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Sanitary and Phytosanitary measures in agri-food imports from the European Union: Reputation effects over time

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ABSTRACT: The EU's Rapid Alert System for Food and Feed provides information on sanitary and phytosanitary (SPS) notifications. With a set of data from the 1998-2013 period, we test the hypothesis that past notifications can determine current notifications. This is the "reputation effect", meaning that inspectors may tend to target products or countries with previous SPS problems. We analyze the scope of the reputation effect over time. We used two count data models to estimate the distribution of current notifications. In line with previous literature, our findings indicate that reputation does affect current EU notifications. Furthermore, we identify some relevant exporter countries for which reputation is long-lasting.

KEYWORDS: Agri-food trade, Count models, RASFF, Reputation effect, SPS measures.

JEL classification: F13, F14, Q17, Q18.

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Medidas sanitarias y fitosanitarias en las importaciones agroalimentarias de la Unión Europea: los efectos reputación a lo largo del tiempo

RESUMEN: El sistema de alerta rápida para alimentos de la UE informa sobre notificaciones sanitarias y fitosanitarias. Con datos del periodo 1998-2013, se comprueba la hipótesis de si notificaciones pasadas afectan a las notificaciones presentes. Se trata del efecto reputación, que implica que los inspectores pueden dirigir sus inspecciones a productos o países que hayan tenido previamente problemas sanitarios y fitosanitarios; también se analiza el alcance temporal de la reputación. Se utilizan dos modelos de recuento para estimar la distribución de las notificaciones actuales. Los resultados muestran que la reputación influye en las notificaciones actuales de la UE. Además, se identifican varios exportadores relevantes para los que la reputación tiene un efecto duradero.

PALABRAS CLAVE: Comercio agroalimentario, Modelos de recuento, Sistema de alerta rápida para alimentos, Efecto reputación, Medidas sanitarias y fitosanitarias.

Clasificación JEL: F13, F14, Q17, Q18.

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1. Introduction

Non-Tariff Measures (NTMs) are practices that alter the conditions of international trade, including those measures that restrict it as well others that incentivize it. Prices as well as traded quantities are altered as a result of those practices. Economic literature has treated extensively NTMs in recent decades. One line of discussion refers to the political economy behind the implementation of NTMs in different countries. Some analysts argue that NTMs are implemented to guarantee high quality and compliance with technical standards (Mahé, 1997; Disdier *et al*., 2015); in this vein, Henson and Jaffee (2008) employed the expression "standards as catalysts", stating that the standards help to correct market failures, while others point to protectionist reasons. For instance, one classical hypothesis is the existence of "policy substitution" (Copeland, 1990; Ederington, 2001; Bagwell and Staiger, 2001). Its proponents argue that, together with multilateral tariff cuts, countries may implement NTMs to secure a certain level of protection for domestic production.

Therefore, to ascertain the trade-enhancing or trade-deterrent role of NTMs, some recent researches have investigated how NTMs affect the agri-food trade (Cadot *et al*., 2012; Yue and Beghin, 2009). A point to stress is that limited access to consistent and updated information and various methodology limitations make the estimation of the NTM impacts on the agri-food trade a hard task. Another point to stress, based on literature findings, is that the trade-enhancing and trade-deterrent effects found empirically are very often country- and sector-specific (Dal Bianco *et al.,* 2015). For instance, fresh and processed food are not significantly affected by these measures (Fontagné *et al*., 2005).

A specific category of NTMs includes border measures "…*such as restriction for substances and ensuring food safety, and those for preventing dissemination of disease or pests* as well as *all conformity-assessment measures related to food safety, such as certification, testing and inspection, and quarantine*" (UNCTAD, 2015; p. 4). These kinds of NTMs which are termed are the so-called Sanitary and Phytosanitary (or SPS) Measures. Many actors are involved in the definition of specific SPS measures (policymakers, producers' and consumers' organizations, environmental associations, etc.) which is why these measures tend to be very diverse across countries and their application is usually a very dynamic and complex process. Consequently, complying with SPS rules can be a challenge for trading partners.

Over the past few decades, food scares have become a recurring theme in the European Union (EU). Food safety standards in the EU are therefore becoming more stringent in order to limit the risks associated with contaminated food products. Sanitary concerns are more relevant for products like fruits and vegetables or fisheries products (Jaud *et al.,* 2013). Indeed, consumer health has become a key concern in EU public health policies, a fact which in turn could influence the EU's preferences in supplier selection (Taghouti *et al.,* 2015). Such concerns have the potential to influence the evolution of EU agri-food imports, and therefore limit market access for suppliers who have difficulties in complying with EU sanitary standards.

In the EU, SPS border measures are defined at the EU level, so that common sanitary and safety standards for food products are set for the EU as a whole, while national border authorities have the responsibility to control whether or not imports meet the established standards. There are some issues related to these controls that deserve special attention. In fact, limited resources to inspect all imported agri-food products can lead to under-inspection as well as over-inspection. The past can determine which products are controlled, as inspectors might primarily target products that have had problems in the past or countries with a high probability of having problems to export certain products identified as sensitive in previous inspections. As discussed in the next section, a considerable amount of literature has focused on this "reputation effect".

As a tool to raise awareness across Member States about compliance with SPS rules by food imports, the European Rapid Alert System for Food and Feed (RASFF) provides information in the form of notifications that indicate when, where and why there are food alerts or border rejections of a specific consignment. In this paper, we use this database to analyze the EU's behaviour in the implementation of food safety standards at its borders.

