



The KENYA INSTITUTE for PUBLIC
POLICY RESEARCH and ANALYSIS

Effect of Trade Digitalization on Kenyan Exports to the African Continental Free Trade Area

Shadrack Mwatu and John Karanja

DP/302/2023

THE KENYA INSTITUTE FOR PUBLIC POLICY
RESEARCH AND ANALYSIS (KIPPRA)

Effect of Trade Digitalization on Kenyan Exports to the African Continental Free Trade Area

Shadrack Mwatu and John Karanja

Kenya Institute for Public Policy
Research and Analysis

KIPPRA Discussion Paper No. 302
2023

KIPPRA in Brief

The Kenya Institute for Public Policy Research and Analysis (KIPPRA) is an autonomous institute whose primary mission is to conduct public policy research leading to policy advice. KIPPRA's mission is to produce consistently high-quality analysis of key issues of public policy and to contribute to the achievement of national long-term development objectives by positively influencing the decision-making process. These goals are met through effective dissemination of recommendations resulting from analysis and by training policy analysts in the public sector. KIPPRA therefore produces a body of well-researched and documented information on public policy, and in the process assists in formulating long-term strategic perspectives. KIPPRA serves as a centralized source from which the Government and the private sector may obtain information and advice on public policy issues.

Published 2023

© Kenya Institute for Public Policy Research and Analysis

Bishops Garden Towers, Bishops Road

PO Box 56445-00200 Nairobi, Kenya

tel: +254 20 2719933/4; fax: +254 20 2719951

email: admin@kippra.or.ke

website: <http://www.kippra.org>

ISBN 978 9914 738 28 5

The Discussion Paper Series disseminates results and reflections from ongoing research activities of the Institute's programmes. The papers are internally refereed and are disseminated to inform and invoke debate on policy issues. Opinions expressed in the papers are entirely those of the authors and do not necessarily reflect the views of the Institute.

Abstract

The African Continental Free Trade Area (AfCFTA) aligns with the Kenya National Export Development and Promotion Strategy (2018), which acknowledges the significance of regional integration in achieving the Kenya Vision 2030. The AfCFTA provides an opportunity for Kenyan goods and services to reach new markets across the African continent. This paper examines the effect of trade digitalization on Kenyan exports to AfCFTA. Specifically, the study examines the effects of information access, ICT infrastructure, digital payments, addressing systems, and cyber security on flows of exports to AfCFTA. These are key pillars that anchor digital trade. An analysis using the Vector Autoregressive (VAR) model on time series data has shown that investing in ICT infrastructure and promoting digital transactions can boost Kenyan exports to the AfCFTA. The study found that access to information had a positive and significant effect on exports, with the Internet being the main source of information on digital trade. The availability of digital infrastructure was also found to be crucial, as exports rose with increased international bandwidth. Digital payments were identified as a key factor in increasing Kenyan exports to the AfCFTA. Furthermore, the country's addressing system was found to have a positive and significant effect. The findings indicate that an increase in the capacity to send more outbound commodities by courier leads to a rise in Kenyan exports to the AfCFTA. To fully tap into opportunities presented by digital trade, issues relating to digital interoperability, digitalization of customs border processes, cyber security, digital trust, consumer protection, e-signatures, e-invoices, e-payments, data protection, investment in big data, e-taxation and digital tax administration, and dispute resolution could be given priority. Kenya could finalize the development and approval of the draft National Addressing Policy (2023) and the draft National Addressing Bill (2023), undertake full implementation of the Information Communication and Technology (ICT) Policy Guidelines of 2020, advocate for harmonization of data protection laws among AfCFTA members, and consider having a chapter on digital trade in current and future negotiations for trade agreements, strategic investment and economic partnership frameworks with specific focus directed towards supporting knowledge and technological transfers to Kenyan exporters.

Abbreviations and Acronyms

AfCFTA	Africa Continental Free Trade Area
CAK	Communication Authority of Kenya
EAC	East African Community
ICT	Information Communication Technology
ITC	International Trade Centre
OECD	Organization for Economic Cooperation and Development
UNCTAD	United Nations Conference on Trade and Development
Obs.	Observations
Std. Dev.	Standard Deviation
Min.	Minimum
Max.	Maximum
KRA	Kenya Revenue Authority
KNBS	Kenya National Bureau of Statistics
GDP	Gross Domestic Product
IDI	ICT Development Index
APEC	Asia-Pacific Economic Cooperation (APEC) economies

Table of Contents

1.	Introduction	1
2.	Policy Review	3
2.1	Trade Digitalization Legal Framework	3
3.	Literature Review	6
3.1	Review of Theories	6
3.2	Empirical Review	9
3.3	Summary of the Literature Review	12
4.	Methodology	14
4.1	Theoretical Framework	14
4.2	Data and Variables	15
4.3	Summary Statistics	17
4.4	Diagnostic Tests	20
5.	Results and Discussion	23
5.1	Empirical Results	23
6.	Conclusion and Policy Implications	28
6.1	Conclusion	28
6.2	Policy Implications	28
7.	References	29

List of Tables

Table 4.1: Description of the variables.....	15
Table 4.2: Summary statistics.....	17
Table 4.3: Augmented Dickey-Fuller Stationarity Test—at levels.....	21
Table 4.4: Augmented Dickey-Fuller Stationarity Test—at first differences	21
Table 5.1: Results from Vector Autoregressive (VAR) estimation	23

1. Introduction

The African Union (AU) established the African Continental Free Trade Area (AfCFTA), which is a single cross-border market for goods and services across the continent. The AfCFTA offers preferential market access in 54 African countries by eliminating import tariffs on 90 per cent of tariff lines, making African products less expensive and more preferred in the African market. However, the question on how to access the larger continental market remains a challenge for African countries due to inadequate interconnectedness in the region (UNCTAD, 2019).

To strengthen intra-Africa trade, and market access in the region, the Africa Union developed the Digital Transformation Strategy for Africa (2020-2030). The development of this strategy is an indication that digitalization is key in facilitating market access for exports in the region. The strategy aims for African countries to develop and improve digital networks and services and to give high priority to digitally supported socio-economic development. This is meant to promote digital trade across the continent by establishing a secure digital single market in Africa by 2030, where free movement of people, products, and capital is assured, and individuals and businesses can easily access and engage in online activities (Digital Transformation Strategy for Africa, 2020).

Although studies have shown that digitalization of trade promotes exports performance and economic growth (Andrianaivo and Kpodar, 2012; Jiang and Jia, 2022; Wang and Li, 2017; Arvin et al., 2021; Song and Isaac, 2021; Haftu, 2019; Shahiduzzaman and Alam, 2014; Erumban and Das, 2016; Ward and Zheng, 2016; Jin and Cho, 2015; Rodriguez-Crespo and Martinez-Zarrazoso, 2019; Abelianksy and Hilbert, 2017; Salahuddin and Gow, 2016), few have examined the influence of digital trade on Kenyan exports within the African Continental Free Trade Area (AfCFTA). Access to information, existence of a supportive and facilitative infrastructure, digital payments, an addressing system, and cyber security are key pillars that anchor digital trade. These pillars of digital trade facilitate the reduction of transaction and adjustment costs (Abramovsky and Griffith, 2006; Tang, 2006). Reduction in these costs incentivizes trade activity. Milner and McGowan (2013) observe that countries that incur low trade costs account for a larger share of world exports.

The existing studies have gaps as they have scarcely examined the influence of these pillars of digital trade on Kenyan exports within the AfCFTA framework. The current study, therefore, endeavours to fill this gap in the literature and to generate evidence that could inform policy options for promoting the contribution of Kenya's exports to the country's Gross Domestic Product (GDP) as envisioned in the country's Integrated Export Development and Promotion Strategy. Against this background, this study aims to examine the effect of trade digitalization on Kenyan exports to the AfCFTA. Specifically, the study strives to achieve five objectives, which are: examine the effect of information access on Kenyan exports to AfCFTA, examine the effect of ICT infrastructure on the flow of Kenyan exports to AfCFTA, examine the effect of digital payments on Kenyan exports to AfCFTA, examine the effect of addressing system on Kenyan exports to AfCFTA,

and examine the effect of cyber security on Kenyan exports to AfCFTA. Therefore, examining the effects of trade digitalization on Kenyan exports flow to AFCFTA is timely and critical to policy makers as the country embarks on accessing the regional digital market.

2. Policy Review

2.1 Trade Digitalization Legal Framework

In Kenya, trade digitalization framework takes place in form of e-commerce. The Electronic Transactions Bill of 2007 and the Information and Communications Bill of 2008 were the first laws in Kenya to regulate e-commerce. Furthermore, the Kenya Information and Communications Act of 2009 was enacted because of these efforts. The Electronic Transactions Regulations of 2009, which went into force in 2010, were promulgated in response to the Act. Additionally, the government is dedicated to encouraging the expansion of electronic commerce in Kenya by simplifying electronic transactions in accordance with CAP. 411A Laws of Kenya.

The Laws of Kenya CAP. 411 commits to increase public trust in the integrity and reliability of electronic records and transactions by building good frameworks to reduce the occurrence of falsified electronic records and fraud in electronic commerce and other electronic activities. The Computer Misuse and Cybercrimes Act of 2018 was enacted to further protect the use of data. The Act aims to protect the confidentiality, integrity, and availability of computer systems, programmes, and data while also making it easier to prevent, identify, investigate, prosecute, and punish cybercrime.

Therefore, Kenyan online trade platform, are not regulated under the Kenya Information and Communications Act of 2009 since they are not electronic services as defined by the Act and are not licensable. As a result, customers are unable to benefit from the Consumer Protection Regulations 2010, which apply when the Authority's licensees provide services. This poses a challenge in accessing the AfCFTA market through online trade platforms. In addition, the National Payment System Act (2015) and the Guidelines on Cybersecurity for Payment Service Providers (2019) were enacted to make online payment settlement easier to regulate and supervise. The Kenya National Payments System Vision and Strategy (2021-2025) was also released by the Central Bank of Kenya, with the aim of strengthening Kenya's global leadership in digital payments by developing a world-class, secure, resilient, and collaborative payments system that drives Kenya's economy and transition to cash lite.

Currently, the e-commerce regulatory environment is changing with the introduction of the Finance Act 2020, which introduced digital service tax (DST) at a rate of 1.5 per cent of the gross transaction value, which shall be payable by a person whose income from services is derived from or accrues in Kenya through a digital marketplace. The tax shall be due at the time of the transfer of the payment for the service to the service provider (Kenya Revenue Authority, 2021). The DST became effective on 1st January 2021, with implementing regulations by the KRA now in force. Despite the robust growth of the digital economy, the DST poses significant uncertainties and concerns and it is unclear on how the tax will affect the growth of digital trade in the country as traders embrace technology in doing business.

The National ICT Policy (2019) recognizes technology as a tool for competitive advantage in the global market, which facilitates growth in cross-border trade. The Communications Authority of Kenya (2020) has identified the availability of Internet services and access to financial services as the two key enablers of e-commerce in the country. As a result, Kenya has taken steps to promote trade digitalization and automation through the formation of the National Electronic Single Window System (NESW) under the National Electronic Single Window System Act of 2016. The NESW attempts to address the issues affecting import and export cargo documentation procedures.

