

# The Impact of The Regulatory Distance Index of Non-Tariff Measures on Agri-Food in Apec Countries

*(Impak Indeks Perbezaan Peraturan Pengukuran Bukan Tarif terhadap Sektor Agromakanan Negara-Negara Kerjasama Ekonomi Asia Pasifik (APEC))*

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## ABSTRACT

*The agriculture sector is increasingly subject to trade barriers that affect its global supply chain. This study examines the intricate relationship between non-tariff measures (NTMs) and trade in the agricultural and food products through various models, including pooled, fixed effects, random effects, and the Poisson Pseudo-Maximum Likelihood model. The study emphasized that economic strength, in both exporting and importing countries, significantly influences the export of agri-food products. Geographic distance is a consistent trade barrier, highlighting the significance of proximity in international trade. The impact of exchange rates is multifaceted differing across models. The regulatory distance index of NTMs presents varying impacts, with positive and negative coefficient becoming more pronounced through entity-specific factors. Since NTMs are increasingly shaping global trade, particularly in the Asia-Pacific Economic Cooperation (APEC), these complex relationships need better understanding to minimize trade barriers and promote growth in the sector. The study offers valuable insights for policymakers, industry players, and researchers, underlining the importance of addressing NTMs towards formulating harmonized regulatory standards to boost trade and economic growth. Future researcher should explore the evolving dynamics of NTMs in the global trade landscape.*

*Keywords: Regulatory distance index; non-tariff measures (ntms); agri-food; apec; poisson pseudo-maximum likelihood model*

## ABSTRAK

*Sektor pertanian semakin terdedah kepada halangan perdagangan yang menjejaskan rantaian penawaran global. Kajian ini mengkaji hubungan antara pengukuran bukan tarif (NTMs) dan perdagangan produk agro-makanan dengan menggunakan pelbagai model, termasuk model berkelompok, kesan tetap, kesan rawak, dan model Poisson Pseudo-Maksimum Likelihood. Kajian ini menekankan bahawa kekuatan ekonomi, di kedua-dua negara pengeksporth dan pengimport, mempengaruhi eksport produk agro-makanan secara signifikan. Jarak geografi merupakan halangan perdagangan yang konsisten, menonjolkan kepentingan kedekatan dalam perdagangan antarabangsa. Kesan kadar pertukaran adalah pelbagai berbeza merentasi model. Indeks jarak regulasi NTMs menunjukkan kesan yang berbeza, dengan koefisien positif dan negatif menjadi lebih ketara melalui faktor spesifik entiti. Memandangkan NTMs semakin membentuk perdagangan global, terutamanya dalam Kerjasama Ekonomi Asia-Pasifik (APEC), hubungan kompleks ini perlu difahami dengan lebih baik untuk mengurangkan halangan perdagangan dan menggalakkan pertumbuhan dalam sektor tersebut. Kajian ini memberikan dapatan yang bermanfaat untuk pembuat dasar, pemain industri, dan penyelidik, menekankan kepentingan menangani NTMs ke arah membentuk pengukuran*

*yang sama bagi meningkatkan perdagangan dan pertumbuhan ekonomi. Penyelidik masa depan harus meneroka dinamika NTMs yang berkembang dalam lanskap perdagangan global.*

*Kata kunci: Indeks perbezaan peraturan langkah-langkah bukan tarif (NTMs); agro-makanan; APEC; Model Poisson Pseudo-Maximum Likelihood*

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## INTRODUCTION

The agriculture sector has emerged as a resilient contributor to economic growth, generating national income, export earnings, and employment opportunities. However, the world is currently prioritizing the demand for safe, high-quality, and sustainable agricultural development. As a result, the agricultural and food industries face more regulatory restrictions than the manufacturing sector (Mao et al. 2023). The implementation of non-tariff measures (NTMs) in regulating trade has led to protectionist and regulatory purposes (Eum 2023; Tröster et al. 2023). According to the definition provided by the United Nations Conference on Trade and Development (UNCTAD), NTMs encompass policy measures beyond regular customs tariffs that have the potential to impact global trade; these measures involve permits, licenses, certificates, and various regulatory prerequisites imposed by governmental entities.

NTMs encompass a variety of measures, such as sanitary and phytosanitary (SPS) measures and technical barriers to trade (TBT). These measures aim to safeguard public health, food safety, and environmental concerns, but they can lead to substantial trade costs (Cali et al. 2024). The study by Nga et al. (2023) explores the effects of non-tariff measures (NTMs) on Vietnam's agricultural exports to key markets, such as the United States, European Union, China, and Japan. NTMs, particularly Sanitary and Phytosanitary (SPS) measures and Technical Barriers to Trade (TBT), have generally restrictive effects on Vietnam's exports. Japan's SPS policies reduce Vietnam's agricultural export revenue by 1.6%, demonstrating how these policies affect Vietnam's ability to access Japanese markets. Vietnam's export revenue has also decreased by about 0.3% as a result of China's SPS policies, particularly for agricultural goods. The study by Ridley et al. (2024) and Gourdon (2020) examines how regulatory differences between trading partners impact trade costs, finding that greater regulatory distance or lack of alignment in non-tariff measures (NTMs) increases these costs. However, sanitary and phytosanitary (SPS) measures and technical barriers to trade (TBT) can support trade by enhancing consumer confidence and ensuring product quality. Harmonizing these regulations, particularly through preferential trade agreements, can reduce costs and facilitate smoother trade flows in agricultural products.