Against this background, the main objective of our paper is to explore the reputation effect in the case of European agri-food imports by testing whether past notifications somehow influence current notifications. More specifically, we want to ascertain, in the first place, whether this reputation exists or not and, if so, we aim to identify and address other questions that can help us gain an insight into the topic: Are there differences in the "trade effect" of reputation across countries? What are the influencing factors that determine the reputation of a given product or country in agri-food trade? Does reputation evolve over time for a given country?

The rest of this paper is structured as follows. The next section introduces the notion of reputation at product, sector and country level, departing from a discussion of existing literature in this respect. We then explain and discuss the methodology chosen for the analysis. The results section shows the relevance of reputation on SPS control at the EU borders according to the empirical findings and, after that, we set out the main conclusions drawn from the empirical analysis.

2. The notion of reputation

The term "reputation" has been recently employed in literature regarding the implementation of SPS measures. This section reviews the emerging literature in this area. First, we explore and define the notion of reputation when analysing trade in agri-food products. Then we extend the discussion by highlighting the importance of considering the effect of reputation over time, which involves differentiating and comparing its effects in the short and the long run.

The notion of reputation was first introduced by Jouanjean *et al.* (2012; 2015) by examining the behaviour of the United States (US) in rejecting agri-food products at its frontiers. The above-mentioned authors tested the hypothesis that the border rejections for a product coming from a certain exporter in a given year could raise the probability of future rejections for the same product and origin, and they called this effect "reputation". Their results confirmed the hypothesis, i.e. previous-year notifications increase the probability of notifications in the current year. Hence, Jouanjean *et al.* (2015) suggested that NTMs are not only implemented on the basis of current risk, but are also influenced by past risks.

Jouanjean *et al.*'s methodology involved codifying the US refusals with an aggregation by country of origin and product (classified with 4-digit HS code[1]) over the period 1998-2008. Additionally to this "product-country" reputation, their paper distinguishes a "region" and a "sector" reputation effect. For the "region" reputation, they tested the hypothesis that if a product from a neighbouring country –i.e. belonging to the same "region" – was refused in the previous year, then the number of refusals for the exporting country in the current year could be expected to increase for the same product. As for the "sector" reputation, the same holds true when considering the aggregation of products at the two-digit level (HS2): the odds of a refusal increase if a product from the same sector–i.e. belonging to the same HS2 chapter – was notified in the previous year.

Taghouti *et al.* (2015) explored EU food safety notifications on agri-food imports, giving special attention to Mediterranean Partner Countries (MPCs). Four types of reputation were considered, namely product, sector, country and region reputations. The results showed that EU notifications are affected mainly by a product's own reputation as well as by the country's reputation. Besides, the study showed no sign of protectionist behaviour by the EU against MPCs, even taking into account products that compete with domestic production.

The results from Tudela-Marco *et al.* (2016) highlight the fact that EU Member states have no common behaviour in implementing border controls for fruits and vegetables. Tudela-Marco *et al*.'s study supports the evidence found by Jouanjean *et al.* (2015) and Taghouti *et al.* (2015) with regard to reputation. Product reputation appears to be more significant in comparison to sector and country reputation. Furthermore, the results of the above-mentioned study showed a strong correlation between the degree of development of exporting countries and the number of notifications.

The main conceptual contribution of the present paper is to extend the concept of reputation to cover a longer time span. In existing literature, product reputation appears to be the most influential. However, to date, the impact of reputation has been checked only over a one-year period, and our starting hypothesis is that this effect might be longer-lasting. So we will check not only whether notifications in a given year affect notifications the following year, but we will also examine whether product reputation extends backwards in time up to the third preceding year. A further contribution is that we consider fixed country effects in order to examine whether SPS border treatment differs for different exporters.

[1] HS refers to the Harmonized System, a standard international system for classifying goods in international trade, adopted in the late 1980s.

3. Data and descriptive analysis

As mentioned in the introduction, RASFF is a system of notification and information exchange on emergency sanitary measures at the border of EU Member States. It provides information on food notifications at the EU's borders, specifying which shipments of specific products from exporting countries do not comply with food safety requirements.[2]

This data source has been used previously in order to analyze the impact of SPS measures on the agri-food trade. In particular, Kleter *et al.* (2009) explored the usefulness of RASFF notifications to identify emerging trends in recent food safety issues, based on EU reports. For their part, Jaud *et al.* (2013) examined the RASFF notifications of 146 exporters to the EU in order to determine the geographical concentration of EU agri-food imports; and Kallummal *et al.* (2013) used the RASFF database to analyze the impact of EU food safety measures on trade flows between South Asian countries and the EU as a whole.

In our case, in order to analyze the effect of reputation on EU food import notifications, we used an original database of 39 countries[3] selected on the grounds that they are the most notified partners by the EU in the period under consideration. Overall, these countries' exports received 15,098 notifications, which account for 34 % of total notifications in the period 1998 to 2013[4] and which we took as the starting point for our research: It should be noted that the RASFF portal provides a complete database with product information in verbal form, but notifications are not classified under the Harmonized System. Our study includes imports from EU Member States[5], and all the notifications found belonging to the selected countries were painstakingly classified with 4-digit HS codes. The biggest challenge we faced when building this database was converting all the recorded product notifications from verbal form to HS code. To do so, we designed a word-recognition algorithm complemented by user assessment for ambiguous verbal forms.

Each notification was coded specifying all of the following parameters: the identity of the exporting country, the notified product, the sector, and the date of notification. The unit of observation is defined as "product (HS4), exporter country, year of the notification". For further analysis, notifications are summed over notified products of the same sector (HS2) and over notified products of each country to take into account the notifications per sector and per country in each year of the sample.

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[2] In addition to the EU, the four European Free Trade Association countries are also RASFF members.

