Print ISSN: 2288-4637 / Online ISSN 2288-4645
doi:10.13106/jafeb.2019.vol6.no2.95

A Panel Analysis on the Cross Border E-commerce Trade: Evidence from ASEAN Countries

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Received: December 21, 2018 Revised: January 02, 2019 Accepted: March 30, 2019

Abstract

Along with the economic globalization and network generalization, this provides a good opportunity to the development of cross-border e-commerce trade. Based on this background, this paper sets ASEAN countries as an example to exploit the determinants of cross-border e-commerce trade including the export and the import, respectively. The panel data from the year of 1998 to 2016 will be employed to estimate the relationship between cross-border e-commerce trade and relevant variables under the dynamic ordinary least squares and the error correction model. The findings of this paper show that there is a long-run relationship between cross-border e-commerce trade and relevant variables. Generally speaking, the GDP(+) and real exchange rate(-export & +import) have an effect on cross-border e-commerce trade. However, the population (+) and the terms of trade (-) only have an effect on cross-border e-commerce import. The empirical evidences show that the GDP and the real exchange rate always affect the development of cross-border e-commerce trade. Therefore, all ASEAN countries should try their best to develop the economic growth and focus on the exchange rate regime so as to meet the need of cross-border e-commerce trade development.

Keywords: Cross-border E-commerce Trade, ASEAN Countries, Dynamic Ordinary Least Squares.

JEL Classification Codes: B40, F10, F19.

1. Introduction

Along with the rapid development of modern economy, the cross-border e-commerce trade has become a new trade mode in the global economic activities. It can not only effectively remedy the predicament of the shortage of resources in various countries, but also optimize and rationalize the allocation of existing resources in various countries. The continuous development and popularization of cross-border e-commerce trade have a certain impact on a country's economic model. As for the cross-border e-commerce trade, It refers to an international business activity that belongs to different trading entities, through electronic commerce platform to achieve transactions, payment and settlement, and through cross-border logistics to deliver goods and complete transactions. The flourishing development of cross-border e-commerce trade is obvious to all. However, The factors that affects cross-border e-commerce trade also arise at the historic moment. A great deal of scholars have noticed this problem. Blum and Goldfarb (2006) use the internet access data of 2654 local Americans from December 12, 1999 to March 31, 2000 to study the influencing factors of non-physical commodity trade in cross-border e-commerce under the gravity model. Gomez-Herrera, Martens, and Turlea (2014) set 27 EU countries as the research object with a questionnaire as data source, they use the revised gravity model to study the factors that affect the cross-border e-commerce trade between EU countries.

This paper sets ASEAN countries (ASEAN countries include Brunei Darussalam, Cambodia, Indonesia, Laos, Malaysia, Myanmar, Philippines, Singapore, Thailand and Vietnam) an example to exploit the determinants (cross-border e-commerce export, cross-border e-commerce import, GDP, population, terms of trade and real exchange rate) of cross-border e-commerce trade. The panel data from the year of 1998 to 2016 will be employed to estimate the relationship between cross-border e-commerce trade

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and relevant variables under the dynamic ordinary least squares and the error correction model. The findings of this paper show that there is a long-run relationship between cross-border e-commerce trade and relevant variables. In terms of cross-border e-commerce export, the GDP has a positive effect on cross-border e-commerce export. The terms of trade and the population have a positive effect on cross-border e-commerce export, but both of them are not significant in statistics. The real exchange rate has a negative effect on cross-border e-commerce export, but only significant at 10%. In terms of cross-border e-commerce import, the GDP, the real exchange rate and the population have a positive effect on cross-border e-commerce import. The terms of trade have a negative effect on cross-border e-commerce import.

The rest of this paper will be recognized as follows: Chapter two presents the literature review that is a summary of previous achievements so as to show the difference between this paper and that of previous. Chapter three provides the theoretical framework that forms a base for this paper. Chapter four uses the dynamic ordinary least squares and the error correction model to explore the relationship between cross-border e-commerce trade and relevant variables. Chapter five shows the conclusion and the limitations of this paper.

2. Literature Review

With the popularization of internet and economic globalization, the development of cross-border e-commerce trade is advancing rapidly. Because the developing history of cross e-commerce trade is relatively short, the factors affecting its development are still unclear. Based on this background, a large number of scholars have tried their best to explore the factors that may affect the development of cross-border e-commerce trade.

