

Knowledge Assets and Bilateral-Trade Flows in ASEAN-5 Countries: An Extension of Gravity Panel Data Model

*(Aset-Aset Pengetahuan dan Aliran Perdagangan Dua Hala dalam Negara-Negara ASEAN-5:
Lanjutan daripada Model Data Panel Graviti)*

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ABSTRACT

This study analyses knowledge asset as a determinant factor to bilateral trade flows in ASEAN-5 countries, namely, Singapore, Malaysia, the Philippines, Indonesia and Thailand from 2000 to 2015. The gravity model of trade is extended by incorporating the five components of knowledge assets, namely, national's market capital, financial capital, renewal and development capital, human capital and process capital as explanatory variables. The empirical investigation is based on pooled ASEAN-5 data and done using random effects and fixed effects models. The principle findings corroborate that knowledge assets are positive and have significant effects on bilateral trade flows in ASEAN-5 countries. The consideration of improving human capital and financial capital is vital given that it is a major contribution to the changes of bilateral trade in ASEAN. This study is open for further research on the negative and significant influences of process capital towards bilateral trade flows in ASEAN-5 countries.

Keywords: Intra-trade flows; knowledge assets; ASEAN; export; gravity model

ABSTRAK

Kajian ini menganalisis aset pengetahuan sebagai faktor penentu kepada aliran perdagangan dua hala di antara negara-negara ASEAN-5, iaitu Singapura, Malaysia, Filipina, Indonesia dan Thailand dari tahun 2000 hingga 2015. Model graviti perdagangan diperluaskan dengan memasukkan lima komponen pengetahuan aset iaitu modal pasaran negara, modal kewangan, modal pembaharuan dan pembangunan, modal insan dan modal proses sebagai pemboleh ubah bebas. Penyelidikan empiris didasarkan pada data panel ASEAN-5 dan dilakukan dengan menggunakan model efek rawak dan tetap. Penemuan kajian menyokong bahawa aset pengetahuan berhubung secara positif dan mempunyai kesan signifikan ke atas aliran perdagangan dua hala di negara-negara ASEAN-5. Pertimbangan untuk meningkatkan modal insan dan modal kewangan dalam aliran dagangan dua hala adalah penting memandangkan ia menyumbang kepada perubahan perdagangan dua hala di ASEAN. Kajian ini terbuka untuk penyelidikan selanjutnya mengenai hubungan negatif dan signifikan di antara modal proses dan aliran perdagangan dua hala di negara-negara ASEAN-5.

Kata kunci: aliran perdagangan dua hala; aset pengetahuan; ASEAN; eksport; model graviti

INTRODUCTION

International trade has been proven to be a powerful means for emerging markets to stimulate economic development and alleviate poverty. The adoptions of open market policies and bilateral trade agreement in certain emerging market economies have helped the country massively in their rapid economic growth and trade opportunities (Wang et al., 2010). Moreover,

the benefits of regional cooperation such as the establishment of Association of South East Asian Nations (ASEAN) in 1967 by the five original member countries (ASEAN-5), specifically, Malaysia, Indonesia, Thailand, the Philippines and Singapore, have helped the members of ASEAN to have effective trade openness (Salleh and Yusoff, 2017). After the establishment of ASEAN-5, Brunei Darussalam joined in 1984, followed by Vietnam, Lao PDR, Myanmar and Cambodia.



As a trade-creating block with 10-member states, ASEAN integration has led to the improvement of trade facilitation and an increase in intra-ASEAN trade and ASEAN's trade with global trade. The implementation of ASEAN Free Trade Area (AFTA) over the few decades has significantly reduced trade costs on average by more than 15% within ASEAN and approximately 8% percent with the global trade. Moreover, the trade costs of ASEAN-5 countries considerably fell by 50% between 1990 and 2007 (AFTA 2018), which has led to an increase in ASEAN trade flows. ASEAN trade flow was further deepened through the implementation of a series of regional agreements, such as the ASEAN Framework Agreement on Services (AFAS), the ASEAN Trade in Goods Agreement (ATIGA), the Framework Agreement on the ASEAN Investment Agreement (AIA) and the ASEAN Agreement for Promotion and Protection of Investment (IGA) (AFTA 2018).