[3] Argentina, Australia, Brazil, Canada, Chile, China, Colombia, Costa Rica, Cote d'Ivoire, Ecuador, Egypt, Ethiopia, Ghana, Guatemala, Iceland, India, Indonesia, Israel, Japan, Korea, Malaysia, Mauritania, Mexico, Morocco, Namibia, New Zealand, Nigeria, Norway, Pakistan, Peru, Philippines, Russia, Saudi Arabia, South Africa, Thailand, Turkey, Ukraine, United States and Vietnam.

[4] We chose a 15-year period, considering that the last data available were from 2013 when the codification was made. Overall, there were 44,502 notifications.

[5] We took into account the imports of the former EU-15 Member States to ensure consistency and coherence over a long period.

It is important to make two remarks: First, products enter the database only if they are exported to the EU15. This has implications for the type of zeroes found in the database (see below). Secondly, we included all the notifications for agri-food products except those of the first HS chapter (HS01: Live animals) and HS24 (Tobacco and manufactured tobacco substitutes).

Figure 1 shows the evolution over time of the number of notifications. The total number of notifications shows a sharply rising trend starting in 1998, with the curve levelling off after 2007. Indeed, in the first period (before 2007) the total number of notifications rose yearly by 26.27 % while after 2007 this figure dropped to 9 %. The average number of notifications in the current year (t) is 944, in one lagged year 868, two lagged years 783, and three lagged years 695.

While we do not specifically analyze this aspect in our paper, some explanation on the type of notifications issued may be appropriate. There are different types of notifications, depending on the action taken: alert notifications, information and news notifications, and border rejections. They are indicators about which exporting countries and products fulfill the food safety and quality standards required by EU (RASFF, 2013). In accordance with the Regulation (EC) No 16/2011, an alert notification is defined as an information sent when a food or feed presenting a serious health risk on the market has to be treated with priority. Information notifications are used when a risk has been detected about food or feed placed on the market, but the other members do not have to handle it quickly. Besides, any information related to the safety of food and feed products which has not been transmitted as an alert or an information notification, but which is considered interesting for the control authorities, is sent to the members under the heading 'News'[6]. Finally, border rejections mean a notification of a rejection in respect with food and feed consignments that have been tested and rejected at the external borders of the EU when a health risk has been identified.

Over 36 % of notified products were rejected at the borders of the EU in the period 1998-2013. 51.5 % of total notifications were information notifications. Figure 1 illustrates the changes for different types of notifications: in addition to the increase in the total number of notifications since the early 2000s, a change took place from 2007 onwards, i.e. a shift from information to the more restrictive category –rejections– is apparent. While this is probably linked to the above-mentioned greater concern for food safety, it clearly also points to a more restrictive implementation of SPS measures at the EU borders.

Figure 2 shows a significant level of heterogeneity among notifying EU Member States in terms of their respective share of the total number of notifications, based on averages over the period 1998-2013. Italy (16.4 %), United Kingdom (16.4 %) and Germany (16.3 %) are the top notifying countries. This fact might reflect the different agri-food imports structure and volumes among EU Member States. It could also indicate inspections are not operated uniformly across the EU, as the findings from Tudela-Marco *et al*. (2016) suggest.

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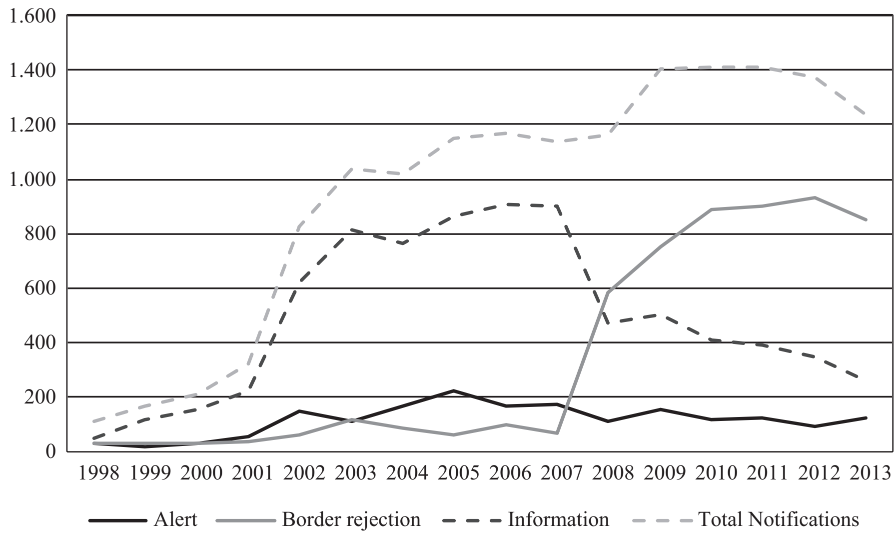
[6] For this reason, we plot News and Information together.

FIGURE 1

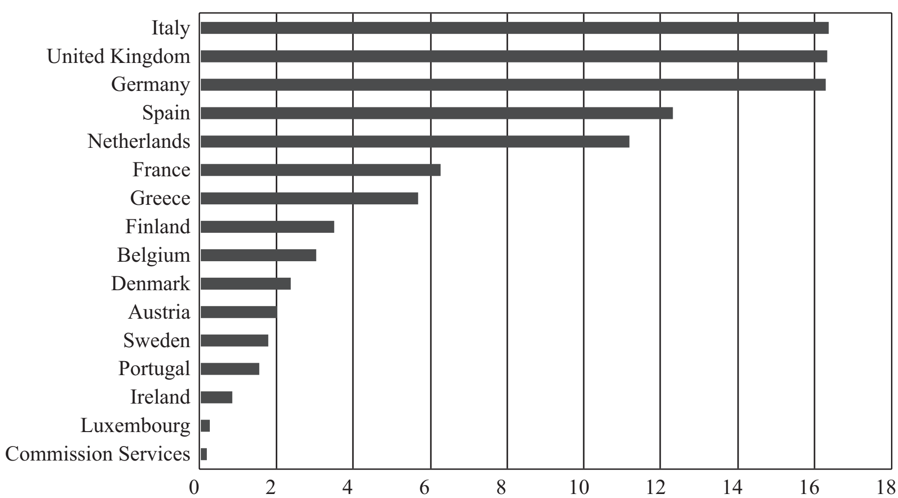
Evolution in the number of notifications and breakdown by type. 1998-2013



Source: Authors' calculations based on RASFF data.

