



The determinants of export promotion in Africa: evidence from the implemented trade facilitation measures

Olayinka Idowu Kareem¹

Accepted: 10 December 2024

© The Author(s), under exclusive licence to Springer-Verlag GmbH Germany, part of Springer Nature 2024

Abstract

The export flow bottlenecks impact the extensiveness and intensiveness of Africa's exports to its trade partners. These bottlenecks are influenced by supply chain disruptions, administrative inefficiencies, quality infrastructure deficiencies, customs procedures' inefficacies, a proliferation of trade documentation, etc. The preponderance of these bottlenecks brought to the fore the need to improve exports through trade facilitation policies. Several trade facilitation measures have been implemented with different export outcomes. Nevertheless, the opportunities characterising the implementation of trade facilitation measures have provided the necessary impetus for many African countries to embark on export promotion. This study investigates the determinants of the implemented trade facilitation measures in Africa from the perspective of extensive and intensive margins of exports. An augmented gravity model derived from Helpman, Melitz and Rubenstein's framework is adopted in this study to a panel of 54 African countries between 2005 and 2018. The findings indicate that export-facilitating quality infrastructure such as telephone, internet services and time to import and export determine the improvement in export facilitation at the extensive and intensive export margins. An improved implementation of these quality infrastructures, except for the exporting time, propels the probability of export; while they enhance the trade intensity, except for internet service usage. Although the robustness checks also suggest somewhat similar outputs, the logistics performance index indicates that though there are challenges in Africa's quest for improved trade facilitation, the implemented export-facilitating quality infrastructures are export-enhancing.

Keywords Export promotion · Trade facilitation measures · Export · Gravity model · Africa

✉ Olayinka Idowu Kareem
Olayinkaidowu.kareem@uni-hohenheim.de; olayinkaidowuus@yahoo.com

¹ Agricultural and Food Policy, University of Hohenheim, Stuttgart, Germany

1 Introduction

The importance of trade facilitation in enhancing trade, especially for African countries, cannot be overemphasized. Most of the empirical studies in this area suggest the trade-improving potentials and benefits of trade facilitation (Hoekman and Shepherd 2015; Sakyi and Afesorgbor 2019). Many of the studies have focused on the trade volume and/or value impact of trade facilitation (Safaeimanesh and Jenkins 2021; Sakyi et al. 2017). The knowledge of different strands of literature is important to the understanding of the extent to which trade facilitation reforms and/or improvement can enhance trade for the existing traders at the intensive trade margin. Moreover, it is also essential to know and understand the extent to which trade facilitation or its reforms could stimulate and expand the export base and increase the number of potential traders as well as propel the decision to enter import and export markets (extensive margin of trade).

Considering the traffic of the empirical studies in this area, only Portugal-Perez and Wilson (2008) and Seck (2016) are seen to have investigated the impact of trade facilitation at both the extensive and intensive margins of trade. However, Portugal-Perez and Wilson (2008) used cross-sectional global trade data for Africa, which differs from the panel data used in this study. Besides, Persson (2013) only investigated trade facilitation at the extensive margin of export. The scarcity of empirical studies in both trade margins tends to inhibit evidence-based policy decisions at expanding trade volume (trade base) and the number of traders (importers and exporters) because of inadequate empirical evidence to stimulate and enhance trade flows between and among trade partners. This study bridges this gap by investigating both the extensive and intensive margins of export effects and determinants of the trade facilitation implementation using the lens of the soft and hard export-promotion quality infrastructure measures.¹ The extensive margin of export is the propensity, probability and/or decision to export by new exporters, export of new products from existing exporters, export of new products to new export markets and reappearing to the export markets by the disappearing exporters due to the trade costs. The intensive margin of export is the actual volume or value of export. The export-promotion quality infrastructures are vital for the facilitation of export and the sustainability of the quality of the export goods.

However, studies in the literature often measure trade facilitation with costs and time of the trade, the required number of trade documentation and time spent to finalise the documentation. Attention has not been focused on the importance of the trade-promotion quality infrastructure in facilitating trade; hence, this study departs from previous studies by using export-promotion quality infrastructure measures. The importance of this study has been brought to the fore during

¹ Quality infrastructure measures are the tangible (automated ports, modern laboratories, certification facilities, highways, etc.) and intangible (policy, customs management, accreditors, inspectors, etc.) required for the implementation and facilitation export.

this post-COVID-19 pandemic period because of the need for Africa to improve its exports and the income therein to ameliorate some of the adverse effects of the COVID-19 pandemic and other internal shocks. This necessitates the investigation of the impact of the implemented export facilitation measures on Africa's exports. This shed light on the avenue to which the ease of exporting and provision of export-promotion quality infrastructure stimulate the decisions of prospective and potential as well as actual exporters. Hence, this study investigates the determinants and effects of the implemented trade facilitation measures in Africa.

Furthermore, evidence has shown that despite the importance of this issue to trade proliferation and regional integration in Africa, only scanty empirical studies are targeted toward the continent (Seck 2016; Sakyi et al. 2018). The scanty evidence-based and policy-oriented research studies on Africa are amazing despite the increasing glamour in the international trade development circle and within Africa about the importance of improving the ease of trading in the continent (Kareem and Wieck, 2022). Jordaan (2014) opined that the empirical literature on trade facilitation is limited. Although some other non-empirical studies exist on this issue in Africa (Sithole 2021), however, they engaged in normative narratives. Besides, the only accessible Africa-focused study that has investigated the trade effects of trade facilitation at the extensive and intensive margins of trade (Portugal-Perez and Wilson 2008; Seck 2016), though informative, applied limited trade facilitation measures. Further, the majority of the African-related studies concentrated on trade facilitation reforms in the empirical strategy. However, the indicator(s) used to measure the reforms in trade facilitation is (are) nominal trade facilitation variable(s) without distilling the reform(s) (Sakyi and Afesorgbor 2019; Portugal-Perez and Wilson 2008). Africa's participation in international trade potentially provides opportunities for reducing the level of unemployment and poverty and enhancing the tendency of the attainment of sustainable development. This study distills the determinants of Africa's export promotion through the lens of the implemented trade facilitation measures at extensive and intensive margins. Besides, this study departs from using only logistic measures of trade facilitation, by combining both the logistics indicators with export promotion quality infrastructure measures in an augmented firm heterogeneity and selection model.

1.1 Review of the literature

The issue of trade facilitation has become topical in the literature and international trade fora and/or discourse owing to its impact on all economic agents not only in developing economies but at the regional and global levels. Trade facilitation measures are increasingly seen as the essential impetus to expand trade and government revenue in developing countries, especially when it is broadly viewed to incorporate transportation, distributional and communication issues. Milner et al. (2008) identify the types of trade reforms that could address the issue of trade facilitation and deliver a return in terms of increased revenue collection efficiency, reduction in

trade costs and promotion of greater regional cooperation. Moreover, trade facilitation reforms in a country have been acknowledged by Jordaan (2014) as not only the determinant of its trade but also the reforms in its trade partners, while there is economic growth potential in the provision of adequate institutional structure through increased trade among countries. More so, the trade facilitation reforms have been linked to productivity, competitiveness, export performance and diversification growth by Beverelli et al. (2015), Spence and Karingi (2011) and Portugal-Perez and Wilson (2010).

The adoption of trade facilitation policies to improve the ease of trading and trade flows (Iwanow and Kirkpatrick, 2007), particularly in Africa, could act as a catalyst for the provision and availability of quality infrastructure, which increases economic activities, trade flows, aggregate output, economic growth and development (Sakyi et al. 2017; Shepherd 2017; Marti et al. 2014; Moïsé and Sorescu 2013). The improvement in trade facilitation potentially enables countries that are not in the global value chains (GVC) to be integrated and those operating within the GVC to strengthen their connectivity with others (Shepherd 2016; Hoekman and Shepherd 2015). Further, the implementation of trade facilitation reforms has been investigated to have distribution welfare, poverty and inequality effects in many countries, especially in Africa (Beverelli et al. 2023; Hoekman and Shepherd 2015; Viet 2015). Hoekman and Shepherd (2015) demonstrated the existence of large potential welfare benefits of trade facilitation; however, a salient enquiry lies in the distribution of the benefits.