The countries of ASEAN have recently launched the ASEAN Economic Community (EAC) Blueprint 2025 with the objectives of a single market and production base, a region of fair economic development, a highly dynamic and competitive economic region and a region fully integrated into the global economy. If these goals are achieved, then ASEAN will be categorised as a free movement of goods and services and the free flow of skills and capital (ASEAN Secretariat 2008). The integration of EAC generates a hope that ASEAN would be the third biggest market area in the world. For the achievement of these objectives, empirically analysing the main factors that contributed to the improvements of the international trade flows of ASEAN that could help ASEAN turn into a competitive region in the world market is necessary (Yew et al. 2017).

Despite the successful story of a tariff system in the ASEAN region, the emergence of digital economy and technology savvy in the international trade facilitation has created a new means of trade, e-commerce and smart factory industry in ASEAN counterparts, which created a new challenge for ASEAN to boost up its productivity in international/bilateral-trade flows. Facing this challenge on the improvement on knowledge assets is considered a critical endeavour for the members of ASEAN to improve the technology ladder by encouraging transfer of technology and stimulating innovation and creativity (Herciu & Ogrea 2015).

Few decades ago, global trade flows were dominated by commodity-intensive flows from resource-rich economies and labour-intensive flows to low-cost manufacturing nations. However, in the current digital world economy, knowledge asset is a new source of competitiveness advantage for firms, countries and regions (Erickson & Rothberg 2018; Liu & Atuahene-Gima 2018). Through the evolution of technology 4.0, low cost production can be everywhere and anywhere, no matter from capital rich-countries or labour rich-countries. Thus, over the internet of things (IOT), the

importance of knowledge assets could not be ignored. Given the breadth and depth of the trade literature, to our knowledge, no study that has directly documented whether the differences of knowledge assets amongst nations can affect the international trade flows is carried out. Our study fills this gap in the literature by providing strong evidence and a fundamental link amongst economics, technology and international trade. During this investigation, this study aim to provide an alternative extension of the gravity model for analysing bilateral trade flows amongst ASEAN-5 countries from the year 2000 to 2015. We choose ASEAN-5 as evidence of the phenomenon in the 6 first ASEAN countries—Malaysia, Indonesia, Brunei Darussalam, Singapore, Thailand and the Philippines—that successfully eliminated their tariff to the 0% to 5 % tariff range. Brunei Darussalam is excluded in this study because of the insufficient data.

This study differs from other studies in many ways. Firstly, this study is guided by new trade theories, and the four components of knowledge assets, namely, market capital, human capital, process capital and renewal and development capital, are included as the additional explanatory variables. Secondly, by using the panel data series of ASEAN-5 countries, this study examines the relationship between bilateral trade flows and its explanatory variables. Thirdly, this study concern on the possible endogeneity of knowledge asset as extension of national wealth that applied in the fixed effects model to deal with endogeneity biases.

The rest of the paper is structured as follows. The literature review section considers the guidance from new trade, knowledge assets and new growth theories regarding the sources of bilateral trade flows. The data and methodology section deals with the standard gravity model used to incorporate knowledge asset as a new national economic size factor. The estimation results section presents the empirical results followed by the conclusion remarks.

LITERATURE REVIEW

In the global trading system, trading block is practically subjected to multilateralism and regionalism. Recently, the growth of the regional trading block has been one of the major developments in global economics. The structure of the regional trading block greatly varies in many ways, but they usually have the common objective of reducing trade berries amongst member countries by introducing tariff systems (Ghani et al. 2008). Through the free trade area in the regional trading block, bilateral trade flows are determined not only by income, population and distance, but also by the success of trade agreements that have been signed by regional member countries, such as ASEAN.

For instance, through the AFTA agreements, most of the ASEAN regions are now a free trade area. The Common

Effective Preferential Tariff (CEPT) scheme for the AFTA has reduced their tariffs on intra-regional trade to the 0% to 5% tariff range for almost all products in the Inclusion List. In 2010, more than 99% of the products listed in the CEPT Inclusion List (IL) of ASEAN-6 have been brought down to the 0% to 5% tariff range. The rest of the ASEAN's members, namely, Laos, Cambodia, Myanmar and Viet Nam, have implemented their CEPT commitments with almost 80% of their products having been moved into their respective CEPT ILS and approximately 66% with tariffs within the 0% to 5% tariff band (AFTA 2018).

