REPLY TO THE REFEREE'S REPORT

(Full version)

We would like to express our sincere thanks to the referee for valuable and constructive comments. These comments will surely help us to improve our paper significantly. We fully agree with all the reviewer's comments and try our best to revise our manuscript accordingly.

Main comments: The paper topic is of interest for trade economists and policy makers, but it has to be considerably improved before being publishable. First, it needs to be reorganized and some sections have to be restructured. In particular, the abstract should be re-formulated to reflect the content of the paper and the focus on three – and not only two- target determinants of trade efficiency (freedom of trade). The first section is a mixture of introduction and literature review and it should be separated into two distinct sections. The second of which, should be better organized, and more to the point, than the actual introduction. The “Materials and Methods” section should be renamed Methodology, the actual name is misleading and a sub-section describing the variables and data sources is also missing.

Revision: First, we re-formulated the abstract to reflect the content of the paper and focus on three determinants of trade efficiency as follows:

This paper aims to analyze the impact of institutional and cultural distances and trade barriers on ASEAN’s trade efficiency using bilateral trade data from 2006 to 2016. The authors first employ an improved version of the stochastic frontier model to control endogeneity in estimating efficiency scores and then apply a sys-GMM model to estimate the impact of institutional and cultural distances and trade barriers on trade efficiency. The major findings are summarized as follows: first, the trade efficiency of ASEAN’s with the rest of the world is moderate, ranging from 0.48 to 0.60, and shows a downward trend. This indicates that considerable trade potential exists between ASEAN countries and the rest of the world. Second, institutional and cultural distance negatively affects ASEAN’s trade efficiency. Third, trade freedom is an important factor that positively influences ASEAN’s trade efficiency. Based on these findings, this study concludes that efforts to reduce differences in institutions and culture and to promote trade liberalization are strongly suggested as remedies for ASEAN countries to turn potential trade performance into actual trade performance.
**Revision:** Second, we also separated the first section into the Introduction section and the Literature Review section.

1. **Introduction**

Over the past 20 years, the trade performance of ASEAN countries has been gaining encouraging achievements. According to WITS statistics, between 1997 and 2017, ASEAN's two-way trade volume increased 3.52 times, from 719.6 billion USD in 1997 to 2,534.7 billion USD in 2017 (WITS, 2018). However, in the past five years, it can be seen that ASEAN’s international trade is somewhat fluctuating. Specifically, it decreased from 2535.5 billion USD in 2014 to 2,232.3 billion USD in 2016, then increased to 2,534.7 billion USD in 2017. Besides, the average growth rate of ASEAN’s total trade in the period of 1997-2007 is 7.58 percent per year while this figure in the period 2008-2017 is only 2.86 percent per year. This situation implies that the trade efficiency of ASEAN countries is on a decreasing trend and there must be potential barriers to ASEAN’s trade efficiency.

Potential trade is conceived of as maximum possible trade, which can be achieved under the context of completely frictionless free trade (Doan & Xing, 2018; Kumar & Prabhakar, 2017a). In contrast, actual trade is given by the current level of restrictions and institutions. The ratio of actual trade to potential trade is then defined as trade efficiency (Doan & Xing, 2018; Peter Drysdale, Hijang, & Kalirajan, 2012; Kang & Fratianni, 2006; Nguyen & Doan, 2017). The difference between potential and actual trade flows is interpreted as trade inefficiency. It is precisely equivalent to an unexhausted trade, which is the trade potential. When the potential trade is far higher than actual trade, the country-pair is said to have a low trade efficiency (Stack, Pentecost, & Ravishankar, 2018).

To this date, there has been plenty of studies on trade potential, potential trade, and trade efficiency. Despite the difference in approach, four research strands have emerged.

The first strand consists of those studies, which use indices to calculate potential trade levels (De, 2020; Kodithuwakku, Weerahewa, & Boughanmi, 2016; Oramah & Abou-Lehaf, 1998; Paswan, 2003). According to this approach, potential trade is estimated by matching the total export supply for a given commodity of a country with the total import demand for that commodity of a trading partner (Bano, Takahashi, & Scrimgeour, 2013). A variant of this approach is the indicative trade potential index (Kodithuwakku et al., 2016). This index allows
for the identification of the products for which there is the highest trade complementarity between the exports of the exporting country and the imports of the importing country. In short, the index of trade potential is easy to apply because the calculation is straightforward. The disadvantage of this approach, however, is that it does not take into account trade barriers or resistances in the estimation process.

The second strand includes those studies that employ the traditional gravity models to estimate potential trade levels (Abbas & Waheed, 2019; Evelyn S. Devadason, Govindaraju, & Mubarik, 2018; Johnston, Morgan, & Wang, 2015). According to this approach, the estimated model is used to estimate potential trade, which is the predicted trade from the model (Agrawal & Sangita, 2017). Then trade efficiency is the ratio of actual trade to potential trade (Tochkov, 2018). Untapped trade potential is the absolute difference between the potential trade and the actual level of trade (Batra, 2006; Irshad, Xin, Hui, Arshad, & Watson, 2018). Accordingly, a positive value implies the possibility of trade expansion in the future while a negative value shows that the actual trade has exceeded its trade potential. In contrast, several studies defined the trade potential as the ratio of potential to actual trade (Agrawal & Sangita, 2017; Roy & Chatterjee, 2013). If the trade potential index is unity, then the actual trade is precisely equal to the potential trade. When the trade potential index is less than unity, then the actual trade is greater than the potential trade, implying that the two countries have very close trade relations. When trade potential index is greater than unity, then actual trade is lower than the potential trade. In this case, there is a potential to increase bilateral trade (Ravishankar & Stack, 2014).

In short, the advantage of this approach is that it takes into account observed resistances to trade. However, two potential problems arise from this approach. First, conventional gravity models estimate the central value of a dataset (the mean effects of the determinants of bilateral trade), whereas potential trade is, by definition, involved at the upper limit. Second, unobserved resistances to trade such as asymmetric information and internal and external constraints are difficult to quantify and thus are lumped into the error term. For this reason, the expected value of the error term is no longer zero and normally distributed. Therefore, the normality assumption is violated, leading to inconsistent estimates (K. Kalirajan & Findlay, 2005).

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1 Breuss and Egger (1999) is an exception, who used the OLS estimator to calculate confidence intervals to evaluate the sampling variation of trade potential of a country’s exports to its trading partner.
The third strand consists of those studies, which applied the stochastic frontier analysis (SFA) to the traditional gravity model to overcome the disadvantages of the traditional gravity model (Evelyn Shyamala Devadason & Chandran, 2019; Kumar & Prabhakar, 2017b; Ravishankar & Stack, 2014). Instead of assessing whether a country underperforms or outperforms the mean sample, SFA measures how much trade resistances exist in the bilateral trade relationship (Armstrong, 2007). This approach is based on the assumption that trade relationships are subject to two economic disturbances. So the error term is decomposed into conventional random error term and non-negative term, which captures trade inefficiency due to unobserved trade resistances (Armstrong, 2007; Peter Drysdale & Garnaut, 1982; Salim, Kabir, & Mawali, 2011). Therefore, the actual level of trade is always lower than the potential level of trade because trade resistances hinder the actual trade from reaching the maximum level (Nguyen & Doan, 2017). The advantage of this approach is that it estimates the frontier level of trade in the hypothetical case of no restriction. However, a potential limitation of this approach is that the endogeneity problem in SFA might lead to biased estimates.

