

ORIGINAL ARTICLE

Broadband use and trade facilitation: Impacts on bilateral trade of sub-Saharan countries

Margarita Billon¹  | Antonio Rodríguez-Andrés²  | Ernesto Rodríguez-Crespo¹ 

¹Department of Economic Structure and Development Economics, Universidad Autónoma de Madrid, Madrid, Spain

²Department of Economics, Faculty of Management and Technology, German University in Cairo, Al Tagamoa, Gamal Abdel Nasser, New Cairo, Cairo, Egypt

Correspondence

Ernesto Rodríguez-Crespo, Department of Economic Structure and Development Economics, Universidad Autónoma de Madrid, Francisco Tomás y Valiente, 5, Madrid 28049, Spain.

Email: ernesto.rodriguez@uam.es

Abstract

This paper investigates the direct and combined impacts of trade facilitation and information and communication technology (ICT) on bilateral flows of 25 sub-Saharan countries. For that purpose, we select time to export and import as specific trade facilitation indicators and broadband use to study ICT impacts. Our sample covers a total of 93 countries over the period 2004–2018. By preprocessing data analysis, we impute time costs missing values, an essential shortcoming of the available databases, to study trade facilitation over time. Lastly, we employ a gravity model and implement a Bonus Vetus Estimation. Our results show that broadband use exerts a positive and significant effect on trade, especially relevant for intra-African trade flows. Furthermore, the combined effects indicate that broadband also modulates the negative impacts of time to export and time to import in the case of intra-SSA countries' trade. The more significant result is found for time to export. Our results also confirm that time costs are not only particularly harmful to intra-African trade but also negatively impact trade flows from SSA countries to the rest of the world. These outcomes show the importance of coordinating trade facilitation and digital transformation policies, particularly those devoted to digitally transforming African customs.

KEYWORDS

broadband, gravity model, ICT, missing values, sub-Saharan Africa, trade facilitation

1 | INTRODUCTION

Trade facilitation and digital transformation drive economic development and integration in sub-Saharan Africa (SSA) (African Union Commission, 2015; United Nations Conference for Trade and Development, 2021). However, despite the opportunities, Africa faces fundamental challenges in these areas. Regarding trade facilitation, SSA countries show exceptionally high trade costs, particularly those associated with border and documentary compliance when importing or exporting goods. In 2020, compared to other regions on the continent, border and documentary compliance took between 31% and 77% more time in SSA countries than the global average. The cost of documentary compliance ranged from 19% to 54% above the worldwide average (World Economic Forum, 2022). Due to African trade specialization, import and export time costs rapidly affect the depreciation of traded products, increase inventory costs, and make it

This is an open access article under the terms of the Creative Commons Attribution License, which permits use, distribution and reproduction in any medium, provided the original work is properly cited.

© 2023 The Authors. *African Development Review* published by John Wiley & Sons Ltd on behalf of African Development Bank (AFD).

more difficult for companies to adapt to the demand. In addition, it negatively affects SSA countries' integration in manufacturing global supply chains ('Ofa & Karingi, 2014; Kaminchia, 2020).

One way to reduce time costs is to take advantage of information and communication technologies (ICT) and digital transformation opportunities. Both ICT use and infrastructure impact trade by reducing transaction costs (Freund & Weinhold, 2004; Vemuri & Siddiqi, 2009), facilitating access to market information and knowledge, favoring services trade and new digital developments, such as digital trade and data. At borders, ICT facilitates access to information about import and export procedures and documents, allowing traders to benefit from automated clearance systems, such as electronic document processing, e-payments, and, when available, a single window. In addition, ICT reduces time costs by speeding up customs inspections and cargo release after customs clearance. As a result, customs processes improve simplicity, predictability, and transparency at borders and ports (World Economic Forum, 2022). However, SSA countries also remain far behind much of the world regarding broadband use, connectivity, and customs' digital transformation (World Economic Forum, 2022).

Despite their relevance, the combined effects of time costs and ICT use have barely been analyzed by the academic literature. In addition, studies on SSA countries are limited, perhaps due to the lack of available data. One of the reasons might be that one of the most commonly used data sets (World Bank Doing Business Database) presents many missing values for this area. Besides, among those studies that quantitatively analyze the issue, most examine the impacts of trade facilitation measures and technology use separately. Only a few studies jointly consider both dimensions (Portugal-Perez & Wilson, 2012; Seck, 2017). However, these studies use aggregate indicators that do not allow determining the effect on trade using a specific technology or trade facilitation measure. However, defining and measuring trade facilitation indicators as precisely as possible is crucial to inform policy-making (Wilson et al., 2005). In addition, the literature has demonstrated that the results differ according to the type of technology (e.g., Rodriguez-Crespo et al., 2021) and trade facilitation measures (Djankov et al., 2010). Finally, the previous studies cover former stages of ICT diffusion with little account of recent ICT developments in SSA countries (Portugal-Perez & Wilson, 2012; Seck, 2017; World Economic Forum, 2022).

Against this background, this paper examines the impacts of time costs and ICT use, considering their direct and combined effects on SSA intra- and external trade flows. Our study contributes to the academic literature in several ways. First, in addition to the separate analysis of the direct effects of both measures, we analyze the combined impact of broadband use and time costs on trade. Second, unlike previous studies that mostly use aggregate indicators, we focus on a single technology to provide enough specificity to the analysis. Third, we investigate broadband use effects because it plays a prominent role in Africa's sustainable development and trade (Hinson & Adjasi, 2009). Besides, the available evidence shows that ICT impacts differ from one technology to another (Rodriguez-Crespo et al., 2021). To our knowledge, no studies address this type of analysis. Fourth, to overcome data constraints that would impede us from evaluating the impacts over time, we employ Honaker and King's (2010) algorithm, which exploits cross-country variation, to fill in missing values consistently. Moreover, it allows us to use panel data from 93 countries for 2004–2018, using a gravity model of bilateral trade. This period captures the most critical stage of ICT diffusion in SSA countries.

The remainder of this paper is organized as follows. Section 2 reviews the related formal literature. Next, the research model is outlined in Section 3. Section 4 shows the data and estimation strategy. In Section 5 we report our main empirical findings. Lastly, we present the key conclusions and discuss the implications of our findings in Section 6.

2 | RELATED LITERATURE

Studies exploring the impacts of trade facilitation measures on SSA countries' trade flows are limited. Using a gravity model, Wilson et al. (2005) in a sample of 75 countries for 2000–2001, which included only three African countries, investigated the effects of specific trade facilitation measures, such as port efficiency and customs environment. They obtain small gains for exporters compared to that of importers. Most recent studies have demonstrated the positive effects of aggregate trade facilitation indicators on trade performance (Sakyi et al., 2017). However, the few papers that specifically investigate the effects of time to export/import on bilateral trade find negative impacts both at the country (Djankov et al., 2010; Seck, 2016) and the firm levels (Seck, 2016; Shepherd, 2013). As for the effects of ICT use on African trade flows, the academic literature has found positive outcomes from internet use (Hinson & Adjasi, 2009) or combining it with other variables, such as institutional quality and education (Bankole et al., 2015).

