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THE ROLE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY TO STRENGTHEN BILATERAL TRADE FLOWS OF ASEAN-5 USING RANDOM EFFECTS QUANTILE REGRESSION

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ABSTRACT: ASEAN-5 (Indonesia, Singapore, Malaysia, Thailand, and the Philippines) is an economic powerhouse in the Southeast Asian region. Singapore is one of the developed countries, while the other four are the emerging market countries. One of the economic strengths of ASEAN-5 is sustained from international trade. ASEAN-5's export performance in the world continues to increase yearly. During the period 2000-2018, the United States (US) and China became the main export destination countries of ASEAN-5. The growing development of ICT is indicated can increase the export volume of ASEAN-5 to these countries. This study analyzes the role of ICT on ASEAN-5 exports to the US and China in 2000 until 2018. The method used is the Random Effects Quantile Regression because the research uses a time-invariant variable, and there is a violation of normality and homoscedasticity assumption. The results show that ICT in each quantile give different effect to ASEAN-5 exports to the US and China. ASEAN-5 countries are expected to be able to increase ICT, especially internet usage, in conducting international trade. It is also useful for marketing superior local products from the hard-to-reach area, especially in archipelagic countries such as Indonesia and the Philippines.

KEYWORDS: ASEAN-5; International Trade; ICT; Panel Data; Random Effects Quantile Regression

I. INTRODUCTION

ASEAN experienced very rapid economic growth. In 2019, the ASEAN economy was the sixth-largest in the world (ASEANStats, 2020). In the last two decades, ASEAN international trade has shifted its destination countries and commodity types. ASEAN trade commodities shift from natural resource-intensive goods to electronics and other manufacturers embedded in global supply chains (Petri & Plummer, 2013).

ASEAN-5, which is Indonesia, Malaysia, the Philippines, Singapore, and Thailand, supports economic acceleration in ASEAN. ASEAN-5 has higher economic rates and more advanced compared to other ASEAN countries. Indonesia has the highest Gross Domestic Product (GDP) in ASEAN, reaching 1.042 trillion USD in 2018 (WorldBank, 2020a). The highest GDP, followed by Thailand, Singapore, Malaysia, and the Philippines.

Singapore is one of the developed countries, while four other countries are emerging markets. Emerging Market Economy countries are in the process of being developed and generally moving towards a free market or a mixture, more industrialized quickly, and have a higher rate of economic growth than developed countries. Emerging market countries tend to be export-oriented countries.

The United States (US) and China are the two main export destinations for ASEAN-5. The total share of ASEAN-5 exports to the US in 2018 reached 9.62 percent. The Philippines has the largest export share to the US, reached 15.63 percent in 2018. Manufacturing Goods are the main ASEAN-5 exports to the US. Indonesia and Thailand have the largest export proportion of labor-intensive producers-based commodities such as textiles, clothing, and footwear to the US. Singapore and Malaysia export more electronic components to the US (WorldBank, 2020b).

China has been the most important trading partner in Southeast Asia since 2009, especially after the global financial crisis. The trend shows that the share of China continued to increase and shift ASEAN's

traditional partners, like the US (Oh, 2017). It is indicated that there has been a transition of ASEAN-5 export destination countries from the US to China. ASEAN-5 export share to the US before 2009 reached more than 10 percent but continued to decline to 7.70 - 9.62 percent (WorldBank, 2020b).

China experienced a shift in export orientation from an export-oriented economy towards a more driven by domestic demand economy. With the opening of the Chinese economy, it can give enormous opportunities for the imported product's market. It will give benefit to neighboring countries (Abeysinghe & Forbes, 2005). Nevertheless, the US remains the second-largest country as the main export destination countries of ASEAN-5 until now.

The development of infrastructure and the use of ICT has an important role in bilateral trade. Thiemann (2013) found that an increase in trading volume in global markets can be caused by increased supply, increased demand, and decreasing trade costs. This study aims to analyze the role of ICT on bilateral trade flows between ASEAN-5 and the main export destination countries, the US, and China. This study employs an augmented gravity model from 2000 until 2018.

II. LITERATURE REVIEW

Although ASEAN has a similar geographical area, regional integration must be carried out because of its extremely diverse in many factors. Regional integration based on the principle of economic cooperation reached its peak when the Free Trade Agreement (ASEAN Free Trade Area) was established. The AFTA subsequently gave rise to new industrial countries such as Singapore, Indonesia, Malaysia, and Thailand (Vahalík, 2014). Siah, Choong, and Yusop (2009) found that although the AFTA preferential arrangement is important, not all ASEAN countries take the benefits from the AFTA formation. ASEAN countries will experience a worse impact in the case of trade deflection in the regional market so that during the crisis, ASEAN countries will tend to increase their exports to developed countries while reducing their imports from their neighbors.

ASEAN is important for the US economy. The US is the traditional ASEAN market besides the European Union and Japan. The US became the ASEAN-5's larger export market and a major source of foreign investment. The importance of the US as an export market varies for each ASEAN-5 country. Until 2018, the Philippines has the highest proportion of exports to and imports from the US compared to other ASEAN countries. It is due to historical reasons (Tongzon, 2002). The transformation of China as the second-largest economy in the world makes China one of the main export destinations of ASEAN. In 2012, the most widely exported commodities by ASEAN to China were mineral fuels, and machinery and transport equipment (Vahalík, 2014).

