



The Impact of ICT Use on Trade Openness in Sub-Saharan African Countries

Nicholaus Ngowi^{1*}, Anicet Rwezaula² and Mohamed Awadhi¹

¹Department of Regional Development Planning, Institute of Rural Development Planning, Lake Zone Centre, P. O. Box 11957, Mwanza, Tanzania.

²Department of Population Studies, Institute of Rural Development Planning, P. O. Box 138, Dodoma, Tanzania

*Corresponding author: email: ngowinicholaus@irdp.ac.tz

Ikisiri

Utafiti huu unatumia takwimu za jumla za kuanzia mwaka 2000 hadi 2020 kutoka nchi 48 za kusini mwa jangwa la Sahara. Lengo la utafiti ni kuchunguza matokeo ya matumizi ya TEHAMA (matumizi ya mtandao) kwenye uwazi wa kibiashara. Takwimu zimechakatwa kwa kutumia ulinganishi kwantalia (quantile regression). Utafiti umepima uwekezaji wa kigeni (FDI), upatikanaji wa fedha, upatikanaji wa mitaji na kiwango cha mfumuko wa bei. Matokeo ya utafiti yanaonesha kuwa matumizi ya TEHAMA yana athari chanya na muhimu kitakwimu katika uwazi wa biashara kwenye nchi za kusini mwa jangwa la Sahara kama inavyothibitishwa katika idadi kubwa ya viwango kikwantalia (30, 40, 50, 60, 70, 80, na 90). Hii inamaanisha kwamba ongezeko la matumizi ya mtandao limesababisha uwazi chanya wa kibiashara katika Kanda. Zaidi ya hayo, matokeo ya utafiti pia yanaonesha kuwa upatikanaji wa mtaji na uwekezaji wa kigeni (FDI) una athari chanya kitakwimu katika uwazi wa biashara kwa viwango vyote wakati upatikanaji wa fedha (mikopo ya ndani kwa sekta binafsi) na mfumuko wa bei una athari tofauti tofauti katika uwazi wa biashara kwa sehemu ndogo. Inapendekezwa kuwa nchi za kusini mwa jangwa la Sahara ziongeze matumizi ya mtandao na kuwezesha matokeo chanya ya matumizi ya TEHAMA kwenye shughuli za biashara.

Abstract

This study uses panel data for 48 sub-Sahara Africa countries, ranging from the year 2000 to 2020, to empirically examine the impact of Information and Communication Technology (ICT) use and adoption (internet use) on trade openness, employing quantile regression analysis. The study controlled Foreign Direct Investment (FDI), access to finance, capital formation and inflation rate in the quantile regression. The study findings demonstrate that internet use (i.e., ICT) has a positive and statistically significant impact on trade openness in sub-Saharan African countries, as evidenced in the majority of quantiles (30th, 40th, 50th, 60th, 70th, 80th, and 90th). This implies that an increase in internet use has resulted to positive trade openness in the region. Furthermore, results of the study also reveal that capital formation and Foreign Direct Investment (FDI) have positive statistically significant impact on trade openness at all quantiles while access to finance (domestic credit to private sector) and inflation has heterogeneous effect on trade openness in sub-Saharan African countries. We recommend sub-

Saharan African countries to increase internet users and penetration to influence the use of ICT technologies (electronic mail, telephones) on trade activities.

Key Words: Trade Openness, Sub-Saharan Africa, Internet use, Quantiles regression

