Assessing the impact of sanitary, phytosanitary and technical requirements on food and agricultural trade: what does current research tell us?[1]

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ABSTRACT

In last decades, international trade has been characterized worldwide by a significant opening up, mainly based on the reduction of tariffs. However, simultaneously there has been an increase in non tariff measures (NTMs) notified to the WTO. Within this category they are technical barriers to trade (TBT) and sanitary and phytosanitary measures (SPS). The increasing importance of these requirements highlights the need to attend to the effects that SPS/TBT measures have on the flow of imports and exports. In order to address this matter, a literature review was made to consider the latest research in the field specifically in the case of food and agricultural sector. Finally, as an overall result the existence of a "dual" effect was shown regarding the relationship between SPS/TBT and food and agricultural international trade which depends on the trade-off between implementation costs and the benefits of a better positioning in an gradually more demanding market.

Introduction

Today in agricultural markets there are two simultaneous tendencies: the increase of consumption and concern about the origin and composition of products. However, it is obvious that some of the attributes which influence the purchase decision of customers worried about food safety or by the environmental sustainability of production processes cannot be directly verified by the consumers themselves[2]. In this sense, the World Trade Organization (2012) states that the presence of information asymmetries is one of the reasons for the imposition of non tariff measures (NTMs), more specifically in the form of sanitary, phytosanitary and technical requirements. However, WTO warns that the protectionism and manipulation of exchange terms (derived from political or private interests) also motivate certain NTMs. The effects on welfare of these measures would mostly depend on the extent to which they effectively address market failures.

More precisely, nowadays NTMs have an important role in trade regulation. In this sense, Santana & Jackson (2012) confirmed the increasing significance of NTMs in WTO disputes over goods, particularly for agricultural products. Domestic measures on sanitary, phytosanitary and technical requirements were evidenced as one of the largest contingency issues in these disputes. As well as information asymmetries, the standards mentioned are able to address negative externalities and also the lack of provision of public goods by private supply (Hobbs, 2010; Van Tongeren, Beghin & Marette, 2009).

However, when any sanitary, phytosanitary or technical requirement on a product causes "more than necessary" trade restrictions, not sufficiently justified by the effects of not imposing the standard, these measures should be considered a trade barrier. In this context, in order to avert these limitations to international trade, as well as to harmonize requirements adopted and avoid discrimination between products based on origin, during the Uruguay Round countries adopted the two international agreements on Sanitary and Phytosanitary Measures (SPS)[3] and Technical Barriers to Trade (TBT)[4] existing since 1995.

Despite this important progress, the prevention of trade protectionism is hindered by inner difficulties when assessing the rationality of SPS/TBT enforced by countries.

Furthermore, today the role of public and private sectors in standards implementation are blurred. In recent years there has been a significant increase in the amount of private

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[2] These unobservable attributes of products are what Darby & Karni (1973) identified as "credence qualities", in contrast to "search" and "experience" qualities previously defined by Nelson (1970).

[3] "Members shall ensure that any sanitary or phytosanitary measure is applied only to the extent necessary to protect human, animal or plant life or health, is based on scientific principles and is not maintained without sufficient scientific evidence" (SPS Agreement Art. 2.2).

[4] "Members shall ensure that technical regulations are not prepared, adopted or applied with a view to or with the effect of creating unnecessary obstacles to international trade. For this purpose, technical regulations shall not be more trade-restrictive than necessary to fulfill a legitimate objective, taking account of the risks non fulfillment would create" (TBT Agreement Art. 2.2).

certification schemes on agricultural products. Some of these schemes have already been consolidated, such as GlobalGAP[5], FSC[6] or Fairtrade International[7]; while other certifications are still emerging, e.g. CarboNZero and CEMARS[8]. In any case, these standard schemes are based on the work of private certification bodies, which accomplish the mission of guaranteeing that labeled products fulfill the appropriate requirements. The progressively increased weight that some major retailers are giving to private certifications on their imports is so much so that it has motivated the question of whether these private standards can still be considered as "voluntary" from a market perspective (Salles de Almeida, 2008). However, in spite of its increasing importance the treatment that the WTO will give to private standard schemes is still very imprecise (Wouters & Geraets, 2012).

Despite these complexities, in a society in which many consumers are becoming increasingly demanding about the attributes of products they purchase, and where public health crises relating to livestock and crops (BSE, H5N1, H1N1, E-coli…) have repeatedly occurred, sanitary and phytosanitary requirements for food products must be made a major issue in political agenda. Specifically in developing countries, where agricultural exports are very significant for their economies, the challenge is not only pursuing food security for its population (understood as the satisfaction of nutritional needs guaranteeing food safety), but also supporting producers (especially those with a lower technological level) in order to meet the requirements imposed by the major markets. Nevertheless, this challenge can also be seen as an occasion to improve production systems. In this sense, FAO, CEPAL & IICA (2012) affirm that product diversification according to new market requirements is one of the most important opportunities in the case of Latin America's agricultural sector[9].

Considering all of the above, evaluating the actual effects that a specific SPS/TBT (or a pool of them) has on agricultural international trade confers a constructive background for public strategy. Accordingly, as stated in the UNCTAD (2012) "ultimately trade analysts and policymakers are mainly interested in better understanding the effects that NTMs have in particular on international trade and more in general on welfare" (p.37).

In actual fact, recent specialized economic literature has paid increasing attention to SPS/TBT impact assessment. In this context, the main aim of the present paper is to address this topic by reviewing the results of the current econometric research in the field.

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[5] http://www.globalgap.org/uk_en/
[6] https://ic.fsc.org/
[7] http://www.fairtrade.net/
[8] http://www.carbonzero.co.nz/
[9] Likewise, in the calculation of a composed market access index for agriculture exports, Josling (2009) identified standards compliance as a relevant cost, but also as a chance to access premium prices.