The fourth strand includes those studies, which go beyond the estimating trade efficiency scores by running a second regression equation, which analyzes the determinants of trade efficiency scores estimated from SFA (Doan & Xing, 2018; Peter Drysdale et al., 2012; Nguyen & Doan, 2017; Noviyani, Na, & Irawan, 2019). Accordingly, there are two groups of factors that affect trade performance and efficiency, including behind-the-border (internal) constraints and beyond-the-border (external) constraints (Kaliappa Kalirajan & Singh, 2008). These constraints include the cultural, political, and institutional characteristics of the exporting and importing countries (McPherson & Trumbull, 2008). In short, the advantage of this approach is that it analyzes a wide range of factors that affect trade efficiency. However, there remain two potential problems. First, to explain the variation in trade efficiency, previous studies only focus on the quality of either internal constraints or external constraints or both. They have not tackled the differences between the internal constraints of the exporting country and the external constraints of the importing country. International transactions involve at least two countries with different jurisdictions and systems. Therefore, differences in institutional structures, regulatory framework, and cultural values between exporting and importing countries should be important factors, which hinder trade from reaching the maximum level and thus lower trade efficiency. Second, the endogeneity problem from the regression equation, which explains the variation in trade efficiency, potentially leads to biased estimates.
Through the review of related literature, we identify two knowledge gaps. First, the SFA model used to estimate trade efficiency, as well as the models used to quantify the determinants of trade efficiency, have not solved the endogenous problem. Second, previous studies have not analyzed the impact of institutional and cultural distances on trade efficiency. In addressing such a knowledge gap in the existing literature, this paper aims to analyze the bilateral influence of cultural and institutional distance on ASEAN’s trade efficiency. To accomplish the research objective, this paper is guided by the following research questions:

- Is ASEAN’s trade with the rest of the world efficient?
- What are the determinants of trade efficiency between ASEAN and the rest of the world?
- What policy implications can we derive from the estimated results?

The unique features of this study are as follows: First, this is the first study on the impact of the differences between internal constraints and external constraints on trade efficiency, specifically, the impact of institutional and cultural distances on ASEAN’s trade efficiency. Second, in order to obtain accurate efficiency scores, we use an improved version of the standard stochastic frontier model proposed by Karakaplan (2018). The advantage of this method over previous ones is that it can control the problem of endogeneity. Third, in quantifying the determinants of trade efficiency, we apply a sys-GMM estimator in order to overcome the problem of resulting from endogeneity, measurement errors, and omitted variables.

2. Literature review

According to Armstrong (2007), quantifying the determinants of trade efficiency requires two steps of estimation. The first step involves the estimation of trade efficiency scores based on the stochastic frontier gravity model and the second step involves a regression equation to analyze the determinants of trade efficiency scores.

*Estimation of trade efficiency*

Much research conducted to estimate trade efficiency is based on the gravity model using SFA (Demir, Bilik, & Utkulu, 2017; Kumar & Prabhakar, 2017b). The traditional gravity model was pioneered by Tinbergen (1962), Pöyhönen (1963), and Linnemann (1966). Undergone a
number of modifications, it has become very popular and been widely used to assess the determinants of bilateral trade. Accordingly, bilateral trade between any two countries is affected by export supply, import demand, and trade resistances.

**Figure 1. The general gravity model in international trade**

In Figure 1, the export supply includes factors that represent the exporting country’s ability to produce goods for export, while import demand consists of factors that reflect the importing country’s ability to import. Trade resistances can be broken down into natural resistances and man-made resistances, as presented in Figure 1 (Armstrong, 2007). Natural resistances are objective and observable barriers. They can be controlled. In contrast, man-made resistances are subjective and unobserved barriers. They are difficult to quantify and thus lumped into the disturbance term (Baier & Bergstrand, 2009). In reality, man-made resistances always exist. Because of this, the volume of actual bilateral trade is always beneath the highest possible levels, indicating the presence of trade inefficiency. In this case, the traditional gravity model is not appropriate because the assumption of the normally distributed error term is violated due to the unobserved man-made resistances. This econometric problem leads to the application of SAF (Assefa, 2017; Demir, Bilik, & Utkulu, 2019; K. Kalirajan, 2010).

Instead of estimating the mean effect of the determinants of bilateral trade, SFA estimates how much man-made resistances exist in a bilateral trade relationship. Among studies on estimating trade efficiency scores, Ravishankar and Stack (2014) employed a gravity equation using the SFA to estimate Eastern European countries’ trade potential. Their panel sample consisted of bilateral export flows from 17 Western European countries to 10 new EU member countries for the period 1994–2007. The estimated efficiency scores imply a high degree of East-West trade integration. Besides, early trade liberalization and the removal of barriers under bilateral free trade agreements (FTAs) have boosted trade efficiency. Other studies that followed a
similar stochastic frontier approach to estimate trade efficiency scores include Hassan (2017),
Kumar and Prabhakar (2017a), Viorica (2015), and Stack et al. (2018), among others.

Barma (2017) used a stochastic gravity model of trade to analyze the determinants of Indian
agricultural export flows to 112 partner countries for the period 2000-2013. An improvement
of this study is that it employed various time-invariant and time-varying specifications in a
stochastic gravity model. The empirical results support high yet decreasing home country inefficiency.

Determinants of trade efficiency

Although studies on estimating trade efficiency are numerous, those on quantifying the
determinants of trade efficiency are scant. As explained above, man-made resistances hinder
actual trade from reaching the potential level. These resistances are influenced by the behind-the-border (internal) constraints of the home country and the beyond-the-border (external) constraints of the trading partners. They include socio-economic, cultural, institutional, and political rigidities (Salim et al., 2011; Sayavong, 2015).

One of the early studies on the determinants of trade efficiency was conducted by Peter
Drysdale, Huang, and Kalirajan (2012). Their sample included China’s trade with 57 countries
in the rest of the world (ROW) for the period 1991-1995. They found that trade tariffs in both
the exporting and importing countries were not significant; the economic freedom indexes in
the two groups of countries turned out to be essential determinants of China’s trade efficiency.
Using a similar approach, Doan and Xing (2018) applied a stochastic gravity model to estimate
efficiency levels of Vietnam’s exports to its major trading partners during the period 1995-
2013. In the second stage, the study investigated the impact of FTAs and rules of origin on
export efficiency. The empirical results showed that membership in ASEAN contributed
positively to the country’s trade efficiency while rules of origin and non-membership in EU
and NAFTA had a negative impact.