Most of the extant literature on this issue concentrated on developing countries, particularly Africa (Portugal-Perez and Wilson 2009; Iwanow and Kirkpatrick 2007; Hoekman and Shepherd 2015; Sakyi et al. 2017; Beverelli et al. 2023). This is because of their inadequate, inefficient and/or deficiencies in trade facilitation policies and practices, especially the ease of trading measures, policies, regulations and quality infrastructure, which impact the transit time, trade costs and the benefits therein. Besides, some challenges such as the duplication of duties of the trade regulatory agencies, institutional trade documentation and enforcement and high risks and costs of the trading environment affect African trade facilitation. Hence, African firms often face difficult challenges in the course of trading, especially when compared to their counterparts in developed countries (Seck 2016). The preponderance of African trade facilitation barriers and the inadequate transformation of the trade facilitation measures for better trade flows have necessitated and/or motivated empirical studies in the literature. Portugal-Perez and Wilson (2009) provide the context with which we can understand how trade facilitation and the lowering of trade costs are germane for Africa given the fact that its costs are higher than other regions. Siziba (2016) mapped the main *de jure* and *de facto* trade barriers faced by companies in the course of doing business in Southern Africa, while Eberhard-Ruiz and Calabrese (2018) determine how the increased trade facilitation affects the trucking services' prices in East Africa.

Furthermore, the findings of many of the African-oriented studies indicate that the implementation, improvement, or reformation of trade facilitation is

trade-enhancing (Iwanow and Kirkpatrick 2007; Eberhard-Ruiz and Calabrese 2018; Beverelli et al. 2015; Spence and Karingi 2011; Sakyi et al. 2017; Seck 2016). This assertion is premised on the fact that the peculiarity of Africa being characterised by high risk, high costs and deficiencies in trade-oriented quality infrastructure is mitigated through the provision of enabling trading platforms and a trade governance environment. However, scanty empirical studies find an adverse trade effect of trade facilitation measures. For instance, Francois and Manchin (2007) found a negative effect of soft infrastructure, government and regulatory intervention, which was more in high-income countries than in low-income countries in the North–South trade. Similarly, Shepherd's (2016) findings show that trade facilitation did not impact GVC but rather the expansion and intensification of economic activity, especially in low-income East African countries. Also, Siziba (2016) concluded that only regional integration rather than trade facilitation will enable the Southern African Development Community (SADC) to achieve the benefits that would turn it into a real economic powerhouse. Besides, Lee and Kim (2012) empirical results indicate that there was an insignificant relationship between trade facilitation and trade at the intensive margin.

The focus of many of the extant empirical studies on African trade facilitation is in the context of Africa's aggregate trade with the world (Akinkugbe 2006; Seck 2016; Portugal-Perez and Wilson 2009; Sakyi and Afesorgbor 2019; Shepherd and Wilson 2008; Safaeimanesh and Jenkins 2021; Portugal-Perez and Wilson 2008). Some of the studies explored the subregional countries and/or regional economic communities' trade data either at the aggregate or firm levels (Siziba 2016; Safaeimanesh and Jenkin 2021; Eberhard-Ruiz and Calabrese 2018), while a few used country-level trade data (Portugal-Perez and Wilson 2012; Jordaan 2014). Moreover, these extant studies adopted different research strategies to investigate trade facilitation in the context of Africa (Moïsé and Sorescu 2013; Persson 2013; Portugal-Perez and Wilson 2009; Shepherd 2016). The gravity model was adopted in many of the studies (Jordaan 2014; Seck 2016; Iwanow and Kirkpatrick 2007; Portugal-Perez and Wilson 2009); studies such as Persson (2013), Portugal-Perez and Wilson (2012) and Safaeimanesh and Jenkins (2021) used model simulations, while other econometrics models were adopted in other studies (Akinkugbe 2006; Shepherd 2017; Sakyi et al. 2017; Spence and Karingi 2011; Eberhard-Ruiz and Calabrese 2018). Besides, many of these studies explored the empirical analysis at the intensive trade margin (Safaeimanesh and Jenkins 2021; Sakyi et al. 2017; Portugal-Perez and Wilson 2009; Iwanow and Kirkpatrick 2007; Eberhard-Ruiz and Calabrese 2018; Hoekman and Shepherd 2015) or the extensive trade margin (Beverelli et al. 2015; Persson 2013) or both (Seck 2016; Lee and Kim 2012).

This study extends the frontier of knowledge by exploring the quality infrastructure-oriented trade facilitation indicators to depart from the common trade logistics measures (time and costs of import and export, trade documentation, etc.) of trade facilitation in the literature. Besides, it investigates the effects of

trade facilitation on the decision and/or probability of export, which gave the basis for consideration of zero trade data that has been acknowledged to embed relevant information (Melitz 2003; Helpman et al. 2008) that could influence trade. More so, the empirical strategy adopts the extensive and intensive margins of trade effects of the trade facilitation using panel data, which is yet to be explored in the literature, except for Seck (2016) which used a different model, dataset and countries' coverage.

2 Material and method

The empirical strategy in this study is derived from the theoretical framework of Helpman et al. (2008)—HMR. This framework provides the basis for the simultaneous empirical modelling of the extensive and intensive margins of trade (two-stage selection model) and presents theorems that can essentially be used to evaluate frequent trade data regularities. The 'new' new trade theory provides the theoretical basis for the consideration of firm heterogeneity as implemented in HMR. This necessitates the importance of considering the issue of non-trading firms (zero trade values) in international trade analysis. The elimination or truncation of zero trade data and adding a constant to the zero-trade data lead to sample selection bias whenever the zero elimination is not randomly done. HMR modifies Heckman's (1979) procedure which rectifies the sample selection bias and specification error with non-random data by applying the model to heterogeneous firm-level trade data while controlling for the sample selection bias and non-random zero trade. HMR asserts that selection bias occurs whenever only actual trade is considered without considering the non-trade countries. Moreover, there is vital information in the zero bilateral trade data preponderance for the modelling of gravity equations as this indicates the presence of selection biases and provides vital information—the reasons countries are not trading. Non-consideration of zero trade data will lead to an inadequate understanding of patterns and structure of bilateral trade. The identification of the country-pairs bilateral trade flows asymmetric, the regularity of zeroes in trade outcomes and the generality of a good fit of gravity model are the three high frequencies in trade data that are considered in this framework (Santos Silva and Tenreiro 2009).

This HMR framework postulates estimation bias whenever only positive trade flows are considered in trade relations. Besides, it asserts that most standard gravity models are characterised by symmetry, which is inconsistent with the trade data and thus leads to biased estimations. To mitigate these biases, the HMR model considers positive and zero trade flows between or among trading countries and derives estimation procedures that make use of available information in the dataset of trading and non-trading countries. HMR scaled up Anderson and van Wincoop's (2003) gravity model by developing an estimable two-stage sample selection equation of

the impact of trade policy on trade at the extensive and intensive margins of trade² in line with the Melitz (2003) model. The HMR model presents firms' heterogeneity in the country's industry while arguing that any model of firms' level export effects of trade policy without consideration for the heterogeneity of firm and zero trade would be liable to selection bias. The significance of this two-stage gravity model has been enunciated by Ferro et al. (2013), Munasib and Roy (2013), Kareem (2016) and Kareem (2022).