Methodological approaches to the assessment of SPS/TBT impact

Research related to the impact assessment of SPS/TBT on international trade has focused principally on the effects of these requirements on import/export flows in terms of quantity and/or value. This investigation has been frequently addressed by the use of econometric methodologies, among which the estimation of gravity models has been the most recurrent (WTO, 2012). The use of these models to explain international trade flows was first developed by Tinbergen (1962), who enunciated that exports between two countries could be explained as a function of their respective Gross National Products and of the distance between them[10]. The author himself mentioned that other variables could be added to the model, such as territorial neighborliness or membership to trade agreements.

In the passage of time, there have been some important extensions to the theoretical fundaments of gravity equations. For instance, the consideration of Constant Elasticity of Substitution functions in relation to demand behavior (Anderson, 1979), the inclusion of Hecksner-Ohlin model to explain commercial structure (Bergstrand, 1989; Deardorff, 1998), the addition of fixed effects related to trade resistance (Anderson & Van Wincoop, 2003) or the specification of the model according to exporting patterns of companies countrywide (Helpman, Melitz & Rubinstein, 2008). Likewise, several authors evolved the estimation approach applied initially to gravity models, since some problems were identified associated to the use of Ordinary Least Squares (Demaría, Rau & Schlueter, 2011). One of the first to be underlined was selection bias, which has commonly been corrected by applying the adjustment proposed by Heckman (1979) of a two-stage model (sample selection and results equations) estimated by joint maximum likelihood (MLE)[11]. Despite its popularity, Heckman's model has also been criticized for assuming the homoscedasticity of error terms. Considering this problem, in addition to the lack of contemplation of the implications of Jensen's inequality on traditional log-linear models used for gravity equations, Santos Silva & Tenreyro (2006) recommended the application of Poisson Pseudo Maximum Likelihood estimation. However, given that Poisson´s model assumes equi-dispersion; Burger, Oorts & Linders (2009) adapted the approach proposed by Santos Silva and Tenreyro suggesting the use of a Negative Binominal Regression model in the presence of over-dispersion. Although, if the number of zero values on explained variable is higher than expected, authors advocated the use of Zero Inflated models. This estimation would be done on two stages: first by a Logit (or Probit) regression, which considers the probability of the existence of a trade relationship, and then by gravity model (Poisson or Negative Binominal) including only trade partners.

More specifically, gravity models have been frequently used to estimate the effects of policy changes on international trade flows and, as it was pointed out at the beginning, this

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[10] In his book "Shaping the World Economy: Suggestions for an International Economic Policy", Tinbergen enunciated gravity model as follows: $E_{ij} = \alpha_0 \, Y_i \alpha_1 \, Y_j \alpha_2 \, D_{ij} \alpha_3$. Where E_{ij} represents exports from country i to country j; Y_i is the Gross National Product (GNP) of the country i; Y_j is the GNP of the country j; D_{ij} is the distance between country i and country j. The parameters α_1, α_2, and α_3 show that explanatory variables and explained variable are not necessarily proportional. The factor α_0 is a constant term.

[11] The use of MLE in this case was also advocated by authors such as Amemiya (1981) and Maddala (1983).

research has included SPS/TBT. In this sense, the enforcement of sanitary, phytosanitary and technical requirements has often been introduced in gravity models by a dummy variable (presence/non presence), as well as by "coverage" and "frequency" ratios[12], or by their ad valorem equivalence[13] (Carrere & De Melo, 2009; WTO, 2012). Actually, as Didier, Fontagné & Mimouni (2008) mentioned the calculation of these variables has been a key point in quantifying the relative importance of NTMs in part of the related empirical literature. In this sense, gravity models are not the only methodology used to explore SPS/TBT impact. As said by UNCTAD (2012) the quantification of the effects of NTMs has also been addressed by: inventory approach, price comparison, evaluation of quantity impact, computable general equilibrium models and cost-benefit analysis (See e.g., Disdier & Van Tongeren, 2010; Kee, Nicita & Olerreaga, 2009; Van Tongeren *et. al.*, 2009).

It must be taken into account that when in accordance with any of these methodologies the presence and/or effects of SPS/TBT are addressed regarding countries' notifications may be a significant bias. This is because WTO notifications may not indicate necessarily that more trade limits are imposed than before, but that countries are more concerned with reporting.

Finally, it is worth noting that there is also an important amount of studies on SPS/TBT conducted by case study methodology from the collection of primary data (See e.g. Mimouni, Averbeck & Skorobogatova, 2009; World Bank, 2008; UNCTAD, 2010). In this sense, these investigations have been based principally on interviews with producers in which the topics raised were for instance the stringency levels of different categories of SPS/TBT, the relative restrictiveness of importing countries, the consequences of SPS/TBT compliance on income/expenses and the implemented strategies.

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[12] According to the OECD Glossary, in the context of international trade, import coverage ratio refers to the sharing of a country's imports that is subject to an NTM (or to a group of them), while frequency ratio is the number of national tariff lines affected by an NTM (or to a group of them).

[13] The ad valorem equivalent (AVE) refers, in this case, to the estimation of the correspondence of an NTM (or to a group of them) with a tariff calculated as a percentage of the market value of the product(s) affected.

Literature review

As previously mentioned, there is an extensive amount of research that has recently applied econometric methodologies in order to define the impact of sanitary, phytosanitary and technical requirements on the trade of agricultural products. In this context, some authors have analyzed the effects of specific measures (e.g. GMOs, MRLs, HACCP…) as well as the effects of SPS/TBT on particular products. On the other hand, some authors researched the impact of a group of requirements (or overall SPS/TBT) on a pool of products. In this section, a collection of selected research on each of the mentioned categories will be reviewed, as well as a group of investigations into the impact of similarity/dissimilarity in SPS/TBT regulations between countries in relation to food and agricultural trade.

