



THE IMPACT OF FOREIGN DIRECT INVESTMENT ON THE CHANGE IN THAILAND'S INDUSTRIAL STRUCTURE

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Abstract:

Foreign direct investment (FDI) has played a significant role in Thailand's economic development. This study utilizes the Vector Error Correction Model (VECM) to analyse the impact of FDI on the change in Thailand's industrial structure. Based on the analysis results of the VECM model, it is evident that the impact of FDI on these changes is slightly smaller than that of the industrial structure itself; it is also positive. Both the industrial structure itself and FDI have long-term positive promoting effects on the change in Thailand's industrial structure. Furthermore, the impact of GDP per capita, imports and exports on changes in the industrial structure is subject to volatility. Initially, GDP per capita, imports, and exports had a short-term positive promoting effect on Thailand's industrial structure change. However, in the long term, the growth of these two economic factors constrains the change in Thailand's industrial structure.

JEL: F21; O14; O53; C32; L52

Keywords: Thailand, foreign direct investment, industrial structure changes, vector error correction model, long-term effect

1. Introduction

As the second-largest economy among the Association of Southeast Asian Nations (ASEAN) countries, Thailand's total GDP exceeded 500 billion US dollars for the first time in 2018, making it the second ASEAN nation to achieve this milestone, following Indonesia. Since 1960, Thailand has maintained an average annual GDP growth rate of over 7.4 per cent, establishing itself as one of the world's fastest-growing economies. Being one of the earliest Southeast Asian countries to attract foreign direct investment (FDI), Thailand has experienced significant economic development. FDI has played a pivotal role in transforming Thailand from a traditional agricultural nation into a modern

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industrialized country (Wattanadumrong, *et al.*, 2014), exerting a profound impact on all aspects of Thailand's economic growth.

Regarding the impact of FDI on the Thai economy, Poapongsakorn & Tangkitvanich (2001) highlighted that FDI has been one of the most important forces behind the change in Thailand's industrial structure. Qiuli (2006) indicated that changes in the main investment industries of Japanese FDI have played a significant role in promoting the transformation of Thailand's industrial structure. Nokita (2012, 2018) analyzed the current situation of Japanese FDI in Thailand, and they also pointed out that Japanese FDI mainly concentrates on Thailand's manufacturing industry. The growth of Japanese FDI has had a positive impact on changes in Thailand's industrial structure and trade. Xuechun (2016) pointed out that China's FDI in Thailand between 2004 and 2014 was primarily concentrated in manufacturing industries such as metal machinery and equipment, chemical products, mining, ceramic products, electrical and electronic products, as well as light manufacturing and textiles, so he suggests that China's FDI has also positively impacted Thailand's industrial structure transformation. However, Tanomponkang (2017) discussed the impact of FDI on Thailand's economic growth, environmental issues, and export trade, but did not specifically discuss the change in Thailand's industrial structure.

While the aforementioned studies have qualitatively analyzed the impact of FDI on the Thai economy and industrial structure, they have not quantitatively analyzed the influence of the increase in FDI on Thailand's industrial structure. This paper aims to employ the Vector Error Correction Model (VECM) to quantitatively analyses the specific impact of FDI on the change in Thailand's industrial structure. First, this paper will introduce the current state of FDI in Thailand. Secondly, this paper will construct a VECM to assess the influence of FDI on the change in Thailand's industrial structure.

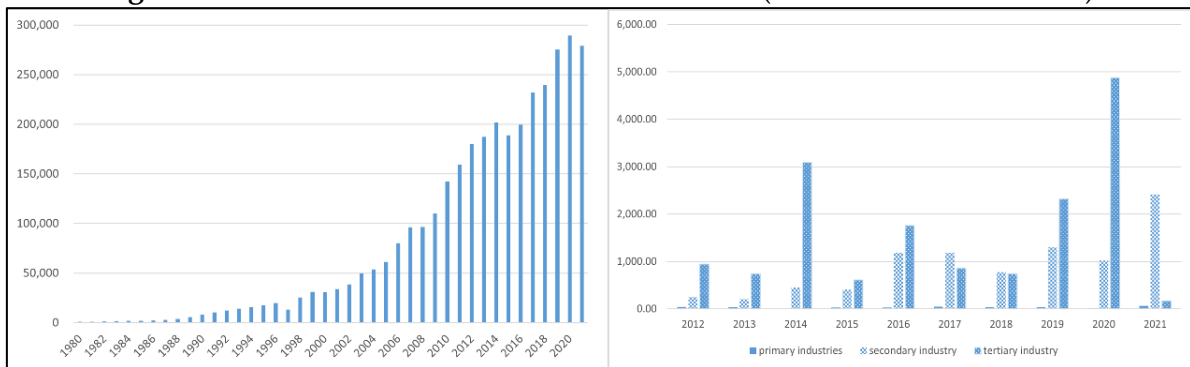
2. The Current Situation of FDI in Thailand

