The effects of non-tariff barriers on the agricultural industry: An analysis of Mexico's place within the APEC

América Ivonne Ivonne Zamora Torres (americazt@gmail.com)
Universidad Michoacana de San Nicolás de Hidalgo https://orcid.org/0000-0003-1811-4711

Mirta Aveces
Universidad Michoacana de San Nicolás de Hidalgo: Universidad Michoacana de San Nicolas de Hidalgo

Juan Gonzalez
Universidad de Colima

Research

Keywords: APEC, agribusiness, exports, non-tariff barriers, international certifications

Posted Date: March 9th, 2022

DOI: https://doi.org/10.21203/rs.3.rs-1328236/v1

Abstract

Barriers unrelated to agricultural tariffs prevent that companies from emerging economies enter export markets successfully. Additionally, over the last two decades, the technical measures enacted by World Trade Organization-member countries have become stricter. Therefore, this study aims to identify whether the implementation of trade restrictions and other technical measures contributes to an increase in exports. Therefore, this study examines the non-tariff measures implemented by the economies within the Asia-Pacific Economic Cooperation region (including Mexico, Australia, Chile, China, Korea, the United States, Japan, and Peru) for the period of 2002 to 2018. To this end, we conducted a correspondence analysis via principal components analysis, which allowed us to assess the impact of non-tariff barriers on the export volume of the agricultural industries of the analyzed economies. This study did not find evidence of a significant increase in trade between these economies, which indicates that the implementation of non-tariff barriers for the agricultural industry is, in fact, affecting trade.

Introduction

The international trade of goods and services is determined not only by their competitiveness, but also by government policies related to the promotion or restriction of trade transactions between domestic and foreign stakeholders. For instance, for the trade of food products, it may be both convenient and necessary to implement sanitary regulations to ensure that said products are safe for human consumption and that all related transactions are beneficial for the national economy (Quiroz 2015).

Calo and Méndez (2017) noted that the increase in non-tariff barriers (NTBs; frequently associated with economic liberalization) is owed to governments' commercial policies, as they are primarily concerned with the benefits obtained by domestic companies. Although the various regulations issued by the World Trade Organization (WTO) have managed to reduce or eliminate tariffs worldwide, NTBs, such as sanitary and phytosanitary measures (SPMs), have become major barriers to trade (BTTs) (Chin and Ahmad 2015). Furthermore, the World Bank (2006) has acknowledged that, within the context of economic development, economic liberalization is not enough to guarantee economies' integration into international markets. Therefore, NTBs may prevent the successful integration of companies from emerging economies into export markets.

Gradually, the restrictions implemented by trade-related policymaking have decreased, as analysts and political stakeholders have recognized the wide range of economic and institutional factors that may affect international trade. As the efforts of multilateral economic liberalization have fostered an overall decrease in tariffs, NTBs have become more prominent in international trade. Further, scholars have observed that comparative analyses of NTBs are not easily quantifiable (Helble et al. 2007).

Non-tariff measures are generally defined as policies (different from ordinary customs tariffs) that have economic repercussions in the international trade of goods and services, whether by modifying the volume of transactions, prices, or both (United Nations Conference on Trade Development [UNCTAD] 2012). The framework of international regulations for NTBs is detailed in the WTO's guidelines. According to the WTO, governments may enact non-tariff measures only under exceptional circumstances, as described in the Agreement on Technical Barriers to Trade and in the Agreement on the Application of Sanitary and Phytosanitary Measures. Said agreements allow governments to accomplish important objectives, such as safekeeping agricultural products from pests. However, certain non-tariff measures' sole objective is to provide domestic companies with a competitive advantage in the global market, in which case such measures are considered NTBs (Westreicher 2021).

Additionally, NTBs may be *weaponized* when two or more economies impose economic sanctions on each other as retaliation for perceived sociopolitical or economic attacks. Further, agricultural products may become ensnared in trade wars stemming from conflict in more lucrative industries (Quiroz 2015). The NTBs analyzed in the present study are shown in Table 1.

Table 1. Non-tariff technical measures

Technical measures	**A** Sanitary and phytosanitary measures.
	B Technical barriers to trade.
	C Prior inspection and other formalities.

Source: Author's own creation based on data from the World Trade Organization (2019).

In recent years, the implementation of technical measures has become more common among WTO-member countries. For instance, Table 2 shows evidence of the increase in SPMs within the agricultural industry.

Table 2. Sanitary and phytosanitary measures in World Trade Organization-member countries (2007–2018)

SPMs	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Issued	627	587	522	704	685	546	652	832	1018	769	1001	1316
Currently active	240	353	313	418	360	345	346	368	287	329	114	3

Abbreviation: *SPMs*: sanitary and phytosanitary measures.

Source: Author's own creation based on data from the World Trade Organization (2019).

Similarly, Fig. 1 shows the rise in the implementation of SPMs within the agricultural industry in recent years. Several WTO-member countries have issued provisional measures to solve temporary or seasonal issues; if the WTO is not notified of any changes within 180 days, these measures are formally introduced.

The WTO's 2019 Annual Report states that, from 2000 to 2018, WTO-member countries reported 14,867 ordinary notifications, 5,588 additions and amendments, and 1,988 urgent notifications, for a total of 22,443 notifications related to SPMs. Over the 18-year period, the number of ordinary notifications exhibited a yearly 7.1% increase, while additions and amendments increased 9.1% yearly, and urgent notifications increased 4.4% yearly. From 1995 to September 15, 2018, fifteen WTO-member economies issued the most urgent and ordinary notifications related to SPMs (Research Center for Sustainable Rural Development and Food Sovereignty 2019). Most of the economies in this group belong to the Asia-Pacific Economic Cooperation (APEC) forum. The United States of America reported the highest number of notifications (19% of the total), followed by Brazil. Additionally, Canada was in third place, followed by China (4th), Peru (5th), the European Union (6th), South Korea (7th), Japan (8th), Chile (9th), Taipei (10th), New Zealand (11th), Australia (12th), Mexico (13th), and Thailand (14th).

While currently active measures have decreased, new measures (whether preventive or temporary) continue to be issued at a faster rate. Although the WTO allows for the implementation of such measures to rectify market failures, it is undeniable that sometimes these measures are used as protectionist policies that cause commercial and economic imbalances. These imbalances are especially harmful to developing countries, as their gross domestic product (GDP) depends primarily on the export of goods and services to foreign markets, as is Mexico's case (UNCTAD 2015). Accordingly, non-tariff regulations and restrictions have a considerable impact on Mexico's agricultural producers, who are more vulnerable to the negative effects of these restrictions (López 2014). According to Ruiz (2005), SPMs comprise the main NTBs for Mexican exports. Chemical production is the second industry where Mexico faces considerable NTBs in the Pacific Rim.

Mexico's push towards greater economic liberalization is an important step forward in the facilitation of trade. According to a report that assessed compliance with Bogor's Goals during 2010, regarding conformity-related norms and procedures, Mexico adjusted 765 technical regulations and 4,291 voluntary standards to ensure compliance with international standards (Noor 2012). Although Mexico's goal is to facilitate international trade in forums such as the APEC, the results have been underwhelming. Therefore, a growing commercial deficit in Mexico's proportion of imports/exports has been forecast by some scholars (Celaya et al. 2016).

