Trade effects of food regulations and standards:

Assessing the impact of SPS measures on market structure

Didier Yélognissè Alia [*1], Yuqing Zheng [2], Yoko Kusunose [3], Michael Reed [4]

[1] Ph.D. Candidate, Department of Agricultural Economics University of Kentucky
332 Charles E. Barnhart Building, Lexington, KY 50546 d.alia@uky.edu
d.alia@uky.edu

[2] Assistant Professor, Department of Agricultural Economics University of Kentucky
317 Charles E. Barnhart Building, Lexington, KY 50546 yoko.kusunose@uky.edu
yuqing.zheng@uky.edu

[3] Assistant Professor, Department of Agricultural Economics University of Kentucky
318 Charles E. Barnhart Building, Lexington, KY 50546 yoko.kusunose@uky.edu
yoko.kusunose@uky.edu

[4] Professor, Department of Agricultural Economics University of Kentucky
308 Charles E. Barnhart Building, Lexington, KY 50546 yoko.kusunose@uky.edu
mrreed@email.uky.edu

Selected Paper prepared for presentation at the 2017 Agricultural and Applied Economics Association Annual Meeting, Chicago, IL, July 30th - August 1st

Trade effects of food regulations and standards:

Assessing the impact of SPS measures on market structure

Abstract

World trade has increased tremendously over the past two decades as the result of a substantial decline in tariffs and landmark improvements in storage and transportation technologies. However, trade continues to be hindered by various non-tariff-measures. In this paper, we assess the impact of Sanitary and Phytosanitary measures, the most common forms of non-tariff measures and public standards, on trade and export market structure in developed countries. We focus on vegetables and fruits, the food product most affected by SPS, and combine data on trade from the UNCOMTRADE and SPS-related measures from the WTO over the period 1995-2014. We use panel fixed-effect regression to address unobserved heterogeneity among exporting countries and control for various import shifters. We find that increased use SPS measures crowds out imports of vegetables and fruits from developing countries but is favorable to high-income countries. Therefore, SPS measures increase the concentration of suppliers and make the export market less competitive. Taken together, our findings suggest that, public regulations by developed countries distort trade and is especially unfavorable to developing countries. Given that export of high-value products to developed countries is essential income generating activities for developing countries, it is important that these countries receive the support to comply with SPS measures and improve their competitiveness.

Keywords: Standards, SPS measures, International Trade, Supplier concentration

1. Introduction

Over the past two decades, the world trade system made substantial progress toward freer and easier flow of goods and services across countries. Numerous rounds of international negotiations under the World Trade Organization (WTO) and Multilateral Free Trade Agreements (FTA) between groups of countries increased trade liberalization and led to substantial reductions in tariffs and other quantitative barriers to trade (WTO 2012; Baldwin, 2016). The removal of these obstacles combined with major technological improvements in storage, processing, and transportation contributed to a substantial decrease in trade costs and the global expansion of world trade to unprecedented levels (Arvis et al., 2016; Bernhofen et al., 2016). Despite the recent progress, there still exist many barriers to trade reflected in high trade costs, weak demand, and various public and firm-specific regulations. These barriers take new forms not fully observed in tariffs and quantitative restrictions.

While the importance of tariffs and other quantitative barriers such as import quotas progressively decreases, other forms trade policies instruments acquire a growing importance (Kee et al. 2013). In particular, many public regulations, and products and process standards increasingly govern trade. Although these regulations and standards have always been prevalent in commerce, their use substantially has increased during the recent years (Beghin, Maertens, and Swinnen, 2015). This upsurge in the use of standards is partially driven by the numerous food scares that draw public outcries and the increasing exigency of consumers, particularly in rich countries, on the quality of their foods (Jaud et al., 2013; DeLind and Howard, 2008).

Standards are subsets of a larger group of non-quantitative trade instruments referred as Non-Tariff Measures (NTMs). The United Nations Commission on Trade And Development (UNCTAD) defines NTMs as "policy measures, other than ordinary customs tariffs, that can

potentially have an economic effect on international trade in goods, changing quantities traded, or prices or both" (UNCTAD, 2010). The most popular forms of NTMs affecting agricultural and food products are technical measures such as the Sanitary and Phytosanitary Measures (SPS)[1]. SPS measures are enacted under the WTO Agreement on SPS signed in 1995. The agreement allowed members' states to define the requirements that products need to meet before entering into their territory provided that the regulations are based on scientific evidence and are not intentionally discriminatory and trade-distorting (Peterson et al., 2013; Josling et al., 2004). However, its appear that the adoption and application of these measures have become the preferred trade instruments in the face of pressure to eliminate tariffs.

The preeminence of SPS measures among non-tariff measures clearly appears in the number of such measures used by countries. The WTO data show that over the period 1995-2014, there were about 19,945 SPS-related measures taken by WTO countries covering a broad range of issues related to food and feed safety, animal health, plant health, and public health. A particularly striking observation about SPS measures is that developed countries, which are also the major buyers of food and agricultural products, are more inclined to use these measures[2]. The WTO data show that more than half of the measures enacted and enforced are by countries members of the Organization for Economic Co-operation and Development (OECD) with the European Union countries, the United States, and Canada being the top notifiers.

