[1] **Rattanameechai Chinwadee**
[2] **Chaiboonsri Chukiat**
[3] **Chokethaworn Kanchana**

Analysis of Road 3 Asia (R3A)'s Impacts on Border Trade of Thailand

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Abstract: - Trade opening has become an important asset for economic development in many countries and an important engine of economic globalization (Wang, Shan-Li, et al, 2020). With continuous foster on the regional economic cooperation, countries with close proximity further promote the mobility and development of infrastructures and policies. Nevertheless, testing a trade integration model of bilateral trade is not sufficiently well estimated with the Bayesian approach to provide practical evidence of trade integration. Moreover, in identifying the factors determining trade integration, testing using the Bayesian gravity equation is essential. After performing a series of simulation experiments, a relationship between bilateral trade volume and simulated trade determinants was predicted for the trade model. The results of the estimated coefficients on GDP in Thailand and GDP of Yunnan province, China are positively significant predictors of the trade growth. The distance between the countries has a negatively significant estimation that implies barriers in trade. The model predicts trade integration, especially towards the trade on route R3A. The Bayesian approach of the gravity model gives robust estimates for determining the impact factor for the bilateral trade, including the fact that the elasticities of total trade volume with respect to distance, population, and the exchange rate of Thailand are negative while the GDP per capita are positively significant. Further, economic size, GDP per capita, and exchange rate of the destination, and population and area of Yunnan province are positively predicted by the model. The estimated parameters are directly the elasticities, in which increases in GDP is consistent with the higher trade volumes. Further, evidence of the gravity equation is used for understanding trade potential, and after some integrations, the estimation is applied for the real trade. The measures of bilateral trade resistance or costs associated with the trade flow has influenced the expanding of the bilateral trade in the model in the GMS economies. Finally, trade integration can be implemented with evidence and estimates of the gravity model. The Bayesian experiment for the estimation of the impacts of the trade integration on route R3A predicts an increase of GDP, population, exchange rate, and GDP per capita as predominant predictors in the Bayesian gravity model. Thus, the results revealed that economic size, bilateral distance, and GDP per capita has affected the plausible trade agreements for trade integration on route R3A.

Keywords: R3A, Border Trade, Bayesian Gravity Model, GMS economies

I. INTRODUCTION

With the establishment of China's "Look South" policy, Chinese government has been encouraging expansion, trade, and investment south-wards in foreign markets by connecting Yunnan Province, China to the countries of Southeast Asia. (Sukandont et al, 2019) Especially Yunnan Province, where there is no direct access to the sea, further drove China to cooperate with its neighboring countries to solve this disadvantageous issue. Thailand, as a major transit, has been given a priority with mutual collaboration project called North-South Economic Corridor: NSEC. (Fongissara, 2015) Route Road 3 Asia or R3A was established in 1995 under cooperation to connect Thailand, Lao PDR, and China. The purpose is to promote transportation connectivity along North-South Economic Corridor (NSEC). This is a strategic route connecting Southern China to Thailand. (Sukandont, 2019) The distance is about 1800 kilometers linking Kunming city, China to Bangkok, Thailand. (Tarathorn, 2013; Fongissara, 2015) With such development, changes in community condition such as impacts of the economy, society and culture, environment and tourism are unavoidable. This is supported by a study conducted by Jamaree Chiangthong and Samak Kosem (2008) and Supang Chantavanich et al and Thikakarn Wantog (2006). Lao PDR's strategy "From Landlocked to Land-linked" has received supports from countries like Thailand, China, and Japan. Defined by Masviriyakul (2004), the strategy focuses on promoting effective private investment in trade, agricultural and industrial production, tourism, and other services within the corridor through integrated approaches, corresponding to The Asian Development Bank's statement in 2016. Economic corridors not only provide opportunities for finding concrete solutions to rural poverty and environmental problems, but also for strengthening socioeconomic ties among subregional people. Route R3A was beneficial for Thailand's economy. In order to develop sustainable economic growth, the principal development strategy on route R3A must be examined. Access to the transportation infrastructure, together

[1] Graduate student, School of Economics, Chiang Mai University, Thailand, Chinwadee@gmail.com
[2] Assoc. Prof., School of Economics, Chiang Mai University,Thailand, Chukiat1973@gmail.com
[3] Assoc. Prof., School of Economics, Chiang Mai University, Thailand

with proximity, demographics, and economic growth, is a major drive of urbanization. It has significantly improved the border economy and accessibility. (Kasraian, D. et al., 2020) Furthermore, it is the shortest land route connecting Thailand to Southern China.

a. Route R3A

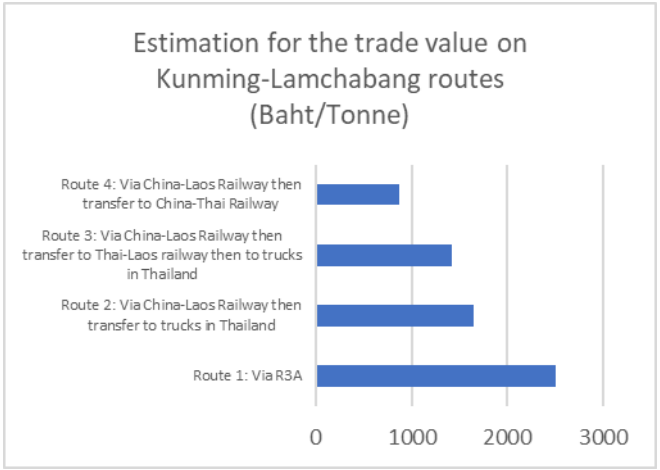
Table 1: Comparison of various routes connecting China and Thailand.

