LUND UNIVERSITY
School of Economics and Management

# The effect of sanitary and phytosanitary measures on EU exports: The case of agri-food products

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October 2018
Master thesis year one, 15 ECTS
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**Abstract**

With protectionism on a global rise, non-tariff measures have been an object for public debates and research, as the work of WTO has reduced the possibilities of raising traditional trade restrictions as customs tariffs. Hence governments have turned to non-tariff measures and regulatory standards to fulfill their agendas. This study aims at shedding light on the question of whether non-tariff measures, and particularly sanitary and phytosanitary (SPS) measures, have been decreasing trade between 2002 and 2017. This is conducted by investigating the effects of EU exports of agri-food products as the importer imposes an SPS measure towards these products. The result is estimated by applying Ordinary Least Squares and Pseudo-Poisson Maximum Likelihood to the gravity model of trade. The data sets include EU export of agri-food gods to 122 countries during 2002-2017. This study does not find any decreases in EU exports. However, the results are mostly insignificant and any definite conclusion can not be drawn. There is, however, significant proof of a decrease in exports towards low-income countries as these impose SPS measures.

Keywords: *Gravity Model, Trade, Non-tariff Barriers, SPS, European Union*

JEL Codes: F13, F14

**1. Introduction**

With protectionism on a global rise, non-tariff measures have been an object for public debates and research, as the work of WTO has reduced the possibilities of raising traditional trade restrictions as customs tariffs. Hence governments have turned to non-tariff measures and regulatory standards to fulfill their agendas. This study aims at shedding light on the question of whether non-tariff measures, and particularly sanitary and phytosanitary (SPS) measures, have been decreasing trade between 2002 and 2017. This specific focus on SPS measures is motivated by the clear purpose of achieving governments public policy goals it withholds. Furthermore, SPS measures hold the complexitivity of may both hinder trade and economic growth but at the same time fulfill the mission of protecting humans, animals and nature from diseases and destruction.

According to the World Trade Organization (WTO), the EU is one of the most frequently targeted trading partners considering SPS measures. The SPS measure targets foremost the agri-food sector, one of the three largest export groups of the European Union. These facts together are the motivation behind the choice of studying the effects of SPS measures on EU exports of agri-food products.

The purpose of the study is to examine what effect the implementation of SPS measures towards EU by third country have on EU export of agri-food products. A panel data set is put together with data on EU exports to 122 countries between 2002-2017. To capture the effect of SPS, a simple dummy variable equals to one if the EU notifies at least one SPS measure targeting their export of agri-food products. To do the empirical investigation of the trade effects caused by SPS implementation a modified gravity model has been used. The model has EU export as the dependent variable and importer GDP, trade values and the SPS dummy as explanatory variables, applying fixed effects to account for heterogeneity and correlation within the data.

After various robustness checks, the paper rarely finds any significant results of adverse trade effects caused by the implementation of SPS measures on EU export of agrifood goods. A relatively surprising result that is thoroughly discussed.

The paper will begin with a description of non-tariff measures and their increasing importance to international trade. The focus will be on the sanitary and phytosanitary measures and a discussion on their effects on trade. A review of earlier research on the topic will also be found in this section. After that follows the economic theory of estimating bilateral trade flows with a gravity model, followed by the modified empirical model used in this paper outlined and described. Lastly is a description of the results together with a discussion regarding these, followed by a conclusion of the findings of the study.

## 2. Non-tariff measures and their structure

### 2.1. *NTMs - what are they?*

The usage of the term measure instead of barriers has during the last decades become widely used in the literature as a conceptual way to emphasize that non-tariff measures (NTMs) do not necessarily have a protectionistic nature. Compared to ordinary customs tariffs, NTMs are generally defined as policy measures that may affect international trade as they change traded quantities, prices or both (UNCTAD, 2012).

However, the literature differs between different types of interventions made as interventions through NTMs. Non-tariff barriers with the purpose of increasing national welfare are differentiated from those motivated by some political economy goal. Where the former one comes with the explicit purpose to correct market failures and to exploit market power, such use of non-tariff measures come at expenses of the trading partner and lead to unintended consequences of the policy (WTO, 2012). The latter one, political economy motives, reflects the response towards special interest groups whom usually are assumed to be organized producer groups who can put pressure on politicians on issues regarding consumer health and safety. The motives behind implemented NTMs can be found in the resulting distributional effects, where they either benefit consumers or producers of the product targeted (WTO, 2012).

Governments can besides economic purposes also use non-tariff measures to restrict international trade, in a pure protectionism action. Implementation of NTMs can be used to hinder the supply of goods not wished to be circulated on the domestic market (WTO, 2012).

The classification and quantification of non-tariff measures is a long-standing area of research (Baldwin, 2007; Laird and Yeats, 1990; Deardorff and Stern, 1998; Dee and Ferrantino, 2005). This work has lead to the existence of a framework for the various NTM databases and definitions existing today (WTO, 2012). What stands clear is that there is not only one way non-tariff measures can be categorized and the reasons for implementation of NTMs are many. The following section will present the highly important evolution of SPS measures. Categorization and explanations are stated important separately by the WTO and United Nations Conference on Trade and Development (UNCTAD) and will provide the reader a broader understanding of the trade phenomenon used by some as a protectionist measure and at the same time emphasize the complexity of NTMs in general and SPS measures in specific.