Thus, to model the decision to export and/or probability to export—extensive margin of trade—HMR gave the assumptions of normality and homoscedasticity. This framework defines the indicator variable as T_{ij} , which equals 1 when country j exports to i and 0 otherwise. The probability that country j exports to i is ρ_{ij} is conditional on the observed variable.³ A probit equation is specified as follows:

$$\rho_{ij} = Pr(T_{ij} = 1) = \Phi\left(\frac{\gamma_0 + \xi_i + y_i - \gamma d_{ij} - k\phi_{ij}}{\sigma_{u+v}}\right) \quad (1)$$

where $\Phi(\cdot)$ is the cumulative distribution function (CDF) of the unit-normal distribution, σ_{u+v} indicates the standard deviation of $(U_{ij} + V_{ij})$, d_{ij} is the natural logarithm of trade costs, γ and k are the parameters, ξ_i is the importer fixed effects, y_i is the exporter fixed effects, while ϕ is the country-specific fixed trade costs. The selection equation is derived from the firm-level decision, which does not include the unobserved and endogenous variables that are associated with the fraction of exporting firms. However, consistent estimates of the unobserved and endogenous variables are derivable from the probit equation. The HMR estimates the bilateral trade flows of the country pairs through the specification of a consistent estimation equation that controls for both the endogenous number of exporters and the selection of the country pairs into trading partners. The structural equation is specified as follows:

$$M_{ij} = \beta_0 + \lambda_j + \chi_i - \gamma d_{ij} + \ln\left\{\exp\left[\delta\left(z_{ij}^* + \varsigma_{ij}\right)\right] - 1\right\} + \mu_j \quad (2)$$

where $\varsigma_{ij} = (u_{ij} + v_{ij}/\sigma_{u+v})$ and $\sigma = \sigma_{u+v}(k - \varepsilon + 1)/\varepsilon - 1$, z_{ij}^* is the latent variable divided by the standard deviation; u_{ij} is the error term. This theoretical framework also departs from Heckman's (1979) selection model with the inclusion of the latent variable to correct the biases generated from the unobserved firm-level heterogeneity. Heckman's model is only valid where there is no heterogeneity among firms or where the heterogeneity is not related to the decision to export. Moreover, the Heckman selection model does not consider the potential relevance of trade facilitation and/or trade policy measures and country characteristics that could impact the share of export firms. It is on this basis that HMR augmented the Heckman model with firm-level heterogeneity.

² Extensive margin of trade is the probability of new firms/exporters to access the export market, while the intensive margin is the volume/value of trade.

³ See Helpman et al. (2008) for full detail.

Despite the novelty of HMR to the frontier of knowledge, some concerns were raised concerning the specification of the model. Santos Silva and Tenreiro (2009)—hereafter SST—critic the HMR model on the identification of potential specification issues. SST argued that the approach employed by HMR to deal with the selection bias caused by eliminating the observations with zero trade is only approximately correct. They opined that the model and the associated estimator relied on the untested distributional assumption, which is not supported by HMR data. More so, SST posits that the results of HMR two-stage estimation methods are very sensitive to the presence of heteroscedasticity. SST concludes that there were possibilities that the HMR model might be misspecified, which motivated them to specify an augmented HMR model with the inclusion of additional regressors. However, irrespective of the limitations of HMR, SST asserts that HMR is still reasonably accurate in many empirical studies and practical situations.

However, the limitations of HMR as identified by SST have been resolved by Porojan (2001) who made several attempts to deal separately with heteroscedasticity. Besides, in the presence of heteroscedasticity, estimating with the least square is no longer efficient and this estimation problem can be resolved by controlling for heteroscedasticity. This could be done through the use of the Feasible Generalized Least Square (FGLS) estimation technique (Martinez-Zarzoso 2013). It was argued that the retransformation of the models is no problem when errors are linear, normal and homoscedastic. Also, Baser (2007) posits that if errors are normally distributed, then a transformation can still be applied to account for any form of heteroscedasticity.

To this end, this study applies the augmented HMR model to test the null hypothesis that the implemented export-facilitating quality infrastructure measures determine export flows. We specify the reduced form of the HMR two-step equation as follows:

$$T_{ijt} = \beta_1 + C_{ijt}\vartheta + \pi E_{ijt} + \alpha TFM_{jt} + \varepsilon_{ijt} \quad (3)$$

$$V_{ijt} = \beta_2 + \pi TFM_{jt} + C_{ijt}\vartheta + \varphi \sigma_{ij} + \tau_{ij} + \varepsilon_{ijt} \quad (4)$$

where T_{ijt} is a binary variable that equals 1 if export from country i to j at time t is nonzero; otherwise, it is 0, and V_{ijt} is the actual export value from country i to j at time t . The intercepts are β_1 and β_2 ; C_{ijt} is a vector of pair-varying control variables such as the economic size of the trade partners measured by the gross domestic product (GDP) and distance for the baseline estimations. E_{ijt} is the exclusion variable that does not enter the second-stage regression; τ_{ij} is the unobserved firm heterogeneity—the number of firms exporting from country i to j , which can be zero—and σ_{ij} is the inverse Mills ratio from the first-stage selection equation. The trade facilitation measures in the equations are the TFM_{jt} . The trade facilitation measures or variables for the baseline estimations are exporting and importing time, internet provision and telecommunication. In the robustness check estimations, the per capita GDP of the trade partners and common colony are included as control variables. Also, exporting and importing time, telecommunication, internet provision, logistics

performance index, trade and transport quality infrastructure and customs efficiency are used as the trade facilitation variables. The first stage (Eq. 3) is a probit model while the second stage (Eq. 4) is estimated with the FGLS technique, which corrects for any heteroskedasticity in standard errors and any potential endogeneity issue.

The HMR first stage presents the decision to export to the market, that is, the probability, propensity and/or tendency of a new country exporting to the market, which is known as the extensive margin of export. The intensive margin of export refers to the actual volume, magnitude, or value of exports and it is the second stage of the model. Also, the intensive margin considers the selection into trade flows, which is obtained from the extensive margin of export with the inclusion of the inverse Mills ratio (IMR) as a regressor. This IMR is extracted from the first stage (probit regression) and used as a regressor in the second stage to correct possible selection bias that can be induced by firms' heterogeneity. The IMR is measured as the ratio of the probability density function to the cumulative density function of the normal distribution, which is expressed at the predicted outcomes divided by the probit estimation's standard error. Furthermore, an exclusion variable or restriction is said to be an instrumental variable that impacts the outcome variable indirectly. It is a variable that affects the outcome through another variable that directly affects the outcome. The exclusion restrictions are identifying restrictions that perform causal inference by exploiting the presence of variables that have a causal effect on the treatments but not a direct causal effect on the outcomes (Van den Berg 2007). Hence, there is a high correlation between the exclusion variable and the probability of export and not necessarily correlated with the magnitude of exports. Language is used as an exclusion variable in the model, which is used in the selection estimation (see Helpman et al. 2008).

The data for the estimations are sourced from the United Nations Conference for Trade and Development Statistics, which provides data on the economic size—the gross domestic products (GDPs)—the trade statistics are from the World Integrated Trade Solution of the World Bank, the trade facilitation variables are from the World Bank World Development Indicator and language and distance are from the CEPII. The average trade facilitation performance index⁴ used in the robustness check is sourced from Beverelli and Ticku (2022). The data point for the model estimation estimations covers the period from 2005 to 2018 for 54 African countries trading bilaterally with 184 countries across the globe.⁵

The models' estimation strategy involves a gradual inclusion of the regressors based on the prevalence and/or common variables used in different models in the previous studies and the novelty measures/variables—export-facilitating quality infrastructure—inclusion in the estimations in this study. This is to show whether

⁴ The index is the average of the Organization for Economic Cooperation and Development's (OECD) eleven developed trade facilitation indicators (information availability, involvement of the trade community, advanced rulings, appeal procedures, fees and charges, documents, automation, procedures, internal border agency cooperation, external border agency cooperation and governance and impartiality).

⁵ See the Tables 6 and 7 in the Appendix for the list of countries included in the estimations.

Table 1 Extensive margin of export

Variable	Estimation 1	Estimation 2	Estimation 3
Distance	− 1.0957*** (0.0010)	− 1.0026*** (0.0000)	− 1.0028*** (0.0060)
Africa GDP	7.6632*** (0.0000)	8.7931*** (0.0000)	8.0825*** (0.0000)
Importer GDP	2.8765*** (0.0000)	2.7421*** (0.0000)	2.8041*** (0.0000)
Exporting Time	2.1475*** (0.0030)	1.6240*** (0.0170)	2.4821*** (0.0010)
Importing Time	− 1.1598** (0.0520)	− 0.9417*** (0.1200)	− 1.1876** (0.0590)
Telecoms	0.8663*** (0.0000)		0.6710*** (0.0020)
Internet Usage		0.5637*** (0.0000)	0.3393* (0.0650)
Language	9.1164*** (0.0000)	7.9968*** (0.0000)	9.0973*** (0.0000)
Constant	− 447.7195*** (0.0000)	− 490.8392*** (0.0000)	− 463.6728*** (0.0000)
Wald Chi ²	518.64*** (0.0000)	441.33*** (0.0000)	455.28*** (0.0000)
Observation	89,838	88,757	88,214
Remoteness_Exporter	7.5743*** (0.0000)	8.5842*** (0.0000)	7.9298*** (0.0000)
Remoteness_Importer	2.6404*** (0.0000)	2.5109*** (0.0000)	2.5646*** (0.0000)