Route	Distance (km)	Duration (hrs)	Cost/ 40ft container (Baht)
R3A route	1160	21	163,500
Mekong River	1070	40/52 (normal/upstream)	139,800
China-Laos railway	1706	22	81,200

Source: World Bank (2019)

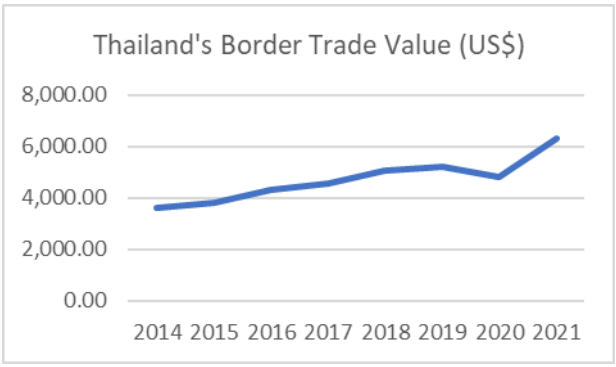
Initially, route R3A passed through three countries with the distance of approximately 1887 kilometers (827 km in China; 247 km in Lao PDR; 813 km in Thailand). Ferries were the main carriages to bring vehicles across Mekong River. With the assistance of supporting mechanisms and favorable circumstances, the route has received increasing popularity and trade volume rose rapidly. Particularly, with the advantage of the establishment of the fourth Thai-Laos Friendship bridge in 2012, convenience and instantaneous procedures conveys users to prefer this route to the Mekong River, regardless of the higher cost of transportation. This is due to the lower in transportation time and loading cost. It also enables vehicles to travel on land continually, creating flexibility. (Kongdee, 2015) The development of the road routes saves time and costs for transporting goods, especially perishable products, compared to the original transport across the Mekong River. Additionally, this solves the problem of the seasonal incapability. (Manarungsan, S., 2003; Hongwei, 2011; Somjai, 2016)

R3A is an alternative transportation route for Thai companies to export their products to China conveniently and quickly. This will expand the export channels for the fruit to China, directing it to markets in southern China provinces that were initially only available mainly by sea and air. R3A road is currently the most convenient road transportation from Thailand to China, so more that 90% of most fruits imported from Thailand by Chinese enterprises rely on R3A transportation. It is especially suitable for transporting fruits that require short delivery time. (Sirisophonsin, 2018) Route R3A is the shortest land route connecting Thailand to Southern China. In a study by Chaiburin, N., et al. (2017) they found that the Chiang Saen River deck is currently in less commercial use, which according to the study by Fujimura (2008), led to believe that it is the result of the route conversion to R3A, which takes shorter transit time than the river route. Especially for perishable products, less damage is expected compared to the initial transportation across the Mekong River.



Source: World Bank (2019)

Figure 2 : Estimation of trade volume on different routes



Source: Bank of Thailand (2022)

Figure 3： Thailand's border trade value from 2014-2021 (US$)

Continuously boosted by the Regional Economic Cooperation Programme, trade between Thailand and neighboring countries has flourished and continues to grow. (See figure 3) The economic interdependence becomes intensified due to better physical connectivity and the gradual effects of several trade agreements signed with neighbouring countries. The Asian Development Bank (2016) reviewed that the strategic trade route aims to benefit all countries along the route. This is expected to extend the benefits of better transport connectivity to remote and landlocked locations in the GMS, which are hampered by a lack of integration with more prosperous and better-located neighbors.

II. LITERATURE REVIEW

Route R3A is currently considered sensible. The transportation is convenient and fast. (Srisangnam and Arwatchanakarn, 2019) It is especially suitable for transporting fruits that require short delivery time. (Sirisophonsin, 2018) Border trade has played a significant role in Thailand's development over the years. From the previous studies, many researchers have studied the factors affecting border trade between Thailand and neighboring countries. Sukloet, S. et al. (2022) investigated the factors that influence the value of border trade between Thailand and neighboring countries. Krainara, C. & Routray, J. K. (2015) studied cross-border trade and commerce between Thailand and neighboring countries. Chairathivat, S. & Cheewatrakoolpong, K. (2015) examined Thailand's economic integration with neighboring countries. The growth of border production processes has contributed to the rise of sub-regionalism, which aims to link economic complementarity across borders with similar economic activity. (Soavapa, 2020) Improving Transport Convenience as the highest priority (Ishida, M. and Isono, I., 2012), building and improving road infrastructure to facilitate trade and investment between countries, assist geographically disadvantaged populations, and boost economic activity. The concept of economic corridor acts as a link connecting production, trade, and infrastructure within a specific geographical framework. (Hill, 2020) It is also expected to contribute directly to poverty reduction through accelerating overall economic growth, and indirectly through enabling connectivity to markets for services and manufacturing.

