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“When you need it quick, let us ship it right”: on the importance of port efficiency and service quality to comply with food trade standards in Ghana

Lukas Kornher^{1,5} · Daniel Sakyi² · Linus Linnaeus Tannor^{3,4}

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Abstract

Agricultural exports are especially important because of their great potential for poverty reduction among smallholder farmers. However, many African countries, such as Ghana, fail to realize their full export potential due to institutional and technical constraints. This paper examines the importance of port efficiency and service quality in complying with food trade standards in Ghana. We provide a stylized theoretical model in which exporting firms are willing to pay for improved port service quality as long as the marginal revenue derived from a reduced likelihood of (border) rejection exceeds the marginal costs for improved service quality. We test the model's predictions using primary data from 120 agri-food exporters in Ghana. Our results show that about two-thirds of exporting firms have a positive willingness-to-pay for a reduction in the handling time at the port and the risk of spoilage due to inadequate handling. These findings emphasize the importance of trade facilitation measures in improving port efficiency and service quality to accelerate agricultural exports.

Keywords Fruit and vegetable exports · Ghana · Port efficiency · Choice experiment · Food standards · Sanitary and phyto-sanitary regulations

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1 Introduction

International trade is the engine of the global economy. Many developing countries rely heavily on trade not only for imports of goods and services they do not produce, but also for exports to generate income and welfare (Dollar & Kraay, 2004; Sakyi et al., 2015). Given the similar economic structure of many African economies, exports of agricultural goods and services to the European Union (EU) and/or the United States (US) have the greatest potential for African exporters. Agricultural exports are especially important because they have a great potential for poverty reduction among smallholder farmers (Anderson & Martin, 2005; Maertens et al., 2012). However, many African countries fail to realize their full export potential due to institutional and technical constraints (Kareem et al., 2022).

Market entry of food products into the US and EU markets necessitates certificates and quality standards (from both official authorities and the private sector), at times incongruent (Disdier et al., 2015), which are referred to as non-tariff measures (NTMs) to trade. Despite international trade liberalization, the number and scope of NTMs have grown in recent years, particularly following the 2008 financial crisis (Niu et al., 2018). Among the various NTMs, sanitary and phytosanitary (SPS) regulations, which protect consumer health at the point of destination, are the most prominent food standards accounting for the majority of border rejections at the EU and other high-income destinations (Otsuki et al., 2001a; Kareem et al., 2018). These standards may have ambiguous effects on trade: they can be trade-promoting when demand for imports rises as a result of increased consumer confidence in foreign producers, but they can also be trade-inhibiting when compliance raises the marginal costs of trading, which is especially true for countries with limited export infrastructure (Santeramo & Lamonaca, 2019a; Kareem & Martínez-Zarzoso, 2020).

Some scholars have argued that Africa's agricultural export falls short of its potential because of supply-side constraints, infrastructural barriers, and poor trade facilitation in Africa, in addition to trade-inhibiting effects caused by exporters' difficulties complying with standards (Bouët et al., 2017; Kareem et al., 2022). The export of perishable products, like fruits, vegetables, and fish, places a special strain on the exporting countries' infrastructure (Vega, 2008). Important infrastructure include laboratory testing facilities to monitor the maximum residue levels (MRL) for pesticides, access to dry and cold storage facilities, and facilities' adequacy at the port of exit. Furthermore, the port's service quality and efficiency determine the risk of spoilage (due to mishandling and inadequate storage) and the predictability of the dwell time (Freund & Rocha, 2011), which is critical for the proper treatment of products before shipment.

Several authors have analyzed the role of NTMs and limited export infrastructure for below-potential agricultural exports of low-and-middle-income countries (LMIC) (Henson & Loader, 2001; Otsuki et al., 2001a; Melo et al., 2014; Xiong & Beghin, 2014; Crivelli & Groeschl, 2016; Kareem et al., 2018; Kinzius et al., 2019;

Santeramo & Lamonaca, 2019b; Kareem & Martínez-Zarzoso, 2020). However, previous studies have mostly discussed NTMs and export infrastructure in isolation and not in conjunction with each other. Santeramo and Lamonaca (2019b) present an excellent overview with respect to the effects of NTMs on African agri-food exports. Although the trade effects of NTMs are ambiguous when examining trade flows globally, NTMs are found to inhibit African agri-food exports because African exporters have higher "costs of compliance with NTMs and obtain lower profits than producers in the destination market" (Santeramo & Lamonaca 2019b, p. 12). Kareem et al. (2018) provide a more nuanced picture arguing that the level of protectionism may vary across sectors and that NTMs may be less protective of import-dependent sectors. In general, the effects can vary across sectors and firms, and they are more likely to impact less experienced exporters stronger than countries or firms with longer trade experience (Crivelli & Groeschl, 2016).

The heterogeneous trade effects of NTMs have been explained by differences in exporters' domestic productive supply and export capacity. For instance, Xiong and Beghin (2014) explain the negative trade effects of NTMs for LMICs as the lack of resources to comply with SPS, such as MRLs, which cause disadvantages for their exporters. Some of these factors are closely related to Africa's internal supply constraints (Baumüller et al., 2021) as well as domestic infrastructure that causes time delays and increases the cost of trading (Djankov et al., 2010). For instance, Djankov et al. (2010) find that an additional day of export duration was equivalent to the trade-inhibiting effect of an additional 70-km distance between trading partners. This effect was even stronger for time-sensitive perishable agricultural export products. Freund and Rocha (2011) emphasize the relationship between domestic delays and export infrastructure. They find that reducing the time required for documentation, transit and port handling, and customs clearance by one day could result in a 7% increase in trade.

The Logistics Performance Index (LPI) combines these data to provide a better assessment of a country's logistics infrastructure (Arvis et al., 2014). A country's logistics performance is largely related to port infrastructure, including storage facilities, logistics costs, reliability of services, and cargo dwell time. In the literature, these elements are summarized as port efficiency and service quality (Sakyi et al., 2021).¹ Only recently have (sea)port efficiency and port service quality been identified as important means of improving Africa's logistics infrastructure and export capacity (Sakyi & Immurana, 2021; Sakyi et al., 2021; Mlambo, 2021; Ayesu et al., 2022).

Other studies argue that the regulatory distance and the level of similarity between NTM policies across different states are major reasons for trade-inhibiting effects of NTMs. For instance, Santeramo and Lamonaca (2022a) examine how the mismatch in the level of economic development between importers and exporters affect SPS and find that agreeing on SPS has trade enhancing effects, particularly when SPS intensity

¹ Sakyi et al. (2021) define seaport efficiency by the average cargo dwell time, the reliability of the terminal's service operations for the multimodal interface, the loading/discharging rate, the average length of ship's service time by the seaport, the efficiency of the port/terminal's service operations for the multimodal interface, and the speed of customs clearance.

is high. Further, anti-discriminatory NTM policies and mutual recognition of food standards in preferential trade agreements (PTA) are found to be associated with more agricultural trade (Santeramo & Lamonaca, 2022b; Kim & Steinbach, 2023).

