Indonesian Export Efficiency : A Stochastic Frontier Gravity Model Approach

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ABSTRACT

Export performance is an important aspect to encourage economic growth and economic prosperity. Export performance can be analysed using export efficiency variable. Export efficiency can be defined as ratio of the actual to potential exports. Knowing the export efficiency and factors affecting it could help policy maker to minimize and mitigate the affects of existing restrictive measures of trade. This study was conducted to analys the efficiency of Indonesia's merchandise exports and the affecting factors using stochastic frontier gravity model. Result of this study shown that Indonesian merchandise export flows with 62 trading partners is significantly positively affected by Gross Domestic Product (GDP) and population, then significantly negatively affected by bilateral distance. The study also found that the average export efficiency of Indonesia to 62 trading partner countries up to 51.35 percent in 2012 and 49.69 percent in 2016. The highest value of export efficiency was in Singapore and the lowest was in Portugal. Result of technical inefficiency model reveals that export inefficiency increased by business freedom, investment freedom, and landlocked dummy, and then export inefficiency decreased by labor freedom, financial freedom, contig dummy and FTA dummy.

Keywords : Indonesia Export Efficiency, Merchandise Exports, Stochastic Frontier Gravity Model

I. INTRODUCTION

Economic globalization causes the international trade of goods and services transactions has been greater and easier. Every country in the world is required to expand both trade openness and financial openness. Trade openness can be illustrated by reduce and remove of trade barriers, both in the form of tariffs and non-tariffs barriers, and also the increasing of capital and labor mobility between countries. International trade was considered important in improving economic growth and welfare. Mercantilism maintained that the rich and powerful nation was who can export more than to import. Indonesia is one of the open economies country, but statistics shows that Indonesian merchandise exports has decreased year in year from US$ 203.49 billion in 2011 to US$ 144,84 billion in 2016. The declined of exports made Indonesian trade balance being a deficit (Ministry of Trade, 2018).

The declined of Indonesian exports could be due to export inefficiency so therefore necessary to do more in-depth research on exports. The research should not only be limited to analysing export performance and export competitiveness but also analysing export efficiency. This research is important to provide policy recommendations for the Indonesian government.

Trade efficiency is defined as the ratio of actual exports to its maximum potential export (Doan and Xing 2018). Trade potential between two countries can be defined as the trade that could be achieved by country at an optimum trade frontier, given the determinants, when there is no resistance to trade between them (Kalirajan, 1999).

Knowing the export efficiency and the affecting factors could help policy maker to minimize or remove the existing restrictives of trade in order to achieve full export potential. Previous researchs have estimated the export potential or predicted value of export between two countries by using basic gravity equation through ordynary least square (OLS) as estimation tools (Baldwin, 1994). However estimation using OLS might result in bias and inconsistent estimators because the OLS estimates represent the centered value of the data set not the upper limits of the data.

Export potential refers to free trade with no restrictions to trade so it requires an estimation that represents the upper limits of the data (Kalirajan, 2008). To address this, Kalirajan (2008) suggests the concept of stochastic frontier gravity model (SFGM) to provide a more meaningfull estimation. According to the reason bellow, this study is an attempt to investigates Indonesian export efficiency and factors affecting inefficiency using SFGM.

II. METHODS AND MATERIAL

The analytical method used in this study is stochastic frontier gravity model that was formally introduced by Kalirajan (1999). This model is integration of gravity model and stochastic frontier producion function model. The gravity model first applied by Tinbergen (1962) to estimated the international trade flows. The basic equaion in gravity model is :

$$X_{ij} = A \frac{Y_i^{\alpha} Y_j^{\beta}}{D_{ij}^{\gamma}} \qquad (1)$$

The α is elasticity of exporting country's GDP, β is elasticity of importing country's GDP, and γ is elasticity of distance. By taking natural logarithm of equation 1 and adding the error term so the equation can be :

$$\log X_{ij} = \log A + \alpha \log(Y_i) + \beta \log(Y_j) - \gamma \log(D_{ij}) + \varepsilon_{ij} \qquad (2)$$

Anderson (1979) is the one of first economist who developed a gravity model, he argued that trade costs are dependent not only on geographical distance between countries but also on other factors emanating from the existing infrastruc-tural, institutional, socio-economic, and political rigidities in both exporting and importing countries. These latter costs are defined as 'economic distance' in the literature (Anderson 1979). Thus, the conventional gravity model given above has omitted this potentially important explanatory variable. Furthermore, this inherent omitted variable bias is overlooked by OLS estimation.

