The Impact of Sanitary and Phytosanitary Measures on Market Entry and Trade Flows*

Pramila Crivelli† and Jasmin Gröschl‡

August 6, 2012

Abstract

In an attempt to disentangle the impact of sanitary and phytosanitary (SPS) measures on trade patterns, we estimate a Heckman selection model on the HS4 disaggregated level of trade. We find that aggregated SPS measures constitute barriers to agricultural and food trade consistently to all exporters. But conditional on market entry, trade flows are positively affected by SPS measures. Additionally, we find that SPS measures related to conformity assessment hamper market entry and trade flows, while SPS measures related to product characteristics pose an entry barrier but increase bilateral trade flows conditional on meeting the standard.

Keywords: Agriculture, International Trade, Sanitary and Phytosanitary Measures, Conformity Assessment, Heckman Selection Model
JEL-Classification: C23, F14, Q17

*We are grateful for comments and suggestions by Gabriel Felbermayr, Benedikt Heid, Marcelo Olarreaga, Roberta Piermartini, and by participants at the Geneva Trade and Development Workshop 2012, especially Gretchen Stanton, Michele Ruta, Cristian Ugarte, Marco Fugazza, Nicolas Maystre and Céline Carrère. We thank Gianluca Orefice for the preparation of the database and Joonas Uitonen for preparing the split of SPS measures in the SPS database. This study was conducted as research for the World Trade Report 2012. The authors worked as consultants for the WTO during the writing of this paper.

†University of Geneva, Switzerland; pramila.crivelli@unige.ch

‡Ifo Institute - Leibniz Institute for Economic Research at the University of Munich, Poschingerstr. 5, 81679 Munich, Germany; groeschl@ifo.de

In the light of decreasing tariffs, quotas and prohibitions due to multilateral and bilateral agreements over the last decades, non-tariff measures (NTMs), such as sanitary and phytosanitary (SPS) measures[1], are on the rise. Countries seek alternatives to protect what was previously carried out by classical trade policy instruments (Roberts, Josling and Orden, 1999). SPS measures pose methods partly regulated under the SPS Agreement of the World Trade Organization (WTO), but their design and use are less restricted and rather flexible. In principle, SPS measures are meant to provide countries with a possibility to protect the health of animals, humans and plants, but major concerns are regularly expressed that SPS regulations are used as protectionist devices. Due to their design, SPS measures may also be used as instruments to achieve certain policy objectives, such as protecting domestic producers, even though WTO members[2] are required to restrain from applying measures for any protectionist purposes.

Limited knowledge on the particular trade effects of SPS measures exists. Economic theory does not provide a clear cut prediction on the impact of standards on trade. Instead, theory suggests that the impact of SPS measures on agriculture and food trade may be diverse and need not always be negative. While increased production costs that may arise in order to meet higher SPS standards reduce trade, information on food safety and product quality may lead to increased consumer confidence and trust in foreign products, reduced transaction costs and thus foster trade. Further, trade may also rise due to increased producer efficiency, as quality signals help to promote the competitiveness of foreign producers who meet stringent standards. This suggests that the implied trade effect of standards depends on the relative costs of domestic to foreign production and the willingness of consumers to pay a higher price for safer products (WTO, 2012). To achieve a certain health safety objective, policy makers can choose from a range of different SPS measures. These measures

[1]This paper focuses on SPS measures, most prevalent in agricultural and food trade.
[2]All of which are also members of the SPS Agreement.

entail diverse effects on trade as some affect fixed costs and thus market entry, while others affect post-entry activities, hence, variable trade costs. Assessing the effects of SPS measures on the intensive and extensive margins of trade is thus an empirical issue.

Recent empirical research on the nexus between NTMs and trade has mostly been focusing on the forgone trade via the gravity equation. They provide evidence that NTMs hamper trade (Gebrehiwet, Ngqangweni and Kirsten, 2007; Disdier, Fontagné and Mimouni, 2008; Anders and Caswell, 2009), while harmonization of regulation fosters trade (De Frahan and Vancauteren, 2006). But, when looking at various sectors, Fontagné, Mimouni and Pasteels (2005) and Disdier, Fontagné and Mimouni (2008) find positive and negative NTM effects. These approaches focus on aggregate NTMs rather than on the trade effect of diverse regulations that equivalently reduce risk with respect to health safety. Evidence on product-specific regulations, such as maximum residue levels, suggests that such measures hamper trade (Otsuki, Wilson and Sewadeh, 2001*a*,*b*; Wilson and Otsuki, 2004; Disdier and Marette, 2010; Jayasinghe, Beghin and Moschini, 2010; Drogué and DeMaria, 2011; Xiong and Beghin, 2011).

Three main issues arise within the literature. First, most of the previous studies assess the impact of either a global or a specific SPS measure on the volume of trade at the aggregate or sectoral level. But, they rarely provide evidence regarding potential market entry barriers caused by regulations. To our knowledge, only three studies identifying the impact of SPS measures on the intensive and extensive margins. Using a Heckman selection model, Disdier and Marette (2010) find an insignificant effect of maximum residue levels (MRLs)[3] on market entry but a negative significant impact on the import volume of crustaceans. Jayasinghe, Beghin and Moschini (2010) show that the probability to trade and the trade volume of US corn seeds are both negatively affected by MRLs. Xiong and Beghin (2011) analyze the effect of EU aflatoxin standards on

[3]MRLs are standards imposed by countries on maximum pesticide levels or toxic compounds in food or agricultural products. Disdier and Marette (2010) use limits on chloramphenicol in crustacean imports.

trade in groundnuts between the EU15 and nine African countries from 1989 to 2006. They find no significant impact of the MRL set by the EU on trade in groundnuts. Contrasting results may arise from sector or country specific factors or from different definitions of SPS measures. While Disdier and Marette (2010) define SPS measures using country specific MRLs, Jayasinghe, Beghin and Moschini (2010) use SPS regulations based on EXCERPT (Export Certification Project Demonstration), and Xiong and Beghin (2011) use data from the Food and Agricultural Organization (FAO) on global regulations and from the European Communities on aflatoxin contaminants. Thus, further research is needed in order to provide solid evidence on the impact of SPS measures on both market entry and trade volumes in agricultural and food products.

Second, most studies focus on a specific measure, such as MRLs, and can thus not compare the impact of various SPS instruments on trade, even though policy makers may choose from a range of possible measures to achieve equivalent health safety objectives. Heterogeneity across countries in implementing diverse SPS requirements may cause ambiguous trade outcomes. To our knowledge, the only two studies that deal with the impact of different regulatory measures on trade are Schlueter, Wieck and Heckelei (2009) and Fassarella, Pinto de Souza and Burnquist (2011). Both studies look specifically at the meat sector. Schlueter, Wieck and Heckelei (2009) estimate the impact of various types of SPS measures on trade in meat products. The authors estimate a Poisson pseudo maximum likelihood (PPML) gravity model on trade flows of meat on the HS4 digit level. Aggregated over all regulatory instruments, they find a positive effect of SPS on trade flows in meat products. Disaggregated results show diverse effects. In particular, conformity assessment promotes trade in the meat sector. In a similar manner, Fassarella, Pinto de Souza and Burnquist (2011) analyze the effect of SPS and TBT measures on Brazilian exports of poultry meat between 1996 and 2009. Deploying a PPML model, they find an insignificant impact of aggregated measures on Brazilian exports of poultry meat. On the disaggregated level, the authors find that conformity assessment-related measures decrease the volume of poultry meat exports from Brazil to its major trade partners, while requirements on quarantine treatment and labeling increase the amount of poultry trade. As results on SPS measures on the aggregated and on the disaggregated level are only available for the meat sector and are ambiguous across studies, even contradict each other, the topic needs more insight and investigation.

Third, previous studies often use notification-based data. Contrasting this, our paper deploys the more sophisticated specific trade concerns database of the WTO. The trade concerns database overcomes limitations of notification-based data[4] because government incentives to report a concern increase if a SPS measure potentially affects their trade. In addition, the database allows us to consistently differentiate SPS measures and to perform bilateral estimations.

This paper builds on the previous literature but contributes by assessing the impact of SPS measures on the extensive and the intensive margin of trade, not only in a specific industry, but aggregated over all agricultural and food sectors. More specifically, we assess the impact of SPS measures on the probability to enter a destination market and on the trade volume. To control for zero trade flows and a potential sample selection bias, we use a Heckman selection model. The key findings of the study are that concerns over SPS measures pose a negative impact on the probability to export to a concerned market. Although, conditional on market entry, the amount of exports to markets with SPS measures in place tends to be higher. A possible explanation of the positive effect relates to the fact that information provision to the consumer may be relatively stronger than the costs of the producer. By enhancing consumer trust in foreign products, SPS measures increase trade for foreign exporters that manage to overcome the fixed cost of entering a market.

We further differentiate the impact of bilateral from multilateral SPS measures by assessing the impact of a SPS concern on the market entry and trade volumes of all potential trade partners of a protected market. Our results sug-

[4]WTO members have usually no incentives to notify their own SPS measures.

gest that SPS measures deter market entry uniformly across all trading partners, whereas SPS measures positively affect bilateral exports, namely of the country raising the concern. Besides, SPS measures have a negative impact on the trade volumes of other exporters.