According to Staiger (2012), non-tariff measures can be classified according to whether they are applied at the border, to exports (e.g., export taxes, quotas or bans) and imports (e.g., import quota, import ban), or behind the border. The behind the border measures can be broken down according to whether the NTMs are national taxes, other charges  and subsidies, or whether they are regulatory. This study will heavily focus on the regulatory, i.e., behind the border, non-tariff measure of sanitary and phytosanitary measures used to uphold food safety together with human and animal health.

What SPS measures have in common is that they, irrespective of their motive, affect trade in either liberal or restrictive matter. Sometimes the trade effects are a necessary evil from pursuing a particular public policy goal, other times the direct trade effects are the primary goal of the implemented measure (WTO, 2012). Governments tend to argue that their policies are legitimate and with welfare increasing objectives, but to find the motives behind the trade interventions one must investigate the type of NTM, from which sector to which it is applied and from the actual impact on trade flows (WTO, 2012).

### 2.2. *The SPS measures and their purposes*

To further understand the restrictions and purpose of this study it is important to somehow make a distinction between the different type of NTMs. The WTO has split NTMs into three categories depending on if they are price, quantity or quality focused. This study will focus on the third of these three, the quality-focused measures, which lead to a change of some features of the finished product or the production process (WTO, 2012). This study will as stated earlier focus on sanitary and phytosanitary measures[1].

SPS measures are more complex than an ad valorem tariff as the SPS measure requires specialized knowledge (Ghodsi et al., 2017). Further, it also requires a high level of transparency as the trading

[1] Besides sanitary and phytosanitary measures technical barriers to trade (TBT) is an important quality focused measure. TBTs often take familiar form as SPS measures but are serving a different purpose. TBTs typically affect the manufacturing sector such as machinery and electrical equipment (Ghodsi et al., 2017).

partner cannot see *behind the border*, where the SPS measure is implemented (Collins-Williams and Wolfe, 2010). Below will follow a short description of SPS measures, the today most frequently used quality focused measure to regulate trade in agri-food products (Ghodsi et al., 2017).

The aim of SPS measures is the protection of human, animal and plant life and can take different forms. Countries can impose a temporary prohibition or restriction on products with characteristics posing a threat to human, animal or plant health. An example could be areas affected by avian flu, which can not export to countries imposing the SPS measure towards them. SPS measures can also take the form of standards, which could be tolerance limits for residues of substances in foodstuff, labeling or hygienic requirements related to food safety. A recent example is a bilateral SPS measure of the EU, stopping the import of dried beans from Nigeria due to pesticide residues at levels exceeding the reference dose as stated by the European Food Safety Authority. However, SPS measures are also implemented on not single products or specific exporting country. Taking the EU as an example, the Union takes measures to prevent the spread of transmissible diseases, such as spongiform encephalopathies (Ghodsi et al., 2017).

### 2.3. *Reasons for higher levels of SPS implementations*

There is a couple of theories and confirmed reasons for the increased usage of SPS measures in international trade. As the awareness across customers regarding food safety has increased, measures controlling for food safety has become more important for countries and governments as they want to offer attractive and functional markets. Given their interest in international trade, it is wished by both countries and governments to understand the impact of food safety measures (WTO, 2012). The issue has also been given attention on the private level (Henson and Caswell, 1999). As the market itself fail to provide the customers desirable level of quality and safety, governments have been intervening (Smith, 2009), agri-food enterprises, on the other hand, employ private standards as a tool for product differentiation and to compete on a quality level (Henson and Reardon, 2005). As both governments and private sector pushes for measures in the agri-food sector, results have been observed on both the demand and the supply side of the agri-food system (WTO, 2012).

Considering the demand side of the market, today's consumer demand is profoundly affected and influenced by developments in technology together with social and economic developments.

Recent food safety incidents have strengthened this trend even further (WTO, 2012). With a stronger focus on consumer awareness, the demand for higher levels of regulation has risen and turned the market from being price based towards being quality-based (WTO, 2012). Reasons to this shift in the market are demographic and social trends such as urbanization and the greater role of women in workplaces, which have modified and evolved patterns of food demand (Reardon and Barrett, 2000). Furthermore increasing level of income, technological advances, more sophisticated information about the influence of diet on health and its mass communication have influenced consumer attitude and habits regarding food attributes and food safety, as it has increased the awareness of eating behavior (Caswell and Mojduszka 1996; Kalaitzandonakes et al., 2004; Grunert, 2005). These changes have made consumers focus on aspects and characteristics of food that cannot be verified at the time of consumption (Caswell and Mojduszka, 1996). Additionally, consumers have increased their concerns regarding process characteristics such as the environment, worker welfare and global poverty (Henson and Reardon, 2005).