Kareem et al. (2022) is one of the few studies that analytically and empirically link the negative effect of NTMs on agri-food exports to domestic logistics infrastructure. In detail, the authors thoroughly examine the reasons for border rejections of African food exports to the EU. They find that border rejections were significantly related to the quality of exports, domestic infrastructure, domestic regulatory quality, and the number of documents required for exporting, which include documents for customs clearance, port processing, and other agencies. For fruits and vegetables, the number of clearance days was also strongly correlated with a higher rate of rejection. In addition to that, agri-food exports are rejected by business partners after they were allowed to enter the EU. Rejections are related to the importance of maintaining an intact cold chain for these products and time delays (de Melo & Nicita, 2018). UNIDO (2010) constructs the Standards Compliance Capacity Index (SCCI) and includes port infrastructure as an important component of the logistics infrastructure. This is supported by the findings of Sakyi et al. (2021), who show that seaport efficiency and service quality influenced exporters' choice of West African seaports. Therefore, we argue that reducing travel, documentation, and customs bureaucracy, as well as port time, is strongly related to perishable product's, such as horticulture and fish, export performance, and thus, seaport efficiency and service quality are strongly related to food standard compliance. We focus on seaport efficiency (instead of airport efficiency) because the majority of agri-food trade, also in perishable products, is seaborne. This will further increase within the next few years with advancements in refrigerated container shipments (del Rosal, 2024). In addition to that, seaport efficiency is much more relevant for product quality and possible border rejections at the destination than airport efficiency because dwell time at seaports is much higher (Arvis et al., 2023).

We focus in our study on Ghana, which has become a rising exporter of horticulture products and fish with the EU as the main destination market, where about two-thirds of Ghana's agri-food exports go to (World Bank, 2024). Although Ghana has experienced rapid economic growth, traditional export products, such as oil and gas, timber, gold, and cocoa, continue to dominate the country's export sector, like in many other LMICs. Ghana represents a suitable case study country because Ghana has recently experienced a number of EU border rejections (Kareem et al., 2022). Besides, Ghana has made substantial investments in its seaport infrastructure to increase its export capacity and seaport efficiency.

The contributions of this study are threefold. First, this study quantifies the administrative costs, i.e. costs of obtaining all necessary export documents, for exporting tropical fruits, vegetables, (oil-), and fish from Ghana to high-income destinations. This includes the costs of specific certification documents. Second, we develop a stylized theoretical model that describes the demand for port service quality as a function of the service costs and the likelihood of (border) rejection at the export destination. The theoretical framework brings out two main hypotheses that are empirically tested in this work: Agri-food exporting firms have a positive willingness-to-pay (WTP) for improved port efficiency and service quality; and the WTP for improved port efficiency and service quality is not the same for all

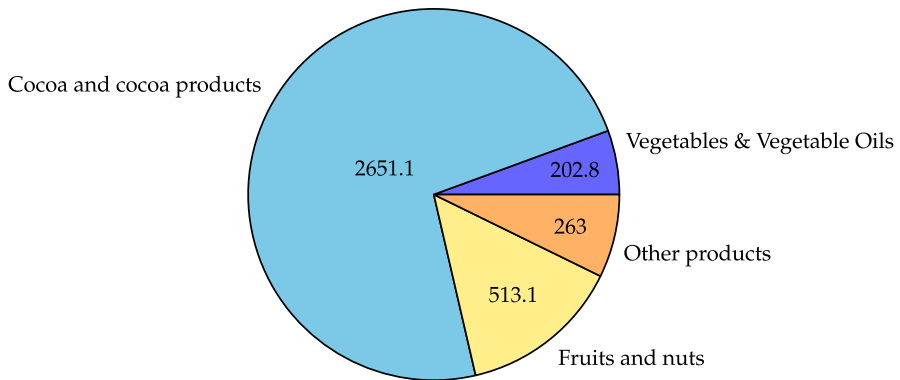


Fig. 1 Ghana's total annual agri-food exports (2018–2020) in million USD. Source: FAOSTAT (2022)

firms. Finally, we empirically test and analyze these hypotheses through a choice experiment among agricultural exporters in Ghana. By doing so, we add an empirical dimension to the field's existing literature.

The remainder of the paper is organized as follows. Section 2 provides a brief overview of the case study's setting, including a description of Ghana's agri-food export sector and the issues associated with food standard compliance. Section 3 then introduces our stylized theoretical model to explain the demand for improved port service quality. Section 4, presents the data and key descriptive statistics, explains the experimental design, describes the econometric model, and presents the choice experiment results. Finally, Sect. 5 concludes with important policy recommendations.

2 The setting

Ghana has experienced rapid economic growth in recent years, as well as significant improvements in poverty reduction and food security. For instance, poverty reduced from around 40% in 1998 to less than 25% in 2016. Similarly, the prevalence of undernourishment has dropped from 15% to 4% since 2000 (World Development Indicators, 2022). Due to the importance of the agricultural sector in poverty reduction, growth in both the horticulture and fish sectors can support further progress in this regard, as these products have the potential for further processing which creates jobs and adds value. Tropical fruits, such as pineapples, are sometimes processed in Ghana and air-shipped to EU destinations (Kleemann et al., 2014). Apart from cocoa, the horticulture sector is already an important agri-export sector in terms of total export revenue (see Fig. 1), whereas Ghana's fish exports are still substantially lower; currently up to 300 million USD but growing (Asiedu et al., 2018). The principal fruits exported are pineapples, citrus, bananas, and papaya. The main vegetable exports are chillies, okra, and eggplant. In this regard, Ghana's agri-food export

structure is similar to that of many sub-Saharan African countries (Kornher & von Braun, 2020).

There is a growing market in the EU and other high income regions for these products. Horticulture and fish products, as opposed to cocoa, are considered high value crops, but are still grown by many smallholders. Therefore, export growth in these sectors unleashes poverty reduction potential. However, all of these products are perishable, and food safety considerations, due to the use of pesticides, are critical. Therefore, these products must comply with several technical standards that fall under NTMs. Since 2007, the number of NTMs applied to Ghanaian exports of pineapple, vegetable oil, and fish has significantly increased. For instance, the UNCTAD TRAINS (2022) database lists 100 NTMs for fish exports from Ghana to the United States in 2020. This figure has risen from 40 since 2007. Importation into the EU, at the time of the study (2020 data), was subject to 30 NTMs (pineapple), 80 NTMs (vegetable oil), and 40 NTMs (fish). Furthermore, global value chains require producers to follow private voluntary standards, such as the GlobalGAP, with even stricter food safety, quality, and traceability standards (Kleemann et al., 2014).