FIGURE 2

Percent of total notifications by Member State (1998-2013). In percentage

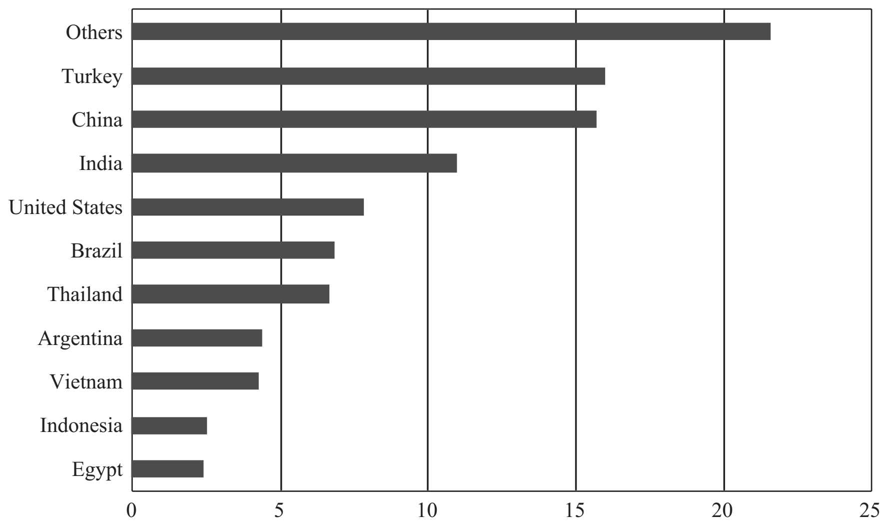


Source: Authors' calculations based on RASFF data.

Figure 3 depicts the heterogeneity among countries that receive notifications. Apart from Turkey, the countries most affected by notifications are the two largest Asian countries, followed by the United States. Turkey accounts for 16.1 % of observations, followed by China (15.8 %), India (11.1 %) and the US (7.9 %).

FIGURE 3

Percent of total notifications by country (Top 10 notified countries), average 1998-2013

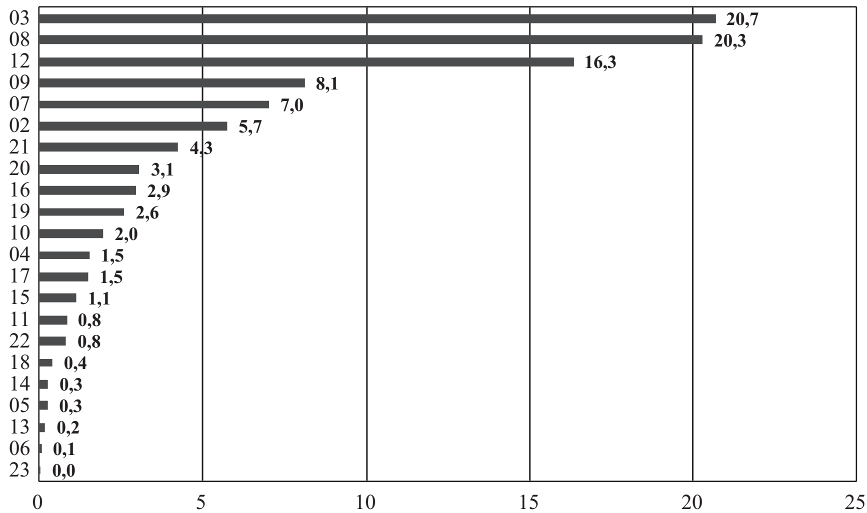


Source: Authors' calculations based on RASFF data.

Figure 4 shows the frequency of notifications for each agri-food sector. The most notified sectors are "Fish and crustaceans" (HS03) and "Fresh fruits" (HS08), each accounting for more than one fifth of total notifications in our database. These sectors are followed by HS chapters 12 (Oil seeds and oleaginous), HS 09 (Coffee, tea and spices) and 07 (Vegetables).

FIGURE 4

Percent of total notifications by HS2 chapter, average 1998-2013



Source: Authors' calculations based on RASFF data.

4. Methodology and model specification

Given the definition of all notifications types (see the previous section), it is important to stress that we assume that the reputation of a product or an exporting country can be affected by any type of information transmitted by the RASFF network. Therefore, in the present study the number of notifications includes all types of notifications. This choice also relies on previous studies carried out by several authors (Kleter *et al.*, 2009; Jaud *et al.*, 2013; Kallummal *et al.*, 2013; Jouanjean *et al.*, 2012, 2015). These authors use notifications as dependent variable to determine the impact of SPS measures on agro-food trade. Also, the number of notifications is widely used as a measure to analyze the behavior of countries in respect with the implementation of food safety standards on vegetable and animal products.