1. Introduction

ICT services have developed into a useful tool for trade activities with the advancement of technology everywhere on the globe. For example, according to Mattes *et al.* (2012), there is a positive and significant relationship between ICT and trade openness between countries within the European Union as well as trade between the European Union and other countries outside the union. Due to the use of ICT, the trade sector has undergone a significant transformation throughout the world (Cheng *et al.*, 2021; Åkerman, 2022). ICT is considered the driving force behind social-economic growth and development in most developing nations due to its significant role in fostering competitiveness through export trade (World Bank, 2016; Rodriguez-Crespo *et al.*, 2021; Ozcan, 2018; Chiu and Lee, 2019; Mishra and Nayan, 2015). ICT advancements have transformed the global economy into the digital economy which is characterized by a number of remarkable advantages, such as improved access to trade information, improved interaction and business activity conducted via digital networks (Pradhan *et al.*, 2018, Asongu *et al.*, 2016, World Bank, 2016; Nath and Liu, 2017; Åkerman, 2022). In recent decades, private and public trade and financial institutions have been urged to increase their spending on investments in ICT products and services due to the growing importance of ICT in trade and financial management. In response to this, for instance, in 2015, the global financial

industry spent over 195 billion US dollars on ICT services and products, which was the highest level of spending since 1990 (Chien *et al.*, 2020).

ICT's significance in the growth of trade has been studied in the past for a number of different reasons. First, ICT has decreased the time and expense needed to complete business tasks (Asongu *et al.*, 2016; González-Paramo, 2017; Boccia *et al.*, 2022). Second, ICT has significantly lowered the barriers associated with distance and the global market when conducting business (Spanos *et al.*, 2002; Lin, 2015; Hanna, 2010; Boccia *et al.*, 2022). Third, the use of electronic finance has improved internal control and business reporting (Asongu *et al.*, 2016; Donner, 2006). Fourth, ICT boosts productivity and lowers unemployment, which raises living standards by increasing people's purchasing power and contributes to economic growth (OECD, 2010; Donner, 2006; Nabi *et al.*, 2022; Aziz *et al.*, 2022). Last but not least, the use of ICT in business fosters a strong relationship between export flows among trading nations (Yushkova, 2013; Luong and Nyuyen, 2021).

Several similar studies have been done in different parts of the globe including the study done by Freund and Weinhold (2002), applying a cross sectional model and an extended panel data model using a sample of panel data ranging from 1994 to 1999 to examine the effects of ICT on trade between the USA and other 31 countries reveals a significant positive

relation between ICT and trade openness which is also supported by the study done by Vemuri and Siddiqi (2009) which assessed the impacts of ICT infrastructures on international trade between 64 countries using data ranging from the year 1985 to 2005. The findings of the study support the existence of a significant positive relationship between ICT infrastructures (i.e., internet infrastructures) and the development of international trade.

Also, Choi (2010), investigated the impact of internet use on service trade using data from 1990 to 2016 in examining 151 economies. The results of this study demonstrate that the double increase in the use of the internet within the country is likely to improve the service trade value from 2% to 4%. Likewise, according to Freund and Weinhold (2002), 10% increase in internet use (penetration) in United States trade partners was resulted to 1.7 % growth in the value of its trade. Furthermore, Ozcan (2017) in analysing the impact of ICT in international trade between Turkey and other 34 countries by applying a statistical dynamic panel data model using data ranging from the year 2000 to 2014 revealed that ICT has positive and significant impact on both import and export trade which all complement trade openness. In addition, Asongu and Nwachukwu (2018), investigated how openness influences ICT penetration for improved government quality in sub-Saharan Africa applying the Generalized Method of Moments based on forward orthogonal deviation and among the findings of their study revealed that mobile phone use contributes to the increase in the number of internet users which also complement to trade openness

in the region. Such a result was also supported by Frankfurter *et al.* (2020) who found that the increase in the use of smartphones has accelerated internet use and penetration in sub-Saharan Africa. Nevertheless, Nath and Liu (2017), used panel data from 49 nations to empirically analyse the impact of ICT on import and export trade in ten service items from the year 2000 to 2013 and the findings of their study indicated that among the 10 service items, 7 of them were significantly positively affected by ICT development. Likewise, Xing (2018) examined the influence of the internet and e-commerce implementation on inter-trade for a group of 21 developing and least-developed countries and 30 OECD economies. The empirical results indicated that, the adoption of e-commerce applications and access to internet has promoted bilateral trade flows among the countries in trade. Last year Adeyele *et al.* (2021) explored the ICT trade nexus on economic as well as inclusive growth based on 53 African economies from 2005 to 2015, the results indicated that the ICT-trade nexus varies considerably across sub regions.