In recent years, the rise in public regulations on food and agricultural products together with increasing role played by large retails stores in the world food system sparked the emergence

[1] Another form NTMs also commonly used refer to Technical Barriers to Trade (TBT) which concern more agro-industrial and manufactured goods

[2] It should be noted that developing countries increasing use SPS measure an now account for than half of all notification

of new form standards often termed as private voluntary standards[3]. These standards are defined and enforced by the retail food firms, and their requirements are often more stringent that those set in SPS measures (Henson and Humphrey, 2009). Despite being labeled as voluntary, PVSs are 'de facto' mandatory for producers and exporters to access developed countries markets (Henson and Northen, 1998; Fulponi, 2006). Unlike public standard, PVSs cover a broad range of dimensions including food quality and safety, environmental and social equity, labor and management, business integrity, and organic production.

Though public and private standards have real benefits for plant, animal and human health protection (Jaffee et al., 2005), their proliferation over the past decades raises several concerns over their trade impacts (Disdier et al., 2008). This question received considerable attention in the literature from various perspectives with mixed evidence. On one hand, the successful compliance with the requirements of these standards opens up high-value markets and allows producers and exporters to benefit from a price premium when selling on developed countries markets (). As such, compliance with standards and the certification can enhance and catalyze trade by signaling to consumers the high quality of the products. On the one hand, however, the cost of compliance is in general too high for small producers and exporters resulting in distorting effects on export (Maskus et al., 2005). This suggests that the enforcement of standards necessary make some winners and some looser. As a consequence, standards can have important implications exporters' market access and the structure of export markets.

The objective of this study is to assess the impact of standards on the market structure with a focus on supplier concentration. Although there are several studies on the trade effects of standards, most of these studies focus on access the impact of standards on the total value of export

[3] UNCTAD estimated the number PVSs in 2007 at 400 and a recent inventory by the European Commission in 2010 identified more than active on the EU market.

or bilateral trade (Beghin et al., 2015). The dominant narrative is that both public and private standards distort trade, at least in the short run by crowding out producers or exporters who fail to comply with the requirements (Disdier and Van Tongeren, 2010). However, few studies have documented the trade-enhancing effects of standards for some producers who can comply with the requirements and get a certification. These producers are often the most productive and are more connected to the global value chain through contract farming. We provide a direct test of these implications by analyzing market structure and assessing the change in market concentration due to the enforcement of SPS standards.

The analysis complements the empirical evidence on the impacts of standards on trade. We use trade data from UNCOMTRADE to estimate indices of supplier concentration and assess the effect increasing of SPS measures reported to the WTO by developed countries on the total import and the share of import from various groups of countries as well as on the Herfindahl-Hirschman Index of market concentration. We find that more SPS-related measures imply high costs of trade, thus lower imports. However, we find that countries are not impacted symmetrically. While the share of import from OECD countries increases, the market share for Developing Countries which is already very low decreases further. As consequent, more stringent standards result in higher market concentration.

Our study is closely related to the vast and growing literature on public standards and their trade effects on developing countries (see Beghin et al., 2015 for a recent review). This literature stems from the broader strand of the economic literature on international trade and the key drivers of world trade patterns (Helpman, Melitz, and Rubinstein, 2008). It suggests that public and private standards act as barriers to trade and substantially affect export. Our focus on the implications of standards for developing countries connects our study to the development literature which aims to

understand what limit income opportunities and income growth in developing countries. By crowding out least developed countries out of the high-value crops export market which have a considerable potential for raising rural incomes and reducing poverty, standards also have large implication for the export performance and more generally their development prospect.

The rest of paper is organized as follows. In section 2, we present a conceptual framework to analyze the implications of standards on market concentration. The model provides us the testable implication that increased in the level of stringency of standard increases supplier concentration ratio. In section 3, we discuss the empirical approach and the econometric models with a particular focus on identification issues. Section 4 presents the data and the description of the main variables used in the analysis. Finally, the results are presented and discussed in section 6 followed concluding remarks.

Conceptual framework

We develop a conceptual model of export to show how supplier concentration relates to compliance with food and agricultural products standards. The model builds on the model in Shi, Chavas, and Stiegert (2010) to derive the relationship between the Herfindahl-Hirschman Index of market concentration and the price markup. We argue that compliance with standards operate essentially by raising production and trade costs, and consequently crowds out some supplier from the markets and allows the compliers to enjoy a price premium and a high markup. This, in turn, increases the concentration of the market making it less competitive. The primary purpose of the model is to motivate the empirical analysis. Although we have not analyzed the welfare implications of standards, we can argue that social efficiency of the increased concentration of suppliers depends on whether the benefit from a safer product outweighs the hike in prices paid by consumers.