In an attempt to identify the channels that lead to our results, we systematically assess the relevance of different SPS measures applied for various safety purposes on trade in agriculture and food. The analysis distinguishes concerns related to conformity assessment (i.e., certificate requirements, testing, inspection and approval procedures) and concerns related to the characteristics of a product (i.e., requirements on quarantine treatment, pesticide residue levels, labeling or packaging). In particular, we show that conformity assessment-related SPS measures constitute a market entry barrier, as such measures might be particularly burdensome and costly, while SPS measures related to product characteristics explain most of the increase in the amount of trade. The latter suggests that SPS product characteristic measures sufficiently enhance consumer trust such as to foster trade. This contribution is particularly interesting for policy makers as they often have to choose from a range of measures that are assumed to equivalently reduce health risks but entail diverse trade costs. Depending on a policy maker's choice of SPS measures, the implied impact on trade varies strongly. In addition, we show that conformity assessment-related SPS measures constitute a market entry barrier to all potential trade partners, whereas product characteristic measures positively affect the trade volume of the country raising a concern at the SPS committee of WTO.

The remainder of the paper is structured as follows. Section I. provides detailed information on the empirical strategy and describes the data. In section II., we provide benchmark results on the Heckman selection model using the aggregate SPS measure and a sensitivity analysis of results. Section III. distinguishes by type of concern (conformity assessment versus product-related concerns). The last section concludes.

I. Empirical Strategy and Data

A. Empirical Strategy

In an attempt to disentangle the impact of SPS measures on trade in agricultural and food products, we estimate a Heckman selection model (Heckman, 1979) to control for a possible bias in our results from non-random selection or zero trade flows in the data. Controlling for zero trade flows is important as SPS measures implemented in the wake of a disease outbreak might provoke a complete ban in the trade of some products. An alternative way to control for zeros would be to estimate a Poisson model. In contrast to the Heckman model, the Poisson method assumes that there is nothing special about zero trade and would not allow us to tackle the sample selection issue with respect to reporting. While the Poisson model is able to better control for heterogeneity, it disregards the existence of another data generating process that produces excessive zeros in the trade matrix caused by self-selection into no trade.[5] Hence, we prefer the Heckman method. Besides, the Heckman model enables us to distinguish the effect of SPS measures on the extensive margin (the probability to trade) and the intensive margin (the amount of trade conditional on market entry). The latter considers zero trade values by potential censoring. We estimate both, the selection and the outcome equations, simultaneously using the maximum likelihood technique.[6] Both equations include the same independent variables, except for the selection variable, in our case common religion as in Helpman, Melitz and Rubinstein (2008). The selection variable helps to identify the model as it is assumed to have an impact on the fixed costs of trade, but to have a negligible effect on variable trade costs. We estimate a probit binary

[5]Alternatively estimating zero inflated Poisson or a negative binomial model is not easy either. Due to strong non-linearity, they are difficult to implement (Greene, 2003).

[6]Wooldridge (2002, p.566) states that the maximum likelihood method produces more efficient estimates, preferable standard errors, and likelihood ratio statistics compared to the two-step estimation technique.

choice model of the form

$$\begin{aligned}\Pr(M_{ijts} > 0) = \mathbf{\Phi}[\hat{\alpha_1} SPS_{ij(t-1)s} + \hat{\alpha_2} \ln(GDP_{it} \times GDP_{jt}) \\ + \hat{\alpha_3} \ln(POP_{it} \times POP_{jt}) + \boldsymbol{\hat{\alpha}_4 X_{ij}} + \boldsymbol{\hat{\alpha}_5 MR_{ijts}} \\ + \nu_i + \nu_j + \nu_s + \nu_t + \varepsilon_{ijts}]\end{aligned} \tag{1}$$

where $\mathbf{\Phi}(\cdot)$ is a standard normal distribution function. And an outcome equation of the form

$$\begin{aligned}\ln(M_{ijts}|M_{ijts} > 0) = \beta_1 SPS_{ij(t-1)s} + \beta_2 \ln(GDP_{it} \times GDP_{jt}) \\ + \beta_3 \ln(POP_{it} \times POP_{jt}) + \boldsymbol{\beta_4 X_{ij}} + \boldsymbol{\beta_5 MR_{ijts}} \\ + \beta_\lambda \lambda(\boldsymbol{\hat{\alpha}}) + \nu_i + \nu_j + \nu_s + \nu_t + \epsilon_{ijts}\end{aligned} \tag{2}$$

where M_{ijts} denotes the import values of a specific HS4 product s of country j from country i at time t. $SPS_{ij(t-1)s}$ reports a concern over a SPS measure between the reporting country i and the maintaining country j at time $t-1$ for a specific HS4 product line. $\ln(GDP_{it} \times GDP_{jt})$ depicts the log of the product of GDPs of country i and country j at time t and $\ln(POP_{it} \times POP_{jt})$ denotes the log of the product of country $i's$ and country $j's$ total population at time t. These variables proxy for the supply capacities and market capacities of the exporting and the importing countries. The vector $\boldsymbol{X_{ij}}$ contains the usual gravity controls, such as the log of distance, measured as the geographical distance between capitals, adjacency, common language and variables of colonial heritage. The vector $\boldsymbol{MR_{ijts}}$ contains multilateral resistance terms based on adjacency, distance, common language and variables of colonial heritage, as well as on the SPS concern. We follow Baier and Bergstrand (2009), who derive theory-consistent MR indexes from a Taylor series expansion of the Anderson and Van Wincoop (2003) gravity equation. We adapt their strategy to the panel environment. Hence, all regressions include multilateral resistance terms.[7] To control for any country-

[7]A popular alternative way to account for multilateral remoteness would be to include the full array of interaction terms between country and year dummies and combined fixed effects.

specific characteristics, product specifics and time trends, we include full arrays of importer ν_i, exporter ν_j, HS4 product ν_s, and year dummies ν_t separately in the equation. Hence, we control for a wide array of observable and unobservable factors, i.e., geographical variables or global business cycles.[8] Error terms ε_{ijts} are heteroskedasticity-robust and clustered at the country-pair level. $\lambda(\hat{\boldsymbol{\alpha}})$ denotes the inverse mills ratio which is predicted from equation (1).[9]

The focus of this paper is on SPS concerns reported by exporters to the WTO. For SPS measures, we consider two different variables: (i) a dummy variable equal to one if at least one concern is notified at the 4-digit level of the HS classification, and (ii) a normalized frequency measure $\text{SPSFreq}_{ij(t-1)s}$. The normalized SPS measure is defined as the number of concerns on HS4 products within a HS2 product category and divided by the total number of HS4 product items within the HS2 sector. In a second approach, we dissociate the impact of the measure on the country raising the concern from the impact on all potential exporters. We thus additionally include a *multilateral* variable equal to one if at least one concern regarding a measure maintained by a given importer exists ($\text{SPS}_{j(t-1)s}$), and its associated normalized frequency SPS measure ($\text{SPSFreq}_{j(t-1)s}$). To circumvent potential reverse causality between imports and SPS measures, we use the first lag of the variable on SPS concerns.[10]

However, due to the large number of observations this is computationally not possible in our sample. Within transformation is unfortunately not possible with the Heckman specification due to the nonlinearity of the first stage.

[8]The large number of observations does not allow for the use of combined fixed effects and within transformation is not possible using the Heckman model due to the nonlinearity of the first stage.

[9]The inverse mills ratio is the ratio of the probability density function over the cumulative distribution function of $\hat{M}_{ijts}$ from equation (1).

[10]Using further instrumentation methods is not straightforward in the Heckman model. For robustness reasons, we estimate a probit and a two stage least squares (2SLS) model separately. The two instruments used in the 2SLS model are (i) the sum of SPS concerns of all other partner countries $k \neq i$ against the importer j in sector s and (ii) the sum of SPS concerns raised by country i against the importer j in sectors l different from s but within the same HS2 category. Results in Table 5 Panel A and Panel B confirm our findings. Hence, forward looking actors seem not to be a problem in our framework.

B. Data Sources and Sample

The SPS Information Management System (SPS IMS) of the WTO contains information on specific SPS concerns reported to the WTO by a raising country towards a maintaining country for 1995 to 2010, respectively.[11] For each single concern, we have information on the raising and maintaining country, the HS4 product code concerned, the year in which the concern was reported to the WTO, and whether it has been resolved. To measure SPS restrictions, we generate a simple dummy variable on SPS concerns that is equal to one when a concern is reported to the WTO and shifts to zero whenever the concern is resolved. Alternatively, we also calculate a normalized frequency measure, which counts the number of SPS measures in place on HS4 product lines within an HS2 sector and divides them by the number of products within an HS2 sector. Similar 'normalized' frequency measures on various levels of disaggregation have also been used by Fontagné, Mimouni and Pasteels (2005); Disdier, Fontagné and Mimouni (2008); Fontagné et al. (2012). If HS4 product codes are not available, but instead the HS2 sector is listed in the concern, we assume that all HS4 product lines under the HS2 sector are affected. The database reports the HS2002 classification, which are converted to the HS1992 classification to be able to merge them to the trade data.