Hence, there is a scarcity of information regarding the effects of international certifications (as NTBs) on the agricultural industry's exports in APEC countries. Therefore, this study aims to answer the following research questions (RQs):

- RQ1: What are the effects of NTBs on the exports of Mexico's agricultural industry and its main trade partners within the APEC?
- RQ2: How do international certifications, as NTBs, impact the exports of Mexico's agricultural industry and its main trade partners in the APEC?

Based on these RQs, this paper builds on the following general hypothesis: NTBs have a negative effect on the exports of Mexico's agricultural industry and its main trade partners in the APEC. Subsequently, this paper also presents a specific hypothesis: international certifications (as NTBs) have a negative effect on the exports of Mexico's agricultural industry and its main trade partners in the APEC. Accordingly, this paper is organized in five sections. As is evident from the present section, this article presents an introduction to provide the reader with an overview of the problem and to define the study's research questions. In the following section, this article presents a literature review of research on international economy and protectionism in foreign trade, analyzing different perspectives on the subject. In section 3, the methodology used for this study is presented. The fourth section presents the results of correspondence analysis. Lastly, the fifth section presents the present study's conclusions and provides a space for discussing the study's findings.

Literature Review: The International Economy And Trade Protectionism

Adam Smith and other economists have defended free trade as an ideal which trade policy should adhere to. Smith did not consider government control to be of particular importance for the economy, favoring instead a *laissez faire* approach (according to which individuals determine their own objectives and actions within the boundaries defined by the law). In this context, the government's role would be limited to ensuring that the market remains free and unimpeded, removing any barriers for the effective operation of the market's "invisible hand" (Appleyard and Field 2003).

The Ricardian Trade Model is a useful tool to examine the rationale underlying trade and the effects of international trade on national well-being. Regarding commercial policy, groups and stakeholders that do not conduct profitable trade transactions often pressure their governments to protect their interests by restricting trade. As such, import restrictions are a clear example of politics' influence on international trade (Krugman and Obstfeld 2008).

According to classical economics, the value of goods and services is determined by the cost of the factors of production. Conversely, in neoclassical economics, value is determined by goods and services' utility for consumers, as well as by their relative scarcity; as such, factors' supply and demand determine price and rent. Regarding commerce, in classical economics, the basic prediction of the Ricardian Trade Model (that countries tend to export goods whose productivity is relatively high) has been confirmed by various studies. However, neoclassical theory is currently the most widely accepted school of thought in the field of economics; it posits free trade as the main force behind economic development and as a means to capitalize on countries' specific advantages (Gallardo 2005).

When a given market does not allow for the efficient allocation of resources, it has failed. Some reasons for this failure include monopolization, monopolistic competition, and oligopolization; these market structures lead to improper resource allocation, as they cause marginal values (prices) to exceed marginal costs. However, markets may fail for reasons other than their structures' lack of competitiveness. Additionally, while subsidies aim to ensure for the efficient

allocation of resources in specific markets, there is no guarantee of their success in accomplishing this objective. Moreover, subsidies require public revenue usually obtained through taxation, however, taxes themselves tend to diminish the system's efficiency (Emery 1994).

However, globalization cannot take place in a political vacuum; international economic integration has only occurred because governments have made it possible. Beyond the scope of specific political decisions, economists must consider the institutional context in which decisions are made. Societies' legal, political, social, cultural, ethical, and religious structures determine whether a given environment is conducive to economic prosperity and stability (Feenstra and Taylor 2012).

There are many ways in which the state can influence trade; for instance, some governments may restrict imports indirectly. Several tariffs, import fees, and other measures of trade policy may be established to protect the interests of specific groups. As such, politicians may support certain policies to protect national interests. Another argument for restricting trade that it may allow policymakers prevent nationwide market failures. For instance, the global trade of agricultural products is highly regulated, as it is relatively easy for policymakers to create obstacles for trade, such as sanitary and customs-related security protocols (Krugman and Obstfeld 2008).

Following the 2008 global economic crisis, several countries tightened protectionist regulations on imports, thereby damaging overall trade as well as various industries and countless consumers worldwide, in clear violation of international agreements. The enactment of these regulations has an underlying political component, as some governments issued these restrictions to answer the demands of unions, industry leaders, and companies (both private and public), limiting the rate at which their competitors' products overtake the market. Further, although these protectionist policies have also been issued in Europe and Asia, Latin American countries stand to lose the most as a result (Camacho 2012). While the WTO and various countries have denounced these policies, many of them are still in place.

Bain (1956), as well as Caves and Porter (1977), among other scholars mentioned by Yao (1988), posit that excessive costs comprise a barrier to entry, that is, they preclude newcomers from entering certain industries. Helble et al. (2007) showed that transparency between importers and exporters may be crucial factor in the liberalization of tariff and non-tariff barriers for APEC-member countries. They considered transparency as comprising two dimensions: predictability (reducing the costs related to uncertainty) and simplification (by reducing the costs related to information) (Helble et al. 2007).

The implementation and renovation of certifications are considered useful tools in promoting international trade, as they allow for agricultural products' incursion into new markets, leading to an increase in exports. Further, acquiring certifications is often seen as a development opportunity for the agricultural industry within the context of global trade. However, these certifications often serve as NTBs, given that they often originate from protectionist policies (as is the case for some of Mexico's trade partners), rather than from a willingness to engage in open trade, which could benefit all nations involved (Deardorff 2012; United Nations Economic and Social Commission for Asia and the Pacific 2019; UNCTAD 2021).

Further, within the context of the global economy, internal conflicts of interest in certain countries may lead to economic policies that affect other nations. Therefore, it is important to elucidate whether non-tariff measures promote or restrict the exports of Mexico's agricultural industry, and to examine the trade relationships between APEC-member countries.

If, from a theoretical standpoint, governments' profits comprise the most important aspect of the global economy, the never-ending struggle between free trade and protectionism would be the most important topic to analyze from a political perspective. Since the origin of modern nation states in the XVI century, governments have been concerned with the impact of international competition on the prosperity of their national industries, and have tried to protect them from foreign competitors, whether by imposing restrictions on imports or by subsidizing exports. Thus, international economics research has focused on analyzing the effects of such protectionist policies, frequently (but not always) criticizing protectionism, and highlighting the advantages of free trade (Yao 2019; Baldwin 1970; Carrère et al. 2011).

After World War II, various advanced democracies (led by the US) adopted a consistent policy of eliminating all barriers to international trade, thereby highlighting the idea that free trade was a force not only for prosperity but for world peace as well. Additionally, in the first half of the 1990s, several important free trade agreements were signed between nations. However, in the late 1990s, the debate on the limits of free trade began to shift in a new direction.

For Bahri (2018), over the last 25 years, advances in communication and general technological improvements have influenced the progress of globalization. Regarding the benefits of globalization, it posits that if goods do not cross borders, soldiers will, and that the international exchange of goods brings world peace, jobs, and economic growth, while also increasing quality of life. Conversely, the main reason underlying protectionism is the threat that trade poses for nations' local industries. Thus, protectionist policies aim to avoid the loss of jobs, citizens' health, public policy, national security, and self-sufficiency. Thus, according to this perspective, unfettered international free trade would only increase the wealth gap among individuals and among nations; thus, regulation and legislation are needed.

