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Factors underlying sanitary and phytosanitary regulation for food and agricultural imports notified by WTO members

Sofía Boza  and Jazmín Muñoz

Department of Agricultural Economics, Faculty of Agricultural Sciences and Institute of International Studies, University of Chile, Santiago, Chile

ABSTRACT

The impact of sanitary and phytosanitary (SPS) measures has been extensively studied in the trade literature. However, there is very scant research on the factors underlying the World Trade Organization (WTO) members' regulatory process. The aim of this paper is to fill that gap, examining the main determinants for the development of SPS regulation considering the notifications presented by WTO members. A negative binomial regression was estimated, where the dependent variable was the number of SPS measures notified during the period 1995–2012 by WTO members, while the explanatory variables were related to each country: (1) agricultural production value; (2) agricultural imports weight; (3) health concerns; (4) agricultural import tariffs; and (5) scientific and legal capacities. The results provide evidence that legal and scientific capacities are major factors in the number of notifications presented by WTO members. On the other hand, those countries with a higher relative weight of the agricultural sector in the economy or of agricultural products in their imports have notified fewer SPS measures. This leads to the conclusion that it is necessary to reinforce actions that strengthen institutional and technical capacities for further convergence.

KEYWORDS World Trade Organization; sanitary and phytosanitary measures; transparency; regulation; food and agricultural trade

JEL CLASSIFICATIONS F13, Q17, Q18

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1. Introduction

Sanitary and phytosanitary (SPS) measures are a type of technical non-tariff measure with the aim of protecting human, animal and plant health, and regulating food safety in agricultural trade. They are subject to multilateral regulation through the Agreement on the application of sanitary and phytosanitary measures (SPS Agreement) as a result of the World Trade Organization (WTO) Uruguay Round. The objective of the SPS Agreement is to ensure that countries can adopt and enforce SPS measures that are not more trade restrictive than required.

CONTACT Sofía Boza  sofiaboza@u.uchile.cl

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The SPS Agreement establishes that countries shall justify their measures on scientific principles and maintain them with sufficient scientific evidence (Article 2.2.). For this, SPS measures must be based on a risk assessment appropriate to the circumstances (Article 5). Members are not required to carry out risk analysis themselves for every SPS measure. They can use those from other members, from supranational organizations or from independent research bodies for instance. Additionally, to stimulate legal homogeneity and compatibility, the SPS Agreement encourages countries to incorporate (if possible) international SPS standards, guidelines or recommendations (Article 3.1.), and to recognize the measures of other members as equal (Article 4.1.). In this sense, the Agreement recognizes as an 'international standard, guideline or recommendation' those established for food safety by the Codex Alimentarius Commission, for animal health and zoonosis under the International Office of Epizootics, and for plant health under the Secretariat of the International Plant Protection Convention (Annex A, Par. 3); the foregoing are institutions open to the participation of every WTO member.

Another key principle within the SPS Agreement is transparency, according to which countries undertake to: (1) publicly announce their intention to introduce a SPS regulation; (2) notify the contents of the SPS regulation draft through the WTO Secretariat; (3) upon request of another member, provide further details about the regulation; (4) allow time for comments from other members, discuss them if required and consider this process in the final proposal; and (5) publish the final version of the SPS regulation. The obligations mentioned apply when there is not an international standard, guideline or recommendation or the content of the SPS measure is not substantially the same, and if the measure may possibly have an impact on the trade of other WTO members (Annex B, Par. 5).

Considering the latter, despite the regulatory framework imposed by the SPS Agreement, it is probable that SPS measures indeed have an impact on import/export flows in food markets. In fact, recent research has been focused on assessing the implications of SPS measures for international trade using estimations obtained predominantly by gravity equation models.

A significant number of these investigations have concluded that SPS regulation has a negative impact on the international trade of food products (Achterbosch et al. 2009; Vigani, Raimondi, and Olper 2009; Disdier and Fontagné 2010; Hoekman and Nicita 2011; Beghin and Melatos 2012; Wei, Huang, and Yang 2012a, 2012b; Wieck, Schluter, and Britz 2012). In contrast, a substantial body of research supports the uncertain effects of SPS measures. That uncertainty could be based on the type of measure (Schlueter, Wieck, and Heckelei 2009; Crivelli and Gröschl 2012; Mangelsdorf, Portugal-Perez, and Wilson 2012; Almeida, Gomes, and Silva 2014; Melo et al. 2014), the harmonization level between trading partners (Drogué and De María 2012; Munasib and Roy 2013; Murina and Nicita 2017), the producer's characteristics (Song and Chen 2010; Ferro, Otsuki, and Wilson 2015; Grant, Peterson, and Ramniceanu 2015) or the exporting country's economic level (Disdier, Fontagne, and Mimouni 2008; Wilson and Bray 2010; Penello 2014). Also, although to a lesser extent, some authors have analyzed the effects of SPS measures on social welfare using partial equilibrium models (Peterson and Orden 2008; Disdier and Marette 2010; Xiong and Beghin 2014).