In International trade, the H-O theory plays a significant role in applying the comparative advantage theory (1817) of the Ricardian model. The theory was developed by Eli Heckscher (1919) and Bertil Ohlin (1933). It explains why some countries have comparative advantages from certain commodities, excluded of the differences in technological knowledge in the two countries. From the bilateral trades of goods with reference to neighboring countries, it is revealed that the pattern of border trade and commerce greatly varies depending on respective comparative advantages. (Krainara, C. and Routray, 2015) Ohlin (1933) also states that a country will export goods that use its abundant factors intensively and import goods that use its scarce factors intensively. China's export structure consists mainly of industrial products and processed consumer goods, with less of agricultural and food products. This is because China's production of these goods is still insufficient. China has to meet enormous demand from domestic consumers.

The Gravity model of trade was initiated by Tinbergen (1962) and Poyhonen (1963) and has been widely applied in studies to quantify the commercial impact of economic linkages alliance. They concluded that exports are expected to be positively affected by the income of the trading countries and that distance can be expected to negatively affect to trade (Jayasooriya, 2021; Batra, 2004; Zhun and Gu, 2009). Fujimura (2008) confirms this point by conducting an econometric analysis and found that economy size appears to be a dominant driver of regional trade; the elasticity of trade in major exports, likely to be transported over land between GMS economies with respect to development in cross-border road infrastructure.

Ishida (2007) applies the concept of a gravity model to assess the effectiveness of GMS Economic Corridor and adequately explains why the Bangkok-Hanoi Road (BHR) is being focused on more than the EWEC. By applying these measures to the NSEC and SEC, it has been shown that the Central Sub-corridor of the SEC is more effective than the BHR, and that the Bangkok-Kunming Road would be as effective as the BHR. Quang, et al. (2018) conducted research using a gravity model with the presence of interactions between spatial lags to study the determinants of intra-industry trade between Vietnam and ASEAN countries. On the other hand, Aung (2009) states that the increase in border trade is due to the bilateral cooperation of the country with its neighboring countries. The border points are an important channels for importing products to respond to domestic demand. Sukloet (2022) indicated that significant demographic factors contain the population of border provinces, and the number of border provinces significantly contributed to Thailand's total border trade value, border trade export value, and border trade import value. Congdong (2000, 2001) applied Byesian gravity models to explain the population flows, covering spatial movements. Similarly, a study by Jayasooriya (2021) applied Bayesian gravity model for digitalization on bilateral trade integration in Asia. The Bayesian estimated the impacts of trade integration and predicted an increase in GDP, digitalization proxies, population, exchange rate, and area of the destination as predominant predictors. The results revealed that digitalization has affected the plausible trade agreements for trade integration in Asia.

III. METHODOLOGY

This paper follows the previous empirical studies on the application of gravity and is extended to the estimation of the Bayesian approach with econometric specifications. (Congdon, P., 2000; 2010; Jayasooriya, S.P., 2022; Ranjan, P. and Tobias, J.L., 2007; Eicher, T.s., 2010) Much of the economic literature has devoted considerable efforts to developing trade theories, describing, and predicting the observed bilateral trade flows. In addition to the basic gravity model equation, this paper estimates an augmented gravity model equation to first analyze international trade flows and then estimate the trade potential for Thailand with her trading partners along the route R3A.

The dataset used in the analysis covers bilateral trade volume between Thailand and Yunnan Province, China, over 1999-2019. Like other recent studies, this paper seeks to investigate the impact of certain aspects on bilateral trade volumes. At the macroeconomic level, the gravity model predicts the effects of trade liberalization on the economies that support economic growth. (Jayasooriya, S.P., 2021) To promote open economic policies in terms of trade integration, this study analyzes the Bayesian Gravity Model for the pair of countries to thoroughly evaluate the determinants of trade volume. From an economic growth perspective, open economic policy analysis has been devoted to explaining trade integration relationships at the aggregate level.

Trade opening has become an important asset for economic development in many countries and an important engine of economic globalization. (Wang, Shan-Li, et al, 2020) With continuous foster on the regional economic cooperation, countries with close proximity further promote the mobility and development of infrastructures and policies. The economic interdependence becomes intensified due to better physical connectivity and the gradual effects of several trade agreements signed with neighbouring countries. Various papers have conducted studies on the activities related to border trade and economics. (Krainara, 2008; Chaiburin and Nimsai, 2017; Fan, 2011; Sukandont, 2019; Sukloet, 2022) This paper will examine the impacts of border trade between Thailand and Yunnan province, China, along R3A route. Furthermore, it attempts to fill the gap by analyzing the impacts in three dimensions; economic, social, and environmental. Taking border trade prospects into major consideration, the author aims to identify the potential and schemes resulting from greater connectivity and accessibility and economic sectors to be promoted. This paper is going to estimate a Bayesian based gravity model for the analysis of bilateral trade over a 20-years-long (1999-2019) of the countries along route R3A to analyze the trend of border trade on route R3A and thus, able to implement recommendations to promote sustainability and growth of the following route. Regarding the limitation in data collection and the impact of the Covid-19 pandemic, which significantly disrupted trade flows, Bayesian approach is added to the classical gravity model to ensure the efficient analysis of the data. (Jayasooriya, 2021; Ranjan and Tobias, 2007; Congdon, 2000) The paper finds out that the economic sizes (GDP) of the two countries have influenced the bilateral trade between them. The growth of GDP assists in the increase of the total trade value. Bilateral distance negatively affects the bilateral trade