Therefore, regulatory barriers aim to protect trade. Stiglitz (2002) pointed out that although the US advocates for free trade, when poorer countries introduce goods or services to the market in a bid for exporting them to the US, the latter adopts protectionists policies to favor their own interests. Consequently, to protect union-related and business-related interests, fair-trade laws (which may be perceived as the opposite by potential business partners) are frequently invoked to protect national interests, establishing a barrier against imports.

This topic became highly relevant in economics research during the 1960s (e.g., Macario 1960; Soligo and Stern 1965). Macario (1960) studied Latin American countries' protectionist systems, highlighting that their restrictions were not caused by high taxation, but by their tariff structure.

Scholars have developed a theoretical framework of effective economic protection to study the impact of protectionism (and its changes) on economic activity. The literature on economic development and international trade has emphasized topics such as the protection of national industries, import

substitution, the benefits of restricting trade through tariffs, and the potential decrease of well-being as a result of the inappropriate implementation of these restrictions. This viewpoint considers that the nominal tariff applied to a given merchandise's import does not reveal the impact of protection on national industries that rely on imported supplies for their productive processes. The effective rate of protection is defined as the percentual change in added value for national industry as a result of the implementation of tariffs and other protection measures on products and supplies. This is the main indicator of protection's effect on resource allocation.

Table 3 presents the studies that have supported the idea that NTBs have a negative impact on the exports of the agricultural industry. Most of these studies emphasize that one of governments' main priorities is protecting their internal markets, including those from countries in the APEC. They present consistent concerns regarding the negative consequences of NTBs, such as increases in transaction costs and restrictive regulations in the food industry. The main way for stakeholders to overcome said NTBs is to obtain international certifications. Acquiring certifications implies incurring additional expenses that increase products' price, which decreases their competitiveness in the market. That is, these certifications sometimes have no other purpose than to serve as NTBs for imports. This is an especially poignant issue for nations that are at a disadvantage when they enter the market to compete with better-established economies in the foreign trade landscape. It is also noteworthy that some of the studies mentioned in Table 3 highlight the importance of participating in economic and trade forums, such as the APEC, for which there is scarce evidence regarding the benefits that it brings its members.

Table 3. Works that have explored factors associated with non-tariff barriers

Variables/non-tariff barrier-associated factors	Helble, Shepherd, and Wilson 2007	Melo. et al. 2014	Okumura 2015	Shepherd 2016	APEC Business Advisory Council, 2016	Cadot and Gourdon 2016	Zhaohui Niu, Liu, Gunessee, and Milner 2018	Olanike Kareem. et al. 2018	Santeramo and Lamonaca 2019	Kinzius et al. 2019	Santeramo and Lamonaca 2020	K 2
The food industry's import dependency.												
Trade facilitation												
Transaction costs												
Free trade agreements												
APEC												

Source: Author's own creation.

Some scholars such as Barragan, et al (2021) and Goedhuys, et al (2016) have found that certifications have a positive impact on internationalization, as they help stakeholders gain credibility in developed markets. Moreover, some measures have been associated with exports' success, such as obtaining approval from the US government's Federal Drug Administration. Similarly, some studies have pointed out the need to increase food safety tests, considering the dangers inherent to international trade regarding the use of dangerous substances in food products.

However, the theoretical and empirical studies mentioned in this paper show that strict regulation has a negative effect on trade, as exporters perceive imbalances in the severity of regulations on international trade. The most commonly required international certifications include sanitary and phytosanitary standards, as well as technical and quality requirements. These studies also show that non-tariff measures are on the rise in the APEC region, making the trade of food products a much more complicated and drawn-out process.

Methods

3.1 Correspondence Analysis

Correspondence analysis is a descriptive technique that can be used with most data matrixes that have non-negative inputs. It is especially useful to represent contingency tables, reducing their multivariate characteristics to the fewest dimensions possible (Leguina 2009). Correspondence analysis was first developed by Benzécri (1973), however, its inclusion among standard statistical analysis techniques occurred much later. By merging proximity analysis with principal component analysis, correspondence analysis allows researchers to analyze in greater depth modalities' similarity, as well as the association between attributes and the attraction/repulsion relationships of their modalities in contingency tables using primarily qualitative variables. Correspondence analysis

accomplishes this by projecting modalities on a metric space wherein principal component analysis may be performed to facilitate a simple causal interpretation of the similitude/attraction behaviors of said modalities via the principal components (Senra 2010).

Analyzing the similarity (proximity) between the different modalities of an attribute (represented by their corresponding conditioned frequency distributions), which determines whether said modalities condition the modality distribution of a different attribute, allows us to analyze the homogeneity of these attributes in a space comprising two dimensions (*p* and *q*) by using Benzécri's distance. To simplify the presentation and interpretation of these results, principal component analysis must be performed.

When correspondence analysis is conducted to examine the modalities of only two variables in a contingency table (with only two dimensions), it is known as simple correspondence analysis. Conversely, multiple correspondence analysis refers to analyzing the modalities of more than two variables.

3.1.1 Row Space

To measure the degree of proximity between the modalities of A in the *q*-dimensional space, Benzécri proposed the following measure of dissimilarity, which is known as Benzécri's distance:

$$d^2(i,i') = \sum_{j=1}^{q} \frac{1}{f_{\cdot j}} \left(\frac{f_{ij}}{f_{i\cdot}} - \frac{f_{i'j}}{f_{i'\cdot}} \right)^2 \quad (1)$$

As shown above, Benzécri's distance has a typical X^2 shape, the sum of squared differences, though it weights each term inversely by the marginal frequency of the summand's corresponding modality. This projects each modality, *Ai*, of attribute A in a point of the q-dimensional Euclidean space[1] of coordinates. To obtain (from the row space) a smaller and simpler space that allows us to visualize the proximity relationships between the modalities represented in the point cloud, it is necessary to perform principal component analysis. Further, the characteristic directions of the principal components are shown by the eigenvectors of the data's variance and covariance matrixes. Additionally, the dispersion explained by each component is equivalent to its associated eigenvalue.

3.1.2 Simple Correspondence Analysis: Common Space

After conducting several principal component analyses on the point cloud of the modalities' rows and columns projected in both spaces (the q-dimension rows and the p-dimension columns), the respective solutions are linked via a lineal relationship that allows us to go easily from one to the other, which, in turn, allows us to represent all modalities (both rows and columns) within a common space.

The mathematical model to conduct factor analysis assumes that each of the *p* observable variables is a function of an *m* number of common factors ($m < p$) plus a specific or unique factor. Neither the common or specific factors are observable, and their identification and interpretation leads to the result of factor analysis.

Suppose a total of *p* typified observable variables and that *m* common factors exist. As mentioned earlier, factor analysis is used to find a reduced number of subjacent common factors (e.g., *K* factors), which lineally reconstitute the original *p* values. The model is thus defined as follows:

$X_{ij} = \lambda_{1j} f_{i1} + \lambda_{2j} f_{i2} + \ldots\ldots + \lambda_{kj} f_{ik} + u_{ij}$ (2)

where

X_{ij} = Is the value of the *i*th observation of the *j*th variable

$_j$ = Is the set of linear coefficients or factor loadings.

f_{ik} = Is the *i*th observation of the *k*th common factor (latent variable), with a mean of 0 and a variance of 1.

u_{ij} = Is a term of random error known as the unique or specific factor associated to the *j*th variable. This explains variability in *xj* (including the variance caused by errors associated due to low reliability during data collection) that is not shared by other variables in the observable variables' matrix.