Nevertheless, the prior studies do not analyze the interaction between specific trade facilitation and ICT measures. Those scarce studies that tackle this analysis employ aggregate indicators. Portugal-Perez and Wilson (2012), covering 101 countries from 2004 to 2007, find that physical and telecommunication infrastructure (hard infrastructure) and soft infrastructure (that includes border efficiency, among others) positively affect trade performance. Both indicators are complementary; the most significant impact is obtained for hard infrastructure. Seck (2017), analyzing data for only 2 years (2007 and 2012) and 41 SSA countries explores the effects of border efficiency (time and document costs) and a composite indicator for technology (e-business). When considering all commodities and destinations, he obtains positive impacts of this latter indicator only for SSA exporter countries. However, he did not report significant results for intra-African trade. Recently, Jiahao et al. (2022) explore the direct and interactive impacts of trade facilitation and institutional aggregated indexes on GDP per capita growth for 41 SSA economies from 2005 to 2019. They report positive direct effects of both the trade facilitation index and the institutional factor while confirming the positive impact of the interactive effect of both indicators on economic growth.

Regarding broadband use impacts, we expect different impacts on trade flows in different groups of countries. Differences in trade structure and specialization affect countries differently, according to the type of traded goods (Nguea et al., 2022). The empirical evidence shows that greater use of ICT relates to increased exports of more complex products (Wang & Li, 2017) since these products embed a greater degree of differentiation and sophistication. Besides, some goods are more time-sensitive (Djankov et al., 2010). Differences in telecommunications and network infrastructure may also influence the intensity and the type of broadband usage by businesses for trade purposes (Ismail, 2021). The empirical evidence proves that the effects may differ for importers and exporters and depend on the size and other firms' characteristics (large vs. small and medium-size companies) (Seck, 2016). In addition, trade environment limitations in developing countries open up more possibilities to obtain more significant benefits in terms of trade cost reduction due to broadband use at customs. Geographical barriers and distance would explain higher impacts of broadband use for African trade flows on trade logistics. Finally, differences in the diffusion process (Lechman, 2015) would explain disparities in the intensity of trade effects between developed and developing countries.

3 | RESEARCH MODEL

Our empirical approach is borrowed from an augmented gravity equation of trade rooted in Anderson and Van Wincoop (2003). Our gravity Equation (1) is log-linearized and conveniently augmented with ICT use and trade facilitation variables. The baseline model in log-linear form is shown as follows:

$$\begin{aligned} \ln X_{ijt} = & \beta_0 + \beta_1 \ln TEXP_{it} + \beta_2 \ln TIMP_{jt} + \beta_3 \ln BRB_{it} + \beta_4 \ln BRB_{jt} + \beta_5 (\ln TEXP_{it} * \ln BRB_{it}) + \beta_6 (\ln TIMP_{jt} * \ln BRB_{jt}) \\ & + \beta_7 \ln GDP_{it} + \beta_8 \ln GDP_{jt} + \beta_9 \ln DIST_{ij} + \beta_{10} LANDL_i + \beta_{11} LANDL_j + \delta_z Z_{ij} + \beta_{12} RTA_{ijt} + \beta_{13} \ln P_{it} \\ & + \beta_{14} \ln \Pi_{jt} + \varepsilon_{ijt}, \end{aligned} \quad (1)$$

where subscripts i , j , and t refer to exporter country, importer country, and time, respectively, and \ln denotes natural logarithm. X_{ijt} is bilateral exports from i to j during t . $TEXP_{it}$ and $TIMP_{jt}$ are time to export and time to import for i and j during t , respectively. BRB_{it} and BRB_{jt} refer to broadband users for i and j during t , respectively. $(\ln TEXP_{it} * \ln BRB_{it})$ and $(\ln TIMP_{jt} * \ln BRB_{jt})$ denote crossed product between trade facilitation and broadband variables for i and j during t , respectively. GDP_{it} and GDP_{jt} are GDP for i and j during t , respectively. $\ln DIST_{ij}$ is the logarithm of bilateral distance between each country pair. We also consider a vector Z_{ij} that comprises a set of bilateral variables described as follows, in line with Frankel's (1997) specification: ADJ_{ij} is a control variable that takes value 1 if both countries share a common border and 0 otherwise. $CLANG_{ij}$ takes value 1 if population in both countries shares a common language and 0 otherwise. COL_{ij} takes value 1 if both countries shared past colonial linkages and 0 otherwise. Last control variable, RTA_{ijt} , takes value 1 if both countries are engaged in a regional trade agreement and 0 otherwise. P_{it} and Π_{jt} are multilateral resistance terms (MRTs) for i and j during t , respectively. Finally, ε_{ijt} denotes the classical random term.

Following Seck (2017) and given that time costs affect the bilateral trade relationship to both exporter and importer countries, we include time to export and time to import, expecting adverse effects of both variables on bilateral trade flows. On the other hand, we expect broadband use to increase bilateral flows (Wang & Li, 2017). As for the interactive term, we anticipate an inverse relationship between both variables, time to export/import and broadband use.

We include GDP and distance since early gravity models assumed a positive relationship between trade and size but negative between trade and distance (Anderson & Van Wincoop, 2003). Being landlocked is a geographical determinant since it substantially increases countries' transport costs (Djankov et al., 2010). Concerning adjacency, this variable is strongly related to the role of distance since countries prefer to concentrate trade flows with nearby countries, given the large number of trade barriers that may dampen trade (Anderson & Van Wincoop, 2003). Colonial and linguistic ties represent the long-term effect of informal institutions on trade and are deemed to enable trade flows (Head et al., 2010). Regional trade agreements imply a reduction in trade costs, so they are included as explanatory variables assuming a positive relationship (e.g., Weidner & Zylkin, 2021). Finally, following Anderson and Van Wincoop's (2003) seminal contribution, MRT refers to the effects induced by third countries on the bilateral trade relationship between exporter and importer (e.g., trade barriers and trade policy, among others).

4 | DATA AND ESTIMATION STRATEGY

4.1 | Preprocessing data analysis

Before proceeding with the estimation of the gravity equation models, we need to discuss the issue of missing values in our data set gathered from the World Bank—Trading Across Borders.¹ Missing data is very frequent in economics, either because some variables are missing or values are missing for some observations. What is common in practice is to remove the variables or observations from the analysis or just impute them. In the current paper, we employ Honaker and King's (2010) approach, that is designed to work well with time series using cross-sectional data and can also deal with complicated features like country-year observations. Honaker and King's (2010) method is particularly attractive because its multiple imputation algorithm efficiently exploits the panel nature of the data set and makes it possible, among other things, to properly take into account the issue of cross-country heterogeneity by introducing fixed effects and country-specific time trends.