The model considers a destination country that is divisible into $M = \{1, \dots, M\}$ markets with each markets corresponding to a particular product-type. The division of the market is based on the observable characteristics of the products, which we restrict to the country of origin. Thus, on product type represent import from on specific origin country. Products across markets are similar but not identical. For example, let consider carrot: for the consumer carrot from USA or from Colombia is the same carrot with the exception that one type in sourced from the US and the other type from Colombia. This simplistic hypothesis place the focus on origin country and leaves aside quality differentiation. In our empirical application, we consider horticultural (edible vegetable and fruit) products developed countries OECD countries.

Let denote by $q = (q_1, \dots, q_M)$ the vectors of output supplied to countries by each firm. More specifically q_m is the total value of import from the country m. Each sub-market is characterized by a downward slopped demand and the price-dependent demand is $p_m(y_m)$ with $p'_m(q_m) \leq 0$. For ease of exposition, and without loss of generality, we can consider a linear inverse demand function in each market as: $p_m = a_m - q_m$.

Markets are dependent, and as such, even though the products are distinct, the degree of similarity is such that they are imperfect substitutes. Thus, the demand for imported products from partner country m is a function of the aggregate import, including import from other competing partners. The substitutability also implies that an increase in the aggregate supply in other markets lower the price in the market m. We model this interdependence by reformulating the term a_m as $a_m = a - \sum_{k \neq m}^{M} q_k$. Rewriting equation (1), the inverse demand function for market m is:

$$p_m = a - \sum_{k=1}^{M} q_k \qquad (1)$$

In order to produce and ship products from the country m, and thus to the market m, firms incur a cost $C(q_m)$ that take the simple form $C(q_m) = c_m q_m$ where c_m represents a constant marginal cost specific to each producing country. Firm maximize their profit $\pi_m = (p_m - c_m)q_m$ choosing the quantity to supply. Allowing for corner solution, when it is not profitable to export, the Kuhn-Tucker first order conditions of the maximization problem can be written as.

$$\frac{\partial \pi_m}{\partial q_m} = \frac{\partial p_m}{\partial q_m} q_m + p_m - c_m \leq 0 \quad (2)$$

$$q_m \geq 0 \quad (3)$$

$$\frac{\partial \pi}{\partial q_m} q_m = \left(\frac{\partial p_m}{\partial q_m} q_m + p_m - c_m\right) q_m = 0 \quad (4)$$

Our analysis exploits the information in equation (4) to establish that standards increase supplier concentration. Let denote by $Q = \sum_{m=1}^{M} q_m$ the aggregate import and by $S_m = \frac{q_m}{Q} \in [0.1]$ the market share of country m. Dividing both side of equation (4) by Q, replacing $\frac{\partial p_m}{\partial q_m}$ by -1, and summing across all markets, we have:

$$-\sum_{m=1}^{M} S_m^2 \, Q + p_m - c_m = -Q * HHI + p_m - c_m = 0 \quad (5)$$

With $HHI = \sum_{m=1}^{M} S_m^2$ representing the Herfindahl-Hirschman Index of market concentration. This relation shows that the market concentration index HHI is increasing with the price markup $p_m - c_m$.

To introduce standards in this framework and assess how they affect supplier concentration, we assume that compliance with the requirements of these standards increases firms' production and trade costs. The need to adjust costs to comply with the requirements of SPS measures and private standards often stems from the differences in the production environment, agro-climatic conditions, regulations frameworks, social systems and traditions between trading

partners. Compliance with public standards often entails a complete overhaul and upgrading of production systems, which requires the acquisition of new equipment, the construction of new infrastructure, and a major shift in production practices. In addition, certifications to private standards are costly. For instance, the cost of obtaining GlobalGap certification is as high as 2000 euro per year.

At the same time, compliance with the standards provides several benefits. First, it ensures that the product can be exported and passes inspections at the border. Second, and most importantly, it increases the quality of the products and provides the possibility to benefit from a price premium (Andriamananjara et al., 2004; Cadot and Gourdon, 2014)). For example, the application of procedures to limit the amount residual of chemical substances and contaminants in food products enhance the quality of the product for which many consumers are willing to pay a high price. Standards and certifications assure to consumers that the goods are of certain quality and satisfy some sustainable and social norms. If we assume that producers will likely pass all the increase in production costs due to the standards to the consumers, the resulting net effect of standards on price markup is positive for exporters who comply. This implication, together with the exclusion of some suppliers from the market, will result in an increase in market concentration.

Empirical model and estimation

To assess the impact of food regulations and standards on exporter concentration, we consider the following empirical model

$$Y_{it} = \alpha S_{it} + \beta X_{it} + \delta_t + \mu_i + \varepsilon_{it} \quad (6)$$

Where Y_{it} is our indicator of market concentration is, S is the variable measure the extent of use of standard, X is a vector control variables. Given the panel nature of the data, we include

country fixed-effects to account for unobserved heterogeneity and time fixed effect to account changes that business cycles and changes in trade patterns occurring naturally over time.