Further, the 2016 National ICT Policy places science, technology, and innovation (STI) at the heart of the country's economic competitiveness. Indeed, trade digitalization is a critical component that could improve the competitiveness of Kenyan firms in diversifying their products and accessing new markets in the continent, thus boosting the achievement of the country's development aspirations as espoused by the Kenya Vision 2030. The ICT policy aims to secure cross-border broadband connectivity to enhance cross-border trade in goods and services.

In addition, the Kenya Digital Economy Blueprint (2019) provides the digital business pillar, which emphasizes the growth of a robust digital market categorized by improved quality of fair competition, financial inclusion, solid information infrastructure, progressive consumer protection, and better regional integration (Ministry of Information Communications and Technology, 2019). The development of a vibrant industry for digital trade, financial services, and content is emphasized through the digital business pillar. However, this requires establishing a cost-effective, efficient, and secure payment system, promoting a stronger legislative framework, and developing regional channels for cross-border trade. These pillars advocate for e-commerce to transcend national borders and for Africa to unite as a unified digital market, resulting in economies of scale.

2.1.1 Data protection

To enhance online transaction data protection, Kenya's Data Protection Act (DPA) came into effect in 2019. The DPA gives effect to Article 31 of Kenya's Constitution, which guarantees the right to privacy as a basic right. The DPA is largely based on the General Data Protection Regulation of the European Union. The DPA 2019 established the Office of the Data Protection Commissioner (ODPC), giving effect to Article 31(c) and (d) of the Constitution, which contain the right to privacy; regulates the processing of personal data; provides for the rights of data subjects; and imposes requirements on data controllers and processors.

The ODPC acts as a resource tool for data protection information, guidelines, compliance requirements, and data subject rights. Members of the public will, therefore, be able to report online issues such as data breaches, file complaints, and bring privacy concerns to the attention of the data commissioner. The Act also empowers the data commissioner to issue regulations that, among other things, establish mandatory registration thresholds for data controllers and processors. Importantly, the Act allows personal data to be transferred to other countries

or organizations that have put in place the essential protections to protect data subjects' privacy rights in connection to their personal data. As a result, personal data cannot be transferred outside of Kenya unless verification of competent data protection processes can be shown.

The Act demonstrates Kenya's readiness to participate in cross-border digital trading. This is important for trade digitalization since the Act requires data and information managers to make data storage, transit, and lineage more transparent. Since cross-border trade through digitalization will involve data transfer, a clear understanding of what data is obtained, where it is kept, and when it is migrated to other organizations will be crucial for improving individual data privacy and rights.

2.1.2 Consumer protection

The Consumer Protection Act (CPA) 2012 was enacted to promote and advance the social and economic welfare of consumers in Kenya, including the protection of the consumer and preventing unfair trade practices in consumer transactions. The CPA sought to address issues of consumer protection that had not been addressed by the Competitions Act of 2010. The CPA clarifies the legal relationship between firms and consumers during electronic transactions. The Act prohibits all unfair trade practices especially when the vendor purports that the goods or services are available or can be delivered or performed when the person making the representation knows or ought to know they are not available or cannot be delivered or performed.

Further, the Kenya Information and Communications (Consumer Protection) Regulations 2010, seek to protect consumers as stipulated by the Constitution of Kenya 2010, Article 46. The regulations are meant to ensure that a customer shall have the right to receive clear and complete information about rates, terms and conditions for available and proposed products and services. Further, the regulations require that customers be charged only for the products and services they subscribe to. In addition, the regulations emphasize on personal privacy and protection against unauthorized use of personal information.

To ensure that there are fair trade practices, the regulations require vendors to provide accurate and understandable bills for products and services authorized by the customer, and to fair prompt redress in the event of a dispute in the provision of the products and services. Further, unfair trade practices are prohibited, including false and misleading advertising and anti-competitive behaviour by licensees. This is very critical in accessing the AfCFTA market, as it will provide equal opportunity for access to all vendors, and ensure customers are provided with the same type and quality of service as other customers in the same area. However, the Consumer Protection Act does not adequately capture the pertinent issues such as trust in digital transactions.

3. Literature Review

3.1 Review of Theories

3.1.1 Endogenous Growth Theory

Development and utilization of technological knowledge is internal to the economic system (Howitt, 2010; Aghion and Howitt, 1998; Aghion and Howitt, 1992). At the heart of this theory is the argument that the rate of technological progress influences competitiveness of an economy and in effect this promotes growth. Technological progress takes place through innovations that reduce trading costs and thus promote competitiveness as a key driver of sustainable growth and development (Pece et al., 2015).

Technological progress as manifested through innovations is endogenous because countries can influence their development and utilization through targeted policy incentives (Grossman and Helpman, 1991; Romer, 1990; Uzawa, 1965). Digitalization of trade is a novel innovation that promotes symmetry of information between buyers and sellers on key aspects such as product being offered for sale, product characteristics, product selling price, and even aspects of the buyer, such as preferences for certain products. Digitalization as an innovation also develops an ICT infrastructure that facilitates digital transactions, deepens the uptake of digital payment options, develops and synchronizes an addressing system, and presents solutions to cyber security concerns.

3.1.2 Schumpeterian Theory of Innovation

According to Schumpeter, preferences for consumers are provided for and they are not done spontaneously, meaning they do not affect economic changes. Consumers are further seen to play a passive role in contributing towards economic development. In addition, Schumpeter adds that development is a historical process of structural transformation driven by innovation, to a large extent. He categorizes innovation into five sub-components as follows: launching of a new product/species of products that are already known; employing new ways of production or sales of the products; opening of new markets; sourcing of new supply of raw materials/semi-finished goods from new sources; and destroying monopoly position by the creation of a new industry structure.

The AfCFTA presents opportunities that will require the launching of new products to access new markets. This will involve employing new ways of production, which will require innovation and the use of technology to enhance sales in markets that were not accessible before in the continent. As such, digitalization in trade will be key in sourcing raw materials. According to Schumpeter, innovation is an integral driver in enhancing competitiveness. Firms or individuals seeking to maximize profits must be innovative. He attributes the benefits of innovation to

the employment of the existing productive systems of the economy. Innovation is seen to be the core of economic change creating the notion of “creative destruction” in the disciplines of Socialism, Capitalism, and Democracy as per Schumpeter assertion (Bailey et al., 2018). Innovation is further seen to bring about industrial mutation, constantly revolutionizing the economic structure from within while destroying the old and creating new systems.

Since the coining of innovation as a driver of development and structural changes, Schumpeter further categorizes innovation into four dimensions starting from invention, innovation, diffusion to imitation. He then brings the concept of entrepreneurs into the equation bringing about the possibility of emanating from scientist discoveries and investors in the creation of new investment opportunities, employment, and growth. According to Schumpeter’s assertion, the invention phase has little impact compared to diffusion and imitation which, has a high impact on economic situation. The macroeconomic effects may take a long period before they are felt. Schumpeter further emphasized that investment, employment, and economic growth are a result of basic innovation diffusion rather than its discovery. This is the period when the potential profits are felt by the investors from the new products developed or the processes involved, thus making them embrace technology and invest more in it.

Lastly, Schumpeter's school of thought believed that innovations are “creative destruction” that builds the economy while the changes are brought about by entrepreneurial skills. Entrepreneurs are bestowed with the functions of conducting and carrying out innovations (Śledzik, 2013). Some fundamental characteristics of entrepreneurs include intelligence, alertness, energy, and determination, which translates to actual innovations. The most lasting contribution of Schumpeter was the emphasis on entrepreneurship as a factor of production that drives economic growth and development. The success in market access under AfCFTA through digitalization will need the entrepreneurs to enhance their skills for innovations to transfer into actual outputs. As a result, the entrepreneurs in this platform of digital trading will be a very essential factor of production. The theory suggests that technology will drive competitiveness, which is key in market access.

3.1.3 The Teece Model of Innovation

The Teece model of innovation, developed by David Teece in 1986, examines who benefits from technological innovations, and the roles of technology imitability and complementary assets in appropriating gains from innovations. The model explains why certain businesses are unable to benefit from new technologies. Inventing a product or service, according to this paradigm, is not enough for a company to profit from it. The gain from innovations is determined by the innovation's imitability and complementary assets.

Under the AfCFTA, complementary assets in innovation will play a critical role in trade digitalization. The ability of digital trade inventions to withstand the threat of being copied by competitors will be a major factor in determining how much benefit the firms will reap from innovation. Furthermore, according to the

model, a firm should develop complementary assets in the form of activities such as distribution channels, marketing, brand name, customer service, partnerships, and collaborations. Controlling these activities ensures that a firm benefits from innovations.

To gain from digital trade in Kenya and enhance market penetration, firms will need to develop complementary assets such as digitally enabled new distribution channels, digital marketing, innovative customer service, and strategic partnerships and collaborations. To reap the benefits of digital trading, innovative approaches to ensure market access within the AfCFTA will need to be established.

3.1.4 The Standard Trade Theory

The Standard Trade Theory combines the Ricardian, Specific Factors, and Heckscher-Ohlin theories. It stipulates that differential in technological innovations drive differences in production possibility frontiers, which consequently determine a country's relative supply function for tradeable goods and services (Krugman et al., 2017).

Under the AfCFTA, liberalization is expected to eradicate entry barriers for Kenyan goods and services within the continental market, thus sending a signal to local traders to expand the volume of goods and services exported to the continent. Kenyan exports of goods and services to AfCFTA are, therefore, expected to increase with liberalization, which comes with reduced market access barriers. Liberalization is also expected to present consumers with choice over variety of goods and services that satisfy their tastes and preferences and thus improve their welfare. As consumers from importing countries within AfCFTA endeavour to satisfy their tastes and preferences from the variety of goods and services, Kenya's exports to AfCFTA as a share of the country's total exports to the world or as a share of Kenya's exports to AfCFTA in the continent's total imports is expected to surge. This is expected to make the Kenyan economy better off than it was before liberalization under the trade deal.

Digitalization is expected to improve Kenya's terms of trade by providing an opportunity for the country to market and showcase its goods and services, provide a digital medium through which exchange of goods and services can take place, and enhance trade facilitation by linking sellers to potential buyers at lower costs. A rise in Kenya's terms of trade due to digitalization will in effect improve the welfare of the country and facilitate the realization of development aspirations as enshrined in the Kenya Vision 2030.

3.2 Empirical Review

3.2.1 Information and export flows

Various studies have used Internet subscriptions as a proxy for information access (Rodriguez-Crespo and Martinez-Zarzzoso, 2019; Abelianksy and Hilbert, 2017; Stenberg, 2018; Basu, 2011). Borrowing from these studies, this study uses the number of website domains and the number of mobile SIM subscriptions as proxies for access to information. The understanding is that website domains and mobile SIM subscriptions are heavily reliant on Internet use. Access to the Internet has also been demonstrated to integrate countries into the world market, and this plays a critical role in promoting export performance (Gnangnon and Iyer, 2018; Mina, 2010; Harb, 2017; Omanga, 2019).