Additionally, the specific factors have a mean of 0 and are not correlated: E (u_{ij})=0; *Cov* (u_{is}, u_{it})=0, ∀ $s \neq t$; being also the independent common and specific factors: *Cov* (f_{ik} ,u_{ijt})=0, ∀ *k*=1,2,...., *k;j = 1,2...,p*. The observable variables are only the xj´s, while all other elements on the right side of the equation must be estimated, beginning with the matrix of correlations between the observed variables (Martínez de Ita 2010).

[1] A Euclidean space is a type of geometric space where Euclidian geometry's axioms are fulfilled.

Results And Discussion

This section analyzes the aforementioned variables to determine their degree of correlation. To this end, this study used correspondence analysis.

4.1 Rotated Component Matrix

The rotated component matrix reports the methods of extraction, rotation, and iterative convergence. The method of extraction was principal component analysis, whereas the method of rotation was Varimax rotation with Kaiser normalization (table 4).

Table 4. Rotated component matrix[a]

	Component	
	1	2
Exports	-.145	.776
Non-tariff barriers	.824	-.188
Income	.233	.791

[a] The rotation converged in 3 iterations

Source: Author's own creation based on the results of correspondence analysis.

The matrix contains the correlations between the variables and the factors of the rotated solution. These correlations represent each variable's gross contribution to each factor. The variables that correlate with a given factor will also be correlated with all other factors related to it. Thus, the variables that are correlated (or those that somehow have the same focus or viewpoint regarding the issue being studied) will tend towards clustering under the same component, which reveals that said variables are linked with each other and with said component.

To elucidate the effect of the rotation, Fig. 3 shows the proximity or correlation between the variables *exports* and *income*, while the variable *non-tariff barriers* is apart from the others. The *0* indicates the origin of the coordinates, which range from *-1.0* to *+1.0*. The numbers on the axes represents the factor loadings. The values of the rotated component matrix confirm that the variables *exports* and *income* are correlated, which is why they remain in component 2. The variable *non-tariff barriers* is far removed from the aforementioned variables, remaining in component 1.

4.1.1 Dot plot

Fig. 4 shows a dot plot generated for the analysis of the coded variables, which shows the studied economies' position regarding NTBs on the x-axis, whereas their income is shown on the y-axis. As economies' x-axis values tend toward the right, they will exhibit higher scores regarding their implementation of NTBs. The countries that exhibited the highest x-axis values include the US, South Korea, Chile, Mexico, and Peru, as they are the economies that have implemented the most NTBs, compared with other economies in the APEC. As mentioned earlier, the y-axis shows the indicators of income; the higher the economies are positioned on the vertical axis, the higher their income is. The US, Japan, Australia, and South Korea were positioned toward the top of the y-axis, thus, exhibiting the highest incomes in the region. Conversely, Peru exhibited the lowest income, being the lowest economy in the graph.

Fig. 5 shows the analyzed economies' implementation of NTBs (on the x-axis) and their exports (on the y-axis). Higher scores of NTB implementation will tend towards the right on the x-axis. The US, South Korea, Chile, Mexico, and Peru were found to have implemented more NTBs, compared with the rest of the analyzed economies. Conversely, the y-axis shows the indicators of the analyzed economies' exports; higher scores for this variable will tend toward the top of the y-axis. The country that exhibited the highest export scores, compared with the rest of the economies, was the US, followed by China. The lowest relationship in the graph was that between Australia and Peru, which showed the link between Australian exports and Peru's implementation of NTBs.

4.2 Correspondence Analysis according to NTB Type

This paper aims to determine the impact that NTBs have on trade between APEC-member countries. Thus, it is important to identify which countries have implemented NTBs for other countries within the APEC region. Fig. 6 shows countries' NTBs for the agricultural industry (as percentages). Peru implemented the most NTBs (29%), followed by the US (23%), Mexico (16%), Chile (13%), South Korea (13%), and Australia (5%). Although Japan and China have implemented various NTBs, these have been applied on a general basis, rather than for countries within the APEC; as such, they exhibited the smallest percentage of NTBs implemented for specific countries in the APEC (≤1%).

These NTBs have been applied to products from the food industry, which are related to the agricultural industry (chapters 7–15 and 17–24 of the Harmonized Commodity Description and Coding System). Most of these measures can be found in the following chapters:

- Chapter 7: edible vegetables and certain roots, and tubers.
- Chapter 8: edible fruits; citrus rinds and melons.
- Chapter 12: seeds and oil-bearing fruits; grain, seeds, and fruits; industrial or medicinal plants; straw and forage.

Moreover, this study aims to perform a correspondence analysis of the elements that make up the *NTBs* independent variable, as this is a discrete quantitative variable that can be expressed and measured using integers. Therefore, this study classified the elements that comprise NTBs into the following categories:

- Sanitary and phytosanitary measures (SPMs).
- Barriers to trade (BTTs).
- Ordinary measures.

- Urgent measures.

4.2.1 Correlations Matrix

Table 5 shows the correlations matrix of the types of NTBs analyzed in this study. The matrix shows the correlation coefficients between the categories used in analysis.

Table 5. Correlations matrix for the variable of *non-tariff barriers*

Correlation	SPMs	BTTs	ORDINARY	URGENT
SPMs	1.000	.238	.977	-.291
BTTs	.238	1.000	.398	.079
ORDINARY	.977	.398	1.000	-.377
URGENT	-.291	.079	-.377	1.000

Source: Author's own creation based on the results of correspondence analysis.

Abbreviations: *SPMs:* sanitary and phytosanitary measures; *BTTs*: barriers to trade.

The analysis of this matrix confirms the existence of correlations between the different classifications of NTBs in the present study. Subsequently, this section will detail the elements that comprise the correlation matrix to provide the reader with a more comprehensive understanding of its content. The first column and the first row include the types of NTBs, of which this analysis seeks to determine their degree of correlation. All possible correlations among the variables generate the correlations matrix, which is symmetrical and shows a value of 1 along a diagonal line.

The relationship between SPMs and BTTs is .238, which indicates a positive correlation. The relationship between SPMs and ordinary measures is .977, which indicates a highly positive correlation. Conversely, the relationship between SPMs and urgent measures is -.291, which indicates it is negative.

The correlation between SPMs and ordinary measures confirms that most measures take some time to have an effect on trade, which is why its value is so high. Ordinary and urgent measures are mutually exclusive.

Similarly, the NTBs that are classified as urgent are typically BTTs and only rarely SPMs. A correlation matrix of the variables analyzed is presented to show the correlation coefficients among the NTB categories analyzed.

4.2.2 Rotated Component Matrix

The rotated component matrix reports this study's methods of extraction, rotation, and iterative convergence. The method of extraction was principal component analysis, whereas the method of rotation was Varimax rotation with Kaiser normalization. Subsequently, Table 6 shows the rotated component matrix for the NTB variable.

