



Research

Gravity model in Thailand with ASEAN and NON-ASEAN Empirical analysis in Trade

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Abstract: *In this paper, the trade volume between Thailand and ASEAN members and non-members is empirically analyzed by using the gravity model. The 1995-2018 panel data were used to establish a gravity model with variables such as distance from Thailand to each country, GDP, per capita GDP and whether it is an ASEAN country. According to the results of the gravity model, the economic aggregate of each country, the distance from Thailand and whether it is an ASEAN country have a significant influence on the trade volume between Thailand and each country.*

Keywords: *The gravity model ; ASEAN*

As the largest free trade area in the world established by a developing country, the ASEAN trade area has a profound influence on the world economy and political culture in the first half of the 21st century. Therefore, it is necessary to study the influence of ASEAN in developing countries. From the perspective of Thailand, this paper tries to understand the influence of the establishment of ASEAN on Thailand's economy and trade. Thus, it also shows that the establishment of ASEAN is of great help to the economic development of the whole southeast Asia. In recent years, the economic exchanges between Thailand and ASEAN have gradually increased their share in the whole economic trade of Thailand, and their status has become more and more important. The complementary relationship between Thailand and ASEAN member

states contributes greatly to ASEAN economic growth. Therefore, it is of great research value to study Thailand's trade with ASEAN and non-ASEAN countries.

1 Gravity Model

The Trade Gravity Model derives from Newton's law of universal gravitation, that is, the force between two objects is proportional to the mass of the two objects and inversely proportional to the distance between the objects. Tinbergen (1962) and Poyhonen (1963) were the first to propose the trade economy model. Introduce it into the field of international trade, and set the form of model: that is, the GDP of both trading countries and the distance between the two trading countries to analyze international trade.

The basic form of trade gravity model is:

$$X_{ij} = (Y_i Y_j) / D_{ij}$$

Among them; X_{ij} represents Thailand's total imports and exports to these countries; $Y_i Y_j$ is the GDP of the country I and country j ; D_{ij} is the distance between two countries

Later, Goodman, Leamer, and Stern conducted quantitative studies on bilateral trade flows based on probability models. Based on the traditional trade gravity model, later scholars constantly added explanatory variables to describe the characteristics of bilateral countries to adapt to the changing application environment. Explain variables covers trade in the state of the economy (including GDP, per capita GDP, the consumer price index, capital distribution, the wholesale price index), geographical features, climate (distance, territorial borders), population features, language, religion, population and urban and rural residents income level, urban and rural land use), trade characteristics (non-tariff coverage index, the average tariff rate, bilateral exchange rate, transportation cost).

2 Model Building

2.1 Overview of ASEAN

ASEAN is the Association of Southeast Asian Nations. The ASEAN community was founded in 1967 in Bangkok, Thailand. It started with just five countries: Indonesia, Malaysia, the Philippines, Singapore, and Thailand. Gradually, Brunei, Vietnam, Laos, Myanmar, and Cambodia joined. ASEAN is now one of the most dynamic and promising regions in the world economy.

ASEAN is composed of three parts: ASEAN Political and Security Community, ASEAN Social-cultural Community and ASEAN Economic Community (AEC). The ASEAN Economic Community was formally established in 2015. The main goal of the AEC is the "single market and production base". The goal is to open up a free trade area, allowing free movement of trade, foreign investment, and labor. After the establishment of the AEC, ASEAN partners were divided into three forms: ASEAN 10+1, ASEAN 10+3 (ASEAN with China, Japan, and South Korea) and ASEAN 10+6 (China, Japan, South Korea, Australia, New Zealand and India).

2.2 Variable

In this paper, considering the specific situation of Thailand for ASEAN member states and non-ASEAN member states, whether the basic variables such as GDP, GDP per capita, distance and so on can be added as the variable of ASEAN countries. Thus, you end up with explanatory variables (basic and extended). The meaning and theoretical explanation of explanatory variables are shown in table 1.

