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Digital Technology and Trade Performance in Sub-Saharan Africa

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Abstract. This study examines the relationship between digital technology and trade performance with a focus on export trade in sub-Saharan African countries. The main objectives are to examine the impact digital technology measured by ICT goods import, internet use and mobile telephone subscriptions have on export trade in Sub-Saharan Africa (SSA), to evaluate the link between the degree of the region's development and export trade and the form of digital technology most suitable in facilitating trade in the region. The study hypotheses are that: (1) ICT goods import, internet use and mobile telephone subscriptions do not influence significantly export trade in SSA; (2) the region's development does not link appreciably to export trade in SSA; (3) no form of digital technology can facilitate trade in the region. The panel regression estimation technique is adopted considering the panel least squares, fixed effect and random effect estimation techniques. Results show that information and communication technology imports exert greater positive and significant impact on export trade flows compared to internet usage demonstrating theoretical and practical relevance of technology in trade flows. The degree of development is low and does not show an appreciable impact on trade flows in the region indicating that trade integration can thrive better in a well-structured economy. Redundant fixed effect test confirms that the panel least squares estimation is better compared to the fixed effect estimation. Hausman test demonstrates that random effect estimation is also better than fixed effect estimation. In attaining the reality of the contribution of digitalization process in SSA, policy makers need to pursue major goals that would address problems hampering its success.

Key words: digital technology; trade; panel least squares; fixed effect; random effect.

JEL F10, N7, O3, O31, O32, O33

1. Introduction

Digital technology plays a major role in global trade and investment and is expected to continue to shape the trade relations within the Sub-Saharan Africa (SSA) and beyond. The patterns of trade in goods that can be digitized have been transformed following advancement in internet and computer technologies [1]. Goods in these categories include software and media products such as films and various forms of recorded information on carrier media among others [2].

In 2014, cross border merchandised trade in products experiencing digitization reached about 0.3% of the world-merchandised trade with printed books meant for exports and accounting for almost half of this. Exports by Asia-Pacific economies have accounted for almost 30% of the world exports of digitalized products ESCAP calculation[1].

China takes the lead in the region's exports of games and printed books; Singapore dominates the region's exports of software and sound media. While Korea is next,

[1] ESCAP. Escap population data sheet 2016. Social Development Division. 2016. https://hdl.handle.net/20.500.12870/898

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Japan remains the major Asia-Pacific exporter of film. The e-commerce, which reflects the online purchase and sales of goods and service, is a good reference point [3].

Sub-Saharan Africa (SSA) is skewing towards digitization with potential for more innovations as far as it addresses short falls in physical and human capital, digital governance and regional trade agreements and the importance of this was recognized by the international organizations in late 1990s. Improvement in transport and information and communication technologies (ICTs) [4] through reduction in transportation and communication costs has consequently increases trade relations between countries [5].

Digital technologies through concrete innovation can considerably boost exports trade in developing nations [6]. Empirical evidence has shown the gains in trade both at the global and developing countries scenarios through new digital technologies such as the adoption of robots, more reliance on artificial intelligence and big datasets and trade costs reduction.

Accordingly, digital technologies are expected to have a significant impact on trade making global trade grow by 2% points per annum higher compared to the previous level between now and 2030 and that trade growth for developing countries becomes 2.5% points higher than what it would have been in the previous period [7].

International Monetary Fund observes that internet penetration in SSA has moved up to tenfold since 2000s, contrary to threefold increase for rest of the world. Between 2014 and 2019, the percentage of mobile internet penetration almost doubled in Kenya with mobile phone subscriptions surpassing the population by 12% in 2019.

In Nigeria, ICT sector contributes about 14% to the GDP with investment in high-speed internet thereby lowering bandwidth prices and increasing network capacity [8]. Nigeria is home to cryptocurrency trade and generated over $400 million worth of cryptocurrency trade in 2020 placing it third place after the US. South Africa accounts for 49% of the region's cellular internet of things (IoT) connections and has launched commercial 5G services.