Table 6. Rotated component matrix[a] (non-tariff barriers)

	Component	
	1	2
SPMs	0.94	0.027
BTTs	0.404	0.778
ORDINARY	0.986	0.085
URGENT	-0.515	0.686

[a] The rotation converged in 3 iterations.

Source: Author's own creation based on the results of correspondence analysis.

Abbreviations: *SPMs:* sanitary and phytosanitary measures; *BTTs*: barriers to trade.

The matrix contains the correlations between the NTB variable's categories and the factors of the rotated solution. These correlations represent the gross contribution of each category to each factor. The categories that are correlated with a factor will also be correlated with other factors related to it. In this case, each category that belongs to NTBs that are correlated will tend to cluster under the same component, which will allow us to determine which categories are linked with each other and with said component.

The elucidate the effect of the rotation, Fig. 8 shows the proximity or correlation between the NTB categories. The *0* indicates the origin of the coordinates, which range from *-1.0* to *+1.0*. The numbers on the axes represents the factor loadings. The values of the rotated component matrix confirm that the category of SPMs and ordinary measures are more closely correlated, which is why they remain in component 1. Further, BTTs and urgent measures are found further apart from the other two categories, which is why they remain in component 2.

4.2.3 Dot plot (non-tariff barriers)

Fig. 9 shows a dot plot for the analysis of the coded NTB categories. The x-axis indicates countries' position regarding the implementation of SPMs, with higher scores being positioned to the right. The countries with the highest SPM scores (were Peru, the US, Mexico, Chile, and South Korea, which confirms the findings shown in the previous section, as these were the countries that implemented the most NTBs to other economies within the APEC. Conversely, the y-axis shows countries' position regarding the implementation of BTTs, with higher scores being positioned to the top of the dot plot. The countries that implemented the most BTTs were the US, Mexico, and South Korea, whereas Australia, Chile, China, Japan, and Peru did not implement BTTs.

Fig. 10 shows a dot plot for the analysis of the coded NTB categories. The x-axis indicates countries' position regarding the implementation of ordinary measures, with higher scores being positioned to the right. The dot plot indicates that most restrictions have been implemented through ordinary measures. Conversely, the y-axis shows countries' position regarding the implementation of urgent measures, with higher scores being positioned to the top of the dot plot. The countries that implemented the most urgent measures were South Korea, the US, Chile, and Japan.

Conclusions

Overall, the implementation of NTBs in the studied economies increased. Further, this study did not find evidence of a significant increase in trade between these economies, which indicates that the implementation of NTBs for the agricultural industry is, in fact, affecting trade. As such, NTBs were found to have a negative impact on the exports of the agricultural industry of Mexico and its main trade partners within the APEC. Thus, the findings corroborated the hypotheses developed in this study, accomplishing this study's objective.

The findings highlight the real impact of the implementation of restrictive measures on the volume of the agricultural industry's exports, providing evidence of international certifications serving as NTBs that do not contribute significantly to the increase in exports or to allowing emerging economies enter new markets, confirming findings from the studies analyzed in this paper.

The only export relationship that exhibited growth during the study period was the one established between Mexico and the US, where the former's imports increased in spite of the latter's implementation of NTBs. Mexico's imports increased fivefold, even though its main trade partner (the US) has imposed a greater number of NTBs to the Mexican agricultural industry. However, this is an exceptional case, as various companies have made significant efforts to maintain a similar export volume to that before the implementation of these NTBs, given that the US is the main destination for Mexican exports.

While Japan and China have implemented several NTBs, these have been applied on a general basis, not specifically for other countries within the APEC. As the present analysis only took into consideration bilateral relationships, said general NTBs were not included.

Although each company is responsible for having the necessary capacity and resources to face their competitors for the purpose of becoming export-oriented firms, many of them depend significantly on macroeconomic factors, such as the imposition of NTBs.

Therefore, in the Mexican context, both producers and providers in the agricultural industry must be made aware of the current regulations in the US (as it is Mexico's main trade partner), if they wish to enter the export market. All food products that are exported to the US must meet the requirements and certifications issued by the FDA, which require a system of food safety supervision, the evaluation and approval of vendors, and the labeling of products, among other requirements (FDA 2016; IDEA Food Safety Innovation 2014).

In Mexico, various government institutions, such as ProMéxico (2015), indicate that companies trying to enter the export market should increase their competitiveness by acquiring certifications and meeting international standards. However, as shown by the present study, APEC countries have not exhibited a significant increase in exports on par with the increase in NTBs on the agricultural industry. The World Bank (2018) has stated that one of its main objectives is to promote the sustainable development of the agricultural industry, highlighting that it is necessary to rectify and avoid trade restrictions in the global agricultural market, in compliance with the directives of the Doha Development Round.

The impact of NTBs is particularly relevant in the contemporary global trade landscape. In recent years, tariffs have decreased to a historical low worldwide, as a result of various bilateral and multilateral trade agreements. However, governments have increased the implementation of NTBs (whether with or without proper justification), affecting global trade (Westreicher 2021).

Mexico's search for a new strategy for its economic integration into international markets has contributed to its development. Unfortunately, the country has lacked a consistent strategy as a result of political turmoil, the lack of proper follow-up and sufficient knowledge, without mentioning geographic factors and a decrease in commercial trade transactions. However, XXI-century regionalism posits that economic, social, institutional, environmental, and cultural factors determine regions beyond their geographic characteristics. Thus, Mexico should develop economic integration strategies that respond to its needs and goals (González et al. 2017).

It is evident that, on average, tariffs have decreased among countries in the APEC region; however, the benefits of belonging to this forum (which Mexico has been a part of since 1993) remain inconclusive. Although there was no consensus among experts regarding the APEC's real contribution, Mexico had to implement various structural reforms (both regarding its competency and its standards) that strengthened its legal and operational framework of trade before

its main trade partners. The APEC's potential benefits are vast, but they appear only to be only marginal at present. According to Huerta Nava (2013), the Mexican government is currently implementing various administrative reforms to improve its standing in global trade, fostering commercial transactions by investing in human capital and institutional development.

Declarations

Availability of data and materials

Data collection was conducted based on the following factors: the present study's literature review (presented in section 2); the consideration of dependent, independent, and control research variables; the need to obtain relevant, significant, and sufficient quantitative data that can be measured to ensure that validity and that can be analyzed using research tools to accomplish the study's objectives. This study used a longitudinal database which includes information on a group of several economies over time (2002–2018). Information regarding the creation of this database is shown in Table 4.

Indicators and sources for each variable

Variable	Period	Indicator	Source
Exports between the selected APEC economies.	2002–2018	Quantity in thousands of USD. Note: this only includes the codes of select products from the Harmonized System for the agricultural industry.	Trade Map: Trade statistics for international business development. https://www.trademap.org/Bilateral_TS
Non-tariff barriers	2002–2018	Number of non-tariff technical measures implemented (both issued and currently in place), of each of the economies studied.	World Trade Organization. Statistics of non-tariff measures. https://i-tip.wto.org/goods/default.aspx?language=en
Income	2002–2018	Per-capita GDP according to purchasing power parity. Data are expressed as international dollars for importing countries.	World Bank: Database of the International Comparison Program. https://data.worldbank.org/indicator/NY.GDP.PCAP.PP.CD

Source: Author's own creation (2020).