4.2 | Data and sources

Our data set comprises bilateral trade between 93 countries, among which we can find 39 high-income countries, 29 low- and middle-income, and 25 SSA economies from 2004 to 2018. Table 1 shows the list of countries.

Data are extracted from different statistical sources, such as World Development Indicators and Doing Business from World Bank or the Centre d'Études Prospectives et d'Informations Internationales (CEPII). Table 2 displays summary statistics.

Concerning Doing Business, we focus specifically on the Trading Across Borders data set, which collects a yearly questionnaire to citizens belonging to each country to know their opinions on four items: Reform update, Export Case Study, Import Case Study, and Research on Good Practices. When applicable, the methodology is recalculated for 1 year to provide consistent values and scores for the previous year that can be used for overtime comparisons.

Missing values are one of the significant issues concerning the dependent variable. In the current study, we follow Santos Silva and Tenreyro's (2006) suggestion of replacing missing values of the dependent variable with zeros.

4.3 | Consistency of trade facilitation measures

Ensuring the consistency of our trade facilitation measure drawn by the World Bank Trading Across Borders database is a crucial issue in order to deliver a proper analysis. For this reason, it is key to provide a comprehensive comparison between our indicator and others that share a similar purpose. Given our strong focus on the trade dimension, we compare our indicator with the Logistics Performance Index (LPI), a similar indicator also developed by the World Bank.²

LPI is elaborated utilizing a survey of logistics professionals from different countries. They are asked questions about the context of foreign countries in which they operate. The index is constructed using a simple average of six dimensions related to trade: (i) customs, (ii) infrastructure, (iii) ease of shipping, (iv) quality of logistics, (v) tracking and tracing, and (vi) timeliness. Time coverage includes different representative cross-sections and in relation to

TABLE 1 List of countries (93).

Algeria	Denmark	Italy	Panama	Tanzania
Argentina	Ecuador	Jamaica	Paraguay	Thailand
Australia	Egypt	Japan	Peru	Togo
Austria	El Salvador	Kenya	Philippines	Tunisia
Benin	Equatorial Guinea	Latvia	Poland	Turkey
Brazil	Eritrea	Lithuania	Portugal	Uganda
Bulgaria	Estonia	Madagascar	Russia	United Arab Emirates
Burkina Faso	Finland	Malawi	Rwanda	United Kingdom
Burundi	France	Malaysia	Saudi Arabia	United States
Cambodia	Germany	Mali	Senegal	Uruguay
Cameroon	Ghana	Mauritius	Sierra Leone	Venezuela
Canada	Greece	Mexico	Singapore	Zambia
Central African Republic	Guatemala	Mongolia	Slovakia	Zimbabwe
Chile	Honduras	Morocco	Slovenia	
China	Hungary	Mozambique	South Korea	
Colombia	Iceland	Netherlands	Spain	
Costa Rica	India	New Zealand	Sri Lanka	
Croatia	Indonesia	Nicaragua	Sudan	
Czech Republic	Ireland	Nigeria	Sweden	
Côte d'Ivoire	Israel	Norway	Switzerland	

TABLE 2 Descriptive statistics.

Variable	Observations	Mean	Standard deviation	Min	Max
X_{ijt}	129,735	1,281,520	8,605,742	0.00	4.97e+08
$TEXP_{it}$	129,735	80.07	90.46	0.50	816
$TIMP_{jt}$	129,735	105.10	136.33	0.50	1330
BRB_{it}	123,225	12.15	12.93	0.00	46.31
BRB_{jt}	123,225	12.15	12.93	0.00	46.31
GDP_{it}	128,712	6.80e+11	2.00e+12	9.15e+08	2.06e+13
GDP_{jt}	128,712	6.80e+11	2.00e+12	9.15e+08	2.06e+13
$DIST_{ij}$	129,735	7498.455	4394.46	9.56	19812.04
$LANDL_i$	129,735	0.17	0.38		
$LANDL_j$	129,735	0.17	0.38		
ADJ_{ij}	129,735	0.03	0.16		
$CLANG_{ij}$	129,735	0.14	0.35		
COL_{ij}	129,735	0.02	0.14		
RTA_{ijt}	129,735	0.24	0.42		

country coverage, the last year covered around 160 countries worldwide, showing a high degree of resemblance with the Trading Across Borders data set.

Although time and scope of LPI and our trade indicator are coherent and consistent to be compared, data is collected for separate cross-sections impeding us from making proper comparisons in the context of panel data, where we assume that countries increase their trade flows by means of improving trade facilitation over time. We also find sharp differences between countries' coverage in both data sets, since there is a substantial number of missing values.

We build on previous studies that check the accuracy of different measures and provide a scatter plot comparing target variables together with a linear prediction (Suárez-Varela & Rodríguez-Crespo, 2022). We show results in Figure 1, as follows, for the variables Time to export and LPI.

As shown in Figure 1, the linear association between both variables is negative. This can be considered consistent with the expected outcomes since further improvements in LPI are associated with better trade performance, resulting in a lower time to export. More importantly, this negative association persists for 2018 on the right-hand side. Results show that our indicator can be considered a good proxy of trade facilitation and also enable us to use it in the context of panel data.

4.4 | Estimation strategy

Panel data models give us more degrees of freedom and result in more accurate estimates. These models allow us to control for unobserved heterogeneity and reduce omitted variable bias (see, for instance, Baltagi et al., 2015). Despite the wide variety of estimators for the gravity equation in the presence of panel data, we find several methodological challenges to be tackled, among which we highlight MRT.

For gravity equations, the most feasible alternative to capture MRT adequately has been to resort to a Pseudo-Poisson Maximum Likelihood (PPML) estimator that incorporates controls for exporter and importer countries interacted with time controls (Weidner & Zylkin, 2021). However, such exporter-time and importer-time control variables are perfectly collinear with time-varying explanatory variables and other time-invariant variables that may be relevant for SSA African countries,