In simple language, omission of the economic distance term leads to heteroskedastic errors which results in bias in the estimation of the model parameters. The log-linearization of the empirical model in the presence of heteroskedasticity leads to inconsistent estimates because the expected value of the logarithm of a random variable depends on higher order moments of its distribution (Silva and Tenreyro 2003). Also, it affects the normality assumption of the error term. As a result, an OLS estimation will lead to biased estimator (Kalirajan 2007).

A stochastic gravity model with varying coefficients would explain better the trade flows between countries than a gravity model with fixed

coefficients. Following Kalirajan (2007) and Miankhel et al. (2014), the gravity equation for exports can be estimated alternatively as :

$$Ln\ X_{ij} = \ln f\left(Z_j, \beta\right) exp^{(v_i - u_i)} \qquad (3)$$

The term X_{ij} represents the actual exports from country i to country j. Then the term $f(Z_j, \beta)$ is a function of the determinants of potential bilateral trade Z_j include distance, GDP, and population to represent supply and demand conditions. The term β is a vector of unknown parameters.

The single sided error term, u_i is the economic distance bias referred by Anderson (1979), which is due to the influence of the "behind the border measures" of the importing country. This bias creates the difference between actual and potential trade between two countries. The term of u_i takes value between 0 and 1 and it is usually assumed to follow a truncated (at 0) normal distribution $N(\mu, \sigma_u^2)$. When u_i takes the value 0, the bias or country specific behind the border constraints are not important so the actual export will be the same with potential exports, assuming there are no statisical errors. In the other hand when u_i takes the value equal to 1 this indicates that the bias or country specific behind the border constraints are important and they constraint the actual exports from reaching potential exports. The double-sided error term v_i captures the influence on trade flows of other left out variables, including measurement error that are randomly distributed across observations in the sample. It is assumed to be $N(\mu, \sigma_v^2)$ (Miankhel et.al , 2009).

Adopted and modified the methodology purposed by Kalirajan and Singh (2008) and Deluna and Cruz (2014) so the empirical model using SFGM in this research can be rewritten as :

$$Ln\ X_{ijt} = \beta_0 + \beta_1 lnGDP_{jt} + \beta_2 lnPOP_{jt} + \beta_3 lnDist_{ijt} - u_{ijt} + v_{ijt}$$

$$(4)$$

Where : X_{ijt} is the total value of exports from Indonesia (i) to partner country (j) at time t, GDP_{jt} is Gross Domestic Product of country j at time t as proxy for income, POP_{jt} population of country j as proxy for market size, and $Dist_{ijt}$ is the geographical distance between the capital cities of country i and j measured in kilometers. u_{ijt} is single sided error for the combined effects of inherent economic distance bias or behind the border constraints, which is specific to the exporting country with respect to the particular importing country. It creating the difference between actual and potential bilateral trade. Also It is assumed to have an iid nonnegative half normal distribution. v_{ijt} is double sided error term that captures the impact of inadvertently omitted variables and measurement errors that are randomly distributed across observations in the sample. It is assumed to follow an iid normal distribution with mean zero and constant variance. The disturbance term can be specified as : $\varepsilon_{ijt} : v_{ijt} - u_{ijt}$.

Using the result of equation (4), the exports efficiency with particular trading partner can defined as :

$$TRE_{ijt} = \frac{exp[lnX_{ijt}]}{exp[lnf(Y_{ijt};\beta) + v_{ijt}]}$$

$$= \frac{f(Y_{ijt};\beta)\ exp(v_{ijt} - u_{ijt})}{f(Y_{ijt};\beta)\ exp(v_{ijt})}$$

$$= exp(-u_{ijt}) \qquad (5)$$

where $exp[lnX_{ijt}]$ is actual exports and $exp[lnf(Y_{ijt};\beta) + v_{ijt}]$ represents the greatest possible export or potential export. Higher TRE_{ijt} implies higher efficiency, or export volume closer to the export frontier. That function is based on the time decay inefficiency model proposed by Battese & Coelli (1993).