Further, to consider the possible heterogeneity of various SPS measures, we divide concerns into two categories in accordance to the specific description of concerns contained in the SPS database, referenced documents, or occasionally national documents, if the database and referenced documents were too vague about a certain concern. We create two dummy variables indicating whether a specific concern relates to conformity assessment or product characteristics. Conformity assessment-related measures refer to Annex C of the SPS Agreement and include concerns about certification requirements, testing, inspection and approval procedures. Annex C was understood broadly. Hence, conformity assessment-related measures also include concerns on delays, un-

[11] The SPS Information Management System is available under http://spsims.wto.org.

revoked suspensions, or administrative procedure problems. Measures related to product characteristics refer to concerns regarding the requirements on process and production methods, transport, packaging, and labeling that are directly related to food safety, concerns on the requirements of pesticide residue levels and quarantine or cold treatments, as well as concerns over strict bans, regional division, or protected zones. Concerns depicted in the WTO database may relate to one, or both issues at the same time. Out of the 312 trade concerns raised by one or several countries against a specific importing country, 57 percent are associated with conformity assessment-related measures, while 78 percent relate to concerns over product characteristics.

Data on bilateral trade come from the United Nations Commodity Trade Statistics Database (Comtrade) and are obtained in the HS1992 classification. The European Union is considered as a single country, hence, trade data is summed up over all EU member states. Total population and nominal GDP in US dollars provide a proxy for market size. Data stem from the World Bank's World Development Indicator (WDI) database and enter equations through the log of the product of the GDPs of the importer and the exporter and the log of the product of the total population of the importer and the exporter. Bilateral distance is the geographic distance between capitals.[12] Data is extracted from the CEPII database on distance and geographical variables, as are all other gravity variables contained in the equations, such as adjacency, common language, and variables on colonial heritage. Data on common religion across countries is obtained from Elhanan Helpman's homepage. Helpman, Melitz and Rubinstein (2008) define the index of common religion across countries as (% Protestants in country i × % Protestants in country j) + (% Catholics in country i × % Catholics in country j) + (% Muslims in country i × % Muslims in country j).

For robustness checks, we include applied tariff data that are combined from the WTO's Integrated Data Base (IDB) and UNCTAD's Trade Analysis and Information System (TRAINS). As tariff data have little time variation and are miss-

[12] The distance to and from the EU is measured as the distance to and from Brussels.

ing to a large part, we only include them in a robustness check.[13] IDB tariff data are preferred over TRAINS if both are available, as IDB contains comprehensive information on applied preferential tariffs *and* provides data on general tariff regimes whenever available. To handle missing observations and to keep as many observations as possible, we adapt an 'interpolation' rule. If a tariff is available for a certain HS4 product in a certain year, we assume that the same tariff was also valid for the HS4 product up to 4 years previous to the tariff reported in the database if these are missing. After the 'interpolation' rule has been adapted, we further assume that all remaining missing observations are zero, to keep the exact similar sample as to when not including tariff data. Following the literature, we use applied tariff data that is weighted by imports.

Our sample consists of 164 importer and 150 exporting countries, and 224 HS4 product categories in 34 HS2 sectors (compare Table 11) observed over a time period of fifteen years, from 1996 to 2010, due to the lag considered in the SPS measure implemented to circumvent reverse causality.

II. SPS Measures and Trade

A. Benchmark Results

The first two columns of Table 1 present results using the SPS dummy variable, while columns (3) and (4) use the normalized SPS frequency measure. All regressions include importer, exporter, and HS4 product fixed effects, a full array of year dummies and multilateral resistance terms. In addition, all columns include gravity controls. These are the log of the product of GDPs, the log of the product of populations, the log of distance, adjacency, common language and colonial heritage. Common religion is the selection variable and thus excluded in column (2) and (4), respectively. All specifications apply the Heckman selection procedure using the maximum likelihood approach and thus account for

[13]Results on the impact of SPS measures on trade do not change qualitatively nor quantitatively by the inclusion of tariffs.

potential sample selection and zero trade flows.

Overall, gravity variables are in line with the literature. Countries similar in income trade more with another, while countries similar with respect to population size show a higher probability to trade, but no significant effect on the amount of trade conditional on market entry. As expected, distance has a negative impact on trade, and adjacency, common language and common colonial heritage increase trade, while country pairs in a colonial relation after 1945 experience a negative impact on the probability and the amount of trade. Common religion reduces the fixed costs of trade, hence, positively affects the probability of market entry. This result is in line with the findings of Helpman, Melitz and Rubinstein (2008). As in Helpman, Melitz and Rubinstein (2008), we assume that common religion does not affect trade flows once the exporting decision has been made.

In column (1), we find a significantly lower probability to trade bilaterally in the presence of SPS concerns. Our results suggest that the probability to enter an export market is about 4.3 percent lower in the presence of a SPS measure (compare Table 2 column (1) for marginal effects). This indicates that SPS measures increase fix costs of trading and thus constitute an effective market entry barrier in agricultural and food sectors. Interestingly, the outcome equation in column (2) indicates that SPS measures significantly increase the amount of trade once a market has been entered. This positive effect can be explained by the fact that SPS measures provide information on product safety to consumers. If SPS measures enhance consumer trust in the quality of imported goods proportionally more than they increase variable trade costs due to product adaption, producers gain market share. This leads to an increase in trade volumes for exporters that manage to overcome the fixed cost of entering a market. The dummy variable indicates that SPS measures increase the amount of trade in agriculture and food products by 77 percent on average. The marginal effect for the outcome equation[14] is depicted in Table 2 column (2). Results are

[14]The estimated coefficient in the Heckman outcome equation does not indicate the

TABLE 1. The Impact of SPS on Agricultural and Food Trade (1996 - 2010)

	Heckman Selection Model (maximum likelihood)			
Equation:	Selection	Outcome	Selection	Outcome
Dependent Variable:	$\Pr(\text{import}_{ijts} > 0)$	$\ln(\text{import}_{ijts})$	$\Pr(\text{import}_{ijts} > 0)$	$\ln(\text{import}_{ijts})$
	(1)	(2)	(3)	(4)
$\text{SPS}_{ij(t-1)s}$	-0.139**	0.642***		
	(0.06)	(0.14)		
$\text{SPSFreq}_{ij(t-1)s}$			-0.155**	0.625***
			(0.06)	(0.15)
Controls				
$\ln$ $\text{GDP}_{it} \times \text{GDP}_{jt}$	0.220***	0.468***	0.219***	0.471***
	(0.02)	(0.03)	(0.02)	(0.03)
$\ln$ $\text{POP}_{it} \times \text{POP}_{jt}$	0.248***	0.076	0.250***	0.058
	(0.05)	(0.09)	(0.05)	(0.09)
$\ln$ Distance_{ij}	-0.329***	-0.946***	-0.329***	-0.946***
	(0.01)	(0.03)	(0.01)	(0.03)
Adjacency_{ij}	0.123***	0.392***	0.122***	0.392***
	(0.03)	(0.10)	(0.03)	(0.10)
Common Language_{ij}	0.123***	0.265***	0.123***	0.265***
	(0.02)	(0.05)	(0.02)	(0.05)
Ever Colony_{ij}	-0.021	0.055	-0.021	0.056
	(0.05)	(0.15)	(0.05)	(0.15)
Common Colonizer_{ij}	0.081***	0.268***	0.081***	0.268***
	(0.02)	(0.07)	(0.02)	(0.07)
Colonizer post 1945_{ij}	-0.112***	-0.441***	-0.112***	-0.443***
	(0.04)	(0.11)	(0.04)	(0.11)
Common Religion_{ij}	0.150***		0.150***	
	(0.02)		(0.02)	
Estimated correlation (rho)	0.460***		0.461***	
	(0.01)		(0.01)	
Estimated selection (lambda)	1.369***		1.371***	
	(0.04)		(0.04)	
Observations	5,452,147		5,452,147	

Note: ***, **, * denote significance at the 1%, 5%, and 10% level, respectively. Constant, importer, exporter, HS4 product and time fixed effects and MR terms are included but not reported. Common religion is the selection variable and thus excluded in columns (2) and (4). Country clustered robust standard errors reported in parenthesis.

confirmed when using the SPS frequency measure in Table 1 columns (3) and

marginal effect of SPS measures on the trade flows as the independent variables appear in the selection and the outcome equation and $\rho \neq 0$. Hence, we calculate the marginal effect of the outcome equation according to Greene (2003, p.784). The marginal effect on the volume of trade is composed of the effect on the selection and the outcome equation. If the outcome coefficient is β and the selection coefficient is α, then

$$dE[y|z^* > 0]/dx = \beta - (\alpha^* \rho^* \sigma^* \delta(\alpha)),$$

where $\delta(\alpha) =$ inverse Mills' ratio*(inverse Mill's ratio*selection prediction).