Theoretically, for the study to reach the expected result, the neoclassical economic growth theory developed by Solow and Swan (1956) was adopted. The theory suggests that in order to reach economic growth, capital, labour and technology must be considered as the key motivating factors. Basing on the theory technology enhance the unlimited growth in economy compared to limited capital and labour resources. Furthermore, it is believed that economic growth depends on how technology facilitates labour productivity and enhances labour output capacity. The theory also explains the difference

between long-term and temporary equilibrium that long-term equilibrium does not require the three factors namely: labour, capital and technology but rather depends on how people use their money to enhance the accumulation of wealth in the economy. Considering the pinpointed grounds, neoclassical economic growth theory is adopted in this study due to the fact that it influences the advancement and use of ICT technologies, which are the cornerstone for economic performance and trade openness (Manickam *et al.*, 2021; Ueki and Tsuji, 2019; Radosevic, 2022; Albaity, 2022).

Nevertheless, the fact that sub-Saharan Africa has a very low percentage of internet users (30%) compared to 85% in Europe and 92% in North America (World Bank, 2020), is one of the factors motivated the researchers to conduct the study despite the fact that there are numerous studies that examined the relationship between ICT and trade openness. Second, the region has a negative trade balance of 1.2 trillion US dollars, a very low export share of GDP (20.6%), a very low import share of 19.3%, and a very low share (3%) of global trade in goods and services (World Bank Indicators, 2022). Third, although the rate of ICT adoption (i.e., internet use) in the region appears to be accelerating quickly, from 4.4% in 2010 to 30% in 2020, the proportion of people in the region who use ICT services is still very low when compared to Europe, Asia and America (see for example, World Bank Indicators, 2022). Fourth, despite the region's rapidly expanding use of ICT services (such as the Internet), there is still a dearth of literature examining the link between ICT indexes and trade

openness, with the majority of studies focusing on the industrialized nations of Europe, America, and Asia. Finally, we use quantile regression with up-to-date data from the year 2000 to 2020 to empirically assess whether ICT (internet use) has a positive or negative impact on trade openness in SSA as a key novelty to fill the gaps in the existing studies. We use quartile regression due to the fact that to the best of our knowledge there is no similar study that has applied this method in Sub-Saharan Africa. Furthermore, quantile regression analysis is used due to the fact that 48 sub-Saharan African countries have heterogeneous data related to internet use, trade openness and other heterogeneity factors.

2.0. Methodology and Data Sources

2.1. Data sources

Our data span 48 sub-Saharan African countries between the year 2000 and 2020. The study used trade openness as a dependent variable measured in percent of GDP as used by (Fernandes *et al.*, 2019; Salahuddin and Gow, 2016; Ngouhouo *et al.*, 2021) while internet users as a percentage of the population a proxy of ICT use was used as an independent variable. The study also employed Foreign Direct Investment (FDI) measured as a net inflows percent of GDP, access to finance measured in percent of domestic credit to the private sector, capital formation measured in terms of percentage of fixed capital directed towards infrastructure development on GDP as a proxy of domestic investment, and inflation rate measured in consumer price (annual %) as control variables. These variables were used as explanatory variables in model 1 as used in the works of (Ngouhouo *et al.*,

2021; Mbogela, 2019; Osei *et al.*, 2019). All variables were obtained from the World Bank's Development Indicators database (2022).

2.2. Model estimation techniques

In comparison to other regression techniques, quantile regression (i.e., median estimates) is more flexible in considering different relationships at various points of the dependent variable's distribution. The adoption of quantile regression is important to accurately make predictions and quantify the

$$Qtrade_{it}(\tau/k'_{it}) = \beta_i k'_{it} + \mu_{it} \dots \dots \dots (1)$$

Where k' represents vector of explanatory variables for each fixed country i at time t , internet use (% of population using internet), capital formation, domestic credit to private sector, foreign direct investment and other control variables such as inflation rate.