The most important datasets generated during this study are included in this published article, any other datasets generated are available from the corresponding author on reasonable request.

Competing interests

The authors declare that they have no competing interests

Funding

The authors would like to thank the Mexican National Council of Science and Technology (CONACYT) for funding this research.

Authors´s contributions

This research identified the non-tariff measures implemented by the economies within the Asia-Pacific Economic Cooperation region (including Mexico, Australia, Chile, China, Korea, the United States, Japan, and Peru) for the period of 2002 to 2018. This study did not find evidence of a significant increase in trade between these economies, which indicates that the implementation of non-tariff barriers for the agricultural industry is, in fact, affecting trade. All authors read and approved the final manuscript.

Acknowledgements

Not applicable

Authors´s information

Not applicable

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Figures

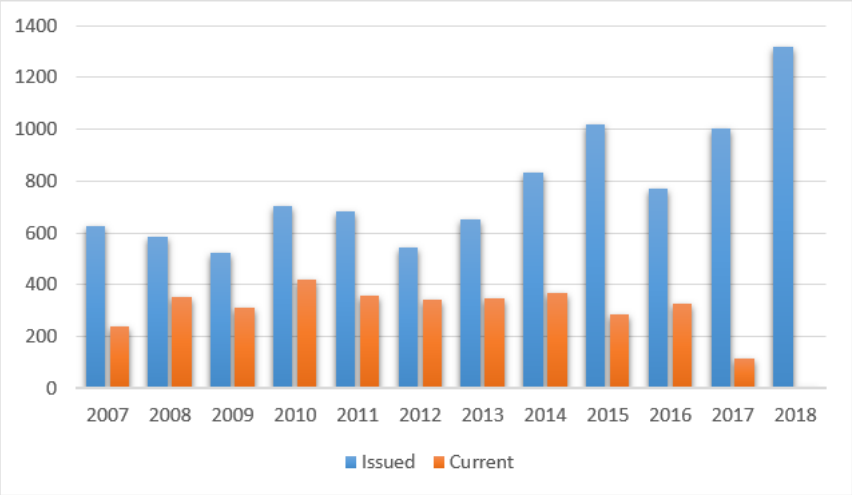

Figure 1

Sanitary and phytosanitary measures in World Trade Organization-member countries (2007–2018)

Source: Author's own creation based on data from the World Trade Organization (2019).

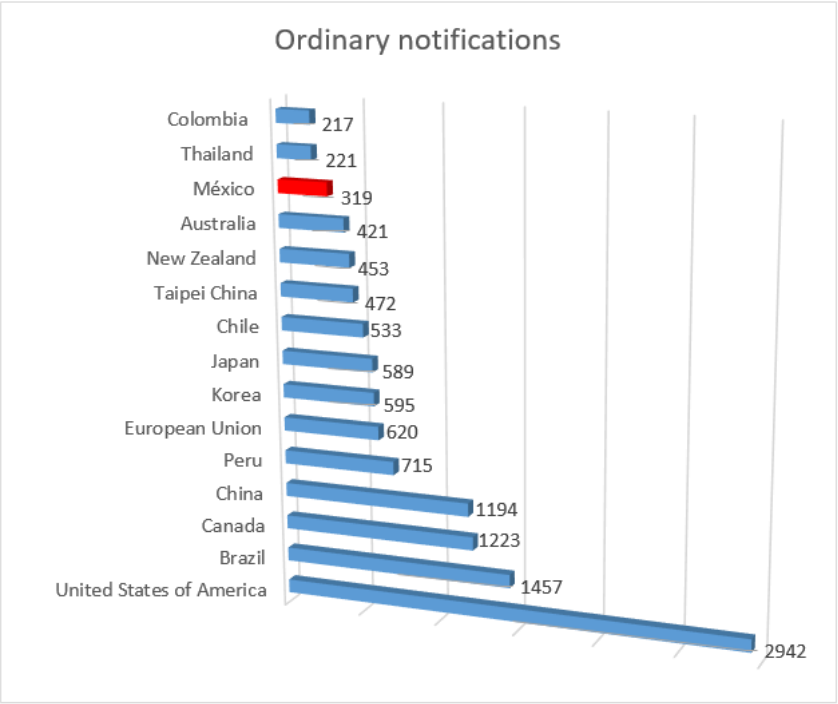

Figure 2

WTO-member countries that have reported the highest number of notifications (1995-2018).

Source: Research Center for Sustainable Rural Development and Food Sovereignty with data from the World Trade Organization (2018).

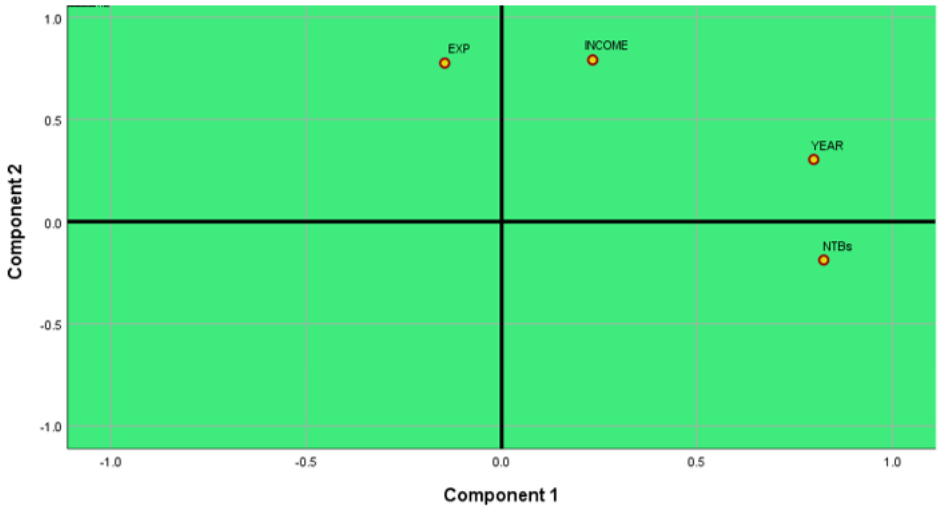

Figure 3

Components in a rotated space

Source: Author's own creation based on the analysis of rotated components.