In modeling panel data related to international trade, Kumar and Ahmed (2015) use the gravity model to examine the determinants of exports and imports flows from South Asia's countries. Aliyu and Bawa (2013) use the gravity model to prove the Linder hypothesis in Nigeria, and their finding has important implications for gaining better trade performance in the future by socio-cultural, economic, and bilateral trade negotiations. First introduced in the 1960s, the gravity model has been used for policy implications in international trade because of its considerable explanatory power and empirical robustness (Kepaptsoglou, Karlaftis, & Tsamboulas, 2010).

The utilization of ICT in international trade has also been carried out by many previous studies. Liu and Nath (2013) examine the effect of ICT on the international trade of emerging market countries. The research used the growth of telecom investment and international internet bandwidth as representing ICT infrastructure, and internet subscriptions per 100 people and the number of internet hosts per 100 people as represented the use of ICT. Yushkova (2014) analyzes the role of ICT, namely the use of the internet by the business community in the international trade flow between OECD countries, Brazil, China, India, Indonesia, Russia, and South Africa.

The quantile regression model is different from the general linear regression model, which is limited by conditional averages. Hao, Naiman, and Naiman (2007) explain that the use of classical regression will only work well when the regression assumptions are met. Chetverikov, Larsen, and Palmer (2016), through quantile regression, conclude that the increase in Chinese import competition had a more significant effect on low-wage earners in the US than high-wage earners. Vu, Holmes, Lim, and Tran (2014) found different results when conducting a study of the linkage between export status and firm profit growth in Vietnam in 2005-2009. By using quantile regression, it is concluded that export participation is positively related to the profitability of high profit growth firms, but negatively related to those low-profit growth firms.

In general, research related to quantile regression in panel data mostly produces fixed-effect models. Ponomareva (2010) conclude that the fixed effect equation may be different for each different quintile when the covariate has a continuous distribution. Youxi and Maozai (2010) conclude that estimation with fixed effects panel data model with Monte Carlo simulation shows better results compared to the mean regression method, especially when the error distribution is non-normal. However, in some cases involving time-invariant variables, this method cannot be used (Arellano & Bonhomme, 2013; Galvao & Poirier, 2017). By comparing fixed effect quantile regression, the random effect quantile regression has several advantages, which allows for time-

invariant regressors, time-series dimensions could be small and fixed, and simple to carry in practice (Galvao & Poirier, 2017).

III. METHODOLOGY/MATERIALS

3.1 Gravity Model

Gravity equation was first introduced by Tinbergen (1962) and Pöyhönen (1963) to analyzed the international trade flows. The simple trading gravity model can be simply expressed as:

$$T_{ij} = \propto \left(\frac{Y_i Y_j}{D_{ij}}\right)$$

where T_{ij} is the value of exports from country i to country j, Y_i and Y_j are the economic scales of the two countries, D_{ij} is the distance between two countries, and $\propto$ is a constant. Furthermore, this equation develops into the augmented gravity model by adding other variables as new explanatory variables (Liang & Zuo, 2010). Augmented gravity model explained by Bergstrand (1985) follows the specification:

$$PX_{ij} = \alpha(Y_i)^{\beta_1}(Y_j)^{\beta_2}(D_{ij})^{\beta_3}(A_{ij})^{\beta_4}u_{ij} \quad (1)$$

where:
PX_{ij} = the USD value of the trade flow from country i to country j
Y_i (Y_j) = the USD value of nominal GDP in the country i (j)
D_{ij} = distance from the economic center of country i to country j
A_{ij} = other factors either aiding or resisting trade between country i and country j
u_{ij} = error term with $E(\ln u_{ij}) = 0$
The conventional approach to estimate Eq (1) is by taking logs of both side of it, as follows:

$$\ln(PX_{ij}) = \beta_0 + \beta_1 \ln(Y_i) + \beta_2 \ln(Y_j) + \beta_3 \ln(D_{ij}) + \beta_4 (A_{ij}) + \varepsilon_{ij} \quad (2)$$

where $\beta_0 = \ln \alpha$ and $\varepsilon_{ij} = \ln u_{ij}$

3.2 Random Effects Quantile Regression

Koenker and Hallock (2001) explained that the difference between classical linear regression and quantile regression is the classical linear regression estimates the model for conditional mean function. In contrast, quantile regression estimates the model for conditional quantile function. Koenker (2004) developed the use of quantile regression for longitudinal data in general approach estimation. But this method does not accommodate the inclusion of time-invariant predictors in the consequences of the individual-specific effects. Galvao and Poirier (2017) proposed a random effect model for quantile regression panel data with time-invariant predictors. This method can also capture the heterogeneity and non-normality problems along with the conditional-response variable distribution.