Given that we chose as the dependent variable the number of notifications for a given product (i) from an exporter (j) in year (t) as N_{ijt}, the empirical analysis developed in this section is based on three types of reputation, i.e. we count the number of notifications per product, sector and country:

- ***"Product reputation"***$(N_{ij(t-k)})$ is defined by the correlation between the number of notifications for a given "product-exporter-year" combination N_{ijt} and the number of notifications for that "product-exporter" in the previous years N_{ijt-k}. If k=1, we consider the influence of notifications for that "product-exporter" in the previous year N_{ijt-1}. We will label this as the short-term reputation[7]. If k=2, we will refer to the influence of notifications for that "product-exporter" in the second previous year N_{ijt-2}.We will label this as the medium-term reputation. If k=3, we consider the number of notifications for that "product-exporter" in the third previous year N_{ijt-3}. This will be indicative of a long-term reputation.
- ***"Sector reputation"***$(N_{Ij(t-1)})$ refers to the influence on the number of notifications, for a given "product-exporter-year" combination N_{ijt}, exerted by the number of notifications for all products belonging to the same HS2 chapter for that exporter in one lagged year $N_{Ij(t-1)}$.
- ***"Exporter reputation"***$(N_{J(t-1)})$ represents the influence on the number of notifications, for a given "product-exporter-year" combination N_{ijt}, exerted by the total number of notifications applied to the same exporter in the previous year.

As an additional explanatory variable, the database includes the one-year lagged per capita Gross Domestic Product (GDPpc) of each country of origin, based on World Bank data, at constant 2005 prices in US dollars. This variable is collected to take into account whether EU control of imported agri-food products is influenced by the level of development of the country of origin. The underlying assumption, as suggested by Taghouti *et al.* (2015), is that richer countries are less likely to fail a SPS control, due to more developed pre-export facilities and, in general, to a more export-oriented value chain.

We also consider the possibility of protectionist behaviour, with over-control after an export surge of a product, by including among the explanatory variables the previous year value of imports for that product –extracted from COMEXT-EUROSTAT data. The model specification is shown in Equation 1:

$$\begin{aligned} & \delta_0 + \sum_{k=1}^{3} \delta_K N_{ijt\text{-}K} + \varphi(N_{1jt-1}) + \theta(N_{Jt-1}) + \\ Ln\, N_{ijt} = & + \rho(Ln\ GDP_{pc\ j(t-1)}) + \sigma(Ln\ Import_{i(t-1)}) + \sum_{j=1}^{10} \beta_j Z_j + \\ & + \sum_{j=1}^{10} \sum_{k=1}^{3} \gamma_{jk} Z_j N_{ij\ (t-k)} \end{aligned} \qquad [1]$$

Where δ_k, φ, θ, ρ, σ, β_j, γ_{jk} represent the coefficients of the explanatory variables to be estimated, and Z_j is a dummy variable that takes the value of 1 for country (j) and zero otherwise. Z_j represents the fixed effects of the 10 main agri-food exporters

[7] This is the product reputation studied previously in the available literature.

among the 39 selected countries. This fixed effect is understood to consist of a distinctive shift for those countries in comparison with the general effect of notifications[8].

By examining the descriptive statistics of the set of variables, we note that the standard deviation of almost all variables is greater than the mean, which suggests that over-dispersion can be a problem for the econometric estimation. Another challenge posed by the data is the enormous amount of zero observations (no notifications for a given "product-origin-year")[9]. These facts point to the need for effective count models to accurately estimate the relationship given in [1]. Table 1 shows the descriptive statistics of the variables used in our estimation.

TABLE 1

Descriptive statistics

Variable	Mean	Std. Dev	Min	Max	% of "zeroes"
N_{ijt}	0.12	1.694	0	140	97.0
N_{ijt-1}	0.11	1.620	0	140	97.1
N_{ijt-2}	0.10	1.513	0	140	97.4
N_{ijt-3}	0.09	1.438	0	140	97.7
N_{Ijt-1}	1.16	7.454	0	210	83.2
N_{Jt-1}	21.72	43.721	0	294	18.1
Ln $GDP_{pc(t-1)}$	8.32	1.476	4.850	11.120	0
Ln $Import_{(t-1)}$	1	0.064	1	15	0

Source: Authors' calculations.

The available literature indicates that count variables follow a Poisson or one of its related distributions. However, the standard Poisson model is very sensitive to problems of over-dispersion and excess zeros in the dependent variable (Burger *et al.,* 2009). Therefore, we estimate the previous equation with two different count models: the Negative Binomial model (NB) and the Zero-Inflated Negative Binomial model (ZINB). These models are commonly used to deal with count variables in social sciences (Zeileis *et al.,* 2008). The model depicted in [1], estimated with the ZINB, is called ZINB1, and when estimated with NB is called NB1.

The NB belongs to the family of modified Poisson models. It is commonly used to correct the over-dispersion problem (Cameron and Trivedi, 2013). The ZINB is widely used for modelling over-dispersed count data with excessive zeros (Lambert, 1992; Greene, 1994). This model consists of a modified version of the NB. It

[8] Fixed product effects could not be estimated as convergence issues were insurmountable. The analysis of the most notified products (e.g., nut products) will constitute another area that merits further attention as a case study, so that the main factors that can affect product reputation can be identified.

[9] In fact, there are 126,720 observations from the 15,098 notifications.

is assumed that the zeroes present in the database can have two possible generation processes: one groups together only “strict” zeroes, i.e. if there is no trade flow for a “product-country”, it is not possible to record a notification. The second generation process corresponds to a situation of full compliance with SPS rules by actual trade flows. In this case no notification is reported, although a notification might, possibly, have been issued. Formally, the first process is modelled with a logit model to consider the probability of zeroes with no possible notifications. The second process is a NB regression for the non-zero probability cases detected in the logit model.