Terzi (2011) studies the determinants of e-commerce trade in terms of international trade and employment. He finds that e-commerce trade presents economy-wide benefits to all countries. Concretely speaking, the developed countries will benefit most in the short run while the developing countries will benefit more than that of developed countries in the long run. The e-commerce trade has a positive effect on international trade. But its effect on employment is not significant. Conversely, both of them can affect the e-commerce trade to some degree. Kwon, Kim, Yoon, and Jeon (2010) investigate the relationship between MRO (maintenance, repair and operation) e-commerce system and purchase effects. They find that business to business e-marketplace will increase and diversify electronic commerce continuously. Morganti, Seidel, Blanquart, Dablanc, and Lenz (2014) investigate the relationship between e-commerce trade and final deliveries from the prospective of alternative parcel delivery services in France and Germany. The e-commerce trade for physical goods leads to a significant demand for dedicated delivery services, and leads to increasingly difficult last mile logistics. They find that the e-commerce trade can increase the number of successful first-time deliveries, optimize delivery rounds and lower operational costs. Liu (2012) figures out that in the small cross-border e-commerce trade, customs clearance, logistics and credit problems are prominent to impede the small enterprises to perform the cross-border e-commerce trade. Lai and Wang (2014) find that customs clearance, market supervision and settlement restrict the development of cross-border e-commerce. Wang and Yang (2014) also point out that the cross-border logistics is the bottleneck of cross-border e-commerce rule demand. Ren and Li (2014) hold the view that the cross-border e-commerce trade has an impact on transformation and upgrading of foreign trade, and they put forward countermeasures and suggestions for the problems of customs clearance, payment, credit and logistics in cross-border e-commerce trade. Aydın and Savrul (2014) set Turkish as an example to study the relationship between globalization and e-commerce trade. The globalization has become one of the most remarkable phenomenon of the 20th century that has shaped the world economy dramatically. Globalization process is followed behind the decrease in administrative barriers to conduct trade, sharp decreases in the costs of communication and transportation, production processes fragmentation and development in information and communication technology which, by opening up new markets and acquiring new raw materials and resources, lay a foundation for resource diversification, creation and development of new investment opportunities. They find that the globalization provides a good channel for the development of e-commerce trade. Yang and Lu (2014) find that cross-border e-commerce of China's foreign trade enterprises has many problems in electronic payment, customs clearance and logistics, and lacks systematic laws and regulations. Moreover, Zhang and Jang (2014) figure that the cross-border e-commerce trade has such problems as consumer distrust, imperfect service system, language and geographical barriers.

Liu and Zhao (2015) use the 2010-2016 import and export of cross-border electricity trade size diagram to analyze the development trend in recent years of cross-border electricity supplier. They find that the logistics time, logistics cost, relevant policies such as traditional customs policy and cross-border return process are the most significant factors that block the development of cross-border e-commerce trade. Liu (2015) analyzes the influencing factors of cross-border e-commerce trade development in terms of “cross-

border“. He finds that at present, the cross-border social culture, the cross-border marketing, the cross-border e-commerce platform, the cross-border payment, the cross-border logistics, the cross-border inspection and the customs are the main factors that affect the cross-border e-commerce trade development. Anvari and Norouzi (2016) use the panel data from 2005 to 2013 to explore the relationship between e-commerce trade and economic development in some selected countries. Via conducting the empirical analysis under the generalized least square regression approach, They find that the e-commerce trade has a significant and positive impact on GDP per capita based on purchasing power parity. Concomitantly, the development of GDP per capita also has a positive effect on e-commerce trade. Lu (2015) selects three main factors (external marketing, internal management and leadership decision-making) to describe the key factors that affect the success of cross-border e-commerce trade. The cross-border e-commerce trade can be said to be the product of the combination of foreign trade and information technology. He finds that in the process of internal operation of enterprises, the degree of informatization has a great impact on the development of cross-border e-commerce trade. Moreover, the technology & quality of employees, information system and maintenance technology of enterprises directly determine the development trend of cross-border e-commerce trade. Meanwhile, the external market environment also has a certain impact on the development of cross-border e-commerce trade. Still, the decision-making of enterprise leaders is an important guarantee for the normal development of cross-border e-commerce trade.

Jiang, Wang, and Liu (2017) construct a revised trade gravity model to empirically test the influencing factors of cross-border e-commerce trade based on the cross-sectional data of China's cross-border e-commerce goods import & export trade in 2012 and the characteristics of cross-border e-commerce trade. Their results show that the theory of "trade gravity" is also applicable to the cross-border e-commerce trade. The level of infrastructure of trading partners and the quality of internet connection are the most important factors affecting the scale of import and export of cross-border e-commerce goods in China. He and Wei (2017) employ the annual data from 2000 to 2016 to analyze the relationship between e-business trade and economic growth under the vector auto regressive model. They find that the economic growth is a driving factor to promote the development of e-business trade. Wang (2017) also studies this proposition via the ordinary least squares. His result matches that of He and Wei (2017). Valarezo, Pérez-Amaral, Garín-Muñoz, García, and López (2018) attempt to explore the determinants of the individual's decision to conduct the cross-border e-commerce trade. By using logistic regression techniques and a standard neoclassical utility maximization framework, their findings indicate that becoming a male has a positive effect on probability of practicing the cross-border e-commerce trade. Education has a significantly positive effect on probability of being involved in the cross-border e-commerce trade with European Union countries. Computer and internet skills are regarded as significant and positive factors in explaining the cross-border e-commerce trade (either with European Union countries or with the rest of the world). Foreign nationality also increases the likelihood of using the cross-border e-commerce trade.