Source: Estimated. Note: All variables are in the logarithm forms except the dummy and index variables. The standard errors have been corrected for heteroscedasticity and are presented in parentheses. The Wald Chi-square in parentheses is the probability value. The significant variables are denoted by the *, ** and *** at 10, 5 and 1 per cent significance levels, respectively. The trade facilitation measures are included gradually from estimations 1 to 3

the inclusion of the novelty export facilitation measures makes an empirical-oriented policy difference from the regular variables' estimations. Although it would have been preferable to specify Eqs. 3 and 4 with the importer and exporter time fixed effects, however, the possible estimation issues that might arise by combining these fixed effects with the trade facilitation variables (some of which are time-invariant) have prevented the use of the fixed effects. Hence, three different model estimations are performed in the baseline estimations, as can be seen in the tables of results (Tables 1 and 2); however, four estimation columns are presented for the robustness checks because of an additional tariffs-inclusive estimation column (estimation1 in Tables 3 and 4). The trade facilitation measures are gradually introduced from estimations 1 to 3 in Tables 1 and 2 as well as Tables 3 and 4 (estimations 2–4) to disentangle the impact of the included variables, particularly those that are not often used in the literature. The last model estimation (estimation 3 in the baseline estimations

Table 2 Intensive margin of export

Variable	Estimation 1	Estimation 2	Estimation 3
Distance	− 1.7351*** (0.0000)	− 1.7211*** (0.0000)	− 1.3950*** (0.0060)
Africa GDP	− 0.7451*** (0.0000)	− 0.8636*** (0.0000)	− 0.9605*** (0.0000)
Importer GDP	1.3230*** (0.0000)	1.3062*** (0.0000)	1.1373*** (0.0000)
Exporting Time	− 0.6404*** (0.0000)	− 0.5762*** (0.0000)	− 0.6418*** (0.0000)
Importing Time	− 0.1431*** (0.0000)	− 0.3056*** (0.0000)	− 0.3158*** (0.0000)
Telecoms	− 0.2155*** (0.0000)		0.0758*** (0.0000)
Internet Usage		− 0.1987*** (0.0000)	− 0.2250*** (0.0000)
Inverse Mill Ratio	0.0894*** (0.0000)	0.0896*** (0.0000)	0.0827*** (0.0000)
Constant	40.4298*** (0.0000)	46.8349*** (0.0000)	56.8179*** (0.0000)
Wald Chi ²	1333193.0*** (0.0000)	4609882.0*** (0.0000)	2116773.0*** (0.0000)
Observation	57,899	57,899	57,899
Remoteness_Exporter	− 1.5402*** (0.0000)	− 1.6771*** (0.0000)	− 1.8048*** (0.0000)
Remoteness_Importer	0.0822*** (0.0000)	0.0630*** (0.0000)	− 0.1059*** (0.0000)

Source: Estimated. Note: All variables are in the logarithm forms except the dummy and index variables. The standard errors have been corrected for heteroscedasticity and are presented in parentheses. The Wald Chi-square in parentheses is the probability value. The significant variables are denoted by the *, ** and *** at 10, 5 and 1 per cent significance levels, respectively. The trade facilitation measures are included gradually from estimations 1 to 3

and estimation 4 in the robustness check) is the focus estimation that is discussed because all the variables are included. The extensive margin of export (the probability to export) estimations are based on semi-elasticities regressions (level-log model) while log–log regressions are estimated for the intensive margin of export.

3 The results and discussion

The results of the determinants and effect of export facilitation measures on the decision and/or probability to export to the rest of the world are shown in Tables 1 and 3, while that of the intensive margin of export is presented in Tables 2 and 4.

Extensive margin The prospective African exporters that want to explore new global markets, export new products, or reappear in the global export markets after

Table 3 Extensive margin

Variable	Estimation 1	Estimation 2	Estimation 3	Estimation 4
Distance	− 7.8428*** (0.0000)	− 1.7994*** (0.0000)	− 1.7987*** (0.0000)	0.1610*** (0.0020)
Africa GDP	0.1764 (0.4130)	0.7722*** (0.0000)	0.7726*** (0.0000)	0.0291 (0.3620)
Importer GDP	1.1642*** (0.0000)	1.2147*** (0.0000)	1.2147*** (0.0000)	0.1306*** (0.0000)
Africa GDPPC		− 0.0137 (0.7160)	− 0.0140 (0.7100)	− 0.2319*** (0.0010)
Importer GDPPC		0.0672*** (0.0040)	0.0672*** (0.0040)	− 0.1563*** (0.0000)
Exporting Time	15.4453*** (0.0000)	− 0.6287*** (0.0000)	− 0.6384*** (0.0000)	0.8345*** (0.0010)
Importing Time	− 22.3010 (0.0000)	0.0881 (0.4380)	0.0938 (0.4100)	− 0.5796** (0.0100)
Telecoms		− 0.2782*** (0.0000)	− 0.2753*** (0.0000)	0.5700*** (0.0000)
Internet Usage		0.0098 (0.4510)	0.0102 (0.4340)	0.0237 (0.5130)
Logistics_Perf_Index		0.1524*** (0.0070)	0.1965*** (0.0120)	0.3083 (0.3260)
QI_Trade&Transport			− 0.0511 (0.4160)	− 0.3150 (0.2160)
Customs efficiency				− 0.1279 (0.6740)
Common colony		0.7963*** (0.0000)	0.6752*** (0.0000)	0.5828*** (0.0000)
Language		0.5026*** (0.0000)	0.7768*** (0.0000)	5.7621*** (0.0000)
Tariffs	1.2310*** (0.0000)			
Constant	101.6175*** (0.0000)	− 24.3315*** (0.0000)	− 24.3380*** (0.0000)	− 1.9694* (0.0750)
Wald Chi ²	13,961.31*** (0.0000)	10,822.18*** (0.0000)	10,823.45*** (0.0000)	111.54*** (0.0000)
Observation	10,556	19,080	19,080	19,932
Remoteness_Exporter	0.4800*** (0.0230)	5.8293*** (0.0000)	6.0037*** (0.0000)	6.1783*** (0.0000)
Remoteness_Importer	− 1.4014*** (0.0000)	2.0678*** (0.0000)	2.0256*** (0.0000)	2.0770*** (00.0000)

Source: Estimated. Note: All variables are in the logarithm forms except the dummy and index variables. The standard errors have been corrected for heteroscedasticity and are presented in parentheses. The Wald Chi-square in parentheses is the probability value. The significant variables are denoted by the *, ** and *** at 10, 5 and 1 per cent significance levels, respectively. Tariff is included in estimation 1 with the trade facilitation measures as estimated in estimation 3 but many of the measures were unidentified and dropped. The trade facilitation measures are included gradually from estimations 2 to 3

Table 4 Intensive margin

Variable	Estimation 1	Estimation 2	Estimation 3	Estimation 4
Distance	− 2.1195*** (0.0000)	− 1.6918*** (0.0000)	− 1.6910*** (0.0000)	− 1.6910*** (0.0000)
Africa GDP	0.4222*** (0.0000)	0.7833*** (0.0000)	0.7937*** (0.0000)	− 0.7821*** (0.0000)
Importer GDP	3.3410*** (0.0000)	1.2483*** (0.0000)	1.2483*** (0.0000)	1.2483*** (0.0000)
Africa GDPPC	0.1867*** (0.0000)	− 0.0162 (0.6630)	− 0.0166 (0.6550)	− 0.0158 (0.6700)
Importer GDPPC	0.1117*** (0.0000)	0.0898*** (0.0000)	0.0898** (0.0000)	0.0899*** (0.0000)
Exporting Time	− 0.9897*** (0.0000)	− 0.6312*** (0.0000)	− 0.6419*** (0.0000)	− 0.6469*** (0.0000)
Importing Time	0.4288*** (0.0000)	0.0830 (0.4610)	0.0893 (0.4290)	0.0970 (0.3930)
Telecoms	0.0486 (0.1990)	− 0.2916*** (0.0000)	− 0.2885*** (0.0000)	− 0.2900*** (0.0000)
Internet Usage	− 0.3457*** (0.0000)	0.0105 (0.4210)	0.0109 (0.4010)	0.0115*** (0.3780)
Logistics_Perf_Index	1.1074*** (0.0000)	0.1532*** (0.0070)	0.2018*** (0.0100)	0.2326*** (0.0140)
QI_Trade&Transport	0.0728 (0.2670)		− 0.0562 (0.3700)	− 0.0465 (0.4750)
Customs efficiency	− 0.6229*** (0.0000)			− 0.0406 (0.5670)
Common colony	1.2392*** (0.0000)	0.8661*** (0.0000)	0.8661*** (0.0000)	0.8655*** (0.0000)
Tariffs	− 0.5535*** (0.0000)			
Inverse Mill Ratio	3.5224*** (0.0000)	0.4819*** (0.0000)	0.4824*** (0.0000)	0.4828*** (0.0000)
Constant	− 103.3330*** (0.0000)	− 26.6840*** (0.0000)	− 26.6918*** (0.0000)	− 26.6727*** (0.0000)
Wald Chi ²	1,202,072.0*** (0.0000)	11,400.84*** (0.0000)	11,402.79*** (0.0000)	11,410.76*** (0.0000)
Observation	3,169	19,080	19,080	19,080
Remoteness_Exporter	− 0.3143*** (0.0010)	9.3477*** (0.0000)	9.6869*** (0.0000)	8.5015*** (0.0000)
Remoteness_Importer	2.1723*** (0.0000)	2.6456*** (0.0000)	2.5534*** (0.0000)	2.5273*** (0.0000)