Zhen (1990) noted that Thailand's economy began to experience rapid growth in the 1960s, prompting the government to implement policies to encourage foreign companies to invest in the country. Kohpaiboon (2003) highlighted the substantial increase in FDI inflow into Thailand, rising from approximately 400 million US dollars in 1970-1974 to surpassing 6.56 billion US dollars in 1995-1999. During the 1980s, FDI's share in total domestic investment ranged from 2-3 per cent, but it surged to 20 per cent in 1998. As depicted in Figure 1.a, the scale of FDI in Thailand during the 1980s remained relatively small, totaling only 981 million US dollars. However, starting in the latter half of the 1980s, FDI in Thailand began to experience significant growth. The Asian Financial Crisis in 1997 temporarily dampened FDI inflows. Nevertheless, post-crisis, Thai companies grappling with severe debt and liquidity issues, coupled with an increase in foreign companies' mergers and acquisitions (M&A) activity and the purchasing power of foreign investors benefiting from the baht's depreciation, contributed to the resurgence of FDI (Brimble & Sibunruang, 2002; Pisit, 2014). Entering the 21st century, FDI in

Thailand experienced rapid expansion. In 2004, FDI in Thailand exceeded 50 billion US dollars for the first time, and by 2020, it had reached an impressive 289.4 billion US dollars (Figure 1.a).

According to ASEAN Stats Data Portal, the top 8 countries (regions) with FDI in Thailand are Japan, Singapore, Hong Kong, USA, the Netherlands, China, British Virgin Islands, and the UK. Japan is Thailand's largest source of FDI, contributing to 30-40 per cent of the total FDI inflow into Thailand. Second is Singapore, also a member of ASEAN, accounting for 15-20 per cent. Following closely are Hong Kong, the United States, the Netherlands, and China, with the combined FDI from these four countries comprising 20-25 per cent of Thailand's total FDIⁱⁱ. The total FDI in Thailand from these eight countries (regions) exceeds 80 per cent. Thanyakhan (2008) highlighted that during its early economic development, Thailand heavily relied on FDI from the United States and Japan. Thai government incentive policies played a pivotal role in attracting foreign enterprises to invest in Thailand during this period.

Figure 1: The Current Situation of FDI in Thailand (in millions of US dollars).



a. FDI in Thailand b. FDI in Thailand's three major industries

Source: United Nations Conference on Trade and Development (UNCTD) database, and ASEAN Stats Data Portal database.

Japan holds the distinction of being the largest source of FDI in Thailand. The history of Japanese FDI in Thailand can be traced back to the late 1950s, although it didn't gain significant momentum until the 1970s. Ozawa (1992) noted that Japanese FDI initially took the form of low-wage labor-seeking investments, particularly in labor-intensive industries. This trend began in the late 1950s and gained substantial momentum after the mid-1960s, especially following the yen's revaluation in the early 1970s. During this period, Japanese FDI was driven by the need to transfer excess domestic production capacity and mitigate trade friction issues arising from export competition (Qiuli, 2006; Xiaoyu, 2021). However, the sharp appreciation of the yen following the signing of the Plaza Accord in 1985 eroded Japan's competitive advantage in exports (Hiley, 1999). In response, Japanese companies accelerated their overseas FDI efforts to relocate domestic labor-intensive industries that had lost competitiveness (Xiaoyu, 2021, p. 45.). It was

ⁱⁱ Notably, Singapore, Hong Kong, and the Netherlands serve as international financial centers, with a significant portion of their FDI originating from Japan, the United States, and China.

around this time that Japanese FDI in Thailand began to experience rapid growth. Starting in 1987, driven by rising labor costs and currency appreciation in Japan and other Asian countries, direct investments in Thailand surged at an exceptional pace. Japan experienced the most significant increase in FDI in Thailand during this period, skyrocketing from 33 percent in 1986 to 48 percent in 1988. Thanyakhan (2008) similarly noted that during the 1980s, as Japanese companies actively sought new production bases abroad to mitigate the impact of yen appreciation, Thailand's rapid economic growth and the government's favorable policies to attract foreign enterprises proved highly attractive to Japanese firms, leading to a substantial increase in FDI in Thailand. However, with the burst of Japan's economic bubble in the 1990s, Japanese FDI in Thailand experienced a sharp decline. In the 21st century, as the Japanese economy gradually recovered, Japan once again accelerated its pace of FDI in Thailand.

On the other hand, following the Chinese government's introduction of the Belt and Road Initiative at the end of 2013, the total FDI from Chinese companies in Thailand has experienced rapid growth. Figure 1 illustrates that China's share of FDI in Thailand has gradually increased from 1.6 per cent in 2014 to 4 per cent in 2021. While the proportion of FDI from China in Thailand is still relatively small, it is growing at a significant rate. Zhu & Liumei (2020) pointed out that FDI from Chinese enterprises in Thailand is primarily concentrated in primary and secondary industries, including agriculture and agricultural products, metal products and machinery, chemicals and paper, electrical appliances and electronic products, the light manufacturing industry, and the textile industry. Their analysis also noted that this concentration highlights an issue with the relatively narrow and single-focused investment industrial structure.