The subcontinent recent advancement in global internet enhanced by the development of high-capacity telecommunications SMCs together with inadequacy of wire line terrestrial infrastructure turned the mobile phones main channel for mobile communications.

Despite these contributions on transformation, there seems to be less focus on digital trade in the region. Given the connections between global digitalization and trade, the poor national digital strategies and inadequate digital provisions in trade relations serve as potential threats and slow down SSA's digital transformation. The region is beset with low property protection (IP), data protection and cyber security which mitigate competitiveness, security, and trade development. Poor attention on digital technology impact on trade in SSA despite its potential to change the phase of trade relation; has paved way for this study.

The objectives of the study are to examine the impact of ICT goods import, internet use and mobile telephone subscriptions, which are measures of digital technology on export trade in SSA, to evaluate the link between degree of the region's development and export trade and to determine the form of digital technology most suitable in facilitating trade in the region.

The hypotheses that are to be tested are that:

H1. ICT goods import, internet use and mobile telephone subscriptions do not impact significantly on export trade in SSA;

H2. The region's development does not link appreciably to export trade in SSA;

H3. No form of digital technology can facilitate trade in the region.

Following the introductory section are sections 2 and 3 comprising the relevant literature and methodology and data respectively. Section 4 is estimation while section 5 concludes.

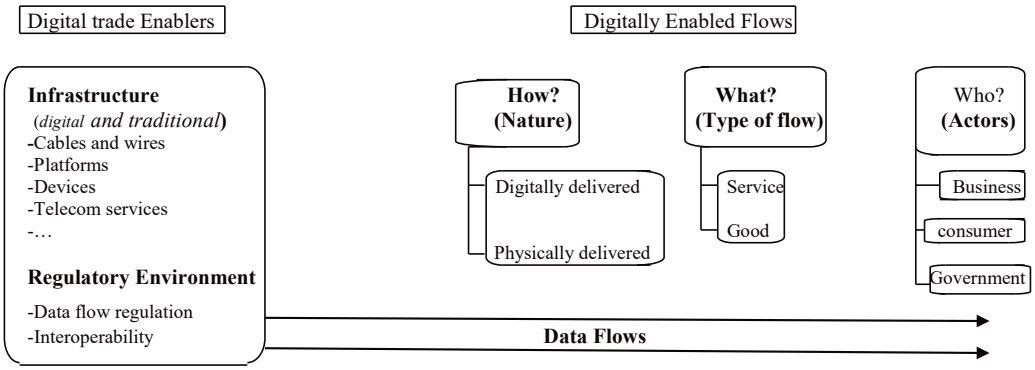

Figure 1. Schema on components of digital trade adopted from [5]

2. Literature Review

The revolution put in place by the development of data analytics and machine learning in the monetization of data digital services is reflected in commerce through personalization of services, which subsequently increases the efficiency of transactions and consumer welfare further leading to expansion in commerce.

Based on a survey, Deloitte[1] observes that over 50% of consumers have shown willingness to pay higher for a personalized product or service while just 22% of consumers feel happy to share some data to gain access to a more personalized product or service. Benefits from trade can be more enhanced by the free flow of data in as much as the online ecosystem is reliable wherein online consumers are free from any risks of using their data different from their missions, as this is fundamental in promoting online trade.

Parker et al. [9] showed that digital technologies have created platform ecosystem through which services are traded. Platforms are considered as having lower costs compared to previous market forms to create scale that can be of relevant value for an attraction between their markets. Moreover, platforms are new methodologies of addressing the fundamental problem encountered in economic organization such as coordinating supply and demand without complete information.

As explained by Baldwin [10] and Lopez-Gonzalez & Jouanjean [11], digital trade considered not new is taking new form and has continuously adding new dimension to globalization process. A broad consensus has been reached that digital trade entails digitally enabled international transactions in goods and services which can be delivered either physically or digitally. Figure 1 demonstrates the well-accepted components of digital trade.