Therefore, it is evident that the impact of SPS measures has been extensively studied in the trade literature. However, there is scant research on the determinants of the different countries' regulatory activity on SPS. On this topic, Aisbett and Pearson (2012) showed, after applying an econometric model on SPS notifications, that their increase was related

to the negotiation of lower tariff levels. Moreover, environment-associated variables, such as regulation stringency or governance level, were also evidenced by the authors as being significant. These results differ from those obtained by Besedina and Coupe (2015) in the case of Russia, where the most significant factor for SPS notifications was shown to be political pressure from stakeholders. Meanwhile, after reviewing the evolution of SPS notifications, Boza and Fernandez (2016) proposed the existence of a link with a country's level of development, as high and upper-middle income countries have been much more active than others.

The gap between developed and developing countries in terms of the proper implementation of the SPS Agreement and the compliance with importing members' SPS regulations is implicitly recognized in the Agreement itself. It establishes the obligation of members to facilitate technical assistance to the other members, especially developing countries that request it, for issues related to: (1) compliance with measures; (2) generating national institutions in SPS; and (3) participation in international forums (Article 9). Similarly, the Agreement states that the SPS Committee may even grant, in cases where it is found appropriate, exceptions from obligations for developing members, although always for a limited period of time and upon the request of the country concerned (Article 10.3). In the same sense, least developed and developing members were granted an initial delay of five and two years, respectively, in the application of the Agreement (Article 14).

In view of the results presented, it seems that there are some variables that underlie countries' SPS regulation. However, the evidence is still very scarce. The aim of this paper is to fill that gap, examining what the main determinants are for the development of SPS regulation by considering the notifications presented by WTO members. The success of this research will contribute significantly to the existing literature on SPS measures, approaching the topic from a practically unexplored perspective.

2. Methodology

2.1. Data description

This study uses panel data for the period 1995–2012, considering all countries that have joined the WTO since its creation or that have joined it during the years studied. In the second case, prior to accession, information was not registered in the database. The European Union was considered a unique identity, imputing to common notifications those presented individually by its members.

The information on SPS notifications was collected from the WTO SPS information management system database (SPS-IMS). This facility was chosen due to the fact that it is the most comprehensive global database on SPS notifications available today. It contains an updated inventory with open access to all SPS notifications reported to the WTO by its members, identified by the member(s) imposing the measure and (when available) the product(s) affected. For each notification, a link to the official relevant documents is also provided. In this sense, it is pertinent to clarify that the scope of the different notifications considered in this study is very heterogeneous. For instance, some SPS notifications affect a wide group of products while others are directed to a specific one. On the other hand, the notification practices might differ among WTO members regarding the level of decision they inform. Nevertheless, the SPS Agreement does not oblige members to



Figure 1. Level of participation in SPS notifications by country (1995–2012).
Source: Own preparation based on WTO SPS-IMS.

notify every administrative resolution they make related to a measure; some countries are more exhaustive than others in this sense.

While the aspects mentioned might call into question the use of an inventory approach instead of the calculation of some kind of stringency index, the second option was discarded because of the large number of notifications considered in this research and the lack of some essential information that would have made it viable. Additionally, as already mentioned, the objective of our research is to identify the determinants of SPS regulatory development, not the specific characteristics of that regulation. In the same sense, another limitation of using the number of notifications as a way to address SPS regulation is the possible non-fulfillment of transparency obligations. As Wolfe (2013) stated, for WTO members, ‘notification is a legal obligation, but compliance is voluntary in practice, with no tangible or coercive penalty’. In the specific case of SPS regulation, it is likely that countries’ resource constraints might also limit their notification activity. In fact, in response to a questionnaire on transparency on SPS measures submitted in 2015 by the WTO Secretariat, 68 members answered that they would need technical assistance in this regard, among which 97 percent were developing and least developed countries.