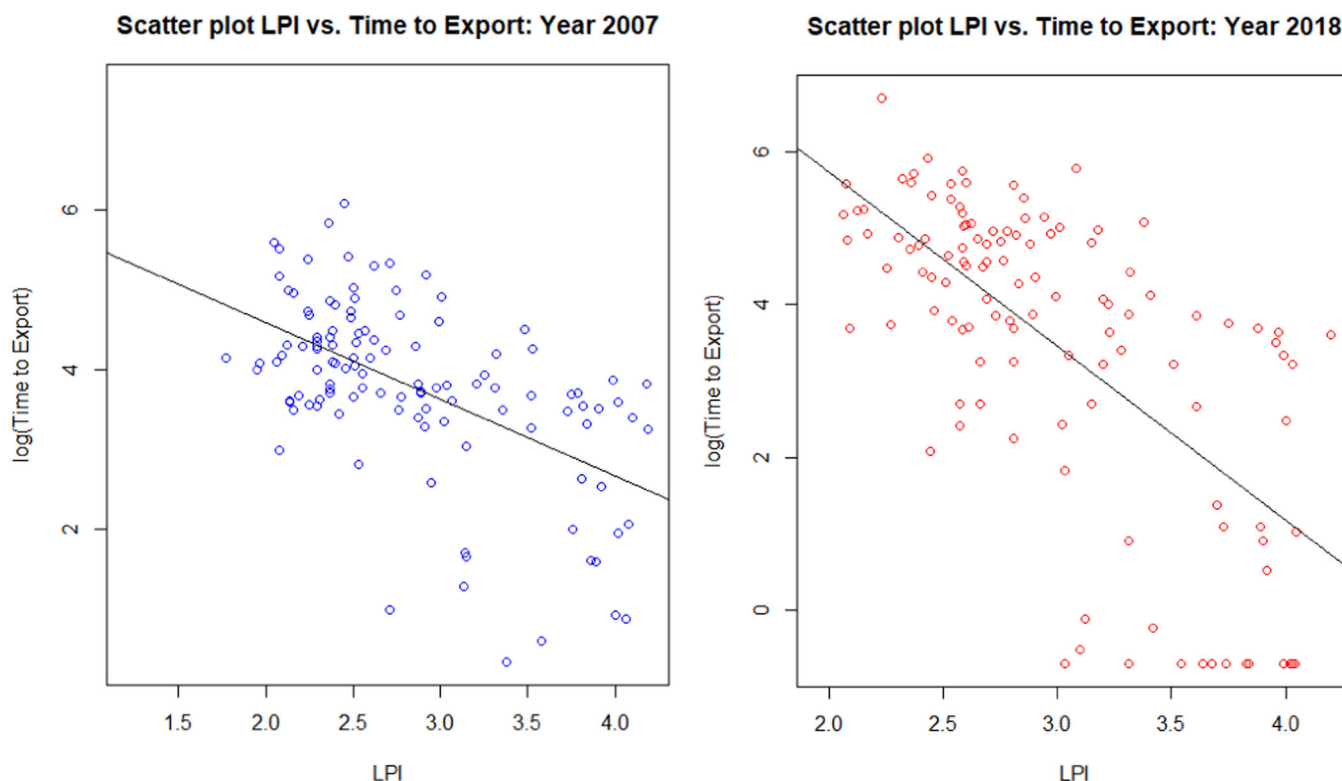


FIGURE 1 Linear prediction for time to export and LPI variables for years 2007 and 2018. Authors' elaboration using World Bank data. Both variables have been converted to a logarithmic scale.

such as being landlocked (Djankov et al., 2010). Consequently, all these variables would be dropped from the regression and cannot be considered for policy purposes, rendering an unfeasible estimation.

To overcome this problem, we follow Baier and Bergstrand (2009). They propose a new estimator named Bonus Vetus Ordinary Least Squares (BVOLS) to make gravity equations consistent with the abovementioned Anderson and Van Wincoop (2003). They depart from the OLS estimator but introduce a novelty that becomes particularly relevant. Applying a first-order Taylor expansion to all bilateral variables from trade costs makes the effect identical to the use of control variables to explain MRT. Consequently, no variable is omitted from the regression, and coefficients can be appropriately interpreted. Many scholars have applied this estimator to several contexts of international trade and have obtained consistent outcomes (e.g., Portugal-Perez & Wilson, 2012). We show Baier and Bergstrand's (2009) weighting terms in Equation (2).

$$\varnothing_{ij}^* = \left[\left(\sum_{k=1}^N \theta_k \varnothing_{ik} \right) + \left(\sum_{m=1}^N \theta_m \varnothing_{mj} \right) - \left(\sum_{k=1}^N \sum_{m=1}^N \theta_m \theta_k \varnothing_{km} \right) \right], \quad (2)$$

where i and k denote the additive terms, and θ_k and θ_m are considered as the weighting terms. Such weighting terms, which determine the final outcome of the polynomial transformation, can be constructed twofold: either through just simple averages or weighting them using countries' GDP. We follow Baier and Bergstrand (2009) and use simple averages as our baseline specification.

Equation (3) introduces this expression in Equation (1) and displays the final functional form. The main novelty is Z_{ij}^{BV} , which denotes the correction of bilateral variables in vector Z_{ij} , as Baier and Bergstrand's (2009) approximation has been applied to them. A similar procedure has been applied to transform other variables, such as $DIST_{ij}^{BV}$ and $RTA_{ij,t-1}^{BV}$.

$$\begin{aligned} \ln X_{ijt} = & \beta_0 + \beta_1 \ln TEXP_{i,t-1} + \beta_2 \ln TIMP_{j,t-1} + \beta_3 \ln BRB_{i,t-1} + \beta_4 \ln BRB_{j,t-1} + \beta_5 (\ln TEXP_{i,t-1} * \ln BRB_{i,t-1}) \\ & + \beta_6 (\ln TIMP_{j,t-1} * \ln BRB_{j,t-1}) + \beta_7 \ln GDP_{i,t-1} + \beta_8 \ln GDP_{j,t-1} + \beta_9 \ln DIST_{ij}^{BV} + \beta_{10} LANDL_i + \beta_{11} LANDL_j \\ & + \delta_z Z_{ij}^{BV} + \beta_{12} RTA_{ij,t-1}^{BV} + \varepsilon_{ijt}. \end{aligned} \quad (3)$$

In addition to Baier and Bergstrand's (2009) correction of bilateral variables, we also lag certain explanatory variables 1 year. The objective is to prevent endogeneity issues since this is a common problem when examining empirical patterns of international trade (Trefler, 1993). To this end, we acknowledge the existence of endogeneity problems between trade and trade facilitation (Portugal-Perez & Wilson, 2012), information technology (Freund & Weinhold, 2004), GDP (Anderson & Van Wincoop, 2003), and also regional trade agreements (Baier & Bergstrand, 2007).

Our strategy to deal with endogeneity issues is described as follows. As a robustness check, we resort to two well-known techniques raised by Baltagi et al. (2015) when estimating gravity models of trade using panel data: first, an instrumental variables approach by Hausman and Taylor (1981) regression, which has been successful in gravity equations to solve endogeneity problems (Vemuri & Siddiqi, 2009). This estimator applies a two-step instrumental variables regression to exogenous and endogenous variables and predicts regressors using errors. Variables are instrumented using their own individual group means. However, due to computational limitations, we acknowledge that Hausman–Taylor regression only works in the presence of time-invariant fixed effects.³ Second, we include country-pair fixed effects, which have been considered an effective way to deal with endogeneity (Weidner & Zylkin, 2021). In this strategy, unobservable determinants between explanatory variables and error term are removed. This strategy has been widely used in the academic literature covering gravity models (Baier & Bergstrand, 2007). We also take 1-year lags to explanatory variables that may be subject to potential endogeneity issues (Freund & Weinhold, 2004).