The physically delivered goods and services across borders do not differ based on the transactions that describe whether the trade is digital or not. Digitalization is seen to have increased the physical delivery of final and as well as intermediate goods and services but not that it has changed the nature of trade relation.

While it is difficult to estimate the importance of digital trade from international institutions including the Organization for Economic Cooperation and Development (OECD)[2] or the World Trade Organization (WTO)[3] which have some

[1] The Deloitte Consumer Review: Made to Order: The Rise of Mass Personalisation. London: Deloitte. 2015. https://www2.deloitte.com/content/dam/Deloitte/ch/Documents/consumer-business/ch-en-consumer-business-made-to-order-consumer-review.pdf

[2] OECD (2019). Trade in the Digital Era, OECD, Paris

[3] WTO (2018). World Trade Report 2018: The future of world trade: How digital technologies are transforming global commerce, WTO, Geneva

reports on digital trade, notwithstanding, digital transformation has created a noticeable impact on physically delivered trade. It should be noted that it is easier to physically deliver goods than services; therefore, digital transformation is more impactful on manufactured goods than on trade in services.

In the manufacturing sector, it is expected that digital transformation will reduce employment compared to what has already been done in the past.

Baldwin & Forslid [12] just as some others are of the prediction that manufacturing may become jobless and thus having significant socio-economic effect implications but would be derived through changes in the process of production rather than through changes in trade. The way new technology impact on trade performance between advanced and developing economies characterized by different labour costs is dependent importantly on the how the new technology is able to reduce transportation and other costs of transactions and hence encouraging firms to source products considering minimal labour costs and as well as the labour intensity of the production process. In services, the major impact expected of the digital transformation which is already in force is the drastic reduction in transportation and other transactions costs which is further accelerated by the emergence of the COVID-19 pandemic, and this essentially renders many services tradable compared to their initial non-tradable status.

Zhao et al. [13] showed that on a theoretical level and considering the impacts on economic activities at the micro-level, the economic value of technology can be seen in increased efficiency, product quality and product variety.

Kan et al. [14] showed that Increased efficiency relates to reduced production and transaction costs wherein firms deliver same product to consumers with lower cost via improved productivity or declining transaction cost. Product quality entails making products better to meet functionality, ergonomics, and durability conditions. For product variety, new products and services can be introduced to expand the choices available to the consumers.

Literature in economics identifies three important effects driving firm incentives for innovation. These are (1) Schumpeterian effect, (2) Escape-competition effect, and (3) Preferences effect.

"Schumpeterian" effect hinges on import competition and innovation. Import competition results in a negative impact on firm's innovation. Accordingly, a declining market share of the firm implies lower profits to be extracted from innovating.

Dasgupta & Stiglitz [15] reaffirmed the Schumpeterian effect and further showed that rising competition affects profit margins and end up in less investment in R&D and hence less innovation.

The Escape-competition effect on the other hand emphasizes that import competition would have a positive effect on firm technological innovation and by innovating a firm could benefit from the profits of its competitors.

The model introduced by Aghion et al. [16] suggests that firms having similar technological capacity seem to benefit from increasing returns to innovation based on competition as it can put a firm ahead of its competitors.

The Preference effect, which is another mechanism, was introduced by Hart in 1983. The idea that firms are profit maximizing and thus import competition would have a direct relationship with firm innovation was challenged. On assumption, firm managers tend to have private benefits to reap in addition to the firm's financial profits, which subsequently affect decisions for innovation.

According to Chen & Steinwender [17], private benefits may be extracted only in the case where firms are in existence and thus triggers innovation efforts due to rising competitive pressure.

Brezis et al. [18] showed that in the context of SSA, expansion of digital technologies such as mobile money is often referred to as "leapfrogging technologies". This theory has pointed to the role technological revolutions play in fostering reversal of fortunes among nations across the globe. Within the context of a major technological change, dependence of an advanced country on old technology makes a new technology becomes unattractive in the short run as it is seen less profitable.

Further theoretical demonstration of the link between digital economy and trade can be observed through direct and indirect effects. Considering the direct effect, digital technology can lower the cost incurred in export trade.