Nguyen and Doan (2017) employed a stochastic gravity model to estimate the efficiency
performance of Vietnam’s trade with its main trading partners from 1995-2015. They found
that Vietnam’s membership in the ASEAN Free Trade Agreement has improved the trade
efficiency, whereas tariffs and domestic devaluation have reduced it. To analyze factors
affecting trade efficiency and trade potential of countries along the Belt and Road, Kexin
(2018) used trade data from 35 countries for the period 1995–2014. Using cointegration estimation methods, he found that trade diversification, trade concentration, and trade complementarity index are essential determinants of trade efficiency. Noviyani et al. (2019) analyze the efficiency of Indonesia’s merchandise exports and the factors affecting Indonesia’s export efficiency. Their sample includes Indonesia’s exports to its 62 trading partners for the period 2011-2016. They found that export inefficiency increased by business freedom, investment freedom, and landlocked dummy, and then export inefficiency decreased by labor freedom, financial freedom, contiguous dummy and FTA dummy.

Based on the review of the literature, it is clear that previous studies only analyzed the impact of the quality of internal and external constraints on trade efficiency. No study has assessed the impact of the differences between the internal and external constraints on trade efficiency. The inclusion of such differences is justified on the ground that cross-border transactions involve in at least two countries with different socio-economic characteristics, institutional and regulatory structures, political systems, and cultural values. These differences affect trade efficiency because they potentially lower trust, increase uncertainty and risk, and lead to misunderstanding and unfamiliarity.

**Institutional distance and trade efficiency**

Based on Kostova (1996)’s definition, institutional distance refers to dissimilarity in a wide range of structures such as contract enforcement, property rights, and the rule of law that influence international trade (Anderson & Marcouiller, 2002; Méon & Sekkat, 2008). For international trade to take place, enterprises from different jurisdictions must agree on and comply with the signed contract (Nunn, 2007). However, institutions differ greatly from country to country (Acemoglu & Dell, 2010). In order to survive, firms must conform to the prevailing rules and belief systems (Scott, 1995). The rules here may be formal (such as formal contracts) or informal (such as relational contracts). Therefore, in many cases, enterprises are left with imperfect realizations of contracts. Like cultural distance, differences in institutional quality and structures between any two countries restrict actual trade from reaching the potential level in several ways. First, as the institutional quality and structures of the two countries are similar, enterprises in these two countries are more familiar with each other’s business systems and procedures. In this case, trust and commitment between them develops more easily. They necessarily reduce trade costs resulting from search, networking, and adjustment costs (de Groot, Linders, Rietveld, & Subramanian, 2004; Mendonça, Lirio, Braga,
& Silva, 2014). Second, similar institutional framework contributes to contract enforcement and transaction mechanisms (Ranjan & Lee, 2007). Reducing the risk of opportunistic behavior and enhancing law enforcement can lower the control and monitoring costs of contracts. Third, homogeneous institutions decrease information asymmetries by channeling information about market conditions (Borrmann, Busse, & Neuhaus, 2006). The goods flowing from each of these similarities indicates that the more distant the institutional quality of the two countries is, the higher the transaction costs are (de Groot et al., 2004). Therefore, institutional distance is expected to have a negative impact on trade efficiency.

**Cultural distance and trade efficiency**

The cultural distance can be defined as the degree to which shared norms and values differ between countries (G. Hofstede, 2001). Such distance is found to impede bilateral trade (Boisson & Ferrantino, 1997; Tadesse & White, 2008a, 2008c). In other words, it prevents actual trade from reaching the maximum level. The mechanism through which cultural distance affects trade efficiency is related to trade costs (Williamson, 1979). First, cultural distance potentially leads to a lack of trust and commitment, which is needed to overcome moral hazards in business transactions and can reduce transaction costs (Xing & Zhou, 2018). Since the delivery and payment may take place at different times, confidence is of paramount importance to the international transaction (White & Tadesse, 2008). As pointed out by Tadesse and White (2008b), parties involved are potentially vulnerable to fraud or risk because contracts between them are often incomplete. International trade laws alone are enough to ensure the commitments of the parties involved. Therefore, a certain level of trust and commitment is needed to initiate trade deals, make sure that trading partners comply with the contracts, and complete transactions (Coyne & Williamson, 2012; Guiso, Sapienza, & Zingales, 2009; Tabellini, 2010). Second, cultural differences between countries increase uncertainty about the business partners, which results in higher exposure to risk (Geert Hofstede, 1989). People from different cultures may have different understandings and interpretations of the same situation. According to Brouthers and Brouthers (2000), such difference can result in noise and complicate interactions between parties. Third, the cultural distance may raise the search and networking costs associated with finding appropriate trading partners. It is because cultural differences hinder information exchange and communication between countries involved. Understanding each other’s cultures make it easier to acquire information about profitable international trade opportunity. Another possibility is that people are biased against cultures
that are highly different from their own culture or biased in favor of cultures that are more like
their own. As confirmed by Glaeser, Laibson, Scheinkman, and Soutter (2000) cultural distance
reduce the effectiveness of decision making because it increases perceived costs. Therefore,
cultural distance is expected to have a negative impact on trade efficiency.

**Trade barriers and trade efficiency**

Economists often agree that trade barriers are one of the reasons leading to the reduction of
overall economic efficiency (Archer, 1996). Trade barriers include two types: tariff and non-
tariff barriers. *First*, tariffs are the common names for taxes on imported goods. Countries use
tariffs for two main purposes: (i) Contributing to ensure revenue for the state budget; and (ii)
Protection of domestic production. Accordingly, importing countries will impose high taxes on
foreign goods in order to increase the selling prices of imported goods, creating a competitive
advantage for domestic goods (Adekola & Sergi, 2016). Therefore, the tariff barrier will restrict
goods from abroad. *Second*, non-tariff barriers include two main types: (i) Administrative
barriers include provisions to prevent or restrict foreign goods such as the laws on import,
embargo, import licenses, quotas, voluntary export restrictions and mandatory localization
rates. (ii) The technical barrier is a nation’s technical and quality requirements for goods
coming from abroad. In some cases, the authorities use these requirements as a way to impede
imports into the domestic market (Cavusgil, Rammal, & Freeman, 2011). This barrier is often
seen in agricultural goods or some nature-intensive products. So far, although countries have
been aiming at trade liberalization, tariffs and non-tariffs are still used by countries as a tool to
restrict imports and protect domestic goods. Actually, excessive use of tariffs and non-tariffs
can lead to trade wars and reduce trade efficiency, such as the US-China trade war. Therefore,
the higher the trade barriers, the lower the trade efficiency.
Revision: Third, the "Materials and Methods" has been renamed "Methodology."

Revision: Fourth, we included a sub-section describing the variables and data sources as follows.

3. Methodology

This study requires two steps of estimation as proposed by Armstrong (2007). The first step involves the estimation of the stochastic frontier gravity model (Equation 1) and then the calculation of the efficiency scores (Equation 3). In the second step, we analyze the factors affecting trade efficiency scores (factors explaining the variation in the one-sided error term) using the system GMM approach (Equation 4).