The equation to estimates the determinant of exports efficiency is :

$$U_{ijt} = \delta_0 + \delta_1 LnArea_{jt} + \delta_2 FF_{jt} + \delta_3 IF_{jt} + \delta_4 FI_{jt} + \delta_5 MF_{jt} + \delta_6 LF_{jt} + \delta_7 BF_{jt} + \delta_8 TB_{jt} + \delta_9 landlocked + \delta_{10} FTA + \delta_{11} comlang + \delta_{12} contig + w_{ijt} \quad (6)$$

Where : Area is size of land area of the partner country, BF is Business Freedom index developed by The Heritage Foundation, IF is Investment Freedom Index, FI is Fiscal Freedom index of country j, LF is Labor Freedom index of country j, MF is Monetary Freedom index of country j, FF is Financial Freedom index of country j, landlocked is a dummy variable, 1 if the country j is landlocked and 0 otherwise FTA is dummy variable, value 1 if Indonesia has the same FTA with partner and 0 for otherwise, comlang is a language dummy variable, contig is dummy variable, value 1 if two countries are contiguous.

The panel data set includes in this study is 62 of Indonesia trading partners as cross secions and in the periods 2011-2016 as time series. The sellected countries are according to the greatest value of merchandise export and based on the most complete data for each variable. Table 1 shown the variables, unit, and sourch of the data in this study. The estimation of gravity equations 4 and export efficiency model 6 was done simultaneously following the usual sochastic frontier production funcion using Frontier 4.1 software. This sofware was introdused by Coelli (1996).

TABLE I
VARIABLES AND SOURCES OF DATA

Variable	Unit	Source
Export Value	US$	UN Comtrade
GDP	US$	WDI
Population	People	WDI
Distance	Km	CEPII
Landlocked	-	CEPII
Contig	-	CEPII
Comlang Ethno	-	CEPII
Land Area	Km²	WDI
FTA	-	ADB
Business Freedom	Index	Heritage Foundation
Investment Freedom	Index	Heritage Foundation
Labor Freedom	Index	Heritage Foundation
Financial Freedom	Index	Heritage Foundation
Tax burden	Index	Heritage Foundation
Monetary Freedom	Index	Heritage Foundation

III. RESULTS AND DISCUSSION

Results of the simultaneous estimation of equations 4 and 6 were presented in Table 2 and 3. The estimated parameter signs for GDP and population are positive and significant as expected. Furthermore, the negative sign for distance between them is also as expected. These results are consistent with previous researches (Deluna and Cruz, 2014; Amin, et al., 2009). The variable of GDP of partner countries significantly affects the export with positive sign which means that a higher level of GDP in partner countries results in a higher export value from Indonesia. For example, if the GDP of Singapore increases significantly, it makes citizen of Singapore will expect more good hence implies an increase in the domestic demand. If the domestic demand exceeds the domestic supply, Singapore should import more from their partner countries, in this case from Indonesia.

The variable population of partner countries also positively affects merchandise export flows of the Indonesian, and significant at the 5% level. Population is proxy to market size of the partner

countries. On the average, a percent increase in population or market size of the partner country will increases value of Indonesian export by 0.12 %.

On the other hand, bilateral distance was seen to have negative effect to export flows so can reducing trade between Indonesia and the partner countries. Distance is a proxy of transport costs and other cost of trade like communication cost, and transaction cost, among others. The greater distance is means the higher of the cost. This implies that even with modern transport technology, distance/cost of trade in many forms still significantly affects trade flows among countries. For example, distance can reflect logistical difficulties.

These results suggest that to increase export flows of the country, it should focus on strengthening trade linkages/partnership in form of bilateral or multilateral agreement in nearby countries with higher income and fast growing population. This leads us to a very important question on "which nearby countries posed potentials for market expansion of Indonesian export?