A. Data

Data	Abbreviation	Source
Bilateral trade (Million USD)	$Trade_{ijt}$	Department of Foreign Trade (DFT), Ministry of Commerce
Bilateral distance (kilometers)	$dist_{ijt}$	The World Bank
Distance x Petrol (Diesel price in	dst_p_{ijt}	The World Bank

USD)		
GDP (Million USD) – TH	GDP_{it}	The World Bank
GDP (Million USD) – YU	GDP_{jt}	Yunnan Statistical Yearbook, National Bureau of Statistics, China
GDP per capita – TH	$GDPpercap_{it}$	The World Bank
GDP per capita – YU	$GDPpercap_{jt}$	Yunnan Statistical Yearbook, National Bureau of Statistics, China
Exchange rate – TH	$exch_{it}$	The World Bank
Exchange rate – YU	$exch_{jt}$	The World Bank
Environmental Policy Stringency (EPS) – TH	EPS_{it}	OECD stat
Environmental Policy Stringency (EPS) – YU	EPS_{jt}	OECD stat
Population – TH	Pop_{it}	The World Bank
Population – YU	Pop_{jt}	Yunnan Statistical Yearbook, National Bureau of Statistics, China
Common FTA (dummy)	$ComFTA_{ijt}$	Various academic papers and journals

Data is collected from the two countries: Thailand and Yunnan province, China over the period 1998-2019. The available data are extracted from assorted years based on the availability. All nominal values are converted to 2019 US Dollar using CPI., The bilateral trade flow is the key dependent variable. The data on GDP, GDP per capita, and population have been updated with the World Bank Development Indicators and the Yunnan Statistical Year Books. The distances measured were in kilometer (km) multiplying by the cost of transportation, which petrol price is used in this paper. The exchange rate is adjusted to 2019 USD. Environmental Policy Stringency (EPS) values were taken from OECD database. Dummy variable is used to measure whether the two countries share the common Free Trade Agreements.

B. Empirical Method

This paper follows the previous research on the gravity application and is influenced to extend the studies to the estimation of the Bayesian approach with econometric implications.

This empirical method is used as a benchmark for econometric issues for robust estimations. (Jayasooriya, S.P., 2022) The trade flows among the three economies (Thailand, Laos, and Yunnan province, China) are not necessarily related to the long-run equilibrium since their economies are still in transition market economy. Even though China is more developed, however Yunnan province is still developing and transitioning its market economy. The gravity model in this study for trade is employed to estimate the equation to provide a touchstone, using trade volumes and trade partners. Much research attempted to come up with trade theories to describe and predict the flow of trades. One of the significant efforts is to model the gravity models. (Congdon, P., 2000; 2010; Jayasooriya, S.P., 2022; Ranjan, P. and Tobias, J.L., 2007; Eicher, T.s., 2010)

In this paper, standard gravity model provides all bilateral flows of trade at time t between Thailand and the Yunnan province, China. A gravity equation explains the trade with the size of the economies and their distances, suggesting a stable relationship between the size of the economies, proximity, and trade among countries to infer trade flow potentials and to estimate the effects on trade of institutions such as trade agreement, exchange rate mechanism, and international borders. Physical distance is an explanatory variable for trade measure resistance issues such as transaction costs, transport costs, perishability/loss of goods during transport, synchronization costs, communication costs, and cultural distance.

C. Linear Regression Model

Multiple linear regression models can be used to evaluate the relationship between dependent variables with two or more independent variables. (Syarifah Diana Permai et al., 2018) Given a dependent variable (Y) is the bilateral trade values and n independent variables, a multiple linear regression model can be written as follows

$$Y = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \cdots + \beta_n x_n + \varepsilon \quad (1)$$

$$Y = x\beta + \varepsilon \quad (2)$$

where

Y = dependent variable

x = independent variable

β = parameters
ε = error term

The β parameter is estimated to obtain the regression model.

D. Gravity Model

The gravity approach has been widely applied in empirical studies of bilateral trade since it was introduction by Tinbergen (1962) and Poyhonen (1963). Like other recent studies, this paper seeks to investigate the impact of certain aspects on bilateral trade volumes. At the macroeconomic level, the gravity model predicts the effects of trade liberalization on the economies that support economic growth. (Jayasooriya, S.P., 2021) While economic theory has been reasonably clear regarding the specification of variables such as GDP and distance in the gravity model, the theory does not exactly support how contract enforcement or other contractual instruments are implemented by remains ambiguous as to how dominate bilateral trade.

The standard gravity equation (McCallum, 1995) expresses the volume of trade between two countries as a function of the sizes of those countries and the distance between them, as expressed in equation (3). To promote open economic policies in terms of trade integration, this study analyzes the Bayesian Gravity Model for the pairs of countries to thoroughly evaluate the determinants of trade volume. From an economic growth perspective, open economic policy analysis has been devoted to explaining trade integration relationships at the aggregate level.