At the firm level, firms with access to the Internet have also been shown to be the ones that export more (Clarke, 2008), and this points to the elevated role of the Internet in providing information to sellers about requirements of buyers in different markets. The Internet empowers buyers and consumers by making them more knowledgeable (Asongu and Nwachukwu, 2016; Sun, 2021; Pingo, 2014). Enhanced knowledge among consumers promotes demand for high quality goods and services while for sellers, improved knowledge on preferences of consumers enhances packaging and supply of goods and services that meet the specific market needs. Gnangnon (2020) illustrates that enhanced access to the Internet improves diversification of exports. This is possible because the Internet presents buyers and sellers with information that is then used to match supply with demand in a manner that satisfies consumer preferences. Information also supports innovation by firms, and this is key in developing new and improved products for export (Zhang and Liu, 2023).

Studies have shown that digitalization enhances access to information, knowledge, financial services, and markets (Mabaya and Porciello, 2022). Digitalization reduces trading costs and creates incentives among producers to improve quality of the produced goods for the export market (Chiappini and Gaglio, 2023). Other studies have shown that access to the Internet improves digital skills (Caldarola et al., 2023) and this is key in enhancing digital efficiency. Access to information through the Internet promotes inclusive growth (Ejemeyovwi, 2018; Fuller, 2019; Xing, 2017). The Internet has been used to establish and nurture relationships (Adjei et al., 2016). This study argues that these relationships are central for market access and survival, which is important in sustaining Kenyan exports to the AfCTA.

3.2.2 Infrastructure and export flows

Evidence shows that ICT infrastructure supports digital trade with the outcome being a rise in exports (Kere and Zongo, 2023). ICT infrastructure also promotes economic growth (Pradhan et al., 2014). As measures of the supportive ICT

infrastructure, broadband and bandwidth capacity have been shown to have a positive effect on exports (Abeliansky and Hilbert, 2017; Yong et al., 2011). Barbero and Rodriguez-Crespo (2018) also examined the effect of broadband as a proxy for ICT infrastructure on trade in the European Union and found that ICT infrastructure has a positive and statistically significant effect on trade patterns across EU members. Fibre and broadband infrastructure have also been shown to have a positive effect on export competitiveness on the European Union economies (Gruber et al., 2014; Stoycheff and Nisbet, 2014).

Chung et al. (2013) used fixed telephone lines as proxy for ICT infrastructure. Their findings indicate that ICT infrastructure has a positive and significant effect on export flows of Asia-Pacific Economic Cooperation (APEC) economies. Investments in ICT infrastructure positively influence economic growth (Pradhan et al., 2016). Indeed, ICT investments have positive effects on the export of manufactured commodities, especially from industries with low technological content (Santibanez and Castillo, 2011). Export competitiveness is one of the key channels through which sustainable economic growth is realized. E-commerce platforms are seen as innovations presenting opportunity to producing firms to engage in trade and reach new markets (Moodley and Morris, 2007). Indeed, studies note that ICT infrastructure is an enabler of digital transactions (Afolabi, 2023; Nguyen et al., 2023; Haruna and Alhassan, 2022; Rodriguez-Crespo et al., 2021) and therefore serves as the backbone upon which digital trade takes place.

A study conducted by Chiappini and Gaglio (2022) on digital intensity, trade costs, and export quality upgrading, the influence of digital intensity on exports from developing countries is particularly important in specific sectors. The study reveals that digitalization in trade reduces the barriers to sharing common languages. Further, there is an increase in sectoral digital intensity associated with an improvement in the quality of exported products. The study concludes that digitalization is critical in improving export flows. It helps reduce communication and shipping costs while improving the quality of exported items.

3.2.3 Digital payments and export flows

Evidence demonstrates that digital payments promote export competitiveness through reduction of transaction costs and enhancement of financial inclusion (Ghosh, 2016; Tchamyu et al., 2019). Digital payments promote exchange of goods and services, and this is key in promoting export activity. On financial inclusion, studies have demonstrated that digital payments could improve gender parity in participation in trade activity, with women being more empowered to participate in export trade (Asongu et al., 2021; Mndolwa and Alhassam, 2020).

Previous studies have demonstrated that digital payment platforms allow users to access preferential credit that is key in facilitating trade activity (Johnen and Oliver, 2022). In Kenya, the M-pesa digital payments system has enhanced payments and facilitated trade activity (Kingiri and Fu, 2019; Morawczynski, 2009; Shaw and Kesharwani, 2019). The digital payments platform is widely used in trade transactions especially within the East African Community (EAC) countries.

Studies have demonstrated that mobile money transactions have a positive effect in Africa and elsewhere in the world (Ahmad et al., 2023; Onyango and Ondiek, 2021; Kleibert and Mann, 2020; Tetteh, 2023; Gheraia et al., 2022; Kabbiri et al., 2018); and sustains the resilience of households, hence sustaining the demand for exported commodities (Yao et al., 2023; Wang et al., 2005; Xu et al., 2023). Evidence shows that the Internet encourages usage of mobile payment systems (Nguyen et al., 2020; Paolo and Roberts, 2022; Das and Chatterjee, 2023; Uwamariya et al., 2021).

According to a study by Schierz et al. (2010) of German customers' mobile payment behaviour, accessibility, convenience, and personal mobility are the primary variables influencing consumers' use of mobile payment. The same result was drawn from the study on Korean customers' mobile payment habits by Kim, Mirusmonov, and Lee (2010). Age, external influences, usefulness, and perceived risk have all been demonstrated to affect people's readiness to accept mobile payments in other studies (Liébana-Cabanillas, Sánchez-Fernández, Muñoz-Leiva, 2014). Consumers typically use cash because it is simple to use and widely accepted, according to the model of consumer payment choice. However, the effects of incentive programmes for credit cards will encourage the use of debit cards instead of cash. Consumers still favour using cash in numerous transactions, even after taking merchant card acceptance into account (Arango, Huynh, Sabetti, 2015). The results of evaluating the effects of debit card use on cash holdings and cash usage reveal that these factors are greatly decreased by the payment function of debit cards, making them an ideal alternative to cash. Consequently, it is evident that digital payments significantly impact on consumer demand, promoting household consumption and sustainable economic development (David, Abel, Patrick, 2016).

3.2.4 Addressing system and export flows

Digital trade is incomplete without an elaborate addressing system that facilitates identification of the locations where buyers and sellers are based. Such an addressing system could facilitate delivery of goods ordered through digital platforms. The system could facilitate sellers and buyers to locate each other in case of a dispute. The addressing system is, therefore, central to reduction of costs of conducting trade, hence governments and development partners could invest in development of elaborate addressing systems that are recognizable digitally (Okunoye, 2022; Zhou et al., 2018). It could reduce the time taken for ordered goods to be delivered, and this is key in reducing trading costs and encouraging trade activity.

An elaborate addressing system could develop and nurture relationships between sellers and buyers in different countries within the AfCFTA. This could promote survival and competitiveness of Kenyan exporters to the AfCFTA. The exchange of information through the established relationships could inform product improvement to suit buyer preferences. The outcome is sustained and competitive performance of Kenyan exports within the AfCFTA.

According to a study by UNCTAD in 2015, nearly 60 countries do not have a postcode system in place. Developing countries are facing a major challenge when it comes to addresses, particularly in large urban areas with crowded neighbourhoods. Delivery personnel must often call recipients repeatedly as they navigate through narrow alleys and lanes to confirm directions. In the absence of government intervention, markets and technology are filling the gap, with companies innovating to overcome these obstacles. This poses a challenge in the update of digital trade in the developing countries such as those that are members of the AfCFTA.

3.2.5 Cyber security and export flows

Previous studies hold that access to secure and reliable Internet and ICT services unlocks bilateral trade flows especially among developing countries (Xing, 2017). In China, evidence has shown that cyber security concerns reduce manufactured exports by about 2.32 per cent on average (Jiang et al., 2022; Jiang et al., 2023; Alaca and Celik, 2023; Yelland, 2013). This study argues that when the safety of Internet users is guaranteed, then confidence and trust is instilled, and this encourages trade activity whose outcome is improvement in Kenyan exports to the AfCFTA.

Studies have also documented that a secure cyber space discourages trade in counterfeit products and encourages transactions on genuine and quality products (Gachago, 2013; Gomez and Lichtenberg, 2007). Safety and privacy of data while transacting through digital platforms is key to buyers (Greuter and Sarmah, 2022; Galinec et al., 2017) and ensuring digital platforms used to undertake transaction digitally are safe and secure in a manner that promotes security could enhance participation in export activity. Privacy and security of data while transacting digitally nurtures trust, reciprocity, and confidence, which consequently encourages utilization of digital platforms for trade (Cofta, 2006; Ebert, 2020; Crandall and Allan, 2015; Griffith, 2022; Dai and Gomez, 2018).

A study by Metalidou et al. (2014) found that humans are 86 per cent and 63 per cent more likely than technology to create a security breach. According to a different study by Saeed et al. (2013), errors made by humans are responsible for 80 per cent of cyber attacks. Information security risks based on human behaviour are constantly a challenge for businesses to prevent and mitigate. While human-technology interactions present security hazards, it is necessary to embrace and invest in advanced information systems to gain a competitive advantage and seize a sizable portion of the market. According to Alavi et al. (2016), customers and employees working in a firm are the weakest link in cyber security risk and management.

3.3 Summary of the literature review

The reviewed literature shows that previous studies have not been able to quantify the effects of digitalization on export activity. However, information and

communication technology (ICT) has been acknowledged as a vital component in trade digitalization. According to the literature, developing economies that need to use digitalization for cross-border trade and market access should consider their local digital infrastructure capabilities, which could limit their ability to exploit trade digitalization.

While appreciating the efforts by African countries in Internet penetration, the literature highlights the need to develop human capacity, particularly at the levels of education, development of improved digital skills, investment in public access to digital platforms, and the capacity to build a safe and trusted cyberspace, which are essential for market penetration in international trade through digitalization. All these are necessary to reduce the possibility of human rights' breaches through technology and particularly the privacy of personal information.

Further, the need to create trust with online business and transactions remains an issue from the previous studies especially with institutions handling data in developing countries in Africa. Literature has emphasized more on enhancing cross-border trade through digitalization, but the issue of market access through trade digitalization, has not been comprehensively addressed in the literature, and this study therefore aims to fill that gap.

4. Methodology

4.1 Theoretical Framework

For digital trade to take place, buyers should gain access to information on the various goods and services being sold and the selling price. For this to happen, there must be infrastructure enabling buyers to place orders and sellers to showcase the various products available for purchase. Once buyers can successfully place orders, the next step is to make payments. The payments are made digitally. For the ordered product to be discharged from the seller and successfully reach the buyer, an addressing system is vital to help deliver the product at the buyer's location. The addressing system helps the buyer locate the seller. It is integral in creating mutual trust, confidence, and exchange of feedback. Lastly, successful access to information, placement of order, and making of payments digitally is dependent on the security of the digital platforms used.