TABLE II

MAXIMUM LIKELIHOOD ESTIMATES OF STOCHASTIC FRONTIER GRAVITY EQUATION (FACTORS OF TRADE CONTRIBUTING TECHNICAL EFFICIENCY)

Variable	Coefficient	Std-eror	T-ratio
Constant	11.91	1.03	11.52*
GDP	0.58	0.04	13.17*
POP	0.12	0.06	2.13*
Distance	-0.91	0.09	-10.63*

* significant 5% level

Table 2 shown the estimates of the technical inefficiency effect model. The estimated sigma squared is highly significant. This is a measure of the mean total variation over the five year time periods. This implies that the exports flows of the Indonesia

during this period have been changing. The hypothesis however, that there is technical inefficiency in the model was accepted as implied by significant gamma. This means that this variation is due to technical inefficiency in the model. But the coefficient of gamma was low. Thus, further modification and inclusion of variables both beyond and behind the border is necessary to understand this variation.

This study included trading partner's natural specific characteristics such as land area, language, dummy variables indicating whether the two countries are contiguous and dummy if the country is landlocked. This study also used the disaggregated components of economic freedom of partner countries to capture the impact of country specific indicators covering macroeconomic stability, the role of the government and corporate sector in business, price stability, legal system and policies regarding investment and international trade. Variables that turns out significant at 5% level are business freedom, labor freedom, investment freedom, financial freedom, landlocked, contig, and FTA, while area, monetary freedom, tax burden, and comlang ethno are insignificant.

Business freedom increases inefficiency by 1.31%, this implies that high business freedom in partner countries means high cost to trade. This variable analyses the cost, time and freedom to open, operate, close a business in partner countries, and taking into consideration factors like electricity. The freer business in partner countries can implies increasing on domestic production so by indirect way it makes decrease on demand of import good from Indonesia.

Labor freedom is about quantifies the intrusivness of labor rights such as minimum wage, laws inhibiting layoffs, severance requirements, and measurable regulatory restraints on hiring and hours worked, plus the labor force participation rate as an indicative measure of employment opportunities in

the labor market. Freer labor of partner countries decrease inefficiency it means increase efficiency of Indonesian export. The high labor freedom allows certainty and increase in salaries of workers, so it can increase their consumption side and if domestic consumption exceeds domestic production, the country will open gates more broadly to import products from other countries.

The results of this study found that the investment freedom index of trading partner countries had a significant and positive effect on Indonesia's export inefficiency, meaning that the higher the investment freedom index of partner countries would reduce the efficiency of Indonesia's exports. The investment freedom index indicator shows the freedom and ease of investment and the smooth flow of investment both domestic and foreign. If the investment climate in partner countries is good, it will encourage an increase in domestic production, so that domestic consumption will be fulfilled by domestic production itself, so that demand for imported products will decrease and then will reduce the efficiency of Indonesian exports to that country.

The financial freedom index has to do with the ease of the financial system and the performance of banks that are good at dealing with domestic and foreign transactions. In this study it was found that the financial freedom index of trading partner countries had a significant and negative effect on the inefficiency of Indonesian exports, if the index increase it would increase efficiency. The better performance of banks, especially in servicing cross-country payments, will facilitate the payment of export-import transactions so that it will increase the efficiency of Indonesia's exports to that country.

This study shows that lanlocked dummy has a positive effect on inefficiency, meaning that if the trading partner country is a landlocked country then the inefficiency of Indonesian exports will increase,

which means that efficiency decreases. The efficiency of exports to landlocked countries will be more inefficient, because transportation costs are relatively more expensive by road or air compared to sea transportation. LPEM (2005) research shown that sea transportation is a major supporter of international trade, 95% of international trade is carried out through sea transportation.

The contig dummy is dummy variables indicating whether the two countries are contiguous so the dummy will value "1". In this study it was found that this dummy had a negative and significant effect on export inefficiency. Indonesian exports will be more efficient if the trading partner countries are close to the Indonesian state.

The coefficient of FTA dummy in this study is positive and statistically significant, suggesting that FTAs help improve export efficiency. Indonesia should form FTAs to increase export efficiency because FTA can reduce and remove trade constraints between two countries. This result in line with Deluna and Cruz (2014) and Doan and Xing (2018).

Estimated export efficiencies were presented in tables 4 to 8. This study found that export efficiency is changing minimally during the five years period. The mean export efficiency for all samples ranged from 48% to 42% during 49.69 to 51.35 during these periods. Export flows in 2016 is more efficient in ASEAN+3 with mean value of 84.85%, ASEAN 72.88%, APEC 60.6%, NAFTA 40.26%, and EU 30.62%.

