The Conditions of Economic Progress*. Macmillan Company.

Deyun, X. (2008). Determination of Industrial Structure Changing Form: A Theoretical Explanation and Verification of Measurement. *Fiscal Research*, *1*, 46-49.

Feng, L., & Yanhua, W. (2023). Research on the impact of digital economy development on industrial structure upgrading. *Journal of Science and Technology Management, 25*(3), 13-25.

Hao, C., Ziwei, Z., & Chuanchuan, L. (2024). Research on the Sustainable Development of Chinese Enterprises' Investment in Thailand under the Background of "One Belt and One Road". *Journal of Changsha University of Science and Technology (Social Science), 39*(3), 53-61.

Hiroshi, Y., & Matsumoto, K. (2000). *Structural Change and Economic Growth, Research Institute of Capital Formation (RICF), CIRJE-J-37*. https://www.cirje.e.u-tokyo.ac.jp/research/dp/2000/2000cj37.pdf.

Hoffman, W.G. (1931). *The Growth of Industrial Economics (German Edition), 1958 (English Translation)*, Oxford University Press.

Jianmin, L., Xiaomei, H., & Jinguang, W. (2017). Fiscal decentralization, financial efficiency and upgrading the industrial structure: an empirical analysis of a spatial heterogeneity model. *Journal of Applied Statistics, 44*(1):,181-196.

Milner, C., Reed, G., & Talerngsri, P. (2006). Vertical linkages and agglomeration effects in Japanese FDI in Thailand. *Journal of the Japanese and international Economies*, *20*(2), 193-208. https://doi.org/10.1016/j.jjie.2005.01.003

Ning, W., & Zuankuo, L. (2021). Higher education development, technological innovation and industrial structure upgrade. *Technological Forecasting and Social Change*, *162*, 120400.

Nokita, H. (2012). The Importance of Thailand for Japanese Companies: Company Strategies and the Effects on the Japanese Economy. *HUE Journal of Economics and Business, 35*(3), 1-16.

Nokita, H. (2018). New Policies of Thailand and Indonesia, and Japanese Foreign Direct Investment: Focusing on the Manufacturing Industries. *HUE Journal of Economics and Business, 41*(2), 93-101.

Paus, E. (2005). *Foreign Investment, Development, and Globalization: Can Costa Rica Become Ireland?* Palgrave Macmillan.

Qiong, Z., & Minyu, N. (2013). Influence analysis of FDI on China's industrial structure optimization. *Procedia Computer Science*, *17*, 1015-1022.

Qiuli, Z. 2006. Japanese Direct Investment in Thailand: Characteristics and Prospects. *Crossroads: Southeast Asian Studies*, *9*, 24-28.

Shasha, Li. (2021). The impact of labor mobility on industrial upgrading in China. *In E3S Web of Conferences, 235*. https://doi.org/10.1051/e3sconf/202123502055

Shojiro, T. (1989). Japan's Direct Investment and Thai Industrialization: Impact of Japan's Direct Investment on Economies and Financial Markets in Thailand. *Journal of Political Economy (Keizaigaku=kenkyu)*, 55, 171-193.

Shuai, Z., & Hongyu, L. (2020). The Technology Spillover Effect of China's Export to Thailand under the "Belt and Road" Initiative. *Asia-pacific Economic Review*, *4*, 119-127.

Wang, J. Y., & Blomström, M. (1992). Foreign investment and technology transfer: A simple model. *European economic review, 36*(1), 137-155.

Wei, Z., & Dong, J. (2011). *ODI and Home Country's Industrial Upgrading: Mechanism and preliminary evidence*. RIETI Discussion Paper Series 11-E-032.

Xuechun, Z. (2016). The Research on Industrial Distribution of China's Direct Investment in Thailand. *Around Southeast Asia*, 5, 41-45.

Yuichi, S. (1965). An Interindustry Analysis of Growth Patterns. *Economic Review, 16*(4), 304-312.

Zheng, T. (2019). Japanese Direct Investment in China and Its Impact on Chinese and Japanese Economies, *Journal of Northeast Asia Studies*, *4*, 132-143.

Zhipeng, X. (1997). The current situation and prospects of trade between Thailand and China, *Southeast Asian Affairs*, *3*, 43-46.