The traditional gravity equation is as follows

$$Trade_{ij} = \beta_{ij} * \frac{GDP_i * GDP_j}{Distance_{ij}} \quad (3)$$

Where, $Trade_{ij}$ is the value of the bilateral trade between country *i* and *j*, and GDP_i and GDP_j are country *i* and *j*'s respective national incomes. Distance is a measure of the bilateral distance between the two countries and is a constant of proportionality.

The estimated gravity equation is expressed as follows

$$Trade_{ijt} = \beta_0 + \beta_1 x_{ijt} + \beta_2 d_{ijt} + \beta_3 \delta_{ijt} + \varepsilon_{ijt} \quad (4)$$

Here $Trade_{ij}$ is the value of bilateral trade from region *i* to region *j*, x_i and x_j are gross domestic production (GDP) in regions *i* and *j*, d_{ij} is the distance between regions *i* and *j*, and δ_{ij} is a dummy variable equal to one for trade agreement (FTA) and zero for no free trade agreement trade.

The augmented gravity equation is as follows

$$Trade_{ijt} = \beta_0 + \beta_1 GDP_{it} + \beta_2 GDP_{jt} + \beta_3 GDPpercap_{it} + \beta_4 GDPpercap_{jt} + \beta_5 dist_{ijt} + \beta_6 dst\_p_{ijt} + \beta_7 exch_{it} + \beta_8 exch_{jt} + \beta_9 EPS_{it} + \beta_{10} EPS_{jt} + \beta_{11} Pop_{it} + \beta_{12} Pop_{jt} + \beta_{13} ComFTA_{ijt} + \varepsilon_{ijt} \quad (5)$$

Where $\beta_0, \beta_1, \beta_2, \beta_3, \beta_4, \beta_5, \beta_6, \beta_7, \beta_8, \beta_9, \beta_{10}, \beta_{11}, \beta_{12}$, and β_{13} are coefficients to be estimated. The error term, ε_{ijt} captures any other shocks, events, and unobserved factors that may affect bilateral trade between the two countries.

Let Thailand be country 'i' and Yunnan province, China be country 'j',

$Trade_{ijt}$ = Bilateral trade flows between Thailand and country 'j' in time 't',
GDP_{it} and GDP_{jt} = GDP of Thailand and GDP of Yunnan province, China in time 't',
Dis_{ij} = Bilateral distance between Thailand Yunnan province, China,
Dst_p = Cost of transportation explained by using bilateral distance multiplies by the price of petrol of the respective year.
$Gpercap_{it}$ and $Gpercap_{jt}$ = GDP per capita of Thailand and Yunnan province, China in time 't',

$Exch_{it}$ and $Exch_{jt}$ = Exchange rates of Thailand and China in time 't',
EPS_i and EPS_j = Environmental policy stringency index (EPS) of Thailand and Yunnan province, China,
Pop_{it} and Pop_{jt} = Population between Thailand and Yunnan province, China in time 't',
$ComFTA_{jt}$ = Binary variables that take the value 1 if countries have common FTA, and 0 otherwise,
ε_{ijt} = Error-term, which is assumed to be normally distributed with zero mean and constant variance for all observations and to be uncorrelated.

According to equation (4), the trade flows between two countries are explained by their economic sizes, bilateral distance, and a set of dummies. Trade flow is predicted to be directly proportional to the country's income and inversely proportional to the distance between them. (UNESCAP, 2016; Renjini, V.R., et al, 2017; Phung, D.Q., et al, 2018) To ensure that each of the dimensions is measured, this paper categorizes the impacts of trade flow into 3 aspects; economic impacts, social impacts, and environmental impacts and sets up the variables to be measured accordingly.

Equation (5) describes how Economic, Social and Environmental impacts can affect the sustainability and growth of the following route. This can have influences on total trade volume. In this study, the volume of bilateral trade Thailand and Yunnan province in China is measured and compared. The effects are measured to analyze the direction of Thailand's border trade and find out whether it is positively or negatively affected. By studying this analysis and empirical studies on the related topics, it will show factors and trends of border trade. Then, recommendations can be implemented to promote sustainability and growth. Hence, the purpose of the study can be reached.

E. Bayesian Approach to Gravity Model

A recent influential paper on the gravity model, Jayasooriya, S.P. (2021) has shown that a Bayesian approach is needed for more accurate estimation results in order to provide robust coefficient results that include trade flow elasticity in term of distance, exchange rate, and economic size between the two countries. To understand the impacts and significance of different variables in the gravity model, Bayesian approach is added into this paper. The approach is that a researcher's prior knowledge is transformed into posterior knowledge based on the sample information. The first reflects the subjective opinion on the topic without considering the observations, while the second depends on the sample data. A key concept of Bayesian statistics that distinguishes it from the sampling theory approach is subjective probability, independent of the frequency of the events under study (Ramsey, 1926; De Finetti, 1937). According to Bijak (2005), one of the major advantages of the application of Bayesian methodology in forecasting the predictive distribution and quantitative analysis of uncertainty is with informative prior distributions consistent with the observations, the Bayesian estimates, and forecasts are expected to carry smaller prediction errors than the sampling- theory ones, what is especially important in the small-sample cases.