An initial analysis of the data shows that WTO members notified 14848 SPS measures to the WTO Secretariat from 1995 to 2012 (Figure 1). Of these, 3489 were notified by the United States, which is the most active member in this regard. Other WTO members with high participation in SPS notifications were Canada (1160 notifications), Brazil (1132), the European Union (949), China (720), New Zealand (618), Chile (516), South Korea (509), Peru (481), Chinese Taipei (452), Colombia (405), Australia (384), Japan (322), the Philippines (310), Mexico (304) and Thailand (269). Particularly striking is the case of China, because despite becoming a WTO member in December 2001, the country is ranked fifth in the world in terms of the number of SPS notifications. The participation of Latin America is also interesting. The region, which is a net exporter of food products, was very active in its number of SPS notifications in the studied period. The most prominent case is that of Brazil, which is third worldwide only after the USA and Canada.

Considering the income level of the country informing for each SPS notification, a clear prevalence of high-income WTO members is evidenced. As shown in Figure 2, they

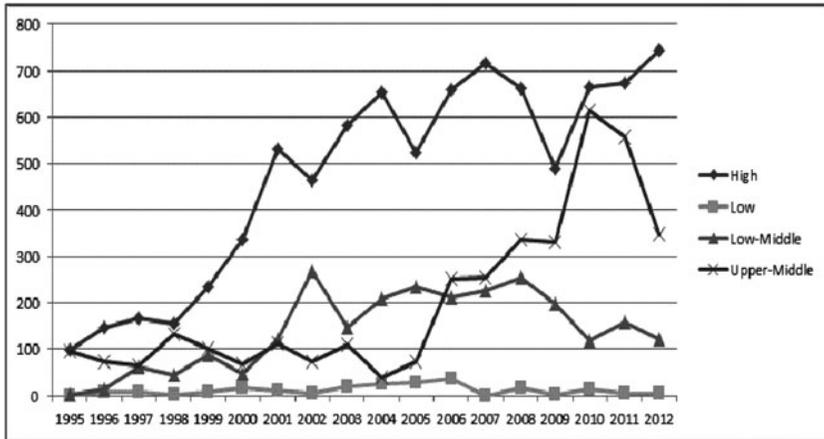


Figure 2. Number of SPS notifications by imposing member income level.
 Source: WTO SPS-IMS, World Bank and author's calculations.

presented 8492 notifications between 1995 and 2012 – i.e. 57.22% of the SPS measures informed in the studied period. Meanwhile, upper-middle income countries constituted 24.45% of the participation, with 3631 measures informed, and lower-middle income countries 16.95% of the participation, which corresponds to 2517 measures. Finally, low-income countries presented just 204 notifications in the period studied.

For the definition of potential SPS notifications determinants, first the analogous studies already mentioned were considered (Aisbett and Pearson 2012; Ghodsi 2014; Besedina and Coupe 2015). However, as such similar literature is still limited, research on the factors that determine the participation of countries in WTO dispute settlement was also reviewed to work from an additional angle. Some of these factors (which could be more comparable) are: (1) economic power (Sattler and Bernauer 2011); (2) legal capacity (Busch, Reinhardt, and Shaffer 2008; Conti 2010); (3) diversity and value of exports (Horn, Mavroidis, and Nordström 1999; Holmes, Rollo, and Young 2003); and (4) financial, human and institutional resources (Guzmán and Simmons 2005; Bohl 2009). In addition to the aforementioned research, a study that was given particular consideration was Götz, Heckeley, and Rudloff (2010), as its focus was dispute initiation related specifically to agro-food products. Some of these studies evidenced a significant gap between countries in accordance with their income level. In fact, after analyzing the main trends in WTO disputes from 1995 to 2015, Leitner and Leister (2016) showed that high and middle-income countries have been by far the most frequent complaining and responding parties (79% and 76% of cases, respectively). The same applies to disputes that invoke the SPS Agreement (Boza and Fernández 2015, 2016).

Given the above, it was decided that the data-set used contained variables under the following categories – (1) agricultural production value; (2) agricultural imports weight; (3) health concerns; (4) agricultural tariffs; and (5) scientific and legal capacities – as well as a categorical variable identifying the region in which the country belongs. Agricultural production was measured in accordance with its contribution to the national economy, as the value added by the agricultural sector as a percentage of the gross domestic product (GDP). The data were extracted from the World Bank's World Development Indicators database. Agricultural imports were included using their percentage

Table 1. Summary statistics.