We are interesting is estimating the parameter α which measures the impact of increased standards in country I during the year t on the market concentration ratio Y. The estimation of this effect is likely compromised by the observational nature of our data and three potential sources of endogeneity related to measurement errors, reverse causality and selection and omitted variable bias (Greene, 2003). Measurement error is less an issue, particularly since we focus the analysis on developed countries which has a strong data recording systems. Reverse causality is possible if country intentionally seek to alter market structure by setting standards. While there are evidence that standard might act implicitly as protectionism instrument in substitute for tariffs and other quantitative measure, WTO law prohibit differential treatments of supplier. As such it is less likely that altering exporters' concentration ratio drives the setting of standard.

The third threat to the identification of causal effects of standards on market concentration concerns selection and omitted variable bias. It is possible that trade and the use of standards are jointly determined by some observable and unobservable factors that make certain countries more likely to set trade standards and have a highly concentrated supply chain. We first address the problem by including a rich set of control variables carefully selected from the literature. These variables include demand shifters such as income and population. To address the endogeneity due to selection on unobservable, we invoke country fixed effects to control for unobserved country heterogeneity and exploit within variation to consistently estimate the effect of standards on supplier concentration.

Data and variable description

Our empirical analysis focuses on horticultural products, mainly edible vegetables, fruit, nuts, and food related products covered in chapter 7 and 8 of the United Nation Harmonized System of product classification. We aggregate the data for all products within these two chapters. Our choice of these products is motivated by the high value both for exporters and consumers in destination countries, and the high prevalence of standards affecting these products (Bachetta et al., 2012; Disdier and Van Tongeren, 2010).

We collect data from various sources. Our data on public standards are from the World Trade Organization. We focus on SPS-related measures which represent the essential forms of public standards affecting food and agricultural products. The SPS agreements require countries to notify any measures they intend to apply to regulate. These notifications are submitted to the WTO and a public available on the organization website. We collect data on all new measures and amendment to previous measures notified to the WTO for every year over the period 1995-2014. The notifications include the notifying country and the groups of products affected. There is no pre-approval process, and once the notifications are submitted, the country can enforce them immediately or soon after. However, the notification process allows trading partners to have a public record of the measures and dispute them if they believe them to violate international trade rules. For the purpose of our analysis, we focus group of developed countries as defined by the WTO. These countries account for more than half of all notifications. They also represent more than 75% of total world import and are the primary destinations of import from developing countries.

We use the cumulative count of all SPS-related measures notified by a country from 1995 to a given year t. This variable is defined as follows: $Cumul\_SPS_t = \sum_{y=1995}^{t} SPS_t$ with SPS_t measuring the number of measure taken in the year t . The cumulative count better captures the stringency of regulations exporter face when shipping products to country. The rationale behind using the cumulative count lies in the fact that one a regulation is established, it affects trade from the time it went into force onward. To account for the fact that SPS measure takes some time before being fully enforced, we use the first lad and second lag of cumulative count of SPS measures as alternative proxy for standards. This allows us to test for the robustness of the results and also circumvent any potential reverse causality bias.

Our trade data are from the UN COMTRADE. The data contain bilateral import and export data for all country-pairings over the period 1995-2014. Following the standard practice in the trade literature, we use data on import which are more reliably recorded and have fewer missing values. We also restrict the sample of importing countries to developed countries 9see table A1 for the list of countries by group) but include all countries as trading partners. Finally, we get data on control variables such are income per capita, total population, and total import of goods from the World Development Indicators. Table 1 presents the list of variables and provides more information on their definition.

Table 1: Definition of the variables used in the analysis

Variable	Description
Dependent variables	
Product import all	Total import of vegetable and fruits from all countries
Product import developed	Total import of vegetable and fruits from high-income countries
Product import developing	Total import of vegetable and fruits from low-income countries
Share import developed	Share import of vegetable and fruits from high-income countries
Share import developing	Share import of vegetable and fruits from low-income countries
HHI	Herfindahl-Hirschman Index of market concentration
Main explanatory variables	
Cumulative count SPS	Cumulative number of SPS measure notified
Lag 1 Cumulative SPS	First lag cumulative number of SPS measures notified
Lag 2 Cumulative SPS	Second lag cumulative number of SPS measures notified
Control variables	
GDP per capita	Gross Domestic Product per person in $US
Total population	Total population
Total Import of goods	Total merchandise import
EU	Dummy variable indicating membership to the European Union

We present in table 2 some basic descriptive statistics on the variable used in the analysis. The table shows the means and the range of the variables as well as within and between variations. In the sample of countries and years analyzed, about two-third of import of vegetables and fruits is sourced from high-income countries and the remaining one-third is sourced from low-income countries. The Herfindahl-Hirschman Index of market concentration ranges from 492.0 to 5057.8 with a mean of 1352.8. Typically the HHI ranges from 0 for a perfectly competitive market to 10000 for an absolute monopoly. Thus, the range of the HHI is our data suggests a strong degree of competition with developed countries sourcing their products a relatively large number of countries. In overall, the substantial variation in the HHI and the over variables are sufficiently large to permits meaning identification of the effect of standards on concentration ratio of suppliers.

