The European Journal of Development Research
https://doi.org/10.1057/s41287-022-00547-9

ORIGINAL ARTICLE

What Drives Africa's Inability to Comply with EU Standards? Insights from Africa's Institution and Trade Facilitation Measures

Fatima Olanike Kareem[1,2] · **Inmaculada Martínez-Zarzoso**[2,3] · **Bernhard Brümmer**[4]

Accepted: 30 March 2022

Abstract

Over the years, there have been a significant number of Africa's food exports rejected at the European Union (EU) borders due to their non-compliance with EU food safety standards. This paper, therefore, provides an in-depth investigation of the potential causes of the non-compliance of Africa's food exports to EU food standards and the subsequent rejection of such food exports at its borders. We contribute to the literature by investigating the roles played by trade facilitation measures and institutions in food export rejections and also exclusively provide a more detailed analysis and specific evidence at the product level. Our results indicate that poor trade facilitation measures, particularly inefficient border and food logistics procedures in African countries, increase the incidence of food rejection at the EU border and add to Africa's challenges in accessing EU markets. Thus, non-compliance with EU food safety standards can be addressed by African governments through the strengthening of their domestic institutions and trade facilitation measures, with policies that improve logistics and border procedures as well as measures that align their food standards to international ones. This will ensure an efficient food supply chain that meets international food safety standards and facilitates food trade.

Keywords Food safety standards · Food exports · Logistics procedures · Infrastructure · Institutional quality

JEL Classification Q17 · Q18 · F13 · F14 · L1

✉ Fatima Olanike Kareem
fkareem@uni-goettingen.de

Extended author information available on the last page of the article

Published online: 10 August 2022

Résumé
Au fil des ans, un grand nombre de denrées alimentaires africaines vouées à l'exportation a été rejeté aux frontières de l'Union européenne (UE) en raison de leur non-conformité aux normes de sécurité alimentaire de l'UE. Cet article propose donc une enquête approfondie sur les causes potentielles de la non-conformité des exportations alimentaires de l'Afrique aux normes alimentaires européennes et du rejet ultérieur de ces exportations alimentaires aux frontières. Nous contribuons au corpus de littérature existant en étudiant le rôle joué par les mesures de facilitation des échanges et les institutions dans le rejet des exportations alimentaires, et nous fournissons également exclusivement une analyse plus détaillée et des preuves spécifiques au niveau du produit. Nos résultats indiquent que de mauvaises mesures de facilitation des échanges, en particulier des procédures frontalières inefficaces en matière de logistique alimentaire dans les pays africains, augmentent l'incidence du rejet de denrées alimentaires à la frontière de l'UE et aggravent les difficultés d'accès de l'Afrique aux marchés européens. Ainsi, le non-respect des normes de sécurité alimentaire de l'UE peut être résolu par les gouvernements africains avec le renforcement de leurs institutions nationales et des mesures de facilitation des échanges, avec des politiques qui améliorent la logistique et les procédures frontalières ainsi que des mesures qui alignent leurs normes alimentaires sur les normes internationales. Cela garantira une chaîne d'approvisionnement alimentaire efficace qui répond aux normes internationales de sécurité alimentaire et qui facilite le commerce de denrées alimentaires.

Introduction

Food safety standards are aimed at ensuring the health and safety of food for consumers (Xiong and Beghin 2011). Thus, conformity assessment is usually undertaken to determine if food exports comply with importing countries' food safety requirements. Such conformity assessment procedures include certification and accreditation of the food product, testing a sample of the product to ascertain if it conforms to specified requirements, pre-inspection of the product in the home country, and inspection of the product at the border. Compliance with such measures is required for both domestic food products and third countries' exports. However, non-compliance can lead to serious actions being taken against defaulting exporting countries, such as outright bans or the rejection of the food product at the border (Baylis et al. 2009).

In the European Union (EU), violation of its food safety requirements is the primary reason for rejections of third countries' exports. Such violations are usually committed by developing countries who have limited institutional and technical capacity to comply with EU standards. Africa accounts for about 30% of the total non-conformity with EU food standards, with about 600 cases of Africa's food shipments refused entry into the EU at its border between 2008 and 2013. The costs of rejections at the border include the reduction in export earnings as the exported goods are often destroyed by the importing country. In addition, rejections damage

the affected country's reputation and reduce its export competitiveness in the long run (Baylis et al. 2009).

A number of studies have pointed out that the reasons for the inability of African countries to benefit from trade cannot totally be attributed to the trade-inhibiting effects of importing countries' food safety standards (c.f. Xiong and Beghin 2011; Kareem and Martínez-Zarzoso 2020). Major factors contributing to the continent's poor trade performance are linked to its domestic supply constraints resulting from its limited productive capacity (Xiong and Beghin 2011), low levels of institutional quality (Chenaf-Nicet 2019), lack of the institutions needed to ensure compliance with importing countries' standards (Kim and Reinert 2009). However, others identified Africa's poorly developed trade facilitation as the source of the problem,[1] particularly in the key areas of infrastructure, customs and border procedures, as well as transportation and communication (Iwanow and Kirkpatrick 2009; Djankov et al. 2010; Freund and Rocha 2011; Portugal-Perez and Wilson 2012).

Given these, Africa's competitive advantage in its abundance of agricultural resources could easily be lost through inefficient logistics and poorly developed trade facilitation measures. Nevertheless, existing studies have overlooked the role of domestic factors such as institutions, trade-related infrastructure, and trade-related logistics procedures in explaining non-compliance with importing countries' food standards. This study differs from previous ones as it investigates the extent to which these factors contribute to African countries' compliance with EU food safety regulations.

The main aim of this study is to analyse the extent to which domestic factors in Africa inhibit its ability to comply with EU food safety standards. To achieve this objective, this study investigates the role of trade-related infrastructure, trade-related logistics procedures and institutions in the rejection of Africa's food exports at the EU border. Most African countries have poorly developed institutions and infrastructures, which may be triggering factors responsible for such rejections. The number of rejections of food exports from Africa at the EU border is used as a measure of the EU assessment of non-conformity with its food safety standards. A similar measure has been used by Baylis et al. (2009) who used the incidence of EU border rejection to measure compliance. The approach has also been used by Beestermöller et al. (2018) and Jouanjean et al. (2015) to measure compliance with US food safety regulations.

We adopt a similar approach by measuring non-compliance with EU food safety standards using the incidences of food products rejected at the EU border as a result of non-compliance to EU food safety regulations. We focus on the most often rejected categories of Africa's exports, namely fish, crustacean, molluscs and other aquatic invertebrates; fruits and vegetables; and nuts, nut products and seeds (edible groundnuts and unprocessed groundnuts). These products are usually more frequently rejected by the EU for many African countries. In addition, these products constitute the main agri-food product traded between the EU and Africa (Traoré, et. al. 2020). These necessitated the focus on these products.

[1] Trade facilitation is defined as the simplification of import and export procedures, and "addresses the logistics of moving goods through ports or more efficiently moving customs documentation associated with cross-border trade" (Wilson et al. 2005, p. 842).

First, a novelty of this paper is to exclusively focus on these products, which represent more than 70% of all refusals of Africa's food exports in the six years studied, and to provide a more detailed analysis and specific evidence by product. Existing studies have neglected the heterogeneity of the products rejected at the importer borders (Baylis et al. 2009; Jouanjean et al. 2015). We argue that exporters might be more efficient in handling some products, thus, averting the rejection of exports at the borders of importing countries. Therefore, unlike other studies, we examine how the heterogeneous impacts of products might influence the occurrences of border rejection. Second, this is the first study to investigate how trade-related measures and institutions drive the incidence of border rejections. Previous studies have investigated the impact of certain domestic factors such as trade protection pressure, product-specific risks, exporter's experience in food trade on incidence of rejections by the United States (US) (Baylis et al. 2009), or the influence of reputation of the exporting countries or the export products on rejections by the US (Jouanjean, et al. 2015). However, none have focused on how domestic trade measures and institutional quality might affect these—a gap which this study bridged. Third, this study represents the first to investigate the causes of EU export rejections; previous empirical studies had instead focused on the causes of export rejections by the US (Baylis et al. 2009 and Jouanjean et al. 2015).

The rest of the study is organized as follows. Section 2 provides the background on compliance with EU food safety standards by African countries. Section 3 describes the methodology and the data of the study, and the empirical results are presented in Sect. 4. The last section concludes with the policy implications of our findings.

EU Food Safety Standards and Conformity Assessment

Food standards are set to achieve high levels of sanitary and health protection for consumers. In the EU, food products that do not meet its stipulated food standards are usually refused entry at the border. EU food standards enforcement has been made possible by the EU's Rapid Alert System for Food and Feed (RASFF). Through this system, the EU receives and sends notifications about violations of feed and food safety standards by both the EU and third countries.