The model of panel data can be written as follows:

$$y_{it} = f(x_{it}, w_i, \alpha_i, \varepsilon_{it}) \quad (3)$$

where:
y_{it} = dependent variable
x_{it} = time-varying predictors
w_i = time-invariant predictors
α_i = unobserved individual-specific components
ε_{it} = disturbance
i = 1, 2, ..., n
t = 1, 2, ..., T

A linear version of (3) can be written as:

$$y_{it} = x_{it}'\beta + w_i'\gamma + \alpha_i + \varepsilon_{it}$$
$$= x_{it}'\beta + w_i'\gamma + V_{it}$$

where $V_{it} = \alpha_i + \varepsilon_{it}$. This model can be generalized to the location-scale model as follows:

$$y_{it} = V_{it} + x'_{it}\beta + w'_i\gamma + x'_{it}h_1(V_{it}) + w'_i h_2(V_{it})$$
$$= V_{it} + x'_{it}\big(\beta + h_1(V_{it})\big) + w'_i\big(\gamma + h_2(V_{it})\big) \quad (4)$$

with the assumption $x'_{it}h_1(.)$ and $w'_i h_2(.)$ are not non-decreasing. This model allows the heterogeneity of V_{it} to depend on both α_i (the individual effects) and ε_{it} (the idiosyncratic error). Then Galvao and Poirier (2017) proposed quantile regression version of (3) and the generalization of (4) as follows:

$$y_{it} = c(V_{it}) + x'_{it}\beta(V_{it}) + w'_i\gamma(V_{it}) \quad (5)$$

where the heterogeneity can be represented by V_{it} and can depend on both the individual effects and the idiosyncratic error, as

$$V_{it} = V(\alpha_i, \varepsilon_{it}) \quad (6)$$

The equation (6) can allow the unobserved heterogeneity to depend on α_i and ε_{it} in a restricted form. Under the assumption which the right-hand side of (5) is increased and normalize $V_{it} \sim \text{Unif}[0,1]$, the conditional quantile of y_{it} can be expressed as:

$$Q_{y_{it}}(\tau|X_i) = c\left(Q_{V_{it}}(\tau|X_i)\right) + x'_{it}\beta\left(Q_{V_{it}}(\tau|X_i)\right) + w'_i\gamma\left(Q_{V_{it}}(\tau|X_i)\right)$$

where $X_i \equiv [X'_{i1},\ X'_{i2}, \ldots, X'_{iT}]'$, $X_{it} = [1, x'_{it}, w'_i]'$, and the quantile of interest is defined by $\tau \in (0,1)$. Under the assumption, the unobserved components are uncorrelated with all predictors, yet $V(\alpha_i, \varepsilon_{it})$ is independent of X_i, then quantile regression can be expressed as:

$$Q_{y_{it}}(\tau|X_i) = c(\tau) + x'_{it}\beta(\tau) + w'_i\gamma(\tau) \quad (7)$$

The equation (7) establishes the linear random effects quantile regression model, given the equation (5) – (6) and condition α_i independence from X_i.

3.3 Data and variable definitions

This study uses panel data of ASEAN-5 and the destination countries (China and the US) from 2000 to 2018. The response variable is the export value (in US$ Thousand) generated from World Integrated Trade Solution. The explanatory variables for the gravity model are separated into two factors:

(1) Basic factors

Economic scale

GDP as a common proxy for economic scales is used for basic gravity model specification. The GDP (in current US$) is generated from The World Bank. The hypothesis is that economic scales have a positive effect on ASEAN-5 export value.

Geographic distance

Xing (2018) uses the physical distance between the capital cities of the countries for modeling bilateral trade flows using the gravity model. The geographic distance (in kilometers) is generated from CEPII. The hypothesis is that distance has a negative effect on ASEAN-5 export value.

(2) General factors

Information and Communications Technology (ICT)

ICT and trade flows are the keys to the New Globalization (Baldwin, 2016). Rodríguez-Crespo and Martínez-Zarzoso (2019) found that ICT and trade are the dynamic factors in the economy, and internet use increases the aggregate trade flows. This study uses the ICT variables which proxied by fixed-telephone, fixed-broadband, and mobile-cellular telephone subscriptions per 100 inhabitants; and the percentage of individuals using the internet from the International Telecommunication Union (ITU). The hypothesis is that each ICT variable has a positive effect on the ASEAN-5 export value.

For the empirical analysis, this study uses developed random effects quantile regression for panel data regression analysis expanded from the gravity model. The model is used because of the inclusion of the distance as a time-invariant variable. Zheng, Shao, and Wang (2017) explain the fixed-effect panel model cannot be applied when the model includes a time-constant explanatory variable such as Distance. The fixed-effect model would not be able to estimate the parameter of the time-invariant variable (Galvao & Poirier, 2017). In addition, to avoid the emergence of multicollinearity problems, a transformation is made for economic scale variables into the market size variable. AhMAd, Ismail, and Hook (2011) use multiplied GDP from both countries as a proxy of market size, respectively: $\text{MarketSize}_{ijt} = \text{GDP}_{it} \times \text{GDP}_{jt}$. This study uses market size as defined by

