AMERICAN JOURNAL OF ECONOMICS AND BUSINESS INNOVATION (AJEBI)

ISSN: 2831-5588 (ONLINE), 2832-4862 (PRINT)

VOLUME 2 ISSUE 3 (2023)

PUBLISHED BY
E-PALLI PUBLISHERS, DELAWARE, USA

American Journal of Economics and Business Innovation (AJEBI)

Volume 2 Issue 3, Year 2023
ISSN: 2831-5588 (Online), 2832-4862 (Print)
DOI: https://doi.org/10.54536/ajebi.v2i3.2051
https://journals.e-palli.com/home/index.php/ajebi

Dynamic and Static Effects of Digital Services Trading on Economic Growth of World Regions

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Article Information

Received: September 25, 2023

Accepted: October 22, 2023

Published: October 27, 2023

Keywords

Dynamic and Static Effects, Digital Services Trading, World Regions, Economic Growth

ABSTRACT

The study examines the effect of digital services trading on the economic growth of panel data from five (5) world regions, namely, Africa, Asia, Latin America, Europe, and the Organization for Economic Cooperation and Development (OECD) between 2005 and 2021. The study employs quantitative experimental methods of Panel vector autoregression (PVAR) models as dynamic estimators and the Fixed Effects (FE) models as static estimators. The PVAR model analyses indicate that the digital services trade has a significant positive long-run effect on Gross Domestic Product (GDP) growth in all five regions. For every 1% increase in digital services trade, GDP in the OECD region increases by 6.75%, followed by Europe at 3.19%, 2.11% in Latin America, 1.02% in Asia, and is lowest in the African region panel at 0.82%. The static FE analyses also shows similar results. These findings confirm the hypothesis that deep internet/digital penetration positively impacts the efficiency of digital services trade. The study, therefore, recommends that policymakers from developing world regions should increase investments in digital deepening infrastructure which should include among others, promoting, policy and regulatory measures that augment digital infrastructure installations in rural places, developing the digital skills to mitigate digital illiteracy, and promoting the adoption of cutting-edge digital technologies.

INTRODUCTION

Since the development of the steam engine and the telegraph in the latter half of the 19th century, the evolution of container shipping around the 1960s, and the developments in transportation and information communication technologies (ICT) in the twenty-first century have fundamentally altered international trade and the basket of goods and services that trading countries specialize in (Cosar and Demir, 2018; Steinwender, 2018; Zhu, Shang, & Li, 2023).

The global digital economy, a core element of the 4th Industrial Revolution, ushered in digital trade (United Nations Conference on Trade and Development, UNCTAD, 2020). According to UNCTAD (2020), digital trade refers to all international transactions that are delivered remotely in electronic format, using computer networks. It involves all trade that is digitally ordered and/or digitally delivered.

From the demand side point of view, the digitization processes have a positive effect as observed by the increase in the variety and volume of production, exchange as well as consumption. Business to Consumer (B2C), Business to Business (B2B), Consumer to Consumer (C2C), and Business entities and Governments (B2G) can all engage in digital commerce transactions (OECD, 2020). It is simple to note that trade in products and services has been significantly disrupted and is increasingly moving from physical to digital forms in certain areas, including but not limited to, among others, education, financial services, entertainment, software, logistics, as well as health service provision (Tele-doctor services, for instance). Some goods that used to be traded in physical form such as movies, music, and books have been digitally transformed and can now be digitally transmitted as video streaming, music downloading, and e-books respectively (Organization for Economic Cooperation and Development, OECD, 2020; UNCTAD, 2022).

The Organization for Economic Cooperation and Development, OECD, (2020) explains that from the supply side, digitization procedures have had a tremendous impact on how goods and services are produced and delivered. Cloud computing, 3D printing, Artificial Intelligence (AI) and the App industry (App developers and vendors) are integrating digital technologies in the production and delivery of goods and services making the flow of data the 'life blood' of the 21st-century international trade. As opposed to traditional trade, digital technology-driven trade makes it simple to coordinate international supply chains, making it relatively quicker, cheaper, and increases trade volumes, which subsequently results in higher economies of scale, reduced trade time, and significantly cuts variable costs via lowered entry barriers (OECD, 2020; Mulenga and Mayondi, 2022).