In Kenya, data on these five pillars of digital trade is obtained from the Communication Authority of Kenya (CAK). Digital trade is an innovation that supports endogenous economic growth (Aghion and Howitt, 1998; Lucas, 1988; Dinopoulos and Thompson, 1998; Schumpeter, 1942). Innovations promote sustainable growth by changing the structure of economies and transforming them to become more dynamic and resilient.

For a regionally integrated market such as the AfCFTA, digital innovations that enhance access to market and product information, strengthen supportive ICT infrastructure, synchronize digital payments across the region, improve identification and location of buyers and sellers through a robust addressing system, and promote cyber security could promote Kenyan exports and in effect spur sustainable economic growth and development. The technological change through digital innovations could enhance Kenya's export competitiveness and in effect improve the contribution of Kenya's exports to the AfCFTA in the country's GDP.

(Exports) = f(information, infrastructure, ePayments, addressing system, cyber security, exchangerate, interest rate) (4.1)

$$Exports_t = \beta_{ot} + \beta_{it} Information + \beta_{jt} Infrastructure + \beta_{kt} ePayments + \beta_{lt} Addressing + \beta_{mt} Cyber + \beta_{nt} Exchange rate + \beta_{ot} Interest rate + \mu \quad (4.2)$$

Kenyan exports to the AfCFTA are conceptualized to be a function of access to information, ICT infrastructure, digital payments, addressing system, cyber security, the exchange rate, and lending interest rate as indicated in equation 4.1. The exchange rate is the price of converting one currency to another while undertaking trade transactions. Theoretically, a depreciation of the Kenyan currency against currencies used to clear trade obligations by the AfCFTA members would be expected to make Kenyan exports cheaper and thus more competitive in the regional market. The lending interest rate is reflective of the cost that would

be incurred to obtain trade financing to get Kenyan commodities to cross-border markets.

The functional form of equation 4.1 is translated into an econometric equation (4.2), which is estimated to obtain coefficients that indicate the effect of the various elements of the five pillars of digital trade and the controls used on Kenyan exports to the AfCFTA. In equation 4.2, $i, j, k, l, m, n,$ and o are vectors representing the various elements of access to information, ICT infrastructure, digital payments, addressing systems, cyber security, the exchange rate, and lending interest rate. The specific elements of each pillar are elaborated in section 4.2 on data and variables.

4.2 Data and Variables

Quarterly time series data is used to support empirical analysis. A total of 35 quarters spanning from the second quarter of 2014 to the fourth quarter of 2022 are used. The 35 time points adequately cover at least 30-time-observations needed in time series data analysis for the central limit theorem to hold (Hoga, 2018; Fortune et al., 2020). The choice of quarterly data is informed by the absence of adequate annual data covering at least 30 years. This is because trade digitalization is a relatively current phenomenon with hitherto scanty data.

The data comes from various sources. The series on flows of Kenyan exports to the AfCFTA is obtained from the Kenya Revenue Authority (KRA) while the series on quarterly GDP is sourced from the Kenya National Bureau of Statistics (KNBS). The share of Kenyan exports to the AfCFTA in Kenya's GDP yields the dependent variable for the analysis. A consistent growth in this share would be indicative of an improving market access for Kenyan exports.

The regressors constitute variables on the five selected pillars of digital trade, which are: information, infrastructure, digital payments, addressing system, and cyber security. The exchange rate and the lending interest rates are incorporated as controls. A tabular format is used to present the variables used in the estimation. The measurement and rationale for use of specific variables is documented in Table 4.1.

Table 4.1: Description of the variables

Variables	Measurement	Purpose
Dependent variable		
Share of exports ¹ in GDP	Kenyan exports to the AfCFTA in Kenyan Shillings divided by Kenyan GDP at market prices in Kenyan Shillings	Measure of market access for Kenyan exports within the AfCFTA. Larger share of Kenyan exports to the AfCFTA in GDP is indicative of enhanced market access

¹ Kenyan exports to AfCFTA

Independent variable		
Information		
i. Website domains	Total number of registered website domains	Facilitates access to information for both buyers and sellers
ii. Mobile SIM subscriptions	Total number of mobile SIM subscriptions	Facilitates access to information for both buyers and sellers
Infrastructure		
i. Available international bandwidth (Gbps)	Bandwidth in billions of bits per second	Indicative of the infrastructure supporting digital transactions
ii. Used international bandwidth (Gbps)	Bandwidth in billions of bits per second	Indicative of the infrastructure supporting digital transactions
iii. Outbound roaming data (MB)	Roaming data in megabits per second	Indicative of the infrastructure supporting digital transactions
iv. Inbound roaming data (MB)	Roaming data in megabits per second	Indicative of the infrastructure supporting digital transactions
Digital payments		
i. Mobile money subscriptions	Total number of mobile money subscriptions	Supportive of digital payments
Addressing system		
i. Outgoing courier items	Total number of outgoing courier items	Proxy for addressing system
ii. Incoming courier items	Total number of incoming courier items	Proxy for addressing system
Cyber security		
i. Cyber threats reported	Total number of cyber threats reported	Proxy for cyber security
i. Cyber threat advisories	Total number of cyber threat advisories	Proxy for cyber security
Controls		
i. Exchange rate	Exchange rate in terms of Kenyan Shillings per United States Dollar	Currency depreciation makes exports cheaper and therefore competitive
ii. Lending interest rate	Lending interest rate in Kenyan Shillings	Lending interest rate is the cost of acquiring trade financing to support export activity

4.3 Summary Statistics

Table 4.2: Summary statistics

Dependent variable	Obs.	Mean	Std. Dev.	Min.	Max
Exports share in GDP	35	0.028	0.009	0.018	0.066
Independent variable					
i. Website domains	35	74,615.510	21,669.080	32,508.000	10,0420.000
ii. Mobile SIM subscriptions (millions)	35	48.900	11.500	32.200	65.700
Infrastructure					
i. Available international bandwidth (Gbps) (billions)	35	5,391.857	3,576.316	1,970.000	1,1971.000
ii. Used international bandwidth (Gbps) (billions)	35	2,289.429	1,902.069	850.000	6,470.000
iii. Outbound roaming data (MB) (millions)	35	21.500	27.800	0.813	110.000
iv. Inbound roaming data (MB) (millions)	35	43.300	42.900	2.462	172.000

Digital payments					
i. Mobile money subscriptions (millions)	35	30.600	3.637	24.800	38.600
Addressing system					
i. Outgoing courier items (millions)	35	0.943	0.500	0.333	2.665
ii. Incoming courier items (millions)	35	1.466	0.983	0.083	2.720
Cyber security					
i. Cyber threats reported (millions)	35	41.500	65.100	3.463	278.000
i. Cyber threat advisories (millions)	35	0.488	1.260	0.0006	5.314
Controls					
i. Exchange rate	35	103.714	7.683	87.249	121.952
ii. Lending interest rate	35	13.780	1.966	11.877	18.147

For the period under study, the summary statistics indicate that Kenyan exports to the AfCFTA have contributed an average of 2.8 per cent to the country's GDP, with the minimum and maximum shares being 1.8 and 6.6 per cent, respectively. Given that the AfCFTA has a population of 1.3 billion consumers and a combined GDP of over US\$ 3.4 trillion (Odetayo and Walsh, 2021), the contribution of Kenyan exports to the AfCFTA in the country's GDP of 2.8 per cent is relatively low, and improving it is a policy priority for Kenya. Studies have demonstrated that the share of intra-African exports in the continent's total exports was 16.6 per cent in 2017 compared to 59.4 per cent for intra-Asian exports (Ndonga et al., 2020). Given that digitalization increases exports (Jiang and Jia, 2022; Li et al., 2023; Myovella et al., 2020), incentives to further strengthen digitalization could support the country's export flows to the AfCFTA.

For trade to take place digitally, information is key as it creates awareness among potential buyers on the products offered in the market by various sellers. The study controlled for access to information using two measures, which are: total number of registered website domains, and total number of mobile SIM subscriptions. For

the studied period, the summary statistics indicate that Kenya had an average of 74,615 registered website domains, with the minimum and maximum number of website domains being 32,508 and 100,420, respectively. The average number of mobile SIM subscriptions was 48.9 million, with the minimum and maximum SIM subscriptions being 32.2 million and 65.7 million, respectively. Existing evidence demonstrates that Kenya is one of the African countries with efficient adoption and usage of ICT (Kayisire and Wei, 2015).

Studies have shown that infrastructure matters in promoting intra-regional trade in Africa (Tandrayen-Ragoobur et al., 2022; Chuku et al., 2022). The summary statistics reveal that Kenya has an average available international bandwidth of 5,391.857 billion of bits per second, with the minimum and maximum bandwidth capacity being 1,970.000 and 11,971.000 billion bits per second, respectively. Out of this, only 2,289.429 billion bits per second are utilized, translating to 42.461 per cent utilization rate. Improving utilization of the available international bandwidth is integral in promoting trade digitalization. Bankole et al. (2013) note that Kenya has low ICT Development Index (IDI) and given that ICT infrastructure enhances globalization and integration of regional markets, expanding the country's ICT infrastructure could enhance Kenyan exports within the AfCFTA. This is key in improving market access as reflected in increased export flows (Kirmani et al., 1984; Fabling and Grimes, 2021). In terms of the infrastructure supporting data roaming, the country supported an average of 21.5 million megabits per second for outbound roaming and an average of 43.3 million megabits per second for inbound roaming. Existing studies demonstrate that roaming infrastructure is central to unlocking the full potential of the digital economy (Madsen and Percy, 2020; Umar, 2005).

Existing evidence demonstrates that digital payments promote market access (McBride and Liyala, 2021; Gosavi, 2017). The summary statistics reveal that within the period under review, the average number of mobile money subscriptions was 30.6 million, with the minimum and maximum subscriptions being 24.8 and 38.6 million respectively. Digital payments between Kenya and trading partners within the AfCFTA could ease transactions and consequently promote Kenyan exports. With an applicable exchange rate, digital payments could support trade in local currencies for trading partners. This could encourage export activity by reducing currency costs associated with use of a third intermediary currency to settle transactions. Although Kenya has a highly developed digital payments ecosystem and high level of financial inclusion, synchronizing Kenya's digital payments ecosystem and that of her AfCFTA trading partners should be a priority.

For digital trade to be successful, an addressing system that locates the buyer and seller and facilitates delivery of ordered goods is critical. The addressing system could support billing and invoicing, which are key in facilitating trade. The study uses deliveries by courier as a proxy for an addressing system. On average, Kenya had 0.943 million outgoing courier items with the minimum and maximum being 0.333 million and 2.665 million, respectively. During the same period, there was an average of 1.466 million incoming courier items with the minimum and maximum being 0.083 million and 2.720 million, respectively. Kenya is in the

process of establishing a framework that provides for naming and numbering of streets, numbering of properties such as buildings and parcels of land with the aim of facilitating identification and location of a parcel or dwelling on the ground. To fully realize this, the draft National Addressing Policy (2023) and the draft National Addressing Bill (2023) should be finalized to ensure the country has the required legal framework.