Xing (2018), respectively $\text{MarketSize}_{ijt} = \left[1 - \left(\frac{\text{GDP}_{it}}{\text{GDP}_{it}+\text{GDP}_{jt}}\right)^2 - \left(\frac{\text{GDP}_{jt}}{\text{GDP}_{it}+\text{GDP}_{jt}}\right)^2\right]$. The estimation of the conditional quantile function expand from Galvao and Poirier (2017) as follows:

$$\begin{aligned} Q_{y_{ijt}}(\tau|X_{ijt}) = {} & \beta_0 + \text{MarketSize}'_{ijt}\beta_1(\tau) + \text{Distance}'_{ijt}\beta_2(\tau) + \text{Broadband}'_{it}\beta_3(\tau) + \\ & \text{Broadband}'_{jt}\beta_4(\tau) + \text{Telephone}'_{it}\beta_5(\tau) + \text{Telephone}'_{jt}\beta_6(\tau) + \text{Cellphone}'_{it}\beta_7(\tau) + \\ & \text{Cellphone}'_{jt}\beta_8(\tau) + \text{Internet}'_{it}\beta_9(\tau) + \text{Internet}'_{jt}\beta_{10}(\tau) \end{aligned}$$

where y_{ijt} is the total export value from country i to country j, MarketSize_{ijt} is the market size of country i and country j, Distance_{ijt} is the physical distance between the capital cities of country i and country j, Broadband_{it} is the fixed-broadband subscription in country i, Broadband_{jt} is the fixed-broadband subscription in country j, Telephone_{it} is the fixed-telephone subscription in country i, Telephone_{jt} is the fixed-telephone subscription in country j, Cellphone_{it} is the mobile-cellular subscription in country i, Cellphone_{jt} is the mobile-cellular subscription in country j, Internet_{it} is the individuals using the internet in country i, Internet_{jt} is the individuals using the internet in country j. The index i is for the home country, j for the destination country, and t for time (year). All variables are set into a natural logarithm.

IV. RESULTS AND FINDINGS

4.1 ASEAN-5 Export to the US and China

As a country that has less natural resources, the main export commodity of Singapore to the US is Capital Goods. Singapore's total exports to the US reached 17.34 percent from total exports to the world. The main export commodities of Singapore to the US are Machinery and Transport Equipment, reaching 64.04 percent averagely during 2000-2018. Based in Figure 1, the export value of Singapore to the US tended to increase, but its share tended to decline. During the global crisis in 2008-2009, the export value of Singapore to the US fell by 33.61 percent.

Malaysia has a significant change in terms of the export value to the US. The total share of Malaysia's exports to the US reached 20.52 percent in 2000. The export commodities of Malaysia to the US are Machinery and Electronics. The commodity export share reached 69.04 percent. The highest of Malaysia's export value to the US is in 2006, reaching 30.19 USD. Since 2008-2009, Malaysia's total export tended to stagnant until 2018. Until 2018 Malaysia's total exports to the US were only around 9.11 percent from total exports to the world.

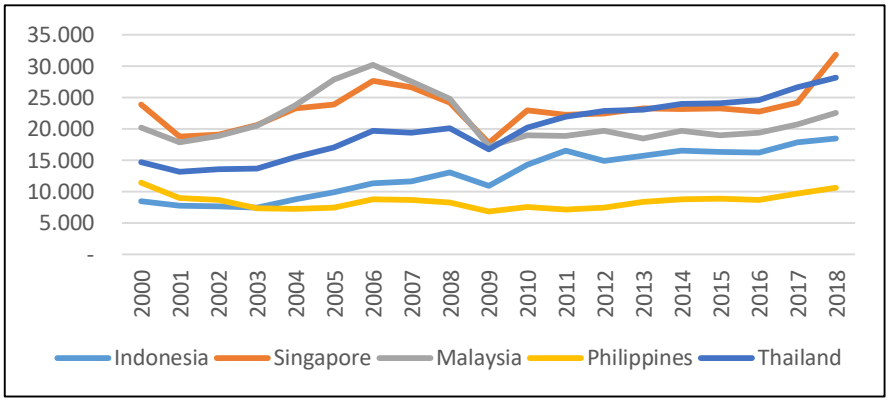

Figure 1. ASEAN-5 export value to the US, 2000-2018 (million USD)
Source: processing from WorldBank (2020b)

Like Singapore and Malaysia, the total exports share from Indonesia and Thailand to the US also tend to decline, but the total export shares of each country are still more than 10 percent. Indonesia had a share of between 8-13 percent. The main commodities of Indonesia to the US are textiles and clothing. It is supported by the involvement of Indonesia in the Global Value Chain (GVC) network in the apparel industry. The US is one of the leading companies and brand holders who shift their production and carry out production contracts to the countries, including the GVC network, which offers the most competitive prices like Indonesia (Munadi, 2015). Indonesia's total exports of textiles and clothing reached 27.34 percent per year, from total exports to the US. Textiles and clothing commodity is also the main commodity exported by Thailand. The average export share reached 9.02 percent. Thailand also exported manufactured goods to the US, with total export share more than 75 percent annually.

Based on Figure 1, the export value of the Philippines to the US is the lowest, but the total export share of the Philippines to the US is the largest than other ASEAN-5 countries. The total share of the Philippines exports to the US reached 18 percent annually. The US has been the main trading partner of the Philippines for the past 19 years. The main commodity exported to the US by the Philippines is Machinery and Electronic, reaching 53.28 percent of total exports to the US.

