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APEC's Exports of Environmental Goods: An Exploratory Analysis of Performance

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Abstract
Understanding the determinants of Environmental goods (EGs) trade is imperative for trade promotion and environmental protection. As the impacts of the determinants differ among EGs subgroups and countries, examining these determinants for each subgroup is necessary for policy recommendations. Export performances measured in terms of export efficiency using the stochastic frontier gravity model and data from APEC from 2007 to 2014 suggest that, albeit, the efforts in tariff reduction of APEC, do not appear to have reduced the constraints to increasing export efficiency of EGs trade over the period of analysis. Through the APEC regional cooperation, there is an urgent need to transfer technology in EGs to those countries with poor export efficiency from those countries enjoying the high level of realization of export efficiency including Japan, USA, China, and Canada.

Keywords:
Environmental goods; Determinants of exports; Export efficiency; Stochastic frontier gravity model; APEC

JEL Classification:
F14; F15; Q56; R11

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1. Introduction

Many emerging economies in Asia have started to move towards a new sustainable development paradigm that would facilitate increasing the phase of poverty reduction along with environmental protection (ADB-ADBI, 2013). Thus, there has been an increasing awareness of climate change, and environment protection activities such as the carbon sequestration and the Clean Development Mechanism (CDM). Such awareness has created demand for environmental goods (EGs), which are mostly imported from developed countries. For example, it is interesting to learn from a recent study by the U.K. Joint Environmental Markets Unit (UKJEMU) that there will be increasing demand from countries like Indonesia, Malaysia, Philippines, and Thailand for EGs concerning solid-waste handling and disposal, and also for filtration and purification of water. It is reported that about 50% of total EGs to be used within 2030 are yet to be created, which emphasizes the urgent need for funding and research and development (R & D) to develop and transfer the technologies to the needy countries. This situation provides an opportunity to strengthen regional production and export capabilities in the area of EG through regional cooperation. Unfortunately, trade and investment in EGs are very low compared to trade and investment in pollution-intensive products (Mikic, 2010).

The global market for environmental goods and services was estimated to have reached US$ 866 billion in 2011 and is expected to rise to US$ 1.9 trillion by 2020 (EBI 2012). Although the effective tariffs on EGs are low, the non-tariff barriers, or 'behind the border' constraints, are very high (Kalirajan, 2012). Therefore, numerous efforts have been undertaken worldwide to eliminate tariff and non-tariff barriers on EGs. As a consequence, environmental concerns in trade has been incorporated into various trade agreements following the North American Free Trade Agreement (NAFTA) in 1992. Environmental policies were also included in several prominent regional agreements such as CITES and Montreal Protocol by detailed element of different environmental agreements (ESCAP 2006). In addition, they have been addressed by trans-regional and bilateral free trade agreements (FTAs) such as the Trans-Pacific Strategic Economic Partnership Agreement (SEP), Trans-Pacific Partnership (TPP), the US-Singapore FTA (USSFTA), and the New Zealand-Thailand Closer Economic Partnership Agreement (CEP). A broad consensus of these agreements is that environmental issues are likely to be the dominant issues in various trade agreements in the near future (ESCAP 2006). Among these efforts, APEC has issued a list of 54 EGs and reduced tariffs on these goods on a volunteering

basis of members. In addition, there are other efforts in clarifying EGs lists, and in negotiating tariff reductions on EGs under the WTO. Moreover, countries are implementing numerous policies related to financial access, technology transfer, awareness raising, and regional cooperation to boost EGs trade.

It is in this context, the following important trade policy oriented question needs to be answered: Are the efforts of improving the infrastructure and policies towards promoting EGs trade effective in the Asian region? This crucial question has not been addressed adequately in the current literature and the objective of this paper is to rectify the limitation.

The structure of this chapter is as follows: Section 2 briefly presents the definitions and trends of EG trade and the existing literature on its determinants. Section 3 discusses the theoretical framework of the Stochastic Frontier Gravity model. Section 4 examines empirical models, and explains the choice of the model specifications. Section 5 presents the data used in the empirical analysis. Section 6 discusses the empirical results about the determinants of EGs trade for each EGs subgroup and for the total EGs. A final section summarises with policy suggestions for EGs trade promotion in APEC.

2. Definitions and lists of environmental goods

There has not yet been consensus on EGs definition or on what goods should be included in the EGs list. OECD/Eurostat (1999) delivers a broad scope of EGs, which are to measure, prevent, limit, minimize or correct environmental damage to water, air and soil, as well as problems related to waste, noise and ecosystems. However, there are also much narrower EGs definitions. According to Hamwey et al. (2003), EGs are limited to any equipment, material or technology used to address a particular environmental problem. The definition given by Katti (2005) is narrower than OECD's one, and is different from Hamway et al.'s. She claims that EGs refer to any products that themselves are "environmentally preferable" to other similar products because of their relatively lesser or reduced negative effect on human health and the environment. Even though definitions of EGs vary, a commonality is that they refer to EGs as products that can reduce negative impacts on the environment.

Many of the EGs lists, such as the Asia-Pacific Economic Cooperation (APEC) Early Voluntary Sector Liberalization (EVSL) initiative list, APEC list (2012), OECD list, the World Bank's list, the International Centre for Trade and Sustainable Development (ICTSD) climate-friendly goods list, and the WTO's 153 list, have been created for purposes of research as well

as to facilitate trade negotiations. This paper has chosen the APEC's 54 list as it is the only list that has been applied in EG trade practices and agreements up to now in the APEC's negotiations. Most of the 54 EGs in the APEC list are included in the WTO list and this list contains goods from various points of view of environmental protection (Matsumura 2016).

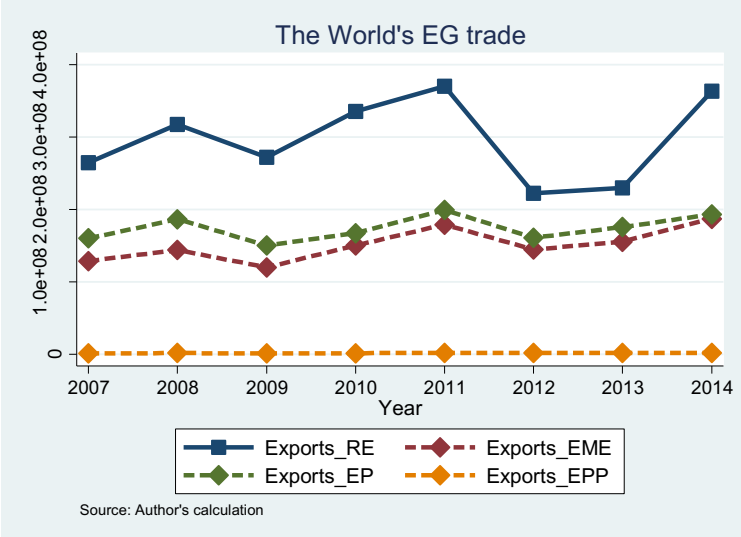
2.1 Trade in environmental goods and tariffs

As mentioned above, EGs are decomposed into four subgroups of renewable energy (RE), environmental monitoring analysis and assessment (EME), environmental protection (EP), and environmental preferable products (EPP) in the APEC 54 list.