3.1. Estimating trade efficiency

The gravity model has been a workhorse in quantifying the determinants of bilateral trade. According to this model, bilateral trade between any two countries is affected by the export supply (e.g., GDP of the exporting country), import demand (e.g. GDP of the importing country), and trade resistances. Trade resistances can be broken down into natural resistances (e.g. geographical distance, language, landlocked status, etc.) and man-made resistances (e.g. institutional and cultural distances). Since natural resistances are observable, they appear on the right-hand side of the gravity equation. However, man-made resistances are unobservable, so they are lumped together into the disturbance term (Baier & Bergstrand, 2009). Drawing on Xing and Zhou (2018) and Atif, Haiyun, and Mahmood (2017), our gravity model is as follows:

\[
\ln \text{Trade}_{ij,t} = \alpha + \beta_1 \ln \text{GDP}_{i,t} + \beta_2 \ln \text{GDP}_{j,t} + \beta_3 \ln \text{DIST}_{ij} + \beta_4 \text{Landlocked}_{ij} \\
+ \beta_5 \text{Colony}_{ij} + \beta_6 \text{Language}_{ij} + \beta_7 \text{FTA}_{ij,t} + \beta_8 \text{Border}_{ij} \\
+ \beta_9 \text{Infrastructure}_{i,t} + \beta_{10} \text{Infrastructure}_{j,t} + \epsilon_{ij,t} \tag{1}
\]

Where:

- \( \ln \) is natural logarithm.
- \( \text{Trade}_{ij,t} \) is the trade volume (export plus import) between country \( i \) and country \( j \) at the time \( t \), measured in thousand USD.
- \( \text{GDP}_{i,t} \) is Gross Domestic Product of country \( i \) at the time \( t \), measured in billion USD.
• GDP\(_{j,t}\) is Gross Domestic Product of country \(j\) at the time \(t\), measured in billion USD.
• DIST\(_{ij}\) is the weighted distance between country \(i\) and the country \(j\), measured in km.
• Landlock\(_j\) is a dummy variable which equals 1 if at least one of the two trade partners (either country \(i\) or country \(j\)) is landlocked and zero otherwise.
• Language\(_ij\) is a dummy variable which equals 1 if both country \(i\) and country \(j\) speak a common language and zero otherwise.
• FTA\(_{ij,t}\) is a dummy variable which equals 1 if both country \(i\) and country \(j\) have FTA agreement in year \(t\) and zero otherwise.
• Border\(_ij\): is a dummy variable which equals 1 if country \(i\) and country \(j\) have common border and zero otherwise.
• Infrastructure\(_i\),\(_t\) is the quality of infrastructure of country \(i\) at time \(t\).
• Infrastructure\(_j\),\(_t\) is the quality of infrastructure of country \(j\) at time \(t\).

The error term consists of two components \((\varepsilon_{ij,t} = v_{ij,t} - u_{ij,t})\). The first component \((v_{ij,t})\) is the conventional symmetric error term, which is purely random and follows the normal distribution, \(v_{ij,t} \sim iid \ N(0, \sigma^2_u)\). The second component \((u_{ij,t})\) captures trade inefficiency due to the man-made resistances, which prevent actual trade from reaching the potential level (Kalirajan, 2007). It is a single-sided error term and follows a half-normal distribution, \(u_{ij,t} \sim iid \ N^+(0, \sigma^2_u)\), which represent deviations from maximum trade that are specific to each bilateral relation. They are distributed independently from each other and from the independent variables. Therefore, our gravity model with decomposed error term is as follows:

\[
\ln \text{Trade}_{ij,t} = \alpha + \beta_1 \ln \text{GDP}_i,\_t + \beta_2 \ln \text{GDP}_j,\_t + \beta_3 \ln \text{DIST}_{ij} + \beta_4 \text{Landlocked}_j + \\
+ \beta_5 \text{Colony}_{ij} + \beta_6 \text{Language}_{ij} + \beta_7 \text{FTA}_{ij,t} + \beta_8 \text{Border}_{ij} + \\
+ \beta_9 \text{Infrastructure}_i,\_t + \beta_{10} \text{Infrastructure}_j,\_t + \\
+ (v_{ij,t} - u_{ij,t})
\]

(1)

The values of \(u_{ij,t}\) range between zero and one. When \(u_{ij,t}\) is zero, Equation 2 becomes the conventional gravity equation. In this case, actual trade and potential trade are identical, meaning that there is no trade inefficiency or the effect of man-made resistances is not important. When \(u_{ij,t}\) is greater zero and smaller or equal to one, there are trade inefficiencies
(the effect of man-made resistances is important). In this case, OLS estimation would violate the assumption of a normally distributed random disturbance because the disturbance in this case includes unobserved man-made resistances (Kalirajan and Findlay, 2005).

To overcome such problem, Armstrong (2007) proposed the gravity stochastic frontier analysis (SFA), introduced by Aigner, Lovell, and Schmidt (1977) and Meeusen and van Den Broeck (1977). Instead of finding the mean effect of the determinants of bilateral trade, SFA estimates unobservable resistances to trade. The application of SFA in the gravity model allows the model to quantify the trade efficiency at bilateral level. Therefore, our first step is to estimate Equation 2 using the SFA. After Equation 2 is estimated, we calculate ASEAN’s trade efficiency scores, which are equivalent to the ratio of country-pair actual trade in any given year $t$ to the corresponding country-pair trade if $u_{ijt}$ is zero (Battese & Coelli, 1988). The country-pair specific trade efficiency scores can be computed as follows:

$$\text{Trade efficiency}_{ij,t} = \frac{\text{Actual Trade}_{ij,t}}{\text{Potential Trade}_{ij,t}} = \frac{\exp(x_{ij,t}\beta + v_{ij,t} - u_{ij,t})}{\exp(x_{ij,t}\beta + v_{ij,t})} = \exp(-u_{ij,t}) \quad (3)$$

The value of the trade efficiency score ranges from 0 to unity. A higher score implies higher trade efficiency, which means that trade volume is closer to the trade frontier. A value of zero indicates a need to raise actual trade nearer to maximal level, whereas a value of unity implies that actual trade coincides with a potential trade².

### 3.2. Analyzing the determinants of trade efficiency

As explained above, the second step is to analyze the factors affecting ASEAN’s trade efficiency. In this study, we focus on the impact of institutional and cultural distances on ASEAN’s trade efficiency with the rest of the world. In doing so, we employ the dynamic panel data model as follows:

$$TE_{ij,t} = a + b_1TE_{ij,t-1} + b_2ID_{ij,t} + b_3CD_{ij} + b_4\ln TF_i,t + b_5\ln TF_j,t + \epsilon_{ijt} \quad (4)$$

² Based on the estimated efficiency scores, trade potential can be calculated as follows:

$$\text{Potential trade}_{ij,t} = \frac{\text{Actual trade}_{ij,t}}{\text{Trade efficiency}_{ij,t}}$$
\(TE_{ij,t}\) is trade efficiency between country \(i\) and country \(j\) in year \(t\) is the efficiency score in year \(t\) derived from the gravity stochastic frontier model.

\(TE_{ij,t-1}\) is the trade efficiency between country \(i\) and country \(j\) in year \(t-1\) is the efficiency score in year \(t-1\) derived from the gravity stochastic frontier model.