I. Effects of SPS/TBT on a particular purpose and/or product

Maximum Residue Levels (MRLs)

Disdier & Marette (2010)

In this paper, Disdier and Marette addressed the impact on trade and social welfare of chloramphenicol MRL standards on crustacean products enforced from 2001 to 2006 by major importers (European Union, United States, Canada and Japan).

Regarding the assessment of trade effects caused by the standards, a gravity model was estimated where the existing requirement was defined by the maximum level of chloramphenicol (in ppb) required by each importing country. Meanwhile, for welfare evaluation, consumption and production functions were optimized in order to compose the standard impact function which compared the standard and the pre-standard scenarios.

The results showed that the decision to trade between countries did not change due to the standards reinforcement. However the volumes traded were negatively affected. At the same time, welfare increased thanks to the standards in the United States, the European Union and Canada. The authors suggested that the reason was the reduction of transaction costs for national consumers and the increase of market prices for national producers.

Xiong & Beghin (2012)

The main objective of this research was to assess the effects for African agricultural exporters produced by the European Union's harmonization of the MRL of aflatoxins. This common standard, announced in 1998, entered into force in 2002.

For this, a gravity model was estimated. Data considered for the explained variable consisted in bilateral trade flows between 14 European and 9 African countries during the period 1989-2006 for three kinds of groundnut products: edible groundnuts, shelled groundnuts and groundnut oil. Meanwhile, the MRL of aflatoxins applied to a product in an EU country was one of the explanatory variables in the gravity model.

Quite contrary to the predictions estimated by Otsuki, Wilson & Sewadeh (2001) on an earlier research on the same subject, from the model previously referred to, the effects on trade due to EU MRL harmonization on aflatoxins were not significant, except for edible groundnuts which according to one of the estimations might have increased. Therefore, the authors concluded that it was not possible to state that either the propensity to trade or the volumes traded were affected by EU aflatoxins MRL.

Wei, Huang & Yang (2012a)

In this paper, the authors evaluated the impact of MRLs on pesticides in Chinese tea exports, a product for which the country is a world leader.

In this regard, first some descriptive statistics were presented, obtaining as a preliminary conclusion that in recent years SPS have increased their presence, while tariffs have decreased. Also, after crossing data on progressions in relation to the number of pesticides regulated and the value of tea exports, the existence of an inverse relationship appeared to be likely, at least in the case of the EU, Japan, South Korea and Sri Lanka.

Subsequently, a gravity model was generated in order to explain more robustly the evolution of Chinese tea exports between 1996 and 2009. Among the explanatory variables, were the maximum levels permitted by each importer of three common residues in tea production (endolsufan, fenvalerate and flucythrinate). Several dummies were also considered which referred to whether the year of an observation came prior to or after a relevant change in the number of regulated pesticides in the major importers.

As a result, it was concluded that the decrease in the maximum level permitted in two of the three residues considered (endolsufan and fenvalerate) had a negative impact on Chinese tea exports. Similarly, it was verified that the enlargement of the number of pesticides regulated by major importers was related to a reduction in tea exports.

It is worth mentioning that, similar to the aforementioned paper, in Wei, Huang & Yang (2012b) the authors addressed the effects of chloromycentin MRL on Chinese honey exports, since it had become progressively more stringent. For this purpose, a gravity model which included among the explanatory variables the chloromycentin MRL permitted by each importer was estimated. The results obtained evidenced that, as in the case of tea, a more stringent MRL was significantly related to a decrease in Chinese honey exports.

HACCP requirements

Wilson & Bray (2010)

In this research, Wilson and Bray addressed the effects of the US Government decision in 1997 to enforce the compulsory implementation of HACCP on the fishery sector. In fact, this decision is considered by the authors to be a milestone in a progressive "change of regime". As a consequence, Wilson and Bray used a gravity model defined as a switching

regression, which indicated not only if HACCP implementation policy affected trade but also since when. In this sense, the authors preliminarily identified three different periods: pre-regime (before 1994), transition (1994-1997) and full implementation (after 1998). The changes in regime were included as a transition path parameter toward the gravity model. A dummy variable was also added relating to exporters' membership to multilateral agreements (ANDEAN, ASEAN, APEC or MERCOSUR). The data considered for the explained variable were trade flows between 142 exporters and 33 importers.

The results obtained showed that, in fact, a structural break took place upon the compulsory implementation of HACCP. This break was based on a negative effect on trade over the time. However this overall impact varied depending on the country's profile. On the one hand, there was a more negative impact on fishery trade from smaller and developing countries, such as the positive weight of a country's GDP on trade flows increased. However, at the same time, HACCP implementation also reduced the traditional negative effects on trade caused by distance. In this sense, authors suggested that HACCP increased consumer trust in products of distant origin. They also found that the impact of US HACCP was different depending on the agreements adhered by countries. For instance, NAFTA and ASEAN countries ended up in a better position as a result of HACCP, while ANDEAN countries were consequently left in a worse state.

Genetically Modified Organisms (GMOs)

Disdier & Fontagné (2010)

The main goal of this research was to assess the impact that European Union legislation regarding Genetically Modified Organisms, as of the beginning of the nineties, had on the agricultural imports from the United States, Canada and Argentina. The choice of those particular countries is justified by the fact that in 2003 their governments officially complained to the World Trade Organization that EU GMO legislation was protectionist.

In order to address this topic, Disdier and Fontagné estimated a gravity model whereby they evaluated the evolution of export flows during the period 1994-2003 using a sample of 20 countries to the EU15 and to the EU25 for 2004/05. A pool of products was selected characterized by high shares of GMO (maize, rapeseed, cottonseed and corn gluten derivatives). The presence of NTMs was introduced to the model by two groups of dummy variables associated with different restrictions on exports from a complaining country to the EU: a) moratorium or specific measures and b) safeguard measures. These variables were defined by four dimensions: time, product, exporter and importer.