World environmental goods exports of the APEC 54 list

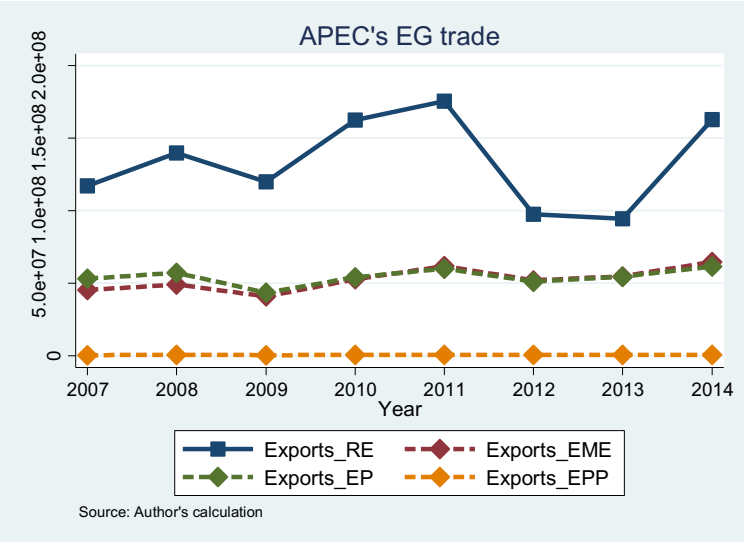
Among EGs exports, RE exports are the biggest, almost double those of EME and EP, whereas EPP exports are relatively very small as shown in Figure 1. There were fluctuations in EGs world trade from 2007 to 2014, but the overall tendency was upward for the three subgroups of RE, EME, and EP. The increase was the most significant in the case of RE.

Figure 1 **World trade in environmental goods, 2007-2014**



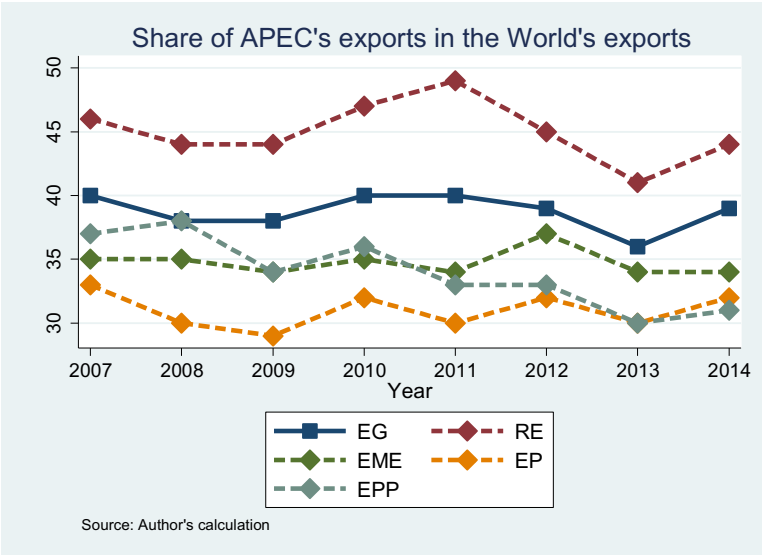
APEC's Environmental good exports of the APEC 54 list

Figure 2 **APEC's environmental good trade, 2007-2014**



Like the world's exports, APEC's exports in RE was the largest, followed by those in EME, EP and EPP. Interestingly, the trend in RE exports of the APEC countries was exactly the same as the total world trade in EGs. EME and EP exports of APEC went up slightly over the period. Due to the global financial crisis, the RE, EME and EP exports all fell in 2009 and due to the European debt crisis in 2011. However, exports rebounded in 2012.

Figure 3 **Share of APEC's exports in the world's exports (%), 2007-2014**



The common tendencies of APEC's export share in the world's exports for total EGs and four EGs subgroups fluctuated and slightly reduced during the period. APEC's total EGs share in

the world's exports in total EGs was around 40%. Share of APEC's RE exports in the world's RE exports was the biggest among the four EGs subgroups, around 45% whereas that of EP is the smallest, around 32% during the period of analysis.

Tariffs on EGs

The 21 APEC members reached agreement in 2011 to reduce the applied tariff rates on EGs to 5% or less by the end of 2015. The APEC list of 54 EGs for tariff reductions was endorsed in 2012. Even though agreement was voluntary, most countries have finished their work in implementing this pledge (Rene, V 2016), as shown in Table 1.

Table 1 **Tariff reductions on EGs of APEC members**

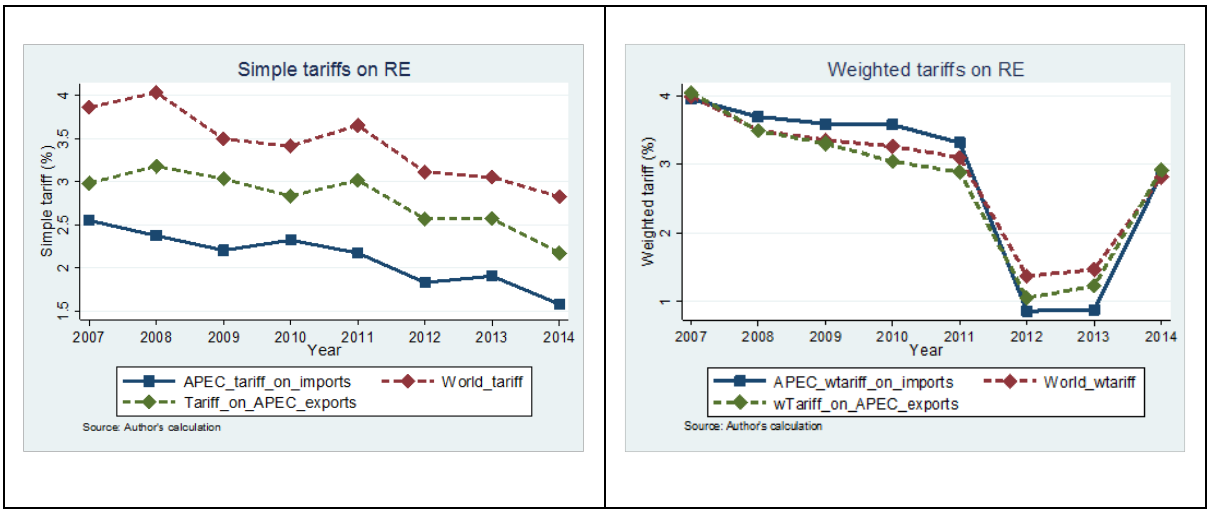
Implementation	Tariff lines	APEC economies (number of national tariff lines)
Fully implemented	273	Brunei Darussalam (84); Canada (2); China (27); Korea (85); Malaysia (8); Mexico (29); Peru (3); Philippines (6); Chinese Taipei (6); Thailand (12); United States (6); Viet Nam (5)
In legislative process	73	Chile (73)
Pending	22	Indonesia (16); Russian Federation (5); PNG (1)
Other tariff reductions	7	Thailand (7) (Tariff reductions only to 7%)

Source: Rene, V (2016)

Tariffs on RE

The fact that weighted tariffs are much lower than simple tariffs suggests that trade between countries is focused on EGs with lower tariffs. Tariffs of the world's RE, on APEC's RE exports, and APEC's tariffs on its RE imports gradually reduced during the period. APEC member countries' tariffs on RE imports were lowest, followed by tariffs of partner countries on their exports and tariffs on the world's RE exports as shown in Table 4.