\(ID_{ij,t}\) is the institutional distance between country \(i\) and country \(j\). It is calculated using the following equation:

\[
ID_{ij,t} = \frac{1}{7} \sum_{k=1}^{7} \left( I_{ki,t} - I_{kj,t} \right)^2 / V_{k,t}
\]  \(5\)

Where: \(I_{ki,t}\) and \(I_{kj,t}\) denote \(k^{th}\) institutional dimension of country \(i\) and country \(j\) in year \(t\), respectively. \(V_{k,t}\) is the variance of \(k^{th}\) institutional dimension across countries in year \(t\). There are seven institutional dimensions with the score for each dimension ranging from 1 (worst) to 7 (best)\(^3\). First, property rights reflect the extent to which a country's law protects property rights (including tangible and intangible assets) of individuals and collectives. Second, ethics and corruption assess the level of bribery and corruption occurring in a country and they based on three variables related to diversion of public funds, people's trust in the government, and irregular payments and bribes. Third, undue influence evaluates the fairness of the justice system and government decisions for companies and individuals within a country. Fourthly, government efficiency refers to the transparency and performance of government in a country. Fifthly, security indicates the influence of criminal organizations on the operation of the business and reliability of police services. Sixth, corporate ethics evaluates the corporate ethics of companies (ethical behavior in interactions with public officials, politicians, and other firms). Seventh, accountability refers to the impact of audit standards, reporting and the level of law protection on the board of directors, shareholders and investors of enterprises.

\(CD_{ij}\) is the cultural distance between country \(i\) and country \(j\). It is calculated using the following equation:

\[
CD_{ij} = \frac{1}{4} \sum_{k=1}^{4} \left( C_{kj} - C_{ki} \right)^2 / V_k
\]  \(6\)

\(^3\) The seven dimensions of institutional quality are developed by WEF (World Economic Forum). Detailed information about seven institutional dimensions is presented in the Appendix 1.
Where: $C_{ki}$ and $C_{kj}$ represent $k^{th}$ cultural dimension of country $i$ and country $j$, respectively. $V_k$ is the variance of $k^{th}$ dimension across countries. There are four dimensions of the national culture score. First, power distance (PDI) is defined as the degree to which people of an organization or institution accept the unequally distributed power. Second, individualism versus collectivism reflects the degree to which a society prefers a loosely-knit social framework in which the role of individual is emphasized (individualism) or a tightly-knit framework in which the role of group is emphasized (collectivism). It also reflects the creative capability of a country. Third, masculinity versus femininity refers to the degree to which a society emphasizes achievement, heroism, assertiveness and material rewards for success (masculine culture) or cooperation, modesty, caring for the weak and quality of life (feminist culture). Fourth, uncertainty avoidance (UAI) describes the degree to which members of a society accept uncertainty, ambiguity, and risks. In a society with High UAI, people cohere to regulations, policies and guiding documents. In contrast, in a society with low UAI. People maintain a more relaxed attitude in which practice is more important than principles.

$TF_{i,t}$ and $TF_{j,t}$ are the indices of trade freedom of country $i$ and country $j$ in year $t$, respectively. Trade freedom is the controlled variable. According to the Heritage Foundation, trade freedom is a composite measure of the absence of tariff and non-tariff barriers that affect the import and export of goods and services. It reflects a country's level of trade freedom in the import of goods and services from other nations, and a measure of free interaction between sellers and buyers in the international marketplace. The score of the trade freedom index ranges from 0 (repressed) to 100 (free trade).

### 3.3. Endogeneity problem

Endogeneity problem with Equation 2 (the stochastic frontier gravity model)

The trade literature has shown that Equation 1 can potentially suffer from the problem of endogeneity resulting from simultaneity on the theoretical ground that GDP can affect bilateral trade(Natale, Borrello, & Motova, 2015; Zheng, Shao, & Wang, 2017), and bilateral trade can affect GDP(Lewer & Berg, 2003; Li & Jiang, 2018; Sakyi, Villaverde, Maza, & Bonuedi, 2017). In this study, the instrument for the GDP variable is estimated using the augmented Solow growth model, whose independent variables are capital, labor, and technology.
In order to confirm whether there is a problem of endogeneity in the stochastic frontier gravity equation, we conduct the test for endogeneity specified in Karakaplan and Kutlu (2017), according to which the joint significance of the components of the $\eta$ term is checked. If the components of the $\eta$ term are jointly significant, then the model suffers from the problem of endogeneity. In this case, a correction would be necessary. Conversely, if the components are not jointly significant, then the model does not suffer from endogeneity. In this case, the correction term is not necessary, and efficiency can be estimated by traditional frontier models.

*Endogeneity with Equation 5 (the determinants of ASEAN’s trade efficiency)*

Because Equation 2 is dynamic, its lagged dependent variable leads to a correlation between the lagged dependent variable and the error term, which makes the OLS estimator biased and inconsistent. In addition, the panel dataset has a short time-dimension and a large country-pair dimension. Therefore, we employ a system GMM estimator, which allows us to overcome the problems of serial correlation, heteroskedasticity, endogeneity, and omitted variables. The estimator is a system consisting of both first-differenced and levels equations. To estimate the equation, we apply the Blundell and Bond (1998) methodology to small-sample correction. The system GMM is consistent if the instruments are valid and there is no second-order serial correlation in the residuals. Therefore, we conduct the Sargan test of over-identifying restriction to check for the validity of the instruments and implement an AR(2) test to check for second-order serial correlation in the residuals.

### 3.4. Data

This study uses a panel dataset of 65 countries around the world. The dataset includes bilateral trade between six ASEAN countries (Indonesia, Malaysia, the Philippines, Singapore, Thailand, and Vietnam) and 59 non-ASEAN countries for the period 2006–2016\(^4\) (the list of countries included in our sample is presented in <Appendix-1>). Our selection of the above six ASEAN countries is based on the fact that they are the major trading countries in ASEAN.

Yearly total bilateral trade between countries is collected from the World Integrated Trade Solution (WITS, 2018), which is adapted from the United Nations Statistics Division. Data on GDP are extracted from the World Economic Outlook (WEO) database of the International

\(^4\) Data for variables such as institutional quality and trade freedom are only available since 2006.
Monetary Fund (IMF). Information regarding weighted distance, colonial relationship, landlocked status, and common language is obtained from CEPII (Centre d'Études Prospectives et d'Informations Internationales, the leading French center for research and expertise on the world economy). Land areas of both importers and exporters are obtained from UNdata. Data on FTAs are extracted from the World Trade Organization (WTO) and the United Nations Economic and Social Commission for Asia and the Pacific (ESCAP). Data on gross capital formation and labor force are taken from the World Bank. Data on institutions are obtained from the World Economic Forum. Data on culture are gained from Hofstede Insights. Data on trade freedom are taken from The Heritage Foundation.

