A Comparative Study on the Efficiency of Direct Investment from China and Japan to ASEAN Countries under the Background of "Belt and Road"

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Abstract

This study employs outward foreign direct investment (OFDI) data from China and Japan to the ten ASEAN countries over the period 2013-2018. By applying a stochastic frontier gravity model, the paper conducts a comparative analysis of investment efficiency, investment potential, and their key determinants for the two countries' direct investment in ASEAN economies. The results show that China's investment efficiency in the ASEAN region has surpassed that of Japan during the sample period, indicating that China's Belt and Road Initiative has achieved substantial progress in enhancing investment cooperation with ASEAN countries since its implementation. Furthermore, the analysis reveals that both China and Japan have significant investment potential in ASEAN countries, but the factors driving their investment efficiency differ. For China, the Belt and Road Initiative has played a crucial role in fostering infrastructure development and policy coordination, which have become key contributors to its higher investment efficiency. In contrast, Japan's investment efficiency is more influenced by its long-standing economic ties, technological collaboration, and corporate networks within the region. These differences highlight the distinct strategies adopted by the two nations in engaging with ASEAN economies. Additionally, the study identifies several common determinants, such as market size, geographic proximity, and trade agreements, that positively impact the investment efficiency of both countries. The findings provide valuable insights for policymakers and businesses aiming to strengthen economic partnerships in the ASEAN region.

Keywords

Belt and Road; Stochastic Frontier Method; Investment Efficiency.

1. Introduction

Since the launch of the Belt and Road Initiative (BRI) in 2013, China's economic linkages with countries along the BRI routes have been significantly strengthened. As a key strategic pivot of the "21st Century Maritime Silk Road," the ASEAN region, supported by its close geographical proximity to China, convenient transportation networks, and deep cultural ties, has become a major destination for Chinese firms' outward foreign direct investment (OFDI). According to the ASEAN Statistical Yearbook (2019), China's OFDI flows to the ten ASEAN countries reached USD 9,940.1 million in 2018, representing a 61.23% increase from USD 6,165.2 million in 2013. It is expected that China's total investment in the ASEAN region will continue to expand in the future [1].

While China has been continuously strengthening its economic and trade relations with ASEAN, it is important to note that ASEAN has also long been a major destination for Japanese outward foreign direct investment. Following World War II, Japan embarked on a path of peaceful development after undergoing democratic reforms, and Japanese enterprises actively expanded overseas, making large-scale and diversified investments in ASEAN countries. To date, Japan has established extensive and substantial economic influence in the ASEAN region. According to the ASEAN Statistical Yearbook (2019), Japan's OFDI flows to the ten ASEAN countries amounted to USD 20,954.5 million in 2018, which was approximately 2.11 times that of China [2].

Therefore, it is evident that Japan will remain a strong competitor for China in ASEAN investment activities in the foreseeable future. At the same time, Japan's extensive experience in outward foreign direct investment by both the government and enterprises can serve as a valuable reference for China in improving investment efficiency and achieving better investment returns. Investment efficiency is a key indicator for evaluating the performance of outward foreign direct investment. A comparative analysis of the investment efficiency of China and Japan in the same host region during the same period is conducive to assessing their relative investment competitiveness in ASEAN [3].

Although the Belt and Road Initiative has gained broader recognition in the ASEAN region and China's investment flows to ASEAN have increased year by year, whether China possesses sufficient competitiveness relative to Japan—another major source country of foreign direct investment in the region—constitutes a fundamental determinant of whether Chinese enterprises can achieve sustainable development in ASEAN [4].

Against this background, this study constructs a stochastic frontier gravity model to estimate the outward foreign direct investment efficiency of China and Japan in ASEAN countries. Furthermore, the paper conducts a comparative analysis of multiple factors affecting the investment efficiency of the two countries and, based on the empirical results [5], proposes policy-oriented recommendations to enhance the feasibility and effectiveness of China's investment activities in the ASEAN region [6].

2. Literature Review

The application of stochastic frontier models to economic research traces back to 1977 when Aigner and two colleagues pioneered the stochastic frontier model, introducing maximum likelihood estimation. However, this seminal work was limited to cross-sectional data analysis. In the same year, Battese and colleagues enhanced the model through reparameterization, significantly improving computational efficiency. Both foundational studies shared a critical limitation: they failed to provide methods for calculating firms 'specific production efficiency. Addressing this gap, Jondrow and colleagues innovatively developed a methodology for measuring firms' production efficiency, transforming efficiency research from theoretical propositions about inefficiency to concrete, quantifiable statements. The stochastic frontier approach achieved a paradigm shift in 1981 when Pitt et al. expanded its applicability from cross-sectional to panel data, thereby broadening its scope and enhancing research validity. Building on Pitt's work, Schmidt and colleagues further explored fixed effects models in 1984, assuming firms' technical efficiency remained constant over time. While this fixed effects assumption was widely accepted at the time, modern economic theory recognizes that such a static assumption—where firms 'technical efficiency is presumed to remain unchanged—has inherent limitations. Contemporary research increasingly emphasizes the dynamic nature of firms' technical efficiency over time. For this reason, Battese and colleagues innovatively proposed a time-varying model in 1992, where firms' technical efficiency changes over time. This approach brought the model closer to real-world production phenomena. Subsequent studies using the stochastic frontier approach to measure efficiency gradually became standardized, integrating with traditional gravity models. The research scope expanded from corporate production efficiency to broader areas like inter-country trade and investment efficiency, though it remained fundamentally within the explanatory framework of the stochastic frontier method [7].