In spite of the existence of the ZINB, the NB estimation does not have to be set apart beforehand. Cameron and Trivedi (2010) warn researchers that, in datasets with excess zeroes, the ZINB does not always fit the data better than the NB does. Statistical tests therefore have to be applied to select the best model. Furthermore, following Tudela-Marco *et al.* (2016), we added a restricted model in order to select which model could minimize the loss in fit with the data. This new model is a nested version of the saturated model [1] and assumes there is no other influence of previous’ years notifications for the top-ten notified exporters, or $\gamma_{jk} = 0$. It is given by Equation 2:

$$Ln\, N_{ijt} = \begin{array}{c} \delta_0 + \sum_{k=1}^{3} \delta_K N_{ijt\text{-}K} + \varphi(N_{1jt-1}) + \theta(N_{Jt-1}) + \\ + \rho(Ln\ GDP_{pc\ j(t-1)}) + \sigma(Ln\ Import_{i(t-1)}) + \sum_{j=1}^{10} \beta_j\, Z_j \end{array} \qquad [2]$$

If the restriction is true, then the loss of fit between [1] and [2] is necessarily small. The model depicted in [2], estimated with the ZINB, is called ZINB2, and when estimated with NB is called NB2. The four estimations ZINB1, ZINB2, NB1 and NB2 were run using the R-language.

5. Results

The logic behind using several autoregressive terms in the model is based on the assumption that reputation effect entails a lag time to be constructed. Thus, the current notification will depend on its own previous values and other explicative variables. One tangible concern with such models is to test the stationarity condition. For this purpose, the Augmented Dickey Fuller (ADF) test has been conducted. This test allows determining whether a unit root is present in an autoregressive model which can lead to biased statistical inference.

Under the null hypothesis, H_0, unit root exists that means data are non-stationary while the alternative H_1 indicates that process has no unit root and data are stationary. The ADF test statistic is -157.48. (p-value=0.01). Hence, at the 5 % level of significance, we reject the null hypothesis that data are non-stationary.

There are various statistical methods to determine the best model choice. In this paper, three methods were utilized: the Akaike Information Criterion (AIC), the likelihood ratio test and the Vuong test. The Vuong test (Vuong, 1989) holds for non-nested models and is based on a comparison of the probabilities predicted by the two different estimation processes (ZINB and NB). Its null hypothesis is that the expected value of their log-likelihood ratios equals zero, which implies that both models are similar. The results of this test are given in Table 2, showing that the ZINB1 estimation is preferable to the NB1 estimation

TABLE 2

Comparison between NB1 and ZINB1 estimations. Vuong test

	ZINB1	**NB1**
No. of observations	126,720	126,720
Overdispersion (α)	8.811***	13.833
Vuong Test[(a)]	6.691***	7.613***
	21.063***	

[(a)] The Z- statistic score is displayed for the Vuong test, which follows a standard normal distribution.
Source: Authors' calculations.

The AIC and the likelihood ratio are suitable to make comparisons across the nested models, hence between ZINB1 and ZINB2, on the one hand, and NB1 and NB2 on the other hand. Table 3 shows that these indicators provide evidence of the superiority of the ZINB1 over its more restricted version ZINB2, as NB1 outperforms NB2.

TABLE 3

NB and ZINB models. Quality of fit indicators

	ZINB1	**ZINB2**	**NB1**	**NB2**
AIC	38,884.107***	39,306.805	41,360.402***	41,968.189
Log Likelihood	-19,389.053	-19,630.403	-20,631.201	-20,965.094
No. of observations	126,720	126,720	126,720	126,720
Overdispersion (α)	8.811***	9.803	13.833	15.850

Source: Authors' calculations.

Analyzing the results presented in Table 4, we find that almost all the reputation effects are statistically significant across models. The only exception is the country reputation, which is only significant according to the NB estimation. However, the effect of the product reputation is substantially greater than that of the sector and country reputations. Besides, the reputation decreases as time goes by: The one-year lagged product reputation is greater than the two-year lagged product reputation, which in turn is greater than the three-year lagged product reputation. However, it is noticeable that the three-year lagged reputation is at least one order of magnitude greater than the sector and country reputations, which confirms its relevance in shaping current notifications.