The drop in consumer confidence towards the supply side has driven the increase of transparency for customers when it comes to the operation of the supply chain (Böcker and Hanf, 2000; Mazzocchi et al., 2008). Parallel public actors have tightened existing measures and instituted new ones for emerging and previously unregulated issues, also food companies have felt the need to control reputational and commercial risks related to food safety (Henson and Reardon, 2005).

Also, the increase in food safety measures on the supply side on the agri-food market can be linked to technological changes and a more fragmented supply chain. With a larger number of players contributing, a heightened need for coordination among firm and government assurance of quality and safety of the food products and processes has unraveled (WTO, 2012).

Market interventions have been conducted by both governments and private sector actors to correct inefficiencies caused by marked failures and adapting to the new conditions of the market, resulting in the introduction of governmental measures that regulates food products and production processes together with the development of private standards (WTO, 2012). The measures described are, among others, the further discussed sanitary and phytosanitary measures.

### *2.4. Earlier studies on the trade effects of food safety measures*

As a result of multilateral, regional and bilateral trade negotiations and agreements the global tariff levels have prominently decreased over time. The need to control international trade has instead awakened the importance and relevance of the use of NTM measures (Fugazza 2013; Moise and Le Bris 2013; Kareem 2014). As a result, scholars have switched focus from the traditional tariffs towards the non-tariff measures. A selection of studies by Beghin and Bureau (2001), Ganslandt and Markusen (2001), Ferrantino (2006), Korinek et al. (2008), Ardakani et al. (2009), Fugazza (2013) and Ghodosi et al. (2016) offers a comprehensive overview of the key economic issues related to the modelling and measurement of NTMs.

Analyzing the literature on NTMs shows that quantification techniques can be grouped as either having an ex-post or ex-ante approach. Taking an ex-post approach a gravity-based econometric model is most often used to estimate the impact of NTMs on trade levels, ex-ante methods provides simulations of tariff equivalents that predict unobserved welfare effects. From both types of perspectives it has been proven that NTMs have not one clear impact on export levels, but rather a range of impacts has been revealed.

Sanitary and phytosanitary measures can create both challenges and opportunities for producers. As different requirements apply in different export destinations, the cost of compliance can cause losses in economies of scale for foreigner producers. Such costs will be a function of the exporters' administrative and technical capacity for managing these different requirements (Henson and Mitullah, 2004; Mathews et al., 2003; Otsuki et al., 2001). Safety measures also demand the capacity of the exporter to test the product to guarantee the standards together with extensive documentation and record keeping, both contributing to extra costs (WTO, 2012). With standards being different for different export destinations, these costs duplicates.

This need of capacity to meet regulatory requirements may also foster advanced regulatory technology leading to an increase in value-added in the exporting country. This is done as the SPS measures implemented triggers trading partners to develop advanced regulatory technology to meet the requirements (WTO, 2012). It has been stressed that rising food safety measures through adapting to the new requirements can catalyze trade allowing exporting firms to re-positioning themselves in competitive global markets with the meeting of new standards as incentives (Jaffee and Henson, 2004; Swinnen and Maertens, 2009). SPS measures impact countries and market actors differently depending on their attributes. High requirements are typically associated with high-value trade, giving the producers of these goods the possibility to receive higher returns. In a supportive policy context, poor producers may benefit directly through contracted participation in the value chain (Jaffee et al., 2011).

The role of private standards, as SPS measures implemented by the companies themselves, play an important and increasing role in determining the outcomes of international trade. Henson and Humphrey (2009) show that retailers with buying power and their food safety standards can create market entry barriers to producers. Developing countries, often seen as "standard takers" rather than "standard makers", are obviously harder affected of this as developing their own standards would be more costly than adopting the standards of the greater markets (Stephenson, 1997).

It has been observed that private companies or group of retailers with market power create their own standards to attract and satisfy consumer demand. This attracts consumers with a demand for specific product characteristics[2] and creates segments on the market (Garcia Martinez and Poole, 2004).

Using SPS measures as a way to fulfill a protectionist agenda could result in diversity in food safety regulations. However, the persistence in the variation of regulations exists also due to different perceptions about risk, preferences and interpretation of scientific evidence resulting in different levels of implementation of and adoption of different levels of food safety regulations. The more obvious contribution to variation in food safety measures and levels of food safety measures is that countries are heterogeneous and hence the optimal level of safety measures to reach same standards across the globe differs (WTO, 2012). Various approaches for reducing the potential negative trade diverting effects of SPS will be presented.

Harmonizing the food safety measures to a single standard or standards system would be one way of approaching the issue. Depending on the chosen benchmark the harmonization will be decided. Regarding food safety regulation the WTO encourages such harmonization towards international

[2] Such could be eco-friendly, environmentally friendly or higher employee standards (Swinnen and Maertens, 2009).

standards set by the Codex Alimentarius Committee[3], where decisions on standards, guidelines and recommendations in the agri-food safety area would be made, this would mean that preferences of all participating countries would be integrated into the process[4].

Another approach would be for countries to recognize food safety measures of trading partners as equivalent even as these measures differ from their own. With this approach, one-size-fits-all will be avoided and countries could develop systems that fit their specific context (Josling et al., 2005).