Table 2: Descriptive Statistics of the variables used in the analysis

Variables		Mean	Std. Dev.	Min	Max
Log Product import all	overall	7.22	1.41	3.06	9.92
	between		1.38	3.76	9.28
	Within		0.40	6.46	8.15
Log Product import developed	Overall	6.81	1.35	2.85	9.45
	Between		1.32	3.50	9.03
	Within		0.39	5.89	7.80
Log Product import developing	Overall	5.97	1.59	1.61	9.66
	Between		1.56	2.40	8.95
	Within		0.43	5.10	6.92
Share import developed	Overall	68.19	14.91	20.56	94.34
	Between		14.90	25.22	92.81
	Within		3.15	59.88	86.02
Share import developing	Overall	31.81	14.91	5.66	79.44
	Between		14.90	7.19	74.78
	Within		3.15	13.98	40.12
Herfindahl-Hirschman Index	Overall	1352.82	809.43	492.02	5057.83
	Between		808.49	703.28	4446.64
	Within		172.68	359.63	2131.29
Cumulative count SPS	Overall	39.27	46.23	0.00	364.00
	Between		24.25	0.00	117.00
	Within		39.68	-74.73	286.27
Lag 1 Cumulative SPS	Overall	35.95	41.73	0.00	321.00
	Between		21.65	0.00	104.00
	Within		35.95	-65.05	252.95
Lag 2 Cumulative SPS	Overall	33.03	38.10	0.00	259.00
	Between		19.35	0.00	91.94
	Within		33.06	-55.91	200.09
Log GDP per capita	Overall	10.44	0.42	9.35	11.54
	Between		0.30	9.73	11.00
	Within		0.30	9.74	11.15
Log Population	Overall	2.74	1.47	-1.32	5.76
	Between		1.51	-1.21	5.68
	Within		0.05	2.60	2.88
Log import of goods	Overall	25.88	1.32	21.53	28.69
	Between		1.29	22.30	28.20
	Within		0.42	24.86	26.73
EU membership	Overall	0.57	0.50	0.00	1.00
	Between		0.44	0.00	0.90
	Within		0.24	-0.33	0.67

Results

We estimate three different models to provide a broad effect overview of the effect of SPS measures in developed countries o supplier concentration. We start the analysis, by assessing the effect of SPS measures on total trade. Next, we show that SPS crowd developing countries out of export markets since they are unable to comply with the requirements and also less competitive. Finally, we show that these two effects of standard, taken together, results in high market concentration

Trade effect of SPS measures

Although we are interested in the relationship between SPS measures and supplier concentrations, we start the empirical analysis by first assessing the effect of SPS measures on total trade. For this purpose, we estimate the model specified in equation (6) with the log of the value import of edible vegetables and fruits as the dependent variable. The model is estimated for both for total import, import from high-income countries, and the import from developing countries. The models are estimated using fixed-effects, and the results are presented in table 3 below. The first three columns report the results of the fixed effect estimation using the cumulative count of SPS measures. The next three columns estimate the same set of regression but with the first lag of the cumulative count of SPS measures. Finally, the last three columns use the second lag of the cumulative count of SPS measures. For each of these sets of three consecutive columns, the dependent variable in the first columns (1), (4), and (7) is the log of total import value; the dependent variable in the second columns (2), (5), and (8) is the log of total import value from high-income countries; and the dependent variable in the third columns (3), (6), and (9) is the log of total import value from high developing countries.

In overall, we find that more SPS notifications increase the total value of import by developed countries. This surprising result suggests that the SPS is positively correlated to the total value of imports of vegetables and fruits. The results are qualitatively the same for other proxies of standards used. The finding is consistent with the literature that suggests standards can enhance trade. However, given that we do not have data on quantity and unit prices, we are not able to disentangle the quantity effect from the price effect which may go to opposite direction.

To further understand this results, we run separate regressions for high-income exporters and low-income exporters. The results show that the aggregate increase in trade observed is essentially driven by the growth in import from developed countries. The effect of SPS on the total import of vegetables and fruits from developing countries is negative but not statistically significant at conventional levels of confidences. Thus, the findings suggest that SPS measures tend to promote import from high countries which have higher financial and technical capacities to comply with the requirements of the measures. However, developing countries seem to have been hurt by the stringent SPS measures imposed on import by their developed trade partners. This finding is consistent with most previous results in literature (Disdier and Van Tongeren, 2010; Beghin et al., 2015).

To further explore this finding, we run a regression with the share of import from developing countries as dependent variables. The results presented table 4 support the previous findings and show that the proportion of export from developing countries substantially decreases as a result of SPS measures and the increased import from high-income countries.