The results obtained proved that all the complaining countries had in fact incurred important opportunity cost that presumably would have been related to the effect of European Union GMO legislation on their exports. The amount of these earnings not incurred differed between the complainers, with the US by far the most affected country.

Sanitary requirements on livestock trade

Schlueter, Wieck & Heckelei (2009)

This research addressed the hypothesis that SPS effects on meat markets depend on the instruments applied in each case. To test this hypothesis, the authors estimated a gravity model in which the presence of SPS was included on different aggregation levels in accordance with the main characteristics of the measures. Data considered for the explained variable was meat trade between 10 major importers and exporters between 1996 and 2007.

The disaggregated analysis of SPS effects led to contrasting results, as some instruments had a negative impact on meat trade flows while other instruments were trade encouraging. For instance, regulation on MRLs for pesticides and some toxins, hormone application and other production processes, meat establishments and irradiation after slaughtering, had a significant and negative impact on trade. However, the application of SPS requirements on salmonella testing, MRLs for dioxin and drugs, inspection/approval procedures for conformity assessments, HACCP and transportation after slaughtering had a significant and positive impact on trade. Finally, in terms of the objectives behind regulations, those related to animal health had a significant and positive impact on trade; while regulations for food safety, plant protection and human protection seemed not to have significant effects.

Beghin & Melatos (2012)

In this paper, Beghin and Melatos addressed the study of the Australian quarantine regime on pig meat imports. In 2003, this regime caused a WTO dispute between Australia and the European Communities, EC (with Canada, Chile, China, India, Philippines, Thailand and United States as third parties), which ended in 2007 when Australia and the EC agreed on a commonly established solution which included: more transparency of the quarantine regime of Australia, principles of market access from the EC and the permanent support of scientific opinions regarding the supervision of the trade of chicken and pig meat.

In order to analyze this issue, authors quantified the effects of the different stages of the Australian quarantine regime on trade and welfare. The data considered were trade flows to Australia from its major exporters, Canada, Denmark and United States, between 1988 and 2009. This data was classified into sub-periods according to four milestones: a) Canadian imports prohibition at the end of the 80s, b) Danish imports permission in 1997, c) United States imports authorization in 2004, and d) the resolution of the WTO dispute in 2007. The methodological strategy was supported by the use of econometric estimation, based on the Wales and Woodland (1983) Random Utility Model of consumption with corner solutions, and on a multimarket simulation model defined in accordance with estimations.

After the previous analysis, authors concluded that the effects on welfare and trade of the Australian quarantine regime were very significant. In fact, they estimated a welfare gain in consumers after the withdrawal of the regime of approximately AU$ 409 million and an expansion of total revenue of AU$ 479 million for the three major exporters. In this sense, they also found that specific reforms had simultaneous effects on all the exporters.

Wieck, Schlueter & Britz (2012)

This paper aimed to assess trade and welfare impact of Avian Influenza policies on major exporting and importing countries of poultry meat.

In order to evaluate trade effects, the authors used a gravity model. This model considered trade flows from 2000 to 2007 between six exporters (Brazil, China, France, Germany, the Netherlands and the United States) and Japan, Russia and a group of "remaining countries" which were defined according to the exporter. Meanwhile, welfare impact assessment was performed by a spatial multi-commodity model. In both cases, data was analyzed assuming different policy scenarios depending on banned products (cooked/uncooked meat) and country limitations (according to Avian Influenza levels). The application or not of regionalization principle[14] was also considered in the analysis.

Authors concluded that for uncooked poultry meat, a ban implied a reduction in trade of 100 per cent. On the other hand, the effect for cooked meat was the contrary, as a ban drove an increase in the volume traded. In spite of this, the global effect of an import ban on international poultry meat trade was negative, whenever the regionalization principle was not applied. For welfare, import bans had a reductionist impact in every scenario.

Regarding these results, Wieck, Schlueter and Britz highlighted that in the case of Avian Influenza import bans entailed an important trade diversion according to the infection level in each country. For example, banned countries addressed their production to local market or to other banned countries. However, at least in this particular case, the regionalization principle would have avoided trade and welfare losses caused by import bans.

Agricultural input trade

Jayasinghe, Beghin & Moschini (2010)

This paper aimed to define which factors characterized the trade of corn seeds from the United States and to evaluate the relative importance of each one of those factors. In order to do this, the authors used a gravity model derived in the first place from a CES production function, which was incorporated as a cost function to conditional factors demand for corn seeds[15]. SPS were introduced into the demand model as part of the resistance factor to trade, which affected the unitary cost of corn production. The explained variable was US corn seed exports during the period 1989-2004 to a sample of 48 countries which had a minimum average production of one million metric tons of corn per year.

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[14] According to the WTO, application of the regionalization principle means that there is recognition that a particular exporting region within a country is disease-free or pest-free. In the case of Avian Influenza, Salles Almeida (2006) states that most of the countries decided to ban completely poultry meat imports, not considering the regionalization principle. This situation implied unnecessary diversion of trade revenues.

[15] Conditional Factors Demand optimizes a factor z demand conditioned to a final production level and given certain factors prices reaching the lowest possible cost for producers.

The results obtained evidenced that commercial costs affected the US corn seed trade, especially tariffs, distance to importers and, finally, SPS regulations. However, in this sense authors found that completely avoiding SPS requirements could lead to some negative consequences for trade. Accordingly, they suggested that the best option could be to rationalize the use of SPS instead of eliminating them. The estimations made supported this conclusion as they showed that SPS rationalization would increase existing trade.

II. Effects of SPS/TBT on a pool of purposes and products

Hoekman & Nicita (2008)

In this paper, Hoekman and Nicita reviewed the trade policy scenario in order to assess the effects of different restrictions on countries' commercial performance. The enforcement of NTMs was among the pool of policies evaluated, as well as tariffs, bilateral preferences and other sources of trading costs (such as red tape costs, customs procedures…).