7 https://www.hofstede-insights.com/models/national-culture/
8 https://www.heritage.org/index/visualize
**Comment 1:** The main drawback of the paper is that the gravity model specification does not include several important factors that could be correlated with the error term: common border as well as connectivity, infrastructure endowments and other trade facilitation proxies, such as cost to import and cost to export (from Doing Business, The World Bank). Since those are important trade costs, if they are not included, and remain in the error term, you will indirectly attribute their influence on trade efficiency to cultural or institutional differences or to freedom of trade. Therefore, the gravity model should be estimated with those factors included.

**Revision:** Following the comments of the reviewer, we added the variables ‘common border’ and ‘infrastructure’ to our stochastic frontier gravity model. However, the data for the variables ‘cost to import’ and ‘cost to export’ is only available for the period 2014-2018 (other potential proxies are ‘time to export’ and ‘time to import.’ However, the units of measurement of these two variables before 2014 and from 2014 onwards are different). Therefore, it is very difficult to include these two variables in the stochastic frontier gravity model. Acknowledging that omitted variables can cause endogeneity, we used an improved version of the standard stochastic frontier model proposed by Karakaplan (2018). The advantage of this method over previous ones is that it can control the problem of endogeneity.

The results of the new stochastic frontier gravity model are presented in Table 1, and the trade efficiency scores of ASEAN countries are displayed in Appendices 1 and 2. As the results reveal, the trade efficiency scores of ASEAN countries are almost the same as before (they only change slightly). It indicates that the model, which can control for the endogeneity problem, provides efficient and consistent estimates.

Besides, we also performed the second equation ('the determinants of trade efficiency’ equation) again with the newly estimated trade efficiency scores (please refer to Table 5 in comment 6). Again, the coefficients only change slightly. It implies that the system-GMM has successfully overcome the problem of endogeneity.

**Table 1: Stochastic Frontier Gravity Model**

<table>
<thead>
<tr>
<th>Dependent variable: lnTrade_{ijt}</th>
<th>Model EX</th>
<th>Model EN</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>0.360</td>
<td>0.269</td>
</tr>
<tr>
<td>lnGDP_{i,t}</td>
<td>0.326***</td>
<td>0.028</td>
</tr>
<tr>
<td>lnGDP_{j,t}</td>
<td>1.168***</td>
<td>0.028</td>
</tr>
<tr>
<td>Variable</td>
<td>Coefficient</td>
<td>Std. Error</td>
</tr>
<tr>
<td>-------------------</td>
<td>-------------</td>
<td>------------</td>
</tr>
<tr>
<td>lnDIST (_{ij})</td>
<td>-0.349***</td>
<td>0.025</td>
</tr>
<tr>
<td>Landlocked (_{j})</td>
<td>-0.264***</td>
<td>0.063</td>
</tr>
<tr>
<td>Colony (_{ij})</td>
<td>0.011</td>
<td>0.134</td>
</tr>
<tr>
<td>Languages (_{ij})</td>
<td>0.361***</td>
<td>0.064</td>
</tr>
<tr>
<td>FTA (_{ij,t})</td>
<td>1.057***</td>
<td>0.063</td>
</tr>
<tr>
<td>Border (_{ij})</td>
<td>0.382</td>
<td>0.320</td>
</tr>
<tr>
<td>Infrastructure (_{i,t})</td>
<td>0.419***</td>
<td>0.015</td>
</tr>
<tr>
<td>Infrastructure (_{j,t})</td>
<td>0.645***</td>
<td>0.016</td>
</tr>
</tbody>
</table>

**Dependent variable: ln(\(\sigma^2_{\mu}\))**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>Std. Error</th>
<th>z-value</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>0.160</td>
<td>0.115</td>
<td>0.067</td>
<td>0.123</td>
</tr>
</tbody>
</table>

**Dependent variable: ln(\(\sigma^2_{\nu}\))**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>Std. Error</th>
<th>z-value</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>-0.362***</td>
<td>0.066</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Dependent variable: ln(\(\sigma^2_{\omega}\))**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>Std. Error</th>
<th>z-value</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>-0.375***</td>
<td>0.066</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\(\eta_1\) \(\ln(GDP_{it})\)  | -0.213*     | 0.085      |
\(\eta_2\) \(\ln(GDP_{jt})\)  | -0.700***   | 0.057      |
\(\eta\) endogeneity test \((X^2 = 161.96)\)  | P > X^2 = 0.000 |

| Observations | 3894 | 3894 |
| Log likelihood | -5733.02 | -6687.84 |
| Mean technical efficiency | 0.502 | 0.515 |
| Median technical efficiency | 0.522 | 0.532 |

Notes: Standard errors are in parentheses. Asterisks indicate significance at the 0.1% (***) , 1% (**) and 5% (*) levels.
Comment 2: The second major point is that you should clearly state why some factors are included in the gravity model and others are relegated to the second stage estimation of the trade efficiency. That is, why is the cultural distance a determinant of trade efficiency and it is not included in the gravity model to estimate trade potential? etc.

Revision: We added an explanation in the literature review section as follows:

According to Armstrong (2007), quantifying the determinants of trade efficiency requires two steps of estimation. The first step involves the estimation of trade efficiency scores based on the stochastic frontier gravity model, and the second step involves a regression equation to analyze the determinants of trade efficiency scores.

Regarding the first step of estimation, much research conducted to estimate trade efficiency is based on the gravity model using SFA (Demir, Bilik, & Utkulu, 2017; Kumar & Prabhakar, 2017b). The traditional gravity model was pioneered by Tinbergen (1962), Pöyhönen (1963), and Linnemann (1966). Undergone a number of modifications, it has become very popular and been widely used to assess the determinants of bilateral trade. Accordingly, bilateral trade between any two countries is affected by export supply, import demand, and trade resistances.

In Figure 1, the export supply includes factors that represent the exporting country’s ability to produce goods for export (e.g., GDP of the exporting country), while import demand consists of factors that reflect the importing country’s ability to import (e.g. GDP of the importing country). Trade resistances can be broken down into natural resistances and man-made resistances (Armstrong, 2007), as presented in Figure 1. Natural resistances are objective and observable barriers (e.g. geographical distance, common border, language, landlocked status, etc.). They can be controlled for. In contrast, man-made resistances are subjective and unobserved barriers (e.g. institutional and cultural distances, trade barriers, etc.). They are difficult to quantify. Since natural resistances are observable, they appear on the right-hand
side of the gravity equation. However, man-made resistances are unobservable, so they are lumped together into the disturbance term (Baier & Bergstrand, 2009).

Therefore, man-made resistances (e.g. institutional and cultural distances, trade barriers, etc.) should be included in the second step of estimation (the regression equation for analyzing the determinants of trade efficiency scores). In reality, there might be many factors affecting trade efficiency. However, due to the availability of the data, the omission of some variables is not avoidable. Taking this problem into account, we employed a system GMM estimator, which can overcome the problems resulting from endogeneity, measurement errors, and omitted variables.
**Comment 3:** The third point is that to my view the three determinants of trade efficiency are possibly highly correlated and therefore the correlation matrix should be shown to justify that it is still possible to identify separated effects.