NTMs were also adopted in the Asia-Pacific Economic Cooperation (APEC) region, in particular, the agriculture sector. The exchange of agri-food products is a significant component of economic activity among APEC countries. While NTMs are essential for ensuring safety and quality, they can also inadvertently create trade barriers and distort market access, thus affecting both producers and consumers. The discrepancies in regulations among countries, including differences in product specifications, conformity assessments, and information requirements, can significantly impede international trade. This has prompted researchers to explore the impact of NTMs and the regulatory dissimilarity on agri-food exports between APEC countries, highlighting the need for regulatory convergence in key areas.

The agri-food sector is crucial for the APEC economy, providing food security and valuable export income. However, agri-food businesses face many regulatory and technical challenges. The expansion of non-tariff measures (NTMs) has accelerated significantly since the World Trade Organization's (WTO) 1994 Agreement on the Application of Sanitary and Phytosanitary Measures, widely referred to as the 'SPS Agreement' (Santeramo & Lamonaca 2019). This increase in NTMs, especially through Sanitary and Phytosanitary (SPS) measures and Technical Barriers to Trade (TBT), has had a notable impact on agri-food trade. As APEC strives to ensure food security and address the nutritional needs of the region through sustainable agri-food systems, it acknowledges the importance of science and risk assessment, aligned with relevant international agreements, such as the WTO's SPS and TBT Agreements—and internationally accepted standards, to guide its policy and regulatory decisions.

Trade costs stemming from NTMs, including compliance costs, procedural delays, and information burdens, are a critical concern. They can be especially burdensome for small and medium-sized enterprises (SMEs) and have a notable impact on trade margins. Understanding the extent of these compliance costs and their effects on businesses

involved in international trade is essential for informed policy decisions aimed at reducing trade barriers and fostering economic growth.

Despite the complex relationship between NTMs and trade, they are increasingly recognized as a significant factor affecting global trade. These measures can either facilitate trade by ensuring product safety and quality or hinder it by creating unnecessary obstacles. Non-Tariff Barriers (NTBs), a subset of NTMs, encompass measures that may impede trade, such as import quotas, subsidies, and discriminatory regulations. With the importance of NTMs as trade barriers continues to grow, ongoing studies seek to gain a deeper understanding of their impact on international trade and economic growth. In addition, this study will also examine the role of economic growth and the population of a country as well as the distance and exchange rate between importers and exporters. This discussion is followed with a literature review, methodology, results, and, lastly, a conclusion. This study is based on the theoretical gravity model (Tinbergen 1962), which emphasizes international trade between countries.

## LITERATURE REVIEW

The gravity model is a widely used framework for analysing trade flows between countries. It is based on the premise that trade between two countries is positively influenced by their economic size, typically measured by GDP, and negatively affected by the distance between them. This model can also be adapted to study non-tariff measures (NTMs) by incorporating "regulatory distance," which represents the differences in regulatory environments that can influence trade costs.

As both an economic theory and an empirical model, the gravity model predicts the flow of goods, services, or people between two places based on two key factors: the size of their economies and the distance between them. The "size of economies" suggests that larger economies, with higher GDPs, are more likely to engage in trade because they generate more economic activity, thereby attracting more trade interactions. On the other hand, "distance" acts as a frictional factor, where greater distances between countries increase trade costs and reduce the likelihood of economic exchanges. In the context of studying NTMs, the gravity model offers valuable insights by showing how regulatory differences between countries can act as trade barriers. These regulatory differences, captured as regulatory distance, can affect trade flows, particularly in sectors such as agri-food. Thus, the gravity model is well-suited for analyzing the impact of NTMs on trade within APEC countries.

Nonetheless, it is important to recognize that additional variables also influence trade, especially NTMs. NTMs encompass a complex set of policy instruments, including sanitary and phytosanitary (SPS) measures, technical barriers to trade (TBT), and various other regulations such as rules of origin, licensing, price controls, and distribution restrictions (Ing & Cadot 2016).

NTMs have evolved into crucial tools for regulating international trade, serving as policy instruments aimed at achieving public policy objectives, including rectifying market inefficiencies and safeguarding public health (Sudip Ranjan Basu & Hiroaki Kuwahara 2012). NTMs when implemented, particularly in the form of quality and product standards, can introduce various variable costs (e.g., laboratory expenses) and fixed costs (e.g., increased equipment or machinery costs and certification processes) (Bustos 2011).

The impact of NTMs on the export performance of specific commodities can be diverse. NTMs can have a positive influence under certain circumstances. For example, study by Rindayati and Kristriana (2018) revealed that NTMs had a positive effect on Indonesia's tuna exports to various major destinations. Similarly, the implementation of TBT-type NTMs had a positive impact on Indonesia's natural rubber exports to various countries (Virginia & Novianti 2020).

Conversely, studies have indicated that NTMs can negatively affect exports. For instance, study by Zainuddin et al. (2020) who examined NTMs and the export performance of RCEP countries found that the implementation of these measures by importing nations reduced the export performance of the health sector. Likewise, study by Permata et al. (2020) observed that NTMs produced an adverse impact on the export performance of Indonesia's fishery commodities. Furthermore, a study conducted in Africa discovered that the application of NTMs by importing countries substantially decreased trade volumes in agricultural products (Liu et al. 2019).