These food standards have increased the compliance costs for African agri-food exporters. Therefore, several studies contend that protectionism may have been the driving force behind the increasing number and stringency of standards (Otsuki et al., 2001a; Kareem et al., 2018). The literature on NTMs for horticultural products focuses primarily on food safety standards related to MRL of pesticides (Wilson & Otsuki, 2004; Ferro et al., 2015; Kareem et al., 2018) and other food contaminants, like aflatoxin (Otsuki et al., 2001b; Vural et al., 2019). Vegetable imports to the majority of destinations require a phytosanitary certificate issued by the national plant protection authority. This requires a physical inspection but not necessarily a laboratory test of a sample. Fosu et al. (2017) report that pesticide concentrations exceeding EU MRLs are prevalent for vegetables in Ghana. As a result of frequent border rejections, the EU banned Ghanaian vegetable exports in 2014 (Kareem et al., 2018). These rejections result in additional expenses. Baylis et al. (2009) find that uncovered violations against import guidelines also cause additional scrutiny in the future. Compliance with international MRL levels is mostly related to production practices and pest management on the farm. Integrated pest management for reduced pesticide use does not necessarily raise production costs, but it does necessitate training of smallholder farmers. From standpoint of the exporter, easy access to laboratory testing facilities would significantly reduce the likelihood of border rejections, and thus the costs of exporting.

For several fruits, such as bananas and pineapple, phytosanitary certificates are not required and MRLs exist, but pesticide residues are less of a concern for African producers than for vegetable products. By contrast, for these products, as well as seafood, EU quality standards pose a significant barrier to increased exports. For instance, EU supermarkets frequently demand MRLs that are stricter than the EU standard. In addition to that, supermarkets prefer tropical fruits that have not yet ripened before being placed on the supermarket shelves. Fruits like pineapples, mangoes, bananas, and papayas are typically harvested when they are fully matured. To meet the demand of EU supermarkets, exporters must carefully manage chemical storage, transportation, and appliances to regulate Ethylene production for timely

Table 1 Ghana's Logistics Performance Index (LPI) between 2007 and 2018. *Source* World Bank (2021). 5 Represents high and 1 low performance

	2007	2010	2012	2014	2016	2018
Overall LPI	2.16	2.47	2.51	2.63	2.66	2.57
Customs	2.00	2.35	2.33	2.22	2.46	2.45
Infrastructure	2.25	2.52	2.05	2.67	2.48	2.44
International shipments	1.75	2.38	2.81	2.73	2.71	2.53
Logistics and competence	2.25	2.42	2.68	2.37	2.54	2.51
Tracking and tracing	2.00	2.51	2.31	2.86	2.52	2.57
Timeliness	2.50	2.67	2.76	2.63	3.21	2.87

ripening. This is also dependent on transit as well as shipment duration and predictability, and proper handling during transit and shipment.

Given the interaction between the exporting country's infrastructure, particularly the port efficiency and service quality, and the exporting firm's capacity to meet governmental and commercial food standards, the literature on NTMs and agri-food export capacity needs to be extended. For instance, as perishable products are shipped, several factors and appropriate actions are essential to keep the right temperature and humidity in the cool chain. These go beyond pure logistics and include port services as well as customs handling, testing, and border inspections. The coordination among and the efficiency of different agencies is also linked to the mode of transport (sea or air), i.e. by providing certain services at the port of exit (e.g. laboratory testing facilities) (OECD, 2018). The most widely used indicator for logistics performance remains the World Bank's LPI. Overall, Ghana was ranked 108 (out of 160) in 2018, up from 125 in 2007. Improving the logistics environment for agri-food exports is also reflected in an increase in the overall score and rank in the LPI (Table 1). Specifically, the environment for international shipments and delivery timeliness has improved, as shown in Table 1, rows (4) and (6). Domestic LPI data also show a significant improvement in the lead time to export and the quality of physical inspections at ports. Meanwhile, the LPI reports that only 61% of shipments met the quality criteria in 2018. Both clearance times without and with physical inspection are significantly longer than for countries ranked high in the 2018 LPI. Therefore, Ghana's limited export infrastructure raises the cost of exporting significantly.

Perishable products, like horticulture products and fish, are shipped by both air and sea. EUROSTAT (2024) reports EU trade by mode of transport. According to the statistics for the years 2020–2024, the majority of Ghana-EU trade in fruits (HS 08), vegetables (HS 07), and fish (HS 03) is seaborne: between 60 and 90% with an increasing trend. The LPI and other infrastructure indicators do not distinguish between the quality of different port types, namely seaports and airports. However, there are notable differences between these two port types. Airports provide much faster transportation service but usually at higher costs (Arvis et al., 2023). In terms of quality of infrastructure, the World Economic Forum's Global Competitive Survey has ranked Ghana between 80 and 100 among 135 countries for both airport and seaport quality of infrastructure (1(low)–7(high)). However, the rating

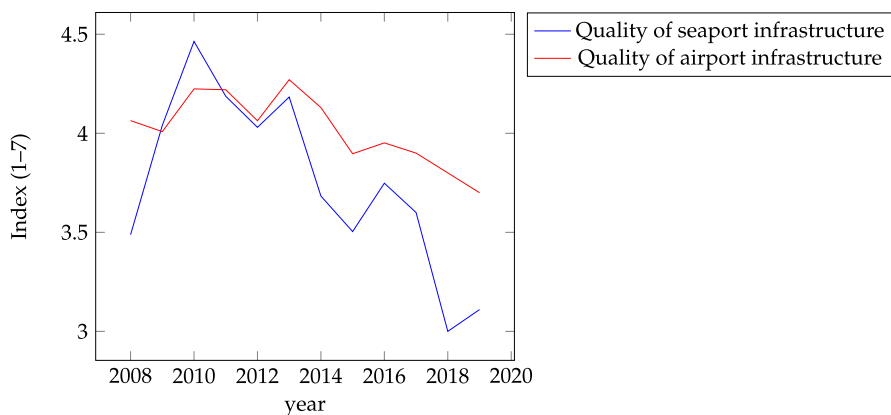


Fig. 2 Quality of Ghana's infrastructure 2008–2019. *Source* WEF (2020)

for the quality of seaport infrastructure has dropped markedly since 2014, whereas that of the quality of airport infrastructure has been relatively constant (2). Despite the opening of a new cargo terminal at the Kotoka Airport in 2016, air cargo volumes have been stagnant since the second half of the 2000 s (Adenigbo et al., 2022). On the contrary, horticulture exports are often air-shipped through normal passenger flight services and do not pass the cargo terminal. Kotoka Airport was ranked 13 in international air connectivity among all African cities with a growth rate of 17% between 2014 and 2019 (IATA, 2020). Together with the improvement of on-ground export infrastructure, this has led to significant growth in the cargo business of agri-food products. On the downside, air shipments are heavily dependent on the availability of cargo in passenger flights (BusinessGhana, 2022) and high fuel prices reduce the international competitiveness of air-shipped agri-food exports. For this reason, we focus on seaport efficiency and service quality in the empirical part of this paper (Fig. 2).