**Revision:** Following the referee’s recommendation, we provided the correlation matrix for explanatory variables in both equation (‘stochastic frontier gravity’ equation and ‘the determinants of trade efficiency’ equation). As the results reveal, all of the correlation coefficients for the explanatory variables do not exceed either -0.5 or +0.5. Hence, there should not be a severe multicollinearity problem in our data.

**Table 4: Correlation matrix**

<table>
<thead>
<tr>
<th></th>
<th>ID_{ij,t}</th>
<th>CD_{ij}</th>
<th>lnTF_{ij,t}</th>
</tr>
</thead>
<tbody>
<tr>
<td>ID_{ij,t}</td>
<td>1.000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CD_{ij}</td>
<td>0.176</td>
<td>1.000</td>
<td></td>
</tr>
<tr>
<td>lnTF_{ij,t}</td>
<td>0.206</td>
<td>0.191</td>
<td>1.000</td>
</tr>
</tbody>
</table>

**Comment 4:** Finally, some econometric issues have to be tackled: In the GMM estimation the AR (2) test shows a p-value lower than 0.10, this indicates autocorrelation and the errors should be made robust to it. Moreover, the Sargan test indicates that the instruments are marginally not valid, with a p-value below 0.10, and, in any case, the Hansen test results and not the Sargan should be reported if there is heteroskedasticity in the error term. Additionally, there is no test shown for weak instruments, those tests are obtained automatically when using the command in stata “xtreg2”. More importantly, since the dependent variable is obtained in a first step estimation the errors should be bootstrapped in the second step estimation.

**Revision:** Following the reviewer's recommendation, we presented the Hansen test to ensure the robustness of the estimation results (Please refer to Table 5 in comment 6). According to Table 5, both the Sargan test and the Hansen test are insignificant, meaning that our instruments are valid. Moreover, to ensure that there is no heteroscedasticity issue due to the dependent variable being obtained in a first step estimation, we run GMM with three options: one-step,
one-step with robust\textsuperscript{9}, and two-step with robust\textsuperscript{10}. According to table 5, all standard error of variables only changes slightly regardless of the presence of heteroskedasticity and autocorrelation within panels. These confirm that our results are efficient.

\textsuperscript{9} One-step with robust specifies that the robust estimator of the covariance matrix of the parameter estimates be calculated. The resulting standard error estimates are consistent in the presence of any pattern of heteroskedasticity and autocorrelation within panels.

\textsuperscript{10} According to Roodman (2009), in two-step estimation, the standard covariance matrix is already robust in theory--but typically yields standard errors that are downward biased. Hence, we use two-step estimation with robust in GMM that requests Windmeijer (2005) finite-sample correction for the two-step covariance matrix to compare with model GMM one-step.
Minor comments

**Comment 1**: Page 1: cultural difference, should be plural, replace by differences.

**Revision**: We replace cultural difference with cultural differences.

**Comment 2**: On institutional distance see also Martínez-Zarzoso and Márquez-Ramos (2019) in The World Economy.

**Revision**: Following the reviewer's comment, we added this reference to our manuscript.

**Comment 3**: The brackets containing “(model bc88 and model pl81) …(modelbc82…) should be deleted, those are not informative at all.

**Revision**: We removed the brackets containing “(model bc88 and model pl81) …(modelbc82…)"

**Comment 4**: In page 4: the “common border” dummy should also be included in the specification of the gravity model.

**Revision**: We included the variable ‘common border' and other variables suggested by the reviewer. After that, we re-performed the model.

**Comment 5** All equations should be numbered.

**Revision**: We revised the number of the equation in a way that is well enumerated.

**Comment 6**: Page 7: why the product of freedom trade is included and not the single variables in each country? It does not have a clear interpretation.

**Revision**: Following the reviewer’s comments, we split the interaction variable of trade freedom ($TF_{ij,t}$) into $TF_{i,t}$ (indicates the level of trade freedom of country $i$ in year $t$) and $TF_{j,t}$ (indicates the level of trade freedom of country $j$ in year $t$). We performed the model again. The results are as follows:
Table 5: Determinants of ASEAN’s Trade Efficiency

<table>
<thead>
<tr>
<th></th>
<th>GMM- one step</th>
<th>GMM- one step with robust</th>
<th>GMM- two step with robust</th>
</tr>
</thead>
<tbody>
<tr>
<td>TE_{i,t-1}</td>
<td>0.764**</td>
<td>0.764**</td>
<td>0.737**</td>
</tr>
<tr>
<td></td>
<td>(0.032)</td>
<td>(0.046)</td>
<td>(0.034)</td>
</tr>
<tr>
<td>ID_{i,t}</td>
<td>-0.004**</td>
<td>-0.004*</td>
<td>-0.004**</td>
</tr>
<tr>
<td></td>
<td>(0.002)</td>
<td>(0.002)</td>
<td>(0.002)</td>
</tr>
<tr>
<td>CD_{ij}</td>
<td>-0.005**</td>
<td>-0.005**</td>
<td>-0.006**</td>
</tr>
<tr>
<td></td>
<td>(0.001)</td>
<td>(0.002)</td>
<td>(0.002)</td>
</tr>
<tr>
<td>lnTF_{i,t}</td>
<td>0.200**</td>
<td>0.200**</td>
<td>0.222**</td>
</tr>
<tr>
<td></td>
<td>(0.029)</td>
<td>(0.037)</td>
<td>(0.027)</td>
</tr>
<tr>
<td>lnTF_{j,t}</td>
<td>0.112**</td>
<td>0.112**</td>
<td>0.124**</td>
</tr>
<tr>
<td></td>
<td>(0.016)</td>
<td>(0.023)</td>
<td>(0.019)</td>
</tr>
<tr>
<td>Constant</td>
<td>-1.190**</td>
<td>-1.190**</td>
<td>-1.319**</td>
</tr>
<tr>
<td></td>
<td>(0.158)</td>
<td>(0.210)</td>
<td>(0.154)</td>
</tr>
<tr>
<td>Number of Observations</td>
<td>3540</td>
<td>3540</td>
<td>3540</td>
</tr>
<tr>
<td>AR(2)- test</td>
<td>Z</td>
<td>1.46</td>
<td>0.78</td>
</tr>
<tr>
<td></td>
<td>Pr &gt; z</td>
<td>0.144</td>
<td>0.433</td>
</tr>
<tr>
<td></td>
<td>Chi 2</td>
<td>5.08</td>
<td>5.08</td>
</tr>
<tr>
<td>Sargan- test</td>
<td>Prob &gt; chi2</td>
<td>0.166</td>
<td>0.166</td>
</tr>
<tr>
<td></td>
<td>Chi 2</td>
<td>-</td>
<td>2.46</td>
</tr>
<tr>
<td>Hansen- test</td>
<td>Prob &gt; chi2</td>
<td>-</td>
<td>0.483</td>
</tr>
</tbody>
</table>

Notes: Standard errors are in parentheses.

Significance at the 0.01 (**), and 0.05 (*) levels.