Policymakers and economists often lack a comprehensive understanding of the causal mechanisms behind the effects of various regulatory and economic policies, often leading to the formulation of rules based on speculative assumptions. These regulations, such as NTMs, can increase the cost of doing business, affecting compliance costs, information costs, and procedural costs, which can, in turn, reduce productivity and impose high compliance costs on businesses. These costs can be categorized into two main types; direct costs associated with government-administered regulatory systems and regulatory compliance costs borne by consumers and producers. Furthermore, differences in regulations between countries can create challenges for exporting firms, requiring them to meet various requirements, resulting in higher compliance costs, particularly in low-income countries. Various measurement methods, such as

Regulatory Distance, have been developed to assess regulatory differences and their impact on trade. Harmonization of regulations, mutual recognition, and regulatory convergence play essential roles in reducing trade costs while allowing countries to meet specific policy objectives. The standardization of NTM regulations can have differing effects on trade, either facilitating or hindering it, depending on the context and the sector. These effects are also influenced by the country's position in the Global Value Chains (GVCs) and its alignment with global standards, as demonstrated in some studies.

## METHODOLOGY

This research utilized the gravity model to examine how regulatory differences in non-tariff measures (NTMs) influence trade, especially in the agricultural and food sector across the APEC region. The gravity model establishes relationship between trade cost and trade flows. According to the gravity model, a positive association is anticipated between the GDP of importing and exporting countries, and a negative correlation between trade costs (comprising factors such as distance, tariffs, and NTMs) and trade flows. The model assumes that larger and more economically prosperous countries are more likely to engage in trade with each other, while factors like distance and trade barriers act as impediments to trade. The gravity model also suggests that variables such as shared language, cultural affinities, and common legal systems can promote trade, resulting in positive associations between these variables and trade flows.

### REGULATORY DISTANCE INDICATOR

To measure the extent of dissimilarity in the structure of NTMs between two trading partners, this study relies on the regulatory distance indicator. The indicator was proposed by Cadot et al. (2015) and Cadot & Ing (2019) to measure the compare between NTM imposed in two countries. If both countries implement identical NTM types for the same products within a specific year, their regulatory structures are deemed similar, resulting in a regulatory distance of zero. Conversely, if country  $j$  does not apply the same NTM to a product, their regulatory approaches are considered different for that particular measure-product pair, assigning a regulatory distance value of one (1). The distance in regulatory structure, or regulatory distance, can be expressed and aggregated as follows, as described by Cadot et al. (2015a) and Cadot et al. (2015b).

The specific NTM type ( $l$ ) imposed by importing country ( $j$ ) on a specific product ( $k$ ) in a given year ( $t$ ) is defined as a "dummy" variable:

$$NTM_{jlkt} = \begin{cases} 1, & \text{if country } j \text{ applies NTM type } l \text{ to product } k \text{ in year } t \\ 0, & \text{if no such NTM is applied} \end{cases} \quad (1)$$

The study compared the regulations imposed in importing countries with those of international standards as a basis of over-regulated and under-regulated policies. Hence, following Cadot et al. (2015a) and Cadot and Ing (2015), the regulatory distance (RD) was calculated at the measure-product level between NTM in importing country ( $NTM_{jlkt}$ ) and international standard ( $NTM_{slkt}$ ) in year  $t$  as follows:

$$RD_{jlkt} = \frac{1}{N} \sum_k \sum_l |NTM_{jlkt} - NTM_{slkt}| \quad (2)$$

The formula for regulatory distance uses  $N$  as the combined total of NTM products and measures the difference in regulations between countries  $j$  and the international standard. The regulatory distance index assesses the relative similarity between countries' regulations but does not indicate the degree of regulation. The approach is extremely flexible and allows for the decomposition of regulatory distance at the product or sector level, the comparison of two or more nations, or the analysis of regional trade agreements. In this study, the regulatory distances for multiple years were calculated for each trade partner separately, focusing on 38 agri-food products (Appendix 1). The products are selected at the HS-4 digit based on the classification used in Suvannaphakdy et al. (2020).

### DATA SOURCE AND MODEL SPECIFICATION

The study subsequently assessed the impact of non-tariffs on APEC agri-food exports by incorporating the regulatory distance index into the gravity equation. In this framework, the export value of agri-food products served as the dependent variable. The selected export destinations comprised APEC's 21 member economies: Australia, Brunei, Canada, Chile, China, Hong Kong, Indonesia, Japan, Malaysia, Mexico, New Zealand, Papua New Guinea, Peru,

Philippines, Russia, Singapore, South Korea, Taiwan, Thailand, United States, and Vietnam. The dataset for this study included export volumes, Gross Domestic Product (GDP) data, distances between capital cities, exchange rate, and the regulatory distance index of NTMs from 21 export destinations. The data spanned 2000 to 2020 and encompassed agri-food products at the 4-digit level in the Harmonized System (HS). Total agri-food export data were sourced from the COMTRADE database by the United Nations, which provided comprehensive and detailed trade data from over 200 countries and territories. Distances between capital cities and exchange rates were sourced from the World Integrated Trade Solution (WITS), and data on NTMs were obtained from the UNCTAD Trains Online Database.