While transacting digitally, cyber security remains central to buyers and sellers and countries could work towards ensuring security of digital trade. Evidence shows that less developed countries are more prone to cyber insecurity compared to developed countries (Gamreklidze, 2014; Burton, 2017). From the summary statistics, Kenya experienced an average of 41.5 million cyber threats, with the minimum and maximum being 3.462 million and 278 million, respectively. Further, an average of 0.487 million cyber threat advisories were reported with the minimum and maximum being 0.0006 million and 5.313 million, respectively.

The exchange rate and lending interest rates are utilized as controls. If the Kenyan Shilling depreciates against currencies of the country's AfCFTA trading partners, then it would be expected that Kenyan exports would become cheaper and therefore competitive² (Zia and Mahmood, 2012; Abeyasinghe and Yeok, 1998). The lending interest rate would constitute the cost Kenyan exporters encounter to obtain trade financing for their goods and services to reach cross-border markets. Low interest rates have been shown to encourage investment activity (Ma, 2017). The summary statistics reveal that over the study period, the exchange rate was 103.714 Kenyan Shillings per US Dollar, with the minimum and maximum being 87.249 and 121.952, respectively. At the same time, the average lending interest rate was Kenyan Shillings 13.780, with the minimum and maximum being Kenya Shillings 11.877 and 18.147, respectively.

4.4 Diagnostic Tests

The study employs the Augmented Dickey-Fuller test to examine whether the series have a unit root (Dickey and Fuller, 1979). The null hypotheses are that each series has a unit root while the alternative hypotheses are that each series is stationary. The trend option of the Dickey-Fuller test is included to control for trend in the series. The results for the test on the series at level indicate that all the series examined had a unit root, meaning they were non-stationary (Table 4.3). To ensure stationarity, the Dickey-Fuller test was repeated on the first differences of each individual series, and the results presented in Table 4.4. All the series became stationary after the first differencing except exchange rate and lending interest rate, which became stationary after differencing twice (Table 4.4). Exchange rate and lending interest rates are prices with a unit root. Previous studies have shown that prices have unit roots (Narayan, 2005; Murthy et al., 2011). Existence of a unit root in prices means that the series do not follow a trend path, and that future prices may not be accurately predicted from previous price changes.

² An appreciation of the Shilling against the AfCFTA currencies or third currency used to settle trade obligations, in converse, would be expected to make Kenyan exports more expensive and thus less competitive.

Table 4.3: Augmented Dickey-Fuller Stationarity Test at levels

Variable	Test-statistic
Log exports	-3.437
Information	
i. Log website domains	-1.798
ii. Log mobile SIM subscriptions	-0.716
Infrastructure	
i. Log available international bandwidth (Gbps)	-2.810
ii. Log used international bandwidth (Gbps)	-1.651
iii. Log outbound roaming data (MB)	-3.311
iv. Log inbound roaming data (MB)	-3.014
Digital payments	
i. Log mobile money subscriptions	-3.277
Addressing system	
i. Log outgoing courier items	-3.307
ii. Log incoming courier items	-1.662
Cyber security	
i. Log cyber threats reported	-2.091
i. Log cyber threat advisories	-1.776
Controls	
i. Log exchange rate	-1.567
ii. Log lending interest rate	-1.295

Note: Test statistic smaller than critical values at 1%, 5%, and 10% for all series

Table 4.4: Augmented Dickey-Fuller Stationarity Test at first differences

Variable	Test-statistic
Log exports	-6.792
Information	
i. Log website domains	-7.206
ii. Log mobile SIM subscriptions	-4.643
Infrastructure	
i. Log available international bandwidth (Gbps)	-6.149
ii. Log used international bandwidth (Gbps)	-4.571

iii. Log outbound roaming data (MB)	-6.351
iv. Log inbound roaming data (MB)	-6.598
Digital payments	
i. Log mobile money subscriptions	-5.546
Addressing system	
i. Log outgoing courier items	-8.165
ii. Log incoming courier items	-4.896
Cyber security	
i. Log cyber threats reported	-6.120
ii. Log cyber threat advisories	-5.560
Controls	
i. Log exchange rate	-6.237
ii. Log lending interest rate	-5.702

Note: Test statistic greater than critical values at 1%, 5%, and 10% for all series

To avoid loss of information associated with attempts to make the series stationary through differencing, the Johansen test for cointegration was carried out with the aim of combining short-run and long-run information and testing whether the series of the estimated residuals from the cointegrating residuals are integrated. The results of the Johansen cointegration test indicated that there were zero cointegrating vectors. This means there is a short-run relationship between digitalization and market access proxied by the share of Kenyan exports to AfCFTA in the country's GDP. This short-run relationship between the response variable and the regressors is, therefore, estimated using the vector auto-regressive (VAR) model on the differenced series.

5. Results and Discussion

5.1 Empirical Results

This section presents the results obtained from estimation of the VAR model on the differenced series. The estimated model had enough degrees of freedom given that a total of 31 time-periods remained after differencing compared to a total of 14 variables used³. The results are presented per each key pillar considered in the analysis and the control variables. Asterisks are used to indicate the levels of statistical significance while the standard errors from the estimation are indicated in brackets. A log-log model was estimated, and the results are interpreted in terms of elasticities.

Of the 13 explanatory variables used, eight (8) had a statistically significant effect on Kenyan exports to the AfCFTA. These variables are: mobile SIM subscriptions as proxy for information, all the variables on ICT infrastructure, mobile money subscriptions, outgoing courier items as proxy for the addressing system, and cyber threat advisories, which is a measure of cyber security threats that have been resolved. The detailed interpretation and discussion of the effect of these variables on Kenyan exports to AfCFTA is presented in sections 5.1 through 5.7.

Table 5.1: Results from Vector Autoregressive (VAR) estimation

Variable	Log exports of Kenyan exports to AfCFTA
Information	
i. Log website domains	0.853 (0.549)
ii. Log mobile SIM subscriptions	4.837*** (1.834)
Infrastructure	
i. Log available international bandwidth (Gbps)	1.648*** (0.359)
ii. Log used international bandwidth (Gbps)	0.783*** (0.275)
iii. Log outbound roaming data (MB)	0.444*** (0.120)
iv. Log inbound roaming data (MB)	0.234*** (0.075)
Digital payments	
i. Log mobile money subscriptions	2.329*** (0.774)

³ To have enough degrees of freedom, the final sample size (n) should be greater than the total number of variables (k) used. This assumption was satisfied.

Addressing system	
i. Log outgoing courier items	0.561*** (0.169)
ii. Log incoming courier items	0.014 (0.057)
Cyber security	
i. Log cyber threats reported	-0.087 (0.065)
i. Log cyber threat advisories	0.056* (0.034)
Controls	
i. Log exchange rate	0.829 (2.009)
ii. Log lending interest rate	-0.822 (0.824)
Number of observations	31
Akaike Information Criterion (AIC)	-459.369
Hannan-Quinn Information Criterion (HQIC)	-453.248
Schwarz-Bayesian Information Criterion (SBIC)	-440.589

5.1.1 Information and export flows

Access to information was measured using the country's total number of registered website domains and mobile SIM subscriptions. Kenyan export flows to the AfCFTA were measured as share of Kenya's total exports to the AfCFTA in the country's GDP. For trade to take place digitally, access to information is vital as it helps sellers reach out to potential buyers. Information helps buyers become aware of the products being sold, the characteristics of those products, and even the selling price. The evidence from the empirical estimation indicates that mobile SIM subscriptions matter in influencing Kenyan exports to AfCFTA in that the subscriptions have a positive and significant effect on Kenyan exports to the regional market. Registered website domains have a positive effect, but it is insignificant.

Specifically, a 1 per cent increase in the number of mobile SIM subscriptions is associated with a 4.837 per cent increase in Kenyan exports to the AfCFTA. The study argues that mobile SIM subscriptions allow users access to the Internet as a main source of information. Existing evidence corroborates this finding, since it shows that access to information increases export flows (Morgan et al., 2012; Cadogan et al., 2005; Khan and Khan, 2021; Sun et al., 2016; Peters, 2022; Jin and Cho, 2016).

Information is integral in undertaking successful marketing and linking sellers and buyers. Ward and Zheng (2016) observe a positive effect of ICT-supported access

to information on economic growth in China. Regional integration through trade agreements encourages the use of the Internet as a proxy for access to information, and this could consequently drive export activity (Clarke and Wallsten, 2007).

5.1.2 Infrastructure and export flows

ICT infrastructure anchors digital trade. The infrastructure is important in supporting interoperability of Internet and information flow from the exporting country to the importing country and vice versa. In this study, ICT infrastructure was measured using available international bandwidth, used international bandwidth, outbound roaming data, and inbound roaming data. All these measures have a positive and significant effect on Kenyan exports to the AfCFTA. The implication is that ICT infrastructure is a key component of digitalization and policy priorities could be directed towards expanding investments in ICT infrastructure.

Specifically, the evidence shows that if the available international bandwidth improves by 1 per cent, then Kenyan exports to the AfCFTA would grow by 1.648 per cent, on average. Further, if the used international bandwidth increases by 1 per cent, then Kenyan exports to the AfCFTA would increase by 0.783 per cent on average. The evidence reveals that a 1.0 per cent increase in outbound roaming data is associated with a 0.444 per cent increase in Kenyan exports to the AfCFTA, while a 1 per cent increase in inbound roaming data is associated with a 0.234 per cent increase in the country's exports to the AfCFTA. Under the Digital and Creative Economy pillar of the Bottom-Up Economic Transformation Agenda (BETA), infrastructure is a key component upon which policy incentives are expected to further enhance the country's ICT infrastructure.

Existing studies have demonstrated that expansion of the Internet infrastructure supports digital trade (Koten, 2023; Moodley, 2019). ICT infrastructure facilitates deployment of information technology (IT) services and supports interoperability of systems and protocols for communicating data. Indeed, studies have shown that investments in ICT infrastructure increase growth by up to 0.7 per cent (Nchake and Shuaibu, 2022). Barbero and Rodriguez-Crespo (2018) found a positive and statistically significant effect of ICT infrastructure proxied by broadband on trade activity.

5.1.3 Digital payments and export flows

The results show that digital payments have a positive and statistically significant effect on flows of Kenyan exports to the AfCFTA. Specifically, a 1 per cent increase in the number of mobile money subscriptions is associated with a 2.329 per cent increase in Kenyan exports to the AfCFTA. To fully unlock the potential of digital payments in supporting Kenyan exports to the AfCFTA, synchronizing the Kenyan digital payments system and the digital payment system for the AfCFTA trading partners could ease payments and facilitate Kenyan exports. Kenya has indeed signed the Pan African Payments and Settlement System (PAPSS), and this is expected to further boost Kenyan exports to the AfCFTA.

The channels through which digital payments promote export trade include reduction of transaction costs and formalization of export trade (Ahmed et al., 2021; Zhang and Eun, 2022; Afonso and Vergara, 2022). Evidence has shown that digital payments stimulate consumption (Hou et al., 2021), and this is key in sustaining demand for Kenyan exports within AfCFTA. Digital payments promote financial inclusion (Mahapatra et al., 2020; Miglionico, 2023; Simatele et al., 2021; Andrianaivo and Kpodar, 2012; Chatterjee, 2020) and this could stimulate demand and exports of Kenyan commodities to the AfCFTA. Studies have shown that cross-border e-commerce, for which digital payments is a critical component, promote exports (Yin and Choi, 2021). Digital payments sustain economic resilience in times of shocks (Banga and Banga, 2022).