Table 1 definition and theoretical explanation of explanatory variables

Explanatory variables	Meaning	Expected symbol	Theory explanation
y_i	The GDP of Thailand (hundred million : \$)	+	It reflects Thailand's potential import and export capacity. The greater the GDP, the greater the potential import and export capacity, and the greater the trade flow
y_j	The GDP of other countries (hundred million : \$)	+	It reflects the potential import and export capacity of other countries. The greater the GDP, the greater the potential import and export capacity, and the greater the trade flow

PCY _i	Thailand's GDP per capita (hundred million : \$)	+	It represents the level of economic development in Thailand. The higher the per capita income is, the larger the volume of import and export trade will be
PCY _j	GDP per capita in other countries (hundred million : \$)	+	It represents the level of economic development in other countries. The higher the per capita income, the larger the volume of import and export trade
D _{ij}	The distance between the two capitals (km.)	-	It represents the high and low transportation cost, which will affect the trade between the two countries
pi	Dummy variable, when both countries are members of ASEAN, take 1, otherwise, take 0	+	When two countries are members of ASEAN, bilateral trade flows increase

2.3 Basic Regression Equation

The basic form of trade gravity model:

$$T_{ij} = \alpha_0 (Y_i Y_j)^{\alpha_1} (PCY_i PCY_j)^{\alpha_2} d_{ij}^{-\alpha_3} u_{ij} \quad (1)$$

Where, T_{ij} is the total amount of bilateral import and export, and ij represents two different countries or regions; A is a constant term; $Y_i Y_j$ represents the gross domestic product (GDP) of two different countries or regions; $PCY_i PCY_j$ is the GDP per capita of two different countries or regions; d_{ij} represents the distance between two different countries or regions (usually the distance between two national capitals).

Expressed as natural logarithm:

$$\ln T_{ij} = \alpha_0 + \alpha_1 \ln Y_i Y_j + \alpha_2 \ln PCY_i PCY_j + \alpha_3 \ln d_{ij} + u_{ij} \quad (2)$$

The extended gravity model is obtained by adding the dummy variable whether it is ASEAN or not into the basic gravity model. When ij represents that both countries are members of ASEAN, set the dummy variable as 1, otherwise (NON-ASEAN) as 0.

2.4 Extended Regression Equation

The extended gravity model :

$$\ln T_{ij} = \alpha_0 + \alpha_1 \ln Y_i Y_j + \alpha_2 \ln PCY_i PCY_j + \alpha_3 \ln d_{ij} + \alpha_4 p_i + u_{ij} \quad (3)$$

In models; T_{ij} refers to bilateral trade volume; $Y_i Y_j$ is the GDP of country I and country j; $PCY_i PCY_j$ represents the GDP per capita of countries I and j; d_{ij} is the distance between two countries; p_i represents dummy variables; u_{ij} represents the error term.

In this paper, an extended gravity model is used to study the trade between Thailand and ASEAN member states and NON-ASEAN member states, and a dummy variable -- ASEAN member states and NON-ASEAN member states is designed. ASEAN members are Indonesia, the Philippines, Malaysia, Singapore, Laos, Myanmar, Cambodia, Brunei, Vietnam, and Thailand. China, South Korea, Japan, India, New Zealand, Australia, and the United States are the major countries that are not members of ASEAN. The model is as follows:

$$\ln T_{ij} = \alpha_0 + \alpha_1 \ln Y_i Y_j + \alpha_2 \ln PCY_i PCY_j + \alpha_3 \ln d_{ij} + \alpha_4 p_i + u_{ij} \quad (4)$$

Among them; T_{ij} represents Thailand's total imports and exports to these countries; $Y_i Y_j$ is the GDP of country I and country j; $PCY_i PCY_j$ represents the GDP per capita of countries I and j; d_{ij} is the distance between two countries; p_i is a dummy variable -- ASEAN member and NON-ASEAN member; u_{ij} represents the error term.

2.5 Samples and data

Data from this paper selected the 10 ASEAN member countries (Thailand, Indonesia, Malaysia, the Philippines, Singapore, Brunei, Vietnam, Myanmar, Laos and Cambodia) 7 countries of ASEAN member countries (China, Japan, South Korea, New Zealand, Australia, India, and the United States) of economy, GDP, per capita income have very big difference. There are also huge differences between ASEAN member states and non-ASEAN member states in various aspects. Therefore, this paper selected countries for analysis for representativeness and diversity,

as well as for Thailand's more comprehensive study on the trade effects of ASEAN member states and non-ASEAN member states.