To constraint the protectionist purposes of SPS measures, countries can commit to different disciplines working with the issue. The WTO SPS Agreement can be seen as one of the most outstanding and comprehensive ones. The agreement contains rules of how the implementation of trade-distorting measures should be linked to scientific justification. Held forward as one of the more important rules of WTO itself is the rules explicitly stating that food safety measures should be “not more trade restrictive than required to achieve their appropriate level of sanitary or phytosanitary protection”. Recognizing what has been mentioned above, different approaches may be taken to reach levels of safety desired in countries with different characteristics (WTO, 2012).

As the largest playfield for cooperation on NTMs, the WTO's rules guide the 163 members to tackle problems with SPS measures misused as a protectionist matter replacing tariffs. The WTO itself states that "countries cooperate on SPS measures to address information problems and to complement market access commitments" (WTO, 2012). One of the key issues in WTO dispute settlement has always been to distinguish NTMs designed with a protectionist purpose from the ones being legitimate (WTO, 2012). Regarding SPS measures this is debated in the WTO SPS Agreement, which requires that members ensure that balance between legitimate policy achievements and the negative effects on trade is reached (WTO, 2012).

However, the changing of international trade regarding NTMs have become more complex and the need for deeper forms of institutional integration is most present (WTO, 2012). Further,

[3] The Codex Alimentarius, or "Food Code" is a collection of standards, guidelines and codes of practice adopted by the Codex Alimentarius Commission. The Commission, also known as CAC, is the central part of the Joint FAO/WHO Food Standards Programme and was established by FAO and WHO to protect consumer health and promote fair practices in food trade. It held its first meeting in 1963.

[4] Further reading: Engler et al., 2012; Hooker, 1999; Sykes 1999.

countries cooperate on the matter of SPS measures to guarantee that the policy goals of the regulation implemented will be achieved, to reduce the protectionist influence and founding of trade barriers. The WTO states that the cooperation is conducted at least three levels: in the WTO SPS committee, at a regional level in regulatory cooperation arrangements and international standardizing bodies (WTO, 2012).

Moreover, food safety measures and quality standards are discussed as being protectionist as there does exist evidence that suggests that SPS measures act as barriers to trade. However, the literature discusses both beneficial and trade repressing effects of the implementation of SPS measures. Considering the conflicting empirical results found in the literature, it becomes clear that there it is a need for more analysis to draw more general conclusions on what impact SPS measures have on trade. To contribute to that mean this study will examine the trade effects SPS measures have on EU export to the rest of the world.

### 2.5. *SPS measures targeting the EU*

SPS measures are foremost implemented on agricultural products, one of the largest export groups of the EU (European Commission, 2018). This study focuses on how the mere existence of SPS measures aimed at the European Union affects the EU export of agricultural products to the rest of the world.

According to the WTO's notification system, the EU is one of the most frequently targeted trading partners when it comes to SPS measures (Ghodsi et al., 2017). It has been stated that richer countries tend to be both the heaviest users of NTMs and the ones being most frequently targeted (Ghodsi et al., 2017). One explanation given is that the developed countries can afford to ask for higher standards for products they consume (WTO, 2012; Ghodsi et al., 2017).

**3. Gravity framework to estimate the impact of SPS measures on EU export**

To estimate the effect of SPS measures on EU export of agri-food products a gravity model will be used. A model considered a key tool for estimating the effect of trade-related issues and frequently used to estimate the impact of food safety regulations and standards on agri-food trade (see European Parliament, 2014; ECORYS, 2009; Arita et al., 2015; Ghodsi et al., 2017). The model stems from Newton's law of gravity and was first used of Tingberg (1962) to determine levels of bilateral trade flows without discriminating trade impediments. Originally the model consists of three main explanatory variables being GNP exporting country, GNP importing country and distance representing trade costs. The main idea of the model refers to that countries will trade in proportion to their economic mass (GDP) and the distance between them is inversely proportional (Shepard, 2013). Hence the model expects larger countries to have larger trade volumes, since they can import larger amounts of goods in absolute terms, at the same time offer larger amounts of tradable goods to other countries. Increased distance between the countries implies higher trade costs and should according to the model decrease trade (Krugman et al., 2009). The model empirically used today has its foundation in Andersson and van Wincoop (2003).

This paper follows Disdier et al. (2008), which measured the impact of SPS and TBT on trade in the agricultural sector. In line with their model a gravity equation with a set of fixed effects for time and importer will be applied to control for various types of country and time-specific factors that may affect the trade flows and mitigate potential endogeneity problems.