5 | RESULTS

5.1 | Main results

In Table 3, we report the results of the gravity estimation for exports from SSA economies to (i) all countries, (ii) high-income economies, and (iii) other SSA countries for the period 2004–2018. First, columns (1)–(3) present the models

TABLE 3 Bonus Vetus OLS gravity estimation for exports from sub-Saharan Africa, 2004–2018.

Exporter	(1) Sub-Saharan Africa	(2) Sub-Saharan Africa	(3) Sub-Saharan Africa	(4) Sub-Saharan Africa	(5) Sub-Saharan Africa	(6) Sub-Saharan Africa	(7) Sub-Saharan Africa	(8) Sub-Saharan Africa	(9) Sub-Saharan Africa
Importer	All	High-income	Sub-Saharan Africa	All	High-income	Sub-Saharan Africa	All	High-income	Sub-Saharan Africa
$\ln TEXP_{i,t-1}$	0.255*** (0.0240)	−0.234*** (0.0350)	−0.314*** (0.0434)				−0.220*** (0.0461)	−0.180*** (0.0668)	−0.675*** (0.0846)
$\ln TIMP_{j,t-1}$	−0.0712*** (0.00976)	−0.00655 (0.0154)	−0.192*** (0.0339)				−0.259*** (0.0215)	−0.188** (0.0856)	−0.537*** (0.0661)
$\ln BRB_{i,t-1}$				0.0300*** (0.00912)	0.0693*** (0.0138)	0.146*** (0.0174)	−0.0682 (0.0595)	−0.0913 (0.0839)	0.637*** (0.116)
$\ln BRB_{j,t-1}$				−0.0475*** (0.00960)	−0.354*** (0.0383)	0.0138 (0.0178)	−0.317*** (0.0320)	−0.518*** (0.102)	0.406*** (0.1000)
$\ln BRB_{i,t-1} * \ln TEXP_{i,t-1}$							0.0254** (0.0127)	0.0338* (0.0179)	−0.0974*** (0.0247)
$\ln BRB_{j,t-1} * \ln TIMP_{j,t-1}$							0.0452*** (0.00651)	0.0385 (0.0264)	−0.0801*** (0.0206)
$\ln GDP_{i,t-1}$	0.844*** (0.0138)	0.925*** (0.0200)	0.754*** (0.0252)	0.783*** (0.0172)	0.898*** (0.0247)	0.607*** (0.0314)	0.828*** (0.0173)	0.926*** (0.0249)	0.658*** (0.0312)
$\ln GDP_{j,t-1}$	0.999*** (0.00918)	1.040*** (0.0141)	0.453*** (0.0252)	1.089*** (0.0116)	1.108*** (0.0161)	0.380*** (0.0316)	1.101*** (0.0116)	1.111*** (0.0162)	0.428*** (0.0314)
$\ln DIST_{ij}^{(*)}$	−0.630*** (0.0338)	−0.548*** (0.0485)	−1.146*** (0.0611)	−0.687*** (0.0391)	−0.527*** (0.0554)	−1.252*** (0.0718)	−0.674*** (0.0392)	−0.548*** (0.0557)	−1.182*** (0.0711)
$LANDL_i$	−0.280*** (0.0453)	−0.405*** (0.0679)	−0.720*** (0.0617)	−0.242*** (0.0495)	−0.403*** (0.0712)	−0.806*** (0.0726)	−0.398*** (0.0510)	−0.490*** (0.0739)	−0.820*** (0.0723)
$LANDL_j$	−1.127*** (0.0301)	−0.919*** (0.0585)	−1.085*** (0.0481)	−1.106*** (0.0350)	−0.920*** (0.0649)	−1.029*** (0.0540)	−1.133*** (0.0356)	−0.886*** (0.0662)	−1.210*** (0.0550)
$ADJ_{ij}^{(*)}$	1.794*** (0.0991)		1.819*** (0.0964)	1.763*** (0.112)		1.838*** (0.107)	1.852*** (0.111)		1.839*** (0.105)
$CLANG_{ij}^{(*)}$	0.791*** (0.0378)	0.618*** (0.0612)	0.840*** (0.0554)	0.725*** (0.0423)	0.657*** (0.0647)	0.815*** (0.0633)	0.788*** (0.0423)	0.702*** (0.0668)	0.806*** (0.0622)
$COL_{ij}^{(*)}$	0.787*** (0.135)	0.890*** (0.141)		0.890*** (0.147)	0.916*** (0.153)		0.758*** (0.147)	0.873*** (0.153)	
$RTA_{ij,t-1}^{(*)}$	1.764*** (0.0576)	1.361*** (0.0950)	2.049*** (0.0753)	1.750*** (0.0641)	1.228*** (0.0978)	2.218*** (0.0858)	1.675*** (0.0640)	1.223*** (0.100)	1.975*** (0.0864)
Constant	−27.41*** (0.462)	−32.35*** (0.759)	−11.73*** (0.949)	−29.78*** (0.599)	−33.40*** (0.912)	−8.968*** (1.223)	−28.65*** (0.631)	−32.89*** (0.979)	−3.902*** (1.311)
Observations	24,480	11,493	6006	20,148	9719	4548	20,148	9719	4548
R^2	0.478	0.450	0.585	0.472	0.448	0.597	0.480	0.452	0.612

Note: The dependent variable for all columns is the logarithm of aggregate exports. Variables with (*) have been transformed in Column (5) using Baier and Bergstrand's (2009) Bonus Vetus OLS correction.

that only include time costs. Next, columns (4)–(6) report the results when we introduce only broadband use. Finally, in columns (7)–(9), we include time costs, broadband use, and the interactive term to capture the direct and interactive effects.

When we analyze the direct effects of time costs, time to export and time to import show a negative and significant impact on bilateral trade in all scenarios. Their influence is greater for intra-African trade flows showing the relevance of time delays associated with border efficiency for both African exporters and importers. However, the negative impact of time to export is more significant when SSA countries export to other SSA economies than that of time to import when importing from them (−0.314 and −0.192, respectively).

The models (4–6) suggest a positive and significant effect of broadband use at the country of origin of export in SSA in all scenarios. Moreover, the more significant coefficients for intra-African trade suggest a greater impact of broadband use on exports within the region compared to exports to the rest of the world. In particular, a one-point scale improvement in broadband use by an SSA exporting country leads to an increase in exports toward other SSA neighbors by 14.6% (3% or 6% in scenarios 4–5, respectively). However, contrary to what was expected, the results for broadband use are negative and particularly significant for high-income importer countries. This result might be hiding the influence of other factors. For example, the broadband diffusion curve in the advanced countries could have already absorbed its effects on this type of trade relationship. In addition, this sign could also relate to the different specialization patterns in trade flows between SSA and rich countries. They are probably less affected by the trade efficiency gains derived from broadband use since the academic literature has demonstrated that the impact is sector-sensitive (Seck, 2017; Wang & Li, 2017).