Since 2010, China has become the second-largest economic power in the world after the US. China's GDP was the second largest in the world in 2009, shifting the position of Japan and Germany. China's economy is supported by the rapid growth of the manufacturing sector. In supporting its economy, China needs a lot of raw materials sourced from ASEAN-5 countries. The trend of ASEAN-5 exports to China is shown in Figure 2 below.

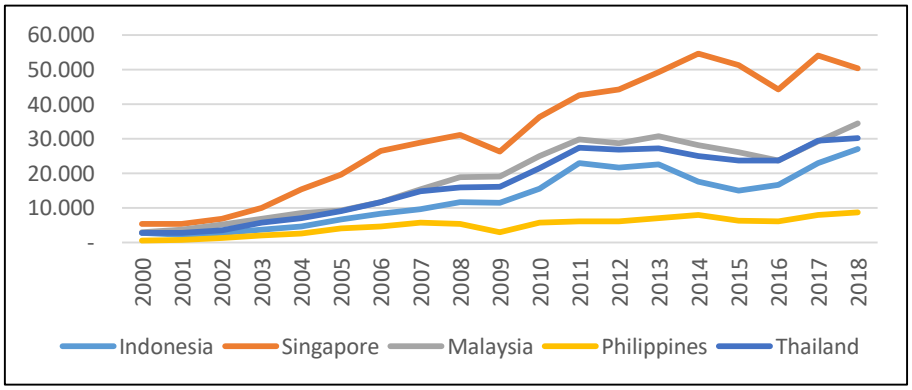

Figure 2. ASEAN-5 export value to China, 2000-2018 (million USD)
Source: processing from WorldBank (2020b)

Based on Figure 2, it can be concluded that the trend of ASEAN-5 exports to China tended to increase, especially after 2009. The total value of Singapore's exports to China increased from 5.38 million USD in 2020 to 50.40 million USD in 2018 or increased by about 44.04 percent per year. The total share of Singapore's exports to China compared to total exports to the world has also increased, from 3.90 percent in 2000 to 12.24 percent in 2018. The main of Singapore's commodities exports to China are Manufacturing Goods, Machinery and Transport Equipment. Singapore also exports Fuels to China, with an average export product share reaching 10.60 percent per year.

In 2000, Malaysia's total exports to China were only 3.03 million USD (3.08 percent of Malaysia's total exports). But in 2018, Malaysia's total export share increased to 34,414 USD (14 percent of total Malaysia's export). The main export commodities are Manufacturing Goods, Machinery and Transport Equipment. Malaysia also exports a lot of Vegetables, Plastic or Rubber, and Fuels.

Indonesia has the largest total export share in China, reaching 15.05 percent in 2018. Indonesia's main export commodities to China are Manufacturing Goods, Fuels, and Agricultural Raw Materials. Since 2005, the commodity exports are dominated by Fuels (more than 30 percent of total exports to China). Indonesia shifts the main export destination from Japan and the US to China since 2016.

Thailand is also experiencing a rising trend in the value of exports to China. Thailand's total export share to China tended to increase, which was only 4.09 percent in 2000 to 11.95 percent in 2018. The main export commodities of Thailand to China are Manufacturing Goods, Machinery and Transport Equipment, Fuels, and Agricultural Raw Materials (such as Plastic or Rubbers, and Woods).

4.2 ASEAN-5 ICT Development

ICT development in ASEAN-5 continues to increase. It is evident from the increase of the ICT Index value in 2016-2017, as shown in Table 1 below.

Table1: ICT Development Index (IDI), 2016-2017

	2016		2017	
Country	**Value**	**Rank**	**Value**	**Rank**
Indonesia	3.85	114	4.33	111
Singapore	7.85	20	8.05	18
Malaysia	6.22	62	6.38	63
Philippines	4.52	100	4.67	101
Thailand	5.31	79	5.67	78

Source: ITU (2017)

ICT Development Index (IDI), a composite index, is used to monitor and compare ICT development between countries. Based on Table 1, Singapore is the country with the highest IDI in ASEAN-5 countries. The Philippines and Indonesia, which is an archipelagic country, is still a country with an IDI ranking above 100. Singapore is the top 20 in the world. It is because the advances in the ICT sector are higher than in other countries in Southeast Asia.

Based on ITU (2020), it can be concluded that the use of fixed-telephone shows a declining trend. Along with the development of technology, the use of a fixed-telephone is substitute by a mobile-cellular telephone, which is more flexible in its use. It in line with the increasing trend of mobile-cellular subscriptions per 100 inhabitants. Indonesia and Thailand have the lowest fixed-telephone subscription per 100 inhabitants, but the trend of mobile-cellular telephone subscriptions per 100 inhabitants tend to increase.

Based on Table 1, the IDI rank of Indonesia is the lowest among ASEAN-5 countries because the ICT development of Indonesia is quite behind than the others. Singapore is more advanced than in other ASEAN-5 countries. Although the Philippines has the same characteristics as Indonesian territory, which is an archipelago, the percentage of internet users in the Philippines is higher than in Indonesia. ICT development, especially internet access, is very beneficial for micro-firms and larger organizations to support international trade. However, the digital divide occurs in micro-enterprises, which are most prevalent in rural areas with geographical constraints such as in an archipelago (Packalén, 2010).