In the EU, high-risk export products coming into Member State's markets are subject to *border rejection.* Border rejection notifications "concern[s] consignment of food, feed or food contact material that was refused entry into the Community for reason of a risk to human health and also to animal health or to the environment if it concerns feed" (RASFF 2014, p. 37). Thus, non-compliance usually leads to refusals at the border or import detention and/or destruction.

There have been a significant number of food exports rejected at the EU border due to food safety concerns, amounting to about 1107 notifications between 2008 and 2013 (RASFF online database). Table 1 shows the evolution of rejections of Africa's exports at EU borders for the most affected countries and products. The most frequently rejected food export category is fish, crustacean, molluscs and other aquatic invertebrates, representing about 40.56% of Africa's total rejected exports

Table 1 EU Rejection of African Exports of the Most Affected Products from the Most Affected Countries, 2008 to 2013

Most affected products	Egypt	Ghana	Kenya	Morocco	Tunisia	South Africa	Nigeria	Senegal	Others	Total	
Fish, Crustaceans, Molluscs and other Aquatic Invertebrates	1	17	4	154	38	9	8	57	159	447	40.56
Nuts, Nut Products and Seeds	89	18	0	1	4	39	52	5	11	219	19.87
Fruits and Vegetables	86	8	23	16	15	4	31	5	15	203	18.42
Feed Material	1	3	0	27	0	3	1	2	28	65	5.90
Herbs and Spices	12	5	1	26	1	2	3	0	9	59	5.35
Cocoa	2	3	1	5	0	0	14	0	3	28	2.54
Fat and Oil	1	5	0	1	0	0	5	3	7	22	2.00
Cereals and Bakery	2	6	0	1	0	2	4	0	2	17	1.54
Meat	2	0	0	0	0	0	0	0	8	10	0.91
Non-alcoholic Beverages	7	0	0	0	0	0	1	0	0	8	0.73
Others	4	4	0	3	1	4	4	2	2	24	2.18
Total by country	207	69	29	234	59	63	123	74	233	1102	100.00

Source Compiled from RASFF Online Database

between 2008 and 2013, or in absolute numbers, 447 of a total of 1107 EU rejections. This is closely followed by nuts, nut products and seeds, constituting about 19.87% of Africa's total food rejections by the EU between 2008 and 2013. Fruits and vegetables are the third most important category of rejected products, accounting for about 18.42% of total rejections of Africa exports. The huge number of rejections implies that non-compliance with EU standards represents an important market access problem for Africa. In fact, Africa's fish, crustacean, molluscs and other aquatic invertebrates, nuts, nut products and seeds, as well as fruits and vegetables—three categories of export products often refused entry into the EU market—account for about 78.85% of all food and feed exports from Africa that are rejected.

The reasons for rejecting Africa's exports are shown in Table 2. Major reasons are exceeding the stipulated EU mycotoxins limit, poor and insufficient controls, adulteration and fraudulent practices. By far, the most significant reason given was violation of mycotoxins limits, accounting for about 22.43% of rejections of Africa's food exports between 2008 and 2013. The countries which most frequently violated EU food standards are Morocco with 252 cases of border rejections, closely followed by Egypt, which has 211 cases of rejection, Nigeria with 113 rejections, and Ghana and South Africa with 75 and 74 cases of rejection, respectively. These rejections indicate the inability of African countries to meet EU standards.

Methodology and Data Description

The number of border rejections of food exports is strictly a non-negative count variable. Furthermore, some exporting African countries have no border rejections in some years, giving rise to the presence of a number of zeros. For this type of data-generating process, a count data model is appropriate.

Data Description

Our objective is to investigate the impact of trade-related infrastructure, procedures, and institutions on border rejections. The potential contributory factors are discussed below.

Country-Level Institutional Capacity

The literature has identified quality institutions as a necessary condition in the developmental process. In fact, a huge gap in institutions between exporter and importer can hinder their trade relations. Thus, we identify lack of strong institutions as a factor which can hinder developing countries' ability to comply with developed countries' standards. The most significant aspect of institutions relevant to compliance with standards is poor government regulatory quality.

Furthermore, developed countries' standards are difficult for developing countries due to the latter's weak domestic regulatory quality, which hinder their capacity to implement testing and certification processes, and formulate and

Table 2 Reasons for the EU Rejecting Africa's Food and Feeds, 2008 to 2013

	Egypt	Ghana	Kenya	Morocco	Nigeria	South Africa	Tunisia	Others	Total	Share (%)
Mycotoxins	84	28	1	0	56	53	4	29	255	22.43
Poor or insufficient controls	3	15	1	56	6	5	15	130	231	20.32
Pesticide residues	80	1	23	36	28	3	3	3	177	15.57
Organoleptic aspects	3	8	1	15	6	2	10	54	99	8.71
Pathogenic micro-organisms	2	1	1	23	4	2	1	33	67	5.89
Parasitic infestation	0	1	0	48	0	2	6	5	62	5.45
Non-pathogenic micro-organisms	13	6	0	11	3	0	3	23	59	5.19
Packaging defective/incorrect	3	2	0	17	1	0	3	7	33	2.90
Adulteration/fraud	3	5	0	6	3	1	4	9	31	2.73
Food additives and flavourings	9	2	0	1	3	5	1	7	28	2.46
Heavy metals	0	0	0	9	1	1	0	12	23	2.02
Bio-contaminants	0	0	0	20	0	0	1	1	22	1.93
Foreign bodies	8	4	0	2	0	0	0	6	20	1.76
Labelling absent, incomplete or incorrect	2	2	0	8	0	0	2	1	15	1.32
Industrial contaminants	1	0	0	0	1	0	0	10	12	1.06
GMO/novel food	0	0	0	0	1	0	0	0	1	0.09
Migration	0	0	0	0	0	0	1	0	1	0.09
Not determined/other	0	0	0	0	0	0	0	1	1	0.09
Total hazard	211	75	27	252	113	74	54	331	1137	100.0

Source Compiled from RASFF Online Database

implement stringent standards (Kim and Reinert 2009). As such, the measure of African countries' institutional capacity to satisfy EU food safety standards includes the quality of their domestic regulatory capacity to enact and implement policies that would ensure food safety. We use data on 'regulatory quality' from the World Bank World Governance Indicators. The latter is a proxy for each country's capacity to formulate and implement food safety regulations, testing and certification procedures. This measure reflects a government's ability to formulate and implement high-quality regulatory policies, the quality of its public service delivery and its commitment to such policies. The intuition is that countries that score high in this indicator would have high regulatory quality, including efficient food regulatory mechanisms and, thus, a low probability of having their food exports rejected at EU borders due to food safety risks.

Country-Level Core Trade Facilitation Measures Trade facilitation describes trade infrastructure and trade-related logistics procedures which are channelled towards ensuring the efficient movement of internationally traded goods through ports. This includes export and import formalities, customs and regulatory environments, as well as conformity to regional or international standards and regulations (OECD 2005). Trade facilitation can, thus, be used to achieve an improvement in compliance with sanitary and phyto-sanitary (SPS) measures. However, it is important to note that an improvement in trade facilitation is a necessary but not a sufficient condition for African exports to avoid being rejected at the EU border. This is basically because countries with sophisticated trade facilitation measures can still produce export products that do not comply with the food standards in the EU market. Major factors relevant for explaining are infrastructure quality (Portugal-Perez and Wilson 2012), and trade-related logistics procedures, which are essentially border and customs procedures. For instance, both soft infrastructure like information and communication technology (ICT) and hard infrastructure such as road, rail, sea and air ports are essential in transporting export goods in a timely manner, especially perishables. Thus, weak or missing infrastructure and poor domestic trade facilitation measures can increase rejections of exported goods. Thus, we investigate how the state of trade-related logistics procedures in Africa and EU SPS measures affects its ability to comply with EU food standards.

Food Safety Standards The inability to comply with EU food safety standards is at the core of the reasons for the rejections of non-complying to food exports as shown in Table 2. Thus, we control for EU standards imposed on each of the products considered in this study. Such standards are non-tariff measures in form of rules and regulations levied to safeguard the health and safety of the consumers, animals, plants as well as the environment. In fact, the literature has identified that standards can act as a barrier for African countries export to access developed countries markets (Czubala et al. 2009; Kareem et al. 2017). Thus, this study controls for EU food safety standards on the four products considered in this study, to further our understanding on how standards affect the incidences of export rejections at the EU border.