Source: Estimated. Note: All variables are in the logarithm forms except the dummy and index variables. The standard errors have been corrected for heteroscedasticity and are presented in parentheses. The Wald Chi-square in parentheses is the probability value. The significant variables are denoted by the *, ** and *** at 10, 5 and 1 per cent significance levels, respectively. The trade facilitation measures are included gradually from estimations 2 to 3 while estimation 1 includes tariffs with other trade facilitation measures as estimated in 3

disappearing due to their exporting incapacitation find the distance a significant hindrance or a barrier to engage in exporting. The probability of export is hindered by 1.00 for every per cent in distance to the export market, which simply indicates a constant rate of change between distance and the probability of export, which affirms Baldwin and Taglioni (2007) proposition. The African GDP significantly motivates prospective African exporters to either decide to export to new countries, export new products, or re-enter the abandoned export markets. This implies that the probability of exporting had been influenced by the economic size of the continent, indicating for every one per cent increase in GDP, the probability of export increased by 8.01. This could be due to the export promotion drives of many countries and the request made by the Comprehensive African Agricultural Programme (CADDP) for countries to spend 10% of the budget on agriculture.

Moreover, African trading partners' GDP, which deals with the absorptive capacity or export demand, significantly enhanced the decision to export such that for every per cent rise in the GDP, the probability to export increased by 2.80. The implication of this is that the aggregate output level that determines the standard of living in the trading partners' countries—which correlates with the extent to which the export would be demanded—significantly influences the decision to export to the market.

Furthermore, Table 1 also shows that exporting time has a direct relationship with the probability of export such that a reduction in the number of days to export significantly decreases the probability of export by more than double (2.48). This implies that the probability of exporting is significantly influenced by the efficacy level of exporting services provided at all stages of exporting. The result means that prospective exporters often prefer to export to different markets and explore different products whenever much time is taken to export, which will give them room to manipulate the system of enforcing exporting regulations and laws to their exporting advantage. However, as the exporting procedures become efficient, the institutions' enforcement levels are strengthened and reduce the time spent in exporting, the room to circumvent the system is no longer available, and the export decision is reduced for prospective exporters engaging in such acts. While Persson (2010) finds that the reduction in export time increases the number of differentiated and homogeneous products, Seck (2016) affirms that the reduction in the time spent by senior management dealing with public regulations decreased the probability of export which aligned with this study's result. Moreover, Portugal-Perez and Wilson (2009) find higher time and costs of exporting and importing (doing business indicators) to impede the propensity to trade.

Telecommunication and internet usage as hard-quality infrastructure indicators of the export facilitation measures present the same impacts but differentiated significant levels. While a per cent improvement in mobile telecommunication usage significantly increases the Africans' probability of exporting to the globe by 0.67, an increase in the level of internet usage is significant (at a 10% confidence level) to the probability of exporting by 0.34 for every per cent rise in

internet usage. This means that the presence of mobile telecommunication to support businesses through mobile-oriented business-to-business (B2B) or business-to-customers (B2C) has been motivating the decision to export. Part of the reason for this is that it is easier to make a call directly to the business partners for feedback on possible export opportunities than using the internet. This is in tandem with Seck (2016) who found the use of telecommunication to propel the decision to export. However, internet usage stimulates potential exporters to enter the exporting market, though there are preferences for direct calls to the trading partners. The prospective exporters find it more convenient and cost-saving to engage in e-commerce, e-transaction and/or e-exporting with their trade partners across the globe, which enhances the probability or possibilities to engage in exporting.

The common language significantly stimulates the probability of export. That is, prospective exporters are often motivated to export whenever they common language with the trade partners. This gravity model control variable is in tandem with the a priori expectation and, hence, depicts the fact that this extensive margin of export (the probability to export) is enhanced by ninefold for every trading partner with a common language. Thus, common language is a relevant and significant determinant at this extensive margin of export.

Intensive margin Table 2 estimations present the effects of the export facilitation measures on the actual level of Africa's exports to the globe. It shows that exports are significantly and adversely impacted by the distance between the trading partners. The African exporters are adversely affected by the distance to their trading partners owing to the trade and/or transaction costs incurred in the course of exporting such that a per cent increase in the distance led to exports plummeting by about 1.40%. The implication of this is that distance still matters in actual Africa's export to the globe, which could be due to the inadequacies in the provision and adoption of soft and hard quality infrastructure such as digital trading systems and telecommunication that will enhance e-Commerce/e-trading, blockchains, B2B, B2C, etc., which reduce the impact of distance on exporting.

The economic size of Africa has not been used to facilitate export across the globe, especially in the agricultural and real sectors owing to the proliferation of natural resources exports in most of the natural resource-endowed countries. The increase in African GDP did not reflect and translate to improved exports such that for every per cent rise in GDP, Africa's global exports plummeted by 0.96%. The implication is that the African export sector has not been given adequate priority, in terms of adequate budgetary allocations that could facilitate improved export performance, despite the African Union Commission's directive through the New Partnership for African Development's Comprehensive African Agricultural Development Programme that countries should allocate 10% of their budget to agriculture.

However, the economic size and the absorptive capacities of the importing countries to demand exports significantly propel Africa's exports such that the exports increase by more than 1.12% for every per cent increase in importing countries' GDP, which conforms with Baldwin and Taglioni (2007) golden rule. This indicates

that the trading partners' economic sizes stimulate the intensity of Africa's exports. This among others is due to the increasing standard of living, especially in the Quad countries, Canada, the EU, Japan and the USA (Africa's traditional trade partners), and the increase in the economic activities of the partners that propel more commodities demand from Africa, especially the extractive commodities that are used in industries.

Furthermore, it is discovered that the soft quality infrastructure measures have direct effects on Africa's exports, which presents the fact that the design, implementation, monitoring and enforcement of these soft quality infrastructure policy measures enhance export intensity outcomes. For instance, the time to export and import at all ports of exit and entry significantly propels exports by 0.64% and imports by 0.32% for every one per cent reduction in exporting and importing time, respectively. This implies that the various export facilitation policies put in place in Africa to ease exporting procedures, especially the reduction in the export documentation requirements, strengthening of trade governance institutions, etc., have somewhat increased port efficiencies and thereby propelled the intensity of export. Many African countries including Algeria, Nigeria, South Africa, Angola, Equatorial Guinea, Kenya, Egypt, Morocco, Ghana and Benin Republic have improved their business regulatory environment and ease of doing business through the reduction in export documentation and procedures, which thereby plummet the time and costs of exporting. While Francois and Manchin (2007) find an adverse effect of soft infrastructure and Seck (2016) finds that a decrease in the time spent on public regulations' documentation enhances the exports of firms in Africa, Portugal-Perez and Wilson (2009) find higher time and costs of exporting and importing to reduce the volume of traded goods.