Fujita et al. [19] find that New Economic Geography (NEG) emphasizes that trade cost is key when it comes to trade location selection, spatial agglomeration, and diffusion of economic activities and thus reduction in this cross-border trade cost triggers export growth.

Felbermayr et al. [20] showed that trade costs, which include transaction costs, search costs, communication costs and transportation costs, are reduced through the digital technology. The "disintermediation" effect saves series of costs generated through varying processes of intermediary transactions for example between the manufacturers and consumers. Digitization process enhances the search for business information through the web and thus, reducing search costs. Communication costs are equally reduced through real-time communication via the internet compared to huge costs incurred in mail or telegrams delivery. According to Newbold [21], this essentially reduces costs associated with logistics.

Leviakangas [22] showed that expansion of trade market is realized through digital economy. This development has reduced the initial geographical restrictions via the scope of export trade market.

Hoffman & Novak [23] find that has been a unification of the real economy and fictitious economy and the emergence of virtual trade and have broken through the geographical restrictions towards improving the efficiency of trade. Advances in the scope of business and information technology have improved financial and educational products thereby reducing restrictions encountered on trade in services in various locations.

Advancement in digital technologies worldwide has paved way for numerous empirical facts relating to the subject matter. At the national, industry and enterprise levels, most analyses have concluded that digital technologies reduce costs incurred in trade and get rid of limitation attributed to transaction time and trading venues to facilitate exports.

Visser [24] find that digital technology plays a prominent role in the promotion of export in developing economies compared to developed economies in Asia. In the same vein, some studies have found indirect relationship between trade and innovation outcomes and using patents and R&D expenditure as direct measures of innovation.

Autor et al. [25] document a negative impact of rising import competition from China on firm and technology class levels for the period 1975-2007. Results show that about 40% drag in patenting is attributed to fast moving import competition.

Xu & Gong [26] using a data base of US manufacturing industries for 1995-2009, find that firms with more import competition from China experience a fall in R&D and thus calling for a reallocation of R&D. While some results are mixed, some empirical studies have found positive impact of import competition on innovation.

Bloom et al. [27] engage in a study of 12 European countries for 1996-2007 and find a positive effect of China's import competition on innovation using firm level data. Majority of studies for developing countries use total factor productivity as

a measure of innovation. While the digital technological impacts on export have been supported empirically across different dimensions, it is not without heterogeneity effects. The spread of technological ideas including improved seeds, solar cook stoves, and agricultural techniques, mobile phone adoption came into existence. Empirical economic studies on mobile phone adoption are still scanty due to inadequate data on individual adoption, difficulty in assessing relevant benefits against costs incurred among others.

Olken [28] and Jensen & Oster [29] find that new technologies-radio and television-impact positively and negatively on social relationships and individuals' behaviour in developing countries.

Aker et al. [30] note that introduction of mobile phones lowers the intensity of a border effect across different ethnic group in Niger.

3. Methodology and Data

The theoretical framework this study adopts is rooted from the theoretical assertion of NEG, which lays emphasis on the direct effect of digital economy on trade. The major tenet here is that digital technology reduces all forms of trade costs including transaction costs, search costs, communication costs through efficient ICT quality imports, internet systems, among others, which subsequently improve export trade flows, increase domestic productivity and foreign exchange earnings.

Based on the theoretical idea, the econometric model specification linking digital technology to trade is demonstrated as follows:

$$Exp^t = f(Dig^{tech}, X, \mu). \quad (1)$$

Therefore,

$$Exp = \beta_0 + \beta_1 Dig^{tech} + \beta_i \sum_{i=1}^{n} X_i + \mu. \quad (2)$$

Where *Exp* represents export trade, which in this case is, merchandise exports and they show value of goods provided to the rest of the world. Exports are considered in this study as a measure of trade because exports positively revive domestic economic activity and thus result in more production, employment, and revenue generation. Essentially, they serve as an injection to the domestic economy.