5.1.4 Addressing system and export flows

The addressing system is an integral pillar of digital trade in that it facilitates delivery of products ordered by buyers to their specific locations. This is possible by informing the seller the specific location where the buyer lives or is ordering the goods from. It informs the buyer about the location of the seller and therefore the origin of the ordered products. The findings from the empirical analysis reveal that a country's addressing system has a positive and statistically significant effect on Kenyan exports to the AfCFTA. Specifically, a 1 per cent increase in the number of outgoing items sent through courier is associated with a 0.561 per cent increase in Kenyan exports to AfCFTA.

An addressing system is key in reducing trade costs, and it is through the decline in costs that exports activity rises and the share of Kenyan exports to the AfCFTA in Kenya's GDP improves. Existing studies have demonstrated that decline in trade costs is indicative of improving economies of scale, efficiency, export sophistication and diversification (Weldemichael, 2013; Qiu and Yan, 2017; Ali and Milner, 2022). As a channel for trade facilitation, the addressing system could promote export diversification (Dennis and Shepherd, 2011), with the outcome being improvement in performance of Kenyan exports to the AfCFTA. Finalization of the draft National Addressing Policy (2023) and the draft National Addressing Bill (2023) could generate a much-needed institutional and legal framework for an addressing system. Other AfCFTA members could ensure their institutional and legal framework anchors the addressing system.

5.1.5 Cyber security and export flows

Security of buyers and sellers while transacting digitally instils trust and confidence and encourages uptake of digital trading platforms in carrying out transactions. The findings indicate that resolution of reported cyber security threats is associated with a growth in Kenyan exports to the AfCFTA. Specifically, a 1 per cent increase in the number of cyber security threats that have been reported and resolved is associated with a 0.056 per cent increase in Kenyan exports to the AfCFTA.

Existing studies reveal that cyber security concerns could discourage participation in economic activities (Rao et al., 2023) and this could in effect have a negative effect on Kenyan exports to the AfCFTA. Cyber security threats are indicative of potential risks that buyers and sellers are likely to face while transacting through digital platforms (Glover and Benbasat, 2014) and the larger the number of cyber threats the higher the risk. Perceived risk in carrying out transactions could discourage utilization of digital platforms in carrying out trade transactions, and this could negatively impact Kenyan exports to the AfCFTA. The draft National Addressing Policy (2023) recognizes cyber security as a priority policy issue and its finalization could reinforce the country's institutional framework to address cyber-security-related issues.

5.1.6 Exchange rate and export flows

An exchange rate applies in cross-border trade especially when exported products must be priced and invoiced in a foreign currency before later being converted into the local currency. A depreciation of the local currency against the foreign currency that exported products are priced and invoiced usually makes exports cheaper and thus competitive in the foreign market (Zia and Mahmood, 2012; Abeysinghe and Yeok, 1998).

The exchange rate used in this study is the Kenyan Shilling against the US Dollar and the findings indicate that a 1 per cent depreciation of the Kenyan Shilling against the US Dollar is associated with a 0.829 per cent increase in Kenyan exports to the AfCFTA. The effect of the depreciation, however, is insignificant on Kenyan exports to the regional market. The implication for Kenya as a developing country is that depreciation of the local currency against foreign currencies used to price and invoice Kenyan exports may not be used as a policy tool for promoting exports.

5.1.7 Lending interest rate and export flows

In most cases, exports are paid for after they have reached the target foreign market, but exporters must incur costs associated with packaging, insuring, and transporting the products to the market. Trade financing becomes critical in meeting these costs and thus facilitating trade. If the lending interest for trade financing is favourable, then export activity becomes attractive.

The findings reveal that higher lending interest rates discourage Kenyan exports to the AfCFTA. Specifically, a 1 per cent rise in the prevailing lending interest rate is associated with a 0.822 per cent decrease in Kenyan exports to the AfCFTA. The implication for this is that policy options that crowd-in exporters could be given priority to ensure trade credit is affordable and trade financing plays its role of facilitating export activity.

6. Conclusion and Policy Implications

6.1 Conclusion

The study sought to examine the effect of trade digitalization on Kenyan exports to the AfCFTA. Time series data was applied on the Vector Autoregressive (VAR) estimator to examine the effect of: access to information on Kenyan exports to AfCFTA, ICT infrastructure on Kenyan exports to the AfCFTA, digital payments on Kenyan exports to AfCFTA, addressing system on Kenyan exports to the AfCFTA, and cyber security on Kenyan exports to the AfCFTA. The findings revealed that access to information, the supporting ICT infrastructure, digital payments, addressing system, and cyber security influence Kenyan exports to the AfCFTA.

6.2 Policy Implications

- i. Finalize the development and approval of the National Addressing Policy (2023) and the National Addressing Bill (2023) to ensure the country has the requisite institutional and legal framework for naming and numbering streets and numbering of properties such as buildings and parcels of land for ease of identification.
- ii. Fully implement the Information and Communication Act of 1998 and the National Information Communications and Technology (ICT) Policy Guidelines, 2020 and advocate for harmonization of data protection laws among AfCFTA members.
- iii. Develop and implement regulations that will strengthen digital trade facilitation, registration of digital businesses, e-payment, e-tax administration, digital interoperability, digitalization of customs border process, cyber security, consumer protection, and dispute resolution.
- iv. Current and future negotiations on trade agreements, strategic trade investment and economic partnership frameworks to consider having a chapter on digital trade with specific focus on knowledge and technological transfers among Kenyan MSMEs to enhance their digital capacity and readiness.

References

- Abelianksy, A., and Hilbert, M. (2017), "Digital technology and international trade: Is it the quantity of subscriptions or the quality of data speed that matters?" *Telecommunications Policy*, 41(1), 35-48.
- Abeyasinghe, T., and Yeok, T. (1998), "Exchange rate appreciation and export competitiveness: The case of Singapore". *Applied Economics*, 30(1), 51-55.
- Abramovsky, L., and Griffith, R. (2006). "Outsourcing and offshoring of business services: How important is ICT?" *Journal of the European Economic Association*, 4(2), 594-601.
- Adjei, D., Annor-Frempong, F., and Bosompem, M. (2016), "Use of social networking websites among NGOs in the greater Accra region of Ghana". *Public Relations Review*, 42(5), 920-928.
- Afolabi, J. (2023), "Advancing digital economy in Africa: The role of critical enablers". *Technology in Society*, 75, 1-11.
- Afonso, H., and Vergara, S. (2022) "Exporters in Africa: What role for trade costs?" *Journal of African Trade*, 9, 144-158.
- Aghion, P. and Howitt, P. (1992), "A model of growth through creative destruction". *Econometrica* 60, 323-51.
- Aghion, P., Howitt, P. (1998), *Endogenous Growth Theory*. MIT Press, Cambridge, MA.
- Ahmad, A., Green, C., Jiang, F., and Murinde, V. (2023), "Mobile money, ICT, financial inclusion and growth: How different is Africa?" *Economic Modelling*, 121, 1-18.
- Ahmed, J., Mughal, M., and Martinez-Zarzoso, I. (2021), "Sending money home: Transaction cost and remittances to developing countries". *The World Economy*, 44(8), 2433-2459.
- Alaca, Y., and Celik, Y. (2023), "Cyber attack detection with QR code images using lightweight deep learning models". *Computers and Security*, 126, 1-9.
- Alavi, R., Islam, S., and Mouratidis, H. (2016), "An information security risk-driven investment model for analyzing human factors". *Information and Computer Security*, 24, 205-227. doi: 10.1108/ICS-01-2016-0006
- Ali, S., and Milner, C. (2022), "Trade costs and the composition of developing countries' exports". *Review of Development Economics*, 26(4), 1971-1996.
- Andrianaivo, M., and Kpodar, K. (2012), "Mobile phones, financial inclusion, and growth". *Review of Economics and Institutions*, 3(2), 1-10.
- Arango C., Huynh, P., Sabetti L. (2015), "Consumer payment choice: Merchant card acceptance versus pricing incentives". *Journal of Banking and Finance*, 55:130-141. doi: 10.1016/j.jbankfin.2015.02.005.

- Arvin, M., Pradhan, R., and Nair, M. (2021), "Uncovering interlinks among ICT connectivity and penetration, trade openness, foreign direct investment, and economic growth: The case of G-20 countries". *Telematics and informatics*, 60, 1-25.
- Asongu, A., and Nwachukwu, J. (2016), "The mobile phone in the diffusion of knowledge for institutional quality in Sub-Saharan Africa". *World Development*, 86, 133-147.
- Asongu, S., Adegboye, A., Ejemeyovwi, J., and Umukoro, O. (2021), "The mobile phone technology, gender inclusive education and public accountability in Sub-Saharan Africa". *Telecommunication Policy*, 45(4), 102-108.
- Bailey, N., Kleinhans, R., and Lindbergh, J. (2018), "The implications of Schumpeter's Theories of Innovation for the role, organisation, and impact of community-based social enterprise in three European countries". *The Journal of Entrepreneurial and Organizational Diversity*, 7(1), 14-36. <https://doi.org/10.5947/jeod.2018.002>
- Banga, R., and Banga, K. (2022), "Scoping the potential for a digital led recovery from COVID-19 in Africa". *Journal of African Trade*, 9, 120-143.
- Bankole, F., Osei-Bryson, K., and Brown, I. (2013), "The impact of information and communications technology infrastructure and complementary factors on intra-African trade". *Information Technology for Development*, 21(1), 12-28.
- Barbero, J., and Rodriguez-Crespo, E. (2018), "The effect of broadband on European Union trade: A regional spatial approach". *The World Economy*, 41(11), 2895-2913.
- Basu, S. (2011), "E-government and developing countries: an overview". *International Review of Law, Computers and Technology*, 18(1), 109-132.
- Burton, J. (2017), "Small states and cyber security". *Political Science*, 65(2), 216-238.
- Cadogan, J., Sundqvist, J., Salminen, R., and Puumalainen, K. (2005), "Export marketing, inter-functional interactions, and performance consequences," *Journal of the Academy of Marketing Science*, 33, 520-535.
- Caldarola, B., Grazzi, M., Occelli, M., and Sanfilippo, M. (2023), "Mobile Internet, skills and structural transformation in Rwanda". *Research Policy*, 52(10), 104-871.
- Chatterjee, A. (2020), "Financial inclusion, information and communication technology diffusion, and economic growth: A panel data analysis". *Information Technology for Development*, 26(3), 607-635.
- Chiappini, R., and Gaglio, C. (2023), "Digital intensity, trade costs, and export's quality upgrading". *The World Economy*, Early view.
- Chuku, C., Simpasa, A., and Ekpo, A. (2022), "Catalysing regional integration in Africa: The role of infrastructure". *The World Economy*, 46(2), 472-495.