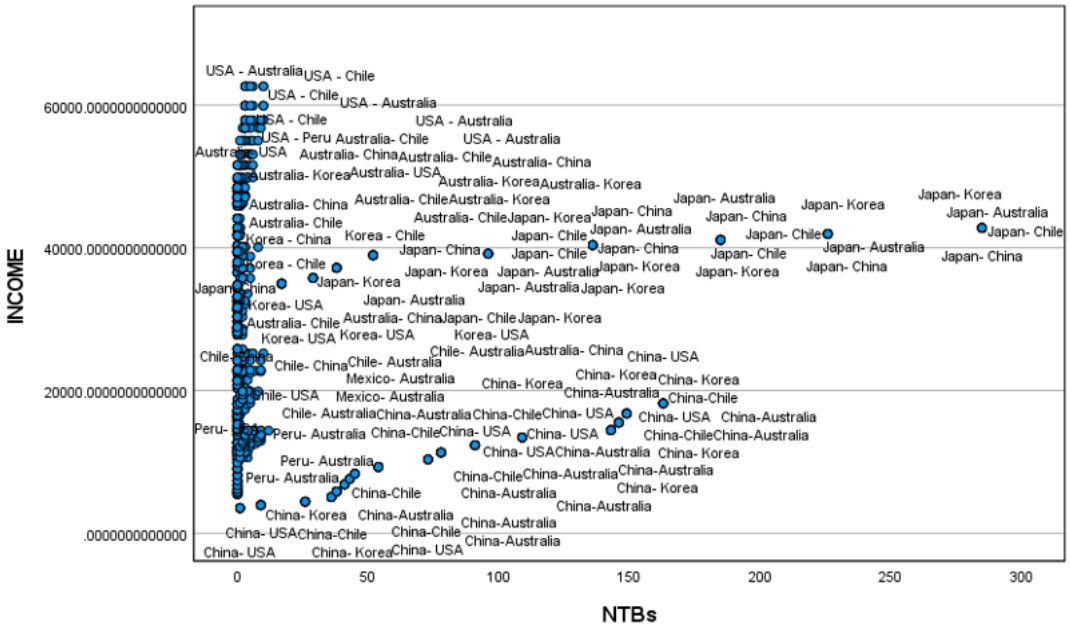

Figure 4

Non-tariff barriers and income scores of the analyzed economies

Source: Author's own creation based on the analysis of rotated components.

Abbreviations: *NTBs:* non-tariff barriers.

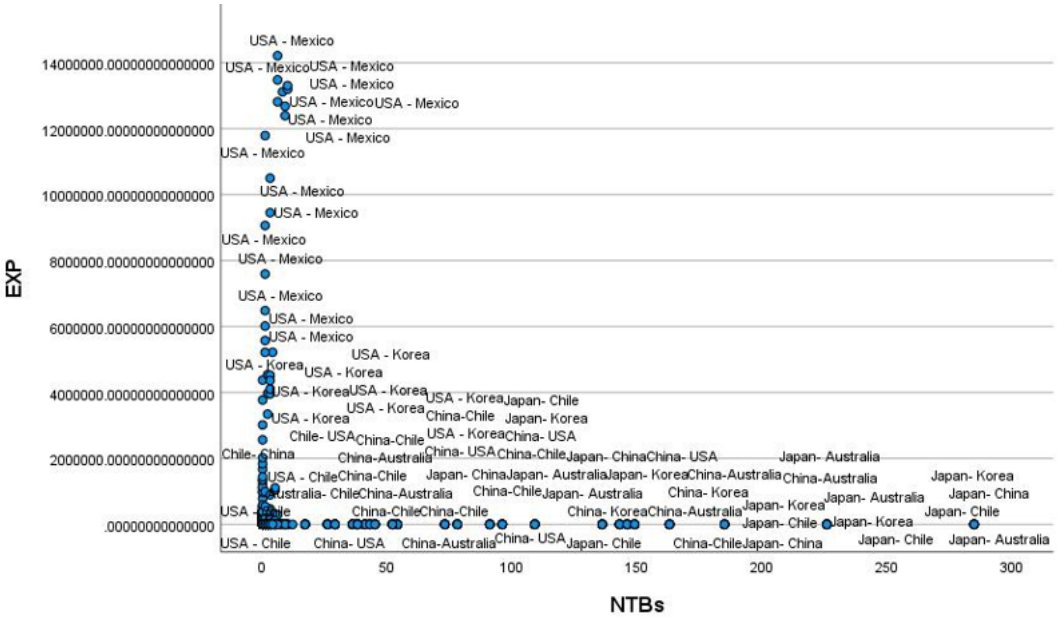

Figure 5

Non-tariff barriers and exports scores of the analyzed economies

Source: Author's own creation based on the analysis of rotated components.

Abbreviations: *EXP:* exports; *NTBs:* non-tariff barriers.

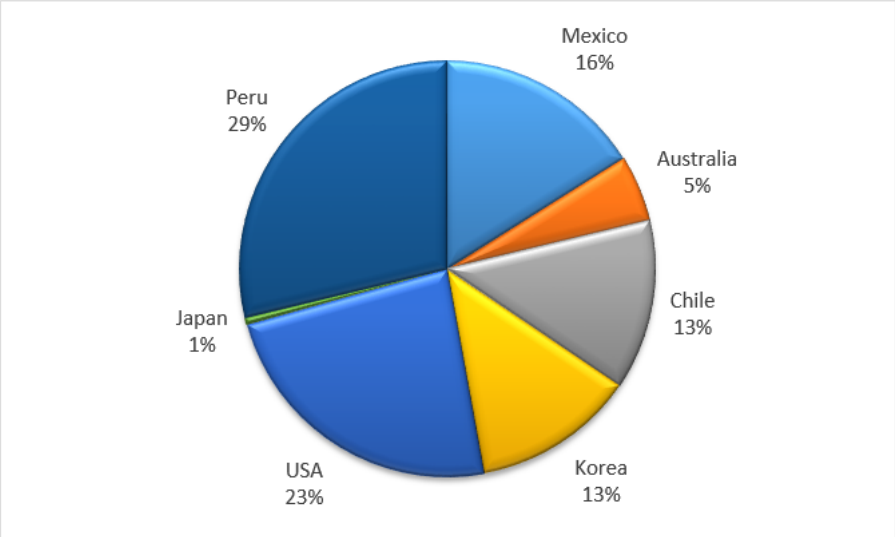

Figure 6

Non-tariff barriers implemented on the agricultural industry among countries in the APEC region (2002–2018)

Source: Author's own creation with data from the World Trade Organization (2021).

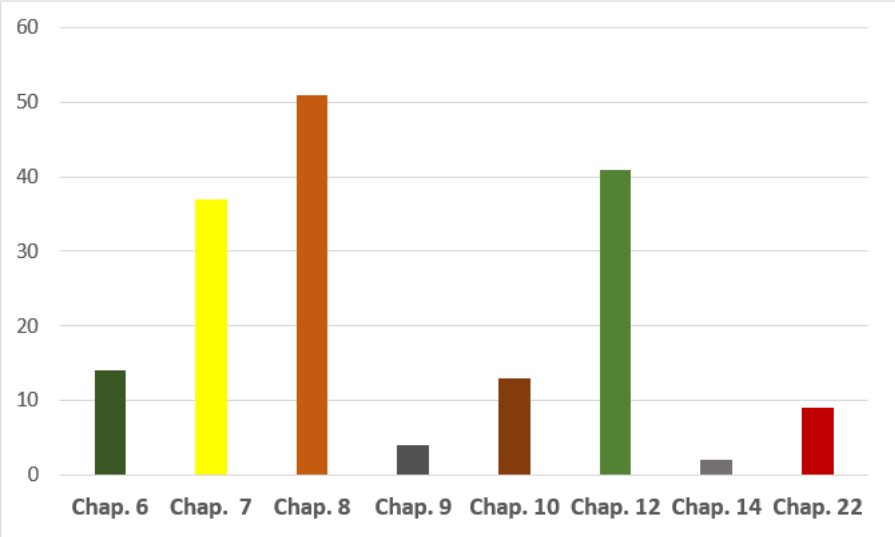

Figure 7

Classification of non-tariff barriers' on the agricultural industry according to the harmonized system (2002–2018)

Source: Author's own creation with data from the World Trade Organization (2021).