Dig^{tech} represents the digital technology variable which in the context of SSA and as employed in this study includes Information and telecommunication technology (ICT) goods imported (*ICTGIM*) to enhance production process and minimize production costs, internet usage (*INTNET*) which essentially reduces search and communication costs, and mobile cellular telephone subscriptions (*MOBCES*) that enhance cellular technology.

X_i include control variables incorporated to reduce omitted variable bias and these are access to electricity infrastructure (*ACELEC*), exchange rate (*EXCR*), a measure of the region's competitiveness, foreign direct investment (*FDI*) which takes into account the degree of trade openness of the region, human capital development (*HCD*) measured by government expenditure on education as a proportion of the gross domestic product (*GDP*), which describes the quality of human capital development and industrial value added (*INDVAD*) capturing the region's industrial structure. Other control variables are Natural resources (*NATRES*), per capita income (*PCIG*) and capture the level of region's development as usual and savings (*SAV*) as a proportion of the *GDP*.

The model for this study defined explicitly takes the form:

$$EXP_{it} = \beta_0 + \beta_1 ICTGIM_{it} + \beta_2 INTNET_{it} + \\ + \beta_3 MOBCES_{it} + \beta_4 ICELES_{it} + \beta_5 EXCR_{it} + \\ + \beta_6 FDI_{it} + \beta_7 HS_{it} + \beta_8 INDVAD_{it} + \\ + \beta_9 NATRES_{it} + \beta_{10} PCIG_{it} + \beta_{11} SAV_{it} + \mu_{it}. \quad (3)$$

Where the variables are as defined above.

$\beta_0, \beta_1, \ldots, \beta_{11}$ are parameters taken as elasticities expect the constant intercept.

All the variables are in logarithmic transformation to essentially reduce the problem of heteroscedasticity resulting from large variance.

μ is the error term, which is identically and normally distributed.

The study employs a panel data regression approach on the basis that it ensures the control for independencies of unobserved independent variables on a dependent variable and this if not controlled may essentially lead to biased estimators in the familiar traditional linear regression models.

In the present study, three variants are employed. These are the panel least square method, the fixed effect, and the random effect methods. The fixed effect model differs clearly from the common effect even though it still employs the ordinary least square principle and is noticed to be consistent and controls for any individual-specific attributes that do not vary across time. However, it has been noted that the random effect is more efficient because it is estimated using the generalized least square and thus, has smaller variance.

Data on the variables was collected from the World Development Indicator for the period spanning 1995–2020; the period believed to have been identified with relative improvement in technological progress within some few countries in SSA.

Based on data issue and advancement in technology compared to other countries, nine countries in SSA were selected. Even at that missing data as a major problem of data gathering process appears inevitable. The countries selected are Angola, Botswana, Ghana, Kenya, Nigeria, Rwanda, South Africa, Uganda, and Zimbabwe.

4. Results

Descriptive statistics of the variables employed- access to electricity, exchange rate, foreign direct investment, ICT goods imported, mobile cellular subscription,

Table 1. **Descriptive statistics**

	EXCR	ICTGDIM	EXP	MOBCES	ACELEC
Mean	3.89	1.59	22.36	2.74	3.47
Median	4.32	1.60	22.25	3.42	3.66
Std. dev	2.71	0.47	1.84	1.82	0.81
Skewness	1.51	–0.28	–0.30	–0.36	–1.28
Kurtosis	11.55	2.45	2.76	1.53	4.62
J-B Prob.	0.00	0.13	0.14	0.00	0.00

Table 1. **Descriptive statistics (the end)**

	FDI	HC	INDVAD	NATRES	PCIG
Mean	0.63	1.49	3.27	2.05	–0.07
Median	0.71	1.62	3.23	2.07	0.73
Std. dev	1.22	0.42	0.39	0.86	2.83
Skewness	–2.74	–0.59	0.61	0.06	–3.20
Kurt	1.56	2.66	2.75	2.55	17.16
J-B Prob.	0.05	0.03	0.00	0.38	0.00

Source: Author's computation using E-views

industrial value added, internet usage, per capita income growth and savings is shown on Table 1.