3 Theoretical framework

We demonstrate the demand for port efficiency in a competitive market using the standard profit maximization framework of microeconomic theory. To account for the possibility of deliveries being rejected at the border, if they do not meet the importing country's trade standards or the customer's quality requirements of, we introduce q as the probability of rejection. The following is the decision problem of an exporting firm in determining its export quantity Q :

$$\max \pi = q(p - t)Q + (1 - q)pQ - c(Q) \quad (1)$$

where p denotes market prices and $c(Q)$ denotes the cost function. t is the additional cost in case of a border rejection. For instance, if the shipment is destroyed on border rejection at the destination, there is no revenue from the export shipment ($t = p$), so that the first part of Eq. (1) becomes zero. Alternatively, it is also possible that the

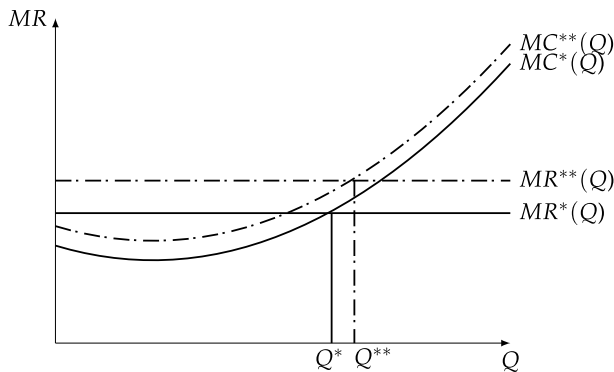


Fig. 3 Marginal costs and marginal revenue for different levels of service quality (k)

border rejection leads to a fee and the shipment will be sent back to the exporting firm. This fee could be greater ($t > p$) or lower ($t < p$) than the price. Equation (1) is solved when marginal revenue ($MR = \frac{\partial q(p-t)Q + (1-q)pQ}{\partial Q}$) and marginal costs ($MC = \frac{\partial c(Q)}{\partial Q}$) are identical. When p is fixed, the MR and the equilibrium quantity Q both decrease in q and t . In the following, we focus on q because t is determined externally and cannot be altered by the firm.

We now introduce the parameter k , which describes the quality of port service and make two critical assumptions. First, port service quality reduces the likelihood of a border rejection, but it cannot completely eliminate rejections. Hence, q decreases in k at a diminishing rate. Kareem et al. (2022) demonstrate this relationship for various aspects of port service and customs service quality. Given the linear relationship between MR and q , $MR(k)$ is defined as $MR'(k) > 0$ and $MR''(k) < 0$. Second, port service quality increases the firm's costs.² We assume costs increase in k at an increasing rate, that is $MC'(k) > 0$ and $MC''(k) > 0$.

Figure 3 depicts the equilibrium quantity for two levels of k and thus q . Despite higher costs, an improved service quality can positively affect the equilibrium quantity Q , in our case food exports. According to the model, this is due to the firms' lower likelihood of receiving a border rejection. Figure 4 shows the partial derivatives of MR and MC with respect to k . Intuitively, as long as the MR exceeds MC , it is profitable to demand improved service quality. In other words, agri-food exporting firms will be interested in improved port service quality as long as the additional expected profits from a reduced likelihood of (border) rejections at the destination outweigh the additional costs for service quality. The equilibrium level of service quality is marked by the intersection between MR and MC .³

We use this simplified framework to derive two testable hypotheses that we can directly tested by the empirical model:

² Improved service quality could, in the long-run, reduce the transaction costs of exporting other than reducing the likelihood of border rejection.

³ If MC of improved service quality is always, across different levels of k , greater than the MR , i.e., $\frac{\partial MC_2}{\partial k} > \frac{\partial MR}{\partial k}$ for all levels of k , then the firm will not demand improved service quality.

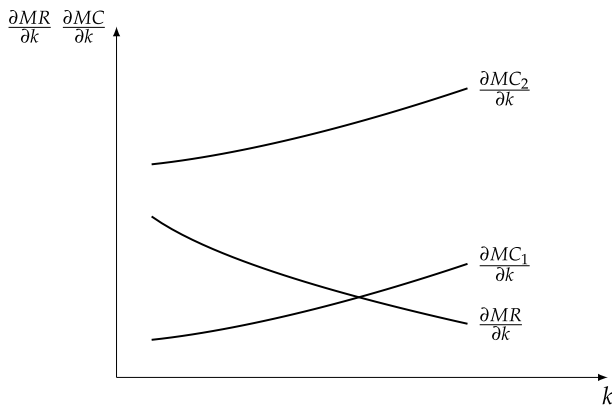


Fig. 4 Equilibrium level of service quality (k)

1. Exporting firms have a positive WTP for improved port service quality.
2. The WTP for improved port service quality is not the same for all firms.

The first hypothesis directly derives from assumptions made in the theoretical framework. It is based on the observation in the literature that NTMs are trade-inhibiting for LMIC exports to high-income countries. In consequence, exporting firms anticipate higher profits despite higher costs with each additional unit of export if the likelihood of a (border) rejection reduces. Exporting firms can invest in improved service quality, for instance, higher quality and faster port services, to increase the likelihood that products comply with the food safety standards in the destination market.

The second hypothesis is motivated by the fact that firms may have different MR and MC functions. That is, firms may differ in their ability to influence the likelihood of (border) rejection $\frac{\partial MC}{\partial k}$. For instance, some exporting firms do not have access to transport and cold storage facilities, and therefore, face substantial delays in transporting export goods to the seaport with the consequence that the time spent for port handling is not decisive. Alternatively, for some firms, the likelihood of border rejection could be driven by on-farm handling and not by port service quality. Last, this may also be the result of different costs of compliance across different products (Crivelli & Groeschl, 2016). In these cases, improving port service quality may have little effect on the likelihood of border rejection, and thus, on MR and will not lead to additional export sales.