(4). For both, the frequency and the dummy SPS variable, the estimated correlation coefficient (rho) and the estimated selection coefficient (lambda) are statistically significant and different from zero, confirming that not controlling for selection effects and zero trade flows would generate biased coefficients.

TABLE 2. Marginal Effects from Heckman Selection Model (maximum likelihood)

	Marginal Effects			
Equation:	Selection (1)	Outcome (2)	Selection (3)	Outcome (4)
$SPS_{ij(t-1)s}$	-0.043**	0.775***		
	(0.02)	(0.00)		
$SPSFreq_{ij(t-1)s}$			-0.048**	0.774***
			(0.02)	(0.00)

Note: ***, **, * denote significance at the 1%, 5%, and 10% level, respectively. Marginal Effects of the outcome equations are calculated according to Greene (2003). Country clustered robust standard errors reported in parenthesis.

B. Bilateral versus Multilateral Effects

The specific trade concerns data help to overcome limitations of notification-based data. First, government incentives to report a concern over a SPS measure increase if an implemented measure potentially affects their trade. Second, specific trade concerns allow to account for the bilateral character of SPS measures. This is particularly important as some SPS measures are really bilateral, i.e. due to a disease outbreak in the exporter country, but, even if measures are multilateral in the sense that they apply to all trade partners, they may eventually affect exporters in different ways. In an attempt to differentiate bilateral from multilateral effects, we estimate a gravity model additionally including a variable equal to one if at least one concern has been raised against the importing country j in sector s. This variable aims at capturing the impact of *multilateral* SPS measures affecting simultaneously all exporter of a given product. For consistency reasons, we also calculate the associated normalized *multilateral*

SPS frequency measure.

Results are reported in Table 3. Columns (1) and (3) provide evidence that SPS measures exert a negative impact on the extensive margin of trade for all potential trading partners, including the country raising the concern. Hence, SPS measures constitute a market entry barrier to all exporters and are thus not discriminatory. On the contrary, bilateral SPS measures in columns (2) and (4) indicate that, once exporters meet the stringent standard, the trade flows of countries concerned over a specific SPS measure increase to the detriment of other trade partners (the bilateral coefficient is positive, while the multilateral variable depicts a negative effect). Most importantly, our results suggest that SPS measures diversely affect exporters already active in a market.

TABLE 3. The Impact of Bilateral and Multilateral SPS on Agricultural and Food Trade (1996 - 2010)

	Heckman Selection Model (maximum likelihood)			
Equation:	Selection	Outcome	Selection	Outcome
Dependent Variable:	$\Pr(\text{import}_{ijts} > 0)$	$\ln(\text{import}_{ijts})$	$\Pr(\text{import}_{ijts} > 0)$	$\ln(\text{import}_{ijts})$
	(1)	(2)	(3)	(4)
$\text{SPS}_{ij(t-1)s}$	-0.027	0.709***		
	(0.05)	(0.14)		
$\text{SPS}_{j(t-1)s}$ multilateral	-0.173***	-0.103**		
	(0.01)	(0.05)		
$\text{SPSFreq}_{ij(t-1)s}$			-0.024	0.697***
			(0.06)	(0.16)
$\text{SPSFreq}_{j(t-1)s}$ multilateral			-0.205***	-0.111*
			(0.02)	(0.06)
Estimated correlation (rho)	0.497***		0.497***	
	(0.01)		(0.01)	
Estimated selection (lambda)	1.091***		1.091***	
	(0.01)		(0.01)	
Observations	5,452,147		5,452,147	

Note: ***, **, * denote significance at the 1%, 5%, and 10% level, respectively. Controls, constant, importer, exporter, HS4 product and time fixed effects and MR terms are included but not reported. Common religion is the selection variable and thus excluded in columns (2) and (4). Country clustered robust standard errors reported in parenthesis.

C. Sensitivity

In the sensitivity analysis, we address two concerns. First, to avoid a potential misspecification and to be able to distinguish the impact of SPS interventions on trade in agricultural and food products from that of bilateral tariffs, we conduct a robustness check that includes bilateral applied tariff protection as a further control variable. Second, reverse causality might be an issue in our framework. As further instrumentation methods are not straightforward in the Heckman model, we estimate a simple two stage least squares (2SLS) model to give an indication that forward looking actors are not a problem.

Bilateral Tariffs. Table 4 includes bilateral applied tariff protection as a further control variable, to avoid a potential misspecification of the model and to be able to distinguish the impact of SPS interventions on trade in agricultural and food products from that of bilateral tariffs.

We include a specific control for bilateral tariffs only in the robustness section for several reasons. First, even though data on bilateral tariffs are provided by IDB and TRAINS, the data pose several limitations with respect to missing values over time. Second, data do not include all specific duties, tariff quotas and anti-dumping duties applied by importers. Third, we cannot distinguish preferential from general tariffs, as data are not always available. In the following, we include import weighted bilateral applied tariffs, with missing values interpolated as discussed in section I.*B*.. We provide evidence that our previous results do not suffer from a bias due to the omission of tariff data in the framework. Table 4 provides the results. Coefficients on gravity controls remain qualitatively and quantitatively similar compared to Table 1. So do our results on the effect of SPS measures on the extensive and the intensive margin of trade. While SPS measures pose a barrier to market entry, producers who meet the more stringent standard increase their trade flows conditional on market entry (compare Panel A). Results on bilateral versus multilateral effects are robust as well (compare Panel B). SPS measures constitute a market entry barrier against

TABLE 4. Robustness: SPS, Tariffs and Trade (1996 - 2010)

	Heckman Selection Model (maximum likelihood)			
Equation:	Selection	Outcome	Selection	Outcome
Dependent Variable:	$\Pr(\text{import}_{ijts} > 0)$	$\ln(\text{import}_{ijts})$	$\Pr(\text{import}_{ijts} > 0)$	$\ln(\text{import}_{ijts})$
PANEL A: BILATERAL SPS (N = 5,452,147)				
	(A1)	(A2)	(A3)	(A4)
$\text{SPS}_{ij(t-1)s}$	-0.134**	0.641***		
	(0.06)	(0.14)		
$\text{SPSFreq}_{ij(t-1)s}$			-0.149**	0.623***
			(0.06)	(0.15)
Tariff_{ijts}, weighted average	0.001***	-0.001**	0.001***	-0.001**
	(0.00)	(0.00)	(0.00)	(0.00)
Estimated correlation (rho)	0.459***		0.460***	
	(0.01)		(0.01)	
Estimated selection (lambda)	1.366***		1.368***	
	(0.04)		(0.04)	
PANEL B: BILATERAL & MULTILATERAL SPS (N = 5,452,147)				
	(B1)	(B2)	(B3)	(B4)
$\text{SPS}_{ij(t-1)s}$	-0.029	0.710***		
	(0.05)	(0.14)		
$\text{SPS}_{ij(t-1)s}$ multilateral	-0.163***	-0.108**		
	(0.01)	(0.05)		
$\text{SPSFreq}_{ij(t-1)s}$			-0.025	0.698***
			(0.06)	(0.16)
$\text{SPSFreq}_{ij(t-1)s}$ multilateral			-0.193***	-0.117*
			(0.02)	(0.06)
Tariff_{ijts}, weighted average	0.001***	-0.001***	0.001***	-0.001**
	(0.00)	(0.00)	(0.00)	(0.00)
Estimated correlation (rho)	0.459***		0.459***	
	(0.01)		(0.01)	
Estimated selection (lambda)	1.364***		1.367***	
	(0.04)		(0.04)	

Note: ***, **, * denote significance at the 1%, 5%, and 10% level, respectively. Controls, constant, importer, exporter, HS4 product and time fixed effects and MR terms are included but not reported. Common religion is the selection variable and thus excluded in the outcome equations. Country clustered robust standard errors reported in parenthesis.

all trade partners, while SPS intervention particularly raises bilateral trade flows conditional on meeting the stringent standard.

Regarding the applied tariffs, we find a slightly positive coefficient on the probability to trade, which suggests only a minor influence of tariffs on market entry fixed costs for agricultural and food trade, respectively. The positive minimal effect is in line with findings by Schlueter, Wieck and Heckelei (2009) for the meat sector. Further, the outcome equations suggest a minimal negative impact of tariffs on trade flows. This negative impact of tariffs on the trade volume stands in line with findings by Disdier, Fontagné and Mimouni (2008) and Fontagné, Mimouni and Pasteels (2005). Still, our results on the minor impact of tariffs on agricultural and food trade should be read with caution since we apply an interpolation rule, as discussed in section I.*B*., and tariffs vary very little over time but rather across countries in the time period that we are looking at. Besides, keep in mind that the focus lies on the identification of the impact of SPS on the extensive and the intensive margin of trade. Tariffs are only included as a control variable for robustness reasons. Most importantly, the inclusion of applied tariffs does not alter our results on the impact of SPS measures.