4.3 Panel Estimation Result

In a panel data model, the use of the fixed-effect model will cause the parameter estimates for time-invariant variables cannot be performed (Galvao & Poirier, 2017). Table 2 presents the results of the random-effect model estimation to see the role of ICT on ASEAN-5 exports through the gravity model approach.

Table2: Estimation results of the random-effects model for the role of ICT on bilateral trade

Variables	Random Effects		
	Coefficient	**Std. Error**	**z-value**
$MarketSize_{ij}$	0.078	0.118	0.663
$Distance_{ij}$	-0.577***	0.124	-4.665
$Broadband_{i}$	0.018	0.020	0.907
$Broadband_{j}$	-0.127**	0.050	-2.557
$Telephone_{i}$	0.219***	0.049	4.500
$Telephone_{j}$	0.549***	0.147	3.739
$Cellphone_{i}$	-0.102*	0.057	-1.796
$Cellphone_{j}$	0.656**	0.262	2.509
$Internet_{i}$	0.119***	0.044	2.691
$Internet_{j}$	0.435***	0.131	3.322
Intercept	15.462***	1.012	15.284

*, **, and *** indicate that the coefficient is significant at the 10%, 5%, and 1% level
Source: processing results using R software

Based on Table 2, the random effect model gives significant results for ICT variables, but this model cannot be used. It is because of the violation of homoscedasticity and normality assumptions. Based on the Breusch-Pagan test, where the null hypothesis is homoscedasticity, it produces a p-value < 0.05. It can be concluded that there is a heteroscedasticity problem. Based on the Jarque Bera test where the null hypothesis is an error normally distributed, it produces a p-value < 0.05. The results of this test provide a conclusion that error is not normally distributed. The estimation is then performed using the random effects quantile regression method presented in Table 3 below.

Table3: Estimation results of random-effects quantile regression for the role of ICT on bilateral trade

Variables	**0.1**	**0.2**	**0.3**	**0.4**	**0.5**	**0.6**	**0.7**	**0.8**	**0.9**
MarketSize	0.662***	0.593**	0.660***	0.488**	0.417**	0.416**	0.410**	0.349*	0.234
$Distance_{ij}$	-0.215	-0.323	-0.524*	-0.619**	-0.618***	-0.631**	-0.602**	-0.436*	-0.351
$Broadband_{i}$	0.031	-0.014	0.022	0.035	0.031	0.033	0.056	0.078*	0.093*
$Broadband_{j}$	-0.029	-0.018	-0.099	-0.116	-0.083	-0.111*	-0.120	-0.105	-0.050
$Telephone_{i}$	0.366***	0.404***	0.373**	0.398**	0.392**	0.415**	0.403**	0.334*	0.257*

$Telephone_j$	0.622***	0.740***	0.674***	0.496**	0.368*	0.442**	0.474**	0.321	0.130
	-	-0.177	-0.171	-	-	-	-	-	-
$Cellphone_i$	0.305**			0.266**	0.235**	0.228**	0.320**	0.416***	0.401**
$Cellphone_j$	0.094	0.170	0.073	0.274	0.005	0.200	0.286	0.373	0.232
$Internet_i$	0.448***	0.382***	0.351***	0.282**	0.249*	0.212	0.258*	0.296**	0.265**
$Internet_j$	0.556**	0.488**	0.787***	0.782***	0.928***	0.862***	0.816***	0.665**	0.635**
Intercept	14.366***	14.316***	16.286***	17.176***	17.990***	17.425***	17.213***	16.769***	17.230***

*, **, and *** indicate that the coefficient is significant at the 10%, 5%, and 1% level
Source: processing results using R software

Based on Table 3, it can be concluded that the coefficient of $MarketSize_{ij}$ is positive and statistically significant for almost all τ level quantile. This variable is important to explain the trade variation among participating countries. It implies that a one percent increase in the potential market of country j for goods from ASEAN-5 countries leads to an increase in the export of ASEAN-5 by 0.349 - 0.662 percent. It is in line with the research of Xing (2018), which concluded that there is a positive and significant relationship between market size and exports. $MarketSize_{ij}$ does not significantly affect the export value in higher quantile.

Although not all τ level quantile yields significant results, the distance gives consistent results that are associated negatively with trade flow. It is in line with the theory advanced by Tinbergen (1962) and Pöyhönen (1963). In international trade, geographic distance plays a key role historically and can be a cause of diminishing trade transactions (Demirkan, Goul, Kauffman, & Weber, 2009). The effect of distance on international trade is no longer significant at lower and higher quantile export values. The distance does not significantly affect Indonesia, Thailand, and the Philippines' export value to China, which is in the lower quantiles. The export commodities from these countries are Agricultural Raw Materials and Fuels, which is very important to support China's manufacturing industries. Supporting ICT development, Singapore and China make the distance is no longer a barrier for their trade (higher quantile).

The process of initiating and making trade because of the use of electronic means and the internet can be easier, less expensive, and faster. When barriers in the form of distance can be controlled, the export value of international trade will increase (Terzi, 2011). Broadband is only significant for upper quantile. It is in line with ITU (2020) where only Singapore has the highest fixed-broadband subscriptions per 100 inhabitants and continues to increase significantly. In contrast, the Philippines and Indonesia have lower development. In 2018, Indonesia only had 3.32, and the Philippines had 3.68, while Singapore had 27.97 subscriptions per 100 inhabitants.