TABLE III
MAXIMUM LIKELIHOOD ESTIMATES OF STOCHASTIC FRONTIER GRAVITY EQUATION (FACTORS OF TECHNICAL INEFFICIENCY)

Variable	Coef	Std-eror	T-ratio
Constant	0.11	1.05	0.11
AREA	0.05	0.04	1.29
Business freedom	1.31	0.35	3.75*
Labor freedom	-0.83	0.22	-3.73*
Monetary freedom	-0.23	0.48	-0.47
Investment freedom	0.57	0.25	2.24*
Financial freedom	-0.92	0.32	-2.86*
Tax burden	0.10	0.28	0.36
Landlocked	1.07	0.36	2.98*
Comlang_ethno	-2.01	1.33	-1.51
Contig	-0.52	0.62	-0.83*
FTA	-1.34	0.25	-5.44*
Sigma-squared	0.58	0.04	13.41*
Gamma	0.20	0.03	6.28*

*significant 5% level

TABLE IV
EXPORT EFFICIENCY (IN PERCENT) OF INDONESIAN MERCHANDISE EXPORTS TO ASEAN MEMBER COUNTRIES

Country	2012	2013	2014	2015	2016
Malaysia	95.86	95.66	95.67	95.30	95.15
Philippines	88.88	87.82	84.32	88.91	87.72
Singapore	96.24	96.35	96.32	96.24	96.16
Thailand	90.91	90.16	88.66	87.15	85.36
Mean	74.38	74.00	72.99	73.52	72.88

Table 4 shown the export efficiency of Indonesian merchandise export to several member countries in ASEAN. Expor efficiency is consistenly very high with Singapore. This is due to the location of Singapore was strategic and supported by port infrastructure and very adequate airport, and also Singapore and Indonesia are coniguous each other so the constraints in this country are relatively low.

TABLE V
EXPORT EFFICIENCY (IN PERCENT) OF INDONESIAN MERCHANDISE EXPORTS TO ASEAN+3 MEMBER COUNTRIES

Country	2012	2013	2014	2015	2016
China	87.70	88.18	85.65	85.79	83.45
Japan	87.50	87.16	85.73	85.35	86.48
South korea	84.20	82.70	84.32	84.62	83.81
Mean	86.46	86.01	85.23	85.25	84.58

The export efficiency of Indonesian merchandise export to several member countries in ASEAN+3 shown at table 5. Both in Japan, China, and South Korea, export efficiency of Indonesia relatively almost the same. The average value is during 84.58% to 86.46%, this value is above the whole average for all sample in this study. The higher export efficiency is due to China, Japan, and South Korea have same FTA with Indonesia, and this study shown that FTA can increase efficiency of Indonesian export.

TABLE VI
EXPORT EFFICIENCY (IN PERCENT) OF INDONESIAN MERCHANDISE EXPORTS TO APEC MEMBER COUNTRIES

Country	2012	2013	2014	2015	2016
Australia	87.10	85.15	84.52	84.57	84.29
Canada	33.67	35.29	35.19	33.09	34.98
Chile	42.66	39.57	37.75	35.58	33.73
China	87.70	88.18	85.65	85.79	83.45
Japan	87.50	87.16	85.73	85.35	86.48
South Korea	84.20	82.70	84.32	84.62	83.81
Malaysia	95.86	95.66	95.67	95.30	95.15
Mexico	31.06	29.01	31.55	34.41	34.07
New Zealand	84.69	84.20	85.16	85.09	84.49
Papua-NG	44.39	43.35	43.39	48.02	45.38
Peru	36.68	36.47	36.27	37.29	36.11
Philippines	88.88	87.82	84.32	88.91	87.72
Russian F	35.91	24.25	25.74	23.81	26.09
Singapore	96.24	96.35	96.32	96.24	96.16
Thailand	90.91	90.16	88.66	87.15	85.36
USA	49.16	49.56	51.38	51.80	51.72
Mean	67.3	65.9	65.7	66.1	65.6

Table 6 shown export efficiency in APEC members. The lowest export efficiency was in Russian Federation, it means that export performance of Indonesia was not good. In the other hand this suggest that there is an immense opportunity for enhancing trade to Russian Federation. So Indonesia must Indonesia needs to accelerate free trade negotiations with Eurasian Economic Union (EAEU) in wish can bring better for Indonesian export.