4 Empirical analysis

4.1 Data collection and descriptive statistics

Between July and October 2021, a structured questionnaire was prepared and administered in the five regions of Ghana: Greater Accra, Brong-Ahafo, Central Region, Ashanti Region, and Eastern Region, where fruits and vegetables are

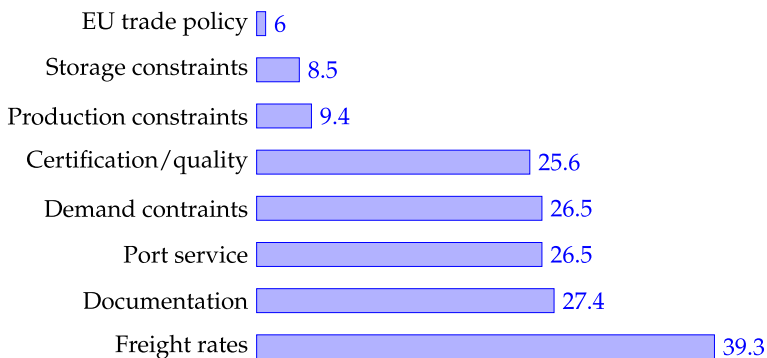
mainly grown. The questionnaire was prepared after consultations with stakeholders, such as Sea-Freight Pineapple Exporters Ghana (SPEG), and pre-tested in July 2021. Due to the nature of the survey that targeted a limited number of firms, that are engaged in export trading, we have used a snowball sampling procedure starting from the major exporter associations, such as SPEG and the Vegetable Exporters and Producers Association of Ghana. The questionnaire was distributed to 120 firms, of which 104 exported and 16 considered exporting. Of these 120 firms, 47 engage in pineapple trading, 40 in mango trading, 34 in vegetable/vegetable oil trading, 20 in papaya trading, 17 in fish trading, 17 in trading of other fruits, and 6 in banana trading.

This section presents the data and focuses on descriptive statistics about the respondent's export costs. The first part of the questionnaire collected information about the firm's profile, such as firm size and revenue sources. In the second part, we gathered information on the firm's export activities, as well as, the specific transaction costs associated with the most recent export transaction. This part of the questionnaire aims to better understand the challenges of international trade to the EU, the most important export market for horticulture and fish products, as well as to quantify the costs of exporting to the EU. The third part of the questionnaire includes a choice experiment to elicit respondent's WTP for services related to handling, testing, and certifying agricultural exports, potentially at seaport facilities. The final part of the questionnaire addressed the manager's perceptions of international exports, technical trader barriers, port efficiency, customs handling, certification, proper handling, testing, transportation, spoilage, rejection at the point of entry, and so on, as well as the benefits of higher sales prices. Table 2 shows the mean and standard deviation of the main variables of interest used in the empirical analysis.

In most cases, the interview was conducted with the firm's managing director. The firms interviewed had been in business for an average of 12.6 years and had exported for an average of 11.2 years. The majority of the firms were also engaged in agricultural production. The firm size varied, but approximately 77.5% of the firms had fewer than 30 employees. Among the firms interviewed, 26% had experienced at least one border rejection, mostly from the EU, and 38% had experienced a business partner's rejection due to poor quality after the products were allowed to enter the EU. Border rejections were significantly more common among vegetable and fish exporters, whereas business partner rejections were more common among fruit exporters, especially pineapple and mango exporters. Although 62% of exporting firms are members of an exporter association, membership is more common among vegetable exporters and uncommon for fish exporters. Approximately 50% of exporting firms own trucks for domestic transportation, but only 34% and 23%, respectively, have access to cold and dry storage facilities. Strikingly, as opposed to the overall trade statistics, the majority of firms (77%) has used air shipment for exporting within the last 2 years, whereas only 38% of the firms have used sea shipment. This could be related to the fact that smaller trading firms do not ship through the seaport individually but rather commission larger trading firms or associations, like SPEG, to export by sea on their behalf. Finally, in the analysis, we take into account the exporters'

Table 2 Summary statistics of main variables of interest

Variable name	Description	Mean	Std
Business experience	Number of years the firm is registered	12.6	8.3
Export experience	Number of years the firm has exported	11.2	7.5
Production	Dummy variable if firm is involved in production activities	0.74	0.44
Firm size	Number of employees (1:1–5;2:6–29;3:30–99; 4:> 100)	1.99	0.93
Fruit	Dummy variable if firm trades fruit products	0.67	0.47
Vegetable	Dummy variable if firm trades vegetable products	0.28	0.45
Fish	Dummy variable if firm trades seafood	0.14	0.35
Border rejection	Dummy variable if firm experienced a border rejection	0.26	.44
Partner rejection	Dummy variable if firm experienced a rejection by a client	0.38	0.49
Association	Dummy variable if firm is member of an exporter association	0.62	0.48
Access cold storage	Dummy variable if firm owns/rents cold storage facilities	0.34	0.47
Access dry storage	Dummy variable if firm owns/rents dry storage facilities	0.23	0.42
Own truck	Dummy variable if firm owns truck(s)	0.49	0.50
Port efficiency	Perception on questions related to quality of port service and infrastructure (factor loadings)	1.0	0.79
Documentation and standards	Perception on questions related to EU standards (factor loadings)	1.0	0.60
Access to multiple buyers	Perception on availability of buyers (1:disagree –7: agree)	4.3	2.2
Costs	Perception on adequacy of costs (1:disagree –7: agree)	3.5	2
Importance of lead time	Perception on importance of lead time (1: disagree –7: agree)	5.6	1.8

**Fig. 5** Export constraints faced by respondents (in %)

perceptions. These variables are formed as a result of the exporter's agreement with a single or multiple statements concerning export bureaucracy, costs, and service quality.

Before delving into the analysis of the choice experiment, which is described in more detail in the following section, we examine the specific costs associated with

Table 3 Median transaction costs paid by exporting firm

Type of cost	Unit/lump sum in GHS	Unit/lump sum in USD
Domestic transportation	360 GHS/ton	59.4 USD/ton
Customs clearance	1400 GHS	232 USD
Export license	275 GHS	45.4 USD
Technical inspection	300 GHS	49.5 USD
Food safety inspection (Phyto certificate)	350 GHS	57.8 USD
Certification (GlobalGAP)	5200 GHS	858 USD
Certification (GEPA)	250 GHS	41 USD
Certification (Origin certificate fish)	700 GHS	115 USD
Port charges	180 GHS/ton	29.7 USD/ton

GHS is Ghana Cedis 1 GHS = 0.165 USD (Oct 2021)

agri-food exporting for Ghanaian firms. Figure 5 depicts the relevance of various export constraints faced by exporting firms. These were derived from an open ended question in which exporting firms were asked to list up to three obstacles to international exports/procedures and regulations that make exporting difficult. High freight rates were identified as the major constraint, followed by difficulties finding buyers (demand constraints), certification difficulty and associated high costs, cumbersome documentation, and limited port service quality. A quarter of the respondents mentioned each of these. Surprisingly, EU trade policies were not regarded as a significant impediment. Rather, the difficulties in meeting standards were mentioned more frequently. The high frequency observed for certification/quality and port services highlights the importance of the study's research question.