Variable	Continuous variables		Dummy variables (% = 1)
	Mean	S.D.	
SPS measures	6.67325	25.52423	
Region			
Africa			32.94
Asia			18.29
America			27.24
Europe			11.78
Middle East			5.48
Oceania			4.27
Agricultural production	15.22814	13.62339	
Agricultural imports	14.02036	5.77807	
R&D expenditure	10.26154	33.02219	
Agricultural tariffs	12.14225	10.03235	
Legal capacities	26.03169	9.79688	
Health concern	313.5668	523.0044	

Source: Compiled by authors

share in total imports, obtained from the World Bank WITS facility. Scientific capacities were approached via the gross domestic expenditure on research and development taken from the UNESCO database on science, technology and innovation. The tariff level was measured by the weighted average tariff for agricultural imports taken from the WITS database. Meanwhile, the level of a country's health concerns was expressed by public health expenditure, obtained from the IFPRI Statistics of Public Expenditure for Economic Development. As for the region, the United Nations classification was used, which considers six categories: Africa, Asia, America, Europe, the Middle East and Oceania. **Table 1** presents the summary statistics for each variable mentioned.

Finally, in the specific case of countries' legal capacity, following Francois, Horn, and Kaunitz (2008) on WTO member participation in its Dispute Settlement, we used a composed index, whose expression is:

$$\text{LEGAL}_{it} = \ln \text{GDP}_{it} \left(\text{RQI}_{it} + \text{abs} \left(\min_{\forall k} \text{RQI}_{kt} \right) \right)$$

where LEGAL_{it} is the value of the calculated index for country i in year t ; $\ln \text{GDP}_{it}$ is the logarithm of the GDP of country i in year t ; RQI_{it} is the Regulatory Quality Index (RQI) for country i in year t ; and $(\min_{\forall k} \text{RQI}_{kt})$ is the minimum value of the RQI for any country k in year t .

It is also important to clarify that, as for notifications, regarding the other variables at our data-set, the European Union was considered as a unique identity. For the variables for which no EU information was available, we used an average of the member data.

2.2. Methodological approach and empirical model

The number of SPS measures notified yearly by each WTO member to the Secretariat is a count variable, as it takes a limited number of integer non-negative values (zero included). As noted by Wooldridge (2002), the use of linear models in this case is not recommended, as it can lead to negative predicted values. A traditional alternative to explain count variables is the use of a Poisson regression, whose primary equation is

(Greene 2002):

$$\text{Prob} (Y_i = y_i | \mathbf{x}_i) = \frac{e^{-\lambda_i} \lambda_i^{y_i}}{y_i!}, y_i = 0, 1, 2, \dots$$

where Y_i is the dependent variable, \mathbf{x}_i is a vector of explanatory variables, and λ_i is a parameter related to \mathbf{x}_i . However, the use of a Poisson model is limited by its assumption of equi-dispersion of the dependent variable ($E(y_i | \mathbf{x}_i) = \text{Var}(y_i | \mathbf{x}_i) = \lambda_i$). In this case, as the variance of our dependent variable is almost ten times its mean, we cannot assume equi-dispersion. To further prove whether the Poisson regression is or is not an adequate approach in this case, we tested its goodness-of-fit after estimate. The results obtained confirm that its use may not be the best possible decision *a priori*.

Considering the limitations presented, we decided to propose a negative binomial regression model, whose use has been extended in cases of count variables and over-dispersion, since it specifies the variance as a function not just of the mean, but also of a particular scattering parameter (Cameron and Trivedi 1986). According to Greene (2002), for mathematical convenience, the parameter u_i assumes a gamma distribution ($g(u_i) = \frac{\theta^\theta}{\Gamma(\theta)} e^{-\theta u_i} u_i^{\theta-1}$), so the expression for the density of y_i would be:

$$f(y_i | \mathbf{x}_i) = \frac{\Gamma(\theta + y_i)}{\Gamma(y_i + 1)\Gamma(\theta)} r_i^{y_i} (1 - r_i)^\theta, \text{ where } r_i = \frac{\lambda_i}{\lambda_i + \theta'}$$

Therefore, the empirical model estimated in this research is a negative binomial regression, generally specified as:

$$\begin{aligned} \text{SPS}_{it} = & \exp(\beta_0 + \beta_1 \text{AGSEC}_{it} + \beta_2 \text{AGIMP}_{it} + \beta_3 \text{AGTAR}_{it} + \beta_4 \text{RDEXP}_{it} \\ & + \beta_5 \text{LEGAL}_{it} + \beta_6 \text{HEALTH}_{it} + \beta_7 \text{AFRICA}_i + \beta_8 \text{ASIA}_i + \beta_9 \text{AMERICA}_i \\ & + \beta_{10} \text{EUROPE}_i + \beta_{11} \text{MIDDLEEAST}_i + \beta_{12} \text{OCEANIA}_i + \delta_t + \varepsilon_{it}) \end{aligned}$$

where $\beta_1 \dots \beta_{12}$ are the parameters to be estimated, δ_t is a vector for year dummies, and ε_{it} is the error term of the model. The independent variables are defined in Table 2.