$Qtrade_{it}(\tau/k'_{it})$ is the τ th conditional quantile of trade openness (% of GDP) as a linear function of the explanatory variables. β_i is the coefficient of $Qtrade_{it} = \beta_0 + \beta_1 INT_{it} + \beta_2 FDI_{it} + \beta_3 DCPS_{it} + \beta_4 DINV_{it} + \beta_5 INFL_{it} + \mu_{it} \dots \dots \dots (2)$

Where i represents a country and t is the time variable. β_0 represents the constant value, μ_{it} is the error term, and β_1 to β_5 , represents the coefficients of the variables included in the model. INT represents internet use, FDI represents foreign direct investment, DCPS represents domestic credit to private investors as a proxy for access to finance, DINV represents domestic investment as a proxy for capital formation, and INFL represents the inflation rate.

accuracy of the prediction as uncertainties are quantified using intervals (quantiles). The prediction intervals are categorized into upper and lower bounds as countries differ in levels of internet users, where all levels might have an impact on the dependent variable (i.e., trade openness). The methodology is also adaptive and can be used for data that are highly heteroskedastic (Romano, *et al.*, 2019). Therefore, the model is described as follows: -

explanatory variables and μ_{it} is the vector of residuals and τ indicate quantile.

From equation 1, we employed a regression model expressed under equation 2 to determine the impact of ICT on the dependent variable using quartile regression.

It is evident that using a linear regression model allows one to determine the average or mean relationship between the explanatory variables. The mean regression method relies on the dependent variable's central distribution tendency without integrating for the upper and lower ranges (Koenker and Bassett, 1978). Additionally, this means that the linear regression estimation method ignores countries with higher or lower internet use, trade, and financial access. In order to address these

shortcomings of the conventional linear regression technique, the panel quantile regression approach was used.

The quantile regression method is based on the assumption that the impact of the independent variables varies along the conditional distribution of the dependent variable (Koenker and Bassett, 1978). The panel quantiles divide the data into nine quantiles (10th, 20th, 30th, 40th, 50th, 60th, 70th, 80th, and 90th) during the estimation process to examine the impact of internet users on trade openness while controlling for other covariates. Quantile regression's primary benefit is its capacity to investigate the heterogeneity and asymmetry of explanatory variables based

on the conditional location of the dependent variable. Therefore, depending on the quantile, the impact of the regressors on the dependent can be either positive or negative. To this end, we examine the impact of internet use (i.e., ICT) on trade openness using unbalanced panel data for 48 sub-Saharan African countries selected from 2000 to 2020.

3.0. Results and Discussion

3.1. Results

Table 1 summarizes the descriptive statistics of the variables for 48 SSA countries from 2000 to 2020.

Table 1: Descriptive Statistics

Variables	N	Mean	Median	StdDev	Min	Max
Trade (%)	885	69.73	60.62	26.73	.78	225.02
Internet use (%)	885	9.84	3.69	13.92	.01	79
Foreign direct investment (%)	968	4.65	2.66	8.25	-11.19	103
Domestic credit to private sector (%)	880	19.45	13.39	22.22	0	142.42
Capital formation (%)	867	22.43	21.29	10.02	0	79.40
Inflation rate (%)	903	10.50	5.26	35.45	-9.61	557.20

Source: Authors computation (2022), N= Number of events

The mean for trade openness in 48 countries in SSA is approximately 70% with a standard deviation of 26.27 percent implying that the volume of exports and imports largely contributes to the economies (GDP) of SSA countries. On the other hand, the lower dispersion of trade openness under the period of study implies that the volume of exports and imports as a percent of GDP is lower among SSA countries. Meanwhile, the

average internet user in the region is 9.8%, which is lower compared to 85% in Europe and 92% in North America (World Bank, 2020). This means that internet use in SSA countries as a whole is lower when compared with other regions. According to the World Bank (2021), Seychelles (79%), South Africa (70%) and Mauritius continue to have the highest internet use and adoption in the region, while Eritrea (1%), the Comoros (8%), as well as the

Congo Republic and Burundi (9% each), have the lowest. Further analysis was done to determine the effect of ICT on trade openness using a quantile

regression. Table 2 shows the quantile regression results for 48 countries in SSA from 2000 to 2020.