When summarizing the previous achievements, we can find that most of them are only focusing on a specific country to study the determinants of cross-border e-commerce trade. In this paper, the panel data from the ASEAN countries will be used to construct a panel data to explore the determinants of cross-border e-commerce trade under the dynamic ordinary least squares and the panel vector error correction model. Said differently, this point is one of the biggest innovations in this paper. All the previous papers will be listed in <Table 1>.

Table 1: Summary of Previous Studies

Author	Year	Determinants
Terzi	2011	International Trade (+), Employment (+)
Morganti, Seidel, Blanquart, Dablanc, and Lenz	2014	final deliveries (-)
Liu	2012	customs clearance (-), logistics (-), credit problems (-)
Lai and Wang	2014	customs clearance (-), market supervision (-), settlement (-)
Wang and Yang	2014	cross-border logistics (-)
Ren and Li	2014	customs clearance (-), payment (-), credit (-), logistics (-)
Aydın and Savrul	2014	globalization (+)
Yang and Lu	2014	electronic payment (-), customs clearance (-), logistics (-), lacks systematic laws and regulations (-)
Zhang and Jang	2014	consumer distrust (-), imperfect service system (-), language (-), geographical barriers (-)

Liu and Zhao	2015	logistics time (-), logistics cost (-), relevant policies (-)
Liu	2015	cross-border social culture (-), cross-border marketing (-), cross-border e-commerce platform (-), cross-border payment (-), cross-border logistics (-), cross-border inspection (-), customs (-)
Anvari and Norouzi	2016	economic development (+)
Lu	2015	external marketing (-), internal management (-), leadership decision-making (-)
Jiang, Wang and Liu	2017	internet connection (+)
He and Wei	2017	economic growth (+)
Wang	2017	economic growth (+)
Valarezo, Pérez-Amaral, Garín-Muñoz, García and López	2018	becoming a male (+), education (+), Computer (+), internet skills (+)

Note: 1) "-" represents the negative effect. 2) "+" represents the positive effect.

3. Theoretical Framework

Gravity model of trade in international economics is a kind of model that forecasts the bilateral trade flows which are based on the economic sizes (usually measured by GDP) and distance between two economic entities. Isard firstly uses this model in the paper called "Location Theory and Trade Theory: Short-Run Analysis". The general model for international trade between two countries gives:

$$tf_{i,j,t} = \alpha \frac{g_{i,t} g_{j,t}}{d_{i,j,t}} \quad (1)$$

Where $tf_{i,j}$ represents the trade flow from country i to country j, g_i represents the economic mass of country ; g_i represents the economic mass of country j, $d_{i,j}$ represents the distance between country i to country j, α represents a constant. Head and Mayer (2014) use this model to analyze the determinants of flows of bilateral trade such as common colonial legacies, common languages, common borders, common currencies, common legal systems. And it has been employed to verify the effectiveness of trade agreements. The model is also used in international relations to assess the impact of treaties and alliances on trade.

Because the gravity model for international trade does not hold completely, in econometrics, the usage of it usually should be specified:

$$tf_{i,j,t} = \alpha \frac{g_{i,t} g_{j,t}}{d_{i,j,t}} \eta_{i,j,t} \quad (2)$$

Where $\eta_{i,j}$ denotes the error term whose expectation is equal to 1.

The traditional way to estimate this equation involves in taking the logarithm of both sides. The form of a log-log model gives:

$$tf_{i,j,t} = \beta_0 + \beta_1 \log g_{i,t} + \beta_2 \log g_{j,t} - \beta_3 \log(d_{i,j}) + \varepsilon_{i,j,t} \quad (3)$$

Where $\alpha \subseteq \beta . \varepsilon$ represents the white noise.