-
- Chung, K., Fleming, P., and Fleming, E. (2013), "The impact of information and communication technology on international trade in fruit and vegetables in APEC". *Asia Pacific Economic Literature*, 27(2), 117-130.
- Clarke, G. (2008), "Has the Internet increased exports for firms from low and middle-income countries?" *Information Economics and Policy*, 20(1), 16-37.
- Clarke, G., and Wallsten, S. (2007), "Has the Internet increased trade? Developed and developing country evidence". *Economic Inquiry*, 44(3), 465-484.
- Cofta, P. (2006), "Convergence and trust in ecommerce". *BT Technology Journal*, 24, 214-218.
- Crandall, M., and Allan, C. (2015), "Small states and bid ideas: Estonia's battle for cyber security norms". *Contemporary Security Policy*, 36(2), 346-368.
- Dai, C., and Gomez, M. (2018), "Challenges and opportunities for cyber norms in ASEAN". *Journal of Cyber Policy*, 3(2), 217-235.
- Das, S., and Chatterjee, A. (2023), "Impact of ICT and digital finance on poverty and income inequality: A sub-national study from India". *Information Technology for Development*, 29(2), 378-405.
- David B., Abel F., Patrick W. (2016), "Debit card and demand for cash". *Journal of Banking and Finance*, 73:55-66. doi: 10.1016/j.jbankfin.2016.08.009.
- Dennis, A., and Shepherd, B. (2011), "Trade facilitation and export diversification". *The World Economy*, 34(1), 101-122.
- Dickey, D., and Fuller, W. (1979), "Distribution of the estimators for autoregressive time series with a unit root". *Journal of the American Statistical Association*, 74, 427-431.
- Dinopoulos, E. and Thompson, P. (1998), "Schumpeterian growth without scale effects". *Journal of Economic Growth*, 3, 313-35.
- Ebert, H. (2020), "Hacked IT superpower: How India secures its cyberspace as a rising digital democracy". *India Review*, 19(4), 376-413.
- Ejemeyovwi, J. (2018), "Investigating the relevance of mobile technology adoption on inclusive growth in West Africa". *Journal of the Academy of Social Sciences*, 15(1), 48-61.
- Erumban, A., and Das, D. (2016), "Information and communication technology and economic growth in India". *Telecommunications Policy*, 40(5), 412-431.
- Fabling, R., and Grimes, A. (2021), "Picking up speed: Does ultrafast broadband increase firm productivity?" *Information Economics and Policy*, 57, 1-13.
- Fortune, T., Peligrad, M., and Sang, H. (2020), "A local limit theorem for linear random fields". *Journal of Time Series Analysis*, 42(5), 696-710.

- Fuller, C. (2019), "Is the market for digital privacy a failure?" *Public Choice*, 180, 353-381.
- Gachago, S. (2013), "Mobile-based verification in anti-counterfeit commodity supply chain management systems". *African Journal of Science, Technology, Innovation and Development*, 5(5), 379-388.
- Galinec, D., Moznik, D., and Guberina, B. (2017), "Cybersecurity and cyber defence: National level strategic approach". *Automatika*, 58(3), 273-286.
- Gamreklidze, E. (2014), "Cyber security in developing countries, a digital divide issues". *The Journal of International Communication*, 20(2), 200-217.
- Gheraia, Z., Abid, M., Sekrafi, H., and Abdelli, H. (2021), "The moderating role of ICT diffusion between financial development and economic growth: A bootstrap ARDL approach in Saudi Arabia". *Information Technology for Development*, 28(4), 816-836.
- Glover, S., and Benbasat, I. (2014), "A comprehensive model of perceived risk of e-commerce transaction". *International Journal of Electronic Commerce*, 15(2), 47-78.
- Gnangnon, S. (2020), "Effect of the Internet on services export diversification". *Journal of Economic Integration*, 35(3), 519-558.
- Gnangnon, S., and Iyer, H. (2018), "Does bridging the Internet access divide contribute to enhancing countries' integration into the global trade in services markets?" *Telecommunications Policy*, 42(1), 61-77.
- Gomez, J., and Lichtenberg, J. (2007), "Intrusion detection management system for ecommerce security". *Journal of Information Privacy and Security*, 3(4), 19-31.
- Gosavi, A. (2017), "Can mobile money help firms mitigate the problem of access to finance in Eastern and Sub-Saharan Africa?" *Journal of African Business*, 19(3), 343-360.
- Greuter, K., and Sarmah, D. (2022), "The baseline of global consumer cyber security standards for IoT: Quality evaluation". *Journal of Cyber Security Technology*, 6(4), 175-200.
- Griffith, M. (2022), "Cyber security and emerging technologies". *Global Politics and Strategy*, 64(5), 174-180.
- Grossman, G.M. and Helpman, E. (1991), *Innovation and Growth in the Global Economy*. Cambridge, MA: MIT Press.
- Gruber, H., Hatonen, J., and Koutroumpis, P. (2014), "Broadband access in the EU: An assessment of future economic benefits". *Telecommunications Policy*, 38(11), 1046-1058.
- Haftu, G. (2019), "Information communications technology and economic growth in Sub-Saharan Africa: A panel data approach". *Telecommunications Policy*, 43(1), 1-12.

- Harb, G. (2017), "The economic impact of the Internet penetration rate and telecom investments in Arab and Middle Eastern countries". *Economic Analysis and Policy*, 56, 148-162.
- Haruna, E., and Alhassan, U. (2022), "Does digitalization limit the proliferation of the shadow economy in African countries? An in-depth panel analysis". *African Development Review*, 34(1), 34-62.
- Hoga, Y. (2018), "Detecting tail risk differences in multivariate time series". *Journal of Time Series Analysis*, 39(5), 665-689.
- Hou, L., Hsueh, S., and Zhang, S. (2021), "Digital payments and households' consumption: A mental accounting interpretation". *Emerging Markets Finance and Trade*, 57(7), 2079-2093.
- Howitt, P. (2010), "Endogenous growth theory", In: Durlauf, S.N., Blume, L.E. (eds) *Economic Growth*. The New Palgrave Economics Collection. Palgrave Macmillan, London.
- Jiang, L., Liu, S., Zhang, G. (2022), "Digital trade barriers and export performance: Evidence from China". *Southern Economic Association*, 88(4), 1401-1430.
- Jiang, M., and Jia, P. (2022), "Does the level of digitalized service drive the global export of digital service trade? Evidence from global perspective". *Telematics and Informatics*, 72, 1-14.
- Jiang, T., Liu, Y., Wu., X., Xu, M., Cui, X. (2023), "Application of deep reinforcement learning in attacking and protecting structural features-based malicious PDF detector". *Future Generation Computer Systems*, 141, 325-338.
- Jin, S., and Cho, C. (2015), "Is ICT a new essential for national economic growth in an information society?" *Government Information Quarterly*, 32(3), 253-260.
- Johnen, C., and Oliver, M. (2022). "Digital credit and the gender gap in financial inclusion: Empirical evidence from Kenya". *Journal of International Development*, 35(2), 272-295.
- Kabbiri, R., Dora, M., Kumar, V., Elepu, G., and Gellynck, X. (2018), "Mobile phone adoption in agri-food sector: Are farmers in Sub-Saharan Africa connected?" *Technological Forecasting and Social Change*, 131, 253-261.
- Kayisire, D., and Wei, J. (2015), "ICT adoption and usage in Africa: Towards an efficiency assessment". *Information Technology for Development*, 22(4), 630-653.
- Kere, S., and Zongo, A. (2023), "Digital technologies and intra-African trade". *International Economics*, 173, 359-383.
- Khan, H., and Khan, Z. (2021), "The efficacy of marketing skills and market responsiveness in marketing performance of emerging market exporting firms in advanced markets: The moderating role of competitive intensity,". *International Business Review*, 30(6), 1-10.

- Kim C., Mirusmonov M., Lee I. (2010), "An empirical examination of factors influencing the intention to use mobile payment". *Compututurs in Human Behaviour*, 26:310–322. doi: 10.1016/j.chb.2009.10.013
- Kingiri, A., and Fu, X. (2019), "Understanding the diffusion and adoption of digital finance innovation in emerging economies: M-Pesa money mobile transfer service in Kenya". *Innovation and Development*, 10(1), 67-87.
- Kirman, N., Molajoni, P., and Mayer, T. (1984), "Effects of increased market access on exports of developing countries". *IMF Economic Review*, 31, 661-684.
- Kleibert, J., and Mann, L. (2020), "Capturing value amidst constant global restructuring? Information-technology-enabled services in India, the Philippines and Kenya". *The European Journal of Development Research*, 32, 1057-1079.
- Koten, E. (2023), "The impact of Internet platform usage on firms' exports: New evidence for Turkish firms". *The World Economy, Early view*.
- Krugman, P., Obstfeld, M., and Melitz, M. (2017), *International Trade: Theory and Policy* (11th ed.). New York: Pearson.
- Lucas, R. (1988), "On the mechanics of economic development". *Journal of Monetary Economics*, 22(1), 3-42.
- Ma, Q. (2017), "Contribution of interest rate control to China's economic development". *Journal of Chinese Economic and Business Studies*, 15(4), 325-352.
- Mabaya, E., and Porciello, J. (2022), "Can digital solutions transform agri-food systems in Africa?" *Agrekon*, 61(1), 67-79.
- Madsen, A., and Percey, M. (2020), "Telecommunications infrastructure in Australia". *Australian Journal of Social Issues*, 55(2), 218-238.
- Mahapatra, M., Mishra, R., and Seetharam, Y. (2020), "Behavioral influence and financial decision-making of individuals: A study on mental accounting process among Indian households". *Cogent Economics and Finance*, 8(1), 1-17.
- McBride, N., and Liyala, S. (2021), "Memoirs from Bukhalalire: A poetic inquiry into the lived experience of M-PESA mobile money usage in rural Kenya". *European Journal of Information Systems*, 32(2), 173-194.
- Metalidou, E., Marinagi, C., Trivellas, P., Eberhagen, N., Skourlas, C., and Giannakopoulos, G. (2014), "The human factor of information security: Unintentional damage perspective". *Procedia Soc. Behav. Sci.* 147, 424–428. doi: 10.1016/j.sbspro.2014.07.133
- Miglione, A. (2023), "Digital payment system and market disruption". *Law and Financial Market Review*, 16(2), 1-16.
- Milner, C., and McGowan, D. (2012), "Trade costs and trade composition".