TABLE 4

Statistical models: Estimated parameters

	ZINB1	**ZINB2**	**NB1**	**NB2**
(Intercept)	-0.2923 (10.433)	0.2827 (41.961)	0.0479 (1555182.188)	0.2790 (1363608.163)
N_{ijt-1}	0.7157 (0.041)***	0.4906 (0.022)***	1.0963 (0.021)***	0.7220 (0.011)***
N_{ijt-2}	0.5555 (0.048)***	0.2339 (0.023)***	0.9556 (0.026)***	0.4398 (0.014)***
N_{ijt-3}	0.2818 (0.047)***	0.1650 (0.0230)***	0.6088 (0.025)***	0.3491 (0.012)***
$N_{Ijt.1}$	0.0178 (0.002)***	0.0180 (0.0024)***	0.0278 (0.001)***	0.0301 (0.001)***
N_{Jt-1}	0.0008 (0.0004)	0.0007 (0.0004)	0.0032 (0.0004)***	0.0031 (0.0005)***
Ln GDP_{t-1}	-0.262 (0.018)***	-0.2804 (0.017)***	-0.1220 (0.017)***	-0.1330 (0.0170)***
Ln $Import_{t-1}$	-0.6060 (10.432)	-0.8741 (41.961)	-3.1288 (1555182.18)	-3.1138 (1363608.16311)
China	1.4076 (0.109)***	0.9038 (0.101)***	1.6920 (0.103)***	1.0797 (0.111)***
Morocco	0.1939 (0.134)	0.3446 (0.111)**	0.4074 (0.124)**	0.4899 (0.115)***
United States	1.4974 (0.103)***	1.2567 (0.100)***	1.7347 (0.106)***	1.3659 (0.111)***
Turkey	1.5814 (0.112)***	0.9969 (0.107)***	1.5764 (0.108)***	0.9355 (0.119)***
Thailand	1.1618 (0.105)***	0.9713 (0.0918)***	1.3936 (0.095)***	1.1495 (0.097)***
Brazil	0.8743 (0.102)***	0.5966 (0.0979)***	1.2153 (0.100)***	0.8520 (0.105)***
Argentina	0.6160 (0.117)***	0.4130 (0.106)***	0.7923 (0.110)***	0.5520 (0.114)***
Ukraine	-1.175 (0.225)***	-0.9545 (0.181)***	-0.9124 (0.214)***	-0.7330 (0.186)***
Vietnam	0.7093 (0.119)***	0.4384 (0.111)***	0.9326 (0.105)***	0.7142 (0.107)***
Egypt	0.0274 (0.132)	-0.0736 (0.120)	0.3436 (0.124)**	0.1826 (0.125)
N_{ijt-1}				
China	-0.483 (0.058)***		-0.8020 (0.033)***	
Morocco	0.1182 (0.160)		0.0822 (0.119)	
USA	-0.2496 (0.08)**		-0.5745 (0.038)***	
Turkey	-0.492 (0.056)***		-0.7753 (0.031)***	
Brazil	-0.283 (0.079)***		-0.5882 (0.048)***	
Argentina	-0.2093 (0.114)		-0.4027 (0.049)***	
Thailand	-0.330 (0.083)***		-0.5352 (0.054)***	
Vietnam	-0.558 (0.084)***		-0.8004 (0.054)***	
Ukraine	1.8046 (0.623)**		2.0309 (0.374)***	
Egypt	-0.1443 (0.128)		-0.3397 (0.097)***	

TABLE 4 (cont.)

Statistical models: Estimated parameters

	ZINB1	ZINB2	NB1	NB2
N_{ijt-2}				
China	-0.460 (0.065)***		-0.8233 (0.038)***	
Morocco	-0.3067 (0.186)		-0.4108 (0.1568)**	
USA	-0.651 (0.073)***		-1.0393 (0.049)***	
Turkey	-0.569 (0.059)***		-0.9767 (0.043)***	
Brazil	-0.477 (0.093)***		-0.8165 (0.067)***	
Argentina	-0.2933 (0.115)*		-0.6022 (0.067)***	
Thailand	-0.2750 (0.090)**		-0.5799 (0.061)***	
Vietnam	-0.447 (0.077)***		-0.8256 (0.057)***	
Ukraine	-1.1198 (0.568)*		-1.6489 (0.693)*	
Egypt	-0.2624 (0.158)		-0.4793 (0.110)***	
N_{ijt-3}				
China	-0.1897 (0.063)**		-0.4913 (0.037)***	
Morocco	0.3659 (0.1762)*		0.2208 (0.170)	
USA	-0.1733 (0.069)*		-0.4858 (0.042)***	
Turkey	-0.2763(0.05)***		-0.5844 (0.038)***	
Brazil	-0.2083 (0.080)**		-0.5151 (0.055)***	
Argentina	-0.3392 (0.1361)*		-0.4474 (0.054)***	
Thailand	-0.1052 (0.100)		-0.2467 (0.058)***	
Vietnam	0.0826 (0.124)		0.1880 (0.059)**	
Ukraine	1.6671 (1.040)		1.7599 (1.077)	
Egypt	-0.0428 (0.140)		-0.2369 (0.107)*	
$^{***}p < 0.001$, $^{**}p < 0.01$, $^{*}p < 0.05$				

Source: Authors' calculations.

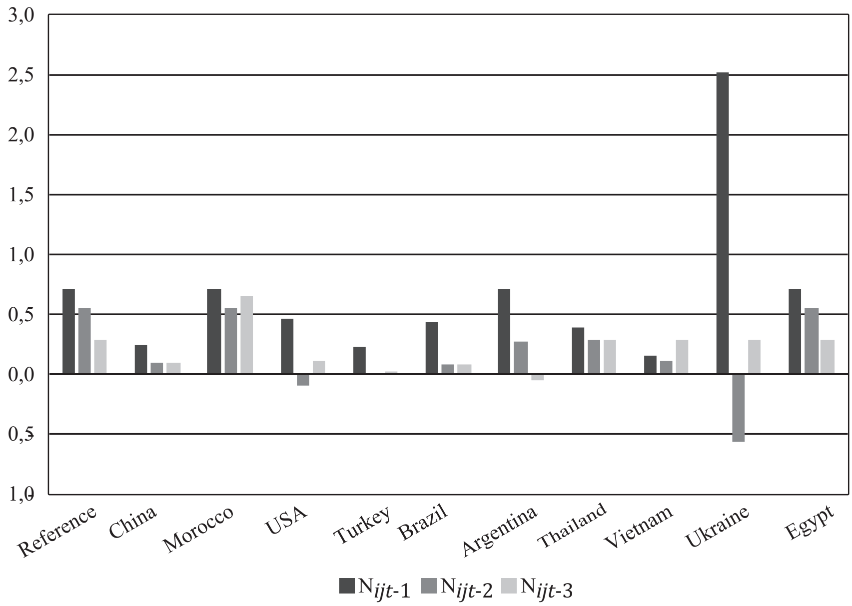
It should be noted that the country of origin per capita GDP is also significant since, as expected, the less is the per capita GDP, the higher is the probability of notifications. Another point to remark is that the value of previous years' imports is not significant in determining current year notifications. The effect of past import surges is therefore not relevant in this case.