Table 2. Definition of the variables.

Variable name	Description
SPS_{it}	Number of sanitary and phytosanitary notifications informed for country i in year t to the WTO Secretariat
AGSEC_{it}	Value added (% of GDP) by agriculture sector for country i in year t
AGIMP_{it}	Percentage of agricultural imports in total imports value for country i in year t
RDEXP_{it}	Gross domestic expenditure on research and development in millions in 2005 PPP US\$ for country i in year t
AGTAR_{it}	Weighted average tariff for agricultural products for country i in year t
LEGAL_{it}	Index composed by Regulatory Quality Index (RQI) and the logarithm of GDP in 2005 PPP US\$ for country i in year t
HEALTH_{it}	Public health expenditure <i>per capita</i> in 2005 PPP US\$ for country i in year t
AFRICA_i	Dummy variable with a value of 1 when country i is in Africa; 0 otherwise
ASIA_i	Dummy variable with a value of 1 when country i is in Asia; 0 otherwise
AMERICA_i	Dummy variable with a value of 1 when country i is in America; 0 otherwise
EUROPE_i	Dummy variable with a value of 1 when country i is in Europe; 0 otherwise
MIDDLEEAST_i	Dummy variable with a value of 1 when country i is in the Middle East; 0 otherwise
OCEANIA_i	Dummy variable with a value of 1 when country i is in Oceania; 0 otherwise

3. Results

The estimation results of the specified model are detailed in Table 3. In the second column, the estimated coefficients are presented, seven of which are statistically significant, while the third column contains the related standard deviation.

Regarding the specific results, the variable AGSEC is statistically significant and negative in relation to the number of SPS notifications ($p < 0.01$). This means that in those countries (and time periods) where the agricultural sector is responsible for a relatively higher contribution to the GDP, the number of SPS measures notified is lower. Although this seems to be a counterintuitive outcome, it suggests *a priori* one possible cause: the richest countries within the WTO members, where the relative weight of agricultural production in their economies tends to be lower, have greater resources and capacities for generating and notifying SPS measures.

Meanwhile, the model evidences that the comparative relevance of agricultural imports (AGIMP) has a significant and negative relationship with the number of SPS notifications ($p < 0.01$). Therefore, in the cases where the composition of the relative weight of agriculture on imports is higher, the number of SPS measures notified is smaller. In some countries that are net importers of food products, this may be based on the following reasons: (1) those countries need the foreign supply of food, so they are not in a position to impose many requirements, (2) food imports do not compete with a scarce domestic production and (3) the phytosanitary conditions in the importing country make worry about the spread of plant pests unnecessary.

The model estimation also shows a non-significant relationship between tariff levels for agricultural products (AGTAR) and the number of SPS notifications. This result discards, at least in aggregate terms, any kind of deviation of trade protectionism from tariff to non-tariff instruments.

Conversely, higher scientific resources (RDEXP) are significant and positively related to the number of notifications presented by WTO members ($p < 0.1$). This result

Table 3. Negative binomial regression: estimation results.

Variables	Parameter	SD
Constant	0.00383	0.52475
AGSEC _{it}	-0.05378***	0.01139
AGIMP _{it}	-0.03787***	0.01252
RDEXP _{it}	0.0016*	0.00094
AGTAR _{it}	0.00153	0.00378
LEGAL _{it}	0.04045***	0.00826
HEALTH _{it}	-0.00003	0.00013
AFRICA _i	-0.90368**	0.38161
ASIA _i	0.3347	0.34039
AMERICA _i	-0.34679	0.32532
EUROPE _i	-0.67874**	0.32207
MIDDLEEAST _i	-2.12341***	0.36591
Log-likelihood	-3199.7619	
Wald chi ²	526.55	
Observations	2225	

Note: * Significant at 10%, ** Significant at 5%, *** Significant at 1%.