The inverse probability is the posterior distribution denoted as $p(\theta|x)$. Posterior distribution relies on prior distribution and the likelihood function. The paper, first, determined a prior distribution which represents the "belief" to solve the complicated model. Parameter estimation by Bayesian approach is done by processing posterior distribution which multiplies the prior distribution with likelihood. Prior distribution equation is constructed as

Posterior knowledge = prior knowledge x likelihood of the data

$$p(\beta, \sigma^2|Y, x) = p(Y|x, \beta, \sigma^2) * p(\sigma^2) * p(\beta|\sigma^2) \quad (6)$$

Despite the subjective measures such as beliefs and intuition, without considering the observations, the base theorem is conditional on the sample data. The prior and the likelihood is determined. Then, the posterior distribution is computed using the Bayes' rule.

IV. RESULTS AND DISCUSSION

The annual data from 1998 to 2019 were collected from Thailand and Yunnan province, China for this paper. The Bayesian gravity model was analyzed by examining the bilateral trade relationships between the two regions. The bilateral trade and other estimates are based on annual values.

Table 3: Correlation test between dependent variable and independent variables

H_0: ρ=0 (There is no correlation between two variables)

H_1: $\rho \neq 0$ (There is correlation between two variables)

VARIABLE	CORRELATION COEFFICIENT	P-VALUE
$dist_{ijt}$	0.1119	0.006652
dst_p_{ijt}	0.1606	0.006652
GDP_{it}	0.2883	0.006652
GDP_{jt}	0.1721	0.006652
$GDPpercap_{it}$	0.1227	0.006652
$GDPpercap_{jt}$	0.0167	0.006652
$exch_{it}$	0.0963	0.006652
$exch_{jt}$	0.5049	0.006652
EPS_{it}	0.1735	0.006652
EPS_{jt}	0.1313	0.006652
Pop_{it}	0.1249	0.006652
Pop_{jt}	0.0175	0.006652
$ComFTA_{ijt}$	0.02543	0.006652

Table 3 shows that the independent variables are correlated with the dependent variable. All p-value is less than 0.05, therefore, it can be concluded that the variables have correlated each other. Hence, the data can be progressed to regression modeling.

Table 4: ADF stationary Test

H_0= Stationary Data
H_1= Non-stationary Data

VARIABLE	ADF TEST	RESULTS	INTERPRETATION
$Trade_{ijt}$	p-value = 0.002	Stationary Data I(0)	Strong evidence for stationary data
$dist_{ijt}$	p-value =0.004	Stationary Data I(0)	Strong evidence for stationary data
dst_p_{ijt}	p-value = 0.004	Stationary Data I(0)	Strong evidence for stationary data
GDP_{it}	p-value = 0.001	Stationary Data I(0)	Strong evidence for stationary data
GDP_{jt}	p-value = 0.05	Non-stationary Data I(1)	Weak evidence for stationary data
$GDPpercap_{it}$	p-value = 0.003	Stationary Data I(0)	Strong evidence for stationary data
$GDPpercap_{jt}$	p-value = 0.05	Non-stationary Data I(1)	Weak evidence for stationary data
$exch_{it}$	p-value = 0.02	Stationary Data I(0)	Strong evidence for stationary data
$exch_{jt}$	p-value = 0.01	Stationary Data I(0)	Strong evidence for stationary data
EPS_{it}	p-value = 0.317	Non-stationary Data I(1)	Weak evidence for stationary data
EPS_{jt}	p-value = 0.03	Stationary Data I(0)	Strong evidence for stationary data
Pop_{it}	p-value = 0.03	Stationary Data I(0)	Strong evidence for stationary data
Pop_{jt}	p-value = 0.003	Stationary Data I(0)	Strong evidence for stationary data
$ComFTA_{ijt}$	p-value = 0.001	Stationary Data I(0)	Strong evidence for stationary data

These two countries have bilateral trade relationships within the region and also with the rest of the world. The gravity model is estimated for total trade. The estimations are based on annual values of real trade of the countries. Consequently, the gravity model predicts trade in each economy.

F. Gravity Model Estimator

Starting from the simple standard model, Table 5 shows the results of the estimated gravity model from the basic model to extended model. Equation (7) shows the GDP and distances, while Equations (8), (9), and (10) represent the augmentation with other variables including the other indices.

Table 5: Linear Regression Model of the basic estimation

VARIABLE	ESTIMATE	T-VALUE	P-VALUE
INTERCEPT	195.35	0.689	0.005542
$dist_{ijt}$	-0.1986	-0.703	0.005542
GDP_{it}	2.85	0.177	0.005542
GDP_{jt}	7.69	1.385	0.005542

$$Trade_{ijt} = 195.35 + 2.85x_{it} + 7.69x_{jt} - 0.19d_{ijt} + \varepsilon_{ijt} \quad (7)$$

Based on the basic estimation (7), the GDP of the country of origin and the GDP of the country of destination are positively significant while the distance between countries is negatively significant.