Border Rejection of Exports Due to Food Risks Border rejection, which is the dependent variable, denotes the incidence of the rejection of food exports at EU borders by designated authorities due to African exporters' inability to comply with EU food safety regulations. The incidence of food exports rejected at the border gives some indication of the losses to the exporters. These include loss of the exported food products, since rejected exports are sometimes destroyed by the importing country, loss of transportation costs, loss of costs due to freight and insurance, immediate reduction in earnings from exports, damage to the country's reputation and reduced export competitiveness in the long run (Baylis et al., 2009). However, the data contain no information about the quantity or monetary value of the loss. Thus, the focus on the count of rejections as the dependent variable is driven by data availability, but it is still informative. Ideally, an estimate of the costs and/or volume of each export rejection would have been used but this information is unavailable.

Model Specification

Given the aforementioned, the impact of institutions, trade infrastructure as well as trade-related logistics procedures on border rejections is modelled as follows:

$$\text{Rejections}_{ijpt} = \beta_0 + \beta_1 \text{Infrastructure}_{it} + \beta_2 \text{Regulatory\_Quality}_{it} + \beta_3 \text{Standards}_{ijpt} + \theta \text{Trade\_Procedures}_{it} + \delta_{ij} + \delta_p + \delta_t + \epsilon_{ijpt}. \quad (1)$$

In Eq. (1), i, j, p and t are exporter, importer (the EU), product and time, respectively. The importer, which in case is the EU, is at the aggregated level. *Rejections* is the total number of border rejections of non-conforming food products exported to the EU by each African country between 2008 and 2013 for the three most frequently rejected products identified in the previous section. These are fish, crustaceans, molluscs and other aquatic vertebrates; nuts, nut products and seeds; and fruits and vegetables. *Infrastructure* is the trade-related infrastructure in the domestic country which includes air and seaports, rails, road, and information and communications technology. *Regulatory_Quality* is the quality of each African country's government regulations and laws as well as the extent of the government's commitment to its enforcement. In addition, *Standards* capture the incidence of yearly existing regulations on food safety standards in the EU markets levied by the EU on the products considered in this study that are in force in each year. All regular and emergency standards notified by the EU to the World Trade Organisation (WTO) are considered. Corrigendum to the existing food standard is treated as additional standards (c.f. Shepherd and Wilson 2013).

Furthermore, *Trade_Logistic_Procedure* refers to a set of operations that export/import products are subjected to during the import/export processes before being made available to specific markets. *Trade_Logistic_Procedure* is a vector of variables which measures the efficiency of the customs clearance process, border controls, as well as the quality of logistics services. These include documents required

Table 3 Summary statistics

Variables	Mean	Standard deviation	Minimum	Maximum	N
Number of exports rejected	1.8	5.010	0	41	480
Documents to export (number)	7.392	1.865	4	11	480
Number of border agencies (exports)	3.777	1.858	1	11	344
Shipments meeting quality criteria (%)	71.030	17.102	40	100	264
Rate of physical inspection of shipments (%)	28.545	25.235	1	100	352
Clearance days with physical inspection	4.097	3.221	0.79	20	344
Quality of infrastructure	2.290	0.449	1.272	3.790	480
Regulatory quality	35.403	15.439	6.22	66.019	480
Standards	21.833	12.354	6	42	480

Source Authors' elaboration

to export, number of border agencies, percentage of shipments meeting quality criteria, rate of physical inspection of shipments, customs clearance times without physical inspection and customs clearance times with physical inspections. θ is the vector of their associated coefficients. δ_{ij}, δ_p and δ_t are dummy variables controlling for exporter–importer (country pair), product and time fixed effects, respectively, while ε_{ijpt} is the residual term of the model. Table 3 reports the summary statistics of the variables while Table 4 reports their correlation matrix.

Sources of Data and Data Description

To estimate the count models, we focus on African countries that had at least one EU rejection between 2008 and 2013 in the food export considered. This amounts to 20 countries. Data on EU rejection of these African export products were sourced from the EU RASFF database. Although RASFF was created in 1979, information on the incidence of border rejections began in 2008. Hence, our analysis starts from this year. The EU classification of import refusal data is at an aggregated level. Thus, to allow a meaningful analysis, we map each notification to the respective Harmonized System (HS) product classification. The analysis focuses on products rejected by the EU as noted in the previous section, namely fish, crustaceans, molluscs and other aquatic invertebrates (HS code 03), fruits and vegetables (HS code 07 plus HS 08) and nuts, nut products and seeds. Nuts, nut products and seeds are then split into groundnuts, not roasted or otherwise cooked, whether or not shelled or broken (HS code 1202) and edible groundnuts, otherwise prepared or preserved (HS code 200811), bringing the number of products considered in the analysis to four. However, we choose not to disaggregate fruits and vegetable products due to the ambiguity in the way in which they were notified in some cases. For instance, for some notifications, there is not enough information to determine whether the refusal relates to a vegetable or fruit product. For brevity, these four product categories are hereafter referred to as fish and fishery products, fruits and vegetables, unprocessed groundnuts and edible groundnuts, respectively.

Table 4 Correlation matrix

Variables	Number of exports rejected	Documents to export (number)	Number of border agency (exports)	Shipments meeting quality Criteria (%)	Rate of physical inspection of Shipment	Clearance days with physical inspection	Quality of infrastructure	Regulatory quality	Standards
Number of exports rejected	1.0000								
Documents to export (number)	− 0.1176	1.0000							
Number of border agency (exports)	− 0.0998	− 0.0283	1.0000						
Shipments meeting quality criteria (%)	0.0537	0.1458	− 0.1612	1.0000					
Rate of physical inspection of shipment	− 0.0345	− 0.0318	0.2145	− 0.2153	1.0000				
Clearance days with physical inspection	− 0.1028	0.0544	0.2079	− 0.1332	0.4600	1.0000			
Quality of infrastructure	0.2274	− 0.2388	− 0.1881	0.1668	− 0.4022	− 0.3134	1.0000		
Regulatory quality	0.2045	− 0.4966	− 0.1324	0.1003	− 0.2774	− 0.3313	0.5375	1.0000	
Standards	0.1639	0.0049	− 0.0055	− 0.0039	− 0.0068	− 0.0085	0.0174	− 0.0064	1.0000

Source Authors' elaboration

Data on documents to export is sourced from the World Bank's Doing Business database. Data on trade-related infrastructure is from the World Bank's International Logistics Performance Index (LPI) database, while indicator regulatory quality is from the World Bank's Worldwide Governance Indicators (WGI). Data on other domestic trade facilitation measures such as the number of border agencies, percentage of shipments meeting quality criteria, clearance days with physical inspection and the rate of physical inspection[2] of shipments are from the World Bank's Domestic LPI yearly reports.[3] The rate of physical inspection of each country's imports is used as a proxy for the rate of physical inspection of shipments (pre-shipment inspection), as data are not available for the latter. We deem this a good proxy because countries that have poor logistics performance tend to perform numerous physical inspections of both exports and imports; they usually subject shipments to repeated inspections by multiple agencies (Arvis et al. 2014). In addition, in many countries in our sample, the number of agencies involved in the physical inspection are often the same for both exports and imports. Thus, the rate of inspection for imports is used to mirror the rate of pre-shipment inspection of exports.

The domestic LPI data was not available for some African countries further limiting our dataset. The countries included in the dataset are reported in Table A1 in the appendix. The domestic LPI contains data detailing the state of domestic trade facilitation measures in each country. However, it is not available on a yearly basis; it was first collected in 2007, then in 2010 and thereafter every two years. Thus, we rely on previous values: for instance, values from 2012 were used for both 2012 and 2013; values from 2010 were used for both 2010 and 2011; and values for 2007 were interpolated to 2008 and 2009.

The border rejection data is from the EU RASFF database. The database is a rich source of information about the export product rejected by each EU country. The information is also available by product and by year, indicating the name of the product rejected and the reason(s) for the rejection. However, there is no information about the volume or value of the shipment rejected. While information on the volume or value of each shipment rejected by the EU would have allowed a more in-depth analysis, we posit that the incidence of border rejection can also provide useful insights into the logistics performance of African exports in relation to food safety concerns. Furthermore, data on food safety standards are sourced from WTO Sanitary and Phytosanitary Information Management System.

[2] The data collected after 2007 differentiated between clearance days with and without physical inspection; the baseline data in 2007 did not.