Reverse Causality. A further concern is that reverse causality might be a problem in our estimated framework if actors are forward looking. However, the use of further instrumentation methods is not straightforward in the Heckman model. To give an indication that forward looking actors are not an issue, we estimate a simple 2SLS model. As instruments for concerns over SPS measures, we use (i) the sum of SPS concerns of all other partner countries $k \neq i$ against the importer j in sector s, and (ii) the sum of SPS concerns raised by exporter i against importer j in sectors $l \neq s$ but $l, s \in$ HS2 sector. The sum of SPS concerns of all other partner countries k against an importer is uncorrelated to bilateral trade between i and j, but is strongly correlated with SPS concerns of the exporter against the importer. Following similar reason, concerns over SPS measures in other HS4 product categories l within the same HS2 sector are unlikely to affect bilateral trade between the importer and the exporter in a specific HS4 product line s, but the sum of concerns related to other products l is strongly correlated to SPS concerns over a specific HS4 product s.

Table 5 Panel A reports the results for the SPS dummy variable and frequency measure, respectively. For comparison reasons, we first show a probit and an ordinary least squares (OLS) model in columns (A1) to (A2) and (A4) to (A5).

TABLE 5. Robustness: SPS and Trade (1996 - 2010)

Dependent Variable:	$\text{import}_{ijts} > 0$	$\ln(\text{import}_{ijts})$		$\text{import}_{ijts} > 0$	$\ln(\text{import}_{ijts})$	
Method:	Probit	OLS	2SLS	Probit	OLS	2SLS
PANEL A: BILATERAL SPS						
	(A1)	(A2)	(A3)	(A4)	(A5)	(A6)
$\text{SPS}_{ij(t-1)s}$	-0.140***	0.771***	0.598***			
	(0.05)	(0.12)	(0.14)			
$\text{SPSFreq}_{ij(t-1)s}$				-0.155***	0.763***	0.614***
				(0.06)	(0.13)	(0.15)
Observations	5,452,147	1,960,755	1,960,755	5,452,147	1,960,755	1,960,755
Adjusted R^2		0.295	0.295		0.295	0.295
Kleibergen-Paap Wald F stat.			645.57			692.10
PANEL B: BILATERAL & MULTILATERAL SPS						
	(B1)	(B2)	(B3)	(B4)	(B5)	(B6)
$\text{SPS}_{ij(t-1)s}$	-0.027	0.752***	0.563***			
	(0.05)	(0.12)	(0.15)			
$\text{SPS}_{j(t-1)s}$ multilateral	-0.173***	0.031	0.054			
	(0.01)	(0.04)	(0.05)			
$\text{SPSFreq}_{ij(t-1)s}$				-0.024	0.736***	0.573***
				(0.06)	(0.14)	(0.15)
$\text{SPSFreq}_{j(t-1)s}$ multilateral				-0.205***	0.046	0.066
				(0.02)	(0.05)	(0.05)
Observations	5,452,147	1,960,755	1,960,755	5,452,147	1,960,755	1,960,755
Adjusted R^2		0.295	0.295		0.295	0.295
Kleibergen-Paap Wald F stat.			386.53			416.89

Note: ***, **, * denote significance at the 1%, 5%, and 10% level, respectively. Controls, constant, importer, exporter, HS4 product and time fixed effects and MR terms included but not reported. Gravity controls included but not reported. Country clustered robust standard errors reported in parenthesis. The instruments are the sum of concerns of all other countries $k \neq i$ against country j and the sum of bilateral SPS concerns in sectors $l \neq s$ with $s, l \in HS2$.

Columns (A3) and (A6) then report results for the 2SLS estimation. The probit results confirm our previous findings that SPS measures constitute a market entry barrier to trade. Even though OLS results are potentially biased due to reverse causality, censoring or sample selection, the simple OLS results also support our previous results. Again, we find a positive impact of SPS measures on trade flows. 2SLS results on the impact of SPS measures also confirm our previous findings. Instrumented coefficients are only slightly smaller than the coefficients from the Heckman outcome equation (compare Table 1 columns (2) and (4)). Hence, 2SLS results indicate that forward looking actors are not a problem in our setup. Our instruments are not only reasonable but also valid. The Kleibergen-Paap Wald F test on excluded instruments indicates that our F-Statistics range well above the 10% Stock and Yogo (2005) critical values, so that we can firmly reject the weak instrument hypothesis (Kleibergen and Paap, 2006). Since we have two instruments, we can also compute a test of overidentifying restrictions.[15] The test fails to reject (p-value of 0.79) and thus indicates that not all the instruments are coherent.

When we dissociate the impact of bilateral SPS measures from that of multilateral SPS measures on trade, results remain generally in line. Table 5 Panel B reports the results. In terms of significance and magnitude, the probit models in columns (B1) and (B4) exhibit similar coefficients as those reported in the selection equations of Table 3. The only major change regarding the OLS and 2SLS models in columns (B2) to (B3) and (B5) to (B6), respectively, concerns the loss of significance of the coefficient associated with the multilateral SPS variable. Our results suggest that SPS measures exert a positive and significant effect on the trade flows of the reporting country, but do not affect the trade flows of other partner countries. This implies that the trade enhancing effect of SPS measures is a bilateral matter which could not be handled using notification-based data. In both 2SLS specifications, using either the dummy variable or the frequency index, instruments are valid and feasible with respect to the first stage F-Statistics. The Kleibergen-Paap Wald F Test on the excluded instruments is way above the 10% Stock and Yogo (2005) critical value.

[15]Note that our results are robust when we use a just identified model using either of the two instruments.

III. Implementation

A. Benchmark Results

In the previous section, we point out that SPS measures pose a market entry barrier due to increased fixed costs. In addition, we find a positive effect on trade flows conditional on market entry due to the fact that the increase in market share is proportionally larger than the variable trade costs due to product adaption. However, governments may choose from a range of SPS instruments to achieve certain policy goals related to animal, plant or human health. The ensuing heterogeneity in SPS intervention may cause ambiguous outcomes on trade, as different SPS instruments entail diverse costs. Measures related to testing, inspection and approval procedures are particularly costly and burdensome for the exporter proportional to the information they provide to the consumer. Such regulations may thus have a negative impact on market entry *and* the amount of trade. Conformity assessment-related measures entail fixed costs that relate to separate or redundant testing or certification of products for various export markets and to the time required to comply with administrative requirements and inspection by importer authorities. The latter may cause time delays that severely impact the profitability of a specific market. Other SPS measures directly related to product characteristics, such as quarantine requirements, pesticide residue levels, labeling or packaging, may pose a barrier to market entry, but once products meet higher standards, exporters gain market share (possibly even in several export markets) due to an increase in consumer trust through valuable product information. Accordingly, we expect that conformity assessment-related measures explain the negative effect on market entry, while concerns related to product characteristics explain the positive impact on trade flows conditional on entering the market.

To systematically compare the implied trade effects of different SPS instruments implemented to achieve a desired level of SPS safety, we distinguish concerns over SPS measure into requirements related to conformity assessment

TABLE 6. The Impact of SPS on Trade, by Type of Concern (1996 - 2010)

	Heckman Selection Model (maximum likelihood)			
Equation:	Selection	Outcome	Selection	Outcome
Dependent Variable:	$\Pr(\text{import}_{ijts} > 0)$	$\ln(\text{import}_{ijts})$	$\Pr(\text{import}_{ijts} > 0)$	$\ln(\text{import}_{ijts})$
	(1)	(2)	(3)	(4)
SPS Conformity$_{ij(t-1)s}$	-0.258***	-0.402*		
	(0.07)	(0.23)		
SPS Characteristic$_{ij(t-1)s}$	0.012	0.943***		
	(0.07)	(0.19)		
SPSFreq Conformity$_{ij(t-1)s}$			-0.290***	-0.461*
			(0.09)	(0.27)
SPSFreq Characteristic$_{ij(t-1)s}$			0.014	0.967***
			(0.07)	(0.22)
Estimated correlation (rho)	0.460***		0.461***	
	(0.01)		(0.01)	
Estimated selection (lambda)	1.368***		1.370***	
	(0.04)		(0.04)	
Observations	5,452,147		5,452,147	

Note: ***, **, * denote significance at the 1%, 5%, and 10% level, respectively. Controls, constant, importer, exporter, HS4 product and time fixed effects and MR terms are included but not reported. Common religion is the selection variable and thus excluded in columns (2) and (4). Country clustered robust standard errors reported in parenthesis.

and concerns related to product characteristics. As expected, Table 6 column (1) shows that the extensive margin of trade is significantly negatively affected by conformity assessment-related measures (SPS Conformity$_{ij(t-1)s}$). The probability to trade bilaterally is lower by 8 percent in the presence of a conformity assessment-related measure.[16] SPS concerns related to product characteristics (SPS Characteristic$_{ij(t-1)s}$) have no significant impact on market entry. Hence, only conformity assessment-related measures constitute market entry barriers, probably due to the relatively high costs and burdensome procedures they impose on foreign producers.