Figure 4 **Average simple and weighted tariffs on RE, 2007-2014**



This is obvious because of APEC's agreements on liberalizing EGs trade, and these reductions were applied not only to imports from APEC-member countries but to all imports from other WTO member countries on the MFN basis. Tariffs on APEC's exports were higher than their tariffs on imports as APEC member countries mostly only enjoy tariff reductions on their exports when exporting to other APEC member countries. Weighted tariffs show the tendency of tariffs applied on actual trade flow. The order of these three groups' weighted tariffs was quite similar to that of simple tariffs. There was a change in the order of tariffs of these three groups. From 2007 to 2011, weighted tariffs on APEC's imports were the highest followed by those on the world's exports, and then those on APEC's exports. However, from 2001 to 2014, weighted tariffs on the world's exports are highest, followed by those on APEC's exports, and those on APEC's imports. The sharp drop in weighted tariffs in 2012 and 2013 and the increase again in 2014 suggest that EGs with relative lower tariffs were traded in these two years. The sharp drop of weighted tariffs in 2012 and 2013 were consistent with the drop in RE exports of the whole world and APEC during these two years. This indicates that, during this time, there were some factors that made RE trade reduced and countries were only able to trade in RE with the lowest tariffs.

Tariffs on EME and on EP

The overall trends of both average simple and weighted tariffs were similar and downward for EME and EP a shown in Figures 5 and 6. All these groups had weighted tariffs significantly

lower than simple tariffs. Both simple and weighted tariffs on world's exports were highest, followed by those on APEC's exports, and those on APEC's imports.

Figure 5 **Average simple and weighted tariffs on EME, 2007-2014**

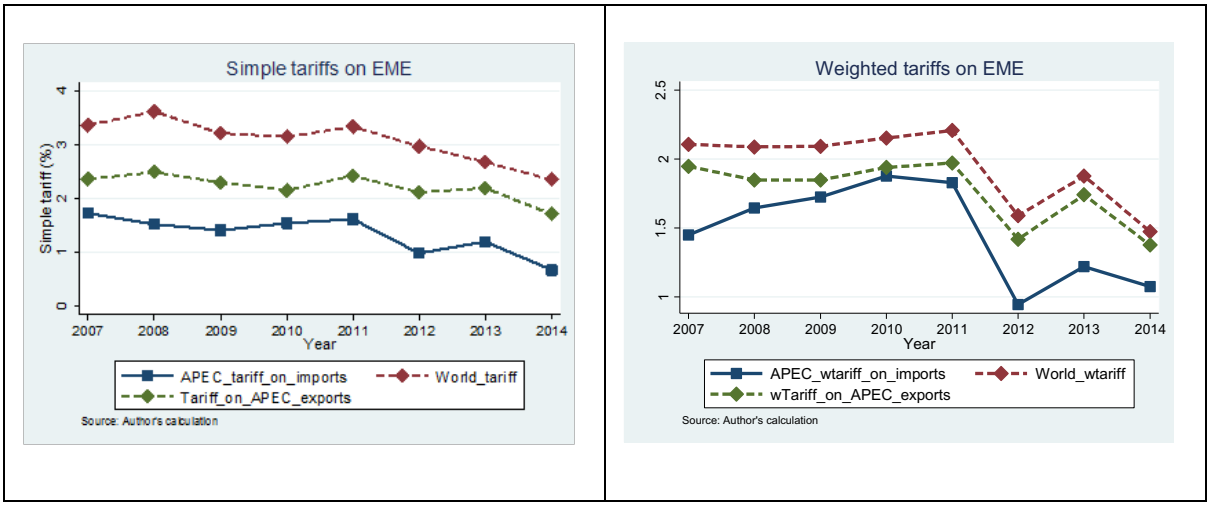
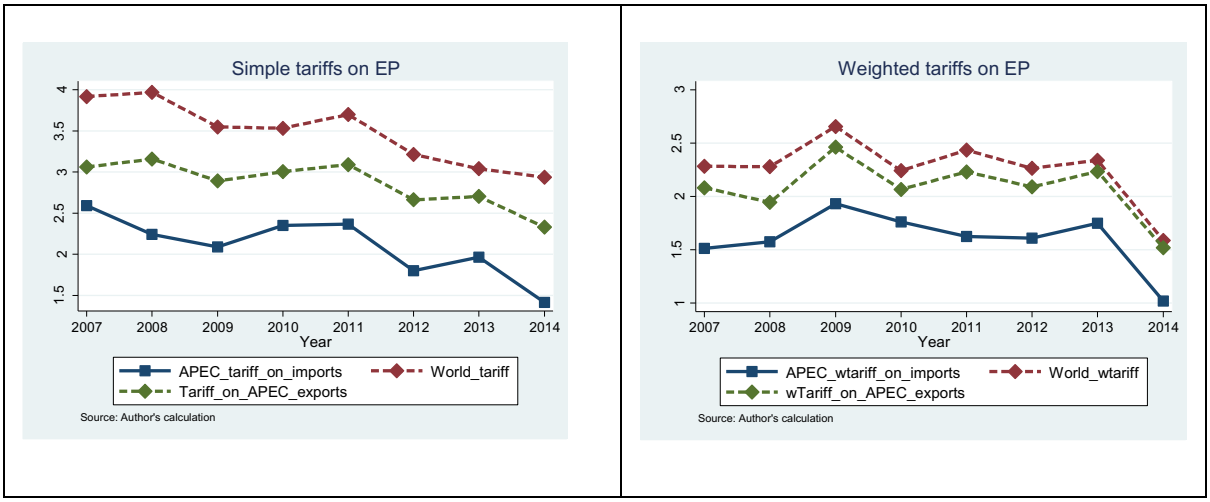


Figure 6 **Average simple and weighted tariffs on EP, 2007-2014**

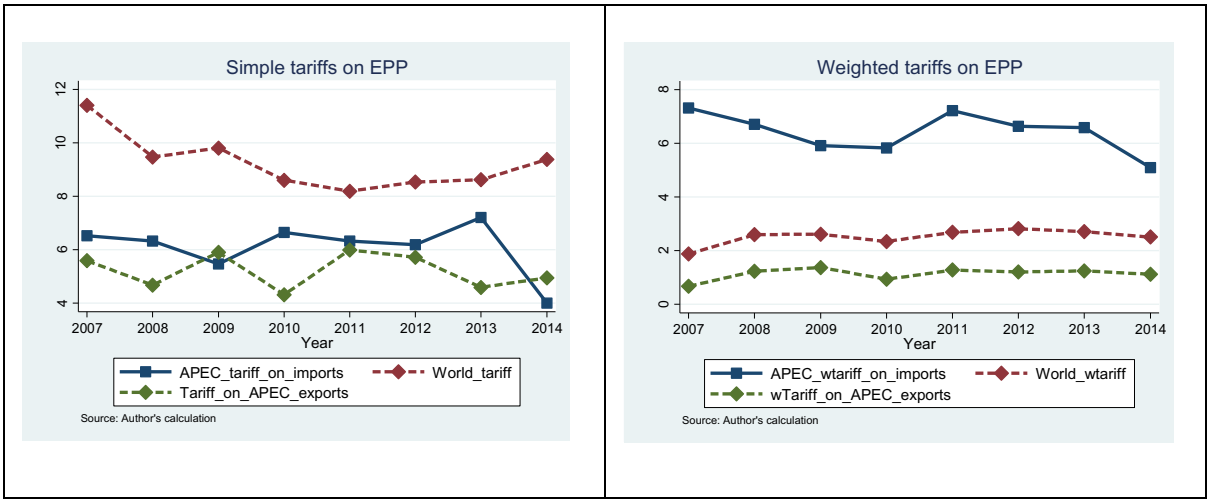


Tariffs on EPP

The trends of EPP tariffs were different from other EGs subgroups, even though the overall trend was also downward. While simple tariffs on world's exports, like other EGs subgroups, were highest, simple tariffs on APEC's exports were lowest most of the time, lower than tariffs on APEC's imports. APEC's simple tariffs on exports of these products were higher than those of partner countries on APEC's exports before 2013, but then they were lower than other

countries' tariffs on APEC's exports in 2014. Interestingly, weighted tariffs on APEC's exports were lowest whereas weighted tariffs of APEC on imports were highest.