TABLE VII
EXPORT EFFICIENCY (IN PERCENT) OF INDONESIAN MERCHANDISE EXPORTS TO NAFTA MEMBER COUNTRIES

Country	2012	2013	2014	2015	2016
Canada	33,67	35,29	35,19	33,09	34,98
Mexico	31,06	29,01	31,55	34,41	34,07
USA	49,16	49,56	51,38	51,80	51,72
Mean	37,96	37,96	39,37	39,77	40,26

Indonesian export efficiency in several countries in NAFTA were presented in table 7. Relative to the members NAFTA, the Indonesian export efficiency to US is the highest value, but still under the whole mean. This might happen because of a trade war and the increase in protectionism. There were many disputes between Indonesia and US, one of which was in 2013, US lawsuit related to restrictions on imports of agricultural and livestock products issued by Indonesia with the aim of protecting domestic production. This implies decreasing of Indonesian export performance to US.

Table 8 shown export efficiency in several EU members. The highest efficiency is Netherlands and the lowest is Portugal. This suggest that there is an opportunity for enhancing export to that countries. The Netherlands in potential trading partner country because, it is the second largest trading partner in Europe for Indonesia. Many Indonesian export commodities enter Europe through Dutch

ports. Rotterdam is one of the largest ports in the world and Amsterdam Schiphol Airport meets high international standards. Indonesia's largest export commodity to the Netherlands is palm oil. So Indonesia should to improve the product diversification in order to enhance export to Netherlands.

TABLE VIII
EXPORT EFFICIENCY (IN PERCENT) OF INDONESIAN MERCHANDISE EXPORTS TO EU MEMBER COUNTRIES

Country	2012	2013	2014	2015	2016
Belgium	46.84	46.08	46.59	41.90	43.28
Denmark	43.89	44.71	43.80	40.61	38.55
Finland	22.67	21.74	21.18	22.64	23.42
France	33.58	30.12	30.84	27.22	27.27
Germany	23.07	25.85	26.66	28.70	27.84
Italy	29.96	32.69	32.98	34.78	33.52
Netherlands	57.49	54.54	50.77	55.67	56.83
Poland	40.19	44.12	38.32	39.11	36.79
Portugal	17.86	19.62	20.67	22.66	23.91
Romania	25.16	24.89	26.10	26.17	27.63
Slovenia	23.42	23.30	26.24	30.56	29.46
Spain	39.55	36.82	37.77	34.95	35.58
Sweden	23.88	23.85	24.42	24.78	24.59
Mean	30.54	30.59	30.45	30.70	30.62

IV. CONCLUSION

The results in this study can be concluded that the factors that significantly affect Indonesian exports are GDP and population of trading partner countries and the distance between the two countries. The GDP and population of trading partner countries are positively significant while distance is negatively significant to export. The average value of Indonesia's export efficiency is around 50 percent, to ASEAN countries and ASEAN +3, the efficiency value is quite high while EU, APEC and NAFTA member country are still relatively low and still below the overall average. Factors influencing

Indonesia's export inefficiencies are landlocked, contig, FTA, business freedom, investment freedom, financial freedom, and labor freedom.

Base on the result of this study, suggestions for policy maker are to improve export performance in countries where the efficiency of this study is still very low, exsamples Norway, Morocco, Switzerland, Portugal, Finland, Greece, Sweden, Romania, Argentina, Germany, Slovenia, Russia, Algeria, Yemen, and France where the efficiency value is still below 30 percent on average. This can be a new market solution for Indonesian exports so as not to depend on export markets in traditional countries. Based on the results of research showing that FTA has a positive effect on export efficiency, so the government needs to seek new cooperation with countries that have not previously had trade agreement with Indonesia. The government must also evaluate existing FTA in order to maximize the benefits that can be obtained from the existence of such agreement. Strategic efforts must also be improve by the government, like improve institutions, infrastructure, and other supports that can increase the performance of Indonesia's exports. The suggestion for further research is to add other variables that can affect the inefficiency of Indonesian exports in order to get the best factors that made Indonesian export was not efficient.

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