[3] These are available at https://lpi.worldbank.org/report

Estimation Technique

To investigate the factors influencing border rejections of African food exports by the EU, we use the Poisson model—a standard count data model—which is represented in a general form of a conditional probability function:

$$\Pr(Y_{ijpt} = y_{ijt}|x_i) = \frac{\exp(-\exp(x'_{ijt}\beta))\exp(y_{ijt}x'_{ijt}\beta)}{y_{ijt}!} \quad (2)$$

In Eq. (2), where subscripts *i, j, p* and *t* are as earlier defined; *y* is the count variable, in this case, the total number of border rejections of African exports by the EU in the selected products over the years; *x* symbolizes the vector of the independent variables of the model; while β is the vector of the associated coefficients. The Poisson estimator is consistent under the equi-dispersion assumption that the conditional mean of the dependent variable is proportional to its conditional variance. However, Santo Silva and Tenreyro (2006) found it to be consistent even under weaker assumptions as the distribution of the data need not be Poisson i.e. the equi-dispersion assumption needs not hold.

Hence, to estimate Eq. (1), the population-averaged Poisson count data model, variants of the generalized linear models (GLM) is employed. Other variants of the model are the fixed-effects and random-effects Poisson models. However, the former model is more appropriate to use when analysing variables that vary overtime which is not feasible in this case due to the nature of the logistic data. Alternatives are then the random-effects and population-averaged Poisson model. While the random-effects model gives the average effect of the estimated coefficients, the population-averaged model gives the estimated effects for the average African country. Given our interest in the average effect of the explanatory variables for the average African country, thus, emphasis is placed on the results of the population-averaged Poisson model.

Empirical Analysis and Results

There are concerns about the possibility of among some of the trade facilitation variables their effects overcrowding one another. This necessitates them to be entered progressively into the regression model.

Table 5 presents the results of the population-averaged Poisson model. For completeness, the results from the random-effects Poisson model are also displayed. The estimates from the population-averaged Poisson model are presented in columns 1 to 4, while those from the random-effects Poisson model are presented in columns 5 to 8. A quick look at the results indicates that both models provide the same signs for the estimated coefficients, although they differ slightly in the magnitudes. However, while the random-effects model gives the average effect of the estimated coefficients, the population-averaged model gives the estimated effects for the average African country. Since we are more interested in the effect of the explanatory

Table 5 Impact of trade-related logistics procedures, infrastructure and institutions on border rejection

Independent variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Population-averaged Poisson				Random-effects Poisson			
Shipments meeting quality criteria (%)	− 0.016**	− 0.034**	− 0.033***	− 0.030***	− 0.015*	− 0.040***	− 0.036***	− 0.034***
	0.008	0.014	0.013	0.010	0.008	0.013	0.014	0.011
Quality of infrastructure	− 1.073**	− 1.502***	− 1.461***	− 1.604***	− 0.918**	− 1.428***	− 1.327**	− 1.668***
	0.418	0.470	0.475	0.363	0.452	0.536	0.574	0.506
Regulatory quality	− 0.091***	− 0.118***	− 0.121***	− 0.116***	− 0.073***	− 0.106***	− 0.105***	− 0.108***
	0.026	0.031	0.028	0.025	0.024	0.029	0.029	0.026
Standards	0.264***	0.282***	0.284***	0.276***	0.231***	0.261***	0.265***	0.237***
	0.077	0.076	0.077	0.075	0.078	0.083	0.085	0.079
Documents to export (number)	0.460***				0.497***			
	0.086				0.085			
Number of border agency (exports)		0.018				0.108		
		0.211				0.222		
Rate of physical inspection of shipment			0.005				0.008*	
			0.005				0.005	
Clearance days with physical inspection				0.169*				0.167
				0.098				0.111
Constant	− 8.730***	− 3.444	− 3.897*	− 4.140*	− 8.758***	− 2.897	− 3.717	− 2.344
	2.310	2.150	2.096	2.157	2.854	3.016	3.271	2.688
Importer–Exporter fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Product fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of observations	264	240	248	240	264	240	248	240

Clustered robust standard errors are in brackets and *$p < 0.10$; **$p < 0.05$; ***$p < 0.01$. Standard errors are clustered at the importer–exporter–product level

variables for the average African country, emphasis is placed on the results of the population-averaged Poisson model.

Baseline Results—Aggregated Product-Level Analysis

In both Poisson models, as expected, the percentage of shipments meeting the domestic criteria turns out to reduce the incidence of such shipment being rejected at the border. The significance of this is that export shipments meeting the quality requirements are less likely to be rejected at the EU border on ground of food safety and quality risks.

Besides, our control variable on the quality of domestic trade-related infrastructure turns out to be negative and statistically significant, indicating that an improvement in the quality of infrastructure would decrease the incidence of Africa's exports being rejected at the EU border. This finding points to the importance of trade infrastructure in meeting importing countries' quality requirements. Furthermore, the variable controlling for institutions also reveals interesting results. The coefficients on domestic regulatory quality for both models are negative and significant indicating that a decrease in regulatory quality will increase the incidence of rejections of unsafe food at the EU border and vice versa. Indeed, this is not surprising since adequate regulatory institutions are needed to implement acceptable food standard regulations. This result supports that of Kim and Reinert (2009) who noted that developing countries' ability to satisfy developed countries' food standards hinge on their institutional capacity such as their ability to implement testing and certification processes.

More importantly, our results show the coefficients on food safety standards to be significantly negative, depicting that EU food standards or the inability to comply with such standards increases rejection of Africa's exports at the EU border and adds to the hurdle of accessing the EU markets. In fact, as shown in Table 2, noncompliance to a variety of EU standards constitutes the major reason for the rejection of Africa's exports. This includes exceeding EU legislated pesticide residues, presence of mycotoxins, pathogenic micro-organisms, parasites, heavy metal in food products, etcetera.

The variable documents required to export indicates the number of documents that customs authorities, container and port authorities, government ministries and parastatals, banks, health and safety control agencies, and other related agencies require in order to clear a good when exporting it. The coefficient turns out to be positive, significantly increasing rejections of Africa's food exports at the EU border. This is because obtaining the documents needed by the importing countries—particularly those relating to health certification—is usually costly, especially for small-scale exporters. In addition, in Africa, such documents are usually cumbersome to obtain as they tend to involve third party certification and accreditation. Exporters who do not have all the documents would have their exports refused entry at the EU border. High number of documents needed to export—such as SPS documents—might cause unnecessary delays, while a lack of the recognized documents

and certificates attesting to the products' conformity with importing countries' standards might also lead to rejections. Indeed, a number of African exports have been rejected on the grounds of lacking the required health certificate and fraudulent practices relating to the health certificate (RASFF online database). Freund and Rocha (2011) also stated that the huge number of documents required to export is one of the factors constraining Africa's export success.

We also examine the number of border agencies encountered when exporting. Such agencies include transport, veterinary, and health or SPS, etcetera. The coefficients in both models are positive. Intuitively, such a positive relationship implies that increase in such agencies might increase the incidence of border rejections of unsafe Africa's food exports due to cumbersome and duplicate border procedure which results in poor trade facilitation measures. However, the coefficients in both models are not statistically significant at the conventional levels.

Besides, the rate of physical inspection of Africa's exports is also positive but only statistically significant in the random-effects Poisson model. Indeed, an increase in the rate at which African shipments are physically inspected increases their chances of being refused entry into the EU. African countries belong to the poor performing countries in terms of LPI and shipments are usually subjected to excessive and repeated physical inspections by multiple border agencies (Arvis et al. 2014). This leads to increased exporting times, which increases the susceptibility of time-sensitive products—particularly perishables—to food safety risks and raises their odds of being rejected by the EU.

Other interesting results relate to the variables on customs clearance days with physical inspection. The coefficient is positive and marginally significant in the population-averaged Poisson model. Our results show that food exports which undergo a physical inspection during the customs clearance days have an increased incidence of border rejections. A two-day increase in clearance days increases the number of border rejections by one. During physical inspection of export goods, delays might increase the chances of the exports becoming spoiled, especially for highly perishables such as fruits and vegetables. This spoilage increases their likelihood of being rejected entry into the EU. For instance, in the case of Benin, it takes about 10 days for the goods to be cleared with physical inspection, and about 4 days for the goods to be cleared when no physical inspection is required. This implies that increased export times associated with physical inspections in the domestic country increases the incidence of border rejection.