Below is the empirical gravity model employed in this study:

$$\ln EX_{ijt} = \beta_0 + \beta_1 \ln GDP_{it} + \beta_2 \ln GDP_{jt} + \beta_3 \ln POP_{it} + \beta_4 \ln POP_{jt} + \beta_5 \ln Dist_{ij} + \beta_6 \ln RER_{ijt} + \beta_7 NTM\_RD_{ijt} + \varepsilon_{ijt} \quad (3)$$

Where  $EX_{ijt}$  represents the export value of agri-food products from country  $i$  to country  $j$  in year  $t$  (in US\$). This bilateral trade relationship structure is applied to all pairs of APEC countries, as each country in the APEC region is both an exporter to and an importer from other APEC countries (21 member economies).  $GDP_{it}$  and  $GDP_{jt}$  denote the Gross Domestic Product of exporting country  $i$  and importing country  $j$  at time  $t$  (in thousand US\$).  $\ln POP_{it}$  and  $\ln POP_{jt}$  represent the population of exporting country  $i$  and importing country  $j$  at time  $t$  (number of people).  $Dist_{ij}$  represents the distance between country  $i$  and country  $j$ .  $RER_{ijt}$  signifies the exchange rate between country  $i$  and country  $j$  in year  $t$ .  $NTM\_RD$  represents the regulatory distance index of NTMs between country  $i$  and country  $j$  in year  $t$  dan  $\varepsilon_{ijt}$  stands for the error term.

#### STATISTICAL ANALYSES

Given the complexity of trade relationships in agri-food products, this study employs multiple estimation techniques, including panel static and Poisson Pseudo-Maximum Likelihood (PPML) models for gravity model. Each model addresses specific issues such as zero trade flows, heteroscedasticity, and fixed effects that vary by country, providing distinct advantages.

There were three types of static panel data analysis models used, namely pooled, fixed effects model, and random effects model. The pooled model treats all observations as a single dataset, ignoring any individual differences between entities over time. This model assumes that each entity has the same intercept term, meaning it does not account for unique, time-invariant characteristics that may influence the dependent variable. On the other hand, the fixed effects model addresses the limitations of the pooled model by allowing each entity to have its unique intercept term. This model is particularly useful when we believe that unobserved characteristics, which do not change over time but differ across entities, could influence the dependent variable. Meanwhile, the random effects model assumes that entity-specific effects are random and uncorrelated with the independent variables in the model. Unlike the fixed effects model, which captures only within-entity variations, the random effects model considers both within-entity and between-entity variations, providing a more comprehensive view of the data when the assumption of independence between entity-specific effects and independent variables is valid. Panel static regressions identify the best model between fixed effects and random effects using the Hausman test.

Meanwhile, the PPML model is particularly effective in handling zero trade values and overcomes issues of heteroscedasticity by using robust standard errors, there is approximately 12% of the data points in this study that reflect zero trade values, which underscores the need for Poisson Pseudo-Maximum Likelihood (PPML) estimation. While PPML with fixed effects models capture entity-specific factors, providing insights into variations in trade patterns. These variations in results are thus expected and reflect the unique properties and assumptions of each model, rather than inconsistencies in the data.

PPML regression is commonly used in international trade and gravity models to address the issues of zero trade values and heteroscedasticity. The traditional linear regression models may not handle zero trade values well because they assume continuous, normally distributed data. In contrast, PPML is designed for count data, making it a suitable choice for zero-inflated datasets. PPML can provide robust standard errors, which account for heteroscedasticity and over-dispersion commonly found in count data like trade transactions. The exponential model for PPML is as follows:

$$EX_{ijt} = e^{(\beta_0 + \beta_1 \ln GDP_{it} + \beta_2 \ln GDP_{jt} + \beta_3 \ln POP_{it} + \beta_4 \ln POP_{jt} + \beta_5 \ln Dist_{ij} + \beta_6 \ln RER_{ijt} + \beta_7 NTM\_RD_{ijt})} \times \varepsilon_{ijt} \quad (4)$$

Where,  $EX_{ijt}$  are the bilateral export value of agri-food products from country  $i$  to country  $j$  in year  $t$  and  $\epsilon_{ijt}$  are the error term. It should be noted that in the PPML model, the dependent variables are not in log form and this was consistent with the gravity model for trade. If both sides were in log form, then the model will get back to equation (4). The likelihood function for the PPML model was derived from the Poisson distribution, where  $Y$  follows a Poisson distribution with mean  $\lambda$ . To estimate the coefficients ( $\beta$ ) and the random effect ( $u$ ), the maximum likelihood estimation (MLE) techniques was used. MLE is commonly employed to calculate the parameter values that maximize the likelihood function. All models were analysed using the STATA software package.

## RESULT

Table 1 presented the descriptive results for each variable used in this study. In total, there are 7,980 observations for each variable, encompassing multiple export destinations. Additionally, the mean values for  $EX_{ijt}$ ,  $\ln EX_{ijt}$ ,  $\ln GDP_{it}$ ,  $\ln GDP_{jt}$ ,  $\ln POP_{it}$ ,  $\ln POP_{jt}$ ,  $\ln DIS_{ijt}$ ,  $\ln RER_{ijt}$ , and  $NTM\_RD_{ijt}$  are reported. For the export variables, the nature of data at this level contributes to the high standard deviation, as noted in Zainuddin et al. (2020). This was also evident from the wide range of export data, ranging from a minimum value of zero to a maximum of US\$18,400,000. The significant dispersion in export values further underscores the necessity of employing PPML regression.

TABLE 1. Descriptive statistics

Variable	Mean	Standard Deviation	Minimum	Maximum
$EX_{ijt}$	237,291.80	886,688.20	0.00	18,400,000.00
$\ln EX_{ijt}$	9.601	3.075	-4.605	16.729
$\ln GDP_{it}$	26.844	1.752	23.120	30.623
$\ln GDP_{jt}$	26.844	1.752	23.120	30.623
$\ln POP_{it}$	17.434	1.780	12.719	21.068
$\ln POP_{jt}$	17.434	1.780	12.719	21.068
$\ln DIS_{ijt}$	8.786	0.866	5.754	9.889
$\ln RER_{ijt}$	0.000	4.310	-10.146	10.146
$NTM\_RD_{ijt}$	0.26	0.08	0.00	0.47

Table 2, presents the Pearson correlation matrix for the key variables employed in the analysis. The correlation coefficients between the dependent variable and independent variables generally align with the anticipated signs. Moreover, noteworthy correlations at the 1% significance level are identified between exports and all independent variables. Furthermore, the coefficients among the independent variables exhibit low correlations (<0.85), indicating the absence of collinearity issues.