Table 2: Panel Quantile Regression. Dependent variable (Trade)

Quantiles	Internet users	FDI	Inflation	Capital	Finance
$\tau = 0.10$	.007(.018)	.102*** (.019)	-.059***(.022)	.204***(.065)	.176*** (.031)
$\tau = 0.20$	.025(.019)	.103 *** (.020)	-.015(.023)	.215***(.070)	.097*** (.034)
$\tau = 0.30$	.034** (.015)	.090 ***(.015)	.001 (.018)	.333***(.054)	.062 ** (.026)
$\tau = 0.40$	.047***(.014)	.092***(.014)	.008 (.017)	.335***(.050)	.044*(.024)
$\tau = 0.50$	.070*** (.015)	.077***(.016)	.03 *(.019)	.315***(.056)	.043(.027)
$\tau = 0.60$	.091*** (.016)	.075***(.016)	.027 (.019)	.350***(.058)	.002 (.028)
$\tau = 0.70$	.098*** (.015)	.067***(.016)	.029(.018)	.363***(.055)	-.012(.026)
$\tau = 0.80$	.101*** (.017)	.071***(.017)	.029 (.020)	.372 ***(.058)	-.002(.028)
$\tau = 0.90$	.105***(.026)	.051* (.027)	.048 (.032)	.494***(.094)	-.024(.045)

Source: Authors Computation (2022), Note: Standard errors in parentheses (), ***, **, * show significant at 1%, 5% and 10% level respectively

The findings of the study in Table 2 demonstrate the existence of a positive and significant effects of internet use on trade openness in the region as shown at the 30th, 40th, 50th, 60th, 70th, 80th, and the 90th quantiles. This suggests that an increase in internet users is related to an increased trade openness in the region. Additionally, the findings of this study as shown in Table 2, indicate that, inflation affects trade openness in an asymmetric way. At the 10th quantile, inflation has a negative effect, while at the 50th quantile, inflation is favourable to trade. Our findings also demonstrate that capital formation and foreign direct investment have statistically significant effects on trade openness across all quantiles. Access to finance (domestic credit to the private sector) has a significant impact on

trade openness in the 10th to 40th quantiles.

3.2. Discussion

The objective of the study was to assess the impacts of ICT (i.e., internet use) on trade openness, focusing on 48 countries in Sub-Saharan Africa using panel data ranging from 2000 to 2020. In this study, Foreign Direct Investment (FDI), inflation rate, capital formation, and domestic credit to the private sector remains to be the controlled covariates. The findings of this study demonstrate that ICT (i.e., internet use) has a positive and significant impact on trade openness in most sub-Saharan African countries. This is to say that an increase in percentage of internet user's result to the improvement on increase in trade openness in the region.