In terms of the hard export-facilitating quality infrastructure measures, the increasing number of mobile telecommunication usage did significantly and directly impact the intensity of exports. The results indicate the actual level of export increased by 0.08% as the number of mobile telecommunication usage increased by a per cent, which confirms Seck (2016), though he got a larger impact magnitude. The impact magnitude means that though African access to mobile telecommunication has risen in recent years, the intensity of its inclusivity across all strata of society and the quality of the services provided needs to be strengthened. Besides, the strength of the connectivity, costs of usage and undue deduction from users' accounts have contributed to the low magnitude of its impact on exporters' intensive ability to use the services for comprehensive export transactions, which gave credence to the adverse effect of distance—the exporting costs. Hence, although mobile telecommunication is considered exporting cost-efficient, it could be used to stimulate and strengthen African exporters' digital exporting or export transactions such as exporter-to-exporter (E2E), exporter-to-importer (E2I) and exporter-to-logistics firms (E2L); the service provided needs to be improved to enhance the magnitude of its direct impact.

However, it is shown in Table 2 that exporters find the usage of internet services as transaction inefficient such that the intensity of export plummeted by 0.22% as the internet usage for trade transactions rose by a per cent. This implies that the proliferation of internet service providers in Africa has not significantly propelled e-commerce such as E2E, E2I and E2L, which adversely affected export performance.

This impact of internet service usage could be attributed to the inappropriate quality of the service provided by the internet service providers and the low bandwidth of the internet services, which impact export performance.

3.1 Robustness check

The tweaking of the regressors in the baseline estimations is made in this section to ascertain whether similar or different results are obtained. Besides, this section analyses the models' sensitivity to different regressions and shows whether the estimations are sensitive to changes in the variables. In this robustness check, some export facilitation-quality infrastructure measures—logistics performance index, trade and transport quality infrastructure and customs efficiency—and control variables such as the per capita income common colony and tariffs of the trading partners are included at both the extensive and intensive margins of export. The inclusion of tariffs in the probit regression (estimation 1), in several scenarios, makes the model unidentified, and many of the export facilitation-quality infrastructures' variables were dropped in the regression. The adjustment of the regressors as estimated gives a somewhat resemblance to the baseline extensive and intensive margins regressions (Tables 1 and 2). The estimations in Table 3—for the extensive margin of export—indicate that the inclusion of these variables has altered some estimated variables' coefficients, especially in Estimation 4. For instance, the distance has become significantly positive in estimation 4 while the African GDP is now statistically insignificant. Besides, the export impact of internet usage has become insignificant. Also, it is observed that the magnitudes of the coefficients of the regressors are sensitive to rejigging of the regressors. The rejigged regressors have made the impact magnitudes of the variables decrease owing to the inclusion of some soft and hard quality infrastructure measures. The inclusion of tariffs (estimation 1) gives a resemblance output to similar variables in estimation 4, in terms of the degree of associations.

However, in terms of the sensitivity of Table 4—the robustness of intensive margin of export results—to the modification and/or rejigging of the baseline estimations' regressors, this study finds that virtually similar degrees of associations of the regressors are obtained. The magnitudes of the regressors in the robustness check estimations (estimations 2–4) hover around the baseline regressions' coefficients, which indicate that the regressors in the robustness estimations are also appropriate measures of the export facilitation measures. Moreover, it shows the importance of considering the hard and soft export-facilitating quality infrastructure in the empirical analysis of the implemented trade facilitation, especially in the context of export promotion. Further, though the inclusion of tariffs gives somewhat similar findings, in most cases, the impact magnitude and significance levels differ.

Furthermore, to ascertain whether the inclusion of a trade facilitation index developed by OECD gives similar results or otherwise, a new sensitivity scenario is introduced to the robustness check. This entails the inclusion of the OECD average

Table 5 Estimations using the trade facilitation performance index

Variable	Extensive margin	Intensive margin
Distance	− 0.0193 (0.1428)	− 2.1318*** (0.1637)
Africa GDP	− 0.3277 (1.2742)	1.8573 (1.5747)
Importer GDP	1.1417*** (0.4583)	3.0672*** (0.7073)
Africa GDPPC	0.4696* (0.2844)	− 0.8744** (0.3771)
Importer GDPPC	− 0.2449*** (0.0720)	0.3172** (0.1433)
Exporting Time	0.9239* (0.5304)	− 1.1567 (0.8432)
Importing Time	− 1.6803*** (0.5615)	1.4121*** (1.0355)
Telecoms	− 0.3848 (0.4037)	1.1178* (0.5998)
Internet Usage	− 0.3146 (0.2692)	0.5492** (0.3493)
Logistics_Perf_Index	1.0963 (0.7952)	− 2.3100* (1.2390)
QI_Trade&Transport	− 0.4511 (0.4279)	1.7454*** (0.6584)
Customs efficiency	− 0.6492 (0.5763)	0.4684 (0.8445)
Common colony	0.2816 (0.2629)	0.7955** (0.3410)
Language	0.6030*** (0.1936)	
Tariffs	− 0.0357 (0.1403)	− 0.5657*** (0.1418)
TF_Performance Index	0.5631 (0.4242)	− 0.5562 (0.6273)
Inverse Mill Ratio		0.7098** (0.3789)
Constant	− 24.9856 (63.0415)	− 160.4231** (75.3803)
Wald Chi ²	64.89*** (0.0000)	601.56*** (0.0000)
Observation	684	633
Remoteness_Exporter	− 1.9574** (1.2102)	1.0366 (1.5087)
Remoteness_Importer	0.9574** (0.4502)	2.0640*** (0.6663)

Source: Estimated. Note: All variables are in the logarithm forms except the dummy and index variables. The robust standard errors are presented in the parentheses. The Wald Chi-square in parentheses is the probability value. The significant variables are denoted by the *, ** and *** at 10, 5 and 1 per cent significance levels, respectively

trade facilitation performance index⁶ (TF_Performance Index) among the regressors. Given the unavailability of many of the time series for this index for the study's coverage period (2005–2018)⁷ in the OECD database, except for 2017, the index data is instead sourced from Beverelli and Ticku (2022) which has the index temporal variation for 2012, 2015 and 2017. Table 5 presents the results of the inclusion of the average trade facilitation performance index, which indicates the sensitivity of the slopes and significancies of some of the variables to the index inclusion. For instance, distance, Africa's GDP, telecommunication and internet usage have become insignificant, while their slopes, except for distance, have also changed at the extensive margin of export. At the intensive margin, changes also occurred either in the slopes or significance of Africa's GDP, import and export time as well as in internet usage. The impact of the average trade facilitation performance index is insignificant at both export margins because of the deficiencies in the adoption and implementation-in-practice of the trade facilitation reforms in many African countries, which was affirmed by OECD (2023).⁸

4 The conclusion

The contemporariness of the issues of export promotion through trade facilitation policies, especially for Africa and other developing emerging countries, and its implication for sustainable development have been acknowledged and reiterated in the literature. Government strategic policies, programmes and/or interventions influence the extent of trade facilitation and the mitigation of the challenges to trade flows from the producers to consumers and the export markets. The facilitation of trade along the supply chains, trade corridors and borders could geometrically stimulate economic activities, which would have distributional effects, particularly for the producers, consumers, and income earners. The associated benefits and/or opportunities (particularly the rise in economic activities which will propel export growth and diversification with the reduction in trade costs which thereby propel national outputs) that are embedded in the facilitation of trade have stimulated many African countries to follow the path of facilitating trade, particularly after the operationalisation of the WTO Trade Facilitation Agreement. It was hypothesised that the full implementation of trade facilitation measures in Africa would enhance exports and plummet trade costs with

⁶ It is the average of the eleven trade facilitation indicators developed by OECD (<https://www.compa-reyourcountry.org/trade-facilitation/en/1/DZA/AGO/default>).

⁷ OECD data on trade facilitation indices are only available for 2017, 2019, and 2022 which do not match with the dataset used in the estimation (2005–2018).

⁸ Although the implementation-in-policy of the trade facilitation indicators such as information availability, trade facilitating automation tools, streamlining of fees and charges, and advanced consultation with traders insignificantly improved the decision to export, however, the implementation-in-practice of these indicators, particularly cross-border agency cooperation, involvement of the trade community, advance ruling, and automation tools, are challenges to the intensity of export.

concomitant economic growth. Thus, this study tests this hypothesis to ascertain whether the implemented export-facilitating quality infrastructure measures determine and impact Africa's exports.