Figure 7 **Average simple and weighted tariffs on EPP, 2007-2014**



Weighted tariffs on EPP were substantially lower than simple tariffs as shown in Figure 7. This is rational as countries trade more on EGs that attract lower tariffs. Both simple and weighted tariffs applied by APEC on RE, EME, and EP imports were lowest among three groups from 2007. This suggests that even before the agreement in reducing tariffs on EGs imports of APEC member countries in 2011, their tariffs on imports of these EGs subgroups were lower than those of other countries. The only exception is tariffs on EPP.

2.2 Studies on environmental goods and environmental goods exports

Studies on EGs in general, and EGs demand and exports in particular, are limited. Kennett and Steenblik (2005) identify the determinants of demand for environmental goods and services (EGS) such as economic performance, population, state of the environment, pressure from stakeholders, civil society and consumers, environmental policy, trade policy, and multilateral environmental agreements for 17 countries. They highlight that the small and medium enterprises (SMEs) tend to be the main producers in EGS. Exports of EGS received careful attention in most of the country studies, and export capacity and overseas sales will continue to increase. ITC (2014) gives more precise analysis in demand for EGS in developing countries. The study notes that the demand for EGS is growing fastest in developing countries in Asia, Africa and Latin America. The report highlights challenges for developing countries, including

prevailing barriers to trade, the absence or inadequate enforcement of environmental regulatory regimes and underdeveloped institutional support services for environmental goods and services firms. It raises the need for ongoing work to better understand this dynamic, rapidly evolving set of industries and their potential to open up new export business opportunities for developing country SMEs. In addition, it discusses the EGs exports of several developing countries, whose exports are lowest among countries such as Malaysia, Thailand, India, South Africa, and Indonesia. Furthermore, LaFleur (2011) identifies trends, risks and opportunities for the EGs exports and imports of Latin America and the Caribbean. He claims that the rapid increase in global demand for EGS and the rapid growth of production of EGS are opening the door for Latin America and the Caribbean to enter new production chains. He also notes that lowering trade barriers to EGS and "greening" the region's export basket will, for Latin America and the Caribbean, result in gains both for the environment and for productive and export diversification.

The consensus reached in these studies is that the demand and market for EGs have increased rapidly, and there are both opportunities and challenges for developing countries. The highlighted point in several studies is that SMEs seem to play important roles in this new market.

There is also a number of studies using gravity models to identify the determinants of trade between countries, estimate the potential of EGs exports and/or its efficiency and constraints of individual countries such as Bangladesh (Rahman 2006) and (Ahsan & Chu 2014), the Euromed region (Southern and Eastern Mediterranean countries) (Ruiz &Vilarrubia 2007), Namibia (Eita 2008), Colombia (Leite 2008), Iceland (Kristjánsdóttir 2011), India (Nguyen and Kalirajan, 2013), the US (Greene 2013), Russia (Weckström 2013), Nicaragua (Díaz & Bone 2013), and Eastern European Countries (Ravishankar & Stack 2014). Regarding trade in EG, Matsumura (2016) uses the sample of 43 countries, including 18 APEC members, to investigate the determinants of trade in 53 out of 54 EGs from the APEC list (excluding bamboo flooring - HS 441872). He categorises these 53 goods into three groups - HS84, HS85, and HS90. His two key conclusions are that production fragmentation depending on trade in parts and components is a key factor to expand overall trade in EGs; and commitment of APEC to liberalize trade in EGs is crucial for environmental protection.

The common conclusion from most of these studies is that geographic distance, population, GDP, tariff, and free trade agreements are important determinants for trade between countries.

However, with the exception of Nguyen and Kalirajan (2013), the above cited studies have overlooked to include the influence of the institutional and infrastructural rigidities that exist within the exporting countries on the exports of EGs and also within the importing countries.

In this context, the stochastic frontier gravity (SFG) model has recently been widely used in examining the export performance taking into account of the institutional and infrastructural rigidities that exist within the exporting countries. Kalirajan (2012) examined the impact of regional cooperation on the export potential in low carbon energy goods (LCEGs), using the WTO 153 list for the period of 2000-2009. He had explored the export potential in LCEGs of major emerging Asian economies, under the "grand coalition", "partial coalition", and "stand-alone" scenarios. The average export efficiency in LCEGs of China, Singapore, India, and Vietnam are 80% 73%, 70%, and 62% respectively. Though the export efficiency (EE) can be improved in both the "grand coalition" and "partial coalition" scenarios, but the improvement was shown to be more significant in the "grand coalition". Thus, the identification of the institutional and infrastructural rigidities that exist within the exporting and importing countries is imperative from the export promotion policy point of view. How these rigidities can be included in the conventional gravity model explaining the trade flows between countries is discussed in the following section.

3 The stochastic frontier gravity model theoretical framework

The gravity model is one of the most popular empirical models in economics. In 1962, Tinbergen was the first to use it in international trade flows. The model applies the principle of Newton's Law of Universal Gravitation in physics to explain determinants of trade between countries. As size and proximity of planets decide their proportion of attraction, similarly, trade among countries are also dependent on their population, GDP, and proximity. Numerous works have been undertaken to provide theoretical underpinnings for the gravity model, including Anderson (1979), Bergstrand (1989), Deardorff (1995) among others.

The basic conventional gravity model can be written as:

$$Tij = \alpha\, Yi^{\beta} Yj^{\gamma} Dij^{\delta} \quad (1)$$

Where "Tij" is the flow of trade from country i to country j, "Yi" is country i's GDP, "Yj" is country j's GDP' representing the countries' sizes, and "Dij" is the geographical distance between the countries' capitals.

The linear form of the model by taking the natural logarithms of all variables is as follows:

$$\log (Tij) = \alpha + \beta \log (Yi) + \gamma \log (Yj) + \delta \log (Dij) \quad (2)$$

There is a major shortcoming of this model in the sense that it assumes that both exporting and importing countries are following the best practices of open trade policies without any institutional and infrastructural rigidities to trade. Therefore, the conventional basic gravity model when estimated using the ordinary least squares (OLS) estimation does not provide an estimate of the maximum possible potential trade flows that can be attained in the scenario of the most open trade policies, trading institutions and trading practices observed. This is because the OLS method provides the estimation at the mean of the sample, not the upper bound, which represents the scenario of the most open trade policies, trading institutions and trading practices observed. Hence, the estimation bias arises due to the variable omission as there are many more different factors influencing the trade between countries, of which some are difficult to measure to include in the models. To overcome this problem, variables, which are measurable such as tariff, population, common languages, common colonies, common borders, and free trade agreements, are added into the basic conventional model. However, institutional and infrastructural rigidities that exit in the exporting and importing countries, on which full information is not available for researchers need to be included into the modelling.