TABLE 2. Correlation matrix

Variable	$\ln EX_{ijt}$	$\ln GDP_{it}$	$\ln GDP_{jt}$	$\ln POP_{it}$	$\ln POP_{jt}$	$\ln DIS_{ijt}$	$\ln RER_{ijt}$	$NTM\_RD_{ijt}$
$\ln EX_{ijt}$	1.0000							
$\ln GDP_{it}$	0.4801*	1.0000						
$\ln GDP_{jt}$	0.4004*	-0.0352*	1.0000					
$\ln POP_{it}$	0.4690*	0.7818*	-0.0360*	1.0000				
$\ln POP_{jt}$	0.2570*	-0.0360*	0.7818*	-0.0511*	1.0000			
$\ln DIS_{ijt}$	-0.1909*	0.0846*	0.0846*	0.0386*	0.0386*	1.0000		
$\ln RER_{ijt}$	-0.1282*	-0.0324*	0.0324*	-0.2736*	0.2736*	0.0000	1.0000	
$NTM\_RD_{ijt}$	0.0700	-0.0098	0.2576*	-0.0135	0.2783*	0.0604*	-0.2612*	1.0000

\*denote significance levels of 1%

Figure 1 shows regulatory distance index by APEC countries. Several countries are shown to increase their regulatory distance index values over this two-decade period. China's regulatory distance index rose from 0.27468 in 2000 to 0.46096 in 2020, indicating a significant increase in regulatory differences. The Philippines also experienced an increase from 0.31608 in 2000 to 0.34569 in 2020. Vietnam had no available data for 2000, but in 2020, its regulatory distance index was 0.31800, suggesting an increase. Thailand's index increased from 0.23729 (2000) to 0.23777 (2020), and Singapore's index similarly improved from 0.20281 (2000) to 0.20690 (2020). Mexico's index saw a slight increase, moving from 0.18592 (2000) to 0.18683 (2020), and Papua New Guinea experienced an increase from 0.26556 in 2000 to 0.21719 in 2020. Countries that experienced an increase in the regulatory distance index indicate that their regulatory environments have become more distinct or different from those of other countries within the period 2000 and 2020. This outcome could be due to changes in regulations, economic conditions, or various other factors that have influenced their regulatory landscapes. China had the highest regulatory distance index in the year 2020, indicating that its regulatory environment was relatively more distinct or different from the regulatory environments of the other countries listed.

Conversely, several countries witnessed a decrease in their regulatory distance index values over the same two-decade span. The United States, for instance, saw a decrease in its index, dropping from 0.30191 in 2000 to 0.28292 in 2020. Russia's regulatory distance index decreased from 0.20345 (2000) to 0.15340 (2020), indicating a notable reduction in regulatory differences. New Zealand's index also decreased from 0.20824 in 2000 to 0.15010 in 2020. Japan's index dropped from 0.19524 (2000) to 0.13919 (2020), showing a decrease in regulatory divergence. Hong Kong's index reduced from 0.14795 in 2000 to 0.11993 in 2020. Chile's index dropped from 0.17570 (2000) to 0.13904 (2020), and Brunei's index decreased from 0.19162 (2000) to 0.20921 (2020). These countries saw a decrease in their regulatory distance index, indicating that their regulatory environments became more similar or less distinct from those of other countries within the 2000 to 2020 period. Japan had the lowest regulatory distance index in the year 2020, indicating that its regulatory environment was relatively more similar or less distinct from the regulatory environments of the other countries listed. More regulatory alignment between nations is linked to increased trade volumes and reduced transaction costs, according to a study by Orefice (2017) and Santeramo and Lamona (2019), which assesses the impact of regulatory distance on agricultural commerce. Disdier et al. (2019) evaluate the role of international regulatory cooperation on reducing SPS and TBT regulatory distances. It finds that regulatory cooperation within international frameworks can enhance trade efficiency by minimizing differences in standards.