Figure 1.b illustrates the proportion of FDI in Thailand's three major industries. It is evident from Figure 1.b that although the proportion of FDI invested in these industries fluctuates annually, the majority of FDI continues to flow into Thailand's secondary and tertiary sectors. Except for 2017, 2018, and 2021, FDI in the tertiary sector consistently surpasses that in the secondary sector. FDI played a pivotal role in propelling Thailand toward industrialization. Zhen (1990) noted that due to the influence of Thai government policies, approximately one-third of the FDI between 1970 and 1985 was concentrated in Thailand's manufacturing sector. Brimble & Sibunruang (2002) similarly noted that Thailand's manufacturing sector has been a major recipient of FDI. Kohpaiboon (2003) noted that manufacturing consistently attracted the majority of total FDI. During the early 1970s, it accounted for 30 per cent of total FDI, which increased to approximately 44 per cent in the latter half of the 1980s and later declined to around 38 per cent in the latter half of the 1990s. Xiaoyu (2021) analyzed Japan's FDI in Thailand's automobile industry and highlighted that Japan's FDI in Thailand has continuously evolved in response to Thailand's industrial policy adjustments. According to Kaname Akamatsu's theory of the flying geese pattern of development, Thailand, currently in the third stage of flying geese economic development, serves as the next industrial transfer center for countries and regions such as Japan, Singapore, Hong Kong, Taiwan, and South Korea.

The rapid growth of Thailand's secondary and tertiary industries is closely intertwined with the FDI from these countries (regions).

On the other hand, despite Thailand's significance as a major recipient of FDI within ASEAN, there remain certain challenges within its domestic investment environment. Haiying & Liangjing (2013) utilized the Principal Component Analysis (PCA) method to construct an investment environment evaluation index for five Southeast Asian countries (Indonesia, Malaysia, the Philippines, Singapore, and Thailand). Their analysis highlights several issues within Thailand, including relatively low economic openness, high business operation costs, and a smaller scale of economic development. He & Meifang (2015) examined the political risks faced by Chinese enterprises investing in Thailand. They considered factors such as Thailand's political stability, governance structure deficiencies, policy changes, government corruption, and terrorism in the southern border provinces of Thailand. Therefore, enterprises venturing into Thailand should be attentive to the variations in investment environments across different regions within Thailand.

3. Literature Review

Regarding the relationship between FDI and the host country's industrial structure adjustments, Chenery (1967) pointed out that FDI can address the capital needs of host countries by bridging the gaps in savings and foreign exchange, thereby promoting economic growth and optimizing industrial structure (Two Gaps model). Kojima (1977) proposed the theory of marginal industry expansion, suggesting that investing in marginal industries enables the host country to leverage its comparative advantage and promote industrial upgrading. Blomström & Persson (1983) highlighted that FDI brings advanced technology, management expertise, machinery, and equipment to industrial development, catalyzing the upgrading of industrial structure. Host countries can leverage foreign capital and technology spillover to stimulate economic growth and facilitate the transformation and upgrading of industrial structures. Markusen & Venables (1999) noted that the investment of multinational corporations (MNCs) in developing countries promotes their industrial structural upgrading.

Kippenberg (2005) found that MNCs promote the upgrading of the industrial structure of the host country through their connections with the host country's economy. Additionally, Kippenberg (2005) noted that FDI promotes the adjustment of the Czech industrial structure. Crespo & Fontoura (2007) noted that FDI serves as a crucial source for domestic enterprises to acquire external knowledge. Additionally, they pointed out that host country enterprises can enhance their technical capabilities by actively imitating, engaging in inter-enterprise cooperation, or passively accepting competition from foreign enterprises. This contributes to the adjustment of relevant industrial structures in host countries. Driffield *et al.* (2010) pointed out that developing countries can benefit from a technology spillover effect through industrial transfer from developed countries. Furthermore, they noted that, in the long run, undertaking international

industrial transfer promotes the upgrading of regional industrial structures. Nefussi & Schweltnus (2010), based on French service and manufacturing enterprises as objects, concluded that FDI has significant demonstration and driving effects, and they believed that the large inflow of FDI into the French manufacturing industry helps to promote FDI in the service industry, which in turn affects the upgrading of the industrial structure. Yin *et al.* (2011) conducted an empirical study on the mutual influence between FDI and China's industrial upgrading, and they found that FDI and industrial upgrading have long-term stable relations and mutually promote each other. However, industrial upgrading changes depend more on their changes, as well as some foreign capital leaving China. Mühlen & Escobar (2020) found that the lagged effect of direct investment and its concentration in industrial sectors, such as manufacturing, contributed to positive changes in economic growth and structural change in Mexico.

However, some scholars have found that FDI inhibits the upgrading of a country's industrial structure. Hunya (2002) studied the impact of FDI on Romania's exports and found that foreign enterprises primarily invested in labor-intensive and low-technology export industries. As a result, he concluded that FDI did not alter the country's trade structure but instead preserved and reinforced Romania's traditional advantage industries. Wijeweera *et al.* (2010) found that when the scientific and technological level of a certain industry in a certain country is very mature, FDI has a significant promoting effect on industrial structure adjustment and economic development. However, in other cases, FDI has no significant positive effect on the domestic economy and industrial structure. Temiz & Gökmen (2014) noted that FDI in Turkey mainly occurs through M&A. Consequently, local enterprises may become exposed to outdated machinery or management practices employed by foreign enterprises. As a result, FDI may not effectively promote Turkey's economic and industrial development. Based on panel data for 271 Chinese cities from 2003 to 2016, Li *et al.* (2021) found that FDI inhibits the upgrading of the industrial structure to a certain extent.