The digital economy in general, and digital trading in particular, enable Small and Medium Enterprises (SMEs) and emerging economies to easily engage in international commerce transactions, which were traditionally controlled by huge multinational enterprises (UNCTAD, 2022). The COVID-19 Crisis seems to have elevated the importance of digital trade in that there was a significant increase in the use of, and development of online platforms for purchasing products and services. UNCTAD (2022) revealed that despite the worldwide economic crisis that emanated from COVID-19 in

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2019, global digital services were remarkably resilient, declining by only 1.8% relative to global traditional services exports, which decreased by 20%.

Although empirical and theoretic literature is replete with assertions of the positive impact/effect of digitization processes on various economic activities, a literature review of related literature (for example, Zhang,*et al.*, 2023; Mulenga & Mayondi ,2022; Ying & Gao 2022; Pingfang, 2021, Wang & Choi,2019; Thomas-Mini, 2018) seems to suggest that research gaps exist regarding empirical studies on the digital services trading-economic growth nexus of world regions. Therefore, this topic remains an open question. The scarcity of research in this area can be partially explained by the apparent absence of a universal definition of digital trade and the scarcity of digital trade measures in official national accounting systems. To this end, therefore, this study conducts the dynamic and static analyses of the effects of digital services trade on economic growth (GDP per capita) in five (5) world regions from Africa, Asia, Europe, the Latin Americas, and the Organization for Economic Cooperation and Development (OECD). The study is predicated on the hypothesis that regions that have deeper internet/digital penetration experience higher economic growth driven by digital services trade.

LITERATURE REVIEW

Conceptual and Theoretical Background

Whereas the digital economy refers to a plethora of terms ranging from digital computing including e-commerce and gig economy, digital trade basically focuses on how the internet is revolutionizing domestic and international trade and reshaping comparative advantage (World Economic Forum, WEF, 2022, OECD, 2020). In simple terms, a digital economy is any economic activity done or facilitated by digital technologies. There seems to be a positive correlation between the growth of digital technologies and digital trade. For instance, digital technologies help small and medium enterprises (SMEs) overcome the challenges of scale and distance and thus make it relatively easier to access global markets previously dominated by large multinational corporations (MNCs).

Although digital trading has positive economic benefits, barriers exist. Some of the barriers are tariffs and quotas imposed on imports of routers and servers, cross-border data flow restrictions, discriminatory national and international laws/standards that depart from recognized international standards (WEF, 2020, Department for International Development DFID, 2020, UNCTAD, 2022).

Situational Analysis: Internet Penetration Precondition for Digital Trade

The potential benefits that accrue to a country or region are determined largely by the digital infrastructure, and regulatory framework (digital/internet penetration, hereafter) tenable in that region or country. It is hypothesized that deep digital/internet penetration augments the long-run economic growth through increased economies of scale and the reduction of variable costs. As can easily be seen in Figure 1, there are great variations among world regions in terms of digital penetration.

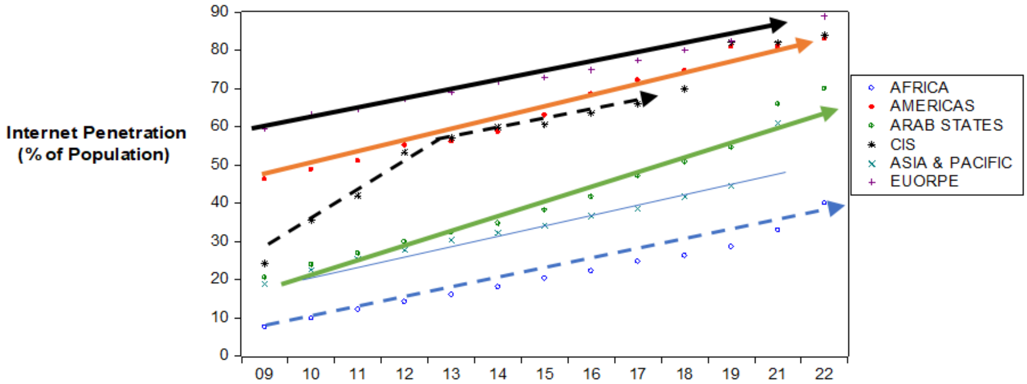

Figure 1: Internet Penetration in World Regions-2009-2022

Source: Author's elaboration on data from the International Communication Union. Note that CIS denotes Commonwealth independent States from the former Union of Soviet Socialist Republic (USSR).