To solve this particular limitation, Kalirajan (2008) integrated the concept of stochastic production frontier analysis into the gravity model to measuring the maximum potential trade between countries. A single-sided non-negative error term, 'ui', is included in the basic conventional model to capture the combined effects of the infrastructural and institutional rigidities that exist within the exporting countries. The existing institutional and infrastructural rigidities that exist within the importing countries, which are not under the control of the exporting countries, and other left variables including statistical errors are included into the modelling by a random variable 'vi'. (Kalirajan 2008).

The stochastic frontier gravity model equation can be written as

$$Xij = f(Zij; \beta)\exp (-uij + vij) \quad (3)$$

Where 'Xij' is actual exports from country i to country j. The term f(Zij; β) is a function of the determinants of potential bilateral trade (Zij) and 'β' is a vector of unknown parameters. 'uij'" is single sided non-negative error term for the combined effects of the institutional and

infrastructural rigidities, which may be named the 'behind the border' constraints. These 'behind the border' constraints are specific to the exporting country with respect to the particular importing country, creating the difference between actual and potential bilateral trade. According to Kalirajan (2007). 'uij' is normally assumed to have a truncated normal distribution, truncated at zero with mean μ and a constant variance. If 'uij' is close to 1, then these constraints are important and are constraining the trade from reaching its potential, if 'uij' takes the value of zero, then the 'behind the border' constraints are not important. 'Behind the border' measures could include product standards and conformity assessment measures, business facilitations, trade finance, physical and regulatory infrastructure such as efficient transport links and networks, logistics in the form of efficient freight forwarders, distributors, and efficiency of telecommunication system (Miankhel et al. 2014). 'vij' is assumed to follow a normal distribution with mean zero and constant variance.

Equation (3) can be re-written in log-linear form as follows:

$$\ln Xij = \alpha + \beta \ln Zij - uij + vij \quad (4)$$

Trade potential is a level of trade that might be achieved in the case of reducing most constraints for exports given the current trade, transport and institutional technologies or practices (Drysdale et al. 2000). Export efficiency is a measure of actual levels of exports against potential exports and can be estimated statistically using the stochastic frontier gravity model (Kalirajan, 2007). This method allows examination of the effect of not only trade policy reforms, but also infrastructure and institutional reforms, on countries' trade performance (Armstrong et al. 2008).

4 Empirical model

The empirical model used in this study is as follows:

$$\ln x_{ijt} = \alpha + + \beta_1 \ln POP_{it} + \beta_2 \ln GDP_{it} + \beta_3 \ln POP_{jt} + \beta_4 \ln GDP_{jt} + \beta_5 \ln dist_{ij} + \beta_6 \ln tariff_{ijt} + \beta_7 \ln officialer_{it} + \beta_8 contig_{ij} + \beta_9 comlang_{ij} + \beta_{10} colony_{ijt} + \beta_{11} APEC + \beta_{12} ASEAN - u_{ijt} + v_{ijt}$$

Where ln is natural log; 'x_{ij}' is exports of country i to country j in period t; 'POP_i'and 'POP_j' is population of country i and j respectively; 'GDP_i' and 'GDP_j' refers to the gross domestic

product of country i and country j respectively; '$dist_{ij}$' is the geographical distance between country i and country j; '$wtariff_{ij}$' is average weighted tariff rate of the importing country i on country j's exports; 'officialer' is the official exchange rate between country i and US dollar; '$contig_{ij}$' is a dummy variable, takes the value of 1 if country i has the same border with country j, otherwise, it takes the value of 0; '$comlang_{ij}$' takes the value of 1 if there if a common official langue between country i and j otherwise, it takes the value of 0; '$colony_{ij}$' equals 1 if two countries were ever in colonial relationship, either i was colonized by j or vice versa, otherwise, it takes the value of 0; 'APEC' is a dummy variable, it takes the value of 1 if both exporting and importing countries are APEC member countries, otherwise, it takes the value of 0, 'ASEAN' is a dummy variable, it takes the value of 1 if both exporting and importing countries are ASEAN member countries, otherwise, it takes the value of zero; 'uij' is the export inefficiency, and has a truncated normal distribution; 'vij' is the statistical error term. A time trend is included to consider the changes over the period of analysis that are not captured by the included variables.

Further, it may be important to know whether the export inefficiency changes over time due to the learning by doing experience of the exporting countries. Therefore, drawing on Battese and Coelli (1995), the inefficiency term is further modelled as follows:

$$uit = \exp(-\eta(t - Ti))\, ui.$$

The above specification implies that inefficiency can decrease at a decreasing rate if $\eta > 0$, increases at a decreasing rate if $\eta < 0$, and constant if $\eta = 0$. The empirical model is estimated using the software FRONTIER 4.1 (Coelli,1996).

5. Data

The sample consists of 20 APEC member countries as exporters and about 150 countries as their trading partners for the period 2007-2014. Taiwan is excluded from the sample as data on its exports are not available. GDP, population, and official exchange rate are retrieved from the World Bank database. GDP is in constant 2010 US dollars. Official exchange rate is importing country currency units relative to the US dollar. Exports and trade-weighted effective applied tariff rates, based on HS 2007, were obtained from the Trade Analysis and Information System (TRAINS) using WITS from the UN COMTRADE database. Simple distances, which use latitudes and longitudes of the capital, are in kilometres and have been downloaded from http://www.cepii.fr/PDF_PUB/wp/2011/wp2011-25.pdf. Information about whether countries

are contiguous, share a common language, and have ever had a colonial link (colony) is drawn from the same source as distance.

6 Discussion of results

6.1 Determinants of EGs exports for the whole of APEC

Results of the estimation are presented in Table 2. The significance of sigma-squared (σ2), which is a measure of total variation in the model, suggests that there is significant variation in potential EGs exports from its means during this period. The high and significant values of gamma (γ) confirm that the SFG models are statistically valid for this data set. This further suggests that the variation in exports of total EGs and the four subgroups comes from the 'behind the border' constraints. This suggests that APEC member countries have to eliminate their infrastructural and institutional constraints that still exist to increase their exports.

The GDP of exporting countries measures productive capacity and is expected to be positively related to trade (Cortes 2007). As shown in Table 2, it has a statistically significant and positive impact on exports for total EGs and three EGs subgroups, except EPP. A 1% increase in the exporting country's GDP induces 1.6% increase in exports of total EGs, 1.3%, 1.8%, and 1.4% respectively for RE, EME, and EP. These results show that the economic development level of exporting countries is important for their exports as it proxies the availability of finance, service, and infrastructure, such as logistics, distribution, and telecommunication. However, for EPP, GDP has a negative and statistically significant relationship with exports. It suggests that economic development level does not support the development of EPP-bamboo floorings. These results may come from the lack of interest of countries in producing these bamboo-based products.

The GDP of the importing country when reflects its absorptive capacity, is expected to have a positive relationship with exports (Cortes 2007). Results from Table 2 show a significant and positive relationship with exports for all groups. Importers' GDP is a proxy for consumer demand. This result is expected as the gross GDP of importing countries shows the consumers' ability to afford goods, especially in the case of EGs whose prices are usually higher than those of other goods. Higher GDP allows consumers to choose more expensive but more environmentally friendly products.