Table 3: Effect of SPS measures on import value

Dependent variable is the import of vegetables and fruits	(1) All Countries	(2) High Income	(3) Low Income	(4) All Countries	(5) High Income	(6) Low Income	(7) All Countries	(8) High Income	(9) Low Income
Cumulative count SPS	0.0006***	0.0007***	-0.0001						
	(0.0002)	(0.0002)	(0.0004)						
Lag 1 Cumulative SPS				0.0006***	0.0006***	-0.0004			
				(0.0002)	(0.0002)	(0.0004)			
Lag 2 Cumulative SPS							0.0006**	0.0007**	-0.0007
							(0.0002)	(0.0003)	(0.0005)
Log import of goods	-0.1374**	-0.0449	-0.342***	-0.1030	-0.0152	-0.2936**	-0.0675	0.0079	-0.2440*
	(0.0626)	(0.0690)	(0.1258)	(0.0633)	(0.0691)	(0.1292)	(0.0634)	(0.0692)	(0.1324)
Log GDP per capita	0.7010***	0.7341***	0.6823***	0.6785***	0.7053***	0.6676***	0.6649***	0.6972***	0.6514***
	(0.0566)	(0.0624)	(0.1137)	(0.0574)	(0.0627)	(0.1171)	(0.0572)	(0.0624)	(0.1195)
Log population	1.5984***	1.6599***	1.3660***	1.6448***	1.6853***	1.3973***	1.6394***	1.7130***	1.2483***
	(0.1828)	(0.2015)	(0.3672)	(0.1823)	(0.1991)	(0.3721)	(0.1850)	(0.2019)	(0.3862)
EU member	-0.0046	0.0100	-0.0522	-0.0231	-0.0091	-0.0550	-0.0257	-0.0095	-0.0630
	(0.0278)	(0.0306)	(0.0558)	(0.0365)	(0.0399)	(0.0746)	(0.0354)	(0.0386)	(0.0738)
Constant	-1.1492	-4.390***	3.5848	-1.8577	-4.875***	2.5127	-2.5983**	-5.451***	1.8369
	(1.2190)	(1.3437)	(2.4484)	(1.2501)	(1.3652)	(2.5514)	(1.2716)	(1.3874)	(2.6542)
Observations	440	440	440	418	418	418	396	396	396
R-squared	0.962	0.952	0.870	0.963	0.954	0.870	0.965	0.956	0.871
Number of countries	22	22	22	22	22	22	22	22	22

Robust Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table 4: Effect of SPS measure on the share of import from developing countries

Dependent variable is the share of import of vegetables and fruit from developing countries	(1)	(2)	(3)
Cumulative count SPS	-0.0153**		
	(0.0070)		
Lag 1 Cumulative SPS		-0.0199**	
		(0.0080)	
Lag 2 Cumulative SPS			-0.0266***
			(0.0093)
Log import of goods	-5.6605**	-5.4888**	-5.0707**
	(2.3513)	(2.3974)	(2.4714)
Log GDP per capita	-1.6868	-1.3164	-1.4530
	(2.1252)	(2.1733)	(2.2306)
Log population	-2.7265	-2.5649	-5.9303
	(6.8629)	(6.9032)	(7.2108)
EU member	-1.1405	-0.8057	-0.9390
	(1.0433)	(1.3833)	(1.3781)
Constant	198.4732***	190.8522***	191.1704***
	(45.7573)	(47.3353)	(49.5593)
Observations	440	418	396
R-squared	0.139	0.134	0.137
Number of countries	22	22	22

Robust Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Effect of SPS on market concentration

The previous analysis provides the evidence that SPS measures related to vegetables and fruits in developed countries crowd out export by developing countries while promoting export by high-income countries. However, for domestic consumers what matters the most is the effect on market structures as it has important implication for price and welfare. To answer this question, we run a regression of SPS measures on the Herfindahl-Hirschman Index of market concentration. The results of the fixed-effects regression are presented in table 5 below. We find that SPS measures do increase market concertation ratio suggesting that the export market in developed

countries become less competitive. Our result is an evidence of a trade-distorting effect of standards and other related measures, particularly for developing countries.

Table 5: Effect of SPS measures on supplier's concentration ratio measured by the Herfindahl-Hirschman Index

Dependent variable is the Herfindahl-Hirschman Index	(1)	(2)	(3)
Cumulative count SPS	2.7070***		
	(0.3777)		
Lag 1 Cumulative SPS		3.3778***	
		(0.4133)	
Lag 2 Cumulative SPS			4.0676***
			(0.4687)
Log import of goods	121.2014	150.7401	165.6053
	(126.8728)	(123.9376)	(123.9757)
Log GDP per capita	176.9551	138.6017	100.9165
	(114.6717)	(112.3503)	(111.8983)
Log population	-470.0408	-318.1707	-64.5081
	(370.3123)	(356.8712)	(361.7281)
EU member	41.2581	-18.2368	-13.8654
	(56.2971)	(71.5096)	(69.1295)
Constant	-2,268.6011	-3,010.3523	-3,660.8191
	(2,468.9872)	(2,447.0792)	(2,486.1175)
Observations	440	418	396
R-squared	0.165	0.200	0.224
Number of countries	22	22	22

Robust Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Conclusion

World trade has increased tremendously over the past decades as result of a substantial decline in tariffs, other forms of quantitative protectionist measures, and major technological improvements in storage, processing, and transportation. Despite this progress in trade liberalization, new forms of trade policies instruments, termed as non-tariff measures, acquire a growing importance and raise the question of their implications for trade. In the recent year, the world trade, and in particular the food system is increasingly governed by various public and private regulations. The most popular forms of these regulations affecting agricultural and food products are technical measures such as the Sanitary and Phytosanitary Measures. These measures are predominantly used by developed countries, but also increasingly used by developing countries to regulate the flow of food products into their countries. This study assesses the trade effect of SPS measures. It focuses on measures imposed by developed countries on vegetables and fruits product and their impact of import and market structure.