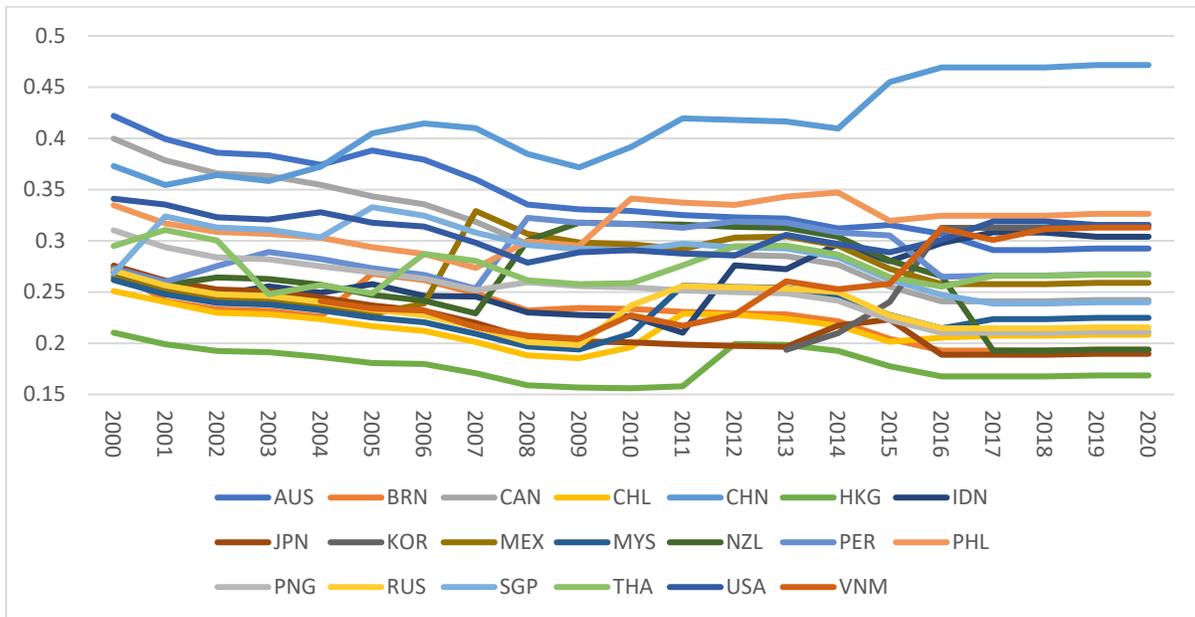


FIGURE 1. Regulatory distance index of NTMs by APEC countries

Table 3 shows the estimation results for all model. Based on the Hausman test and Breusch Pagan LM test for the panel static regression, this study found that the fixed effects model is the best fit, indicating that there are significant variations in entity-specific factors. The relationship between independent variables and the export of agricultural and food products in the fixed effect model indicates  $GDP_{it}$ ,  $GDP_{jt}$  and  $NTM\_RD_{ijt}$  have a positive impact on  $EX_{ij}$ . Meanwhile,  $POP_{it}$  and  $RER_{ijt}$  have a negative impact on  $EX_{ij}$ .

The R-squared results indicate that the Fixed Effects (FE) model has an R-squared of 0.148, the PML model has an R-squared of 0.527, and the PPML + FE model has an R-squared of 0.764. With the PPML + FE model explaining 76.4% of the variation in bilateral exports, this model appears to be the best choice based on its high R-squared and test results. Given the significance of entity-specific factors, the PPML with fixed effects was selected as the optimal model (Table 3).

Model PPML + FE indicate there is three (3) variable positive relationship and significant on export of agricultural and food products. The relationship between GDPi and the export of agricultural and food products show positive coefficient ( $\beta = 0.257$ ) and significant ( $<0.10$ ). That mean 1 percent increase in the GDP of the exporting country ( $i$ ) is associated with a 0.257 percent increase in the export of agricultural and food products. The positive sign suggests that as the GDP of the exporting entity increases, the export of agricultural and food products also tends to increase. This suggests that a stronger economic performance in the exporting entity is associated with a higher export volume of agricultural and food products.

Similarly, the  $GDP_j$  also exhibits a positive coefficient which is significant at level below 0.010. This implies that as the natural logarithm form of  $GDP_j$  increases in 1 percent, the export of agricultural and food products correspondingly increases in 0.826 percent. This positive relationship underscores the importance of economic activity in both the exporting and importing entities (i and j) as a driving force behind the export of agricultural and food products. A stronger GDP in both entities may indicate greater economic capacity, demand, and resources, all of which can contribute to increased trade in this specific sector. The significance of this coefficient in all models reinforces the robustness of this relationship across different model specifications, highlighting the significance of the economic conditions of both the exporting and importing entities in shaping trade patterns in the agricultural and food products sector.

The exchange rate (RER) between the exporting country indicates positive coefficients ( $\beta = 0.0446$ ) and is significant. That means a 1% increase in the real exchange rate (RER) between the two countries is associated with a 0.0446% increase in exports. A higher RER (indicating a relatively weaker currency) makes exports more competitive in international markets, promoting trade. This could be due to various factors, including changes in relative prices, demand, and market dynamics. The statistical significance of these coefficients in all models highlights the importance of considering the real exchange rate (RER) in understanding the dynamics of agricultural and food product exports.

Model PPML + FE also indicate there is two (2) variables negative relationship and significant on export of agricultural and food products. The distance (DIS) between the exporting country and the importing country, represented by the negative coefficient ( $\beta = -0.482$ ), indicates that as the geographical distance between the two entities increases, there is a corresponding decrease in the export of agricultural and food products. Specifically, a 1% increase in distance is associated with a 0.482% decrease in exports. This suggests that the trade of these products is negatively impacted by greater physical distance. The statistical significance of the coefficient in all models underscores the robustness of this relationship. It implies that the influence of distance on the export of agricultural and food products is consistent across different modelling approaches. This finding highlights the practical implications of geographic proximity in international trade. Shorter distances can facilitate trade, reduce transportation costs, and potentially lead to increased exports of agricultural and food products.

The regulatory distance index of NTMs (NTM\_RD) between the exporting negative coefficients ( $\beta = -0.735$ ) and significant ( $<0.10$ ), indicating an inverse relationship with the export of agricultural and food products. It is suggested that as the regulatory distance increases in 1 percent, the regulatory barriers or differences between trading partners become larger, thus eliciting a negative impact on the export of agricultural and food products in 0.735 percent. However, it is important to note that only in the PPML+FE model, the coefficients are statistically significant, implying that the impact of the NTMs may become more apparent when entity-specific factors are considered.