In summary, the increase in FDI can lead to spillover effects in host countries, encompassing both positive and negative outcomes. FDI can yield positive spillover effects for local enterprises. It not only brings substantial investment funds to the host country, creating numerous employment opportunities, training local staff, but also enhancing production standard for backward industries, disseminates advanced science, technology, and management practices through the establishment of factories and Research and Development (R&D) centers. In addition, the foreign companies' subsidiaries have a demonstration effect on domestic enterprises in terms of technology selection and management practice. Furthermore, the adoption of advanced technologies by foreign enterprises exerts competitive pressure on local companies, compelling them to enhance their technological capabilities and contribute to the host country's scientific and technological advancement. Simultaneously, the movement of labor fosters the diffusion of advanced technologies held by foreign firms among local companies, generating a favorable technology spillover effect (Pupphavesa & Pussarungsri, 1994; Kohpaiboon, 2003; Wang, *et al.*, 2020). Conversely, FDI can also generate negative

spillover effects for local firms. Foreign companies employing advanced production technologies may capture market share from local firms through large-scale production, leading to reduced production costs. Additionally, they may acquire local enterprises through M&A, thereby controlling the market. Moreover, foreign companies may attract talent with advanced skills from host countries by offering higher salaries. The loss of a significant talent pool can impede the ongoing development of local companies. Lastly, an uneven distribution of FDI across host country industries may exacerbate imbalances in the host country's industrial structure (Kokko, 1994; Qiuxia, 2014).

Based on the aforementioned positive and negative spillover effects of FDI, it becomes evident that positive spillover effects can expedite the industrial development of the host country and facilitate adjustments to the host country's industrial structure. Conversely, adverse spillover effects can hasten the bankruptcy of relevant local enterprises and the decline of associated industries, while also exerting an impact on the host country's industrial structure adjustments.

4. Material and Methods

4.1. Industrial Structure Changing Indicator

In order to quantitatively analyse the impact of FDI on the change in Thailand's industrial structure, it is essential to establish indicators for measuring this change. The Petty-Clark Theorem offers insights into the evolution of a country's industrial structure (Clark, 1940). As a country experiences a continual increase in per capita Gross National Income (GNI), the labor force initially shifts from the primary industry to the secondary industry. With further improvement in per capita GNI, the labor force transitions from the secondary industry to the tertiary industry. In essence, the key manifestation of industrial structure change is the ongoing decline in the proportion of the primary industry within the overall national economic system, coupled with a rising proportion of the secondary and tertiary industries.

In terms of an industrial structure change index, Deyun (2008) introduced the industrial structure coefficient index to gauge the level of industrial structure change in a country. The industrial structure coefficient of Deyun (2008) provides a more accurate reflection of a country's industrial structure change. In this coefficient, the primary industry is assigned a value of 1, the secondary industry a value of 2, and the tertiary industry a value of 3 to represent the varying levels of the three major industries.

This study utilizes the industrial structure coefficient of Deyun (2008) as the dependent variable to assess the impact of FDI on the change in Thailand's industrial structure. The calculation equation for the industrial structure coefficient of Deyun (2008) is as follows:

$$R = \sum_{i=1}^3 i * Y_i = Y_1 * 1 + Y_2 * 2 + Y_3 * 3. \quad (1)$$

Among them, R is the industrial structure changing index; Y_i is the proportion of the value added of industry i to GDP of the country. The value of R ranges from 1 to 3. When R is closer to 3, it means that the industrial structure of a country is higher. On the contrary, when R is closer to 1, the lower the level of industrial structure of a country.

4.2. Methods

The Vector Autoregression (VAR) model is an unstructured model that does not require a priori theoretical hypotheses. It can capture the dynamic structural relationships between economic variables using real economic data and analyze the influence of random disturbances on these variables. Based on the values of each variable in the current period and its lag period, the model constructs a vector autoregressive model of the lag p order.

The expression of the VAR(p) model is represented by the following equation:

$$y_t = c + A_1 y_{t-1} + \dots + A_p y_{t-p} + u_t, u_t \sim W. N. (\Sigma) \quad (2)$$

Where:

y_t : The column vector of dimensions ($n \times 1$),

c : The constant vector of dimensions ($n \times 1$),

A_i : The autoregressive coefficient matrix of dimensions ($n \times n$),

u_t : The random disturbance term with a covariance matrix representing a zero-mean white noise vector.