For this, the authors conducted a descriptive analysis based on the calculation of two trade restrictiveness indexes: tariff restrictiveness index (TTRI) and overall restrictiveness index (OTRI). Regarding these indices, Hoekman and Nicita concluded that agricultural trade had been far more restricted than manufacture trade, especially for developing countries. This was due not only to tariffs, but also to NTMs, which were more restrictive than tariffs, affecting negatively the countries' market access. The authors suggested as an explanation that tariffs have been the subject of continuous trade agreements in the last decades.

In a subsequent part of the paper, Hoekman and Nicita estimated a cross-section gravity model for trade flows using a sample of 104 importers and 115 exporters from 2006. In order to capture the effect of tariffs the authors included TTRI in the model, as well as the impact of NTMs which was addressed by the difference between TTRI and OTRI. Additionally, the model included other trade costs, comprised by the logistics performance index[16], the doing business "cost of trading"[17] and the trade facilitation index[18].

From this analysis Hoekman and Nicita confirmed that both tariffs and NTMs significantly affected trade flows: "on average, a reduction in the TTRI of 10 percent would increase trade volumes a little more than 2 percent, while NTMs add another 1.8 percent" (p. 16).

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[16] Logistics Performance Index developed by the World Bank, measures a country's performance in six areas: efficiency in customs clearance, quality of trade and transport infrastructures, access to competitively priced shipments, competence and quality of logistics services, affordability of track and trace consignments and frequency of punctual arrival of consignments (World Bank, 2010).

[17] Doing Business Index is a multidimensional indicator, created by the World Bank, which measures the easiness for business derived from country regulations. In this paper, Hoekman and Nicita focused on the information about trade costs, which is part of the index components.

[18] According to Wilson, Mann and Otsuki (2003), trade facilitation "will incorporate relatively concrete "border" elements such as port efficiency and customs administration and "inside the border" elements such as domestic regulatory environment and the infrastructure to enable e-business usage" (p. 4).

Commercial preferences would have little to do with mitigating NTMs impact and practically nothing to do with administrative and logistic commercial costs. These costs were highlighted as particularly trade preventing, which is the reason why Hoekman and Nicita advocated the importance of public policies focused on reducing them.

Disdier, Fontagné & Mimouni (2008)

The main objective of this paper was to evaluate the importance of SPS/TBT in terms of international agricultural trade, as well as to define some of their characteristics.

For this, in the first stage Disdier, Fontagné and Mimouni developed a descriptive analysis of SPS/TBT considering its situation in a sample of 154 importers, 183 exporters and 690 agricultural products in 2004. The authors focused on three variables relating to the intensity and scope of measures: a) number of notifying countries, b) coverage ratio and c) number and value of affected (and potentially affected) import products. Additionally, they calculated once again the coverage ratio and the number of affected products but this time at country-level. This analysis was split into two parts in accordance with whether a country was considered one of those requiring or those affected by the measures.

From this analysis Disdier, Fontagné and Mimouni evidenced the prevalence of SPS/TBT, given that of the 690 tariff lines considered only 4 did not face any SPS/TBT requirement. In this regard, technical barriers related to specific characteristics of products were the measures most recurrently notified. The protection of human health seemed to be the most frequent purpose of SPS/TBT. As a final point, the authors affirmed that (with few exceptions) SPS/TBT requirements were unilaterally implemented by importing countries. The degree to which exporting countries were affected by these measures depended on the structure of their agricultural sector supply chains (especially products and trade partners).

For the second stage, Disdier, Fontagné and Mimouni estimated a gravity model. SPS/TBT requirements were considered as part of the explanatory variables of the model and were introduced by: a) a dummy with a value of one when at least one concern at HS6 level has been notified by the importing country, b) a frequency index and c) an *ad valorem* equivalent. The sample considered was the same as that used for the inventory approach.

In accordance with the estimations made, authors concluded that although SPS/TBT had a non significant effect on agricultural exports from OECD countries, they had a negative impact on developing and least developed countries. Disdier, Fontagné and Mimouni suggested that these results evidenced that SPS/TBT are able to increase the information available to consumers, therefore enhancing trade; however they may also represent a very relevant fixed cost for DC and LDC producers that as a result prevents trade.

Bao & Qiu (2010)

In this paper, the authors addressed the impact of TBT (within other NTMs) on national imports enforced by China, given the increasing importance of these measures.

First a database of TBT frequency index and imports coverage ratio was created. This considered the measures affecting a sample of 96 manufacturing and agricultural products from 43 exporting countries in the period 1998-2006. This inventory showed that 80% of the products had been subjected to at least one TBT. Of these, a third of the products were identified as "TBT rocked", which according to the UNCTAD definition followed by the authors had both a frequency and coverage ratio of over 50% (i.e. those specially affected by Chinese TBTs). All agricultural products in the sample belonged to this category.

Considering the developed database, Bao and Qiu estimated a gravity model to explain the evolution of Chinese imports. In addition to TBT, the authors introduced import licenses and quotas within the explanatory variables in the equation; as well as two dummy variables referring to the development status of the exporting country (developing/non developing) and to the type of product being considered (agricultural/non agricultural). Finally, the authors attended to the differences in import behavior before and after China's entry into the World Trade Organization in 2002.

Using this econometric analysis, Bao and Qiu concluded that TBT frequency index would have a significant and negative impact on the value of Chinese imports both before and after 2002. However, these results were different when regression was made on the TBT coverage ratio. In this case, technical requirements were shown as non significant for the whole period, positive before China's WTO accession and negative after it. In addition, when the sampled products were divided according to their origin it became evident that both TBT frequency index and coverage ratio had a significant and negative impact on agricultural imports but a positive impact on manufacturing imports. The authors suggested that these results were due to the superior presence of technical information asymmetries regarding manufacturing products compared with agriculture products.