All the findings captured from the reviewed empirical studies tended to support, to a large extent the findings of the study in Table 2, that there is a significant positive impact of ICT (i.e., internet use) on trade openness to sub-Saharan African countries. The question remains, by what mechanism does ICT influence trade openness in sub-Saharan African countries? In support to the study's findings, trade openness positively influenced by ICT (i.e., internet use) in different parameters including promotion of export trade by lowering trade cost as well as accelerating innovation, decreasing the time spent in conducting business, improve access to overseas market and last but not least ICT lower the distance constraints in relation to trade (i.e., importation and exportation) (Asongu *et al.*, 2016; Gonz'ales -Paramo 2017; Spanos *et al.*, 2002; Lin, 2015, Hanna, 2010; Nath and Liu, 2017; Wang *et al.*, 2022). Moreover, the application of ICT in trade has significantly changed the way to access and process information to make various business decisions (Chien *et al.*, 2020). It is through the use of ICT that people and institutions are able to collect huge amounts of information and make different analyses which equips them with enough understanding and ability to make various decisions such as what, when, how, and where to produce and sell (Sassi and Goaed, 2013) hence predict and manage risks associated with the business environment (Navaretti and Pozzolo, 2017). All of these aid trade to maintain the competitive advantage in the market (Jensen, 2007). According to Saddique and Singh (2021), the positive relation between ICT use and trade is highly

exhibited in developing as well as in high income countries.

Based on evidence from similar studies from numerous researchers, the application of ICT (internet use) has diverse impacts on trade openness. According to Clarke and Wallsten (2006), internet use has a positive and significant impact on the performance of export trade in developing countries compared to developed countries. Furthermore, internet use has been reported to boost export trade in China's manufacturing industry (Fernandes *et al.*, 2019). Last but not least, evidence from South Africa demonstrates that internet use has contributed to trade openness (Salahuddin and Gow, 2016).

Additionally, it is important to note that the region cannot fully benefit from the importance of ICT (i.e., internet use) if the majority of the people in the region remains to be characterized by low ICT skills. According to Nath and Liu (2017), ICT skills enhance trade openness since they increase demand for various services and products because with the help of ICT (i.e., the internet) people became well informed on the importance and the use of different services and products. Furthermore, a revisit of the trade policies and an improvement of the income of the specific countries in SSA may also be considered as a strategy to accelerate the use of ICT, for example, in trade activities, as recommended by Balamoune-Luts (2003).

On the importance of trade openness, the study done by Dollar (1992) on 95 developing nations using data ranging from 1976 to 1985 indicated that trade openness contributes to the economic

growth of the country. The findings of Dollar (1992) were later supported by Yanikkaya (2003); Tahir and Azid (2015); as well as Canh and Thanh (2020). Other importance of trade openness includes reduction of the gap in economic performance between low-income countries and high-income countries (Sachs *et al.*, 1995); improve productivity of goods and services (Edwards, 1998; Huang *et al.*, 2019) as well as impact positively the income of the countries which are in trade (Frankel and Romer, 1999).

4.0. Conclusion and Recommendations

The study examines the effects of ICT (i.e., internet use) on trade development in 48 sub-Saharan countries using data ranging from 2000 to 2020, control for Foreign Direct Investment (FDI), the inflation rate, capital formation and domestic credit to the private sector by using Quantile Regression. The findings of the study reveal that ICT (i.e., Internet use) has a positive and statistically significant effect on trade openness at almost all quantiles (30th, 40th, 50th, 60th, 70th, 80th, and 90th) in Sub-Sahara Africa. Such a result implies that an increase in adoption of ICT is likely to positively affect trade openness in the region. Our findings also demonstrate that, capital formation and Foreign Direct Investment (FDI) has statistically significant effects on trade at all quantiles. However, access to finance (domestic credit to the private sector) has a significant impact on trade in the 10th to 40th quantiles and inflation has a negative effect, while at the 50th quantile, inflation is favourable to trade. Generally, the study's findings support that, an increase in adoption of ICT (i.e., internet use) will

likely continue to improve trade openness to the countries of sub-Sahara Africa. In order to accelerate trade openness in sub-Saharan Africa, countries in the region are recommended to increase internet users and penetration and to influence the use of technologies (electronic mail and telephone) on trade activities by lowering the cost of using ICT facilities (broadband) Second; increase the budget to spend on investment in ICT (i.e., infrastructure), last but not least, to improve ICT skills among residents of the region. By doing so, the region will likely to increase the proportion of the people using ICT services (i.e., internet) to conduct different social and economic activities including trade.

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