But, there are two main problems with this approach. The one is that its is obvious that this model can not be used when there exists any observation that is equal to zero (If an observation is zero, $tf_{i,j}$ will be equal to zero). Second, Silva and Tenreyro (2006) argue that estimating the log-linearized equation via the ordinary least squares can result in the significant biases. Alternatively, they suggest that the model should be estimated in its multiplicative form.

$$tf_{i,j,t} = Exp[\beta_0 + \beta_1 \log g_{i,t} + \beta_2 \log g_{j,t} - \beta_3 \log(d_{i,j})]\eta_{i,j} \quad (4)$$

Using a Poisson pseudo-maximum likelihood estimator usually employs for count data. One of the authors' more surprising findings is that having past colonial ties does not increase the trade when controlling for a common language shared. This is despite the fact that simpler methods, such as taking simple averages of trade shares of countries with and without former colonial ties proposes that countries with former colonial ties continue to trade more. Silva and Tenreyro (2006) do not explain where their findings come from and even fail to realize their results are highly anomalous. Martin and Pham (2008) figure that using Poisson pseudo-maximum likelihood, when zero trade flows are frequent, the gravity deviates significantly from estimates. But, their findings are challenged by Silva and Tenreyro (2011), who think the simulation findings of Martin and Pham (2008) are based on the model specified by mistake and show that the Poisson pseudo-maximum likelihood estimator performs well even with a large proportion of zero.

In applied work, Baldwin and Taglioni (2007) apply the model that is usually extended by including variables to explain linguistic relations, tariffs, contiguity, maritime access, colonial history, and exchange rate regimes. Yet the estimation of structural gravity which is based on Anderson

and van winkle (2003), and requires the inclusion of fixed effects on importers and exporters, thereby limiting the gravity analysis of bilateral trade costs.

In this paper, GDP will be introduced to the gravity model. Due to the characteristics of cross-border e-commerce trade (population of a country represents the potential consumers in the e-commerce market), the population is also introduced to the gravity model. The real change rate also affects the cross-border e-commerce trade. In therms of domestic country, an increase in the real exchange rate will lead to a decrease in the cross-border e-commerce import due to depreciation of domestic currency. Conversely, an increase in the real exchange rate will lead to an increase in the cross-border e-commerce export due to depreciation of domestic currency. Therefore, the real exchange rate will be introduced into the gravity model. The terms of trade (ratio of export price index to the import price index) also affect the cross-border e-commerce trade. If the export price index increase, the cross-border e-commerce export will decrease. On the contrary, if the import price index increase the cross-border e-commerce import will also decrease. So, the terms of trade will be introduced into the gravity model.

Allayarov, Mehmed, Arefin, and Nurmatov (2018) and Zebua (2016) apply the gravity model to discuss the export and import. Based on their achievements, the export and import of cross-border e-commerce of gravity model, namely, the revised gravity model in this paper gives:

$$\log ex_{i,j,t} = \beta_0 + \beta_1 \log gdp_{i,t} + \beta_2 \log pop_{i,t} + \beta_3 \log rer_{i,j,t} + \beta_4 \log tot_{i,j,t} + \varepsilon_{ex,t} \quad (5)$$

$$\log im_{i,j,t} = \gamma_0 + \gamma_1 \log gdp_{i,t} + \gamma_2 \log pop_{i,t} + \gamma_3 \log rer_{i,j,t} + \gamma_4 \log tot_{i,j,t} + \varepsilon_{im,t} \quad (6)$$

Where $ex_{i,j}$ represents the volume of export of cross-border e-commerce goods from country i to country j, $im_{i,j}$ represents the volume of import of cross-border e-commerce goods from country i to country j. gdp_i represents the gross domestic productivity of country i, pop_i represents the population of country i. tot represents the terms of trade (ratio of domestic export price index to foreign export price index). ε_{ex} and ε_{im} represents the white noise.

4. Estimation Model

4.1. Variable Description

This paper uses the panel data to explore the relationship between cross-border e-commerce trade and relevant variables. There are six variables in this paper, including the cross-border e-commerce export, the cross-border e-commerce import, the GDP, the population, the terms of trade and the real exchange rate. The cross-border e-commerce export and the cross-border e-commerce import are treated as the dependent variables. The GDP, the population, the terms of trade and the real exchange rate are treated as the independent variables. All the data used in this paper are soured from UNCTAD, World Bank, National Bureau of Statistics of China and Research Report on China's Cross-border E-Commerce Market in 2017. Meanwhile, all these data are logged so as to remove the outlires and the heteroscedasticity. All variables will be shown in <Table 2>.