To be able to measure the trade effects of implemented SPS measures a dummy variable (SPS), which corresponds to the two-digit level of the HS classification for four different product groups, takes the value of one if there is an SPS measure implemented towards EU exports. The modified gravity equation that will be used in this paper will, after taking logs, take the form of equation (1).

$$lnX_{it}^{j} = \alpha + \beta_1 ln(GDP)_{it} + \beta_2 SPS + \beta_3 Year_t + \gamma + \delta + \eta + \varepsilon_{it}^{j} \qquad (1)$$

The dependent variable will be the EU export of the agri-food products included in the data. Having *j* representing the group of products (1-4), *i* representing the income level of the importing countries (1-3) and *t* representing the year (2002-2017). In this model, $\alpha$ is as in the original gravity model, the constant. The variable $\beta_1 lnGDP_{it}$ represents the GDP for each importing country *i* through the years *t* and is measured in current US$. The variable $\beta_2 SPS$ is a dummy controlling for implementation of sanitary and phytosanitary measures targeting the EU. In order to capture time-variant characteristics that are the same for each country, such as GDP of the EU and world business cycle, both time and year dummies are added and represented by $\gamma$ and $\delta$. Country fixed effects, $\eta$, are used to capture all historical events that differ between importing countries, that could be different trade agreements and distance. The variable $\varepsilon_{it}^{j}$ is the error term. As the coefficients $\beta$ are interpreted as elasticities the value related to the SPS-dummy will be the percentual effect on the EU exports of product groups targeted in the regression.

However, if zero trade values are experienced in the data set, the use of a logarithm effectively drops these observations from the sample meaning that potentially useful information is removed. Zero trade flows in this study could reflect that zero EU export is caused by SPS measures implemented by a third country. In an effort to overcome these issues, regressions will also be done with the pseudo-Poisson maximum likelihood (PPML) estimation methodology. This method has been documented to provide an econometric solution to the zero value of dependent variables presented in the data together with a way of handling any serious heteroscedasticity problems (Santos Silva and Tenreyro, 2006;2011). The equation will take the form as in (2) where the mixture of variables in levels and log levels are due to the PPML methodology and $X_{it}$ represents the explanatory variables.

$$E(lnX_{it}^{j}|X_{it}) = exp(\alpha + \beta_1 ln(GDP)_{it} + \beta_2 SPS + \beta_3 Year_t + \gamma + \delta + \eta + \varepsilon_{it}^{j}) \qquad (2)$$

The main dependent variable is *GDP*, determine the economic size of the importing country *i* at time *t.* The variable is measured in US$ (constant 2010) is predicted to have a positive effect on the EU export.

The variable most interesting for this study is the dummy variable *SPS,* taking the value 0 if no implemented SPS measure towards the EU regarding the product considered is implemented by the importing country, and 1 if there is such a measure implemented. The dummy takes the value 1 in the same year as the SPS measure is reported active and then continues to be 1 for the years the SPS measure is still active. This means that the regression does not consider different frequencies of SPS measures implemented by the importer for the same type of product, however, the accuracy of this matter was not seemingly high controlling the original data source. This dummy does, however, allow to measuring the effect an SPS measure has on the export of the products included in the dataset.

### *3.1 Data*

To conduct the regressions, a panel data set with data gathered from 122 countries and the EU-28 countries between the years of 2002-2017 were set up. Data concerning the dependent variable were collected from the UNs COMTRADE database, and consists of the trade value of EU exports to all other countries in US$. The lack of data on trade flows earlier than 2002 made a natural demarcation regarding the period considered.

The data for the independent variable *GDP* is gathered from The World Bank and are presented in US$ current 2010. The availability of GDP data affected the countries included in the data set, as the ones lacking GDP-data and was not implementing any SPS measures towards the EU were dropped[5]. Also smaller countries with none or small trade flows and no implementation of SPS measures were dropped[6], lacking relevance to the analysis. Moreover, the countries included in the data set have been divided into three different groups depending on their income level. The groups are defined as high income, middle income and low income and the data on income levels were gathered from The World Bank.

The SPS dummy variable is created with data from European Commission's Market Access Database where all SPS measures reported and active, are presented under the corresponding Harmonized System (HS) codes at both two and four digit level. The HS codes divide traded commodities into product groups where at a 2 digit level products ranging from 01-06 are *Animal & Animal products* and products ranging from 07-15 are *Vegetable Products.* The product groups included in the data set are the ones most frequently targeted by SPS measures from a third country and are the following: 01 *Animals; Live*, 03 *Fish and crustaceans, mollusks and other*

[5] See Appendix 1 for full list of dropped countries.
[6] See Appendix 1 for full list of dropped countries.

*aquatic invertebrates,* 04 *Dairy produce; Birds' eggs; Natural honey; Edible products of animal origin, not elsewhere specified or included* and 07 *Vegetables and certain roots and tubers; Edible*[7].

[7] For full list of products included at the 4 digit level see Appendix 1.

**4. Empirical results: Quantifying the impact of SPS measures on EU export**

The regression results across all models confirm the expected impact of GDP on trade as it is significantly positive and the coefficients are reasonably high. The $R^2$-values are also high and the conclusion that the data fit the model can be drawn. However, as shown in Table 1 below, the effect of implementing an SPS measure is for all baseline estimations insignificant. The reason for the insignificance can be explained by the relatively small amount of implemented SPS measures in relation to the number of trade observations. Their positive effect on EU export is anyhow relevant to discuss, as they could indicate the effect SPS measures implemented by a third country has on EU export.