In order to analyze non-stationary time series, which exhibit a long-term relationship between economic variables with cointegration, and to obtain the short-term adjustments that each variable makes from their common random trend, it is necessary to use the VECM model. The VECM model, a form of VAR model, incorporates cointegration constraints, making it suitable for modeling non-stationary time series with cointegration relationships. The VECM equation is expressed as follows:

$$\Delta y_t = v + \Pi y_{t-1} + \sum_{i=1}^{\rho-1} \theta_i \Delta y_{t-i} + \mu_t \quad (3)$$

Where:

Δy_t : The first difference of endogenous variables.

v : A vector of constants.

Π : The rank of matrix I , representing the number of cointegration vectors.

θ_i : Short-run coefficients.

μ_t : A vector of impulses.

Based on the VAR model, the VECM model is constructed to analyze the long-term dynamic relationship between FDI and Thailand's industrial structure from an empirical perspective. This paper utilizes the industrial structure coefficient index R proposed by Deyun (2008) as the dependent variable. Foreign direct investment (FDI),

per capita gross domestic product (GDPP), and imports and exports (IMEX)ⁱⁱⁱ are employed as independent variables to construct a VECM equation. FDI serves as the primary explanatory variable in this study, which investigates the impact of increased FDI on the change in Thailand's industrial structure. GDP per capita is employed to examine the effect of changes in household consumption on Thailand's industrial structure. Imports and exports are used to assess the impact of increased international trade on the change in Thailand's industrial structure.

To mitigate issues related to heteroscedasticity and data fluctuations in the original data, the values of R, FDI, GDPP, and IMEX are transformed by taking natural logarithms^{iv}. Furthermore, the data analysis for this study covers a sample period from 1995 to 2021, spanning a total of 27 years. The primary data sources for this analysis are the World Bank database and the Thailand Board of Investment (BOI) database.

Table 1: Descriptive Statistics

Indicator	Symbol	Sample Size	Mean	Standard Deviation	Minimum	Maximum	Data Source
Industrial Structure Coefficient Index	LNR	27	0.89	0.01	0.87	0.92	World Bank database
Foreign Direct Investment	LNFDI	27	11.36	0.96	9.50	12.58	World Bank database; Thailand Board of Investment (BOI)
Per Capita Gross Domestic Product	LNGDPP	27	8.45	0.22	8.10	8.77	World Bank database
Import and Export	LNIMEX	27	26.58	0.41	25.88	27.06	World Bank database

Source: The Author.

5. Results and Discussion

5.1. Unit root test

Before constructing the VECM model, it is essential to perform a unit root test on each variable sequence within the VAR model framework to assess whether each variable constitutes a stationary sequence. In cases where each variable is a non-stationary sequence, differencing is necessary. When a variable sequence becomes stationary after taking its *i*-th difference, it implies that the original variable sequence conforms to an *i*-order of integration. Table 2.a demonstrates that the Augmented Dickey-Fuller (ADF)

ⁱⁱⁱ Lee (2009) found that imports and exports can generate an agglomeration effect in the manufacturing industry, thereby promoting the upgrading of the industrial structure. Therefore, the model in this paper employs imports and exports as independent variables.

^{iv} This logarithmic transformation shifts the regression residuals from absolute errors in metadata to relative errors in logarithmic data.

unit root test^v results for LNR, LNFDI, LNGDPP, and LNIMEX do not reject the null hypothesis of “the time series data has a unit root” at the 0.05 significance level, indicating that all original variables are non-stationary. However, for LNR, LNFDI, the ADF unit root test results for their first-order differences (Δ LNR, Δ LNFDI, Δ LNGDPP, and Δ LNIMEX) all reject the null hypothesis of “the time series data has a unit root” at the 0.05 significance level, indicating that they are all stationary sequences. Thus, LNR, LNFDI, LNGDPP, and LNIMEX conform to a single integration of order 1.

Table 2: Statistical Results

a. ADF Unit Root Test Results of Variables							
Variable	Test type (C, T, K)	ADF test value	Critical value is below 0.01 significance level	Critical value is below 0.05 significance level	Critical value is below 0.1 significance level	P-value	Conclusion
LNR	(0, 0, 0)	-0.836	-3.743	-2.997	-2.629	0.8083	Non-stationary
LNFDI	(0, 0, 0)	-1.153	-3.743	-2.997	-2.629	0.6935	Non-stationary
LNGDPP	(0, 0, 0)	-0.418	-3.743	-2.997	-2.629	0.907	Non-stationary
LNIMEX	(0, 0, 0)	-1.197	-3.743	-2.997	-2.629	0.307	Non-stationary
Δ LNR	(0, 0, 0)	-4.226	-3.75	-3.000	-2.63	0.0006	Stationary
Δ LNFDI	(0, 0, 0)	-6.396	-3.75	-3.000	-2.63	0.0000	Stationary
Δ LNGDPP	(0, 0, 0)	-4.056	-3.75	-3.000	-2.63	0.0011	Stationary
Δ LNIMEX	(0, 0, 0)	-4.826	-3.75	-3.000	-2.63	0.0001	Stationary
Note: The test type (C, T, K) respectively indicates that the unit root test equation contains constant terms, trend terms and lag orders; The ‘d’ used in front of the variables indicates the first difference.							
b. The Optimal Lag Order							
Lag	LogL	LR	FPE	AIC	SC	HQ	
0	183.8090	NA	3.65e-12	-14.98408	-14.78774*	-14.93199*	
1	198.3069	22.95508	4.24e-12	-14.85891	-13.87720	-14.59846	
2	220.7647	28.07223*	2.82e-12*	-15.39706*	-13.62998	-14.92825	
Note: * Indicates lag order selected by the criterion; LR: sequential modified LR test statistic (each test at 0.05 level); FPE: Final prediction error; AIC: Akaike information criterion; SC: Schwarz information criterion; HQ: Hannan-Quinn information criterion.							
c. Johansen Cointegration Test Results							
Null Hypothesis	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value		P-value		
None *	0.761058	56.67118	47.85613		0.0060		
At most 1	0.426081	20.88285	29.79707		0.3650		
At most 2	0.202874	7.001159	15.49471		0.5775		
At most 3	0.051908	1.332604	3.841465		0.2483		
Note: Max-eigenvalue test indicates 1 cointegrating eqn(s) at the 0.05 level; * denotes rejection of the hypothesis at the 0.05 level							