As regards country fixed effects, in the most cases there is a higher propensity to receive notifications in the 10 most notified countries compared with the 29-country reference group. Only for Egypt the variable is not statistically significant, indicating a similar behaviour as for the reference group. Furthermore, we may note that Morocco's dummy variable is not significant in the ZINB1 model; and Ukraine shows less propensity, according to the negative significant coefficient in the four models. As far as the remaining countries are concerned, Turkey in the ZINB1 and the US in the other three models have the highest coefficients.

Turning to the interactions between the country fixed effects and the product reputations, in most cases the coefficients are significant. Their magnitude is usually less in the more efficient ZINB1 than in the NB1. We have used these interactions to provide a comprehensive view of the influence of past notifications on current notifications for the top-ten countries. Based on the ZINB1 results, we calculated the total effect of the three product notifications on the current number of notifications. To this end, we added the coefficients of the interactions with each country to the respective coefficients of the product reputation effects. These calculations are depicted in Figure 5.

FIGURE 5

Comparison of the reputation effects between the top-ten notified countries and the reference group



Source: Authors' calculations.

We identified two groups of countries, depending on the evolution of the reputation effects and the long-term reputation. The first group is composed of China, the US, Turkey, Brazil and Argentina. Clearly, the reputation effects are diminishing over time and the effect of long-term reputation is less than for the reference group. This may indicate an effective effort by these countries to fix SPS problems detected in their exports to the EU.

Contrariwise, a second group of exporters, comprising Morocco, Thailand, Vietnam, Ukraine and Egypt, presents long-term reputation effects that are greater or equal to those for the reference group. Furthermore, the reputation effects do not show a decreasing path from the short to the long term, with the exception of Egypt. These countries are therefore performing worse than the previous group both in terms of long-run reputation and in terms of an effective reduction over time. This may indicate that the management of SPS measures in their exports to the EU is a challenge for them.

6. Conclusions

Our study aimed to investigate how past notifications can affect the application of SPS measures to EU imports of agri-food products. This aim is in line with an emerging trend in literature on the implementation of SPS measures. The underlying rationale is that past notifications can be relevant in determining which product, sector or country of origin is subject to checks: Border inspectors can be expected to target products that have had problems in the past or countries with a high probability of having problems to export certain products identified as sensitive in previous inspections. Our approach is based on the fact that EU import notifications are explained by three types of reputation effects, namely product, sector and country reputation. Besides, we checked for the effect of the previous year import value and per capita GDP of exporting countries. Furthermore, this paper raises the question of the effect of the evolution of reputation over time. To this end, we checked whether current notifications are affected by the previous year's notifications as well as by the second and third preceding years' notifications.

We used the RASFF database of EU notifications, in line with a number of recent research studies on trade issues. Three major problems were found in building the database: (1) the conversion of all recorded notifications from verbal form to HS code (2) the over-dispersion in the data and (3) the excess of zeros in observations. Methodologically, and in order to take into account these features of the dataset, a word recognition algorithm was developed, and two count models were used to estimate these relationships.

Our findings support previous evidence found by Jouanjean *et al.* (2015) for the US, as well as by Tudela-Marco *et al.* (2016) and Taghouti *et al.* (2015), suggesting that EU SPS border controls are affected by reputation. As regards the evolution of reputation over time, our empirical results suggest that the number of EU notifications in the current year is affected firstly by the product's own reputation, with a relatively stronger effect in the case of one-lagged-year notifications in comparison with two or three lagged years.

After the product reputations, the sector reputation plays a smaller explanatory role, indicating a certain cross-attribution of reputation among similar products. Conversely, however, country reputation does not affect the number of current notifications or only does so very slightly. Altogether, this indicates that cross-attribution does not impact all the exports from the same country but tends to be limited to similar products.

Similarly, notifications are not affected by previous import values, thus countering the hypothesis of possible protectionist behaviour after an import surge. However, the number of notifications varies negatively with the per capita GDP of the exporter, suggesting that a country's development level is a key determinant of the integration of agro-exporting enterprises in the global value chains in terms of complying with EU product safety standards.

In most of the exporter countries under consideration, two different patterns were detected. For some countries, product reputation effects diminish consistently over time, which points to effective efforts on the part of these countries to fix the SPS problems notified previously. As a result, the long-term effect of a notification is very small or even absent. On the contrary, for another group of countries, a three-years-ago notification has detrimental effects on current SPS compliance. This is probably indicative that the efforts undertaken to fulfil SPS rules have not been sufficient and exports are still burdened by past (bad) performance. More rigorous public policies with pre-export facilities and controls could reverse this trend.

Some implications can be extracted from the results of this study as well as from similar findings in previous literature. First, the product reputation effect has been demonstrated to be a solid element framing SPS compliance in the agri-food imports of the two main agri-food world importers. Checking whether product reputation matters at other major importers' borders can be a relevant research area. Investigating the evolution of reputation effects for different countries in other geographical areas can also help to contrast current results.

Secondly, this paper has shown that long-term reputation also matters and, more specifically, that some countries have been able to soften its impact while others have not. Therefore, analyzing the measures implemented in different instances can be a fruitful exercise, not only in terms of pure academic research but also as a basis for good policymaking. In this vein, Soriano and Garrido (2015) highlight the trade-enhancing effects of public-private investments in infrastructure in developing countries. Some pre-export facilities such as warehouses, terminals, roads etc. are part of this infrastructure and can enhance compliance with SPS rules.

Thirdly, it should be noted that, in dealing with the different types of notifications, our study has not used a causality framework. The shift in the RASFF data from information to border rejections may suggest a tightening of the SPS rules at the EU borders that deserves further attention. Finally, our study provides an opportunity to stress that the RASSF database can be a rich source of detailed information on agri-food trade. Focusing on the reasons for notifications or further investigating the most notified products can provide other valuable insights into the implementation of SPS measures at the EU borders.

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