According to the basic OLS estimation, SPS increase EU export of included agri-food products with 0.12%. Further testing the baseline OLS estimation with robust standard errors give the same result. Finally using the PPML regression an even higher positive impact on EU export, as the existence of an SPS measure increases trade with 0.16%.

The results of SPS implementation having an increasing effect on EU export to countries implementing SPS measures targeting goods being exported comes as bit of a surprise as most of the earlier research has found the existence of SPS measure to cause decreases in the quantity traded. To further control the robustness of the findings in this paper various regressions dividing the data in different ways was conducted, the result of these regressions are presented in Table 2 below.

**Table 1: Estimation Results**

| *Estimation* | *Baseline estimation OLS* | *Baseline estimation OLS Robust* | *Baseline estimation PPML* |
|---|---|---|---|
| *Dependent variable* | *EU export* | *EU export* | *EU export* |
| GDP importer | 0.733***<br>[0.061] | 0.733***<br>[0.117] | 0.614***<br>[0.178] |
| SPS | 0.115<br>[0.117] | 0.115<br>[0.162] | 0.1556<br>[0.336] |
| No. of Observations | 7294 | 7294 | 7812 |
| Exporter FE | Yes | Yes | Yes |
| Year FE | Yes | Yes | Yes |

*Note*: Presented are the results of the coefficients. FE is an abbreviation for fixed effects. Standard errors are reported in brackets, robust for all except baseline estimation OLS. Asterisks denote significance at the 1% (***), 5% (**) and 10% (*) levels.

All the robustness test are done with a PPML estimation, as it takes to account for the zero trade flows. Furthermore, all the robustness tests also show significantly positive estimation results for importer GDP, as expected. The first robustness test respect has been taken to that the effect of EU export could differ between countries with different income levels. Having a look at the results, one can see that EU export decreases with 0.29% to high-income countries, a more expected result even though it is not significant. Regarding middle-income countries, the effect is insignificantly positive, precisely as in the baseline estimations. However, the effect on EU exports to low-income countries significantly decreases with 0.54%.

Robustness test two checks for differences between the product groups included in the data set. None of the estimations turns out significant, but a difference between the products can be detected. Fish and dairy products are both decreasing in EU export levels as they meet SPS measures, as the groups of live animals and vegetable export increases.

In the third robustness test only include observations as the SPS dummy goes from being 0 to 1. The result turns out insignificant even here, also showing a positive effect on EU export while meeting an SPS measure. The coefficient is not far from the ones observed in the baseline regressions.

The last robustness check tests if there is any difference between before and after the global financial crisis. Neither these estimations turn out to be significant but from the results given a change between before and after can be observed as the former is positive and the latter is negative.

**Table 2: Estimation Results**

| *Estimation* | *Robustness test 1* | *Robustness test 2* | *Robustness test 3* | *Robustness test 4* |
|---|---|---|---|---|
| *Dependent variable* | *EU export* | *EU export* | *EU export* | *EU export* |
| GDP importer | 0.615***<br>[0.177] | 0.613***<br>[0.178] | 0.602***<br>[0.182] | 0.610***<br>[0.179] |
| SPS | | | 0.171<br>[0.342] | |
| SPS high-income countries | -0.286<br>[0.302] | | | |
| SPS middle income countries | 0.217<br>[0.372] | | | |
| SPS low-income countries | -0.536***<br>[0.089] | | | |
| SPS Live Animal | | 0.320<br>[0.504] | | |
| SPS Fish | | -0.346<br>[0.365] | | |
| SPS Dairy | | -0.126<br>[0.104] | | |
| SPS Vegetables | | 0.145<br>[0.113] | | |
| SPS before 2008 | | | | 0.238<br>[0.293] |
| SPS after 2008 | | | | -0.094<br>[0.127] |
| No. of Observations | 7812 | 7812 | 7812 | 7812 |
| Exporter FE | *Yes* | *Yes* | *Yes* | *Yes* |
| Year FE | *Yes* | *Yes* | *Yes* | *Yes* |

*Note*: Presented are the results of the coefficients. FE is an abbreviation for fixed effects. Standard errors are reported in brackets, robust for all. Asterisks denote significance at the 1% (***), 5% (**) and 10% (*) levels.

**5. Summary and conclusion**

This paper aims to analyze how the implementation of SPS measures targeting agri-food products affects the EU export. It is analyzed by examining EU's export of four product groups within the agri-food sector. The analysis is driven by a balanced data set covering 122 countries during the years of 2002-2017. To account for the existing zero values in the data a Pseudo-Poisson Maximum Likelihood model with fixed effects are applied to the gravity model.

The predicted value of the SPS dummy was that it should have a negative impact on EU export. However, in most of the econometric estimations, the SPS coefficient has a positive sign and is not significant at a ten percent level. As the data fit the model, there is no reason to disbelieve the results, but as most of the results are insignificant no definite conclusion on the impact of SPS measures on EU exports can in this case be made. However, one can see that SPS measures increase EU exports overall but decreases towards high-income countries and significantly decreases towards low-income countries. It can also be read from the results that it is the two product groups of fish and dairy that drive the decreases while live animals and vegetable products are increasing.