The reduction of tariff has led to the increase of bilateral trade flows in ASEAN. However, the implementation of the AFTA has certain drawbacks (Ghani et al. 2008). Firstly, the reduction of tariffs enables foreign producers to compete with domestic producers with low costs and, thus, generates trade as the high-cost domestic producers. Secondly, the lower trade barriers allow companies in rich countries to take advantage of cheap labour costs, thereby leaving local countries, such as Malaysian, Thailand and Indonesian with labour unemployed. Thirdly, free trade deals can cause vast environmental damage by allowing companies to shift their manufacturing facilities to nations with less or non-environmental regulations. Moreover, the difference of bilateral deals in the ASEAN trade agreements creates legal complexities for buyers and sellers. To promote great utilisation of the CEPT–AFTA scheme and reduce the trading gap within the ASEAN member countries, ASEAN signatories (government) must utilise the resources of national competitive advantages and the advantages of ASEAN integration (Yew et al. 2017).

For the past two decades, the sources of national competitive advantages have started to shift from tangible to intangible assets (Oprescu 2012). In a powerful international competition, countries with knowledge-intensive activities will be the winners not only in per capital wealth but also in terms of future wealth creation. Intangible assets influence productivity and further the competitiveness and prosperity of a country. Moreover, knowledge is a special type of resource for an economy and is a non-rival input in generating new knowledge (Sharif Karimi & Cieřlik 2017). Thus, improving knowledge assets is considered an important determinant for ASEAN member countries to create or reengineer products, to introduce new processes, to improve productivity, to meet new market demands and to apply new marketing strategies to expand trade opportunities by looking at a different perspective (Ghani et al. 2008).

Posner (1961) corroborated that the country hosting a particular innovation or invention activity will lead technology over other countries and will be able to export the goods concerned although the country lacks comparative advantages, such as land, labour and capital. Most of the researchers extensively used knowledge assets to measure the technology competency of such

countries (Afzal et al. 2018; Kimura et al. 2016, Sharif Karimi & Cieřlik 2017; Yew et al. 2017). However, in measuring the bilateral trade flows, the integration of the traditional measurement of the gravity model and knowledge asset measurement is still scarce and must be empirically analysed. Thus, on the basis of economic theory, this study augments the original gravity model by integrating knowledge assets to explain the bilateral trade flows of ASEAN-5 countries.

The traditional assessment of the gravity model specifies that bilateral trade flows are determined by relative economic size and distance from country or region i to country or region j (Anderson 1979). The gravity model predicts that relative economic size attracts countries to trade with one another, whilst great distances weaken the attractiveness. In its original form, income per capita or gross domestic product (GDP) is used to measure the relative economic size of each country. Nevertheless, the measurement of GDP as a proxy for relative economic size is considered an inappropriate measurement because GDP focuses more on the growth of material living standards rather than on the growth of productivity (Herciu & Oğrean 2015). Thus, to obtain a complete picture of relative economic size, each country must consider not only income per capital (GDP) but also knowledge asset as a key driver for national wealth, which means the total goods within a country owned by the inhabitants in their individual or corporate capacity (Herciu & Oğrean 2015). Bontis (2004) affirmed that the most common metric denoting the financial wealth of a nation is its gross domestic product per capita. However, knowledge assets represent the hidden national potential for national growth. A knowledge asset consists of facts, assumptions and heuristics that provide economic value to its possessor (Wilkins et al. 1997). Boisot (1998) validated that knowledge assets are manifested in terms of technologies, capabilities and competences. Knowledge assets are normally measured by market capital, human capital, process capital and renewal and development capital (Bontis 2004; Herciu & Oğrean 2015; Malhotra 2003).