Finally, we present the combined effect of trade facilitation indicators and broadband use (7–9). The results for intra-African trade confirm a negative and significant coefficient for intra-sub-Saharan trade for both exporters and importers. These results suggest that increasing broadband use may moderate the negative impacts of time costs on bilateral intra-African trade. Nevertheless, in the case of the relationships between SSA countries and the rest of the world, the sign of the interactive term is positive and significant. It probably relates to the possible explanations previously given about the sign for broadband use obtained for high-income countries.

About the rest of the variables, most are in line with the expected outcomes from academic literature. GDP and distance are positive and negative, respectively, and significant for all cases. We also find that other control variables contingent on geography matter when explaining sub-Saharan African trade. Being landlocked restrains trade since the coefficient is negative and significant for both exporter and importer. For adjacent countries, coefficients are positive and significant, suggesting the importance of location to export to foreign markets. Finally, control variables for institutional inheritances, common language, and colonial linkages exhibit positive and significant coefficients. These variables are particularly relevant for the case of Africa, given the existence of a past colonial relationship with countries acting as a metropolis (Head et al., 2010).

5.2 | Robustness of estimators

Although Equation (3) solves the problem of explaining MRTs, there may exist other issues that persist unsolved. For example, as demonstrated by several studies (e.g., Santos Silva & Tenreiro, 2006), taking logarithms to trade flows originates problems contingent on missing values, non-normality of residuals, and heteroskedasticity. For this reason, as a first step, we perform several robustness checks to demonstrate that our BVOLS estimator addresses the problems mentioned above.

To this end, we compare the results with those obtained by a PPML estimator. In Table 4, we introduce several estimators: (1) PPML with exporter-time importer-time fixed effects varying every 5 years together with pair fixed effects. This strategy is very close to structural gravity, but it presents the advantage of interpreting time-varying variables without incurring perfect collinearity. In fact, it has been successfully implemented in previous studies (e.g., Martínez-Zarzoso & Márquez-Ramos, 2019); (2) PPML with fixed effects, which poses the advantage of interpreting effects for exporter and importer separately; and (3) PPML with fixed effects as in (2) but adding pair fixed effects. As mentioned, such pair-fixed effects are intended to remove endogeneity bias derived from bilateral time-invariant variables (Weidner & Zylkin, 2021). In Column (4), we include the Instrumental Variables Hausman-Taylor estimator to prove that our results are consistent with endogeneity bias in addition to the inclusion of pair fixed effects. Finally, we present our baseline BVOLS estimator in Column (5), together with a fixed effects (FE) model in Column (6). We report results of well-known specification tests in the panel data, such as Lagrange Multiplier and Hausman tests, and

TABLE 4 Robustness of different gravity estimators, 2004–2018.

Dependent variable Estimator	(1) X_{ijt} PPML	(2) X_{ijt} PPML	(3) X_{ijt} PPML	(4) $\ln X_{ijt}$ HT	(5) $\ln X_{ijt}$ BVOLS	(6) $\ln X_{ijt}$ FE
$\ln TEXP_{i,t-1}$	−0.0277*** (0.00394)	−0.0620*** (0.0151)	−0.0629*** (0.00383)	−0.0685*** (0.00602)	−0.0786*** (0.00512)	−0.0678*** (0.00605)
$\ln TIMP_{j,t-1}$	0.0165*** (0.00305)	−0.0307** (0.0147)	−0.0242*** (0.00323)	−0.0257*** (0.00493)	−0.0387*** (0.00443)	−0.0256*** (0.00495)
$\ln BRB_{i,t-1}$	0.0268*** (0.00892)	0.0514* (0.0270)	0.0531*** (0.0100)	0.0920*** (0.00594)	0.0629*** (0.00350)	0.0922*** (0.00596)
$\ln BRB_{j,t-1}$	0.0295*** (0.00676)	0.0592** (0.0281)	0.0482*** (0.00736)	0.0220*** (0.00581)	−0.0377*** (0.00357)	0.0224*** (0.00584)
$\ln GDP_{i,t-1}$	−0.0277*** (0.00394)	−0.0620*** (0.0151)	−0.0629*** (0.00383)	−0.0685*** (0.00602)	−0.0786*** (0.00512)	0.139*** (0.0200)
$\ln GDP_{j,t-1}$	0.0165*** (0.00305)	−0.0307** (0.0147)	−0.0242*** (0.00323)	−0.0257*** (0.00493)	−0.0387*** (0.00443)	0.609*** (0.0207)
$\ln DIST_{ij}(*)$		−0.222*** (0.0187)		−1.319*** (0.0291)	−0.932*** (0.00940)	
$LANDL_i$					−0.368*** (0.0177)	
$LANDL_j$					−0.499*** (0.0175)	
$ADJ_{ij}(*)$		0.913*** (0.0372)		0.895*** (0.114)	1.249*** (0.0393)	
$CLANG_{ij}(*)$		0.166*** (0.0320)		1.052*** (0.0576)	0.654*** (0.0185)	
$COL_{ij}(*)$		0.315*** (0.0257)		0.295** (0.125)	0.304*** (0.0419)	
$RTA_{ij,t-1}(*)$	0.0247 (0.0151)	0.873*** (0.0251)	0.0545*** (0.0141)	0.0128 (0.0186)	0.569*** (0.0172)	0.0166 (0.0187)
Constant	−1.324** (0.572)	−1.974 (3.179)	−6.152*** (0.582)	−0.340 (0.810)	−34.39*** (0.163)	−5.633*** (0.557)
Exporter fixed effects		X	X	X		
Importer fixed effects		X	X	X		
Year fixed effects		X	X	X		X
Exporter-time fixed effects ^a	X					
Importer-time fixed effects ^a	X					
Country pair fixed effects	X		X			
Number of observations	105,474	107,709	105,474	98,210	98,210	98,210
Adjusted R^2	0.9908	0.8958	0.9923	0.8260	0.744	0.417

TABLE 4 (Continued)

Dependent variable	(1)	(2)	(3)	(4)	(5)	(6)
Estimator	X_{ijt} PPML	X_{ijt} PPML	X_{ijt} PPML	$\ln X_{ijt}$ HT	$\ln X_{ijt}$ BVOLS	$\ln X_{ijt}$ FE
Lagrange Multiplier test (statistic)						190,000
Lagrange Multiplier test (p value)						0.0000
Hausman test (statistic)						4923.87
Hausman test (p value)						0.000
F statistic (p value)	0.000	0.000	0.000	0.000	0.000	0.000

Note: Robust standard errors in parentheses, such as *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Variables with (*) have been transformed in Column (5) using Baier and Bergstrand's (2009) Bonus Vetus OLS correction. In Column (4), we assume that broadband, time to export, and GDP at origin and destination are endogenous regressors. R^2 in Column (5) is calculated by means of $1 - [\text{Sum of Square Residuals}]/[\text{Total Sum of Squares}]$.