In column (2), the intensive margin of trade is negatively and significantly affected by conformity assessment-related measures. This may result either from an increase in marginal costs or from a price effect in the case where producers pass through the costs of conformity assessment to consumers, thereby reducing the demand for their product. In contrast, concerns on product characteris-

[16]Calculating the marginal effect, we get for SPS Conformity$_{ij(t-1)s}$ a coefficient of -0.080 with a standard error of (0.02).

tics have a positive and significant impact on trade flows conditional on market entry. This suggests that SPS measures related to product characteristics provide information that enhance consumer trust in the quality of imported goods. The gain in market share is then relatively higher than the loss due to product adaption costs. This leads to enhanced trade flows for exporters that manage to overcome the fixed cost of market entry. The dummy measure indicates that conformity assessment-related factors decrease trade in agriculture and food products by 15.6 percent on average, while SPS measures related to product characteristics increase trade flows by 93 percent conditional on market entry.[17] Estimates suggest qualitatively similar result when we use the normalized frequency index in Table 6 columns (3) and (4). The coefficient on conformity assessment is again negative and significant for the extensive *and* the intensive margin of trade, while the positive and significant impact of SPS concerns related to product characteristics on trade flows prevails.

B. Bilateral versus Multilateral Effects

In an attempt to dissociate the bilateral from the multilateral character of SPS measures, we again estimate the gravity model by including additional *multilateral* SPS variables. *Multilateral* variables are equal to one for all potential trading partners if at least one respective concern regarding a conformity assessment or a product characteristics measure has been raised against the importer j in sector s. Results are reported in Table 7.

In columns (1) and (3), the negative and significant coefficients on the bilateral and multilateral SPS Conformity variables point out that measures related to conformity assessment reduce the probability of bilateral trade between the country raising the concern and the one maintaining the measure, but also impedes market entry for all other exporters. The negative significant coefficient of the multilateral SPS Characteristic variable indicates that such mea-

[17] Calculating marginal effects of the outcome equation according to Greene (2003), we get a coefficient of -0.156 with a standard error of (0.00) for SPS Conformity$_{ij(t-1)s}$ and a coefficient of 0.931 with a standard error of (0.00) for SPS Characteristic$_{ij(t-1)s}$.

TABLE 7. The Impact of Bilateral and Multilateral SPS on Trade, by Type of Concern (1996 - 2010)

	Heckman Selection Model (maximum likelihood)			
Equation:	Selection	Outcome	Selection	Outcome
Dependent Variable:	$\Pr(\text{import}_{ijts} > 0)$	$\ln(\text{import}_{ijts})$	$\Pr(\text{import}_{ijts} > 0)$	$\ln(\text{import}_{ijts})$
	(1)	(2)	(3)	(4)
SPS Conformity$_{ij(t-1)s}$	-0.188***	-0.348		
	(0.07)	(0.23)		
SPS Conformity$_{j(t-1)s}$ multilateral	-0.107***	-0.090		
	(0.02)	(0.06)		
SPS Characteristic$_{ij(t-1)s}$	0.084	0.952***		
	(0.07)	(0.19)		
SPS Characteristic$_{j(t-1)s}$ multilateral	-0.086***	0.016		
	(0.02)	(0.6)		
SPSFreq Conformity$_{ij(t-1)s}$			-0.222***	-0.435
			(0.08)	(0.28)
SPSFreq Conformity$_{j(t-1)s}$ multilateral			-0.109***	-0.040
			(0.02)	(0.07)
SPSFreq Characteristic$_{ij(t-1)s}$			0.101	0.980***
			(0.07)	(0.23)
SPSFreq Characteristic$_{j(t-1)s}$ multilateral			-0.105***	-0.005
			(0.02)	(0.07)
Estimated correlation (rho)	0.497***		0.497***	
	(0.01)		(0.01)	
Estimated selection (lambda)	1.091***		1.091***	
	(0.01)		(0.01)	
Observations	5,452,147		5,452,147	

Note: ***, **, * denote significance at the 1%, 5%, and 10% level, respectively. Controls, constant, importer, exporter, HS4 product and time fixed effects and MR terms are included but not reported. Common religion is the selection variable and thus excluded in columns (2) and (4). Country clustered robust standard errors reported in parenthesis.

sures hamper market entry as well. Yet, SPS measures related to product characteristics apply to all exporters similarly and are thus not discriminatory, in contrast to SPS measures related to conformity assessment. Most interesting, our results suggest that it is the bilateral component of SPS measures related to product characteristics that trigger a positive and significant effect on trade flows. Hence, depending on the type of regulatory instrument, policy makers may either discriminate against all potential trade partners or even benefit a specific partner that meets the stringent standard.

C. *Sensitivity*

We apply the same battery of robustness checks to the disaggregated SPS regulatory instruments than in section II.*C*.. Results remain generally in line.

Bilateral Tariffs. First, Table 8 Panel A provides evidence that our previous results are not affected by the inclusion of bilateral applied tariff protection. All coefficients on the probability and the amount of trade remain qualitatively and quantitatively similar compared to Table 6. Results still show that most of the negative effect on the probability of entering a market is due to conformity assessment-related SPS intervention, while concerns related to product characteristics explain the positive impact on trade flows. This applies to the frequency as well as to the SPS dummy variables. Regarding the effect of applied tariffs on market entry and on trade volumes, they show a minor impact on bilateral trade and interpretation should again be read with caution similar to results presented in Table 4. Panel B shows that results on bilateral versus multilateral effects are robust as well. Conformity assessment and measures related to product characteristics act as a market entry barrier against all trade partners, while intervention related to product characteristics increases bilateral trade flows conditional on entering the protected market.

Reverse Causality. Second, we estimate a probit and a 2SLS model separately. For comparison reasons, we again also report the OLS coefficients. In the 2SLS model, we deploy a similar instrumentation method as before.[18]

Table 9 Panel A reports bilateral results. Probit, OLS and 2SLS results on the impact of SPS measures on trade confirm our findings from the Heckman model. Estimates exhibit expected signs, significance levels, and similar magnitudes as those reported in Table 6. Instruments in the 2SLS models are generally

[18]Instruments are (i) the sum of SPS concerns related to conformity assessment or product characteristics of all other countries $k \neq i$ against the importer and (ii) the sum of SPS concerns related to conformity assessment or product characteristics raised by the exporter against the importer in sectors $l \neq s$ but included within the same HS2 category, respectively.

TABLE 8. Robustness: SPS, Tariffs and Trade, by Type of Concern (1996 - 2010)

	Heckman Selection Model (maximum likelihood)			
Equation:	Selection	Outcome	Selection	Outcome
Dependent Variable:	$\Pr(\text{import}_{ijts} > 0)$	$\ln(\text{import}_{ijts})$	$\Pr(\text{import}_{ijts} > 0)$	$\ln(\text{import}_{ijts})$
PANEL A: BILATERAL SPS (N = 5,452,147)				
	(A1)	(A2)	(A3)	(A4)
SPS Conformity$_{ij(t-1)s}$	-0.254***	-0.402*		
	(0.07)	(0.23)		
SPS Characteristic$_{ij(t-1)s}$	0.015	0.941***		
	(0.07)	(0.19)		
SPSFreq Conformity$_{ij(t-1)s}$			-0.285***	-0.463*
			(0.09)	(0.27)
SPSFreq Characteristic$_{ij(t-1)s}$			0.017	0.965***
			(0.07)	(0.22)
Tariff$_{ijts}$, weighted average	0.001***	-0.001**	0.001***	-0.001**
	(0.00)	(0.00)	(0.00)	(0.00)
Estimated correlation (rho)	0.459***		0.459***	
	(0.01)		(0.01)	
Estimated selection (lambda)	1.365***		1.367***	
	(0.04)		(0.04)	
PANEL B: BILATERAL & MULTILATERAL SPS (N = 5,452,147)				
	(B1)	(B2)	(B3)	(B4)
SPS Conformity$_{ij(t-1)s}$	-0.189***	-0.347		
	(0.07)	(0.23)		
SPS Conformity$_{ij(t-1)s}$ mult.	-0.098***	-0.093		
	(0.02)	(0.06)		
SPS Characteristic$_{ij(t-1)s}$	0.083	0.953***		
	(0.07)	(0.19)		
SPS Characteristic$_{ij(t-1)s}$ mult.	-0.083***	0.013		
	(0.02)	(0.06)		
SPSFreq Conformity$_{ij(t-1)s}$			-0.224***	-0.435
			(0.09)	(0.28)
SPSFreq Conformity$_{ij(t-1)s}$ mult.			-0.098***	-0.044
			(0.02)	(0.07)
SPSFreq Characteristic$_{ij(t-1)s}$			0.100	0.981***
			(0.07)	(0.23)
SPSFreq Characteristic$_{ij(t-1)s}$ mult.			-0.102***	-0.008
			(0.02)	(0.07)
Tariff$_{ijts}$, weighted average	0.001***	-0.001**	0.001***	-0.001**
	(0.00)	(0.00)	(0.00)	(0.00)
Estimated correlation (rho)	0.459***		0.459***	
	(0.01)		(0.01)	
Estimated selection (lambda)	1.364***		1.367***	
	(0.04)		(0.04)	

Note: ***, **, * denote significance at the 1%, 5%, and 10% level, respectively. Controls, constant, importer, exporter, HS4 product and time fixed effects and MR terms are included but not reported. Common religion is the selection variable and thus excluded in the outcome equations. Country clustered robust standard errors reported in parenthesis.