Market capital reflects the relationship capital across countries. It is derived from a country's capabilities and successes to provide an attractive and competitive solution to the needs of international clients. Following Sharif Karimi and Cieřlik (2017) and Bontis (2004), the present study uses inward Foreign Direct Investment (FDI) stock as a proxy for measuring market capital. Evidently, FDI is a channel for knowledge spillover and technology sales. Sharif Karimi and Cieřlik (2017) verified that technological spillovers from FDI of the leader country generated productivity growth in the follower economy. Hence, if FDI exerts a positive spillover effect on the host economy, then it must be reflected in the increased productivity of the host economy. Thus, FDI and bilateral trade flows are expected to have a positive relationship. However, in a particular industry, the relationship is

somewhat unclear given that FDI may be a substitute for the trade (Thanh & Ji 2014).

Process capital refers to activities or processes and related infrastructures for sharing, creating, transmitting and disseminating knowledge for contributing to individual knowledge workers' productivity (Oprescu 2012). Process capital includes the programs, techniques and procedures that implement and enhance the delivery of goods and services (Kannan & Aulbur 2004). A previous study has used the percentage of individuals with the Internet as a proxy for process capital (Malhotra 2003). Process capital and bilateral trade flows is expected to have a positive relationship given that the differences in process capital endowments resulted in production process efficiency.

Subsequently, human capital is the combination of skills, knowledge, innovativeness, and the ability of a nation's individuals to meet a certain task at hand including cultural, value and philosophy (Bontis 2004; Herciu & Ogrean 2015; Malhotra 2003). Human capital is the property of individuals which cannot be owned by an organisation (Bontis 2001). This includes wisdom, intuition, knowledge, expertise and the ability of individuals to fulfil organisational tasks and goals (Herciu & Ogrean 2015). This study uses human development indexes as a measurement for national human capital. The Human Development Index (HDI) is a summary measure of average achievement in the key dimensions of human development: being knowledgeable, has a long and healthy life and has a decent standard of living. On the basis of the HDI, countries with the same level of GNI per capita can end up with different human development outcomes (UNDP 2016). The coefficient is expected to be similar with the difference in process capital endowment.

The last component is renewal and development capital. It is defined as a nation's future intellectual wealth, which includes its capabilities and actual investments in renewal and development for sustaining the competitive advantages. This study uses R&D investments as a measurement for renewal and development capital (Oprescu 2012). Improvement in learning and skills is expected to increase trade efficiency.

DATA AND METHODOLOGY

The methodology of this study is based on the gravity model used by Tinbergen (1962) and Yamarik and Ghosh (2004) to measure the international trade flows. In its original form, the gravity model is specified as follows:

$$EX_{ij} = A \frac{(GDP_i GDP_j)^{b_1}}{(D_{ij})^{b_2}} \tag{1}$$

where trade_{ij} is the value of bilateral trade between country *i* and country *j*,

GDP_i and *GDP_j* are country *i* and country *j*'s respective national incomes,
D_{ij} is a measure of the bilateral distance between the two countries, and
A is a constant of proportionality.

Taking the logarithms of gravity model Eq. (1), we obtain the following estimable equation:

$$\ln(EX_{ij}) = A + b_1 \ln(GDP_i) - b_2 \ln(D)_{ij} + \varepsilon_{ij} \tag{2}$$

where *A*, *b₁* and *b₂* coefficients to be estimated,
ε_{ij} error term; captures any other shocks and chance events that may affect the bilateral trade between the two countries,
GDP refers to country *i* and country *j*'s respective national incomes.

On the basis of Eq. (2), bilateral trade is predicted to be a positive function of income and a negative function of distance. However, given that constant *A* may be incongruous due to the existence of heterogeneity across countries, individual country effects are allowed to vary across countries. It is specified as a function of its export capabilities to its trading partner *j*. Thus, *A_{ij}* can be considered a function of the interaction between its own national wealth (*GDP_i* + Knowledge assets_{*i*}) and its partner national wealth (*GDP_j* + Knowledge assets_{*j*}).