Song & Chen (2010)

Song and Chen proposed to clarify the effects of safety regulations on Chinese food and agricultural exports, and more specifically the costs that compliance with these requirements implied for exporters. The authors indicated as a focal motivation of this analysis the increasingly frequent notifications that China's main trade partners (Japan, the EU and the US) had presented to the WTO relating to food safety. Furthermore, Song and Chen stated that the Chinese food and agricultural export basket was composed of products (such as fish, livestock and horticulture) which were subject to numerous SPS.

In order to address this issue, Song and Chen used a gravity model where food safety regulations were introduced as the number of WTO/SPS notifications. For the explained variable, the data considered consisted in China's agricultural trade flows to its main trade partners (22 in total were chosen) during the period 2002-2007. In addition to this econometric methodology, the authors conducted two surveys with 90 Chinese agriculture exporting companies concerning SPS compliance costs at a microeconomic level.

Song and Chen evidenced that the effects of SPS in Chinese agricultural exports were different according to the time horizon. While SPS had a significant and negative impact on

Chinese agriculture trade in the short term, the same concerns involved a significant and positive effect in the long term. However, the overall effect of the increasing food safety requirements seemed to be positive. On the other hand, surveys showed that the compliance costs for Chinese exporting companies had increased progressively year by year. In this sense, the HACCP scheme was, according to traders, the most demanding standard. Conversely, compliance with GlobalGAP was the least expensive. The authors also noted that compliance costs were relatively higher for national and small companies.

Meneguelli, Pinto de Souza & Lee (2011)

The major objective of this paper was to assess the impact of SPS/TBT on the Brazilian exports of poultry meat. To do so, two gravity models were estimated. The first one considered the SPS/TBT notifications informed to the WTO by Brazil's importers on an aggregate level as explanatory variable, while the second included five additional dummy variables related to the type of measure as classified by the World Integrated Trade Solution (product, process, labeling, conformity assessment and prohibition or restriction). Data was compiled from the period between 1996 and 2009.

From this analysis, it was ascertained that SPS/TBT had a non significant effect on Brazilian poultry exports, overall. However, the conclusions were different when the focus was disaggregated. In this regard, requirements on labeling and prohibitions/restrictions were significant and positively related with trade. In contrast, measures on conformity assessment were found to be trade preventing. The rest of the categories considered (product and process) were evidenced as non-statistically significant.

Authors suggested that the results obtained showed that SPS/TBT effects are ambiguous, so it is important to address this subject keeping in mind the differences between types of requirements, because their effects on trade may be considerably dissimilar.

Crivelli & Gröschl (2012)

In this research, Crivelli and Gröschl addressed the effects of SPS on food and agricultural trade on both the probability of trade and the volume traded. Authors applied a two-stage gravity equation model, where the outcome equation introduced SPS requirements through two variables: i) a dummy variable with a value of one if there existed at least one WTO complain between an exporting and an importing country for a particular product, and ii) a frequency factor, calculated as the proportion of HS4 products within an HS2 category where complain has been notified. Two other dummy variables were also introduced which indicated the purpose of the measure that caused the complaint: conformity assessment or product characteristics. Finally, the explained variable data considered were bilateral trade flows on a sample of 224 HS4 food and agricultural product categories between 164 importers and 150 exporting countries during the period 1996-2010.

From this analysis, Crivelli and Gröschl concluded that the probability of trade was significantly affected by the presence of SPS concerns related to conformity-assessments. The authors suggested as an explanation of these results that those SPS effectively

represent a high production cost. Conformity-assessment SPS were also significantly and negatively related to the volume traded. However, SPS related to product characteristics had a non-significant effect on the probability of trade and a significant and positive effect on the volume traded. Crivelli and Gröschl justified this result in that those requirements increase consumer trust and, as a consequence, the purchase intention.

Mangelsdorf, Portugal-Pérez & Wilson (2012)

With this research Mangelsdorf, Portugal-Pérez and Wilson aimed to evidence the effects of the implementation of standards on Chinese agricultural exports, also taking into account whether these requirements were internationally harmonized or purely domestic.

To address this objective, the methodology used was the definition of a gravity model in which standards were introduced by four explanatory variables which were distinguished according to whether they were mandatory or voluntary and domestic or international. For explained variable data Chinese trade flows to 132 countries on 7 product categories were used: meat (HS-02), fish (HS-03), vegetables (HS-07), cereals (HS-10), milk (HS-0401 and HS-0402), tea (HS-0902) and sugar (HS-1701 and HS-1702). Meanwhile, data on requirements was collected from the Standardization Administration of China.

The results obtained showed that the implementation of mandatory standards had positive effect on Chinese agriculture exports. This impact was greater when standards were based on international schemes. On the other hand, the effect of voluntary standards was smaller or even non significant. The authors suggested that the reason for this is that Chinese producers had mainly not implemented these requirements. However, they concluded that either way the impact of standards depended on the trade-off between the commercial benefits of the quality signaling and the magnitude of the producers' adaptation costs.

Melo, Engler, Nahuelhual & Barrena (2012)

Melo, Engler, Nahuelhual and Barrena recently researched into the effects of SPS on Chilean fruit exports. For this, first the authors calculated a stringency index on 7 groups of SPS (pest and quarantine treatments, MRLs, microbiological regulations, labeling, marking and packaging requirements, good agricultural practices, quality standards and pest monitoring) enforced by sixteen Chilean trading partners on four products: grapes, apples, cherries and kiwifruit. This index was based on the opinions of a sample of 40 fruit exporting company managers, located throughout the central area of Chile.

Using this analysis it was concluded that the most stringent countries were Mexico, Taiwan, the United Kingdom and China, while the least stringent were Saudi Arabia and the Arab Emirates (see also Engler, Nahuelhual, Cofré & Barrena, 2012).