From the scatter plot in Figure 1, it is easy to note that digital penetration or digital connectivity, defined as the ability to access and use technologies to conduct economic activities including digital services trade (World Bank 2016; Brookings 2017) has been growing across the world regions from 2009. However, it appears that the African Region (light blue dotted scatter plots) has been lagging behind other regions since 2009 even though the percentage of the population's access to digital technologies in Africa has grown from 7.6% in 2009 to 40% in 2022. The European region (black scatter plots) ranking first in terms of internet penetration, grew from 59.6 % to 89 % in the same period. The Americas rank 2nd; it ranges between 46.3% in 2009 and 83% in 2022.

Conceptual Framework of Digital Trade

Data and digital platforms are two essential ingredients of the digital economy in general and digital trade in particular. Conceptually, the fundamental driver of digital trade is data which can be traded and is a means through

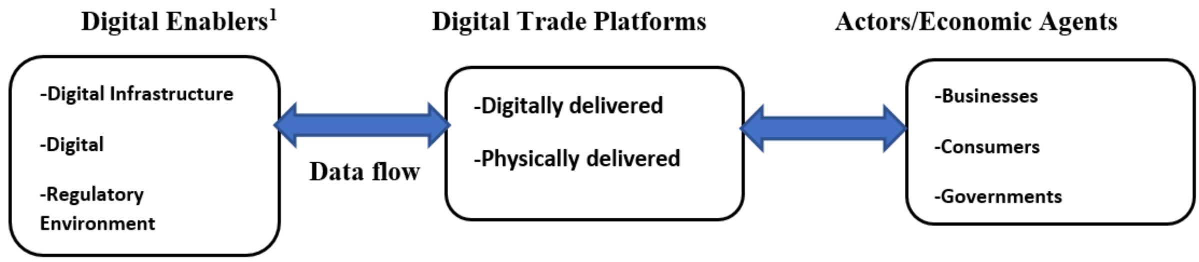

Figure 2: Conceptual Framework
Source: Author's elaboration

which services are traded (World Economic Forum, WEF, 2020, González & Jouanjean,2017). Figure 2 shows the conceptual framework.

The digital trade enablers refer to the hard and software infrastructure. Data flows support trade by enabling control and coordination in the international trade networks or by facilitating a wide range of trading activities. Digital trade is done via physically delivered and digitally delivered platforms (OECD, 2020).

In our analyses, Gross Domestic Product per capita (GDP per capita) is the dependent variable (also referred to as economic growth) whereas digital exports and digital imports (collectively called digital services trading), goods exports and goods imports (as control variables), and the number of people using the internet (% of the population) and Secure Internet Servers are independent variables (Regressors). The level of digital/internet penetration is considered an intervening variable.

Review of Related Literature

For the years 2013 through 2020, Zhang, Ye, and Sun (2023) evaluate the Static and Dynamic Efficiency of the Chinese Digital Economy. They make use of models from the Three Stage Malmquist Index-Based Approach. Their findings show that the effectiveness of the digital economy differs by province. Brazil, Russia, India, China, and South Africa (BRICS) countries' economic growth was examined by Wang and Choi (2019) in relation to the effects of the digital economy for the years 2000–2016. They used the Gravity, Fixed Effects (FE), and Random Effects (RE) models in their investigation. Findings demonstrate that the digital economy has significantly improved. They recommend that the BRICS countries should invest massively in digital trade infrastructure to reap maximum benefits from the effects of the digital economy.

Mulenga and Mayondi (2022) evaluated how the trade in digital services impacted panels of developing, emerging, and developed nations' economic growth for the period 2005 to 2021 using the panel vector autoregression models as dynamic estimators. Results show that even though all the country panels' GDP growth was positively impacted by digital services exports, the developing countries' panel lagged behind. Thus, the study recommends that developing countries should enhance their investments in digital infrastructure. Using fixed effect (FE) models as static estimators for the years 2013 to 2019, Zhu, Shang, and Li (2023) undertake research on the effects of the Digital Economy on global trade. The study finds that the digital economy significantly promotes the development of urban international trade. The study recommends that policymakers should be proactive in increasing investment in digital infrastructure.