Given that GDP is used in the original gravity model measurements, this study extends *A_{ij}* by incorporating the proxy of knowledge assets as follows:

$$A_{ij} = e^n (FDI_i)(FDI_j)^{b_3} (IIU_i)(IIU_j)^{b_4} (HDI_i)(HDI_j)^{b_5} (RND_i)(RND_j)^{b_6} \tag{3}$$

where *FDI_iFDI_j* is country *i(j)*'s inward FDI stock
IIU_iIIU_j is country *i(j)*'s percentage of individuals using the Internet
HDI_iHDI_j is country *i(j)*'s human development index
RND_iRND_j is country *i(j)*'s R&D investments

Substituting Eq. (3) with Eq. (2) and taking logs, we have the following:

$$\ln(EX_{ij}) = A + b_1 \ln(GDP_i) (GDP_j) - b_2 \ln(D)_{ij} + [b_3 \ln(FDI_i)(FDI_j) + b_4 \ln(IIU_i)(IIU_j) + b_5 \ln(HDI_i)(HDI_j) + b_6 \ln(RND_i)(RND_j)] + \varepsilon_{ij} \tag{4}$$

to capture the economic inequality between country *i* and *j*, this study measure the average economic size and dissimilarity of national wealth between country *i* and country *j* respectively. Thus, the national wealth which proxies with GDP, FDI, IIU, HDI and RND of Eq. (4) can be replaced with Eq. (5) as follows:

$$(Y_i)(Y_j) = -\ln 2 + 2\ln Y_{S_{ij}} + \ln sim Y_{ij} \tag{5}$$

where

Y is national wealth, representing GDP, FDI, IIU, HDI and RND; Y_s is the average economic size and $simY$ is the dissimilarity of national wealth. The average economic size is measured as follows:

$$Y_{s_{ij}} = \frac{Y_i}{(Y_i + Y_j)} \tag{6}$$

Meanwhile, the dissimilarity of national wealth is measured as follows:

$$InsimY_{ij} = 1 - \frac{Y_i^2}{(Y_i + Y_j)^2} - \frac{Y_j^2}{(Y_i + Y_j)^2} \tag{7}$$

As in most past studies, a large average of GDP and knowledge assets (proxy for an average economic size) is expected to increase the two-way bilateral trade due to a great demand for products and economies of scale (Thanh & Ji 2014). Hence, the sign of Y_s 's coefficient is expected to be positive. As synthesised by Helpman (1981), a decrease in national wealth dissimilarity (measured by differences in Y) might cause an increase in the share of intra-industry trade. This variable may vary within the range of 0.5 – equal country size and zero (0), absolute divergence in size.

Substituting Eqs. (5), (6) and (7), we have the following equation:

$$\begin{aligned} \ln(EX_{ij}) = & A + b_1 \ln(GDP_{s_{ij}}) + b_2 \ln(simGDP_{ij}) + \\ & b_3 \ln(D)_{ij} + b_4 \ln(FDI_{s_{ij}}) + b_5 \ln(simFDI_j) + \\ & b_6 \ln(IIU_{s_{ij}}) + b_7 \ln(simIIU_{s_{ij}}) + \\ & b_8 \ln(HDI_{s_{ij}}) + b_9 \ln(simHDI_{ij}) + \\ & b_{10} \ln(RND_{ij}) + b_{11} \ln(RND_{ij}) + \varepsilon_{ij} \end{aligned} \tag{8}$$

With panel data analysis in this framework, Eq. (9) can be specified as follows:

$$\begin{aligned} LEX_{ijt} = & A + \beta_1 LGDP_{s_{ijt}} + \beta_2 LsimGDP_{ijt} + \beta_3 LD_{ij} + \\ & \beta_4 LFDI_{s_{ijt}} + \beta_5 LsimFDI_{jt} + \beta_6 LIIU_{s_{ijt}} + \\ & \beta_7 LsimIIU_{ijt} + \beta_8 LHDI_{s_{ijt}} + \beta_9 LsimHDI_{ijt} + \\ & \beta_{10} LRND_{ijt} + \beta_{11} LRND_{ijt} + \varepsilon_{ijt} \end{aligned} \tag{9}$$

where prefix L indicates logged values, β_s represents beta coefficient and i and t are the country-specific fixed and time effects, respectively; $\beta_3 = -\gamma$.