As a second step, the authors produced a gravity model which considered as explained variable the natural logarithm of the volume of fruit exported and among the explanatory variables the calculated stringency index. It was ascertained that the stringency level of the SPS regulations would have had a significant negative impact on Chilean fruit exports.

III. Implications of SPS/TBT heterogeneity/harmonization

Chevassus-Lozza, Latouche, Majkovic & Unguru (2008)

This paper addressed the dynamics of market access for food and agricultural products from Central and Eastern European Countries (CEECs), which joined the European Union in 2004 or 2007, just before becoming a member state. More specifically, the authors were interested in the effects of the adaptation process of national regulations to European Union legislation (*community acquis*) on food and agricultural trade.

Chevassus-Lozza, Latouche, Majkovic and Unguru estimated a gravity model which considered as explained variable the imports of EU15 on about 200 food and agricultural products, distinguished according to their origin: a) other EU15 countries, b) CEECs incorporated in 2004, c) CEECs incorporated in 2007 and d) third countries. Among the explanatory variables, SPS/TBTs were incorporated through three dummies referring to their existence. Tariffs and border effect (i.e. lower trade inter-country than intra-country) were also taken into account. Finally, the model was estimated by a cross-section of data for 1999 (non full agro-food trade liberalization) and 2004 (first EU-15 enlargement).

The results obtained showed different patterns according to the requirement being considered. For instance, sanitary measures did not have negative effects on food and agricultural export market access to the EU for countries on the 2004 enlargement; but they acted as a barrier to trade for CEECs which entered in 2007. Meanwhile, phytosanitary measures did not diminish market access in any of the two groups of countries. However they did seem to negatively affect the volumes traded as well as quality measures.

The authors suggested that the results mentioned were due to the low level of harmonization within the EU of quality and phytosanitary requirements, which led to significant transaction costs for producers relating to their implementation. However, as sanitary standards were more integrated within the member states, once producers were able to fulfill them, they no longer acted as a barrier to trade.

Vigani, Raimondi & Olper (2009)

This paper addressed how similarity/dissimilarity between GMO regulations in exporting and importing countries affects trade. For this, the effects of GMOs standards on bilateral trade flows were considered in a sample of 60 developed and developing countries.

First, the authors ranked the GMO regulations of each country in the sample by the calculation of a "complexity" index. This index was composed of 6 categories of rules: a) approval processes, b) risk assessments, c) label politics, d) traceability systems, e) coexistence management and f) membership to international agreements GMO related (in this case they were considered Codex Alimentarius and Cartagena Protocol on Biosafety). Each one of these categories was valuated according to the total number of requirements.

The standardized sum of each category generated the index values, which were introduced through a non-tariff commercial cost vector as an explanatory variable in a gravity model. Meanwhile the explained variable was the trade flows for 3 crops with significant presence of GMOs such as maize, soy and rape. The period of time considered was 2005-2007.

Results confirmed that countries with greater similarities in GMO regulations had higher bilateral trade flows. For the authors, that would suggest that regulation stringency is not the only significant variable for trade, as the level of harmonization also causes impact. Furthermore, regarding the different regulation categories defined, labeling, approval processes and traceability systems were the most significant for agricultural trade flows.

Drogué & Demaría (2012)

The main objective of this research is to assess the impact of similarity/dissimilarity of pesticide MRL regulations on fruit trade. The authors' interest in this topic arose due to their perception of an important lack of international harmonization on MRL rules.

Drogué and Demaría used a gravity model in which the explained variable was apple, pear and some derivative product trade between 40 importing and 38 exporting countries from 2000 to 2009. In this model the variable related to SPS requirements was a Pearson's coefficient which measured the degree of difference or similarity between pairs of countries in maximum residue levels for regulated pesticides.

Global results showed that a higher level of similarity in MRL regulation between countries had positive effects on the volume of trade of pears and apples (but not on the existence of trade itself). However, some particular conclusions were reached when results were analyzed at country level. For example, for some countries such as New Zealand, Canada or China an increase in trade where the regulatory gap had diminished would have been very significant. However using the same policy in countries such as Argentina, Brazil, Chile, Korea or South Africa it would not have caused any impact, while for United States and Japan it would in fact have been trade diverting. The authors suggested that an explanation of this last result could be that adopting a less stringent standard than the national equivalent would allow market access to less expensive products and, as a consequence, would negatively affect local producers.

Winchester et al. (2012)

This research, derived from the NTM-IMPACT Project funded by the EU, addressed the characterization of the current situation and the impact of SPS/TBT heterogeneity.

For this, first the authors calculated a heterogeneity index of trade regulation (HIT), which in this case was designated as a measure of similarity/dissimilarity between SPS/TBT requirements on an exporting and an importing country. The HIT was estimated for twelve categories of regulations which were pooled in two different groups: stringency HITs (for MRLs on pesticides, vet drugs and contaminants) and regulatory HITs (for requirements on traceability, product, process, monitoring, labeling, conformity assessment, certification,

plant and veterinary requirements). Final results were synthesized considering an average HIT for each importer in relation to all exporters for animal products or plant products.

As a second part of their research, Winchester *et al.* estimated a gravity model in order to assess the effects of heterogeneity on international trade. On the cost matrix the previously calculated HITs were considered within the explanatory variables. The database on trade flows referred to bilateral trade on 2008 and 2009 between EU members and nine other countries studied on the NTM-IMPACT project.

The results of the gravity model estimations showed that heterogeneity did not have a significant effect on trade for the majority of the regulations considered. However, one important exception was evidenced in this sense: MRLs of plant pesticides. In this case, the authors advocated considering international schemes like the Codex Alimentarius.