Source: The Author.

Furthermore, determining an appropriate lag order is crucial to VECM model construction. In selecting the lag order for the VECM model, it is necessary to examine the lag orders of the VAR model first. While choosing a higher lag order for the VAR model can better capture the dynamic characteristics of the constructed model, it also

^v Augmented Dickey-Fuller test (ADF) is a test commonly used in time series analysis to determine whether a time series has stationarity.

reduces the model's degrees of freedom due to the increased number of variables to consider. Typically, VAR models choose the optimal lag order based on the Akaike Information Criterion (AIC). Table 2.b reveals that the optimal lag order for the VAR model is 2.

5.2. Cointegration test

After determining the lag order of the VAR model, a cointegration relationship^{vi} test, which reflects the long-run equilibrium relationship between variables, is conducted on the original sequences to determine the number of cointegration relationships within the model. Given that each sequence conforms to a single integration of order 1, this study employs the Johansen cointegration analysis method to test for long-term equilibrium relationships among the variables.

Table 2.c reveals that the trace statistic value for the null hypothesis of no cointegration is 56.67118, which exceeds the critical value of 47.85613 at the 0.95 confidence level. This indicates a rejection of the null hypothesis that no cointegration relationships exist among the original variables, signifying the presence of at least one cointegration relationship among them. However, for the null hypothesis of "at most one cointegration relation", the value of the trace statistic is 20.88285, which falls below the critical value of 29.79707 at the 0.95 confidence level, preventing the rejection of the null hypothesis. Therefore, the results of the cointegration test suggest the existence of a single cointegration relationship among the variables, specifically a long-term stable equilibrium relationship between FDI and the change in Thailand's industrial structure. Furthermore, based on the cointegration relationship among the model variables, it becomes evident that there exists a positive correlation between FDI and the change in Thailand's industrial structure. Specifically, for each 1 per cent increase in FDI, the change in Thailand's industrial structure is expected to increase by 0.0162 per cent. Likewise, with each 1 per cent increase in GDP per capita, the change in Thailand's industrial structure is expected to increase by 0.3564 per cent. Conversely, with each 1 per cent increase in imports and exports, the change in Thailand's industrial structure is linked to a decrease of 0.2334 per cent. These findings underscore a long-term positive correlation between FDI, GDP per capita, and the change in Thailand's industrial structure while revealing a long-term negative correlation between imports and exports and the change in Thailand's industrial structure.

To express the cointegration relationship in mathematical terms and equate it to the VECM, this paper derives formula (4):

$$\text{VECM} = \Delta\text{LNR} - 0.0162\Delta\text{LNFDI} - 0.3564\Delta\text{LNGDPP} + 0.2334\Delta\text{LNIMEX} \quad (4)$$

(0.01229) (0.04461) (0.02698)

^{vi} The cointegration relationship reflects long-run equilibrium relationship between variables.