An explanation of the different results between income groups could be that it is more common for high-income countries to implement SPS measures to uphold a certain standard and that these measures are harder to meet than the ones implemented by middle-income countries. The negative effects observed for low-income countries may be caused by being less important export destinations for EU, making the EU shift their exports to other countries once experiencing an SPS measure rather than changing their production process to meet the new standard.

The most straightforward explanation to why some products have a negative effect on EU export would be that different products are targeted harder or have been objects for extra strict SPS measures during the time span investigated. The difference between before and after the financial crisis could be due to that SPS measures implemented during the later years are harder to meet and causes EU exports to countries imposing these to decrease.

Another explanation the the overall positive effect on EU export can be that the Union is capable and willing to adapt to new standards implemented by trade partners. This would be in line with earlier findings that richer countries tend to have less of a negative effect from meeting SPS measures compared to developing countries.

Even if the findings in this paper are limited by insignificant results policy makers should be aware that the existence of SPS measures does effect trade in different ways. This study is also limited to four different product groups within the agri-food exports, for further research it would be interesting to investigate an extensive range of products. It would also be interesting to investigate the effects on a higher HS code level, pinpointing the products driving the different results more precisely.

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## Appendix 1

| | | |
|---|---|---|
| **List of countries in data:** | Afghanistan | Algeria |
| | Albania | Andorra |

Angola

Argentina

Armenia

Australia

Azerbaijan

Bahamas

Bahrain

Bangladesh

Barbados

Belarus

Belize

Benin

Bhutan

Bolivia

Bosnia Herzegovina

Brazil

Brunei Darussalam

Burkina Faso

Burundi

Cabo Verde

Cambodia

Cameroon

Canada

Central African Rep.

Central African Republic

Chad

Chile

China China, Hong Kong SAR

China, Macao SAR

Colombia

Congo

Costa Rica Dem Rep. of the Congo

Djibouti

Dominica

Ecuador

Egypt

El Salvador

Equatorial Guinea

Ethiopia

Fmr Sudan

Gabon

Gambia

Georgia

Ghana

Grenada

Guatemala

Guinea

Guinea-Bissau

Guyana

Haiti

Honduras

Iceland

India

Indonesia

Iran

Israel

Jamaica

Japan

Jordan

Kazakhstan

Kenya

Kuwait

Kyrgyz Republic

Kyrgyzstan

Lebanon

Liberia

Libya

Malawi

Malaysia

Mali

Mauritania

Mauritius

Mexico

Morocco

Mozambique

Myanmar

Namibia

Nepal

New Zealand

Nicaragua

Niger

Nigeria

Norway

Oman

Pakistan

Panama

Peru

Philippines

Qatar

Rep. of Korea

Rep. of Moldova

Russian Federation

Rwanda

Saudi Arabia

Senegal
Singapore
South Africa
Sri Lanka
Sudan
Suriname
Switzerland
TFYR of Macedonia
Tajikistan
Tanzania
Thailand
Togo
Trinidad and Tobago
Tunisia
Turkey
Turkmenistan
USA Uganda Ukraine
United Arab Emirates
United Rep. of Tanzania
Uruguay
Uzbekistan
Vanuatu
Venezuela
Viet Nam
Zambia
Zimbabwe

**List of dropped countries in data:**

Aruba
Anguilla
American Samoa
Antarctica
French Southern Territories
Antigua and Barbuda
Bonaire, Sint Eustatius and Saba
Saint Barthélemy
Bermuda
Bouvet Island
Botswana
Cocos (Keeling) Islands
Côte d'Ivoire
Cook Islands
Comoros
Cuba
Curaçao
Christmas Island
Cayman Islands
Dominican Republic
Eritrea
Fiji
Falkland Islands (Malvinas)
Faroe Islands
Micronesia (Federated States of)
Gibraltar
Greenland
Guam
Heard Island and McDonald Islands
Croatia
British Indian Ocean Territory
Iraq
Kiribati
Saint Kitts and Nevis
Lao People's Democratic Republic
Saint Lucia
Lesotho
Madagascar
Maldives
Marshall Islands
Montenegro
Mongolia
Northern Mariana Islands
Montserrat
Mayotte
New Caledonia
Norfolk Island
Niue
Nauru
Pitcairn
Palau
Papua New Guinea
Korea (Democratic People's Republic of)
Paraguay
Palestine, State of
French Polynesia
South Georgia and the South Sandwich Islands
Saint Helena, Ascension and Tristan da Cunha
Solomon Islands
Sierra Leone
San Marino
Somalia
Saint Pierre and Miquelon
Serbia
South Sudan
Sao Tome and Principe
Eswatini
Sint Maarten (Dutch part)
Seychelles
Syrian Arab Republic
Turks and Caicos Islands
Tokelau
Timor-Leste
Tonga
Tuvalu
United States Minor Outlying Islands
Holy See
Saint Vincent and the Grenadines
Virgin Islands (British)
Wallis and Futuna