Our analysis combines data on trade from the UN COMTRADE with SPS notifications submitted to the WTO over the period 1995-2014. We run regressions of the cumulative number of SPS measures on the total value of import from various groups of countries, the share of import from developing countries, and the Herfindahl-Hirschman Index of market concentration. We exploit the panel nature of the data and estimate fixed-effects regression to address unobserved countries heterogeneity. We find SPS measures have substantial trade-distorting effects but countries are not affected symmetrically. More specifically, we find that increases in SPS measures taken by a developed country reduce the import of vegetables and fruits imports from developing countries, but promote import from high-income countries. As a consequence, standards that are more stringent result in higher concentration of suppliers.

Our paper addresses an important question related to the trade effects of standards. The findings suggest that public regulations by developed countries have important trade-distorting effects and is especially unfavorable to developing countries. Given that export of high-value products to developed countries is essential income generating activities for developing countries, it is important that these countries receive the support to comply with SPS measures and improve their competitiveness.

Despite our effort to empirically and consistently estimate the effect of standards on trade, our paper has some limitations that need to be highlighted and addressed in further research. While we focus our analysis on vegetables and fruits products, standards affect all products, and their trade effects might depend on the type of products. Thus, expanding the analysis to other products would provide a broader perspective on the impact of SPS measures on trade. Although SPS measures are the most common form of public standards, it also important to note that other forms of non-tariff measures such as technical barriers to trade (TBT) measures and private voluntary standards play a significant and increasing role in the food system. Expanding the analysis to these forms of standards is an important question to address. TBT measures are less common for primary food products such as vegetables and fruits but are significant for processed food products and manufactured goods. Private standards are crucial, but panel data on these measures at countries level are scant. Expanding the analysis at the firm level is an avenue of research that can be explored to incorporate private standards. Finally, understanding the motivation of countries in setting standards and accounting for this in the econometric models will be essential to address any remaining bias in the estimation to selection on unobservable.

References

Andriamananjara, S., Dean, J. M., Ferrantino, M. J., Feinberg, R. M., Ludema, R. D., and Tsigas, M. E. (2004). The effects of non-tariff measures on prices, trade, and welfare: CGE implementation of policy-based price comparisons. *Trade, and Welfare: CGE Implementation of Policy-Based Price Comparisons (April 2004)*.

Arvis, J.-F., Duval, Y., Shepherd, B., Utoktham, C., and Raj, A. (2016). Trade Costs in the Developing World: 1996–2010. *World Trade Review*, *15*(03), 451–474.

Baldwin, R. (2016). The World Trade Organization and the Future of Multilateralism. *The Journal of Economic Perspectives*, *30*(1), 95–115.

Beghin, J., Maertens, M., and Swinnen, J. F. (2015). Non-tariff measures and standards in trade and global value chains. *Annual Review of Resource Economics*, *7*.

Bernhofen, D. M., El-Sahli, Z., and Kneller, R. (2016). Estimating the effects of the container revolution on world trade. *Journal of International Economics*, *98*, 36–50.

Cadot, O., and Gourdon, J. (2014). Assessing the price-raising effect of non-tariff measures in Africa. *Journal of African Economies*, eju007.

DeLind, L. B., and Howard, P. H. (2008). Safe at any scale? Food scares, food regulation, and scaled alternatives. *Agriculture and Human Values*, *25*(3), 301–317.

Disdier, A.-C., Fontagné, L., and Mimouni, M. (2008). The impact of regulations on agricultural trade: evidence from the SPS and TBT agreements. *American Journal of Agricultural Economics*, *90*(2), 336–350.

Disdier, A.-C., and Van Tongeren, F. (2010). Non-tariff measures in agri-food trade: What do the data tell us? Evidence from a cluster analysis on OECD imports. *Applied Economic Perspectives and Policy*, ppq008.

Fulponi, L. (2006). Private voluntary standards in the food system: The perspective of major food retailers in OECD countries. *Food Policy*, *31*(1), 1–13.

Greene, W. H. (2003). Econometric analysis, 5th. *Ed.. Upper Saddle River, NJ*.

Helpman, E., Melitz, M., and Rubinstein, Y. (2008). Estimating Trade Flows: Trading Partners and Trading Volumes. *The Quarterly Journal of Economics*, *123*(2), 441–487.

Henson, S., and Humphrey, J. (2009). The impacts of private food safety standards on the food chain and on public standard-setting processes. *Joint FAO/WHO Food Standards Programme, Codex Alimentarius Commission, Thirty-Second Session, FAO Headquarters, Rome, 29*.