TABLE 9. Robustness: SPS and Trade, by Type of Concern (1996 - 2010)

Dependent Variable:	$\text{import}_{ijts} > 0$	$\ln(\text{import}_{ijts})$		$\text{import}_{ijts} > 0$	$\ln(\text{import}_{ijts})$	
Method:	Probit	OLS	2SLS	Probit	OLS	2SLS
PANEL A: BILATERAL SPS						
	(A1)	(A2)	(A3)	(A4)	(A5)	(A6)
SPS Conformity$_{ij(t-1)s}$	-0.249***	-0.222	-0.570*			
	(0.07)	(0.20)	(0.27)			
SPS Characteristic$_{ij(t-1)s}$	0.005	0.972***	0.999***			
	(0.06)	(0.17)	(0.22)			
SPSFreq Conformity$_{ij(t-1)s}$				-0.278***	-0.256	-0.509
				(0.08)	(0.24)	(0.27)
SPSFreq Characteristic$_{ij(t-1)s}$				0.006	0.991***	0.981***
				(0.07)	(0.20)	(0.22)
Observations	5,452,147	1,960,755	1,960,755	5,452,147	1,960,755	1,960,755
Adjusted R^2		0.295	0.295		0.295	0.294
Kleibergen-Paap Wald F stat.			167.37			139.43
PANEL B: BILATERAL & MULTILATERAL SPS						
	(B1)	(B2)	(B3)	(B4)	(B5)	(B6)
SPS Conformity$_{ij(t-1)s}$	-0.178**	-0.217	-0.575**			
	(0.07)	(0.20)	(0.27)			
SPS Conformity$_{j(t-1)s}$ mult.	-0.107***	-0.016	0.021			
	(0.02)	(0.05)	(0.05)			
SPS Characteristic$_{ij(t-1)s}$	0.076	0.925***	0.943***			
	(0.06)	(0.17)	(0.23)			
SPS Characteristic$_{j(t-1)s}$ mult.	-0.086***	0.088*	0.086*			
	(0.02)	(0.05)	(0.05)			
SPSFreq Conformity$_{ij(t-1)s}$				-0.208**	-0.277	-0.531*
				(0.08)	(0.24)	(0.27)
SPSFreq Conformity$_{j(t-1)s}$ mult.				-0.110***	0.037	0.064
				(0.02)	(0.06)	(0.06)
SPSFreq Characteristic$_{ij(t-1)s}$				0.092	0.938***	0.920***
				(0.07)	(0.20)	(0.23)
SPSFreq Characteristic$_{j(t-1)s}$ mult.				-0.104***	0.078	0.078
				(0.02)	(0.06)	(0.06)
Observations	5,452,147	1,960,755	1,960,755	5,452,147	1,960,755	1,960,755
Adjusted R^2		0.295	0.295		0.295	0.295
Kleibergen-Paap Wald F stat.			107.651			93.488

Note: ***, **, * denote significance at the 1%, 5%, and 10% level, respectively. Controls, constant, importer, exporter, HS4 product and time fixed effects and MR terms included but not reported. Gravity controls included but not reported. Country clustered robust standard errors reported in parenthesis. Instruments are the sum of SPS concerns related to conformity assessment or product characteristics of all other countries $k \neq i$ against the importer and the sum of SPS concerns related to conformity assessment or product characteristics raised by the exporter against the importer in sectors $l \neq s$ with $s, l \in HS2$, respectively.

valid as the Kleibergen-Paap F-Statistics are way above the 10% Stock and Yogo (2005) critical values. The same applies to bilateral versus multilateral effects of SPS measures. Results hold and are reported in Table 9 Panel B. The positive impact of SPS measures on trade flows can be attributed to SPS measures related to product characteristics which mainly benefit the country raising the concern. But, there is evidence that SPS measures related to product characteristics also promote trade with all partners conditional on entering the market (compare columns (B2) and (B3)). Further, when using instrumentation methods, we find that SPS measures related to conformity assessment significantly reduce the bilateral exports of the country reporting the concern. Instruments are again valid and the first stage F-Tests on the excluded instruments pass the most stringent criterion of the Stock and Yogo (2005) critical values.

IV. Concluding Remarks

This paper contributes to the literature by investigating the impact of SPS measures on the extensive and the intensive margin of agricultural and food trade. Using the database on specific trade concerns on SPS measures of the WTO, we deploy a Heckman selection model at the HS4 disaggregated level of trade that controls for a potential selection bias and zero trade flows using both a dummy variable and a normalized frequency measure on SPS concerns.

We find that aggregate SPS measures pose a negative effect on the probability to export to a protected market, but, conditional on market entry, trade flows to markets with SPS standards in place tend to be higher. This reveals two important issues: First, SPS measures pose a serious barrier to market entry by increasing the fixed costs of trading. Second, SPS standards provide information on product safety to consumers and thus exert a positive impact on the trade flows of those exporters that manage to overcome the fixed cost of entering the market. Hence, foreign producers who meet the stringent standard gain market share. The advantage from gaining market share outweighs the costs of product adaption to meet the standard and leads to a positive effect on trade flows. The results are robust to the inclusion of applied bilateral tariff data and to instrumentation. In addition, we find robust evidence that SPS measures pose market entry barriers to all potential exporters and are thus non-discriminatory. In contrast, conditional on market entry, SPS measures mostly increase trade flows of those countries that raise a concern over an SPS measure at the WTO SPS committee to the detriment of other exporters.

Further, we determine the trade outcomes on agricultural and food products of different SPS regulations implemented by policy makers to achieve certain health safety objectives. We distinguish concerns related to conformity assessment (i.e., certificate requirements, testing, inspection and approval procedures) and concerns related to product characteristics (i.e., requirements on quarantine treatment, pesticide residue levels, or labeling and packaging). Results indicate that conformity assessment-related SPS measures act as a barrier to market entry, while concerns related to product characteristics increase trade once exporters meet the stringent standard. This suggests that conformity assessment-related measures increase fixed costs due to often burdensome and separate certification, testing and inspection procedures in different export markets. In contrast, SPS measures related to product characteristics enhance consumer trust by providing safety information on imported products.

This result is particularly interesting for policy makers who often have to choose from a set of measures that equivalently reduce health risks but entail diverse trade costs. Even though SPS measures cover a relatively narrow area of health and safety measures that are often directly related to consumer protection, policy makers should be aware that policy substitution may be put at some expense. Hence, depending on the policy maker's choice between conformity assessment versus product characteristics measures, the implied impact on trade varies strongly. In particular, conformity assessment-related SPS measures increase the fixed costs of trade in agricultural and food products.

References

Anderson, J. E., and E. Van Wincoop. 2003. "Gravity with Gravitas: A Solution to the Border Puzzle." *American Economic Review,* 93(1): 170–192.

Anders, S. M., and J. A. Caswell. 2009. "Standards as Barriers Versus Standards as Catalysts: Assessing the Impact of HACCP Implementation on US Seafood Imports." *American Journal of Agricultural Economics,* 91(2): 310–321.

Baier, S. L., and J. H. Bergstrand. 2009. "Bonus vetus OLS: A Simple Method for Approximating International Trade-Cost Effects Using the Gravity Equation." *Journal of International Economics,* 77(1): 77–85.

De Frahan, B. H., and M. Vancauteren. 2006. "Harmonisation of Food Regulations and Trade in the Single Market: Evidence from Disaggregated Data." *European Review of Agricultural Economics,* 33(3): 337–360.

Disdier, A.-C., and F. van Tongeren. 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,* 32(3): 436–455.

Disdier, A.-C., and S. Marette. 2010. "The Combination of Gravity and Welfare Approaches for Evaluating Nontariff Measures." *American Journal of Agricultural Economics,* 92(3): 713–726.

Disdier, A.-C., L.l Fontagné, and M. Mimouni. 2008. "The Impact of Regulations on Agricultural Trade: Evidence from the SPS and TBT Agreements." *American Journal of Agricultural Economics,* 90(2): 336–350.

Drogué, S., and F. DeMaria. 2011. "Pesticides Residues and Trade: The Apple of Discord?" *Working Paper EU NTM Impact Project,* FP7 NTM-Impact Working Paper 10/02.

Fassarella, L. M., M. J. Pinto de Souza, and H. L. Burnquist. 2011. "Impact of Sanitary and Technical Measures on Brazilian Exports." *Mimeo.*

Fontagné, L., G. Orefice, R. Piermartini, and N. Rocha. 2012. "Product Standards and Margins of Trade: Firm Level Evidence." *WTO Staff Working Paper.*

Fontagné, L., M. Mimouni, and J.-M. Pasteels. 2005. "Estimating The Impact of Environmental SPS and TBT on International Trade." *Integration and Trade Journal,* 22(3): 7–37.

Gebrehiwet, Y., S. Ngqangweni, and J. F. Kirsten. 2007. "Quantifying the Trade Effect of Sanitary and Phytosanitary Regulations of OECD Countries on South African Food Exports." *Agrekon,* 46(1): 1–17.