Table 2 **Determinants of EGs exports**

	(1)	(2)	(3)	(4)	(5)
VARIABLES	ex_EGs	ex_RE	ex_EME	ex_EP	ex_EPP
lnexporter_GDP	1.578***	1.301***	1.814***	1.399***	-0.304***
	(0.0462)	(0.0548)	(0.0438)	(0.0509)	(0.107)
lnexporter_POP	-0.364***	-0.0886*	-0.665***	-0.264***	0.712***
	(0.0409)	(0.0503)	(0.0422)	(0.0432)	(0.102)
lnpartner_GDP	1.061***	0.990***	1.128***	0.958***	0.738***
	(0.0415)	(0.0512)	(0.0433)	(0.0428)	(0.111)
lnpartner_POP	-0.0399	-0.0177	-0.0839*	0.00734	-0.328***
	(0.0432)	(0.0525)	(0.0433)	(0.0445)	(0.108)
lndist	-1.252***	-1.187***	-1.014***	-1.208***	-0.190
	(0.0793)	(0.0948)	(0.0792)	(0.0837)	(0.185)
lnwtariff	-2.330***	-1.705**	-1.398**	-2.057***	-2.392**
	(0.631)	(0.768)	(0.690)	(0.686)	(1.196)
lnofficialer	-0.0173	-0.0577**	0.00381	-0.00555	0.00498
	(0.0197)	(0.0249)	(0.0193)	(0.0200)	(0.0493)
contig	0.333	0.00279	0.438	0.546*	0.503
	(0.324)	(0.362)	(0.300)	(0.329)	(0.466)
comlang	0.664***	0.767***	0.575***	0.601***	-0.308
	(0.127)	(0.151)	(0.126)	(0.143)	(0.329)
colony	1.448***	1.464**	1.702***	1.475***	1.206*
	(0.487)	(0.571)	(0.479)	(0.486)	(0.651)
ASEAN	0.897**	0.860**	1.412***	0.709*	-0.167
	(0.356)	(0.406)	(0.316)	(0.372)	(0.630)
APEC	0.725***	1.073***	0.704***	0.734***	-0.543**
	(0.140)	(0.170)	(0.136)	(0.147)	(0.273)
Constant	-40.86***	-38.12***	-45.04***	-37.75***	-7.843**
	(1.338)	(1.588)	(1.798)	(1.466)	(3.563)
Sigma squared (σ2)	5.82***	7.30***	4.76***	6.47***	5.76***
	(0.259)	(0.333)	(0.144)	(0.408)	(0.342)
Gamma (γ)	0.73***	0.67***	0.69***	0.71***	0.63***
	(0.012)	(0.015)	(0.010)	(0.018)	(0.025)
Observations	11,106	9,170	9,833	10,082	1,479

Note: Standard errors are in parentheses
*** p<0.01, ** p<0.05, * p<0.1

The population of both exporting and importing countries mostly has a significant and negative relationship with exports. The exporter population is a proxy of human resources for production and importer population is a proxy of market size. The population of importing countries can influence trade though different channels. Firstly, as a proxy of market size, when importer population increases, demand increases. The population of importers also influences imports

through the purchasing power shown by the per capita income. When population increases, per capita income decreases. The increase in demand seems to dominate the decrease in per capita income in the case of necessities, but vice versa in the case of luxuries. According to Bergstrand (1989), a positive (negative) impact of exporter population indicates that the exports tend to be labour (capital) intensive goods, whereas a positive (negative) impact of importer population indicates that the exports tend to be necessity (luxury) goods. As noted by Baldwin (1994), however, both impacts might be negative as larger countries are sometimes regarded as self-sufficient. The results suggest that EGs, RE, EME, EP are capital-intensive goods, while EPP are labour-intensive. Both EME and EPP are luxury goods, while there is no impact of importer population on EGs, RE and EP. That is reasonable as EGs production usually requires advantaged technologies and higher upfront investment. EME and EPP are luxury goods as they have relatively higher prices than non-EGs. Besides the self-efficiency noted by Baldwin (1994), the negative relationship between importer population and trade may come from low-awareness of environmental protection. EGs demand does not automatically increase with population growth, but with environmental protection awareness. The increase in population, which leads to lower GDP per capita, in the context of low awareness of environmental protection, can result in lower accessibility to EGs.

Distance is a proxy of transport costs and other trade costs such as communication costs and transaction costs (Deluna & Cruz 2013). It has a significant and negative impact on exports of total EGs and all subgroups of EGs as expected. It reflects the fact that distance matters for EGs as it increases transportation costs.

The relative prices of the imports are mainly influenced by the tariffs. These may be called changes in ‘explicit beyond the border’ determinants (Kalirajan 2012). Coefficients of tariffs are all negative and significant as expected. The magnitudes of tariff impact on exports are substantial. The tariff reduction of 1% leads to 2.3%, 1.7%, 1.3%, 2.1%, and 2.4% respectively for total EGs, RE, EME, EP, and EPP. The tariff impact is smallest on EME whereas it is biggest for EPP.

Exchange rate used in this analysis is importing countries’ currency units relative to the US dollar; therefore, it is expected to negatively affect their imports. This variable is only significant for RE, but its magnitude is small. A 1% increase in exchange rate of importing countries leads to a 0.06% decrease in exports. However, exchange rate does not affect exports

of other subgroups and of the total EGs. It is a puzzle that needs further analysis, which couldn't be due to lack to proper data.

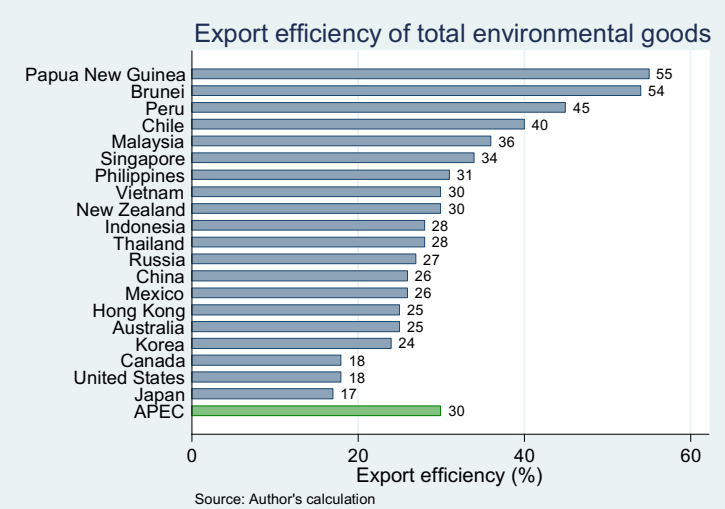
Multilateral trade negotiations in the form of improvement in trade promotion and facilitation policies of both home and partner countries would influence export flows positively (Kalirajan 2012). As expected, exports increase when both exporting and importing countries are ASEAN or APEC member countries for most EGs subgroups, except EPP. The coefficients of ASEAN membership are 0.709 for EP exports, 0.86 for RE exports, 0.897 for total EGs exports, and 1.412 for EME exports. This means that if importing and exporting countries are ASEAN members, exports of these EGs subgroups increase by 103%, 136%, 145%, and 310%[1] respectively for EP, RE, EGs, and EME. If both countries are APEC members, exports increase by 102%, 106% 108%, and 192% respectively for EME, EGs, EP, and RE. This reflects the fact that exports benefit from regional cooperation not only through tariffs but also from non-tariff barrier reductions, for example by using APEC Business Travel Card, enjoying APEC trade facilitation in customs, port, health and quarantine, business mobility and e-commerce. Similarly, this factor is significant for trade among ASEAN members. Coefficients of variables common border, common language, and colonial relationship have expected signs. If countries share common border, common language, and colonial relationship, their trade increase. However, whereas common border only affect trade in EP, colonial relationship significantly influents trade of total EGs and all EGs subgroup, with the range of coefficients is from 1.206 (EPP) to 1.702 (EME). Common language has estimated coefficients ranging from 0.575 (EME) to 0.767 (RE), but has no impacts on EPP exports.