The panel unit root test results are shown on Table 2. The test methods involved the Levin, Lin & Chut, lin, Pesaran and Shin W-stat, ADF-Fisher Chi-Square, and the PP-Fisher Chi Square. In order to accommodate all these, the tests are carried out under "Summary".

The test equation was based on individual effects (constant intercepts). The maximum number of cross sections is nine but where there were missing values, which were inevitable, number of cross sections fell below (Table 3).

5. Discussion

The descriptive statistics computed as shown on table 1 shows that Merchandised exports, which describe the values of goods exported, demonstrated the highest mean and median values in the series during the study period. This is reflecting the large volume of goods exported for the countries selected.

However, per capita income means, and median growth values appeared lowest during the period showing the apparent low level of development in SSA. The per capita income growth even though was lowest in mean and median values came with the highest spread as demonstrated by the standard deviation.

This again is a pointer to the unstable yardsticks in measuring the region's growth and development. The lowest fluctuation in the series was demonstrated by the industry value added. While all the variables appeared with positive kurtosis coefficients, only agricultural machinery, exchange rate, industrial value added, and natural resource rent have been identified with positive skewness during the period.

The J-B probability shows that only the ICT goods imported, merchandised export

Table 2. **Panel Unit Root Test Results**

Variable	Test Eqn.	Test Md	Cross section	Prob.	OI	Decision	Specific Md
ACELEC	Ind. Effect	Summary	9	0.01	I(0)	Stationary	L,L Ch*
EXCR	Ind. Effect	Summary	9	0.00	I(1)	Stationary	Lm, P,Shin, ADF, PP
FDI	Ind. Effect	Summary	9	0.00	I(0)	Stationary	Lm, P,Shin, ADF, PP
HC	Ind. Effect	Summary	4	0.00	I(0)	Stationary	All
ICTGDIM	Ind. Effect	Summary	4	0.0	I(0)	Stationary	All
INDVAD	Ind.Effect	Summary	9	0.00	I(0)	Stationary	L,L,Ch*,PP
NATRES	Ind. Effect	Summary	9	0.00	I(0)	Stationary	All
EXP	Ind. Effect	Summary	9	0.03	I(0)	Stationary	L,L, Ch*
MOBSEC	Ind. Effect	Summary	9	0.00	I(0)	Stationary	L,L Ch* ADF, PP
PCIG	Ind. Effect	Summary	9	0.00	I(0)	Stationary	Lm, P,Shin, ADF, PP
SAV	Ind. Effect	Summary	9	0.00	I(1)	Stationary	

Source: Author's computation using E-views. Test Md=Test Method, OI= Order of Integration, Specific Md=Specific Method

Table 3. **Panel Least Square, Fixed Effect and Random Effect Estimations**

Var.	Coeff.	Std. err	Prob.	Coeff.	Std. err	Prob.	Coeff.	Std. err	Prob.
C	7.18	2.62	0.01	7.20	3.38	0.04	7.18	2.85	0.01
ACELEC	1.87	0.42	0.00	2.21	4.15	0.00	1.87	0.46	0.00
EXCR	0.07	0.13	0.62	0.22	0.20	0.26	0.07	0.14	0.64
FDI	–0.20	0.08	0.01	–0.24	0.09	0.01	–0.20	0.08	0.02
HC	0.67	0.54	0.22	0.70	0.63	0.27	0.67	0.59	0.26
ICTGIM	1.19	0.24	0.00	0.89	0.32	0.01	1.19	0.26	0.00
INDVAD	2.05	0.60	0.00	0.56	0.97	0.57	2.05	0.65	0.00
INTNET	0.36	0.19	0.06	0.88	0.38	0.02	0.36	0.20	0.08
MOBCES	–0.38	0.16	0.02	–0.17	0.39	0.67	–0.38	0.18	0.03
PCIG	–0.08	0.05	0.08	–0.05	0.06	0.47	–0.08	0.05	0.11
SAV	–0.46	0.29	0.12	–0.04	0.38	0.92	–0.46	0.32	0.15
R^2	0.82			0.86			0.82		
R^2 Adj.	0.79			0.75			0.79		
Prob. F-stat.	0.00			0.00			0.00		
F.E Test				0.94/0.67					
Hausman Test							0.60		

Source: Author's computation using E-views

and natural resource rent are normally distributed in the series considering the 5% level of significance.