DATA COLLECTION

The data set employed in the current study covers 5 ASEAN countries, namely, Malaysia, Indonesia, the Philippines, Singapore and Thailand over the period of 2000–2015. All variables are in constant dollar prices, with 2010 as the base year. Table 1 presents the variable measurement and data sources as follows:

TABLE 1. Summaries of variables, measurements and data sources

Variables	Measurements	Data sources
EX	Bilateral export (US\$ thousand)	United Nation Trade and Development (2017)
GDP	GDP (constant 2010 US\$)	World Development Indicators (2017)
FDI	Foreign direct investment, inward stock	United Nation Trade and Development (2017)
IIU	Percentage of individuals using the Internet	International Telecommunication Union (2018)
HDI	Human development index (HDI)	Human Development Report, UNDP (2016)
RND	Research and development expenditures (% of GDP)	World Development Indicators (2017)
D	Distance	

The commonly used set-up of gravity equation is unbalanced because no country exports to itself. Thus, total i is 20, and t is 16, with the total year observation being 320 observations.

ESTIMATION RESULTS

DESCRIPTIVE ANALYSIS

Table 2 reports the descriptive analysis of the export flows of ASEAN-5 countries and its explanatory variables. Moreover, Table 2 exhibits that the mean of the bilateral trade flow amongst ASEAN countries is at 6.687, with a range of 5.122–7.702. The mean value of distance within ASEAN countries shows a height value of 1.706. In terms of national wealth, the mean value of renewal and development capital (proxy by RND), market capital (proxy by inward stock FDI) and process capital (proxy by

TABLE 2. Descriptive statistics

Variable	Mean	Min	Max
EX	6.687	5.122	7.702
GDP	0.103	0.291	0.042
FDI	0.124	0.461	0.103
IIU	0.123	0.479	0.108
HDI	0.094	0.138	0.053
RND	0.138	0.489	0.110
D	1.706	0.873	2.077
Observation	320		

percentage of individuals using the Internet) outperforms the mean value of income per capital (GDP) with values of 0.138, 0.124, 0.123 and 0.103, respectively. Meanwhile, human capital shows the lowest mean value of 0.094 for ASEAN-5 countries. This study continues with estimating a panel data regression model to analyse whether knowledge asset, as a potential of national wealth factors, may contribute to the growth of bilateral trade flows in ASEAN-5 countries.

REGRESSION ANALYSIS

The analysis begins by comparing the fixed effects model and the pooled OLS regression model. To ensure good and reliable estimates of the model parameters, we conduct the poolability test. The result of the fixed effects model affirms that all α_i are zero. Thus, the OLS estimator is inconsistent and biased. On the basis of the test, we reject the null hypothesis and accept the individual effects. To determine the best statistical estimation, this study compares the fixed effects and random effects models. The Hausman test is conducted to verify the correlation between the unobservable heterogeneity and explanatory variables. The probability result is less than 0.05. Thus, the null hypothesis is rejected, and we continue with the fixed effects regression model.

To ensure the validity of the statistical results, we conduct a modified Wald test for the group-wise

heteroskedasticity in the fixed effects model by using the `xttest3` command. The serial correlation test is also conducted by using the `xtserial` command. Both statistical tests confirm a serial correlation and a heteroskedasticity problem in the FE model.

To rectify the above problems, we implement the fixed effects (within) regression with the Driscoll and Kraay standard errors by using the `xtscc` command. The Driscoll and Kraay standard errors are used because of their ability to adjust the standard errors of coefficient estimates for possible dependence in the residuals. The error structure is assumed to be auto-correlated and heteroskedastic up to some lag and possibly correlated between groups. Table 3 shows the results of OLS random effects, fixed effects and fixed effects (within) regression with the Driscoll and Kraay standard errors.

Table 3 presents that the overall performance of the gravity models for knowledge assets and international trade flows are fairly satisfactory in terms of statistical significance. Furthermore, economic interpretations show R -squared 74%. The result corroborates that income per capital (measured by GDP), market capital (measured by FDI), human capital (measured by HDI) and renewal and development capital (measured by RnD, expect RnD similarity) are positive and significantly influence ASEAN-5 bilateral trade flows at the 1% to 5% significant levels. In addition, human capital is the most important determinant of bilateral trade flows in ASEAN-5 countries with a coefficient of 13.255 for average economy size

TABLE 3. Estimation results of GLS random and fixed effects regressions for Eq. (9)