Abbreviations: *Chap*: chapter.

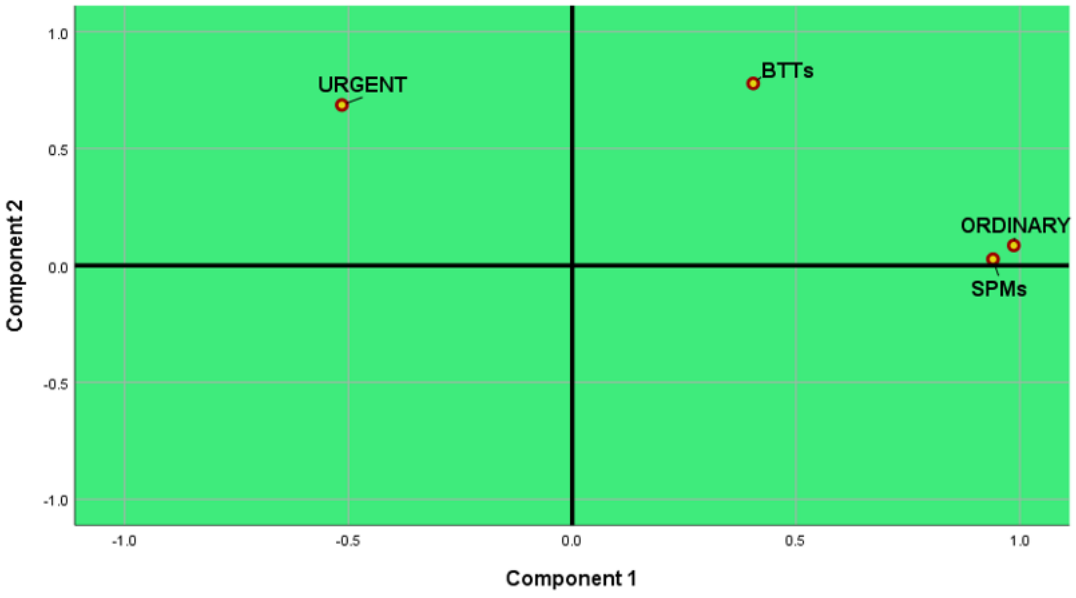

Figure 8

Rotated space components (non-tariff barriers)

Source: Author's own creation based on the analysis of the rotated components.

Abbreviations: *BTTs:* barriers to trade; *SPMs:* sanitary and phytosanitary measures.

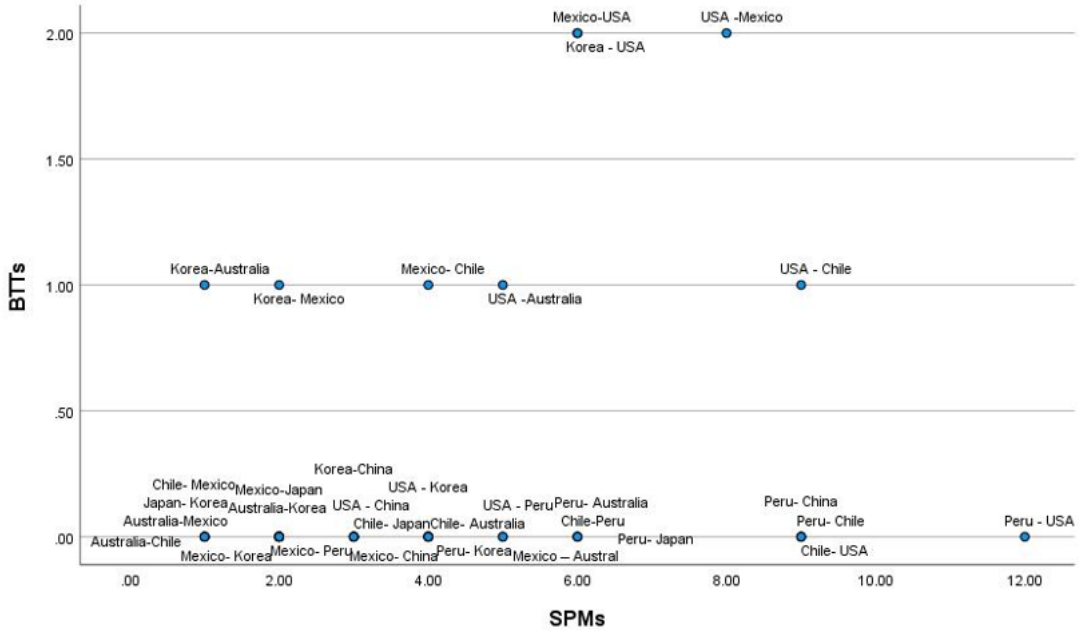

Figure 9

Dot plot of the implementation of sanitary/phytosanitary measures and barriers to trade

Source: Author's own creation based on the analysis of rotated components.

Abbreviations: *BTTs:* barriers to trade; *SPMs:* sanitary and phytosanitary measures.

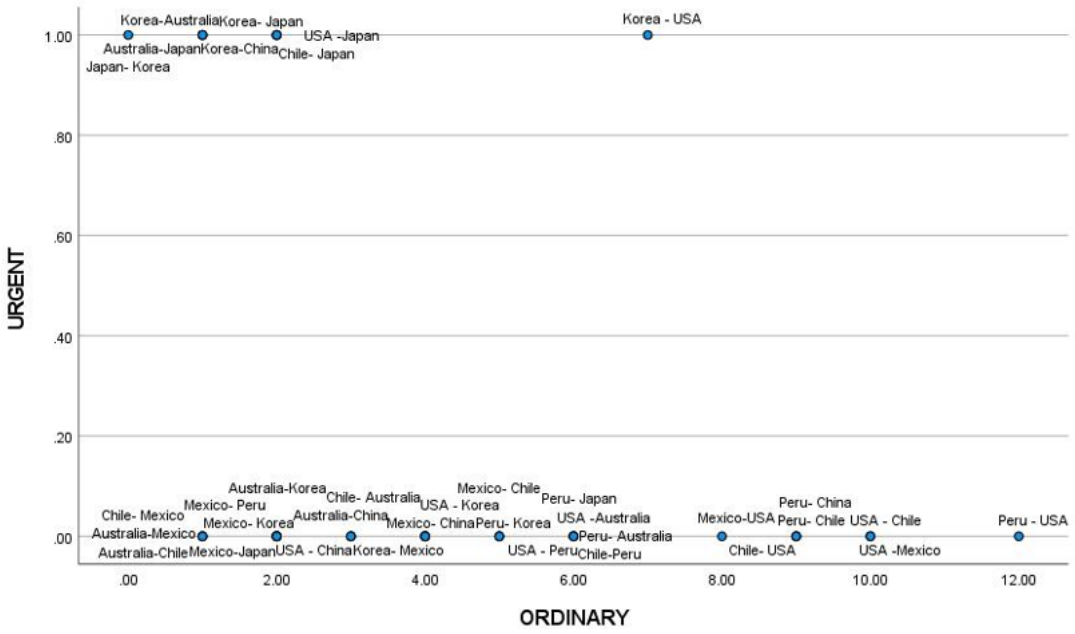

Figure 10

Dot plot of the implementation of ordinary and urgent measures

Source: Author's own creation based on the analysis of rotated components.