In the panel unit root test statistics provided on table 2, each of the variables employed access to electricity, exchange rate, foreign direct investment, ICT goods imported, mobile cellular subscription, industrial value added, internet use, per capita income growth and savings appears stationary in at least one of the test methods which essentially ensured that the variable in question is stationary though at varying levels of integration.

The results are a mixture of both levels and first difference-integrated variables with only exchange rate, savings and human capital variables integrated at their first differences. The study proposed the use of Autoregressive Distributed Lag Models but due to loss of information for the frequent lags on data with already missing observations, this estimation technique was dropped.

The estimated results are shown on table 3 for the panel least squares, fixed effect and random effect estimation techniques. First, starting from the measure of digital economy having controlled for the relevant, only the ICT technology goods imported, and internet users positively and significantly (though at varying levels) impacted on export in all three variants of estimation methods during the period under study. This is apparently in line with Abeliansky & Hilbert [31] who find a positive and significant relationship between export performance data subscription per capita and bandwidth data speed per subscription for 122 countries using gravity model of estimation.

This is also in line with the studies of Chu & Guo [32], Xing [33] and Ozcan [34]. However, greater positive impact of ICT goods imported on trade is shown for the panel least square and the random effect.

Thus, in comparison between the two technological components, the ICT goods imported showed greater positive impact on trade flows. By implication, ICT goods imported, internet usage and mobile cellular phone can foster domestic trade in terms of quantity and quality for export promotion.

However, mobile cellular phone subscription showed a depressing impact on trade flows across all estimations. This may be the results of frequent poor network services for which essentially delays communication. The results further show that both technological components are significant; however, significance of internet usage is only shown in the fixed effect estimation.

Thus, the hypotheses that ICT goods import, internet usage and mobile do not significantly impact on trade and that no form of digital technology can foster trade significantly are rejected.

Turning to the control variables, access to electricity infrastructure variable impacted positively and significantly on export trade in all the estimations indicating that electricity can enhance productive capacity towards improving export trade. Limitation here lies on the fact that many African nations like Nigeria still experience huge epileptic power supply amidst the mission to facilitate trade. Exchange rate demonstrating the degree of competitiveness impacted positively on export trade in the region.

Thus, appreciation of the domestic currency is better off in promoting export for foreign exchange. Industry value added coefficients are positive in all the estimations but significant for the panel least squares and the random effect estimations. This reflects the idea that the region's industrial structure may appear conducive to export trade even though the structure still needs further improvement particularly in SSA.

The coefficients of human capital variable showing government expenditure on education in the region is positive in each estimation but not significant. Thus, human capital can foster labour productivity efficiency in the industries through provision of more qualified workforce at its optimal level towards increasing domestic exports. However, the poor capacity building through low provision of funding essentially makes the impact of human capital less significant to trade in the region.

The per capita income coefficient is negative in each case showing at least 5% decrease in export trade for every 1% increase in regional development and demonstrating an apparently low level of regional development, which in turn does not seem to thrive trade. This is further supported by the insignificant coefficient of regional development indicator. Thus, the hypothesis that regional development does not significantly affect trade is accepted. This is further indicated by the negative coefficient of savings in all the estimations. Thus, the proportion of the national income saved appears not enough in boosting investment for huge export trade flows in the region. This essentially lowers the degree of openness to trade as demonstrated by the foreign direct investment variable whose coefficient is negative in each estimation. Thus, the scale effect, structural effect, and technological effect through which foreign direct investment influence export trade are weak in the SSA.