^aExporter-time and importer-time fixed effects are 5-years varying: they are considered as a control variable that takes value 1 for the first 5 years and the last 5 years of the sample and 0 otherwise.

results are coherent with the expected outcomes: heterogeneities across individuals are important, and a fixed effects model is preferred to a random effects model.

As shown in Table 4, coefficients do not vary when considering different gravity estimations specifications. Time costs and broadband exert a negative and positive effect, respectively, in line with the expected outcomes. The highest magnitudes are found in Column (4) for exporter countries: -0.0685 for $\ln \text{TEXP}_{i,t-1}$ and 0.0929 for $\ln \text{BRB}_{i,t-1}$, respectively. Results for the remaining gravity variables (i.e., GDP, distance, and control variables) are also in line with the expected outcomes. When considering a PPML estimation, we find the expected coefficients in line with previous studies. This fact suggests that our results are not driven by heteroskedasticity or bias from omitting MRTs, as a specification consistent with the latter has included them in Column (1). Regarding endogeneity issues, we implement two robustness analyses that yield identical results: pair effects in Column (3) and HT estimation in Column (4) show equal evidence concerning unaltered coefficients induced by endogeneity bias. Although there has been a growing discussion about the suitability of lagging variables per se to deal with endogeneity, we have performed additional specifications that solve this problem adequately. Such specifications refer not only to pair fixed effects but also to HT.

According to these robustness analyses, BVOLS can be considered an effective alternative to deal with empirical issues derived from gravity modeling, as coefficients are not altered substantially compared to those capturing multilateral resistance and dealing with endogeneity issues. For this reason, BVOLS can be selected with no hesitation as the baseline gravity estimator.

6 | CONCLUSIONS

In this paper, we investigate for the first time the impact of broadband use and time costs on SSA intra- and external trade flows, exploring both their direct and combined effects using a gravity model and panel data for 2004–2018. We overcome data constraints that would impede us from evaluating the impacts over time by applying Honaker and King's (2010) algorithm, which exploits cross-country variation, to impute missing values consistently.

Our work shows that the use of broadband has a direct positive and significant impact on SSA countries' trade with the rest of the world and, above all, on intra-African commercial relationships and exporting countries. When we analyze the direct and interactive effects in this scenario, we find a negative interaction between broadband use and time costs, higher for exporter countries. The results indicate that broadband use contributes directly to bilateral trade flows and modulates the negative impacts of time to export and time for intra-SSA countries' trade. The more significant effects obtained for broadband use for the exporter country may reflect the differences in trade specialization and other development characteristics that also affect time costs between exporters and importers. However, contrary to expected, in the bilateral flows from sub-Saharan countries towards advanced economies, we find that broadband use has a negative and significant effect on importer countries. This result might be associated with African trading patterns with advanced economies, probably less influenced by broadband usage since the academic literature has demonstrated that technology effects are product sensitive. Besides, higher levels of broadband use may

contribute to increasing market and supplier diversification in developed countries. These results confirm that broadband usage impacts different types of countries differently, probably due to differences in economic structure characteristics, institutional and trade environment, and geographical constraints, among other factors.

Our findings also confirm previous results (Jiahao et al., 2022) that time costs are not only particularly harmful to intra-African trade but also impact negatively on trade flows from SSA countries to the rest of the world. In addition, our results suggest that time barriers affecting sub-Saharan trade flows are more significant for the exporting process at the borders of origin than those faced by African products when they arrive at their destination in other developing and developed economies, in line with the results found by Seck (2017).

This study opens up new possibilities for future research. In particular, the analysis may include other types of ICTs, such as emerging ones, and other trade facilitation measures to evaluate their combined effects on SSA countries' trade performance. In addition, it would be relevant to build up a new trade facilitation measure for African countries.

Our findings emphasize the importance of implementing coordinated policies that jointly address the negative time cost impacts by reinforcing digital transformation, such as those devoted to speeding up the digital custom revolution in the context of the African Union's Agenda 2063 (African Union Commission, 2015).

ACKNOWLEDGMENTS

We thank three anonymous reviewers for their comments and suggestions, which have been helpful in improving the quality of the paper. The usual disclaimer applies.

CONFLICT OF INTEREST STATEMENT

The authors declare no conflict of interest.

ORCID

Margarita Billon  <http://orcid.org/0000-0003-4860-9133>

Antonio Rodríguez-Andrés  <http://orcid.org/0000-0001-6578-5118>

Ernesto Rodríguez-Crespo  <http://orcid.org/0000-0002-0189-3715>

ENDNOTES

¹ Available at <https://archive.doingbusiness.org/en/data/exploretopics/trading-across-borders>.

² <https://lpi.worldbank.org/>.

³ Stata command `xthtaylor`. The Hausman and Taylor's approach is an instrumental variables approach. The HT estimator is equivalent to run pooled two-stage least squares on the same data transformation required for the random effects approach with the time means of the time-varying exogenous regressors and deviations from the group means of the time-varying endogenous regressors as legitimate instruments.

REFERENCES

- African Union Commission. (2015). *Agenda 2063: The Africa We Want*. African Union, Addis Abeba.
- Anderson, J. E., & Van Wincoop, E. (2003). Gravity with gravitas: A solution to the border puzzle. *American Economic Review*, 93(1), 170–192. <https://doi.org/10.1257/000282803321455214>
- Baier, S. L., & Bergstrand, J. H. (2007). Do free trade agreements actually increase members' international trade? *Journal of International Economics*, 71(1), 72–95. <https://doi.org/10.1016/j.jinteco.2006.02.005>
- Baier, S. L., & Bergstrand, J. H. (2009). Bonus vetus OLS: A simple method for approximating international trade-cost effects using the gravity equation. *Journal of International Economics*, 77(1), 77–85. <https://doi.org/10.1016/j.jinteco.2008.10.004>
- Baltagi, B. H., Egger, P. H., & Pfaffermayr, M. (2015). Panel data gravity models of international trade. In *The Oxford Handbook of Panel Data* (pp. 608–641). Oxford University Press. <https://doi.org/10.1093/oxfordhb/9780199940042.001.0001>
- Bankole, F. O., Osei-Bryson, K. M., & Brown, I. (2015). The impact of information and communications technology infrastructure and complementary factors on Intra-African Trade. *Information Technology for Development*, 21(1), 12–28. <https://doi.org/10.1080/02681102.2013.832128>
- Djankov, S., Freund, C., & Pham, C. S. (2010). Trading on time. *Review of Economics and Statistics*, 92(1), 166–173. <https://doi.org/10.1162/rest.2009.11498>
- Frankel, J. A. (1997). *Regional trading blocs in the world economic system*. Peterson Institute for International Economics.
- F Freund, C. L., & Weinhold, D. (2004). The effect of the internet on international trade. *Journal of International Economics*, 62(1), 171–189. [https://doi.org/10.1016/S0022-1996\(03\)00059-X](https://doi.org/10.1016/S0022-1996(03)00059-X)