The study of international trade and investment using gravity models traces back to Tinbergen, who revolutionized traditional trade flow estimation models by introducing geographical distance as a key explanatory variable. Poyhonen further explored the relationship between actual trade flows and explanatory variables, including gross national product and transportation distance between countries. In 2003, Grunfeld et al. expanded the application of gravity models to calculate foreign direct investment flows. Concurrently, the stochastic frontier approach began to be combined with gravity models, jointly pioneering a new research path for international investment efficiency [8].

3. Empirical Analysis

The stochastic frontier investment gravity model serves as the foundational framework in this study, having been widely adopted to assess unilateral or bilateral investment potential under free trade conditions. Distinct from traditional gravity models, this approach incorporates institutional variables that influence investment efficiency. By separating stochastic disturbance terms from inefficiency terms during estimation, it effectively addresses the bias in potential estimation inherent in conventional gravity models. The following section provides a detailed introduction to the model [9]:

$$T_{\mathrm{ikt}} = f(x_{ikt}, \beta)\exp(v_{ikt})\exp(-\mu_{ikt}), \mu_{ikt} \geq 0$$

$$\ln T_{ikt} = \ln f(x_{ikt}, \beta) + v_{ikt} - \mu_{ikt}, \mu_{ikt} \geq 0$$

$$T_{\mathrm{ikt}} = f(x_{\mathrm{ikt}}, \beta)\exp(v_{\mathrm{ikt}})$$

$$TE_{\mathrm{ikt}} = T_{\mathrm{iktt}}/T^{*}_{\mathrm{iktt}} = \exp(-\mu_{\mathrm{iktt}}), TE_{\mathrm{iktt}} \in [0,1]$$

Building upon the Armstrong model, this study identifies core variables including gross domestic product (GDP), per capita GDP, distance, and labor force population, while institutional variables comprise the corruption supervision index, government efficiency index, political stability index, regulatory quality index, legal standardization index, and social democracy index. Based on these variables, we construct stochastic frontier investment gravity models for China and Japan targeting ASEAN countries, as detailed below [10]:

$$\ln OFDI_{ikt} = \beta_0 + \beta_1 \ln(GDP_{it}) + \beta_2 \ln(GDP_{kt}) + \beta_3 \ln(PGDP_{it}) + \beta_4 \ln(PGDP_{kt}) + \beta_5 \ln(DIS_{ik}) + \beta_6 \ln(LAB_{kt}) + v_{ikt} - \mu_{ikt}$$

$$.\ln OFDI_{jkt} = \omega_0 + \omega_1 \ln(GDP_{jt}) + \omega_2 \ln(GDP_{kt}) + \omega_3 \ln(PGDP_{jt}) + \omega_4 \ln(PGDP_{kt}) + \omega_5 \ln(DIS_{jik}) + \omega_6 \ln(LAB_{kt}) + v_{jkt} - \mu_{jkt}$$

4. Pattern Checking

Since the estimation results of the stochastic frontier investment gravity model are related to the function form, the model should be tested for its applicability after the model construction. The author uses the maximum likelihood method to test the model in two aspects: (1) whether the investment inefficiency exists; (2) whether the investment inefficiency changes with time.

The core of maximum likelihood test is to calculate the log-likelihood of the constrained and unconstrained models, then calculate the LR statistic, and compare the LR statistic with the critical value of the chi-square distribution at the 1% significance level. If the LR statistic is greater than the 1% critical value, the null hypothesis is rejected; otherwise, it is accepted.

In the first step, we set the null hypothesis that there is no investment inefficiency and the alternative hypothesis that there is investment inefficiency The test result shows an LR statistic of 14.90, which exceeds the 1% significance level (9.21). Therefore, the null hypothesis is rejected, confirming the existence of investment inefficiency.

In the second step, we formulate the null hypothesis as constant investment inefficiency (η=0) and the alternative hypothesis as time-varying inefficiency (η=0). The likelihood ratio (LR) statistic of 0.88 falls below the 1% significance level (α=0.01), thus confirming the null hypothesis. The test results are illustrated in the Table 1 below.