The data used in this article are shown in table 2. The world bank (www.data.worldbank.org.cn) is the source of both GDP and GDP per capita data for each country, and the distance between national capitals is the source of Google Map (www.maps.google.com). This paper adopts panel data for research and selects the data of Thailand on ASEAN member states and non-ASEAN member states from 1995 to 2018.

Table 2 data sources

Data	Source
Total exports and imports of Thailand to all countries	Thai Ministry Of Commerce Website www.moc.go.th
GDP of all countries	Kuaiyi Data Website www.kuaiyilicai.com/stats
GDP per capita of all countries	The world bank website www.data.worldbank.org.cn
The distance between capitals	Google Map www.maps.google.com

Since this paper mainly studies the trade situation between Thailand and ASEAN countries and non-ASEAN countries, all relevant data from the establishment of ASEAN until now are selected to analyze the appeal.

3 Empirical results of the model

3.1 Model results

Using the above data, regression adjustment was carried out under MATLAB 7.01, and the above results were obtained:

$$\ln T_{ij} = -2.8317 - 0.5954d_{ij} + 0.152PCY_iPCY_j + 0.7241 \ln Y_i Y_j + 0.0751p_i \quad (5)$$

$$b = -2.8317 \quad -0.5954 \quad 0.1520 \quad 0.7241 \quad 0.0751$$

$$b_{int} = -3.2762 \quad -2.3873$$

-0.6990 -0.4919
 -0.0427 0.1930
 0.1055 0.1985
 0.6819 0.7663

stats = 0.8447 508.5469 0.0000 0.0908 (export)

$$\ln T_{ij} = -1.8152 - 0.5638d_{ij} + 0.0101PCY_iPCY_j + 0.7166 \ln Y_i Y_j + 0.23p_i \quad (6)$$

b = -1.8152 -0.5638 0.0101 0.7166 0.2300

bint = -2.2635 -1.3670

-0.6683 -0.4594

-0.0368 0.0571

0.6740 0.7591

0.1111 0.3488

stats = 0.8017 377.9839 0.0000 0.0924 (import)

Table 3 Results of extended gravity model

variable	Regression coefficient (import)	confidence interval	Regression coefficient (export)	confidence interval
YiYj	0.7166	(-2.2635, -1.3670)	0.7241	(-3.2762, -2.3873)
PCYiPCYj	0.0101	(-0.6683, -0.4594)	0.152	(-0.6990, -0.4919)
dij	-0.5638	(-0.0368, 0.0571)	-0.5954	(-0.0427, 0.1930)
pi	0.2300	(0.6740, 0.7591)	0.0751	(0.1055, 0.1985)
Constant term	-1.8152	(0.1111, 0.3488)	-2.8317	(0.6819, 0.7663)

The above significant water a was 0.05. B and bint refer to the regression coefficient and confidence interval. Stats is the statistic used to test the regression model. There are 3 values, the first is R2, the second is F, and the third is the probability p corresponding to F.

According to the above regression equation, the trade flow between Thailand and ASEAN member states and non-member states mainly depends on the economic aggregate, level of economic development, and whether it is a member of ASEAN. Countries with high trade flows are due to proximity, low transport costs, and better economic development.

The establishment of ASEAN has become an important factor in the development of Thailand's economy and trade. Therefore, efforts should be made to improve ASEAN's economic exchange environment and accelerate its economic development. Make Thailand's economy more rapid and stable development.

Conclusion

The above analysis shows that it is effective to use the gravity model to analyze the empirical analysis of Thailand's trade with ASEAN and non-ASEAN countries. According to the above gravity model, the basic factors that affect the trade volume between Thailand and other countries are GDP, GDP per capita and distance, which is consistent with the classical gravity model. This paper mainly studies whether ASEAN is the variable. It can be seen from the results of the gravity model that the establishment of ASEAN plays a significant role in promoting the trade economy of Thailand and significantly improving the trade between Thailand and ASEAN countries. This paper holds that in the future, ASEAN should be further developed, trade rules should be improved, economic and trade exchanges between developing countries should be promoted, and common development and progress should be made.

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