Greene, W. H. 2003. *Econometric Analysis.* Prentice Hall International, Inc.

Heckman, J. J. 1979. "Sample Selevtion Bias as a Specification Error." *Econometrica,* 47(1): 153–161.

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

Jayasinghe, S., J. C. Beghin, and G. Moschini. 2010. "Determinants of World Demand for US Corn Seeds: The Role of Trade Costs." *American Journal of Agricultural Economics,* 92(4): 999–1010.

Kleibergen, F., and R. Paap. 2006. "Generalized reduced rank tests using the singular value decomposition." *Journal of Econometrics,* 133(1): 97–126.

Otsuki, T., J. S. Wilson, and M. Sewadeh. 2001*a*. "Saving Two in a Billion: Quantifying the Trade Fefect of European Food Safety Standards on African Exports." *Food Policy,* 26(5): 495–514.

Otsuki, T., J. S. Wilson, and M. Sewadeh. 2001*b*. "What Price Precaution? European Harmonization of Aflatoxin Regulations and African Groundnut Exports." *European Review of Agricultural Economics,* 28(3): 263–284.

Roberts, D., T. Josling, and D. Orden. 1999. "A Framework for Analyzinig Technical Trade Barriers in Agricultural Markets." *Technical Bulletins,* United States Department of Agriculture.

Schlueter, S. W., C. Wieck, and T. Heckelei. 2009. "Regulatory Policies in Meat Trade: Is There Evidence for Least Trade-Distorting Sanitary Regulations?" *American Journal of Agricultural Economics,* 91(5): 1484–1490.

Stock, J.H., and M. Yogo. 2005. "Testing for Weak Instruments in Linear IV Regression." In *Identification And Inference For Econometric Models: Essays In Honor Of Thomas Rothenberg.* 80–108. Cambridge University Press.

Wilson, J. S., and T. Otsuki. 2004. "Standards and Technical Regulations and Firms in Developing Countries: New Evidence from a World Bank Technical Barriers to Trade Survey." *Mimeo.*

Wooldridge, J. M. 2002. *Econometric Analysis of Cross Section and Panel Data.* The MIT Press.

WTO. 2012. "World Trade Report 2012 – Trade and Public Policies: A Closer Look at Non-Tariff Measures in the 21st Century." *Geneva: World Trade Organization.*

Xiong, B., and J. Beghin. 2011. "Does European Aflatoxin Regulation Hurt Groundnut Exporters from Africa?" *European Review of Agricultural Economics,* Published Online November 22.

Appendix

TABLE 10. Summary Table

Variable	Observations	Mean	Std. Dev.	Source
$\ln(\text{import}_{ijts})$	1,960,755	10.440	3.305	Comtrade (2011)
$\Pr(\text{import}_{ijts} > 0)$	5,452,147	0.360	0.480	Comtrade (2011)
$\text{SPS}_{ij(t-1)s}$	5,452,147	0.004	0.067	SPS IMS (2011)
$\text{SPSFreq}_{ij(t-1)s}$	5,452,147	0.004	0.062	SPS IMS (2011)
$\text{SPS}_{j(t-1)s}$ mult.	5,452,147	0.043	0.203	SPS IMS (2011)
$\text{SPSFreq}_{j(t-1)s}$ mult.	5,452,147	0.041	0.188	SPS IMS (2011)
SPS $\text{Conformity}_{ij(t-1)s}$	5,452,147	0.003	0.052	SPS IMS (2011)
SPSFreq $\text{Conformity}_{ij(t-1)s}$	5,452,147	0.003	0.049	SPS IMS (2011)
SPS $\text{Characteristic}_{ij(t-1)s}$	5,452,147	0.004	0.062	SPS IMS (2011)
SPSFreq $\text{Characteristic}_{ij(t-1)s}$	5,452,147	0.004	0.058	SPS IMS (2011)
SPS $\text{Conformity}_{j(t-1)s}$ mult.	5,452,147	0.031	0.174	SPS IMS (2011)
SPS $\text{Characteristic}_{j(t-1)s}$ mult.	5,452,147	0.039	0.193	SPS IMS (2011)
SPSFreq $\text{Conformity}_{j(t-1)s}$ mult.	5,452,147	0.031	0.164	SPS IMS (2011)
SPSFreq $\text{Characteristic}_{j(t-1)s}$ mult.	5,452,147	0.036	0.178	SPS IMS (2011)
$\ln \text{GDP}_{it} \times \text{GDP}_{jt}$	5,452,147	22.928	3.255	WDI (2011)
$\ln \text{POP}_{it} \times \text{POP}_{jt}$	5,452,147	6.210	2.759	WDI (2011)
$\ln \text{Distance}_{ij}$	5,452,147	8.511	0.949	CEPII (2005)
Adjacency_{ij}	5,452,147	0.080	0.271	CEPII (2005)
Common Language_{ij}	5,452,147	0.358	0.480	CEPII (2005)
Ever Colony_{ij}	5,452,147	0.094	0.293	CEPII (2005)
Common Colonizer_{ij}	5,452,147	0.159	0.366	CEPII (2005)
Colonizer post 1945_{ij}	5,452,147	0.061	0.240	CEPII (2005)
Common Religion_{ij}	5,452,147	0.251	0.298	Helpman et al. (2008)
Tariff_{ijts}, weighted average	5,452,147	2.977	15.071	IDB (2011) & TRAINS (2011)
MR Distance_{ijt}	5,452,147	9.512	0.835	own calculation, Baier & Bergstrand (2009)
MR Adjacency_{ijt}	5,452,147	-0.032	0.146	own calculation, Baier & Bergstrand (2009)
MR Common Language_{ijt}	5,452,147	0.297	0.400	own calculation, Baier & Bergstrand (2009)
MR Ever Colony_{ijt}	5,452,147	0.175	0.228	own calculation, Baier & Bergstrand (2009)
MR Common Colonizer_{ijt}	5,452,147	0.119	0.236	own calculation, Baier & Bergstrand (2009)
MR Colonizer post 1945_{ijt}	5,452,147	0.174	0.225	own calculation, Baier & Bergstrand (2009)
MR SPS_{ijts}	5,452,147	-1.779	4.358	own calculation, Baier & Bergstrand (2009)
IV $\text{SPS}_{ij(t-1)s}$	5,452,147	0.212	1.358	own calculation
IV $\text{SPSFreq}_{ij(t-1)s}$	5,452,147	0.200	1.262	own calculation
IV SPS $\text{Conformity}_{ij(t-1)s}$	5,452,147	0.104	0.780	own calculation
IV SPS $\text{Characteristic}_{ij(t-1)s}$	5,452,147	0.192	1.256	own calculation
IV SPSFreq $\text{Conformity}_{ij(t-1)s}$	5,452,147	0.098	0.674	own calculation
IV SPSFreq $\text{Characteristic}_{ij(t-1)s}$	5,452,147	0.182	1.202	own calculation

TABLE 11. List of Agricultural and Food Sectors and Products included in the Data

HS2 Code	Constraint	Specification
01		Live Animals
02		Meat and Edible Meat Offal
03		Fish and Crustaceans
04		Dairy, Eggs, Honey and Edible Products
05		Products of Animal Origin
06		Live Trees and other Plants
07		Edible Vegetables
08		Edible Fruits and Nuts, Peel of Citrus and Melons
09		Coffee, Tea, Mate and Spices
10		Cereals
11		Milling Industry Products
12		Oil Seeds, Miscellaneous Grains, Medical Plants and Straw
13		Lac, Gums, Resins, Vegetable Saps and Extracts Nes
14		Vegetable Plaiting Materials
15		Animal and Vegetable Fats, Oils and Waxes
16		Edible Preparations of Meat, Fish, Crustaceans
17		Sugars and Sugar Confectionery
18		Cocoa and Cocoa Preparations
19		Preparations of Cereals, Flour, Starch or Milk
20		Preparations of Vegetables, Fruits and Nuts
21		Miscellaneous Edible Preparations
22		Beverages, Spirits and Vinegar
23		Residues from Food Industries and Animal Feed
24		Tobacco and Manufacturing Tobacco Substitutes
29	includes 2905	Organic Chemicals
33	includes 3301	Essential Oils, Resinoids, Perfumery, Cosmetic or Toilet Preparations
35	includes 3501 to 3505	Albuminoidal Substances, Starches, Glues, Enzymes
38	includes 3809 and 3824	Miscellaneous Chemical Products
41	includes 4101 to 4103	Raw Hides and Skins (other than Furskins) and Leather
43	includes 4301	Furskins and Artificial Fur, Manufactures thereof
50	includes 5001 to 5003	Silk
51	includes 5101 to 5103	Wool, Animal Hair, Horsehair Yarn and Fabric thereof
52	includes 5201 to 5203	Cotton
53	includes 5301 and 5302	Vegetable Textile Fibers Nes, Paper Yarn, Woven Fabric

Note: This list follows the products listed in Annex 1 in the Agricultural Agreement of the WTO, yet, also including fish, fishing and seafood products. All HS4 product codes in an HS2 sector are included if not specified otherwise in the constraints column.