The coefficient of Telephone for both ASEAN-5 and export destination countries is positive and statistically significant. It means most of the ASEAN-5 countries still use traditional ICT to communicate with the trading partner countries. It is supported by the insignificance of Cellphone in destination countries. The reason for the negative coefficient on Cellphone for home countries is the growth of mobile-cellular telephone subscriptions, which do not always increase. Slowing mobile-cellular telephone subscriptions occurred in all ASEAN-5 countries except Thailand. In 2018, Indonesia mobile telephone subscriptions dropped significantly than the previous year, reaching 27.43 percent.

Using alpha 5 percent, it indicates that the ASEAN-5 fixed-telephone subscription increases by one percent, the export value increases by 0.366 - 0.415 percent. But the ASEAN-5 countries which export value is in higher quantile, Telephone is not significant. But contrast, the variable Cellphone of higher quantile are more significant to affect international trade. It is in line with ITU (2020) where Singapore (a country in upper quantile of export values) has a higher development of mobile-cellular telephone subscriptions than other ASEAN-5 countries.

One of the ICT variables that play a positive and significant role in ASEAN-5 international trade with the US and China is Internet variable. It implies that a one percent increase in the percentage of individuals using the internet from ASEAN-5 countries leads to an increase in the export of ASEAN-5 by 0.212 - 0.448 percent. A one percent increase in the percentage of individuals using the internet of export destination countries leads to an increase in the export of ASEAN-5 by 0.488 - 0.928 percent. The export to high-income countries will increase because of the high internet penetration of the developing countries. It is because internet penetration is mostly done among manufacturing enterprises in high-income countries (Clarke & Wallsten, 2004). It is in line with the export commodities of most ASEAN-5 countries to the US and China, which is a Manufacturing Goods. Less developed countries would be difficult to isolate themselves from the changes

caused by ICTs. Therefore, each country should formulate and implement comprehensive ICT policies (Gholami, Moshiri, & Lee, 2004).

The effect of the use of modern ICT on export value exists for the upper quantile. Only ASEAN-5 countries in the upper quantile have significant Broadband. Fixed-broadband subscription refers to a fixed subscription for high-speed access to the public internet, at downstream speeds equal to or greater than 256 kbit /s (ITU, 2017). ASEAN-5 countries in the upper quantile have also utilized the maximum use of the internet and mobile-cellular telephone.

V. CONCLUSION

In the Southeast Asia region, ASEAN-5 becomes the economy leader because of its high economic growth. Its economy is supported by export besides foreign investment. During the period 2000-2018, the US and China became the main export destination countries of ASEAN-5. The growing development of ICT is indicated can increase the export volume of ASEAN-5 to these countries.

The method used is the Random Effects Quantile Regression because the research uses a time-invariant variable, and there is a violation of normality and homoscedasticity assumption. The quantile regression can relax these assumption violations. The random effect of quantile regression also shows the different impacts of ICT indicators for each level of quantile in international trade.

ICT has a significant effect on ASEAN-5 exports to the US and China. Most of the ASEAN-5 countries still use traditional ICT to communicate with trading partner countries. Singapore, which export value is located in higher quantile, used mobile-cellular telephone than fixed-telephone in international trading. Singapore also has a higher development of mobile-cellular telephone subscriptions per 100 inhabitants compared to other ASEAN-5 countries. One of the ICT variables that play a positive and significant role in ASEAN-5 international trade with the US and China is the internet usage variable. ASEAN-5 countries are expected to be able to increase ICT, especially mobile-cellular telephone subscriptions and internet usage, in conducting international trade. It is also useful for marketing superior local products from the hard-to-reach area, especially in archipelagic countries such as Indonesia and the Philippines.

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VII. REFERENCES

[1] Abeysinghe, T., & Forbes, K. (2005). Trade linkages and output-multiplier effects: A structural VAR approach with a focus on Asia. Review of International Economics, 13(2), 356-375.
[2] AhMAd, N. A., Ismail, N., & Hook, L. (2011). The role of ICT infrastructure on Malaysian trade. Journal of Economics and Management, 5(1), 140-148.
[3] Aliyu, S. U. R., & Bawa, S. (2013). Gravity model by panel data approach: empirical evidence from Nigeria.
[4] Arellano, M., & Bonhomme, S. (2013). Random effects quantile regression. Retrieved from
[5] ASEANStats. (2020). ASEANStats Data Portal. Retrieved from: https://data.aseanstats.org/
[6] Baldwin, R. (2016). The great convergence: Harvard University Press.
[7] Bergstrand, J. H. (1985). The gravity equation in international trade: some microeconomic foundations and empirical evidence. The review of economics and statistics, 474-481.
[8] Chetverikov, D., Larsen, B., & Palmer, C. (2016). IV quantile regression for group-level treatments, with an application to the distributional effects of trade. Econometrica, 84(2), 809-833.
[9] Clarke, G. R., & Wallsten, S. J. (2004). Has the Internet Increased Trade?: Evidence from Industrial and Developing Countries (Vol. 3215): World Bank Publications.
[10] Demirkan, H., Goul, M., Kauffman, R. J., & Weber, D. M. (2009). Does distance matter? The influence of ICT on bilateral trade flows. Paper presented at the Proceedings of the Second Annual SIG GlobDev Workshop.
[11] Galvao, A. F., & Poirier, A. (2017). Quantile regression random effects. Available at SSRN 2746894.
[12] Gholami, R., Moshiri, S., & Lee, S. Y. T. (2004). ICT and Productivity of the Manufacturing Industries in Iran. The Electronic Journal of Information Systems in Developing Countries, 19(1), 1-19.
[13] Hao, L., Naiman, D. Q., & Naiman, D. Q. (2007). Quantile regression: Sage.
[14] ITU. (2017). ICT Development Index 2017. Retrieved from https://www.itu.int/net4/ITU-D/idi/2017/index.html#idi2016byregion-tab
[15] ITU. (2020). The International Telecommunication Union Statistics. Retrieved from: https://www.itu.int/en/ITU-D/Statistics/Pages/stat/default.aspx