In their examination of the strategies for developing digital trade and methods of governance in United States, the European Union, China, and India, Ying, and Gao (2023), use comparative taxonomy models. The study findings reveal that the four economies in the survey employ strategic policies or mechanisms in global digital commercial activities that enable them to substantially derive large amounts of rent. Mini-Thomas (2018) examined how the trade in services impacted India's economic growth using both the Balance of Payments Constrained Growth (BPCG) and the Autoregressive Distributed Lag Co-integration (ARDL) models. The results show that the growth of India's economy was driven largely by the goods trade than the goods services trade.

Simon and Pingfang (2021) use cross-sectional data from 53 nations for the years 2000–2018 to evaluate the effects of the digital economy on economic growth in Africa. They use Fixed Effects (FE) for static models and the System General Method of Moments (Sys-GMM) for dynamic models. The results demonstrate that the digital economy significantly enhances commerce and economic development in Africa. Using the vector auto-regression (VAR) method, Maune (2019) examined how trade in services impacted the economic growth of a panel of ten (10) Southern African nations. In contrast to trade in commodities exports, the study revealed that trade in services had a higher positive coefficient than goods trade. To ascertain the effect of the digital economy (digital index) on provincial economic growth in China, Pan *et al* (2022) employed pooled ordinary regression models (POL). They discovered that although the digital economy had a significant positive effect on China's economy, regional differences in the digital infrastructure penetration caused variations in economic growth. Therefore, to reduce the economic disparities of the effects of the digital economy, the study recommends the integration of the digital economy in all the regions in China.

Theoretical Framework

The augmented Solow growth model might theoretically be conceived as increasing total factor productivity (TFP) arising from the digital economy's growth (Pan *et al*, 2022;

Zhang *et al*, 2021; Mulenga & Mayondi,2022). Solow's augmented growth model as postulated in Mankiw, Romer, and Weil 1992):

$Y_{it}=K_{it}^{\alpha} H_{it}^{\beta} (AL)^{(1-\alpha-\beta)}$ (1)

Where Y_it is regional GDP growth over time (t) with regards to the variations in physical capital K, human capital H, Total Factor Productivity,A. Labor implies the embodiment of natural skills in people while human capital may be defined in terms of skills built in people through channels of education, training, and experience Mankiw, Romer and Weil, 1992; Erken *et al.*, 2016). Therefore, labor may be expressed as shown in equation 2:

$Y_{it}/L_{it}=A^{(1-\alpha-\beta)} ((K_{it}/L_{it}))^{\alpha} ((H_{it}/L_{it}))^{\beta}$ (2)

When expressed in natural logarithms, equation 2 transforms into equation 3:

$\ln(Y_{it}/L_{it})=(1-\alpha-\beta)+\ln(A_{it})+\alpha\ln((K_{it}/L_{it})+\beta\ln(((H_{it}H)/(LL_{it}))$ (3)

It can easily be observed from equations 2 and 3, that the productivity of labor is measured as capital-labor ratio (K/L), human per capital labor ratio(H/L) as well as the residual term (1-α-β) ln(A). The residual term in the context of this study is a parameter that measures the digital/internet penetration in a given world region (Erken *et al.*, 2016).

MATERIAL AND METHODS

Research Design and Data Description

The panel experimental quantitative study design is used in this study. Yearly panel data from 2005-2021 on five (5) world regions (excluding high-income countries) namely, Africa (Sub-Saharan Africa, SSA) Europe (Eastern Europe), Asia (South Asia),the Americas (Latin America & the Caribbean) and the Organization for Economic Cooperation and Development, OECD[2] are used. The OECD region is included as a benchmark region because it represents the high-income and deepest internet penetration region among the regions in this study. The panel regional data, Gross Domestic Product per capita at current USD[3] (as a dependent variable), and explanatory/regressor variables are Goods export namely goods exports (denoted as Goods_EXP,) Goods imports (denoted as Goods_IMP), Number of People Using the Internet (denoted as Internet_Users, expressed in terms of per centage % of the population) and Secure Internet Servers (denoted as Sec_Servers, per 1 million people-these ensure the confidentiality and protection of data from hackers) were extracted from World Bank's Development Indicators database (WDI) of the World Bank (2023). However, the Digital Services Trade Exports regressor variable data were extracted from the United Nations Conference on Trade and Development database (UNCTADstat). The digital trade imports data were not available on the UNCTAD database (UNCTADstat), so the author proxied digital services imports with Computer Communications Services (as a % of commercial service imports) obtained from the World Development Index (2023) database. This study follows Mini-Thomas (2018), Maune (2019) and Mulenga and Mayondi (2022), in using goods exports and goods imports regional panel data as control variables for digital services trade.