Disaggregated Product-Level Analysis

The limited existing studies have not differentiated between food products when examining the impacts of the drivers of border rejections. However, an interesting question is whether the results are heterogenous across products. Thus, we check whether our results are heterogeneous across the four types of products considered by interacting the product dummies with each of our explanatory variables and then drop the product fixed effects from the models. The results are provided in Table 6, which reports both the population-averaged and random-effects Poisson

Table 6 Product-level analysis—differentiating by product types

Independent variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Population-averaged Poisson				Random-effects Poisson			
Shipments meeting quality criteria (%)								
Fish and fish products	− 0.023*	− 0.066***	− 0.072***	− 0.061***	− 0.011**	− 0.036**	− 0.033**	− 0.034*
	0.012	0.018	0.021	0.014	0.004	0.018	0.015	0.019
Fruits and vegetables	0.021	− 0.017	− 0.010	0.003	− 0.011	− 0.031*	− 0.031*	− 0.004
	0.019	0.016	0.022	0.016	0.016	0.019	0.019	0.020
Edible groundnuts	− 0.006	− 0.024	− 0.011	− 0.010	0.014	− 0.010	0.006	0.002
	0.022	0.018	0.018	0.021	0.022	0.030	0.023	0.029
Unprocessed groundnuts	− 0.016	− 0.014	− 0.002	0.001	− 0.015	− 0.005	0.013	0.018
	0.020	0.015	0.019	0.019	0.036	0.036	0.041	0.048
Quality of infrastructure								
Fish and fish products	− 1.166**	− 1.615***	− 2.123**	− 1.592***	− 0.481	− 0.812*	− 0.762	− 0.960
	0.534	0.588	0.831	0.531	0.310	0.453	0.485	0.679
Fruits and vegetables	− 1.517**	− 2.833***	− 2.545**	− 2.488***	− 2.257***	− 2.897***	− 2.710***	− 2.765***
	0.669	0.853	1.080	0.709	0.864	0.960	0.902	0.724
Edible groundnuts	0.321	− 0.203	0.080	− 0.466	− 1.132*	− 0.798	− 1.331**	− 1.237**
	0.659	0.801	0.898	0.690	0.658	0.523	0.606	0.602
Unprocessed groundnuts	0.575	− 0.155	0.599	− 0.434	− 0.275	− 0.533	− 0.195	− 0.876
	0.773	0.914	1.004	0.782	0.736	0.589	0.627	0.599
Regulatory quality								
Fish and fish products	− 0.087***	− 0.072**	− 0.083**	− 0.078***	− 0.094***	− 0.093***	− 0.074**	− 0.093***
	0.031	0.032	0.034	0.024	0.026	0.027	0.030	0.031
Fruits and vegetables	− 0.091***	− 0.170***	− 0.186***	− 0.144***	− 0.082**	− 0.116***	− 0.098**	− 0.094***
	0.035	0.050	0.050	0.041	0.035	0.043	0.045	0.034
Edible Groundnuts	− 0.042	− 0.117***	− 0.138***	− 0.105***	− 0.114***	− 0.130***	− 0.136***	− 0.126***
	0.033	0.036	0.043	0.033	0.036	0.032	0.034	0.033

Table 6 (continued)

Independent variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Population-averaged Poisson				Random-effects Poisson			
Unprocessed groundnuts	− 0.025	− 0.113***	− 0.139***	− 0.090***	− 0.046	− 0.102**	− 0.100**	− 0.070*
	0.030	0.039	0.044	0.033	0.043	0.040	0.045	0.041
Standards								
Fish and fish products	0.654***	0.271***	0.376***	0.349***	0.382***	0.237*	0.258**	0.362***
	0.141	0.096	0.107	0.099	0.118	0.121	0.128	0.134
Fruits and vegetables	0.303***	0.327***	0.328***	0.258***	0.362***	0.357***	0.370***	0.279***
	0.082	0.081	0.101	0.084	0.094	0.092	0.099	0.095
Edible groundnuts	0.547	0.370	0.301	0.513	1.239*	0.580	1.045*	1.147**
	0.518	0.452	0.507	0.453	0.633	0.412	0.551	0.466
Unprocessed groundnuts	0.179	0.135	− 0.017	0.154	0.241	0.139	0.119	0.208
	0.209	0.214	0.235	0.222	0.225	0.225	0.235	0.242
Documents to export (number)								
Fish and fish products	− 0.490				0.141			
	0.384				0.248			
Fruits and vegetables	0.607*				0.366			
	0.329				0.248			
Edible groundnuts	0.829***				0.348*			
	0.320				0.187			
Unprocessed groundnuts	0.982***				0.722***			
	0.301				0.214			
Number of border agencies (export)								
Fish and fish products		0.131				0.239		
		0.256				0.192		

Table 6 (continued)

Independent variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Population-averaged Poisson				Random-effects Poisson			
Fruits and vegetables		0.014				− 0.056		
		0.290				0.332		
Edible groundnuts		0.158				0.431**		
		0.278				0.200		
Unprocessed groundnuts		0.142				0.365		
		0.297				0.270		
Rate of physical inspection of import (%)								
Fish and Fish Products			− 0.0001				0.013***	
			0.014				0.003	
Fruits and vegetables			0.013				− 0.022	
			0.018				0.025	
Edible groundnuts			0.038				− 0.006	
			0.026				0.025	
Unprocessed groundnuts			0.050**				0.026	
			0.025				0.025	
Clearance days with physical inspection								
Fish and fish products				0.006				− 0.014
				0.161				0.138
Fruits and vegetables				0.458***				0.633***
				0.119				0.192
Edible groundnuts				0.229				0.067
				0.231				0.119
Unprocessed groundnuts				0.310				0.326

Table 6 (continued)

Independent variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Population-averaged Poisson				Random-effects Poisson			
				0.232				0.239
_cons	− 14.196***	− 3.949	− 5.543	− 5.382	− 11.887**	− 4.480	− 5.691	− 7.440*
	4.909	3.475	4.367	3.552	4.990	3.872	4.307	3.897
Importer–Exporter fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of observations	264	240	248	240	264	240	248	240

Clustered robust standard errors are in brackets and *$p < 0.10$; **$p < 0.05$; ***$p < 0.01$. Standard errors are clustered at the importer–exporter–product level

models. Once again, the estimates from the population-averaged Poisson model are presented in columns 1 to 4, while those from the random-effects Poisson model are presented in columns 5 to 8. Once again, our preferred model is the population-averaged Poisson model.

As shown in Table 6, most of the estimated coefficients from the population-averaged Poisson model are in line with those obtained at the aggregate level in relation to the impacts of the variables investigated. However, in the case of unprocessed groundnut, the estimated coefficient on the 'rate of physical inspection of shipments' is now significant. The results for the whole sample previously hid this effect. Besides, the number of border agencies remains insignificant in reducing the incidence of border rejection for all products except unprocessed groundnut. The aggregated population-averaged Poisson model previously hid this heterogenous effect.

The disaggregated results show mainly heterogeneous effects though there are some distinct homogeneous effects across the products particularly in the case of most of the coefficients on regulatory quality, depicting that that an increase in it to decrease the number of rejections of all four products at the EU border. Nonetheless, the other results show heterogeneous effects. For instance, an improvement in trade-related quality infrastructure significantly reduces the incidences of rejections only for fish and fish products as well as fruits and vegetables, that is, perishable products. In addition, an increase in the clearance days with physical inspection increases rejections only for perishable products—in this case, fruits and vegetables. This is to be expected as extended exporting times are particularly detrimental for perishables and other time-sensitive products (Djankov et al. 2010; Zaki 2015).

Furthermore, food safety standards requirements significantly increase border rejections but only for both fish and fishery products, and fruits and vegetables. This is not surprising as perishables usually have more stringent food quality standard requirements relative to other product categories. The situation is exacerbated by the absence, in many African countries, of stringently enforced food standard regulations and standards that are somewhat similar to those of the EU, as well as the inadequate sophisticated standard testing and accreditation facilities. Thus, the continuous application of the less stringent domestic food quality standards would bring about increased rejection at the EU border when the EU's more sophisticated and technologically advanced testing facilities are used. This situation depicts a large regulatory *quality gap* as EU quality criteria are much stricter than those of the African countries. Such a quality gap has serious implications for border rejections and can damage the reputation of exporting countries. This result aligns with those of Arvis et al. (2014), who find a wide gap in shipment quality between low performing developing and high performing developed countries, as the acceptable quality requirement is much more stringent in the latter.

Clearly, a diverging trend emerges between the perishable (fruits and vegetables, and fish and fishery products) and the less perishable products (edible groundnuts and unprocessed groundnuts). We can see that lengthy clearance days and food standards affect both fish and fishery products, and fruits and vegetables more frequently than they do unprocessed groundnuts and edible groundnuts. This might be

because the former group of products are more susceptible to food safety concerns due to their highly perishable nature.

In essence, although the impacts of these variables at the product level reveal some heterogeneous product effects, the results still confirm our baseline regression at the aggregate level in relation to the impacts of these variables on the incidence of border rejection. Similar to our previous assertion in relation to the results obtained in Table 5, we again conclude that inadequate trade facilitation measures are the key drivers of the rejection of Africa's exports at the EU border, while improvements in infrastructure and institutions, particularly regulatory quality, help reduce such rejections.