Dependent variable: Number of notifications presented in year t by country i .

The variable OCEANIA_i was omitted due to the presence of collinearity.

Source: Compiled by authors.

coincides with what would be expected considering the provisions in the WTO SPS Agreement. As already mentioned, SPS measures must be justified by a risk assessment properly adapted for each case (Article 5.1–5.2). One of the main elements that must be considered in this risk assessment is any existing scientific evidence, whose preparation is expected to be facilitated by a higher availability of resources for research and development, resulting in specialized laboratories, equipment, qualified human resources and technology. In cases where members base SPS notifications in external risk analysis, the need of resources is much lower; however, the availability of outside appropriate scientific evidence limits it.

On the other hand, the model estimation evidences that not only are scientific resources relevant for generating SPS notifications, but also legal capacities, since the variable *LEGAL* is significant and positive ($p < 0.01$). This relationship seems logical, since SPS measures include laws, decrees, regulations, requirements and procedures that must comply with the multilateral principles under the WTO SPS Agreement. Also, the notification process is in the charge of an institution designated as a national authority whose proper functioning is necessary for notifications to be made in an opportune manner.

Contrary to what might be expected, the variable *HEALTH* is not significant, meaning that countries more concerned about safety issues (measured in this case by public health expenditure) do not necessarily notify a higher number of SPS measures.

Finally, the region is significant and negatively related to the number of SPS measures notified in three cases: Africa ($p < 0.05$), Europe ($p < 0.05$) and the Middle East ($p < 0.01$). The first is not surprising, if we consider that Africa is the poorest region in the world; it has already been mentioned that the previous literature indicates a direct link between income levels and SPS notifications. In this sense, African WTO members pointed out that even during the Uruguay Round, their participation lacked full understanding due to low levels of trade technical skills (Apecu 2013). Meanwhile, for most of the Middle Eastern countries, the domestic production of agricultural products is relatively scarce, and the risk of the spread of pests is minimal given their phytosanitary conditions; so possibly, the interest in developing national food safety institutional frameworks is low, which may limit their notification process. The results for Europe seem to be counterintuitive. However, they may have been influenced by the consideration of the EU as a unique identity, while Eastern European countries (less active in SPS notifications) were observed separately up to their accession. Also, the EU usually notifies a package of specific requirements as one SPS measure (e.g. maximum residue levels (MRLs) for different pesticides), while other members, such as the USA, generally do the opposite.

4. Conclusions

Higher demand in terms of the quality and safety of imported foods is a trend that has settled in international markets through the proliferation of technical requirements. Research conducted in this regard has focused on identifying the impact that such requirements have on the value of trade flows. However, there is little existing evidence regarding the factors that affect a country's SPS regulatory activity. This article aimed to address that issue, identifying the main determinants of the development of SPS regulation by WTO members, considering the number of notifications informed.

The results obtained confirm that legal and scientific resources and capabilities are the major determinants of the number of notifications presented by WTO countries. These conclusions were relatively expected, as SPS measures notified should be based on scientific evidence and adjusted to the WTO regulatory framework, which requires appropriate competences. On the other hand, the results show that those countries with a higher relative weight of the agricultural sector in the economy or of agricultural products in their imports have notified fewer SPS measures. Additionally, the tariff level for agricultural products appears not to be related to the number of SPS measures notified.

It is important to clarify that our results do not unconditionally discard the presence of protectionist intent behind SPS measures notified to the WTO. However, we can affirm that other variables, such as legal and scientific capabilities, prevail, since it is highly unlikely that a regulation and its notification are able to be generated without them. It is expected that this will accentuate the gaps between countries according to their development level. In fact, the results obtained show that for instance African countries are significantly less active in the notification of SPS measures.

From the point of view of public action, we suggest, given the importance of technical skills in developing, adopting and notifying SPS regulation, that the extension of the intensity of assistance is an appropriate measure by which to generate higher equity between WTO members. However, it is questionable whether merely strengthening the existing cooperation initiatives (for example, the Standards and Trade Development Facility, STDF) is enough to reduce the gap with high-income countries. However, we propose that actions should be aimed in that direction, as a low ability to develop and adopt the SPS measures might additionally be associated with an underdeveloped food control system, which will negatively impact not only access to international markets, but also the protection of national food safety and public health.

Disclosure statement

No potential conflict of interest was reported by the authors.

ORCID

Sofía Boza  <http://orcid.org/0000-0001-5824-0515>

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