According to Table 5, the estimated coefficient of both $TF_{i,t}$ into $TF_{j,t}$ are positive and statistically significant at 0.01 level. This result implies that free trade policies of both ASEAN countries and their trading partners play a vital role in promoting trade efficiency. It could be because trade freedom facilitates freer flows of goods and services between ASEAN countries and their trading partners as a result of eliminating tariff and non-tariff barriers.

Given the fact that trade liberalization is an ideal factor for trade development between countries, ASEAN has endeavored to sign many free trade agreements (FTAs) with countries around the world in order to eliminate tariff and non-tariff barriers. According to WTO statistics, ASEAN has signed FTAs with the major trading partners in Asia, such as China, Japan, Korea and India. As a result, the total trade and trade efficiency between ASEAN and these countries is quite high.
Currently, FTAs with EU countries (one of ASEAN's main partners) are still on the negotiating process, but ASEAN's member countries have signed FTAs individually with these countries. Therefore, although the trade efficiency of ASEAN countries with the EU countries is not high, it is still improving thanks to FTAs between the EU and individual ASEAN countries such as Singapore.

**Comment 7:** In many cases a space is missing before brackets, for example twice in the first paragraph of page 8.

**Revision:** we corrected the typing errors.

**Comment 8:** In page 8, reference to a “η” term is made, please link it with the model in eq.(1).

**Explanation:**

\[
\ln Trade_{ij,t} = \alpha + \beta_1 \ln GDP_{i,t} + \beta_2 \ln GDP_{j,t} + \beta_3 \ln DIST_{ij} + \beta_4 \ln Area_i + \beta_5 \ln Area_j + \beta_6 Colony_{ij} \\
+ \beta_7 Landlocked_{ij} + \beta_8 Language_{ij} + \beta_9 FTA_{ij,t} + \epsilon_{ij,t}
\]

(1)

Our equation (1) is built on the theory of Karakaplan and Kutlu (2017). As follow, our stochastic frontier panel data is:

\[
y_{i,t} = x'_{y_{i,t}} \beta + v_{i,t} - u_{i,t} \\
x_{i,t} = Z_{i,t} \delta + \epsilon_{i,t}
\]

\[
\begin{bmatrix}
\bar{\epsilon}_{i,t} \\
v_{i,t}
\end{bmatrix} \equiv \begin{bmatrix} \Omega^{-1/2} \epsilon_{i,t} \\
v_{i,t}
\end{bmatrix} \sim N \left( \begin{bmatrix} 0 \\
0' \end{bmatrix}, \begin{bmatrix} I_p & \sigma_\rho \rho' \\
\sigma_\rho \rho & \sigma_\rho^2
\end{bmatrix} \right)
\]

\[
u_{i,t} = h(x'_{u_{i,t}} \varphi u) u^*_i
\]

(1)

In which: \(y_{i,t}\) is the logarithm of total trade of the \(i\)-th country- pair at time \(t\). \(x_{y_{i,t}}\) is a vector of exogenous and endogenous variables; \(x_{i,t}\) is a \(p \times 1\) vector of all endogenous variables (excluding \(y_{i,t}\)); \(Z_{i,t} = I_p \otimes z'_{i,t}\) (\(z_{i,t}\) is a \(q \times 1\) vector of all exogenous variables); \(\epsilon_{i,t}\) and \(v_{i,t}\) are two-sided error terms; \(u_{i,t} \geq 0\) is a one-sided error term capturing the inefficiency.
\[ u_{i,t} = h(x'_{u_{i,t}}\varphi_u) > 0, \]  
\[ x_{u_{i,t}} \]  
is a vector of exogenous and endogenous variables excluding the constant, \( u_i \) is a producer-specific random component independent from \( \varepsilon_{i,t} \) and \( v_{i,t} \). Hence, \( \Omega \) is the variance-covariance matrix of \( \varepsilon_{i,t} \), \( \sigma_v^2 \) is the variance of \( v_{i,t} \), \( \rho \) is the vector representing the correlation between \( \varepsilon_{i,t} \) and \( v_{i,t} \). Hence, \( v_{i,t} \) and \( u_{i,t} \) can be correlated with \( x_{i,t} \), yet \( u_{i,t} \) and \( v_{i,t} \) are conditionally independent given \( x_{i,t} \) and \( z_{i,t} \). Similarly, \( u_{i,t} \) and \( \varepsilon_{i,t} \) are conditionally independent given \( x_{i,t} \) and \( z_{i,t} \). By a Cholesky decomposition of the variance-covariance matrix of \( (\varepsilon'_{i,t}, v_{i,t})' \), we can represent \( (\varepsilon'_{i,t}, v_{i,t})' \) as follow:

\[
\begin{bmatrix}
\tilde{\varepsilon}_{i,t} \\
v_{i,t}
\end{bmatrix} =
\begin{bmatrix}
I_p & 0 \\
\sigma_v \rho' & \sigma_v \sqrt{1 - \rho' \rho}
\end{bmatrix}
\begin{bmatrix}
\varepsilon_{i,t} \\
\tilde{w}_{i,t}
\end{bmatrix}
\] (2)

Where

\[
y_{i,t} = x'y_{i,t} \beta + \sigma_v \rho' \tilde{\varepsilon}_{i,t} + w_{i,t} - u_{i,t}
\]

\[
= x'y_{i,t} \beta + (x_{i,t} - Z_{i,t} \delta)' \eta + e_{i,t}
\] (3)

Where \( e_{i,t} = w_{i,t} - u_{i,t} \), \( w_{i,t} = \sigma_v \sqrt{1 - \rho' \rho} \tilde{w}_{i,t} = \sigma_w \tilde{w}_{i,t} \) and \( \eta = \sigma_w \Omega^{-1/2} \rho / \sqrt{1 - \rho' \rho} \); \( e_{i,t} \) is conditionally independent of the regressors given \( x_{i,t} \) and \( z_{i,t} \)

\[
e_{i,t} = y_{i,t} - x'y_{1i,t} \beta - \varepsilon_{i,t}' \eta
\]

In which: \( \varepsilon_{i,t} = (x_{i,t} - Z_{i,t} \delta)' \eta \) serves as a bias correction term.

**Comment 9:** Data section: please clarify whether intra-Asean trade is also included or not. It should definitely be included in the estimations, if it is not. Some variables are described and not included in the equations

**Explanation:** Our objective is to examine trade efficiency between ASEAN countries and the rest of the world. To avoid systematic errors, we only examine trade efficiency between ASEAN countries and non-ASEAN countries.
Appendices

Appendix 1: Estimate of ASEAN’s Average Trade efficiency

<table>
<thead>
<tr>
<th>Year</th>
<th>ASEAN</th>
<th>Indonesia</th>
<th>Malaysia</th>
<th>Philippines</th>
<th>Singapore</th>
<th>Thailand</th>
<th>Vietnam</th>
</tr>
</thead>
<tbody>
<tr>
<td>2006</td>
<td>0.611</td>
<td>0.657</td>
<td>0.599</td>
<td>0.636</td>
<td>0.628</td>
<td>0.587</td>
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Source: The authors’ computation

Appendix 2: ASEAN - ROW Potential Trade

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Source: The authors’ computation

Note: Trade potential = Potential trade - Actual trade
References