Robustness Checks: Aggregated Product-Level Analysis

We engaged in a number of robustness checks to assure the reliability of our results. A paramount concern is to ascertain whether the results are driven by economically small export flows. It might be the case that countries with relatively low food export values are not trading much and thus have little or no incentive to put in place more efficient trade facilitation measures and institutions that support trade. If so, these outliers might be driving the negative results obtained so far. Thus, we exclude those countries[4] with low export values in all four products from our analysis. This corresponds approximately to the 15th percentile of the dataset. We estimated Eq. (1) again using both random-effects and population-averaged Poisson estimators. The results of the re-estimation are presented in Table 7, with columns 1 to 4 displaying the estimates from the population-averaged Poisson model while columns 5 to 8 displays those of the random-effects Poisson model. These results further underscore our previous conclusion since they are similar to those obtained in Table 5.

Likewise, some African countries recorded zero rejections in many years and only one or two rejections in other years. Intuitively, countries might have no or few rejections not necessarily as a result of having good trade-supporting measures but rather because they seldom engage in trade with the EU. To address this concern, all countries having an insignificant number of rejections—two at most—in the period of analysis were excluded[5] from the data. These countries correspond to the bottom quartile of the data. Equation (1) was again re-estimated on the reduced dataset and the results are presented in Table 8. These results reinforce our earlier findings as the basic results in relation to the impacts of the explanatory variables remain unchanged.

[4] These are Malawi, Tanzania and Ethiopia. The case of Malawi was particularly notable as it turns out to be the top non-trading country, with Malawi having 77% export flows in all four products. In all the four products and for all the six years considered, the total exports of Tanzania and Ethiopia are in single-digit millions, while Malawi has less than 200 thousand dollars. This is distinct from other exporters, many of whom recorded total exports in double-digit millions and above.

[5] The excluded countries are Cameroon, Togo, Congo Republic, Ethiopia and Malawi. Cameroon and Togo have only one rejection, while Congo Republic, Ethiopia and Malawi have two rejections each.

Table 7 Sensitivity to the exclusion of countries with low export values

Independent variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Population-averaged Poisson				Random-effects Poisson			
Shipments meeting quality criteria (%)	− 0.016**	− 0.034**	− 0.033***	− 0.030***	− 0.014*	− 0.040***	− 0.036***	− 0.034***
	0.008	0.014	0.013	0.010	0.008	0.013	0.014	0.011
Quality of infrastructure	− 1.070**	− 1.509***	− 1.466***	− 1.623***	− 0.912**	− 1.422***	− 1.321**	− 1.661***
	0.422	0.481	0.491	0.375	0.450	0.534	0.571	0.505
Regulatory quality	− 0.091***	− 0.118***	− 0.121***	− 0.117***	− 0.072***	− 0.106***	− 0.105***	− 0.107***
	0.026	0.031	0.028	0.025	0.024	0.030	0.029	0.026
Standards	0.265***	0.285***	0.287***	0.279***	0.232***	0.265***	0.269***	0.241***
	0.079	0.078	0.079	0.077	0.079	0.084	0.086	0.079
Documents to export (number)	0.464***				0.499***			
	0.086				0.085			
Number of border agency (exports)		0.014				0.109		
		0.214				0.221		
Rate of physical inspection of shipment			0.005				0.008*	
			0.005				0.005	
Clearance days with physical inspection				0.173*				0.166
				0.099				0.111
Constant	− 8.818***	− 3.491	− 3.943*	− 4.163*	− 8.815***	− 2.988	− 3.818	− 2.435
	2.356	2.221	2.170	2.215	2.895	3.028	3.286	2.699
Importer–exporter fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Product fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of observations	232	216	224	216	232	216	224	216

Clustered robust standard errors are in brackets and *$p<0.10$; **$p<0.05$; ***$p<0.01$. Standard errors are clustered at the importer–exporter–product level

Table 8 Sensitivity to the exclusion of countries with few rejections

Independent variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Population-averaged Poisson				Random-effects Poisson			
Shipments meeting quality criteria (%)	− 0.016**	− 0.034**	− 0.033***	− 0.029***	− 0.014*	− 0.041***	− 0.036***	− 0.035***
	0.008	0.014	0.013	0.010	0.008	0.014	0.014	0.011
Quality of infrastructure	− 1.044***	− 1.471***	− 1.430***	− 1.553***	− 0.894**	− 1.411***	− 1.312**	− 1.656***
	0.393	0.457	0.450	0.346	0.445	0.534	0.570	0.504
Regulatory quality	− 0.089***	− 0.117***	− 0.119***	− 0.113***	− 0.071***	− 0.105***	− 0.104***	− 0.106***
	0.026	0.031	0.028	0.024	0.025	0.030	0.030	0.026
Standards	0.270***	0.287***	0.291***	0.280***	0.239***	0.270***	0.276***	0.245***
	0.077	0.077	0.077	0.075	0.081	0.086	0.088	0.080
Documents to export (number)	0.466***				0.506***			
	0.087				0.085			
Number of border agency (exports)		0.039				0.126		
		0.204				0.219		
Rate of physical inspection of shipment			0.006				0.008*	
			0.005				0.005	
Clearance days with physical inspection				0.166*				0.168
				0.096				0.111
Constant	− 9.045***	− 3.752*	− 4.249**	− 4.468**	− 9.076***	− 3.131	− 3.968	− 2.518
	2.351	2.156	2.102	2.165	2.944	3.087	3.351	2.731
Importer–exporter fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Product fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of observations	200	192	192	192	200	192	192	192

Clustered robust standard errors are in brackets and *$p < 0.10$; **$p < 0.05$; ***$p < 0.01$. Standard errors are clustered at the importer–exporter–product level

Table 9 Sensitivity to countries with low export values, by product

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Population-averaged Poisson				Random-effects Poisson			
Shipments meeting quality criteria (%)								
Fish and fish products	− 0.023*	− 0.066***	− 0.072***	− 0.061***	− 0.011**	− 0.035**	− 0.032**	− 0.034*
	0.012	0.018	0.021	0.014	0.004	0.018	0.015	0.019
Fruits and vegetables	0.020	− 0.016	− 0.010	0.003	− 0.012	− 0.032§	− 0.035*	− 0.004
	0.019	0.017	0.022	0.016	0.016	0.020	0.019	0.020
Edible groundnuts	− 0.006	− 0.023	− 0.011	− 0.010	0.018	− 0.005	0.012	0.002
	0.022	0.018	0.019	0.021	0.022	0.030	0.023	0.029
Unprocessed groundnuts	− 0.016	− 0.014	− 0.001	0.001	− 0.016	− 0.002	0.019	0.019
	0.020	0.015	0.019	0.020	0.038	0.039	0.048	0.048
Quality of infrastructure								
Fish and fish products	− 1.173**	− 1.625***	− 2.131**	− 1.602***	− 0.509	− 0.800*	− 0.728	− 0.948
	0.533	0.593	0.837	0.534	0.313	0.443	0.462	0.675
Fruits and vegetables	− 1.478**	− 2.810***	− 2.535**	− 2.469***	− 2.179**	− 2.842***	− 2.749***	− 2.758***
	0.663	0.854	1.082	0.706	0.860	0.961	0.873	0.723
Edible groundnuts	0.324	− 0.213	0.082	− 0.462	− 1.211*	− 0.853	− 1.315**	− 1.237**
	0.661	0.805	0.903	0.693	0.669	0.528	0.567	0.602
Unprocessed groundnuts	0.577	− 0.168	0.601	− 0.422	− 0.234	− 0.529	− 0.193	− 0.875
	0.775	0.929	1.010	0.797	0.750	0.595	0.626	0.601
Regulatory quality								
Fish and fish products	− 0.088***	− 0.071**	− 0.083**	− 0.078***	− 0.099***	− 0.095***	− 0.076**	− 0.093***
	0.031	0.032	0.035	0.025	0.026	0.027	0.030	0.031
Fruits and vegetables	− 0.089**	− 0.170***	− 0.186***	− 0.144***	− 0.075**	− 0.110**	− 0.082	− 0.093***
	0.035	0.050	0.050	0.041	0.035	0.044	0.056	0.034
Edible groundnuts	− 0.042	− 0.118***	− 0.138***	− 0.105***	− 0.120***	− 0.133***	− 0.141***	− 0.126***