Henson, S., and Northen, J. (1998). Economic determinants of food safety controls in supply of retailer own-branded products in the United Kingdom. *Agribusiness*, *14*(2), 113–126.

Jaffee, S., Meer, K. V. D., and Henson, H. (2005). Food Safety and Agricultural Health Standards. *World Bank*.

Jaud, M., Cadot, O., and Suwa-Eisenmann, A. (2013). Do food scares explain supplier concentration? An analysis of EU agri-food imports. *European Review of Agricultural Economics*, jbs038.

Josling, T. E., Roberts, D., and Orden, D. (2004). Food regulation and trade: toward a safe and open global system. *Peterson Institute Press: All Books*.

Kee, H. L., Neagu, C., and Nicita, A. (2013). Is protectionism on the rise? Assessing national trade policies during the crisis of 2008. *Review of Economics and Statistics*, *95*(1), 342–346.

Maskus, K. E., Otsuki, T., and Wilson, J. S. (2005). The cost of compliance with product standards for firms in developing countries: An econometric study. *World Bank Policy Research Working Paper*, (3590).

Peterson, E., Grant, J., Roberts, D., and Karov, V. (2013). Evaluating the trade restrictiveness of phytosanitary measures on US fresh fruit and vegetable imports. *American Journal of Agricultural Economics*, *95*(4), 842–858.

Shi, G., Chavas, J., and Stiegert, K. (2010). An analysis of the pricing of traits in the US corn seed market. *American Journal of Agricultural Economics*, *92*(5), 1324–1338.

World Trade Organization (2012) World Trade Report 2012: Trade and public policies: A closer look at non-tariff measures in the 21st century

Appendix

Table A1: Group of countries based on World Bank Classification

Groups	**List of countries**
Developed countries (importers)	Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Japan, Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, United Kingdom, States of America
High-income countries (exporters)	Aruba, Andorra, United Arab Emirates, Antigua and Barbuda, Australia, Austria, Bahrain, Bahamas, Belgium-Luxembourg, Bermuda, Barbados, Brunei, Canada, Switzerland, Chile, Cayman Islands, Cyprus, Czech Republic, Germany, Denmark, Spain, Estonia, Finland, France, United Kingdom, Gibraltar, Greece, Greenland, Guam, Hong Kong, Croatia, Hungary, Ireland, Iceland, Israel, Italy, Japan, Saint Kitts and Nevis, South Korea, Kuwait, Lithuania, Latvia, Malta, New Caledonia, Netherlands, Norway, Nauru, New Zealand, Oman, Poland, Portugal, French Polynesia, Qatar, Saudi Arabia, Singapore, San Marino, Slovakia, Slovenia, Sweden, Seychelles, Trinidad and Tobago, Uruguay, United States
Developing income countries (exporters)	Afghanistan, Angola, Anguilla, Albania, Netherlands Antilles, Argentina, Armenia, American Samoa, Azerbaijan, Burundi, Benin, Burkina Faso, Bangladesh, Bulgaria, Bosnia and Herzegovina, Belarus, Belize, Bolivia, Brazil, Bhutan, Central African Republic, China, Cote d'Ivoire, Cameroon, Democratic Republic of the Congo, Republic of the Congo, Cook Islands, Colombia, Comoros, Cape Verde, Costa Rica, Cuba, Christmas Island, Djibouti, Dominica, Dominican Republic, Algeria, Ecuador, Egypt, Eritrea, Ethiopia, Fiji, Micronesia, Gabon, Georgia, Ghana, Guinea, Gambia, Guinea-Bissau, Equatorial Guinea, Grenada, Guatemala, Guyana, Heard Island and McDonald Islands, Honduras, Haiti, Indonesia, India, Iran, Iraq, Jamaica, Jordan, Kazakhstan, Kenya, Kyrgyzstan, Cambodia, Kiribati, Laos, Lebanon, Liberia, Libya, Saint Lucia, Sri Lanka, Macau, Morocco, Moldova, Madagascar, Maldives, Mexico, Macedonia, Mali, Burma, Montenegro, Mongolia, Mozambique, Mauritania, Mauritius, Malawi, Malaysia, Niger, Nigeria, Nicaragua, Niue, Nepal, Pakistan, Panama, Peru, Philippines, Palau, Papua New Guinea, North Korea, Paraguay, Palestine, Romania, Russia, Rwanda, Sudan, Senegal, South Georgia South Sandwich Islands, Saint Helena, Solomon Islands, Sierra Leone, El Salvador, Somalia, Serbia, South Sudan, Sao Tome and Principe, Suriname, Syria, Chad, Togo, Thailand, Tajikistan, Turkmenistan, Timor-Leste, Tonga, Tunisia, Turkey, Tuvalu, Tanzania, Uganda, Ukraine, Uzbekistan, Saint Vincent and the Grenadines, Venezuela, Vietnam, Vanuatu, Wallis and Futuna, Samoa, Areas, Yemen, Yugoslavia, South Africa, Zambia, Zimbabwe