Table 2: Variables

Variable Type	Log form	Definition
Dependent Variable	$\log ex$	cross-border e-commerce export (from China to each ASEAN country)
Dependent Variable	$\log im$	cross-border e-commerce import (from each ASEAN country to China)
Independent Variable	$\log gdp$	GDP
Independent Variable	$\log pop$	population (each ASEAN country)
Independent Variable	$\log tot$	terms of trade (each ASEAN country in terms of China)
Independent Variable	$\log rer$	real exchange rate (each ASEAN country in terms of RMB)

4.2. Panel Unit Root Test

The panel unit root test has a variety of test statistics which mainly depend on the heterogeneity of each group and the asymptotic characteristics of each group and time-series data as well as the balanced or unbalanced panel. Therefore, we should confirm what kinds of test statistics will be used in this paper before conducting the panel data. Essentially, the panel unit root test is the same as the Dicky-Fuller test of time series. Namely, $\Delta y_{i,t} = \phi y_{i,t-1} + z'_{i,t}\gamma_i + \varepsilon_{i,t}$ is tested with a size hypothesis (null hypothesis: H_0) that $\phi = 0$ for all i. In order to solve the sequence correlation problem of intrinsic error terms, Levin-Lin-Chu (2002) tests the size hypothesis that the lag dependent variables and all panel groups have a unit root (LLC). The model gives:

$$\Delta y_{i,t} = \phi y_{i,t-1} + z'_{i,t}\gamma_i + \sum_{j=1}^{p} \theta_{i,j} \Delta y_{i,t-j} + \varepsilon_t \quad (7)$$

LLC test assumes that the autoregressive parameters of all panel groups are the same ($\phi_i = 0$), and the optimal time lag (p) uses the time lag which obeys the minimization of standard information (Harris & Tzavalis, 1999) test is based on the ordinary least squares' statistics ϕ of $y_{i,t} = \phi y_{i,t-1} + z'_{i,t}\gamma_i + \varepsilon_t$. It is assumed that the intrinsic error term $\varepsilon_{i,t}$ has the same normal distribution with independent and uniformed distribution of group-specific constants. It is similar to the LLC test in that it has the same parameters between panel groups to test the null hypothesis (H_0: ϕ = 0). Breitung (2000) tests its own lag estimates as explanatory variables, calculates test errors before calculating test statistics, and then calculates test statistics. Im-Persarm-Shin (2003) also conducts an estimation on the panel unit root test. The model gives:

$$\Delta y_{i,t} = \phi y_{i,t-1} + \beta Z_{i,t} + \varepsilon_{i,t} \quad (8)$$

This test is different from LLC test. It assumes that each group (i) has different ϕ_i. And for all i, ϕ_i is equal to zero [The IPS test differs from the LLC test assuming that the inherent error term for each panel group has this variance (σ^i)]. Considering the cultural and institutional differences among the panel groups, the IPS test is a more realistic assumption (In the Fisher-type test, the unit root is tested using equation (8) for panel group, and p is calculated. Then, the equation $\mathrm{p} = -2\sum_{i=1}^{n}\log p_i$ is calculated, which follows the $X^2(2n)$ distribution and rejects the null hypothesis that the panel unit root exists as the p value increases. Choi (2001) and Hadri's (2000) LM test tests the null hypothesis that panel data is stable, unlike other tests). Said differently, the IPS test estimates the equation (8) for each panel group and calculates the statistic by averaging t values, while the LLC test calculates the statistics after pooling the index to estimate a pooling regression model for equation (7). The results of panel unit root test show in <Table 3>.

Table 3: Results of Panel Unit Root Test

Variable	IPS	Fisher	LLC	BR	HADRI
$\log pop$	-11.789***	123.747***	-12.518***	-5.482***	5.697***
$\log rer$	-0.176	1.239	-1.550*	-0.531	6.867***
$\log im$	3.531	17.897	-6.053***	3.201	4.964***
$\log ex$	-2.322***	40.094***	-6.544***	3.500	6.182***
$\log tot$	0.035	18.796	7.023	-0.922	7.424***
$\log gdo$	2.162	9.705	-1.293*	2.334	4.664***

Note: 1) * means 10% significant level, **means 5% significant level, ***means 1% significant level.

2) HADRI statistic tests the null hypothesis that the panel data is stable, while the null hypothesis of the other statistic tests the null hypothesis that the panel data has the unit root.

<Table 3> shows the results of panel unit root test. The population (each ASEAN country's population) is analyzed to be stable by rejecting the null hypothesis that "data is stable" in the HADRI test, while rejecting the null hypothesis that all other statistics have unit root. the real exchange rate has a unit root under all statistics except LLC statistic at 10% significant level. The cross-border e-commerce import (China imports from each ASEAN country) has a unit root except the LLC test at 1% significant level. The cross-border e-commerce export (China exports to each ASEAN country) does not have a unit root except the BR test and HADRI test. The terms of trade have a unit root under all statistic tests. The GDP (each ASEAN country's GDP) has a unit root except the LLC test at 1% significant level. Said differently, As a result of the unit root test for the panel data used in this paper, all variables except the population (each ASEAN country's population) are analyzed to have a unit root in statistics. Since panel datum have the characteristics of unstable time series with a unit root, it is necessary to perform the cointegration test to determine whether there is stable linear combination or cointegration relation between variables.