Table 9 (continued)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Population-averaged Poisson				Random-effects Poisson			
	0.033	0.037	0.043	0.034	0.037	0.032	0.037	0.033
Unprocessed groundnuts	− 0.023	− 0.113***	− 0.139***	− 0.091***	− 0.041	− 0.101**	− 0.105**	− 0.070*
	0.030	0.040	0.045	0.033	0.044	0.041	0.051	0.041
Standards								
Fish and fish products	0.666***	0.271***	0.378***	0.350***	0.419***	0.250**	0.263**	0.363***
	0.144	0.097	0.108	0.100	0.120	0.120	0.131	0.134
Fruits and vegetables	0.304***	0.325***	0.328***	0.256***	0.369***	0.359***	0.376***	0.280***
	0.082	0.082	0.101	0.084	0.096	0.093	0.103	0.095
Edible groundnuts	0.581	0.374	0.300	0.511	1.417**	0.634	1.033*	1.155**
	0.523	0.452	0.511	0.457	0.685	0.423	0.570	0.468
Unprocessed groundnuts	0.192	0.137	− 0.018	0.152	0.273	0.148	0.110	0.209
	0.210	0.216	0.235	0.223	0.228	0.225	0.240	0.242
Documents to export (number)								
Fish and fish products	− 0.497				0.145			
	0.388				0.253			
Fruits and vegetables	0.617*				0.398			
	0.328				0.255			
Edible groundnuts	0.825***				0.312§			
	0.319				0.194			
Unprocessed groundnuts	0.989***				0.758***			
	0.300				0.227			
Number of border agencies (export)								
Fish and fish products		0.131				0.233		

Table 9 (continued)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Population-averaged Poisson				Random-effects Poisson			
		0.257				0.191		
Fruits and vegetables		0.014				− 0.075		
		0.291				0.350		
Edible groundnuts		0.146				0.422**		
		0.279				0.198		
Unprocessed groundnuts		0.118				0.371		
		0.302				0.271		
Rate of physical inspection of import (%)								
Fish and fish products			− 0.000				0.013***	
			0.015				0.002	
Fruits and vegetables			0.012				− 0.036	
			0.018				0.039	
Edible groundnuts			0.038				− 0.001	
			0.027				0.026	
Unprocessed groundnuts			0.051**				0.028	
			0.025				0.029	
Clearance days with physical inspection								
Fish and fish products				0.008				− 0.015
				0.160				0.137
Fruits and vegetables				0.461***				0.636***
				0.120				0.194
Edible groundnuts				0.236				0.066
				0.237				0.119

Table 9 (continued)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Population-averaged Poisson				Random-effects Poisson			
Unprocessed groundnuts				0.317				0.326
				0.239				0.241
_Constant	− 14.379***	− 3.882	− 5.546	− 5.390	− 12.947**	− 4.936	− 5.954	− 7.518*
	4.913	3.494	4.378	3.572	5.143	3.891	4.425	3.903
Importer–exporter fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of observations	232	216	224	216	232	216	224	216

Clustered robust standard errors are in brackets and *$p < 0.10$; **$p < 0.05$; ***$p < 0.01$. Standard errors are clustered at the importer–exporter–product level

[§]—estimates show changes in significance but still maintain the same direction of effects in relation to the results obtained in Table 6

Table 10 Sensitivity to countries with few rejections, by product

Independent variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Population-averaged Poisson				Random-effects Poisson			
Shipments meeting quality criteria (%)								
Fish and fish products	− 0.022*	− 0.064***	− 0.063***	− 0.059***	− 0.011**	− 0.038**	− 0.036**	− 0.036*
	0.012	0.018	0.018	0.014	0.005	0.019	0.017	0.022
Fruits and vegetables	0.020	− 0.014	− 0.016	0.006	− 0.007	− 0.030§	− 0.033*	0.001
	0.019	0.017	0.018	0.016	0.016	0.020	0.019	0.019
Edible groundnuts	− 0.019	− 0.029*§	− 0.010	− 0.014	− 0.023	− 0.043	− 0.027	− 0.024
	0.018	0.017	0.017	0.019	0.035	0.038	0.031	0.034
Unprocessed groundnuts	− 0.013	− 0.015	− 0.002	0.002	− 0.019	− 0.008	0.011	0.017
	0.018	0.015	0.015	0.019	0.040	0.047	0.053	0.055
Quality of infrastructure								
Fish and fish products	− 1.086**	− 1.562***	− 1.682**	− 1.526***	− 0.559	− 0.874*	− 0.844	− 1.049
	0.513	0.571	0.684	0.531	0.346	0.495	0.529	0.781
Fruits and vegetables	− 1.630**	− 2.870***	− 3.025***	− 2.516***	− 2.256***	− 2.848***	− 2.907***	− 2.770***
	0.671	0.872	1.005	0.727	0.875	0.988	0.925	0.727
Edible groundnuts	0.519	− 0.108	0.382	− 0.397	− 0.426§	− 0.355	− 0.491§	− 0.987§
	0.682	0.784	0.729	0.681	1.060	0.642	0.727	0.661
Unprocessed groundnuts	0.514	− 0.086	0.452	− 0.419	− 0.144	− 0.434	− 0.153	− 0.858
	0.746	0.891	0.807	0.768	0.834	0.627	0.656	0.628
Regulatory quality								
Fish and fish products	− 0.090***	− 0.072**	− 0.084***	− 0.077***	− 0.103***	− 0.103***	− 0.080**	− 0.098***
	0.030	0.031	0.033	0.024	0.027	0.030	0.032	0.034
Fruits and vegetables	− 0.090**	− 0.171***	− 0.177***	− 0.144***	− 0.078**	− 0.113**	− 0.092§	− 0.092**
	0.037	0.052	0.053	0.042	0.038	0.049	0.061	0.036
Edible groundnuts	− 0.030	− 0.110***	− 0.118***	− 0.096***	− 0.072§	− 0.108***	− 0.108**	− 0.104***
	0.033	0.037	0.040	0.035	0.061	0.040	0.045	0.040

Table 10 (continued)

Independent variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Population-averaged Poisson				Random-effects Poisson			
Unprocessed groundnuts	− 0.023	− 0.111***	− 0.122***	− 0.084**	− 0.035	− 0.097**	− 0.102*	− 0.063[§]
	0.031	0.039	0.041	0.033	0.048	0.045	0.053	0.043
Standards								
Fish and fish products	0.665***	0.280***	0.341***	0.354***	0.433***	0.290**	0.287**	0.404***
	0.144	0.098	0.095	0.099	0.135	0.132	0.139	0.141
Fruits and vegetables	0.320***	0.337***	0.388***	0.264***	0.377***	0.369***	0.391***	0.283***
	0.080	0.081	0.095	0.087	0.096[3]	0.097	0.103	0.098
Edible groundnuts	0.585	0.391	0.147	0.541	1.105[§]	0.667	0.839[§]	1.213**
	0.509	0.461	0.447	0.449	0.775	0.456	0.666	0.505
Unprocessed groundnuts	0.218	0.144	0.029	0.163	0.272	0.179	0.135	0.236
	0.211	0.209	0.225	0.223	0.238	0.234	0.248	0.246
Documents to export (number)								
Fish and fish products	− 0.477				0.167			
	0.383				0.302			
Fruits and vegetables	0.630*				0.361			
	0.337				0.260			
Edible groundnuts	0.852***				0.486*			
	0.309				0.277			
Unprocessed groundnuts	0.972***				0.768***			
	0.298				0.231			
Number of border agencies (export)								
Fish and fish products		0.148				0.270		
		0.250				0.187		

Table 10 (continued)

Independent variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Population-averaged Poisson				Random-effects Poisson			
Fruits and vegetables		0.038				− 0.010		
		0.283				0.385		
Edible groundnuts		0.214				0.524**		
		0.275				0.231		
Unprocessed groundnuts		0.219				0.437		
		0.288				0.277		
Rate of physical inspection of import (%)								
Fish and fish products			0.007				0.013***	
			0.009				0.003	
Fruits and vegetables			− 0.003				− 0.035	
			0.012				0.035	
Edible groundnuts			0.045**§				0.013	
			0.020				0.019	
Unprocessed groundnuts			0.045**				0.027	
			0.021				0.031	
Clearance days with physical inspection								
Fish and fish products				0.001				− 0.005
				0.161				0.144
Fruits and vegetables				0.464***				0.673***
				0.124				0.199
Edible groundnuts				0.217				0.136
				0.224				0.147
Unprocessed groundnuts				0.308				0.370

Table 10 (continued)

Independent variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Population-averaged Poisson				Random-effects Poisson			
				0.231				0.254
Constant	− 14.785***	− 4.546	− 5.611	− 5.798	− 13.094**	− 5.687	− 5.907	− 8.247**
	5.040	3.500	3.670	3.587	5.376	4.145	4.754	4.015
Importer–exporter fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of observations	200	192	192	192	200	192	192	192

Clustered robust standard errors are in brackets and *$p < 0.10$; **$p < 0.05$; ***$p < 0.01$. Standard errors are clustered at the importer–exporter–product level

[§]—estimates show changes in significance but still maintain the same direction of effects in relation to the results obtained in Table 6

Robustness Checks: Disaggregated Product-Level Analysis

We also check the robustness results presented in Table 6 to the exclusion of countries with low export values and those with low rejections. The results, which are displayed respectively in Tables 9 and 10, with the estimates from the population-averaged Poisson model are presented in columns 1 to 4, while those from the random-effects Poisson model are displayed in columns 5 to 8. These results from both tables show significant overlap with those of the product-level results presented in Table 6. While some of the coefficients changed in terms of significance, however, the directions of the effect remain the same. Nevertheless, the estimates from Tables 9 and 10 do not differ much in regard to the impact of the explanatory variables at the product level, signifying that the results are not driven by countries with low export values or those with low rejections.