	GLS random effects		Fixed effects		FE-Driscoll/Kraay standard error	
Constant	-1.458		-0.312		-0.312	
LGDPs	3.026	*	5.220	*	5.220	*
LsimGDP	3.338	*	5.398	*	5.398	*
LFDIs	0.483	*	0.528	*	0.528	*
LsimFDI	0.351	*	0.390	*	0.390	*
LIIUs	-0.257	*	-0.266	*	-0.266	**
LsimIIU	-0.090		-0.098		-0.098	
LHDIs	11.952	**	13.255	**	13.255	**
LsimHDI	7.708	**	8.635	**	8.635	*
LRNDs	0.339	*	0.386	*	0.386	**
LsimRND	0.006		0.043		0.043	
LD	-0.564		Dropped ^d		Dropped ^d	
R-squared	0.7392		0.7439		0.7439	
Hausman test	31.75*		Accepted			
Autocorrelation			28.67*		Accepted	
Heteroskedasticity			49.93*		Accepted	
Observations	320		320		320	

Note: z -statistics for the GLS random effects model and the corresponding t -statistics for the fixed effects and the fixed effects-Driscoll/Kraay standard error model are given in parentheses. An asterisk (*) indicates that the given variable is statistically significant up to a 1% level of significance, ** for 5% and *** for 10% level of significance. ^d indicates that the fixed effects model automatically drops out all time-invariant variables from the model.

and 8.635 for the dissimilarity of knowledge assets within two countries. The coefficient is positive and significant in all specifications. This scenario implies that the combination of skills, knowledge, innovativeness and ability of a nation's individuals is an important determinant to improve ASEAN-5 bilateral trade flows. However, the average economy size of process capital, which proxy by percentage of individuals using the Internet, negatively influences ASEAN-5 bilateral trade flows at the 1% to 5% significant levels. Nonetheless, the similarities of process capital within two countries are insignificant with the level of bilateral trade flows in ASEAN-5 countries.

Krugman (1980) validated that distance is associated with transaction cost. The greater the geographic distance between exporter and trading partners, the higher the cost of trading activities; thus, countries tend to switch from exports to FDI-based production (Gopinath & Echeverria 2004). In terms of process capital, Malhotra (2001) proved that process capital which is embedded with technology, information and communication systems is able to contribute to an individual knowledge worker's productivity. Thus, it is expected to positively influence bilateral trade flows. However, this study reveals contradicting results possibly because ASEAN is still in the initial stage of implementing technology 4.0; thus, it is a destructive competitive advantage for those firms who are struggling in implementing knowledge technology in their process capital.

CONCLUSIONS

This study has attempted to forward our knowledge and understanding on the main causes of ASEAN-5's bilateral trade flows. We extend the gravity model by proposing the four main components of knowledge assets, namely, market capital, human capital, process capital and renewal and development capital. We provide evidence that knowledge asset is one of the national endowment factors that should be considered in a determinant country's bilateral trade flows. The panel data analysis is applied to the estimation of the improved gravity equation. The data set covers 320 years observation.

The main findings are as follows. Firstly, the estimated results of the extended gravity models of bilateral trade flows are generally fairly satisfactory in terms of their statistical significance and economic interpretation. Secondly, the development of human capital in ASEAN-5 countries is the most important factor in knowledge assets that must be improved to increase the bilateral trade flows in ASEAN-5 countries. Meanwhile, the negative influence between a national's process capital and bilateral trade flows in ASEAN-5 countries must be further analysed to achieve a clear understanding of how IOT may matter for bilateral trade flows in ASEAN-5 countries.

The main characteristics of this study are as follows: (1) the extension of the gravity model by incorporating knowledge assets as national endowment factors and (2) the provision of panel data analysis, diagnostic tests and careful treatment of the endogeneity problem to confirm relationships in the long-run between bilateral trade flows and its explanatory variables. This study also confirms that knowledge assets are the important determinants of international trade and that the two-way relationship exists between these variables (the average and similarity of knowledge assets to its bilateral trade). Thus, the interconnection between domestic knowledge assets and trade enhances the economic growth, which, in turn, promotes considerable knowledge assets and trade performances.

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