4.3. Co-integration Test

When the data used in panel model are non-stationary, especially the first integral [I(1)], the estimation via this model will lead to a spurious problem. In order to solve this problem, it is necessary to test the stationary linear relationship between variables, that is, the cointegration, even if the data is non-stationary. In this paper, we will employ Kao (1999), Pedroni (1999, 2004) and Westerlund (2007) test to test the cointegration of panel data. All the above test approaches are based on the panel model for the I(1) of dependent variable $y_{i,t}$.

$$y_{i,t} = X'_{i,t}\beta_i + Z'_{i,t}\gamma_i + \varepsilon_{i,t} \quad (9)$$

Where $X_{i,t}$ represents the I(1) of independent variables. β_i represents the panel group conitegrated vector. γ_i. represents the coefficient. $Z_{i,t}$ represents the deterministic variable representing the fixed effect or linear time trend for each group. $\varepsilon_{i,t}$ represents the unique error term. All tests test the stationarity of $\varepsilon_{i,t}$ and test the null hypothesis that there is no cointegration in $y_{i,t}$ and $X_{i,t}$. After estimating the equation (16) by using the ordinary least squares, we perform a panel unit root test which is similar to the Dicky-Fuller test for the residual of formula $\hat{\varepsilon}_{i,t} = \rho\hat{\varepsilon}_{i,t-1} + v_{i,t}$.

The Kao (1999) test assumes that the cointegrated vector among panel groups is the same, namely, $\beta_i = \beta$ (Kao

(1999) test takes into account the fixed effects of each group but does not include time trends). Therefore, it is assumed that the estimated coefficients of the residual equations are all the same, namely, $\rho_i = \rho$. This test presents modified DF, DF and ADF statistics, and estimated coefficient ρ is estimated by using the Dicky-Fuller and Augmented Dicky-Fuller regression method. The Pedroni (1999, 2004) test is different from the Kao test, which assumes that all panel groups have the same cointegrated vector, and assumes that the panel groups have different cointegrated vectors. It is also assumed that the AR (1) of the residual term is also different for each panel group. The Westerlund (2007) test uses different cointegrated vectors and AR (1), and the variance ratio (VR) statistic is presented to test the null hypothesis and some panel groups are cointegrated (This test also tests the hypothesis that all panel groups are cointegrated under the assumption of $\rho_i = \rho$).

Table 4: Results of Cointegration Test

Equation	Kao statistic	Pedroni Statistic	Westerlund Statistic
(5)	-11.619***	-8.142***	-2.778***
(6)	-2.700***	-2.001***	-1.387*

Note: 1) * means 10% significant level, **means 5% significant level, ***means 1% significant level.

<Table 4> shows the results of cointegration tests by Kao (1999), Pedroni (1999, 2004) and Westerlund (2007), respectively. As a result of the cointegration test for equation (5), the null hypothesis is rejected at 1% significant level in all statistics. Meanwhile, the test for equation (6) also rejected the null hypothesis at the 1% or 10% significance level in all statistics. These results suggest that almost all variables (cross-border e-commerce export, cross-border e-commerce import, real exchange rate, GDP, population and ters of trade) have unit roots. So even if they are non-stationary, the long-run stable linear relationship (cointegration relation) exists.

4.4. Results

In order to quantitatively analyze the determinants of cross-border e-commerce trade, equation (5) and equation (6) will be estimated under the dynamic ordinary least squares produced by Pedroni (1999, 2004) and Kao and Chiang (1999), and estimated under the error correction model including the cointegrated vector term of Westerlund (2007) [Kao and Chiang (1997) analyze OLS, FMOLS, and DOLS models using Monte Carlo simulation when panel data are cointegrated. The OLS and FMOLS estimates are not improved, but the DOLS estimates improve significantly]. The dynamic ordinary least squares model of Pedroni and Kao and Chiang gives:

$$y_{i,t} = \alpha_i + \beta_i x_{i,t} + \sum_{j=-p}^{p} \gamma_{i,t} \Delta x_{i,t-j} + \varepsilon_{i,t} \quad (10)$$

Where β_i represents the estimated slope. $x_{i,t}$ represents the explanatory variables. ρ represents the past and preceding time difference. In order to solve the autocorrelation of inherent error and endogeneity among variables. All these problems include in equation (10). <Table 5> shows the results of dynamic ordinary least squares.