However, there is two (2) variable indicate not significant, which is  $POP_i$  and  $POP_j$ , implying that the population size of the exporter and importing country may not be a significant factor in explaining export variations in this sector.

TABLE 3. Panel data regression results

Variables	Pooled $\ln EX_{ijt}$	RE $\ln EX_{ijt}$	FE $\ln EX_{ijt}$	PPML $EX_{ijt}$	PPML + FE $EX_{ijt}$
$\ln GDP_{it}$	1.171*** (0.0705)	1.171*** (0.0705)	1.573*** (0.103)	0.440*** (0.0350)	0.257* (0.131)
$\ln GDP_{jt}$	1.524*** (0.0720)	1.524*** (0.0720)	1.469*** (0.113)	0.787*** (0.0246)	0.826*** (0.0241)
$\ln POP_{it}$	0.0569 (0.0989)	0.0569 (0.0989)	-1.458*** (0.338)	0.246*** (0.0224)	-1.154 (0.713)
$\ln POP_{jt}$	-0.475*** (0.0988)	-0.475*** (0.0988)	0.150 (0.321)	0.0311 (0.0310)	0.0365 (0.0301)
$\ln DIST_{ijt}$	-1.262*** (0.146)	-1.262*** (0.146)	- -	-0.455*** (0.0234)	-0.482*** (0.0199)
$\ln RER_{ijt}$	-0.0556* (0.0317)	-0.0556* (0.0317)	-0.230** (0.0934)	0.0419*** (0.00823)	0.0446*** (0.00948)
$NTM\_RD_{ijt}$	1.774*** (0.443)	1.774*** (0.443)	2.393*** (0.500)	-0.637 (0.540)	-0.735* (0.413)
Constant	-45.53***	-45.53***	-50.25***	-22.71***	9.277

	(2.018)	(2.018)	(4.880)	(1.110)	(14.63)
Observations	6,702	6,702	6,702	6,770	6,770
R-squared	0.423	0.423	0.148	0.527	0.764
Hausman test		98.83***			
Breusch Pagan LM test		28379.06***			

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

## IMPLICATION AND CONCLUSION

This study employs multiple estimation techniques, including panel static, and Poisson Pseudo-Maximum Likelihood (PPML) models for gravity model. This study select PPML with fixed effects because several coefficients, such as those for NTM\_RD and  $\ln(\text{GDP}_i)$  are highly significant, and this model appears to provide more stable results and having a higher R-squared compared to the fixed effect and simpler PPML model.

This study form PPML with fixed effects highlights several critical factors influencing the export of agricultural and food products, specifically focusing on the role NTMs regulatory differences. In our analysis, the NTMs regulatory distance index emerges as a central variable impacting trade in agri-food products across APEC countries. Higher regulatory distance values, indicating greater regulatory divergence, correlate with reduced trade flows, highlighting how regulatory alignment can facilitate smoother trade exchanges. This implies that when regulations differ significantly between countries, they may become more challenging and costlier for businesses to comply with varying standards, certifications, and administrative procedures. Available evidence indicates that the costs associated with adhering to food safety standards are notably higher for exporters from developing countries in comparison to their counterparts from developed ones.

In contrast to prior studies, our results provide insights into the impact of NTMs on trade in the agri-food sector. For instance, while Disdier et al. (2008) found that sanitary and phytosanitary measures (types of NTMs) generally hinder agricultural trade, our findings in some models show a positive association between regulatory distance and exports. This could align with the argument by Xiong and Beghin (2012) that NTMs can sometimes have trade-enhancing effects by improving product standards and reducing information asymmetry. However, in models where the coefficients are negative and significant, our results support the findings of Crivelli and Gröschl (2016), who reported that NTMs can act as barriers to trade. These discrepancies may arise from differences in regulatory structures among APEC countries compared to other regions, highlighting the regional specificity of NTM impacts.

These costs often surpass any potential benefits related to increased demand resulting from compliance with these standards. As a result, the overall impact on trade for developing countries tends to be unfavourable (Ferro et al. 2015). Disdier et al. (2008) maintained that the findings reveal substantial disparities among developing countries in this regard. African, Caribbean, and Pacific nations experience the most pronounced adverse effects from these standards, both in terms of the variety of affected products and the magnitude of the trade impact. In contrast, Latin American countries also witness a significant negative impact on exports due to standards, while Asian exports are not similarly affected.

Businesses often need to make investments and adjustments to meet different regulatory requirements in various markets. These compliance costs can be a significant burden and may reduce the competitiveness of their products in international markets. When regulatory standards are not harmonized, it can limit market access for exporters. Products that do not meet the specific regulations of a target market may be excluded or face higher trade barriers. As reported in WTO (2012), empirical research indicates that the alignment of standards and the mutual recognition of these standards typically result in a boost in international trade. Moreover, this harmonization process is observed to positively affect the participation of small and medium-sized enterprises in foreign export markets.

Policymakers should therefore recognize the importance of addressing regulatory disparities to promote agricultural and food product exports. However, a one-size-fits-all approach, such as general regulatory harmonization, may not be accurate. Instead, they should consider customized policies that take into account the specific characteristics and challenges faced by different entities or trading partners. Policymakers should also be open to adapting regulations to the specific needs and conditions of different entities rather than seeking uniformity. This may involve negotiating and harmonizing regulations with trading partners while allowing for necessary variations. Additionally, collaborative efforts with trading partners to address NTMs should be encouraged. Developing mutual agreements and standards can help facilitate trade and reduce the costs associated with compliance, benefiting all parties involved. Among the initiatives that has been undertaken is the establishment of the International Regulatory Cooperation (IRC) by the Organization for Economic Cooperation and Development (OECD) in 2013 with the goal of promoting regulatory convergence and transparency through information exchange and sharing. The IRC aims to

achieve equivalent regulatory requirements and reduce conformity assessment costs through mutual recognition and technical cooperation (Von Lampe et al. 2016).