The empirical strategy adopts the augmented gravity model that is derived from Helpman, Melitz and Rubenstein's framework and compatible with the identification of country-pair bilateral trade which flows asymmetric, regularity of zeroes in trade outcomes and ensuring goodness of fit of the gravity model. The empirical findings suggest different trade facilitation implementation outcomes at both the extensive and intensive margins of export in Africa. At the extensive margin, the trade costs are inhibitors to prospective African exporters, while the economic size of the trade partners is a motivating factor for prospective exporters and/or products to new export markets. Besides, the implemented trade facilitation measures selected in this study propel African prospective exporters except for exporting time and customs efficiency (for both baseline and robustness check outputs). This implies that, though infrastructure such as telecommunication stimulates the probability of export, other core implemented trade facilitation measures are not determinants of the decision and/or probability of export. At the intensive margin of export, the trade costs (distance) impede the intensity of Africa's exports and the continent's economic size has not been used to facilitate export. Besides, the time to export and import at all ports of exit and entry, the proliferation of telecommunication usage and the improvement in the logistics performance index significantly propel exports, while customs' efficiency, internet provision and the trade and transport infrastructure are porous to be able to effectively expand export. Hence, the implemented export facilitation measures, soft and hard quality infrastructure, have differentiating impacts on Africa's exports, indicating the fact that the development, execution, monitoring and enforcement measures determine the export intensity outcomes.

Therefore, this study affirms some of the findings in the literature that unearthing the importance of trade facilitation implementation measures, especially time to export and import, information technology, tariffs and logistics services, as determinants of Africa's export. Besides, the economic size and the standard of living and/or the purchasing power of African trade partners are propellers of Africa's exports. However, the trade and transport infrastructure, customs efficiencies and the average trade facilitation performance index as implemented are not drivers of the intensity of Africa's exports. Thus, the implemented trade facilitation measures in Africa have not brought about the desired export intensity and extensiveness outcomes. Africa needs to rejig and/or repurpose its trade facilitation policy and strategic action plans to promote investment and development financing of quality infrastructures such as telecommunication services, trade and transport infrastructure and facilities that could stimulate customs efficiency to enhance export. Also, policy interventions are needed on the part of African governments to attract investors and private financing of quality infrastructure along the trade corridors and the ports.

Appendix

Table 6 Variable description and statistics

Variable	Definition	Min	Max	Source
Distance	This is measured as the distance between the most populated cities (in kilometres)	8.03	19,904.45	Centre d'Etudes Prospectives et d'Informations Internationales (CEPII)
Africa GDP	African gross domestic product (current US\$)	1.35e + 08	5.69e + 11	UNCTAD
Importer GDP	Importers' gross domestic products (current US\$)	2.18e + 07	1.87e + 13	UNCTAD
Africa GDP/PPC	African gross domestic product per capita (current US\$)	151.78	22,943.68	UNCTAD
Importer GDP/PPC	Importers' gross domestic products per capita, US\$	151.68	118,823.6	UNCTAD
Exporting Time	The required number of days to export	10	78	World Development Indicators
Importing Time	The required number of days to import	9	102	World Development Indicators
Telecoms	Subscriptions of mobile cellular per 100 persons	0.53	176.68	World Development Indicators
Internet Usage	Internet subscription per 100 persons	0	16.84	World Development Indicators
Logistics_Perf_Index	The overall logistics performance index	1.34	3.78	World Development Indicators
QL_Trade&Transport	Quality of trade and transport-related infrastructure	1.26	3.80	World Development Indicators
TF_Performance Index	This is the average of the OECD trade facilitation indicators	0.26	1.56	Organisation for Economic Cooperation and Development
Customs efficiency	Efficiency of the customs clearance process	1.28	3.61	World Development Indicators
Common colony	Common colonial affiliation; 1 for common colonizer post-1945	0	1	Centre d'Etudes Prospectives et d'Informations Internationales (CEPII)
Language	The official language; 1 for common official primary language	0	1	Centre d'Etudes Prospectives et d'Informations Internationales (CEPII)

Source: Compiled

Table 7 Importing and exporting countries in the estimations

African countries				
Algeria	Comoros	Gabon	Malawi	Sao Tome and Principe
Angola	Congo	Gambia	Mali	Senegal
Benin	Cote d'Ivoire	Ghana	Mauritania	Seychelles
Botswana	DR Congo*	Guinea	Mauritius	Sierra Leone
Burkina Faso	Djibouti	Guinea-Bissau	Morocco	Somalia
Burundi	Egypt	Kenya	Mozambique	South Africa
Cabo Verde	Equatorial Guinea	Lesotho	Namibia	South Sudan
Cameroon	Eritrea	Liberia	Niger	Sudan
CAR*	Eswatini	Libya	Nigeria	Togo
Chad	Ethiopia	Madagascar	Rwanda	Tanzania
Importing countries				
Afghanistan	Croatia	Italy	Nicaragua	Syrian Arab Republic
Albania	Cuba	Jamaica	Niger	Tajikistan
Algeria	Cyprus	Japan	Nigeria	Tanzania
Angola	Czech Republic	Jordan	Norway	Thailand
Antigua and Barbuda	Denmark	Kazakhstan	Oman	Timor-Leste
Argentina	Djibouti	Kenya	Pakistan	Togo
Armenia	Dominica	Kiribati	Palau	Trinidad and Tobago
Australia	Dominican Republic	Korea, Rep	Panama	Tunisia
Austria	Ecuador	Kuwait	Papua New Guinea	Turkey
Azerbaijan	Egypt, Arab Rep	Kyrgyz Republic	Paraguay	Turkmenistan
Bahamas, The	El Salvador	Lao PDR	Peru	Tuvalu
Bahrain	Equatorial Guinea	Latvia	Philippines	Uganda
Bangladesh	Eritrea	Lao PDR	Poland	Ukraine
Barbados	Estonia	Lebanon	Portugal	United Arab Emirates
Belarus	Eswatini	Lesotho	Qatar	United Kingdom

Table 7 (continued)

Belgium	Ethiopia	Liberia	Romania	United States
Belize	Fiji	Libya	Russia	Uruguay
Benin	Finland	Lithuania	Rwanda	Uzbekistan
Bolivia	France	Luxembourg	Samoa	Vanuatu
Bosnia and Herzegovina	Gabon	Macedonia, FYR	Sao Tome and Principe	Venezuela, RB
Botswana	Gambia	Madagascar	Saudi Arabia	Vietnam
Brazil	Georgia	Malawi	Senegal	Yemen, Rep
Brunei Darussalam	Germany	Malaysia	Serbia	Zambia
Bulgaria	Ghana	Maldives	Seychelles	Zimbabwe
Burkina Faso	Greece	Mali	Sierra Leone	
Burundi	Grenada	Malta	Singapore	
Cabo Verde	Guatemala	Marshall Islands	Slovak Republic	
Cambodia	Guinea	Mauritania	Slovenia	
Cameroon	Guinea-Bissau	Mauritius	Solomon Islands	
Canada	Guyana	Mexico	Somalia	
Central African Republic	Haiti	Moldova	South Africa	
Chad	Honduras	Mongolia	Spain	
Chile	Hungary	Montenegro	Sri Lanka	
China	Iceland	Morocco	St. Kitts and Nevis	
Columbia	India	Mozambique	St. Lucia	
Comoros	Indonesia	Myanmar	St. Vincent and the Grenadines	
Congo, Democratic Republic	Iraq	Namibia	Sudan	
Congo, Rep	Iran	Nepal	Suriname	
Costa Rica	Ireland	Netherlands	Sweden	
Cote d'Ivoire	Israel	New Zealand	Switzerland	

Source: Compiled

Acknowledgements This is to appreciate the support and encouragement of Prof. Christine Wieck, Head of Department, Agricultural and Food Policy, University of Hohenheim, Germany. Besides, I wish to thank Dr. Fatima Kareem for her technical comments and data support.

Data availability The author confirms that all data used or analysed during this study are included in this article data source under the methodology.

Declarations

Competing interests The author declares no competing interests.