Table 5: Results of Dynamic Ordiary Least Squares' Estimation

Equation	Explained Variable	Explanatory Variable	DOLS Statistic (Pedroni)	DOLS Statistic (Kao and Chiang)
(5)	$\log ex$	$\log gdp$	1.730***	0.484*** (0.094)
		$\log pop$	1.135***	0.020 (0.141)
		$\log tot$	1.846***	-0.121
		$\log rer$	-0.572***	-0.080*** (0.014)
Equation	**Explained Variable**	**Explanatory Variable**	**DOLS Statistic (Pedroni)**	**DOLS Statistic (Kao and Chiang)**
(6)	$\log im$	$\log gdp$	1.775***	0.282*** (0.021)
		$\log pop$	1.207***	0.334** (0.075)
		$\log tot$	-2.045***	0.036 (0.145)
		$\log rer$	0.629***	0.086 (0.051)

Note: 1) * means 10% significant level, **means 5% significant level, ***means 1% significant level. ( ) means the standard error.

As <Table 5> shows, the two approaches show that the GDP, the population, the terms of trade have a positive effect on cross-border e-commerce export and the real exchange rate has a negative effect on cross-border e-commerce export. Said differently, the GDP increases by 1% will lead to 1.730% (Pedroni) and 0.484% (Kao-Chiang) increase in the cross-border e-commerce export. The population increases by 1% will lead to 1.135% increase in the cross-border e-commerce export, but not significant in Kao-Chiang approach. The terms of trade increases by 1% will lead to 1.846% increase in the cross-border e-commerce export, but not significant in Kao-Chiang approach. The real exchange rate increase by 1% will lead to 0.572% (Pedroni) and 0.080% (Kao-Chiang) decrease in the cross-border e-commerce export. As for the cross-

border e-commerce import, the GDP, the population, the real exchange rate have a positive effect on cross-border e-commerce import and the terms of trade has a negative effect on cross-border e-commerce import. Said differently, the GDP increases by 1% will lead to 1.775% (Pedroni) and 0.282% (Kao-Chiang) increase in the e-commerce import. The population increases by 1% will lead to 1.207% (Pedroni) and 0.334% (Kao-Chiang) increase in the cross-border e-commerce import, but not significant in Kao-Chiang approach. The terms of trade increases by 1% will lead to 1.846% decrease in the cross-border e-commerce import, but not significant in Kao-Chiang approach. The real exchange rate increase by 1% will lead to 0.629% increase in the cross-border e-commerce import, but not significant in Kao-Chiang approach.

In order to obtain the robustness of estimated results, equation (5) and equation (6) will be separately estimated by using the error correction model (ECM) including the cointegration vector term. The general equation for the ECM model gives:

$$\Delta y_{i,t} = \alpha_i d_t + \beta_i (y_{i,t} - \gamma_i x_{i,t-1}) + \sum_{j=1}^{p} \theta_{i,j} \Delta y_{i,t-j} + \sum_{j=1}^{p} \mu_{i,j} \Delta x_{i,t-j} + \varepsilon_{i,t} \quad (11)$$

Where d_i represents the time trend and constant. β_i represents the adjusted coefficient that measures the rate at which the cointegrated vector converges back to equilibrium when it deviates from long-term equilibrium. represents the cointegrated vector. $\theta_{i,j}$ and $\mu_{i,j}$ represents the coefficients of differencing terms. In this paper, the model is estimated by two methods. The first one is the dynamic fixed effect model considering heterogeneous effects between panel groups. Another is the error correction model that Westerlund (2007) applies. The results show in <Table 6>.

Table 6: Results of Error Correction Estimation

Equation	Explained Variable	Explanatory Variable		Dynamic Fixed Effect	Westerlund Error Correct Model
(5)	$\log ex$	Long-run Equilibrium	$\log gdp$	1.498*** (0.057)	1.366*** (0.054)
		Long-run Equilibrium	$\log pop$	0.025 (0.068)	0.147 (0.166)
		Long-run Equilibrium	$\log tot$	0.033 (0.089)	0.060 (0.118)
		Long-run Equilibrium	$\log rer$	-0.209* (0.117)	-0.209* (0.106)
		Adjusted Coefficient		1.009*** (0.009)	0.502*** (0.042)
		$\Delta \log ex$		0.082*** (0.012)	0.091* (0.058)
		$\Delta \log gdp$		0.672** (0.324)	0.066 (0.442)
		$\Delta \log pop$		0.176*** (0.077)	0.120 (0.144)
		$\Delta \log tot$		0.278** (0.096)	0.133* (0.085)
		$\Delta \log rer$		0.106* -(0.064)	-0.162 (0.153)
(6)	$\log im$	Long-run Equilibrium	$\log gdp$	1.108*** (0.044)	1.026** (0.383)
		Long-run Equilibrium	$\log pop$	0.151*** (0.052)	0.931** (0.461)
		Long-run Equilibrium	$\log tot$	-0.165*** (0.068)	-2.717*** (0.826)
		Long-run Equilibrium	$\log rer$	0.321*** (0.090)	2.717*** (0.831)
		Adjusted Coefficient		0.976*** (0.007)	1.768*** (0.034)
		$\Delta \log im$		0.247* (0.103))	0.133 (0.093)
		$\Delta \log gdp$		0.229*** (0.049)	0.401** (0.184)
		$\Delta \log pop$		0.160*** (0.027)	0.762*** (0.158)
		$\Delta \log tot$		-0.089** (0.034)	-0.036 (0.036)
		$\Delta \log rer$		0.130** (0.042)	0.029 (0.058)