**List of products included at the HS two-digit level:**

| | |
|---|---|
| **01** | **ANIMALS; LIVE** |
| **0101** | **Horses, asses, mules and hinnies; live** |
| **0102** | **Bovine animals; live** |
| **0103** | **Swine; live** |
| **0104** | **Sheep and goats; live** |
| **0105** | **Poultry; live, fowls of the species Gallus domesticus, ducks, geese, turkeys and guinea fowls** |
| **0106** | **Animals; live, n.e.c. in chapter 01** |

| | |
|---|---|
| **03** | **FISH AND CRUSTACEANS, MOLLUSCS AND OTHER AQUATIC INVERTEBRATES** |
| **0301** | **Fish; live** |
| **0302** | **Fish; fresh or chilled, excluding fish fillets and other fish meat of heading 0304** |
| **0303** | **Fish; frozen, excluding fish fillets and other fish meat of heading 0304** |
| **0304** | **Fish fillets and other fish meat (whether or not minced); fresh, chilled or frozen** |
| **0305** | **Fish, dried, salted or in brine; smoked fish, whether or not cooked before or during the smoking process; flours, meals and pellets of fish, fit for human consumption** |
| **0306** | **Crustaceans; in shell or not, live, fresh, chilled, frozen, dried, salted or in brine; smoked, cooked or not before or during smoking; in shell, steamed or boiled, whether or not chilled, frozen, dried, salted or in brine; edible flours, meals, pellets** |
| **0307** | **Molluscs; whether in shell or not, live, fresh, chilled, frozen, dried, salted or in brine; smoked molluscs, whether in shell or not, cooked or not before or during the smoking process; flours, meals and pellets of molluscs, fit for human consumption** |
| **0308** | **Aquatic invertebrates, other than crustaceans and molluscs; live, fresh, chilled, frozen, dried, salted or in brine, smoked, whether or not cooked before or during the smoking process; flours, meals, and pellets, fit for human consumption** |

| | |
|---|---|
| **04** | **DAIRY PRODUCE; BIRDS' EGGS; NATURAL HONEY; EDIBLE PRODUCTS OF ANIMAL ORIGIN, NOT ELSEWHERE SPECIFIED OR INCLUDED** |
| **0401** | **Milk and cream; not concentrated, not containing added sugar or other sweetening matter** |
| **0402** | **Milk and cream; concentrated or containing added sugar or other sweetening matter** |
| **0403** | **Buttermilk, curdled milk and cream, yoghurt, kephir, fermented or acidified milk or cream, whether or not concentrated, containing added sugar, sweetening matter, flavoured or added fruit or cocoa** |
| **0404** | **Whey and products consisting of natural milk constituents; whether or not containing added sugar or other sweetening matter, not elsewhere specified or included** |
| **0405** | **Butter and other fats and oils derived from milk; dairy spreads** |
| **0406** | **Cheese and curd** |

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|---|---|
| **0407** | **Birds' eggs, in shell; fresh, preserved or cooked** |
| **0408** | **Birds' eggs, not in shell; egg yolks, fresh, dried, cooked by steaming or boiling in water, moulded, frozen or otherwise preserved, whether or not containing added sugar or other sweetening matter** |
| **0409** | **Honey; natural** |
| **0410** | **Edible products of animal origin; not elsewhere specified or included** |

| | |
|---|---|
| **07** | **VEGETABLES AND CERTAIN ROOTS AND TUBERS; EDIBLE** |
| **0701** | **Potatoes; fresh or chilled** |
| **0702** | **Tomatoes; fresh or chilled** |
| **0703** | **Onions, shallots, garlic, leeks and other alliaceous vegetables; fresh or chilled** |
| **0704** | **Cabbages, cauliflowers, kohlrabi, kale and similar edible brassicas; fresh or chilled** |
| **0705** | **Lettuce (lactuca sativa) and chicory (cichorium spp.) fresh or chilled** |
| **0706** | **Carrots, turnips, salad beetroot, salsify, celeriac, radishes and similar edible roots; fresh or chilled** |
| **0707** | **Cucumbers and gherkins; fresh or chilled** |
| **0708** | **Leguminous vegetables; shelled or unshelled, fresh or chilled** |
| **0709** | **Vegetables; n.e.c. in chapter 07, fresh or chilled** |
| **0710** | **Vegetables (uncooked or cooked by steaming or boiling in water); frozen** |
| **0711** | **Vegetables provisionally preserved; (e.g. by sulphur dioxide gas, in brine, in sulphur water or in other preservative solutions), but unsuitable in that state for immediate consumption** |
| **0712** | **Vegetables, dried; whole, cut, sliced, broken or in powder, but not further prepared** |
| **0713** | **Vegetables, leguminous; shelled, whether or not skinned or split, dried** |
| **0714** | **Manioc, arrowroot, salep, Jerusalem artichokes, sweet potatoes and similar roots and tubers with high starch or inulin content; fresh, chilled, frozen or dried, whether or not sliced or in the form of pellets; sago pith** |