References

- Akinkugbe O (2006) Trade facilitation and Africa's manufacturing goods export. *J Comp Int Manag* 9(2):3–15
- Anderson JE, van Wincoop E (2003) Gravity with gravitas: a solution to the border puzzle. *Am Econ Rev* 93:170–192
- Baldwin R, Taglioni D (2007) Trade effects of the euro: a comparison of estimators. *J Econ Integr* 22(4):780–818
- Baser O (2007) Modeling transformed health care costs with unknown heteroscedasticity. *Appl Econ Res Bull* 1:1–16
- Beverelli C, Neumueller S, Teh R (2015) Export diversification effects of the WTO trade facilitation agreement. *World Dev* 76(2015):293–310
- Beverelli C, Ticku R (2022) Reducing tariff evasion: the role of trade facilitation. *J Coop Econ* 50:534–554. <https://doi.org/10.1016/j.jce.2021.12.004>
- Beverelli C, Gourevitch I, Heiland I, Keck A, Larch L, Yotov Y (2023). Trade and welfare effects of the WTO Trade Facilitation Agreement. WTO Staff Working Paper No. ERSD-2023–04. Accessed Sept 2024
- Eberhard-Ruiz A, Calabrese L (2018) Trade facilitation, trade costs and the price of trucking services in East Africa. MPRA Paper No. 87150. <https://mpra.ub.uni-muenchen.de/87150/>. Accessed June 2023
- Ferro E, Wilson JS, Otsuki T (2013) The effects of product standards on agricultural exports from developing countries. World Bank Policy Research Working Paper 6518. World Bank, Washington D.C. Accessed June 2023
- Francois J, Manchin M (2007) Institutions, infrastructure and trade. Policy Research Working Paper No. 4152, World Bank, Washington, D.C. Accessed Oct 2023
- Heckman J (1979) Sample selection bias as a specification error. *Econometrica* 47:153–161
- Helpman E, Melitz MJ, Rubinstein Y (2008) Estimating trade flows: trading partners and trading volumes. *Quart J Econ* 123(2):441–487

- Hoekman B, Shepherd B (2015) Who profits from trade facilitation initiatives? Implications for African countries. *Journal of African Trade* 2(1):51–70
- Iwanow T, Kirkpatrick C (2007) Trade facilitation, regulatory quality and export performance. *J Int Dev* 19(6):735–753
- Jordaan AC (2014) The impact of trade facilitation factors on South Africa's exports to a selection of African countries. *Dev South Afr* 31(4):591–605. <https://doi.org/10.1080/0376835X.2014.907535>
- Kareem OI (2016) Food safety regulations and fish trade: evidence from European Union – Africa's trade relations. *J Commod Mark* 2(1):18–25. <http://authors.elsevier.com/sd/article/S2405851315300568>. Assessed October 2023
- Kareem OI (2022) Fruit safety regulations in the transatlantic region: how are Africa's exports faring with the regulations? *J Policy Model* 44(5):886–906
- Kareem OI, Wieck C (2022) Mapping agricultural trade within ECOWAS: structure and flow of agricultural trade products, barriers to trade, financing gaps and policy options". A GIZ-financed project on behalf of BMZ. <https://ageconsearch.umn.edu/record/316918?ln=en>. Accessed November 2023
- Lee H, Kim C (2012) The impact of trade facilitation on extensive and intensive margins of trade: an application for developing countries. *J East Asian Econ Integr* 16(1):67–96
- Marti L, Puertas R, Garcia L (2014) Relevance of trade facilitation in emerging countries' exports. *J Int Trade Econ Dev* 23:202–222
- Martinez-Zarzoso I (2013) The log of gravity revisited. *Appl Econ* 45(3):311–327 (**University of Göttingen**)
- Melitz MJ (2003) The impact of trade on intra-industry reallocations and aggregate industry productivity. *Econometrica* 71(6):1695–1725
- Milner C, Morrissey O, Zgovu E (2008) Trade facilitation in developing countries', CREDIT research paper No. 08/05, Nottingham, United Kingdom. Nottingham: Centre for Research in Economic Development and International Trade. Accessed Sept 2023
- Moïse E, Sorescu S (2013) Trade facilitation indicators: the potential impact of trade facilitation on developing countries trade. Trade Policy Paper 144. OECD. Paris. Accessed May 2023
- Munasib A, Roy D (2013) Non-tariff barriers as a bridge to cross. Selected Paper Prepared for Presentation at the 2013 AAES & CAES Joint Meeting, Washington D.C., August
- OECD (2023) OECD trade facilitation indicators: monitoring facilitation reforms up to 2023. <https://issuu.com/oecd.publishing/docs/oecd-trade-facilitation-update-2023>. Accessed Sept 2024
- Persson M (2010) Trade facilitation and the extensive margin. *J Int Trade Econ Dev* 22(5):658–693. <https://doi.org/10.1080/09638199.2011.587019>
- Persson M (2013) Trade facilitation and the extensive margin. *J Int Trade Econ Dev* 22(5):658–693. <https://doi.org/10.1080/09638199.2011.587019>
- Portugal-Perez A, Wilson JS (2008) Why trade facilitation matter to Africa? The World Bank Policy Research Working Group 4719, The World Bank, Washington D. C.. Accessed June 2023
- Portugal-Perez A, Wilson JS (2012) Export performance and trade facilitation reform: hard and soft infrastructure. World Bank Policy Research Working Paper 5261. Microsoft Word - Portugal-Perez.sg1_finalWP.doc
- Portugal-Perez A, Wilson JS (2009) Trade facilitation in Africa: why reform matters. *World Trade Rev* 8(3):379–416

- Porojan A (2001) Trade flows and special effects: The gravity revisited. *Open Econ Rev* 12:265–280
- Safaeimanesh S, Jenkins GP (2021) Trade facilitation and its impact on the economic welfare and sustainable development in the Ecowas region. *Sustainability* 13:164. <https://doi.org/10.3390/su13010164>
- Sakyi D, Afesorgbor SK (2019) The effect of trade facilitation on trade performance in Africa. *J Afr Trade* 6(1–2):1–15
- Sakyi D, Bonuedi I, Opoku EEO (2018) Trade facilitation and social welfare in Africa. *J Afr Trade* 5:35–53
- Sakyi D, Villaverde J, Maza A, Bonuedi I (2017) Effects of trade and trade facilitation on economic growth in Africa. *Afr Econ Dev*. <https://doi.org/10.1111/1467-8268.12261>
- Santos Silva JMC, Tenreyro S (2009) “Trading Partners and Trading Volumes: Implementing the Helpman–Melitz–Rubinstein Model Empirically”, CEP Discussion Paper No 935
- Seck A (2016) Trade facilitation and trade participation: are Sub-Saharan African firms different? *J Afr Trade* 3(1):23–39
- Shepherd B (2016) Infrastructure, trade facilitation and network connectivity in Sub-Saharan Africa. *J Afr Trade* 3:1–22
- Shepherd B (2017) Infrastructure, trade facilitation, and network connectivity in Sub-Saharan Africa. *J Afr Trade* 3(1):4. <https://doi.org/10.1016/j.joat.2017.05.001>
- Shepherd B, Wilson JS (2008) Trade facilitation in ASEAN countries: measuring progress and assessing priorities. World Bank Group Policy Research Paper Series 4615, Washington DC. Accessed June 2023
- Sithole L (2021) The role of trade facilitation in addressing the NTBs in the ACFTA. *AfronomicsLaw*, March 28. Accessed in September 2023
- Siziba C (2016) Using firm-level case studies to address trade facilitation challenges in Southern Africa. World Trade Institute Working Paper No. 01/2016/January. Accessed June 2023
- Spence MD, Karingi N (2011) Impact of trade facilitation mechanisms on export competitiveness in Africa. UNECA African Trade Policy Centre Work in Progress No 85. UNECA, Addis Ababa. Accessed June 2023
- Van den Berg GJ (2007) An economic analysis of exclusion restrictions for instrumental variables estimation. IZA DP No. 2585, January. <https://docs.iza.org/dp2585.pdf>. Accessed June 2023
- Viet NC (2015) The impact of trade facilitation on poverty and inequality: evidence from low- and middle-income countries. *J Int Trade Econ Dev* 24(3):315–340. <https://doi.org/10.1080/09638199.2014.898315>

Publisher's Note Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

Springer Nature or its licensor (e.g. a society or other partner) holds exclusive rights to this article under a publishing agreement with the author(s) or other rightsholder(s); author self-archiving of the accepted manuscript version of this article is solely governed by the terms of such publishing agreement and applicable law.