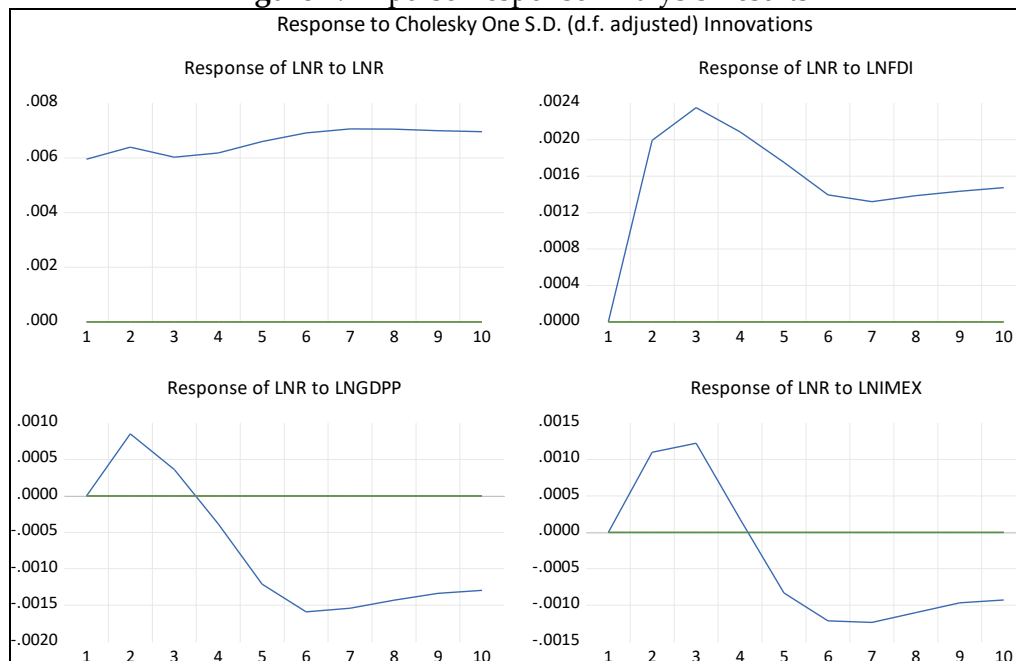
5.3. Impulse Response Analysis

Impulse response analysis is employed to assess the influence of a one standard deviation change in a variable within the model on other variables. It also examines how disturbances affect the entire system.

Regarding the response to changes in industrial structure, both the industrial structure itself and FDI exhibit positive impact responses. Notably, the impact response of the industrial structure itself is larger and relatively stable over time. Conversely, the impact response of FDI demonstrates an initial rapid increase in the first three periods, followed by a decreasing trend from the 4th period onwards. It eventually stabilizes with a positive impact response from the 7th period onward. GDP per capita displays a prominent positive impact response to changes in industrial structure during the first three periods, with the highest positive impact occurring in the second period. However, from the 4th period onwards, the impact response turns negative, with the most significant negative impact response observed in the 6th period. This negative impact response persists and remains stable from the 7th period onward. Imports and exports also exhibit a noticeable positive impact response to changes in industrial structure during the first three periods, with the highest positive impact occurring in the third period. However, from the 4th period onward, the impact response turns negative and remains stable from the 6th period onward.

As depicted in Figure 2, Thailand's industrial structure itself exerts the most substantial positive pulling effect on changes in the industrial structure. While the pulling effect of FDI on Thailand's industrial structure is relatively small, it remains positive. Conversely, GDP per capita, imports and exports initially have a positive pulling effect in the early stage, but this effect transitions to a negative pulling effect in the later stage.

Figure 2: Impulse Response Analysis Results



Source: The Author.

In summary, Thailand's industrial structure itself exerts the most significant positive influence on changes in the industrial structure. While the impact of FDI on the change in Thailand's industrial structure is positive, it is smaller in magnitude compared to the industrial structure itself. This implies that FDI has a long-term, positive, and promoting effect on the change in Thailand's industrial structure. Additionally, the influence of GDP per capita, imports and exports on the change in Thailand's industrial structure is characterized by volatility. In the short term, both factors have a positive promotional effect. However, in the long term, the growth of these economic factors serves as a limiting factor on the change in Thailand's industrial structure.

5.4. Variance Decomposition Analysis

While impulse response analysis helps explain the sign and amplitude of each variable's response to a specific variable, it may not adequately compare the intensity of these responses to different impacts of a specific variable. To further investigate the mutual volatility of each variable, variance decomposition analysis is employed. This analysis decomposes the forecast mean square error of each variable and calculates the relative contribution of each variable's impact.

The results in Table 3 reveal that, in the variance decomposition of changes in the industrial structure, the contribution of the industrial structure itself to these changes decreased from 100 per cent in the first period to 89.9 per cent in the 10th period. The contribution of FDI to changes in the industrial structure is 4.82 per cent in the second period, gradually increasing and peaking at 8.22 per cent in the 4th period. Subsequently, its contribution gradually decreased to 5.58 per cent in the 10th period. The contribution of GDP per capita to changes in the industrial structure is 0.88 per cent in the second period, with a gradual increase, reaching a maximum of 2.64 per cent in the 10th period. The contribution of imports and exports to changes in the industrial structure displayed volatility, rapidly increasing from 1.47 per cent in the second period to 2.15 per cent in the third period, and then stabilizing at around 1.9 per cent after the 7th period.

Table 3: Variance Decomposition Analysis Results

Period	LNR	LNFDI	LNGDPP	LNIMEX
1	100.0000	0.000000	0.000000	0.000000
2	92.82320	4.824216	0.881078	1.471504
3	89.60800	7.558405	0.680399	2.153200
4	89.55296	8.223621	0.596743	1.626675
5	89.49052	7.789135	1.139479	1.580866
6	89.38282	6.959866	1.846224	1.811094
7	89.45644	6.309747	2.261128	1.972684
8	89.61810	5.903416	2.472078	2.006409
9	89.80237	5.646769	2.577233	1.973630
10	89.94737	5.477127	2.640193	1.935305

Source: The Author.