Policy Recommendations and Conclusion

This study investigates the factors driving the rejection of Africa's food exports at the EU border as a result of their non-compliance with EU food safety standards. Our results show that inadequate border and logistic measures—particularly in the areas of export clearance time, documents needed to export, percentage of shipments meeting quality criteria and rate of inspection of shipments—are the main drivers of the rejection of Africa's food exports at the EU border. Conversely, increases in the number of border agencies, trade-related infrastructure and regulatory quality all play significant roles in the reduction of the number of export shipments rejected at the EU border. These indicate that inefficient border and logistics procedures in African countries, increase the incidence of rejection at the EU border and add to their challenges in accessing EU markets.

Our results reveal some heterogeneous product effects as the poor state of logistic and border procedures have greater effect on the rejection of fruits and vegetables, and fish and fishery products than it does on edible groundnuts and unprocessed groundnuts products. Thus, trade-related facilitation measures must be strengthened to enable perishable export products to move more efficiently to their destinations and thereby reduce unnecessary rejections at the EU border. Therefore, in order to move products to the international market more efficiently, African countries must adopt policies to support trade. The issue of export rejections at the border can be addressed through policy measures that improve both logistics and connectivity. Comprehensive reforms and long-term commitments to the implementation of

sustained and strategic policy intervention in the area of trade facilitations, involving the private sector, is an important policy priority. Good customs and border management and the improvement of transit regimes are all areas of trade facilitation that would help to improve logistics quality and move food products to market more efficiently and reliably, particularly for perishable products. This would reduce unnecessary trade time and costs as well as bolstering trade competitiveness.

Our results have also shown that an improvement in infrastructural quality reduces the incidence of rejections only for exports of fish and fish, while regulatory quality plays a significant role in the reduction of the number of exports rejected at the EU border for fruits and vegetables, and fish and fishery products, but not for unprocessed groundnut and edible groundnuts. Thus, investment in both soft and hard infrastructure through public–private partnerships and coordination would ensure goods are cleared even before they reach the importing countries and would minimize delays that cause food spoilage and border rejections. Streamlining unnecessary border procedures could ensure companies' faster access to importing markets, especially for highly perishable products which need to be exported on time. Coordination therefore remains essential in trade facilitation efforts and should include the introduction of best practices, especially in the two key areas of transportation infrastructure and border management.

Finally, our results also show Africa's lack of strong regulatory institution in the area of food quality. Thus, African policy makers also need to make improved long-term regulatory institutional changes that are consistent with the fast-changing standards required by developed countries, particularly the EU, which is their most important trading partner. Provision of sophisticated testing and accreditation technology as well as the implementation of stringent domestic food safety regulatory policies that are aligned with those required by the EU are part one of such policies.

Appendix

See Table 11.

Table 11 List of countries in the dataset

Importer	EU27			
Exporters	Algeria	Egypt, Arab Republic	Malawi	Senegal
	Benin	Ethiopia	Morocco	South Africa
	Cameroon	Ghana	Mozambique	Tanzania
	Congo, Republic	Kenya	Namibia	Togo
	Cote d'Ivoire	Madagascar	Nigeria	Tunisia

Acknowledgements The research is financially supported by the Deutsche Forschungsgemeinschaft (German Research Foundation) under the project grant number 'RTG1666' (GlobalFood).

Funding Open Access funding enabled and organized by Projekt DEAL.

Declarations

Conflict of interest On behalf of all authors, the corresponding author states that there is no conflict of interest.

References

Arvis, J.F., D. Saslavsky, L. Ojala, B. Shepherd, C. Busch, and A. Raj. 2014. *Connecting to compete—The logistics performance index and its indicators*. Washington DC: The World Bank.

Baylis, K., A. Martens, and L. Nogueira. 2009. What drives import refusals? *American Journal of Agricultural Economics* 91 (5): 1477–1483.

Beestermöller, M., A.C. Disdier, and L. Fontagné. 2018. Impact of European food safety border inspections on agri-food exports: Evidence from Chinese firms. *China Economic Review* 48: 66–82.

Chenaf-Nicet, D. 2019. Dynamics of structural change in a globalized world: What is the role played by institutions in the case of Sub-Saharan African countries?. *The European Journal of Development Research*, 1–40.

Czubala, W., B. Shepherd, and J.S. Wilson. 2009. Help or hindrance? The impact of harmonised standards on African exports. *Journal of African Economies* 18 (5): 711–744.

Djankov, S., C. Freund, and C.S. Pham. 2010. Trading on time. *Review of Economics and Statistics* 92 (1): 166–173.

Freund, C., and N. Rocha. 2011. What constrains Africa's exports? *The World Bank Economic Review* 25 (3): 361–386.

Iwanow, T., and C. Kirkpatrick. 2009. Trade facilitation and manufactured exports: Is Africa different? *World Development* 37 (6): 1039–1050.

Jouanjean, M.A., J. Maur, and B. Shepherd. 2015. Reputation matters: Spillover effects for developing countries in the enforcement of US food safety measures. *Food Policy* 55: 81–91.

Kareem, F.O., B. Brümmer, and I. Martinez-Zarzoso. 2017. European union market access conditions and Africa's extensive margin of food trade. *The World Economy* 40 (10): 2277–2300.

Kareem, F.O., and I. Martínez-Zarzoso. 2020. Are EU standards detrimental to Africa's exports? *Journal of Policy Modeling* 42 (5): 1022–1037.

Kim, S.J., and K. Reinert. 2009. Standards and institutional capacity: An examination of trade in food and agricultural products. *The International Trade Journal* 23 (1): 54–77.

OECD. 2005. *The economic impact of trade facilitation*. *OECD Trade Policy Working Paper 21*. Paris: Organization of Economic Cooperation and Development (OECD).

Portugal-Perez, A., and J.S. Wilson. 2012. Export performance and trade facilitation reform: Hard and soft infrastructure. *World Development* 40 (7): 1295–1307.

RASFF. (Online Database). European Commission rapid alert system for feed and food. https://webgate.ec.europa.eu/rasff-window/portal/. Accessed 10 July 2014.

RASFF. (2014). The rapid alert system for food and feed 2014 Annual Report. http://ec.europa.eu/food/safety/rasff/docs/rasff_annual_report_2014.pdf. Accessed 15 Sept 2015.

Santos Silva, J., and S. Tenreyro. 2006. The log of gravity. *The Review of Economics and Statistics* 88 (4): 641–658.
Shepherd, B., and N.L. Wilson. 2013. Product standards and developing country agricultural exports: The case of the European Union. *Food Policy* 42: 1–10.
Traoré, O.Z., K. Latouche, and L.D. Tamini. 2020. European's RASFF Border Rejections, African Countries's Reputation and Exports of Edible Vegetables and Fruits. *Cahier de recherche/Working Paper*, 5.
Wilson, J.S., C.L. Mann, and T. Otsuki. 2005. Assessing the benefits of trade facilitation: A global perspective. *World Economy* 28 (6): 841–871.
Xiong, B., and J. Beghin. 2011. Does European aflatoxin regulation hurt groundnut exporters from Africa? *European Review of Agricultural Economics* 39 (4): 589–609.
Zaki, C. 2015. How does trade facilitation affect international trade? *The European Journal of Development Research* 27 (1): 156–185.

Authors and Affiliations

Fatima Olanike Kareem[1,2] · Inmaculada Martínez-Zarzoso[2,3] · Bernhard Brümmer[4]

Inmaculada Martínez-Zarzoso
martinei@eco.uji.es

Bernhard Brümmer
bbruemm@gwdg.de

1 GlobalFood Research Training Group 1666, University of Göttingen, Heinrich Duker Weg 12, 37073 Göttingen, Germany

2 Department of Economics, University of Göttingen, Platz der Göttinger Sieben 5, 37073 Göttingen, Germany

3 Institute of International Economics, University Jaume I, Castelló, Spain

4 Department of Agricultural Economics and Rural Development, University of Göttingen, Platz der Göttinger Sieben 5, 37073 Göttingen, Germany