- Hausman, J. A., & Taylor, W. E. (1981). Panel data and unobservable individual effects. *Econometrica*, 49(6), 1377–1398. <https://doi.org/10.2307/1911406>
- Head, K., Mayer, T., & Ries, J. (2010). The erosion of colonial trade linkages after independence. *Journal of International Economics*, 81(1), 1–14. <https://doi.org/10.1016/j.jinteco.2010.01.002>
- Hinson, R. E., & Adjasi, C. K. D. (2009). The internet and export: Some cross-country evidence from selected African countries. *Journal of Internet Commerce*, 8(3–4), 309–324. <https://doi.org/10.1080/15332860903467730>
- Honaker, J., & King, G. (2010). What to do about missing values in time-series cross-section data. *American Journal of Political Science*, 54(2), 561–581. <https://doi.org/10.1111/j.1540-5907.2010.00447.x>
- Ismail, N. W. (2021). Digital trade facilitation and bilateral trade in selected Asian countries. *Studies in Economics and Finance*, 38(2), 257–271. <https://doi.org/10.1108/SEF-10-2019-0406>
- Jiahao, S., Ibrahim, R. L., Bello, K. A., & Oke, D. M. (2022). Trade facilitation, institutions, and sustainable economic growth. Empirical evidence from Sub-Saharan Africa. *African Development Review*, 34(2), 201–214. <https://doi.org/10.1111/1467-8268.12630>
- Kaminchia, S. (2020). Effect of transit road quality on trade costs in East Africa. *African Development Review*, 32(3), 316–326. <https://doi.org/10.1111/1467-8268.12441>
- Lechman, E. (2015). *ICT diffusion in developing countries*. Springer. <https://doi.org/10.1007/978-3-319-18254-4>
- Martínez-Zarzoso, I., & Márquez-Ramos, L. (2019). Exports and governance: Is the Middle East and North Africa region different? *The World Economy*, 42(1), 143–174. <https://doi.org/10.1111/twec.12633>
- Nguea, S. M., Fotio, H. K., & Baida, L. A. (2022). Investigating the effects of globalization on economic sophistication in selected African countries. *African Development Review*, 34(3), 324–338. <https://doi.org/10.1111/1467-8268.12666>
- Ofa, S. V., & Karingi, S. (2014). Trade in intermediate inputs and trade facilitation in Africa's regional integration: Trade in intermediate inputs. *African Development Review*, 26(S1), 96–110. <https://doi.org/10.1111/1467-8268.12095>
- Portugal-Perez, A., & Wilson, J. S. (2012). Export performance and trade facilitation reform: Hard and soft infrastructure. *World Development*, 40(7), 1295–1307. <https://doi.org/10.1016/j.worlddev.2011.12.002>
- Rodríguez-Crespo, E., Marco, R., & Billon, M. (2021). ICTs impacts on trade: A comparative dynamic analysis for internet, mobile phones and broadband. *Asia-Pacific Journal of Accounting & Economics*, 28(5), 577–591. <https://doi.org/10.1080/16081625.2018.1519636>
- Sakya, D., Villaverde, J., Maza, A., & Bonuedi, I. (2017). The effects of trade and trade facilitation on economic growth in Africa. *African Development Review*, 29(2), 350–361. <https://doi.org/10.1111/1467-8268.12261>
- SantosSilva, J. M. C., & Tenreyro, S. (2006). The log of gravity. *The Review of Economics and Statistics*, 88(4), 641–658. <https://doi.org/10.1162/rest.88.4.641>
- Seck, A. (2016). Trade facilitation and trade participation: Are sub-Saharan African firms different? *Journal of African Trade*, 3(1–2), 23–39. <https://doi.org/10.1016/j.joat.2017.05.002>
- Seck, A. (2017). How facilitating trade would benefit trade in Sub-Saharan Africa. *Journal of African Development*, 19(1), 1–26. <https://doi.org/10.5325/jafrideve.19.1.0001>
- Shepherd, B. (2013). Trade times, importing and exporting: Firm-level evidence. *Applied Economics Letters*, 20(9), 879–883. <https://doi.org/10.1080/13504851.2012.756574>
- Suárez-Varela, M., & Rodríguez-Crespo, E. (2022). Is dirty trade concentrating in more polluting countries? Evidence from Africa. *Economic Analysis and Policy*, 76, 728–744. <https://doi.org/10.1016/j.eap.2022.09.009>
- Trefler, D. (1993). Trade liberalization and the theory of endogenous protection: An econometric study of US import policy. *Journal of Political Economy*, 101(1), 138–160. <https://doi.org/10.1086/261869>
- United Nations Conference for Trade and Development (2021). *Economic Development in Africa Report 2021—Reaping the potential benefits of the African Continental Free Trade Area for inclusive growth*. https://unctad.org/system/files/official-document/aldcafrica2021_intro_en.pdf
- Vemuri, V. K., & Siddiqi, S. (2009). Impact of commercialization of the internet on international Trade: A panel study using the extended gravity model. *The International Trade Journal*, 23(4), 458–484. <https://doi.org/10.1080/08853900903223792>
- Wang, Y., & Li, J. (2017). ICT's effect on trade: Perspective of comparative advantage. *Economics Letters*, 155, 96–99. <https://doi.org/10.1016/j.econlet.2017.03.022>
- Weidner, M., & Zylkin, T. (2021). Bias and consistency in three-way gravity models. *Journal of International Economics*, 132, 103513. <https://doi.org/10.1016/j.jinteco.2021.103513>
- Wilson, J. S., Mann, C. L., & Otsuki, T. (2005). Assessing the benefits of trade facilitation: A global perspective. *The World Economy*, 28(6), 841–871. <https://doi.org/10.1111/j.1467-9701.2005.00709.x>
- World Economic Forum (2022). *Growing intra-African trade through digital transformation of border and customs services*. https://www3.weforum.org/docs/WEF_Regional_Action_Group_for_Africa_2022.pdf

How to cite this article: Billon, M., Rodríguez-Andrés, A., & Rodríguez-Crespo, E. (2023). Broadband use and trade facilitation: Impacts on bilateral trade of sub-Saharan countries. *African Development Review*, 1–13. <https://doi.org/10.1111/1467-8268.12698>