6.2 Export Efficiency Measures

Even though the APEC's exports of total EGs and each EGs subgroups increased over the years, as shown in Figure 2 and by the positive coefficients of year dummies included in the models, these export increases are not due to the improvement in the EE but to other factors such as the expansion in GDP and population, and tariff reductions. EGs export performances measured in terms of export efficiency of APEC member countries appear to be constant during 2007-2014 as indicated by the insignificant eta in the models, which is not shown here. The export inefficiency (EIE) effect model estimates are presented in Figure 8, 9, 10, 11, and 12.

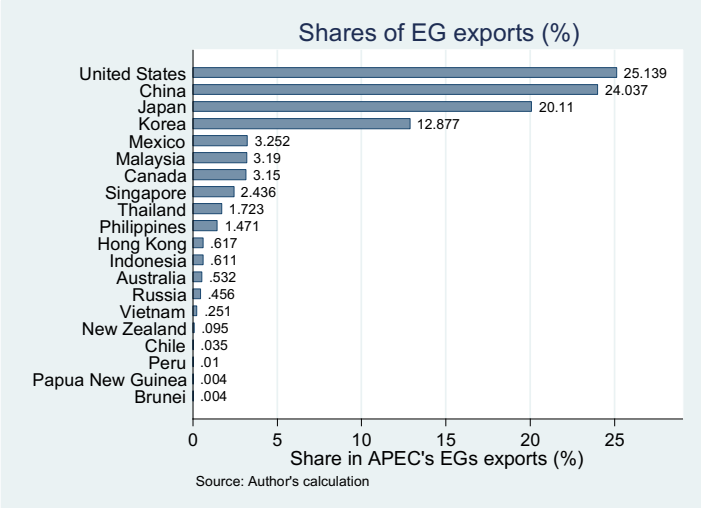
[1] This interpretation is based on the equation $\%\Delta\ \hat{y} = 100*[\exp(\hat{\beta}) - 1]$ of Wooldridge (2009).

Figure 8 **Export inefficiency of total EGs, 2007-2014**



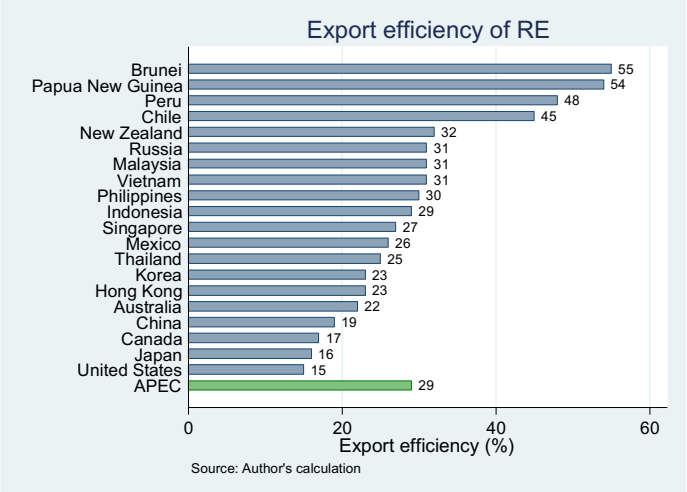
As shown in Figure 8, the EIE for the whole of APEC is 30%, which means that APEC as a whole is able to achieve about 70% of its potential exports of EGs. Papua New Guinea is at the top, with EIE of 55% without realizing 45% of its potential exports, followed by Brunei with EIE of 54% and Peru with EIE 45%. On the other hand, Japan has the lowest EIE of only 17% that implies that Japan has achieved 83% of its potential EGs exports, and the United States and Canada have the EIE of 18%, indicating that both seem to be enjoying about 82% of their potential EGs exports to their partner countries. These results are in conformity with the shares of total EGs exports (shown in Figure 9). The United States' and Japan's exports account for the largest parts of total EGs exports, while Peru's and Papua New Guinea's exports occupy the smallest parts.

Figure 9 **Shares of EGs exports of APEC-member countries** of total APEC's EGs exports**, 2007-2014**



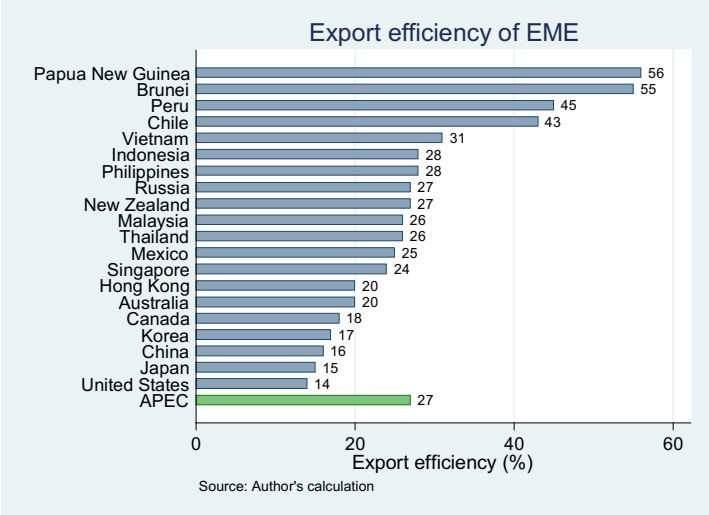
The EIE of RE is similar to total that of EGs. This is obvious as RE accounts for the biggest proportion of EGs exports; therefore, its results influence EGs results the most.

Figure 10 **Export inefficiency of RE, 2007-2014**



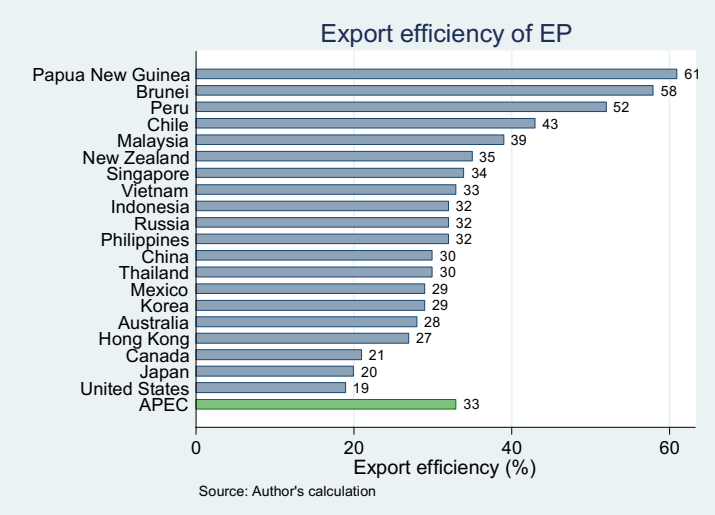
As shown in Figure 10, the EIE for the whole of APEC is 29% that means that APEC as a whole is able to achieve 71% of its potential exports of EGs during the period of analysis. Three highest and lowest EIE countries for RE are the same as in the case of total EGs, only the order of these countries is different. Brunei has the highest EIE, then Papua New Guinea, and Peru. The United States is at the bottom of EIE, followed by Japan, and Canada.