Table 6: Extended Linear Regression Model

VARIABLE	ESTIMATE	T-VALUE	P-VALUE
INTERCEPT	84.86	0.12	0.00671
$dist_{ijt}$	-0.055	-0.14	0.00671
GDP_{it}	4.63	0.55	0.00671
GDP_{jt}	9.51	1.46	0.00671
Pop_{it}	3.59	0.032	0.00671
Pop_{jt}	8.24	0.464	0.00671
$ComFTA_{ijt}$	29.74	0.57	0.00671

$$Trade_{ijt} = 84.86 + 4.63GDP_{it} + 9.51GDP_{jt} + 3.59Pop_{it} + 8.24Pop_{jt} - 0.055d_{ijt} + 29.74\delta_{ijt} + \varepsilon_{ijt} \quad (8)$$

When the model is extended with the population of the country of origin and the population of the country of destination in (8), the population of the country of origin and the population of the country of destination are positively significant. While it further supplemented by the exchange rate of the countries, the exchange rate of the country of destination is also positively significant. However, the literature provides evidence that some other significant variables can have an influence on the trade flow between the countries in Asia. Hence, the model was further elaborated with the binary variables to incorporate barriers to trade integration. Among those variables, the binary variable for common Free Trade Agreement was significantly positive in model (9). GDP per capital also explains the consumer spending capacity of the two economies. As the result in model (9) indicates the positive significance and showing that Yunnan province is more promising in GDP per capital than Thailand. This shows that Yunnan's consumers' spending is larger in proportion, compared to Thailand. This is because Yunnan market is bigger and contribute more to its national economy.

Table 7: Linear Regression Model

	ESTIMATE	T-VALUE	P-VALUE
INTERCEPT	1045.13	0.176	0.00865
$dist_{ijt}$	-0.76	-0.252	0.00809
dst_p_{ijt}	-1.39	-0.963	0.00368
GDP_{it}	2.24	0.163	0.00875
GDP_{jt}	543.51	1.041	0.00332
$GDPpercap_{it}$	2.85	0.196	0.00850
$GDPpercap_{jt}$	539.86	1.035	0.00335
$exch_{it}$	-6.23	-0.384	0.00712
$exch_{jt}$	13.86	1.477	0.00183
EPS_{it}	-153.21	-0.988	0.00356
EPS_{jt}	30.04	0.229	0.00826
Pop_{it}	84.73	0.278	0.00789
Pop_{jt}	166.71	0.590	0.00573
$ComFTA_{ijt}$	72.44	0.722	0.00494

$$Trade_{ijt} = 1045.13 + 2.24GDP_{it} + 543.51GDP_{jt} + 2.85GDPpercap_{it} + 539.86GDPpercap_{jt} - 0.76dist_{ijt} - 1.39dst_{p_{ijt}} + 6.23exch_{it} + 13.86exch_{jt} - 153.21EPS_{it} + 30.04EPS_{jt} + 84.73Pop_{it} + 166.71Pop_{jt} + 72.44ComFTA_{ijt} + \varepsilon_{ijt} \quad (9)$$

The results of the basic gravity model in Table 7 report the estimation of coefficients for the bilateral trade integrating in the two countries. In general, these equations fit the data well, indicating that the proposed explanatory variables were significantly related to bilateral trade. The coefficients of determination (R2) range from 60% to 78%. The F-test (p-value) results show that collectively the models were significant. These results are in line with the usual gravity model findings from other papers.

This implies that, at a robust estimation level, these factors are highly influenced by the bilateral trade flow of the two economies. Throughout the three models, the GDPs of the original and destination countries are positively significant whereas the distance between the countries is negatively significant.

As Table 7 shows, the coefficients on GDP of origin and GDP of destination are significant and positively signed, as are most of the population coefficients. This implies that the rich, highly populated countries tend to trade more and contribute to the trade integration. Further, it can be explained that trade integration will be successful in those countries that contribute to trade integration. As expected in the model, the coefficients on the distance variables were all negative and significant. This also implied that transport costs, a proxy for the geographic distance between the two countries, have a significant influence in determining the volume of trade between countries. This is where route R3A can have a significant influence in minimizing the transaction costs of the trade inflow.

The coefficient on the EPS value of the destination was negatively signed and was significant for Thailand. Literature suggests that this is because Thailand's environmental policy is affected by the bilateral trade.

As compared to Thailand, Yunnan province has much larger population, therefore, requiring much more resources than Thailand. Therefore, it also affects the trade integration of the countries. Hence, higher dependency on import and trade. The inclusion of the exchange rate shows that an increase in the exchange rate of origin or destination implies a depreciation of the real effective exchange rate. As expected, for the coefficients associated with the trading partner, the exchange rate is negatively significant, whereas the exchange rate of destination is positively significant at 5% level. This explains that the exchange rate of Yunnan province is less affected by the world's exchange rate. As expected of Chinese currency, Chinese Yuan is stronger than Thai Baht (THB).

Binary for common Free Trade Agreement at pre-transition and post-transition was also significant in the trade integration. This implies that the common FTA and therefore agreements have influenced the trade contracts between countries. This could be due to the use of technologies in the trading process and the use of cooperation as a common agreement in those countries for international trading, as well as the development in transportation facilities and aids in trading convenience.