During the interview, we also examined the costs associated with the most recent export shipment. Table 3 summarizes these findings. Administrative costs turned out to be primarily lump sum costs. As a result, *MC* are (locally) decreasing in the export quantity. However, we have noticed that customs clearance costs are not always predictable. For instance, although most respondents stated that customs clearance of the most recent shipment took 1–2 h, we recorded a few responses stating that customs clearance took several days. Similarly, in some instances, the reported customs costs were multiple times larger than what is reported as median value in Table 3. It is important to note that certification is not required for each individual shipment but is part of the business's fixed operating costs.

Finally, in Fig. 6, we show the importance of various export cost components, using pineapples as an example. The respective shares are consistent with what Kleemann (2016) reported for 2009. Accordingly, the cost share of domestic transportation is relatively small. Instead, documentation and export bureaucracy account for roughly one-third of the free-on-board (fob) price. Among the total bureaucratic costs, customs clearance accounted for 50% with food safety inspections, export licensing, and technical inspections. Costs associated with packaging and production at the farm (or the farm gate price) are not included here. According to Kleemann (2016), production and packaging costs account for up to 50% of the fob price. Port charges, on the other hand, are relatively minor, accounting for only 3% of the

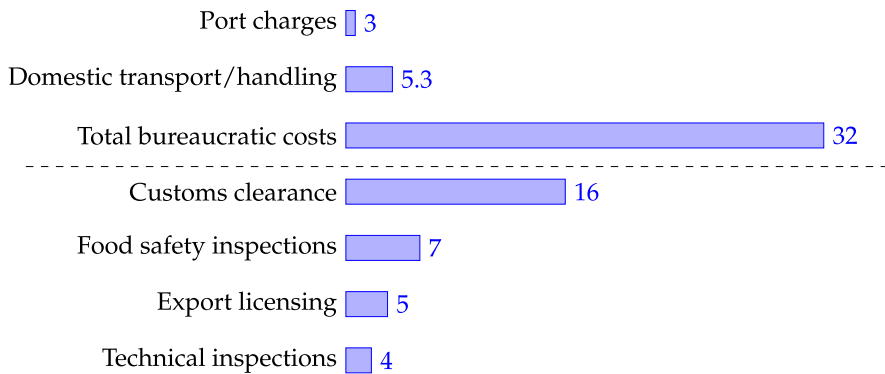


Fig. 6 Transaction costs of pineapple exporting as free-on-board percentage (% fob)

fob price. Overall, these data and figures support the notion that agri-food export bureaucracy is quite costly and trade-inhibiting, especially for small firms and shipments as described by Crivelli and Groeschl (2016).

4.2 Experimental design

To test the predictions of our theoretical model, we elicit the WTP for improved port service quality by a conjoint-based discrete choice experiment. Respondents in this experiment are asked to choose between different service bundles, that is service attributes, offered by the port authority at varying prices. It is possible to estimate the average value of the individual attribute to the respondent or the firm by varying the price attribute. A conditional logit latent class model (LCM) is used to estimate the coefficients, allowing for heterogeneous preferences across groups of exporter firms conditional on their preferences, attitudes, cost structure, and the specifics of the respective sector.

In detail, respondents were asked to select one of three options on behalf of their firm. These options included the service attributes, price, handling time at the seaport, and the risk of product spoilage due to port mishandling. Two of these options had attributes associated with an improved port service quality. For instance, a shorter port handling time or a lower risk of spoilage due to port mishandling. In particular, the port handling time could be -1 or -2 days, and the risk of spoilage due to mishandling at the port could be -50% . These enhanced attributes were associated with a price increase of $+10\%$ or $+25\%$. The attributes were explained to the respondents prior to the experiment. Respondents were given three choice sets in total. The choice set and options were selected using an orthogonal design in Stata. The combined options of a single choice are referred to as a choice set. Figure 7 depicts all three choice sets. Throughout the interviews, the order in which the choice sets were presented to the respondents was randomly varied.

Choice Set 1			
	Option 1 <input type="checkbox"/>	Option 2 <input type="checkbox"/>	Status Quo <input type="checkbox"/>
Price	+10 %	+25 %	+ -0%
Handling time at the seaport	-2 days	1 day	status quo
Risk of product spoilage due to inappropriate handling	status quo	-50 %	status quo

Choice Set 2			
	Option 1 <input type="checkbox"/>	Option 2 <input type="checkbox"/>	Status Quo <input type="checkbox"/>
Price	+25 %	+10 %	+ -0%
Handling time at the seaport	-1 day	status quo	status quo
Risk of product spoilage due to inappropriate handling	status quo	-50 %	status quo

Choice Set 3			
	Option 1 <input type="checkbox"/>	Option 2 <input type="checkbox"/>	Status Quo <input type="checkbox"/>
Price	+25 %	+10 %	+ -0%
Handling time at the seaport	status quo	-1 day	status quo
Risk of product spoilage due to inappropriate handling	-50 %	-50 %	status quo

Fig. 7 Choice sets presented to the respondents

The respondent's choices made remain purely hypothetical. However, previous research has found ways to reduce the respondent's hypothetical bias (Carlsson et al., 2005; de Magistris et al., 2013). To begin with, it is recommended that each choice set includes a no-choice or status quo option. In the current situation, we include a status quo option because responding firms already demand port services. This status quo represents the current level of port service quality at the current price. Second, the hypothetical bias of the choice experiment can be managed and reduced by providing ex-ante information about the hypothetical bias of the choice experiment (Lusk, 2003). The ex-ante information provision is commonly referred to as a cheap talk script. Therefore, we read the following message before the choice experiment was conducted:

Studies show that people tend to act differently when they face hypothetical decisions. In other words, they say one thing but behave differently in reality. For example, state a price they would pay for a service, but they will not pay that price for the item even when this service is offered to them.

Please take into account how important these services are and try to really put the firm in a realistic situation.

4.3 Statistical modeling

Following Lancaster (1966), we assume that the value of service quality V is made up of individual service quality attributes, that affect the likelihood of border rejections. However, we cannot observe how respondent n values the service quality attributes—price, handling time at the seaport, and risk of product spoilage, and their respective levels—but only the respondent's choice of a specific bundle of services (alternative) j from the set of options (choice set) described above. The respondent's multinomial decision can be written as:

$$C_{nj} = f(V_{nj}) = \begin{cases} 1 & \text{if } V_{nj} = \max_j V_{nj} \\ 0 & \text{otherwise} \end{cases} \quad (2)$$

where C is the choice decision, which takes the value 1 for the option with the maximum value, i.e., the options chosen by the respondents, and 0 if he/she does not choose the option. The conditional logit model introduces a fixed effect component of the error term to control for the serial dependence of the error terms of a respondent's decision. Firm characteristics, like business and export experience, firm size, etc., on the other hand, as well as specific quality and service demands of individual export sectors (vegetable, fish, and fruits), cause preference heterogeneity, resulting in attribute values that differ across firms. The latent class model (LCM), on the other hand, allows for the simultaneous classification of firms into homogeneous groups with similar attribute valuation and choice behavior, as well as the identification of firm and sector characteristics that explain group membership. The latter makes the LCM preferable to the mixed logit model (Hess et al., 2009).