This finding is contrary to that of Macedoni [35] whose research finding shows a positive relationship between per capita income of the destination and export trade with concentration on product scope per exporter. The adjusted coefficient of determination, which essentially considers relevant explanatory variables, is high on the average. It shows that the explanatory variables explained over 75% of the variation in the export trade in SSA during

the period leaving out about 25% of the variation unexplained.

The redundant fixed effect tests show the acceptance of the hypothesis that fixed effects are unnecessary making the panel least square as a better choice. Furthermore, the Hausman test indicates that random effect estimation is comparatively better than the fixed effect. Thus, the study essentially relies on the results of both the panel least squares and the random effect estimations.

6. Conclusion

Advancement in digitalization has increased the pattern of flow of trade and trade relations of SSA `with the rest of the world as evident from some countries in SSA. Nigeria, Kenya and South Africa have been better off in terms of digitalization process in SSA with slight advancement in the ICT sector, mobile phone subscriptions and cellular internet of things respectively.

However, the huge success recorded in these areas has not significantly impacted on the region's competitiveness and trade performance due to low property protection, poor data protection, and unimpressive cyber security. Using the variants of panel regression technique, results showed that ICT goods imported, and internet usage positively related with export trade flows but with greater significant impact from the ICT goods imported.

Degree of development in SSA is still low and showed a drag to export trade flow in the region. In attaining the reality of the contribution of digitalization process in SSA, policy makers need to pursue major goals that would address problems mitigating its success.

ICT goods imported should be well coordinated and directed to the appropriate channel to support improvement in quality of produce. Attention should be on how to curb cyber frauds of any degree.

The misuse of technology in causing damage through defrauding has been highly discouraging and does not seem to show significant impact of technology on economic progress. Degree of development is low in SSA. Attempt should be made to increase basic infrastructure to further improve investment wherein saving is increased for a sustainable productivity growth.

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Цифровые технологии и эффективность торговли в странах Африки южнее Сахары

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Аннотация. В исследовании рассматривается взаимосвязь между цифровыми технологиями и показателями торговли с акцентом на экспортную торговлю в странах Африки южнее Сахары. Основные цели состоят в том, чтобы изучить влияние цифровых технологий, измеряемое импортом товаров, использующих информационно-коммуникационные технологии, использованием Интернета и числом абонентов мобильных телефонных сервисов, на экспортную торговлю в странах Африки южнее Сахары (АЮС), а также оценить связь между уровнем развития региона и состоянием экспортной торговли с развитием цифровых технологий, наиболее подходящих для содействия торговле в регионе. Гипотезы исследования заключаются в следующем: 1) импорт товаров, использующих информационно-коммуникационные технологии, использование Интернета и подписка на мобильные сервисы не оказывают существенного влияния на экспортную торговлю в АЮС; 2) развитие региона заметно не связано с экспортной торговлей в АЮС; 3) никакие виды цифровых технологий не могут облегчить процесс торговли в регионе. В работе применялся метод оценки панельной регрессии с учетом метода наименьших квадратов панели, фиксированного эффекта и методов оценки случайного эффекта. Результаты показывают, что импортируемые товары, использующие информационно-коммуникационные технологии, оказывают большее положительное и существенное влияние на потоки экспортной торговли по сравнению с использованием Интернета, демонстрируя теоретическую и практическую значимость технологий для осуществления торговли. Степень развития региона низкая и не оказывает заметного влияния на торговые потоки в регионе, что свидетельствует о том, что торговая интеграция может лучше развиваться в хорошо структурированной экономике. Избыточный тест с фиксированным эффектом подтверждает, что панельная оценка методом наименьших квадратов лучше по сравнению с оценкой с фиксированным эффектом. Тест Хаусмана показывает, что оценка случайного эффекта также лучше, чем оценка фиксированного эффекта. Для достижения реального вклада процесса цифровизации в АЮС лица, определяющие политику, должны преследовать основные цели, которые позволили бы решить проблемы, препятствующие его успеху.

Ключевые слова: цифровые технологии; торговля; метод наименьших квадратов; фиксированный эффект; случайный эффект.

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