In summary,the coefficient on GDP in country of origin and GDP in country of destination, population, and GDP per capita of the original country and destination country is positive and significantly predicts the bilateral trade growth. However, the variables associated with distance between the countries has a negatively significant estimation in the model. Therefore, for these economies, the macroeconomic variables have contributed to the trade integration. From all the estimations, it can be suggested that trade integration has been significantly affected by the GDPs, populations, GDP per capitas, and common FTA of the countries of origin and destination. Therefore, the study suggests that the consideration of the trade integration needs to be deliberated on the impacts of trade flows. Even though the above econometric approach provides evidence on the significant factors that determine the trade integration, the Bayesian approach is required for more precise results of the estimates to give results of robust coefficients to understand the impacts and significance of different variables in the gravity model.

G. Bayesian Model Tests

After running package brm on R program, the model is fitted using 4 chains, each with 2000 iterations of which the first 1000 are warmup to calibrate the sampler, leading to a total of 4000 posterior samples. Brms enable even complex models to be fitted with not more than a few thousand samples. (Hoffman and Gelman, 2014)

The results corresponding to the Bayesian approach of the gravity model for total trade values are depicted in Table 8. The estimates result in the robust parameters for determining the impact factor for the bilateral trade of

the two countries, in that the elasticity of total trade volumes with respect to distance and population of destination and the exchange rate of origin is negative while it is positive for the proxies of economic size, GDP per capita, and exchange rates of destination. The model is tested against its consistency through model testing as shown in Table 8.

Table 8: Linear Regression Model using Bayesian approach

	Estimate	**Quantile (2.5%)**	**Quantile (97.5%)**
Intercept	1045.13	-1472.75	1110.89
$dist_{ijt}$	-0.76	-0.59	0.77
dst_p_{ijt}	-1.39	-1.94	0.74
GDP_{it}	2.24	-6.64	12.93
GDP_{jt}	543.51	-8.94	12.23
$GDPpercap_{it}$	2.85	-5.67	7.88
$GDPpercap_{jt}$	539.86	-9.42	12.07
$exch_{it}$	-6.23	-8.88	9.22
$exch_{jt}$	13.86	-0.42	16.85
EPS_{it}	-153.21	-14.42	13.68
EPS_{jt}	30.04	-13.75	14.38
Pop_{it}	84.73	-14.18	13.53
Pop_{jt}	-166.71	-14.1**0**	13.84
$ComFTA_{ijt}$	72.44	-13.69	13.71

In general, every parameter is summarized using the mean (Estimate) and the standard deviation (Est.Error) of the posterior distribution as well as two-sided 95% Credible intervals (l-95% CI and u-95% CI) based on quantiles. The Eff.Sample value is an estimation of the effective sample size; that is the number of independent samples from the posterior distribution that would be expected to yield the same standard error of the posterior mean as is obtained from the dependent samples returned by the MCMC algorithm. The Rhat value provides information on the convergence of the algorithm (cf., Gelman and Rubin, 1992). If Rhat is considerably greater than 1 (i.e., > 1.1), the chains have not yet converged and it is necessary to run more iterations and/or set stronger priors.

V. CONCLUSION

The Bayesian gravity analysis was conducted to estimate the degree of impacts of determinants on international bilateral trade providing pragmatic evidence for trade integration in the two economies: Thailand and Yunnan Province, China. Further, the gravity model was aimed at identifying the regional trade integration for the aptness of the trade integration in the region. The Bayesian gravity model reveals that the estimated coefficients on GDP in country of origin and GDP in country of destination, population, and GDP per capita of the country of origin are positively significant predictors of the trade growth. The distance between the countries has a negatively significant estimation showing barriers in trade. The model predicts the trade integration especially towards the trade process. The Bayesian approach of the gravity model gives the robust estimates for determining the impact factor for the trade values of the two countries, including the elasticities of total trade values with respect to distance and GDP per capita of destination, and the exchange rate of origin are negative, while the proxies of economic size, exchange rates are negative. The exchange rate of the destination is positive. The estimated parameters are directly the elasticities, in which increases in GDP in a reporter consistent with higher trade volumes.

The trade volume in the model analyzes the “trade creation” and “trade diversion” effects of Regional Trade Agreements. In simulating the scenarios for international trade integration according to explanatory indicators quantify trade potential between two partners. The gravity model is modified for international trade integration according to changes in key determinants; quantify trade potential between two countries and measure the trade costs term instead of trade inflows and to express these costs as a function estimating the barriers for trade integration with the assistance of route R3A. Finally, trade integration can be facilitated with evidence and simulated scenarios for the estimation of the impacts of the trade inflow in Asia. Therefore, combining all the results of the Bayesian gravity model, one of the significant pieces of evidence of this study is that trade integration can be promoted with the increase of particular significant variables at the country level, while

stimulating those towards innovative approaches to trade facilitation in the trade process plays a significant role in the policymaking in these economies. Therefore, the research evidence suggests that policymakers should design appropriate trade openness policies with the use of pragmatic findings for these two countries.

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