In summary, these variance decomposition analysis results align with the conclusions drawn from the impulse response analysis. These variance decomposition analysis results demonstrate that the impact of each variable on the change in Thailand's industrial structure evolves over time, exerting a long-term pulling effect. Notably, the industrial structure itself contributes the most, and among the independent variables, FDI makes the largest contribution. This underscores the significant role of FDI in driving the change in Thailand's industrial structure, highlighting that it as a crucial economic factor alongside Thailand's industrial structure itself in promoting these changes.

5.5. Discussion

Through the above analysis, it is found that there exists a long-term stable equilibrium relationship between FDI and the changes in Thailand's industrial structure. Therefore, FDI has a long-term promoting effect on the evolution of Thailand's industrial structure. This result supports the findings of Poapongsakorn & Tangkitvanich (2001), Qiuli (2006), and Nokita (2012, 2018). Furthermore, the impact of GDP per capita, imports, and exports on the change in Thailand's industrial structure is volatile. In the short term, GDP per capita and imports and exports have a positive promoting effect on the change in Thailand's industrial structure. However, in the long run, these economic factors may limit the change in Thailand's industrial structure.

FDI primarily disseminates advanced technology and management expertise through the technology spillover effect. With the influx of FDI into Thailand, the advanced technologies mastered by foreign enterprises gradually propagate to local enterprises through mergers and personnel exchanges. Through the technology spillover effect, local enterprises in Thailand gradually acquire the advanced technologies mastered by foreign enterprises, thereby promoting the adjustment of the Thai industry. In other words, FDI has a positive externality on Thailand's industrial restructuring through technology spillover effects. Furthermore, in recent years, with the rapid development of Thailand's economy, residents' incomes have also increased significantly. The expanding consumer demand has outpaced the capacity of Thailand's domestic consumer market, leading to a surge in import trade. Thailand's manufacturing industry, particularly technology- and labor-based products, has started to supplant the traditional agricultural sector, thereby driving the continuous expansion of Thailand's export trade. Consequently, with the rapid growth of both import and export trade, Thailand's industrial structure has undergone adjustments.

According to the VECM results, FDI has a significant impact on the changes in Thailand's industrial structure. Traditional FDI theory suggests that developed countries often transfer their marginal industries to developing countries. These marginal industries in developed countries typically entail high levels of pollution and energy consumption. The transfer of these industries to developing countries may temporarily promote their economic development. However, in the long run, it can hinder the optimization and adjustment of their industrial structure. Therefore, when attracting FDI, Thailand should adopt a prudent approach. It should establish a correct concept of

investment attraction, aligning it with Thailand's development status. This involves attracting high-quality FDI into Thailand's high-tech industries while also limiting FDI in sectors characterized by high pollution, energy consumption, and emissions.

6. Limitations

This article has some limitations. There are numerous factors influencing the change in a country's industrial structure. In addition to direct investment, GDP per capita, and import and export trade mentioned in this paper, a country's R&D expenses and other factors also play significant roles. Unfortunately, due to the lack of data on R&D expenses in Thailand over the years, this study did not examine the influence of this factor. If R&D expenses were included in the analysis, it is possible that different results regarding the change in Thailand's industrial structure could emerge.

Furthermore, the FDI analyzed in this study represents the total FDI and is not disaggregated by industry. However, it is worth noting that the impact of FDI varies across different industries, and understanding how FDI influences various sectors in Thailand warrants further investigation.

Additionally, Thailand serves as a significant automobile production hub in Southeast Asia. Compared to other industries, the country's automotive sector attracts a larger total FDI. Consequently, the relatively concentrated nature of FDI in this sector may impact the change in Thailand's industrial structure. Therefore, further investigation into the impact of FDI concentration in Thailand's automobile industry on changes in the country's industrial structure is warranted.

7. Conclusions

In conclusion, this study employed the VECM to analyze the impact of FDI on the change in Thailand's industrial structure. The VECM model offers a more accurate simulation of the impact of various economic factors on the change in Thailand's industrial structure, yielding practical significance.

The analysis outcomes reveal that the industrial structure itself exerts the most significant positive influence on the change in Thailand's industrial structure. While the effect of FDI on these changes is relatively modest compared to the industrial structure itself, it remains positive. Notably, both the industrial structure itself and FDI have a long-term positive promoting effect on the change in Thailand's industrial structure. Conversely, GDP per capita, imports and exports exhibit volatile impacts, with short-term positive promotional effects but long-term limitations on the change in Thailand's industrial structure.

FDI plays a vital role in Thailand's industrial restructuring and fosters these changes. The evolution of FDI in Thailand's investment industries, coupled with the nation's industrial development status, underscores the influence of Thailand's industrial policies on FDI. Throughout its economic development stages, the Thai government

strategically managed FDI inflow within its industries through various incentive policies. This deliberate control has driven adjustments in the nation's industrial structure, shifting from early labor-intensive manufacturing to late-stage technology-intensive automobile manufacturing. As a result, Thailand has emerged as the leading automobile producer in ASEAN. Therefore, FDI has played a crucial and positive role in Thailand's industrial structure adjustment.

Conflict of Interest Statement

The author declares no conflicts of interest.

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