Note: 1) * means 10% significant level, **means 5% significant level, ***means 1% significant level. ( ) means the standard error.

<Table 6> shows the estimated results of the two approaches. When taking long-run relation (cointegrated vector)about the equation (5) into consideration, we can obtain the predicted direction (+) of population and the terms of trade on cross-border e-commerce export, but not significant. This is in contrast to the estimated result of the dynamic ordinary least squares model. Concomitantly, an increase in the economic growth can increase the cross-border e-commerce export (1% significant in statistics). In contrast, a depreciation of domestic currency (an increase in the real exchange rate) will lead to an increase in the cross-border e-commerce export (10% significant in statistics). Meanwhile, The adjusted coefficients that indicate the adjustment speed to the equilibrium are 1.009 and 0.502, respectively, and when they deviate from the long term equilibrium, they will converge to the equilibrium through correcting the error. According to the different models, the dynamic fixed effect model is analyzed to be converged about two times faster than that of Westerlund error correct model and statistically significant. As for the equation (6), An increase in the GDP, the population and the real exchange rate will increase in the cross-border e-commerce import.

Oppositely, an increase in the terms of trade will decrease in the cross-border e-commerce import. Said differently, these results are consistent with the theory in the dynamic fixed effect model. Meanwhile, the adjusted coefficients are significant in statistics. But, the convergence speed of Westerlund error correct model (1.768) is two time faster than that of dynamic fixed effect (0.976).

5. Conclusion

This paper sets ASEAN 10 countries as an example to explore the determinants of cross-border e-commerce trade. The panel data from the year of 1998 to 2016 are employed to conduct a series of such as the panel unit root test and the cointegration test. Concomitantly, the dynamic ordinary least squares model and the error corretion model are also used to estimate the long-run equilibrium relation between cross-border e-commerce trade (cross-border e-commerce export & cross-border e-commerce import) and relevant variables (GDP, population, terms of trade and real exchange rate). Especially, this paper divides the cross-border e-commerce trade into two sectors. One is the cross-border e-commerce export. Another is the cross-border e-commerce import. This treatment is a novel way to display how the relevant variables affect the cross-border e-commerce trade more clearly. Of course, this kind of process is an innovation that can distinguish from other documents. This paper uses a various approaches such as IPS, Fisher, LLC, BR and HADRI to conduct the panel unit root test. Its results show that except the population, the rest has a unit root. Namely, they are non-stationary. We also apply a lot of approaches such as Kao, Pedroni, and Westerlound to perform the cointegration test among cross-border e-commerce export, cross-border e-commerce import, GDP, population, terms of trade and real exchange rate. Its results show that there is a long-run relationship among them. Meanwhile, the dynamic ordinary least squares and error correction model are adopted to estimate the long-run equilibrium relationship among cross-border e-commerce export, cross-border e-commerce import, GDP, population, terms of trade and real exchange rate. Their results show that the GDP, the population and the terms of trade play a positive role in promoting the cross-border e-commerce trade. Unfortunately, the population and the terms of trade do not get through the significant test. At the same time, the real exchange rate pose a negative effect on cross-border e-commerce export, but only significant at 10%. In terms of cross-border e-commerce import, the GDP, the population and the real exchange rate have a positive effect on cross-border e-commerce import. On the contrary, the terms of trade has a negative effect on cross-border e-commerce import.

In summary, the economic growth is a powerful to drive the development of cross-border e-commerce trade. Still, there are a lot of limitations in this paper. some other factors such as social system, cultural system or something else may affect the cross-border e-commerce trade. Due to that it is hard to find out a proper index to measure them, the models used in this paper do not include them. This behavior may lead to an overestimation. Another significant limitation is that the theoretical framework is based on gravity model. because the distance between two country is a constant, it can not be differenced (If it is differenced, the value of it will be zero.). It also does not participate in our estimation.

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