Table 1. Test results (China)

null hypothesis	constraint model	unconstrained model	LR statistics	1 critical value	inspect the conclusion
no investment inefficiency	-80.41	-72.96	14.90	9.21	refuse
Investment Inefficiency Does Not Change with Time	-72.96	-72.52	0.88	11.34	accept

In the first step, we set the null hypothesis as the absence of investment inefficiency (μ_{jkt}=0) and the alternative hypothesis as its presence (μ_{jkt}=0). The test yields an LR statistic of 9.38, exceeding the 1% significance level (9.21), thus rejecting the null hypothesis and confirming the existence of investment inefficiency.

In the second step, we formulate the null hypothesis that investment inefficiency remains constant over time (η=0), and the alternative hypothesis that it varies with time (η=0). The likelihood ratio (LR) statistic of 0.40 is lower than the 1% significance level (11.34), thus rejecting the null hypothesis. The test results are illustrated in the Table 2 below.

Table 2. Frontier test results (Japan)

null hypothesis	constraint model	unconstrained model	LR statistics	1% critical value	inspect the conclusion
no investment inefficiency	-68.95	-64.26	9.38	9.21	Refuse
Investment Inefficiency Does Not Change with Time	-64.26	-64.06	0.40	11.34	Accept

Table 3. Results of the stochastic frontier investment gravity model (China)

Model	time-invariant model	
Variable		t
constant	-29.20***	-4.37
GDPit	1.56***	4.34
GDPkt	2.88	0.38
PGDPit	0.25	0.27
PGDPkt	3.36***	4.20
DISik	-2.36***	3.60
LABkt	2.86***	3.42
σ2	4.28	1.44
γ	0.84***	6.95
μ	3.95***	9.05
log-likelihood	-72.96	

After confirming the applicability of the model, the author used Frontier 4.1 to calculate the stochastic frontier investment gravity model of China to ASEAN countries. The calculation results are shown in the Table 3.

GDP_{it}at the 1% level, it is significantly positively correlated with the efficiency of direct investment. This indicates that the larger the economic scale of China, the more it can promote the improvement of the efficiency of direct investment in ASEAN.

$PGDP_{kt}$ is significantly positive correlated with the efficiency of direct investment at the 1% level. This indicates that with the improvement of people's living standard and consumption level, the ASEAN countries will be more inclined to accept foreign investment.

LAB_{kt} is positively correlated with the efficiency of direct investment at the 1% level. This indicates that when the labor force population increases, ASEAN countries will find it easier to attract foreign investment.

DIS_{kt} is also negatively correlated with the efficiency of direct investment at the 1% level, which indicates that the geographical barriers and the increase of transportation cost have a negative impact on the efficiency of direct investment.

γ at the 1% level, the significance is 0.84. When the value approaches 1, it indicates that the gap between the actual investment level of China in ASEAN countries and the frontier level is mainly caused by the investment inefficiency term.

μ and η is significant at the 1% level, and the coefficient is greater than 0, which proves that China's investment in ASEAN countries is inefficient, and the investment inefficiency has a restraining effect on the improvement of the current investment level.

5. Conclusion

This paper utilizes the relevant investment data of China and Japan in the 10 ASEAN countries from 2013 to 2018. Based on the empirical analysis of the investment efficiency of the two countries using the stochastic frontier investment gravity model, it further analyzes the factors affecting the investment efficiency of the two countries and draws the following conclusions: The empirical results of the stochastic frontier investment gravity model show that the average efficiency of China's direct investment in ASEAN countries is 59.49%, among which China's investment efficiency in Indonesia is the highest at 84.61%, and that in the Philippines is the lowest at only 10.31%; the average efficiency of Japan's direct investment in ASEAN countries is 51.71%, among which Japan's investment efficiency in Cambodia is the highest at 77.30%, and that in Myanmar is the lowest at only 16.96%.

The natural factors affecting the investment efficiency of China in ASEAN countries include the GDP of the investing country, the per capita GDP of the host country, the labor force of the host country, and the geographical distance between the two countries. Among these, the GDP of the investing country, the per capita GDP of the host country, and the labor force of the host country have a significant positive impact on investment efficiency; the geographical distance between the two countries has a significant negative impact on investment efficiency.

The natural factors that affect the investment efficiency of Japan to ASEAN countries are the GDP of the investment country and the geographical distance between the two countries, among which the geographical distance between the two countries has a significant negative impact on the investment efficiency.

The empirical results of the inefficiency model show that the institutional factors affecting the investment efficiency of China in ASEAN countries include the host country's government efficiency index, the host country's regulatory quality index, and the host country's political stability index. The improvement of these three factors has a significant positive impact on investment efficiency.

The institutional factors that affect the efficiency of Japanese investment in ASEAN countries are the host country's government efficiency index and the host country's social democracy index, both of which have a significant positive impact on the efficiency of investment.

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