In the LCM, class membership M_n is explained by firm characteristics and the respondent's perception toward port service quality, export infrastructure, and other export issues. A latent variable represents the unobserved membership:

$$M_{nm}^* = \lambda_m Z_n + \phi_n \quad (3)$$

where Z_n is a vector of firm and sector characteristics that determine the class membership with the respective coefficients λ_m that describe how firm characteristics influence the likelihood of belonging to a specific membership class. ϕ_n is an error term, which is assumed to be independently and identically distributed across firms with a type I extreme value distribution (Boxall & Adamowicz, 2002). The model with the most suitable number of membership classes is chosen based on the minimum value of the information criteria.

Finally, the unconditional choice probability of the firm n to choose a specific alternative j is:

$$P_n(j) = \sum_{m=1}^M \left[\frac{\exp(\alpha \lambda_m Z_n)}{\sum_{m=1}^M \exp(\alpha \lambda_m Z_n)} \right] \left[\frac{\exp(\mu_m \beta_m Z_j)}{\sum_{k \in C} \exp(\mu_m \beta_m X_k)} \right] \quad (4)$$

where $j = 1, 2, 3$ are the three choice options (see above); $k = 1, 2, 3$ are the three choice sets provided to the respondents; X_k is the vector of attributes of the alternatives j . This model shows the joint distribution of the latent membership (first part)

and the choice probability (second part); the probability to choose a specific port service over the other options offered in the choice set. The parameters, λ , α , and β are to be estimated. Dividing the coefficient β estimated for an attribute A by β of another attribute B yields the relative value of attribute A . If attribute B is the price, this ratio is the WTP of attribute A : for instance, the WTP for reduced port handling time.

4.4 Results

In the LCM membership equation, we used all of the variables listed in Table 2. To reduce the perception variables to a manageable number, we ran a factor analysis on all statements about documentation and other food standards, as well as statements about port infrastructure. One factor had an eigenvalue greater than one in both cases. As a result, we reduced the questions about these two issues to one variable each. These two variables are referred to as *Documentation and standards* and *Port efficiency*.

The model selection was done based on Akaike's Information Criteria (AIC) and the Bayesian Information Criteria (BIC). In both cases, the minimum value is achieved for two membership classes, as shown in Fig. 8 in the appendix. Therefore, we proceed with the model with two homogeneous classes. Table 4 displays the maximum likelihood estimator coefficient estimates for the service quality attributes and class membership determinants.

According to the model, roughly two-thirds of the firms belong to class 2. The estimated coefficients for membership classes 1 and 2 indicate that the participating firm's choices are heterogeneous. The magnitude of the coefficient estimates for the service quality attributes in the upper part of Table 4 demonstrate this. For instance, all of the attribute coefficients of firms classified as class 2 are statistically significant. The price coefficient is, as per theory, negative but all other coefficients are positive. On the other hand, three coefficient estimates for firms classified in class 1 are statistically insignificant. Only the coefficient estimate for a reduction in spoilage risk is negative and statistically significant implying that firms in this membership class preferred the options with no change in spoilage risk. The coefficient estimates for the service quality attributes must be interpreted in relation to the coefficient estimate for the attribute price.

We compute the class-specific WTP for the service quality product attributes using the coefficient estimate of Table 4. Table 5 displays these estimates. All WTP estimates are insignificant for firms that are classified as class 1. Meanwhile, class 2 firms have a positive WTP for all three service quality attributes. These firms would be willing to pay an additional 21.8% and 25.6% to reduce port handling time. In addition to that, they would be willing to pay 12.3% more to reduce the risk of spoilage.

Furthermore, the estimated coefficients of the membership equation, as shown in the lower part of Table 4, indicate that preference heterogeneity across firms is driven by firm characteristics and the firm's sector, but less by the firm's business and export experience or previous experience with shipment rejection at the border

Table 4 LCM regression results

	Class 1	Class 2
Price	-0.0952 (-1.58)	-1.367*** (-32.36)
-1 Day handling time	-23.49 (-0.99)	52.21*** (25.64)
-2 Days handling time	-0.794 (-0.58)	35.03*** (42.39)
-50% Risk of spoilage	-2.447*** (-2.85)	16.88*** (28.32)
<i>Membership variables</i>		
Production	0.541 (0.64)	
Fish	2.016* (1.94)	
Business experience	-0.0181 (-0.33)	
Export experience	0.0426 (0.75)	
Firm size	-0.772** (-2.42)	
Vegetable	1.185** (2.05)	
Association	0.517 (0.84)	
Access cold storage	0.153 (0.26)	
Access dry storage	0.473 (0.75)	
Own truck	1.259** (2.05)	
Border rejection	0.263 (0.40)	
Partner rejection	-0.0143 (-0.02)	
Port efficiency	0.0179 (0.05)	
Documentation and standards	-0.570 ⁺ (-1.42)	
Costs	-0.335** (-2.33)	
Multiple buyers	0.156 ⁺ (1.32)	
Importance of lead time	0.196 (1.26)	
(N = 1071)	0.32	0.676

Table 4 (continued)

z statistics in parentheses; $^+ p < 0.2$ $^* p < 0.1$, $^{**} p < 0.05$, $^{***} p < 0.01$
Fruit is base category

Table 5 Willingness-to-pay estimates

WTP for	Class 1	Class 2 (%)
-1 Day handling time	ns	21.8
-2 Days handling time	ns	25.6
-50% risk of spoilage	ns	12.3

Presented are only estimates with $p < 0.01$

ns is not significant

or by the business partner. Marginal effects cannot be provided because the class membership is latent. Therefore, only the sign and the significance level of the coefficient estimate are critical in the membership equation. Accordingly, firms that export fish and vegetables are more likely to be in class 1, whereas firms that export fruits are more likely to be in class 2. Besides, several firm characteristics have a significant impact on class membership. For instance, class 1 membership decreases with firm size and increases with truck ownership. Furthermore, firms with access to multiple buyers are more likely to be members of class 1, whereas firms that see export bureaucracy and standards as an impediment to exports are less likely to be members of class 1. Interestingly, firms that find service costs are adequate are more likely to be members of class 2, which includes firms that value port service quality.