[16] Kepaptsoglou, K., Karlaftis, M. G., & Tsamboulas, D. (2010). The gravity model specification for modeling international trade flows and free trade agreement effects: a 10-year review of empirical studies. The open economics journal, 3(1).
[17] Koenker, R. (2004). Quantile regression for longitudinal data. Journal of Multivariate Analysis, 91(1), 74-89.
[18] Koenker, R., & Hallock, K. F. (2001). Quantile regression. Journal of economic perspectives, 15(4), 143-156.
[19] Kumar, S., & Ahmed, S. (2015). Gravity model by panel data approach: An empirical application with implications for South Asian countries. Foreign Trade Review, 50(4), 233-249.
[20] Liang, Y., & Zuo, X. (2010). Study the Double-Transfer Path of Guangdong Province on Gravity Model and Cluster Analysis. Modern Economy, 1(3), 206-211.
[21] Liu, L., & Nath, H. K. (2013). Information and communications technology and trade in emerging market economies. Emerging Markets Finance and Trade, 49(6), 67-87.
[22] Munadi, E. (2015). Pakaian Jadi Indonesia dalam Perspektif Perdagangan Global.
[23] Oh, Y. A. (2017). China's Economic Ties with Southeast Asia. KIEP Research Paper. World Economy Brief, 17-18.
[24] Packalén, K. (2010). ICT Capabilities and Possibilities in Micro-firms: A Study of Micro-firms in the Åland Islands Archipelago. Paper presented at the Bled eConference.
[25] Petri, P. A., & Plummer, M. G. (2013). ASEAN centrality and the ASEAN-US economic relationship. East-West Center Policy Studies, Forthcoming.
[26] Ponomareva, M. (2010). Quantile regression for panel data models with fixed effects and small T: Identification and estimation. University of Western Ontario.
[27] Pöyhönen, P. (1963). A tentative model for the volume of trade between countries. Weltwirtschaftliches Archiv, 93-100.
[28] Rodríguez-Crespo, E., & Martínez-Zarzoso, I. (2019). The effect of ICT on trade: Does product complexity matter? Telematics and Informatics, 41, 182-196.
[29] Siah, K.-L., Choong, C.-K., & Yusop, Z. (2009). AFTA and the intra-trade patterns among ASEAN-5 economies: trade-enhancing or trade-inhibiting. International Journal of Economics and Finance, 1(1), 117-126.
[30] Terzi, N. (2011). The impact of e-commerce on international trade and employment. Procedia-social and behavioral sciences, 24, 745-753.
[31] Thiemann, F. (2013). The Impact of Information and Communication Technology (ICT) on International Trade in Agri-food Products: A Gravity Approach: Cuvillier Verlag.
[32] Tinbergen, J. (1962). Shaping the world economy; suggestions for an international economic policy.
[33] Tongzon, J. L. (2002). The economies of Southeast Asia: before and after the crisis: Edward Elgar Publishing.
[34] Vahalík, B. (2014). Regional bilateral trade analysis of the European Union, China and ASEAN. Procedia Economics and Finance, 12, 709-717.
[35] Vu, H., Holmes, M., Lim, S., & Tran, T. (2014). Exports and profitability: a note from quantile regression approach. Applied Economics Letters, 21(6), 442-445.
[36] WorldBank, T. (2020a). World Bank Open Data. Retrieved from: https://data.worldbank.org/
[37] WorldBank, T. (2020b). World Integrated Trade Solution. Retrieved from: https://wits.worldbank.org/Default.aspx?lang=en
[38] Xing, Z. (2018). The impacts of Information and Communications Technology (ICT) and E-commerce on bilateral trade flows. International Economics and Economic Policy, 15(3), 565-586.
[39] Youxi, L., & Maozai, T. (2010). Quantile regression for panel data and its simulation study. Statistical Research, 10.
[40] Yushkova, E. (2014). Impact of ICT on trade in different technology groups: analysis and implications. International Economics and Economic Policy, 11(1-2), 165-177.
[41] Zheng, Y., Shao, Y., & Wang, S. (2017). The determinants of Chinese nonferrous metals imports and exports. Resources Policy, 53, 238-246.