In general, these findings provide valuable insights for policymakers, businesses, and researchers in the field of international trade and agriculture. This study highlights the importance of understanding the regulatory distance between countries, particularly in the APEC region, and its impact on agri-food trade flows. Policymakers should consider these regulatory barriers when designing trade policies, focusing on harmonizing standards and regulations to reduce trade costs and promote smoother market access for agricultural products. Businesses, especially those engaged in international trade within the agri-food sector, can use these findings to better navigate regulatory environments and develop strategies to manage compliance with non-tariff measures (NTMs).

For researchers, this study provides a framework for further investigation into the effects of regulatory distance on trade, particularly in other regions or sectors. Future research should compare the findings from the APEC region with other regional trade blocs to identify commonalities and differences in trade dynamics. This will help in developing a more comprehensive understanding of how regulatory differences influence global trade flows.

Despite the valuable contributions of this study, it is important to recognize that the findings are primarily focused on the APEC region, and their applicability to other regions may be limited. To overcome this limitation, future research should focus on comparing trade dynamics across regions, taking into account regional variations and conducting similar studies in different contexts. This could yield a more holistic view of how NTMs and regulatory distance affect international agri-food trade.

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## APPENDIX 1

No.	HS 2007 Product Code	Description
1	301	Live fish.
2	302	Fish, fresh or chilled, excluding fish fillets and other fish meat of heading 03.04.
3	303	Fish, frozen, excluding fish fillets and other fish meat of heading 03.04.
4	304	Fish fillets and other fish meat (whether or not minced), fresh, chilled or frozen.
5	305	Fish, dried, salted or in brine; smoked fish, whether or not cooked before or during the smoking process; flours, meals and pellets of fish, fit for human consumption.
6	306	Crustaceans, whether in shell or not, live, fresh, chilled, frozen, dried, salted or in brine; crustaceans, in shell, cooked by steaming or by boiling in water, whether or not chilled, frozen, dried, salted or in brine; flours, meals and pellets of crust
7	307	Molluscs, whether in shell or not, live, fresh, chilled, frozen, dried, salted or in brine; aquatic invertebrates other than crustaceans and molluscs, live, fresh, chilled, frozen, dried, salted or in brine; flours, meals and pellets of aquatic invertebrates.
8	702	Tomatoes, fresh or chilled.
9	708	Leguminous vegetables, shelled or unshelled, fresh or chilled.
10	710	Vegetables (uncooked or cooked by steaming or boiling in water), frozen.
11	713	Dried leguminous vegetables, shelled, whether or not skinned or split.
12	801	Coconuts, Brazil nuts and cashew nuts, fresh or dried, whether or not shelled or peeled.
13	1005	Maize (corn).
14	1102	Cereal flours other than of wheat or meslin.
15	1201	Soya beans, whether or not broken.
16	1203	Copra.
17	1204	Linseed, whether or not broken.
18	1205	Rape or colza seeds, whether or not broken.
19	1206	Sunflower seeds, whether or not broken.
20	1207	Other oil seeds and oleaginous fruits, whether or not broken.
21	1208	Flours and meals of oil seeds or oleaginous fruits, other than those of mustard.
22	1507	Soya-bean oil and its fractions, whether or not refined, but not chemically modified.
23	1511	Palm oil and its fractions, whether or not refined, but not chemically modified.
24	1512	Sunflower-seed, safflower or cotton-seed oil and fractions thereof, whether or not refined, but not chemically modified.
25	1513	Coconut (copra), palm kernel or babassu oil and fractions thereof, whether or not refined, but not chemically modified.
26	1515	Other fixed vegetable fats and oils (including jojoba oil) and their fractions, whether or not refined, but not chemically modified.
27	1603	Extracts and juices of meat, fish or crustaceans, molluscs or other aquatic invertebrates.
28	1604	Prepared or preserved fish; caviar and caviar substitutes prepared from fish eggs.
29	1605	Crustaceans, molluscs and other aquatic invertebrates, prepared or preserved.
30	2002	Tomatoes prepared or preserved otherwise than by vinegar or acetic acid.
31	2005	Other vegetables prepared or preserved otherwise than by vinegar or acetic acid, not frozen, other than products of heading 20.06.
32	2008	Fruit, nuts and other edible parts of plants, otherwise prepared or preserved, whether or not containing added sugar or other sweetening matter or spirit, not elsewhere specified or included.
33	2009	Fruit juices (including grape must) and vegetable juices, unfermented and not containing added spirit, whether or not containing added sugar or other sweetening matter.
34	2104	Soups and broths and preparations therefor; homogenised composite food preparations.
35	2302	Bran, sharps and other residues, whether or not in the form of pellets, derived from the sifting, milling or other working of cereals or of leguminous plants.
36	2303	Residues of starch manufacture and similar residues, beet-pulp, bagasse and other waste of sugar manufacture, brewing or distilling dregs and waste, whether or not in the form of pellets.
37	2304	Oil-cake and other solid residues, whether or not ground or in the form of pellets, resulting from the extraction of soyabean oil.
38	2306	Oil-cake and other solid residues, whether or not ground or in the form of pellets, resulting from the extraction of vegetable fats or oils, other than those of heading 23.04 or 23.05.