-
- Economic Inquiry*, 51(3), 1886-1902.
- Mina, B. (2010), "An analysis of the determinants and effects of ICT diffusion in developing countries". *Information Technology for Development*, 10(3), 151-169.
- Mndolwa, F., and Alhassan, A. (2020), "Gender disparities in financial inclusion: Insights from Tanzania". *African Development Review*, 32(4), 578-590.
- Moodley, S. (2019), "E-commerce and export markets: Small furniture producers in South Africa". *Journal of Small Business Management*, 41(3), 317-324.
- Moodley, S., and Morris, M. (2007), "Does e-commerce fulfil its promise for developing country (South African) garment export producers?" *Oxford Development Studies*, 32(2), 155-178.
- Morawczynski, O. (2009), Exploring the usage and impact of transformational mobile financial services: The case of MPESA in Kenya". *Journal of Eastern African Studies*, 3(3), 509-525.
- Morgan, N., Katsikeas, C., and Vorhies, D. (2012), "Export marketing strategy implementation, export marketing capabilities, and export venture performance". *Journal of the Academy of Marketing Science*, 40, 271-289.
- Murthy, V., Washer, K., and Wingender, J. (2011), "Are stock prices in the US non-stationary? Evidence from contemporary unit root tests". *Applied Financial Economics*, 21(22), 1703-1709.
- Myovella, G., Karacuka, M., and Haucap, J. (2020), "Digitalization and economic growth: A comparative analysis of Sub-Saharan Africa and OECD economies". *Telecommunication Policy*, 44(2), 1-12.
- Narayan, P. (2005), "Are the Australian and New Zealand stock prices nonlinear with a unit root?" *Applied Economics*, 37(18), 2161-2166.
- Nchake, M., and Shuaibu, M. (2022), "Investment in ICT infrastructure and inclusive growth in Africa". *Scientific African*, 17, 1-16.
- Ndonga, D., Laryea, E., and Chaponda, M. (2020), "Assessing the potential impact of the African Continental Free Trade Area on Least Developed Countries: A Case Study of Malawi". *Journal of Southern African Studies*, 46(4), 773-792.
- Nguyen, C., Doytch, N., Schinckus, C., Su, T. (2023), "Mobile and Internet usage, institutions, and the trade balance: Evidence from African countries". *International Journal of Finance and Economics*, <https://doi.org/10.1002/ijfe.2782>
- Nguyen, C., Su, T., and Doytch, N. (2020), "The drivers of financial development: Global evidence from Internet and mobile usage". *Information Economics and Policy*, 53, 1-10.
- Odetayo, B., and Walsh, M. (2021), "A policy perspective for an integrated regional

- power pool within the Africa Continental Free Trade Area". *Energy Policy*, 156, 1-12.
- Okunoye, B. (2022), "Digital identity for development should keep pace with national cybersecurity capacity: Nigeria in focus". *Journal of Cyber Policy*, 7(1), 24-37.
- Omanga, D. (2019), "WhatsApp as 'digital publics': the Nakuru Analysts and the evolution of participation in county governance in Kenya". *Journal of Eastern African Studies*, 13(1), 175-191.
- Onyango, G., Ondiek, J. (2021), "Digitalization and integration of sustainable development goals (SDGs) in public organizations in Kenya". *Public Organization Review*, 21, 511-526.
- Paelo, A., and Roberts, S. (2022), "Competition and regulation of mobile money platforms in Africa: A comparative analysis of Kenya and Uganda, Review of Industrial Organization". 60, 463-489.
- Pece, A., Simona, O., and Salisteanu, F. (2015), "Innovation and economic growth: An empirical analysis for CEE countries,". *Procedia Economics and Finance*, 26, 461-467.
- Peters, M. (2022), "Digital trade, digital economy, and the digital economy partnership agreement (D EPA)". *Educational Philosophy and Theory*, 55(7), 747-755.
- Pingo, Z. (2014), "Transition from camel libraries to digital technologies in Kenya public libraries". *Public Library Quarterly*, 34(1), 63-84.
- Pradhan, R., Arvin, M., and Hall, J. (2016), "Economic growth, development of telecommunications infrastructure, and financial development in Asia, 1991-2012". *The Quarterly Review of Economics and Finance*, 59, 25-38.
- Pradhan, R., Arvin, M., and Norman, N. (2014), "Economic growth and the development of telecommunications infrastructure in the G-20 countries: A panel-VAR approach". *Telecommunications Policy*, 38(7), 634-649.
- Qiu, B., Yan, Z. (2017), "Market efficiency, heterogeneous trade costs and export-only firms". *Pacific Economic Review*, 22(1), 101-122.
- Rao, S., Chen, H., and Aura, T. (2023), "Threat modelling framework for mobile communication systems". *Computers and Security*, 125, 1-23.
- Rodriguez-Crespo, E. and Martinez-Zarzzoso, I. (2019), "The effect of ICT on trade: Does product complexity matter?" *Telematics and Informatics*, 41, 182-196.
- Rodriguez-Crespo, E., Marco, R., and Billon, M. (2021), "ICT impacts on trade: A comparative dynamic analysis for Internet, mobile phones and broadband". *Asia-Pacific Journal of Accounting and Economics*, 28(5), 577-591.
- Romer, P.M. (1990), "Endogenous technological change". *Journal of Political Economy*, 98, 71-102.

-
- Saeed, S., Saman, A., and Norafida, I. (2013), "Main human factors affecting information system security". *Interdisciplinary Journal of Contemporary Research in Business*, 5: 329–354.
- Salahuddin, M., and Gow, J. (2016), "The effects of Internet usage, financial development, and trade openness on economic growth in South Africa: A time series analysis". *Telematics and Informatics*, 33(4), 1141-1154.
- Santibanez, A., and Castillo, O (2011), "Information and communication technologies (ICT) and Mexican manufacturing exports". *The Electronic Journal of Information Systems in Developing Countries*, 48(1), 1-18.
- Schierz P., Schilke O., Wirtz B. (2010), "Understanding consumer acceptance of mobile payment services: An empirical analysis". *Electronic Commerce Research Applications*, 9:209–216. doi: 10.1016/j.elerap.2009.07.005.
- Shahiduzzaman, M., and Alam, K. (2014), "The long-run impact of information communication technology on economic output: The case of Australia". *Telecommunications Policy*, 38(7), 623-633.
- Shaw, B., and Kesharwani, A. (2019), "Moderating effect of smartphone addiction on mobile wallet payment adoption". *Journal of Internet Commerce*, 18(3), 291-309.
- Simatele, M., Mbedzi, E., and Read, R. (2021), "Consumer payment choices, costs, and risks: Evidence from Zimbabwe". *Cogent Economics and Finance*, 9(1), 1-23.
- Song, N., and Isaac, A. (2021), "The impact of ICT on economic growth-comparing rich and poor countries". *Telecommunications Policy*, 45(2), 1-10.
- Stenberg, P. (2018), "The purchase of Internet subscriptions in native American households". *Telecommunications Policy*, 42(1), 51-60.
- Stoycheff, E., and Nisbet, E. (2014), "What is the bandwidth for democracy? Deconstructing Internet penetration and citizen attitudes about governance". *Political Communication*, 31(4), 628-646.
- Sun, M. (2021), "The Internet and SME participation in exports". *Information Economics and Policy*, 57, 1-15.
- Sun, Q., Paswan, A., and Tieslau, M. (2016), "Country resources, country image, and exports: Country branding and international marketing implications". *Journal of Global Marketing*, 29(4), 233-246.
- Tandrayen-Ragoobur, V., Ongono, P., and Gong, J. (2022), "Infrastructure and intra-regional trade in Africa". *The World Economy*, 46(2), 453-471.
- Tang, L. (2006), "Communication costs and trade of differentiated goods". *Review of International Economics*, 14(1), 54-68.
- Tchamyou, V., Erreygers, G., and Cassimon, D. (2019), "Inequality, ICT and financial access in Africa". *Technological Forecasting and Social Change*, 139, 169-184.

- Tetteh, G. (2023), "Local digital lending development and the incidence of deprivation in Kenya". *Financial Innovation*, 9(102), 1-26.
- The Computer Misuse and Cybercrimes Act, 2018.
- The Consumer Protection Act, 2012.
- The Data Protection Act, 2019.
- The Kenya Information and Communications Act, Chapter 411A
- The National Payment System Act, 2011 No. 39 of 2011
- The National Payment System Regulations, 2014
- Umar, A. (2005), "IT infrastructure to enable next generation enterprises". *Information Systems Frontiers*, 7, 217-256.
- UNCTAD (2015), *Deep regional integration and non-tariff measures: A methodology for data analysis*. Policy Issues in International Trade and Commodities Research Study Series No. (69).
- UNCTAD (2019), *Economic Development in Africa Report: Made in Africa – Rules of Origin for Enhanced Intra-African Trade*. United Nations publication. New York and Geneva.
- Uwamariya, M., Loebbecke, C., Cremer, S. (2021), "Mobile money adoption in rural Rwanda: A domestication perspective". *African Journal of Management*, 7(2), 314-337.
- Uzawa, H. 1965, "Optimal technical change in an aggregative model of economic growth". *International Economic Review*, 6, 18–31.
- Wang, H., Zheng, W., and Archer, N. (2005), "The impact of Internet-based electronic marketplaces on buyer-supplier relationships". *Journal of Internet Commerce*, 4(3), 41-67.
- Wang, Y., and Li, J. (2017), "ICT's effect on trade: perspective of comparative advantage". *Economics Letters*, 155, 96-99.
- Ward, M., and Zheng, S. (2016), "Mobile telecommunication service and economic growth: Evidence from China". *Telecommunications Policy*, 40(2), 89-101.
- World Bank (2014), *Global Financial Development Report*. Financial Inclusion, Washington, DC: World Bank Publications.
- Xing, Z. (2017), "The impacts of information and communications technology (ICT) and e-commerce on bilateral trade flows". *International Economics and Economic Policy*, 15, 565-586.
- Xu, N., Bai, S., Yu, H., and Zhang, M. (2023), "Pricing for online sellers with different payment schemes". *Electronic Commerce Research*, <https://doi.org/10.1007/s10660-023-09690-9>

- Yao, B., Shanoyan, A., Schwab, B., and Vincent, A. (2023), "The role of mobile money in household resilience: Evidence from Kenya". *World Development*, 165, 1-13.
- Yin, Z., and Choi, C. (2021), "The effects of China's cross-border e-commerce on its exports: A comparative analysis of goods and services trade". *Electronic Commerce Research*, 23(1), 443-474.
- Yong, H., Li, J., Wu, X., and Jiang, J. (2011), "Impact of e-commerce on international trade - based on a iceberg cost model". *International Journal of Trade, Economics and Finance*, 2(3), 1-4.
- Zhang, H., and Eun, Y. (2022), "Informal economy and central bank digital currency". *Economic Inquiry*, 60(4), 1520-1539.
- Zhang, W., and Liu, X. (2023), "The impact of Internet on innovation of manufacturing export enterprises: Internal mechanism and micro evidence". *Journal of Innovation and Knowledge*, 8(3), 100-377.
- Zhou, W., Chong, A., Zhen, C., and Bao, H. (2018), "E-supply chain integration adoption: Examination of buyer-supplier relationships". *Journal of Computer Information Systems*, 58(1), 58-65.
- Zia, U., and Mahmood, Z. (2012), "Exchange rate depreciation and export price competitiveness: The case of Pakistani manufacturing industries". *Journal of the Asia Pacific Economy*, 18(4), 529-542.

ISBN 978 9914 738 28 5

**Kenya Institute for Public Policy Research and Analysis
Bishops Garden Towers, Bishops Road
PO Box 56445, Nairobi, Kenya
tel: +254 20 2719933/4, 2714714/5, 2721654, 2721110
fax: +254 20 2719951
email: admin@kippra.or.ke
website: <http://www.kippra.org>**