Disdier, Fontagné & Cadot (2012)

The objective of this research was to assess the effects on South-South trade caused by the inclusion of TBT related clauses in trade agreements between North-South countries. In this sense, the authors assumed that frequently Southern countries adapted to Northern country regulation, which made them less able to establish their own regulations.

The methodological approach used to address this objective was the estimation of a gravity model where North-South and South-South trade flows were considered as explained variable. Likewise, forty three trade agreements were analyzed, differentiating between them according to whether they enhanced the harmonization of standards or not and, if they did, whether regional or international standards were promoted. It was also taken into account whether the agreement was North-South or South-South; and in this last case if one of the partners also had a trade agreement with a Northern country. This categorization of the agreements was introduced to the model through a group of dummies.

From this analysis, Disdier, Fontagné and Cadot evidenced that trade agreements between Northern and Southern countries as expected, increased their bilateral trade. In this context, the harmonization of TBT standards had a trade enhancing impact if based on national regulations. However, it had a negative impact on trade when based on regional standards. The authors suggested that the implementation costs associated with regional standards (imposed by developed countries) are too high for producers in developing countries.

Furthermore, from this research Disdier, Fontagné and Cadot confirmed that North-South trade agreements distorted South-South trade flows. The authors affirmed that this effect could be due to the greater economic appeal of Northern markets for Southern producers.

Conclusions

As evidenced by this review, there is a significant amount of recent research that has applied econometric models in order to define the changes due to SPS/TBT in import/export flows for food and agriculture markets, as well as in trading intention.

An important part of these investigations concluded that increasing the stringency imposed by sanitary, phytosanitary and/or technical requirements hinders food and agricultural trade creating a barrier (Bao & Qiu, 2010; Beghin & Melatos, 2012; De Melo *et al.*, 2012; Disdier & Fontagné, 2010; Disdier & Marette, 2010; Otsuki *et al.*, 2001; Wei *et al.*, 2012ab; Wieck *et al.*, 2012). In this context, some authors highlight that the difficulties that SPS/TBT pose for trade are greater in the case of developing and least developed countries (Disdier *et al.*, 2008; Hoekman & Nicita, 2008; Wilson & Bray, 2010). In this sense, Häberli (2008) stated on the case of LDCs agricultural exports to Switzerland that nowadays NTMs represent a much more important obstacle to trade than tariffs. This would be principally because LDCs lack of technical and financial capacities to adapt to standards.

On the other hand, some research supports that standards do not significantly affect food and agricultural trade (Xiong & Beghin, 2011). In fact in accordance with part of the research reviewed some of these measures can even have positive effects on those producers who are able to fulfill the requirements or, at least, an ambiguous impact (Crivelli & Gröschl, 2012; Jayasinghe *et al.*, 2010; Mangelsdorf *et al.*, 2012; Meneguelli *et al.*, 2011; Schlueter *et al.*, 2009; Song & Chen, 2010; Wilson & Bray, 2010).

Leading on from the previous discussion, in addition to the studies on the impact of standards implementation, other investigations have addressed the effects of standards similarity/dissimilarity on agricultural trade. The main results of these studies suggest that a higher level of similarity in regulations would be positive for food and agricultural trade flows (Drogué & De María, 2012; Vigani *et al.*, 2009). However, regarding harmonization processes some authors evidenced that these positive effects would also depend on the way in which they are carried out (Chevassus-Lozza *et al.*, 2008; Disdier *et al.*, 2012).

Considering the results presented, it seems appropriate to assert that recent research supports the presence of a "dual" effect on the relationship between SPS/TBT and food and agricultural international trade. On the one hand, the implementation of sanitary, phytosanitary and technical standards may increase consumer trust and, consequently, trade. However, the implementation of some requirements can also act as a barrier for exporters due to production costs. The overall result of this trade-off would rely on the producers' profile, which in turn is related to country's economic status, but it would also depend on inner characteristics of requirements such as stringency and harmonization. In this sense, some private standards (such as GlobalGAP) could represent a "previous training" for producers, especially in DCs, in order to fulfill more easily SPS/TBT.

In summary, as affirmed by Swinnen & Vandermoortele (2011; 2012) public standardization can act as a "barrier" but also as a "catalyst" to trade. Consequently the role of the public sector is to implement policies that promote the catalytic effect of SPS/TBT,

especially in countries which are net exporters of agricultural products. This strategy may not be based solely on domestic policies, but also on the multilateral framework.

In this regard, Chile is a good example within the countries mentioned. According to Chilean Ministry of Agriculture Office of Studies and Agricultural Policies (ODEPA) in 2011 Chile exported more than 9.000 million dollars worth of agricultural products (not including forestry products), approximately twice the value of the imports of the same items. Additionally, Chile is the regional leader in exportation of table grapes, apples, peaches, avocados, blueberries, raspberries and plums, which go mainly to the EU and US.

In recent years Chile has further developed its institutions in food quality and safety. A good example of this was the creation of the Chilean Agency for Quality and Food Safety (ACHIPIA) in 2005, as a presidential advisory commission. Meanwhile, at the associative level they have been also some important initiatives to improve agricultural production processes. An early example was the creation of the certification scheme ChileGAP (which adapted the certification GlobalGAP) by the Chilean Exporters Association, ASOEX. Such efforts have facilitated Chile become a reference in food security in Latin America[19].

Therefore, Chile seems to be comparatively advantaged to address compliance with international food and agricultural standards (public or private). However, it is important to continue to emphasize these issues through, among others, linking research and development with policy makers, producers and exporters. This is because the requirements are changing rapidly and, despite having a good initial situation, not been able to fulfill future requirements could lead to a scenario as critical as the reduction of market access.

[19] Under the Food Security Index for 2012 generated by the Intelligence Unit of The Economist, Chile holds the 27th place worldwide, leading Latin American ranking. This index considers not only the availability and affordability of products, but also food safety and quality of domestic supply.

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