Although, most firms are classified as class 2, our findings show preference heterogeneity across firms. For instance, fish and vegetable exporters are more likely to belong to class 1 and thus have less interest in improved port service quality. There are several explanations for this finding. First, the likelihood of a border rejection of vegetables and fish is insensitive to the exporting time. Indeed, previous border rejections of these products were related to poor pesticide management on farms (vegetables) and certification issues (fish). Second, the quality of vegetable and fish exports may be related to the access to cold storage rather than port service quality. The specific attributes included in the choice experiments, in this case, may not have addressed the relevant service quality components for vegetable and fish exporters. In addition to that, vegetables are currently primarily air-shipped. The findings regarding the importance of firm characteristics are consistent with the theoretical model's predictions. For example, truck ownership lowers the cost of lead time delays, and thus, the WTP for a reduction in handling time is higher for firms that must rent trucks. Larger firms export in greater quantities are capable of increasing their marginal revenue, and thus the equilibrium quantity, which is required for the intersection of MC^{**} and MR^{**} ; the new MC and MR . Smaller firms, on the other hand, are constrained by supply and demand, and may not yet reap the benefits of improved service quality through increasing MR . In addition to that, additional costs for improved service quality could be an entry barrier to the export market for these firms. This is supported by the fact that class 2 firms predominantly stated that the

port service costs are adequate. The final intriguing finding is that firms willing to pay for improved service quality are less likely to be able to choose between multiple buyers at the destination and are more likely to regard documentation and standards as an impediment. Again, sectoral differences can explain this. For instance, exporting firms in sectors with oligopsonistic structures, that is a small number of buyers, have limited power to influence trade bureaucracy and buyers' quality standards, and thus, improving quality is the only way to increase export quantities.

Our findings are generally consistent with the existing literature. Our survey results confirm the importance of NTMs and associated export bureaucracy in light of Africa's limited agri-food export capacity. We also confirm the importance of lead time for agri-food exports with firm-level data, as demonstrated by Djankov et al. (2010) and Freund and Rocha (2011). Although we are the first to provide WTP estimates for improved port service quality, our findings are broadly consistent with those of Kareem et al. (2022). We specifically show a relationship between export lead time and the likelihood of (border) rejection. Similarly to Kareem et al. (2022), we find heterogeneity across sectors. Finally, we agree with the findings by Sakyi et al. (2021) that seaport efficiency and service quality are important to African exporters.

5 Discussion and conclusion

This study examines the constraints on Ghana's agri-food exports. We analyze the importance of an exporting country's export infrastructure, particularly port efficiency and service quality, to comply with food standards. We present a stylized theoretical model in which exporting firms are willing to pay for improved port service quality as long as the *MR*, derived from a lower likelihood of (border) rejection exceeds the *MC* for improved service quality. We use primary data collected from 120 Ghanaian agri-food exporters to test the model's predictions.

The survey data show that agri-food exporters in Ghana have significant administrative costs that account for one-third of the fob price. Furthermore, descriptive statistics support the relevance of certification/standards, documentation, and port service quality in the export decision. Our empirical findings from a conjoint-based discrete choice experiment show that the majority of exporting firms have a positive WTP for a reduction in port handling time and spoilage risk due to inadequate handling at the port. These findings indicate that Ghana's exporting firms link port service quality to their cost structure, specifically the likelihood of a shipment being rejected at the border or by a business partner. Overall, firms appear to value the reduction in handling time more than the reduction in spoilage risk. However, we should note that not all firms expressed a WTP to improve service quality. This is because service quality varies across sectors (different products) and firms. Certain agricultural products, for example, do not raise food safety concerns at all, or they are unrelated to port handling, storage, and processing time. Likewise, the likelihood of border rejections may depend on the specific export destination.

Previous research, particularly Kareem et al. (2022), has shown that inadequate border and logistics measures, delays in export clearance, the number, time, and costs required for export documentation, shipment quality, and inspection rate all contribute to the rejection of African agri-food exports at the border and by business partners at the destination. Therefore, our findings lend support to the idea that food standard compliance is influenced not only by high food safety and quality standards at the destination but also by inefficient port service quality and limited export infrastructure in the exporting country.

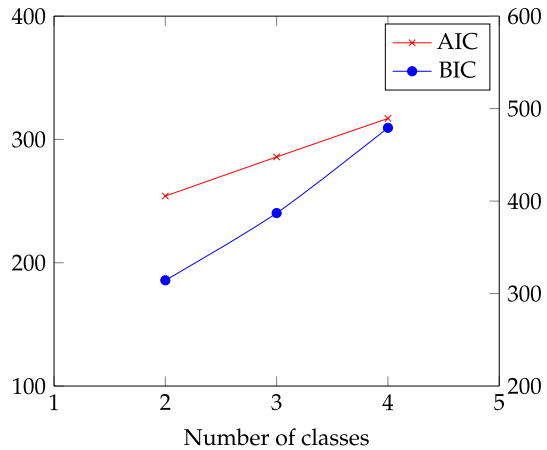
Our findings also lend credence to the literature arguing for trade facilitation as a means of increasing African agri-food exports. A high lead time to export, particularly for perishable products, was identified as a barrier to agri-food exports Djankov et al. (2010). Investing in better port infrastructure, more terminals, cold and dry storage facilities, and additional personnel to expedite inspections and handling has the potential to reduce lead time. However, trade facilitation measures must go beyond simply shortening lead times. For example, border rejections of Ghanaian vegetable exports due to high residue levels were primarily related to improper pesticide use at the farm level, rather than to lead time. Supporting farmers in export sectors with extension services that include integrated pest and disease management, which will reduce pesticide and other chemical use, has the potential to solve quality issues in both the vegetable and fruit sectors. Finally, testing facilities to monitor pesticide residues and laboratories facilitate experimentation with chemical treatment of fruits to make recommendations for chemical spraying for uniform color and delayed ripening (degreening). Other than trade facilitation in the exporting country, the high transaction costs associated with agricultural trade need to be tackled by harmonizing international food standards, for instance by relevant provisions in PTA (Santeramo & Lamonaca, 2022b). Given the challenges created by multiple and overlapping trade rules governed by different PTAs, it is also essential to address the reform of international food standards and NTMs at the global level (Jafari et al., 2023).

There are several limitations associated with this study. First, the study focuses on the demand side of port service quality while ignoring current supply-side constraints to improve service quality. Given the infrastructural limitations prevalent in many LMICs, this must be considered in future studies. Second, the choice situation in the experiment, on which the WTP estimates are based, is hypothetical, and thus additional evidence from revealed preference studies is required to support our findings. Finally, in relation to the previous two points, we did not analyze actual trade flows or food standards but instead relied solely on data provided by the exporting firm.

Appendix 1: Supplementary figures

See Fig. 8.

Fig. 8 Model selection based on AIC and BIC



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Data availability The data and codes that support the findings of this study are available from the corresponding author upon reasonable request.

Declarations

Conflict of interest The authors declare that no conflict of financial or non-financial interests exist.

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