Figure 11 **Export inefficiency of EME, 2007-2014**



The EIE of the whole of APEC is slightly lower for EME than in the case of total EGs and RE, at 27% as shown in Figure 11. The three top EIE countries are the same as for the total EGs and RE; however, there are changes in the bottom EIE cluster. The United States and Japan are still among the lowest EIE countries, but China is the third lowest EIE country replacing Canada.

Figure 12 **Export inefficiency of EP, 2007-2014**

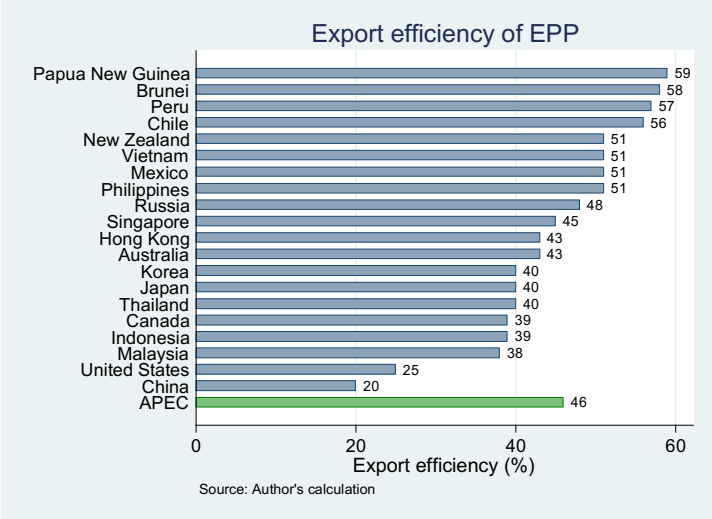


The EIE of the whole of APEC for EP is larger than for total EGs, RE, and EME, at 33% as shown in Figure 12. However, the EIE of the top and bottom clusters are the same with those

of the total EGs, and RE. EIE of all individual countries in EP are also slightly greater than those of the total EGs and other EGs subgroups.

Even though EPP accounts for a small proportion of EGs, export performance in this EGs subgroup of APEC members is the best. Most APEC-member countries achieved approximately half of their potential exports in EPP.

Figure 13 **Export inefficiency of EPP, 2007-2014**



As shown in Figure 13, the EIE of the whole of APEC is 46% that indicates of the realization of 54% of potential exports of EGs. The three top EIE countries are the same with those of the total EGs and other EGs subgroups but the bottom EIE group is different. Only the United States and China are still in the bottom EIE cluster, but Malaysia replaces Japan and/or Canada.

In summary, among the APEC countries, Papua New Guinea, Brunei, and Peru seem to have achieved the lowest export performance measured in terms of export efficiency, whilst the United States', Canada's, and Japan's export performances are the highest. This result suggests that developing countries' existing 'behind the border' constraints appear to restrain the countries from achieving their exports potential of EGs.

7 Summary and policy suggestions

Understanding the determinants of EGs trade is imperative for trade promotion and environmental protection. As the impacts of the determinants differ among EGs subgroups and countries; examining these determinants for each subgroup is necessary for policy recommendations. This study not only explores how each variable affects each country's

exports in each EGs subgroup, but also discovers the reasons for these effects and explains the difference in impacts for individual countries.

The study discovers that while exporter GDP is significant for the whole of APEC's EGs exports, it has impacts on only a few countries' exports, and mainly for EME and EP exports. Production and exports of EGs go together with economic development for these few countries, while other countries in the APEC group may be interested more in other goods. This result suggests that economic development does not always influence EGs from the production side. It needs to go along with environmental protection policies. Economic development is the necessary condition for increasing the EGs production, and environmental protection policies are the sufficient condition to make it happen.

However, from the consumption side, consumers' incomes in importing countries dramatically affect their ability to buy EGs, which are usually more expensive than other goods. This conclusion is obtained from the results that importer GDP has positive impacts on the exports of most countries. Korea, Japan, and Canada's RE, EME, and EP exports are the most responsive to importer GDP, while Thailand, Malaysia, and China's EPP exports respond the most to importer GDP. This means that those countries produce EGs that importing countries need more than EGs of other APEC-member countries. This may suggest that their exports are relatively more competitive and/or have fewer substitutions, and/or they have less 'behind the border' constraints in exporting these products.

The negative relationship between exporter population and RE, EME, and EP exports indicate that they are capital-intensive for the whole of APEC. However, the results vary for individual countries. EPP seems to be labour-intensive for the whole of APEC and a few individual countries.

EME and EPP of the whole of APEC are luxuries, and the results for countries whose coefficients are significant show the same story. However, importer population does not affect RE and EP of the whole region, but only some individual countries with various results. RE and EP exports of some are luxuries whereas those of others are necessarities. Developing countries tend to export necessities while developed countries tend to export luxuries for RE, EME, and EP.

Distance is an important determinant as it is highly significant and negative for most countries in the case of RE, EME, and EP. However, it is only significant for EPP exports of Malaysia and the United States. While China's, Hong Kong's, the Philippines' exports are less responsive to distance; those of Australia and New Zealand are more sensitive to this variable. The reason for that seems to be that these two countries have the biggest average distance to their partners; therefore, transport costs account for bigger parts in their total costs.

Even though tariffs have a significant impact on exports of the total EGs, and all EGs subgroups, they affect negatively exports of only several countries for RE, EME, and EP. The exception is Singapore for RE, Malaysia for EME, and Thailand for EP. This variable does not affect EPP exports of any individual countries. No impacts or positive impacts of tariffs on exports may suggest that the non-tariff barriers increased at the same time as tariff reductions. This raises the need for trade agreements to pay more attention to non-tariff barriers to make tariff reductions effective. However, non-tariff barrier reductions are more challenging than tariff reductions, and they should take a long time. In this situation, technology transfer is a great option as it can help countries to produce and meet domestic EGs demand by themselves.

While RE, EME, and EP exports of the whole region and most individual countries are positively affected by their partner APEC membership, EPP exports seem to be declining when partners are APEC-member countries. Thailand, Malaysia, and the Philippines's RE, EME, and EP exports are the most affected by the partner APEC membership. This shows an intraregional trade tendency in these three EGs subgroups. However, EPP trade seems to be more interregional. This may suggest that demand for bamboo flooring is greater in non-APEC members. From the results for RE, EME, and EP, it seems that developing countries' trade benefit arises more from partners' APEC membership. The reason may be that they face with more constraints in foreign markets than developed countries as developed countries may have more FTAs with their partners or they have better competitiveness to overcome these constraints in non-APEC markets.

Even though the total EGs exports and each EGs subgroups of APEC increase over the years, these export increases do not come from improvement in export efficiency, but from other factors such as the expansion in GDP and population, and tariff reductions. Export performances measured in terms of export efficiency are constant during the period 2007-2014. This suggests that, albeit, the efforts in tariff reduction of APEC, do not appear to have reduced

the constraints to EGs trade over the period of analysis. The high value of gamma suggests that the variation in EGs and four subgroup exports comes mainly from the 'behind the border' constraints. This implies that APEC-member countries have to eliminate their infrastructural and institutional constraints to increase their achieving the exports potential. EPP export performance has outperformed other subgroups. Although the export performances of a majority of countries are low, below 50% in most cases, imply that all countries have great potential for improving their export performance, especially developing countries, such as the Papua New Guinea, Peru and Brunei. Through the APEC regional cooperation, there is an urgent need to transfer technology in EGs to those countries with poor export efficiency from those countries enjoying the high level of realization of export efficiency including Japan, USA, China, and Canada.

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