Regional Panel Unit Root Diagnostic Tests

Green (2003) advises that since economic data seldom exhibit stationarity and frequently gravitates towards the unit root, it is necessary to conduct stationarity and unit root tests. These tests mitigate the incidences of conducting spurious regressions, inferences, and recommendations. Therefore, the researcher carried out four (4) regional panel unit root tests namely, the Common root-Levin, Lin & Chu (2002, LLC,2002 hereafter), the Individual root-Im, Pesaran & Shin (2003, IP & S, 2003 hereafter), Individual unit root-Augmented Dickey-Fuller, (1979 ADF, 1979 hereafter) and Individual root-Phillips and Peron, (1988, PP, 1988 hereafter).

Theoretically, regional panel root tests can be conceived simply as applying multiple panel data time-series unit root test diagnostics (Levin *et al.*, 2002). Panel unit root tests evaluate whether the autoregressive (AR) process is constrained throughout the cross sections of the panel data models (Woodridge, 2000; Dickey & Fuller, 1979). In terms of unit root test algorithms, this study follows Mulenga and Mayondi (2022). Starting with an autoregressive procedure, AR (1):

$y_{it}=\varrho_i\, y_{(it-1)}+X_{it}\, \delta_i+\varepsilon_{it}$ (4)

Where i=1,2,…,N cross sectional series observed over periods $t=1,2,\ldots,T_i$

The X_{it} refers to a matrix of external/exogenous factors in the model which include, among others, fixed effects, and individual trends. ϱ_i measures autoregressive coefficients, whereas the $\varepsilon_{(it)}$is a matrix or vector of white noise error terms.

It follows that given that; $|\varrho_i|<1$, y_i becomes trend/weakly stationary. If, however, $|\varrho_i|=1$, y_i is said to be non- stationary/has a unit root (Phillips and Peron, 1988). The two assumptions normally taken regarding ϱ_i in the process of conducting the panel unit root test diagnostics are that, firstly, we assume that persistence parameter are common across-sections such that $\varrho_i=\varrho$ for all. The LLC (2002) common unit root test is done in accordance with this assumption. Secondly, we assume also that ϱ_i has the freedom to vary across the sections in the panels. The individual IP&S (2003) panel unit root test is conducted in the backdrop of the second assumption. The ADF (1979) and the individual PP (1988) unit root test diagnostics ride on this assumption.

The basic ADF (1979) panel unit root test may be denoted as shown in equation 5:

$\Delta y_{it}=\alpha y_{(it-1)}+\sum^{(pi)}_{(j=1)} \beta_{ij}\, \Delta y_{(it-j)} +X'_{it}\, \delta+\varepsilon_{it}$ (5)

This test rides on the assumption that α=ϱ-1 and that the lag order, ϱ_i, varies freely across the sections. We express the respective null and alternative hypotheses for the ADF (1979) unit root tests as follows:

H_0: α=0, (Implies presence of a unit root is a unit root)

H_1: α<1 (Implies absence of a unit root/ data stationarity)

Given that all the five (5) panel unit root procedures carried out in this study began with the basic ADF

(1979), we only report the test statistics algorithms or model expressions in order to conserve space. The LL& C (2002) common unit panel unit root test, assumes that, under the null, a modified test-statistic for the resultant α is asymptotically normally distributed:

$$\hat{t}^* = \frac{t_\alpha - (NT)S_N\hat{\sigma}^{-2}SE(\hat{\alpha})_{mT^*}}{\sigma_{mT^*}} \tag{6}$$

Where; t_α is the standard test statistic â=0. $\hat{a}^2$ refers to the estimated variance of the stochastic error term, ε_{it} SE(â) is the standard error of â, and T=t-(∑i (ϱ_i/N))-1. The terms $\mu_{(m(T^*))}$, and $\sigma_{(m(T^*))}$, refer to respective adjustments for the mean and variance. The respective null & alternative hypothesis for the IP& S (11) unit root test can be conveniently expressed as shown in equation 7:

H_0=0,∀ i

$$H_1:\begin{cases} \alpha_i = 0\ for\ i\ =\ 1,2,\ldots N_1 \\ \alpha_i < 0\ for\ i\ = N+1, N+2,\ldots,N \end{cases} \tag{7}$$

The average of the t-statistics α_i from the individual ADF regressions $t_{(i(Ti))}$ (ϱ_i):

$$\overline{t_{NT}} = \left(\sum_{i=1}^{N} t_{iT_i}(\rho_i)\right)/N$$

IP&S (2003) assert that a properly standardized $\overline{t_{NT}}$ has an asymptotic standard normal distribution, N(0,1). As an alternative diagnostic panel set of unit root tests, Fisher's test may be employed. This unit root test process tends to combine the p-values from the individual unit roots test processes. Now, Wooldridge (2000) suggested that if π_i is defined as the p-value for any individual unit root test for cross section i, it implies that under the null unit root for all N, for all cross sections, the asymptotic result may be written again in a convenient format as shown in equation 8:

$$-2\sum_{(i=1)}^{N}\log(\pi_i)\rightarrow X_N^2 \tag{8}$$

IP&S (\2003) demonstrate that;

$z=1/(\sqrt{N})\sum_{(i=1)}^{N}\Phi^{(-1)}(\pi_i)\rightarrow N(0,1)$,

Where $\Phi^{(-1)}$ denotes the of the standard normal Cumulative Distribution Function.

E-views 9.5, statistical software employed in this study, yields the asymptotic Fisher chi-squared (X^2) and the standard normal statistics by applying and reporting the ADF 1979, i.e ADF(1979) & PP 1988, i.e PP(1988) individual unit roots diagnostic results. The null and alternative hypotheses are the same as those in individual root-IP& S (2003), panel unit root test procedures as expressed in equation number 7.

The Empirical Econometric Models

The empirical models employed to assess the dynamic and fixed effects of digital services trading on the economic (GDP) growth of each of the five world regions, we follow Mini-Thomas (2018), Maune (2019) and Mulenga and Mayondi (2022) in applying the panel vector auto-regression (PVAR) empirical econometric models. This study, however, is distinct from that of Mini-Thomas (2019) in that while Mini-Thomas (2019) evaluated the impact of Information Communication technology (ICT) on economic growth, our study evaluates the impact of digital services trading on five (5) diverse world regions. Additionally, whereas Maune (2019) applied P-VAR on a panel of countries from one region, specifically from the Sub-Saharan Africa, (SSA), this study evaluates the effect of digital services trade on growth of five (5) world regions. Furthermore, whereas Mulenga and Mayondi (2022) applied PVAR models to determine the digital services-economic growth nexus on panel data from Developed, Emerging and Developing countries, this study employs PVAR dynamic models to examine the effect of digital services trading on five (5) world regions from Africa, Asia, Europe, the Latin America and the OECD cluster, and extends the data analysis by one additional variable (Secure Internet Servers) as well as the time frame from 2005-2021. Additionally, we follow Simon and Pingfang (2021) in employing static models of Fixed Effects (FE) or Least Squares Dummy Variables (LSDV) models. We employ FE estimators to conduct static regressions because the Hausman test rejected the null hypothesis that supports the use of Random Effects (RE) models.

In compact (in log-difference) format, we can express the PVAR dynamic model as shown in equation 9:

$$dlnY_{it}=\alpha_t+\beta_1 dlnX_{it}+\beta_2 dlnX_{it}+\beta_k dlnX_{kt}+\mu Xit(\mu M_{it})+\omega X_{it}+\omega M_{it}+\varepsilon_{(it)} \tag{9}$$

Where the variables X_{it},...,X_{ik} refer to a matrix/ vector of independent(regressor)variables,γ_it refers to the regional economic/GDP growth, the coefficient estimates β_1, β_2,..., β_k refer to the quantitative effects that each respective regressor in the model has on regional GDP growth(γ_{it}), holding other regressors constant i refers to region i, t refers to time, and μx_{it},(μM_{it}) refers regional i's unobservable individual effects on export (import) equation, ω_{Xit}, ω_{Mit} are unobservable time fixed effects for exports and imports respectively and, ε_{it},refers to the stochastic error term parameters α_t refer to a vector of intercepts in each time series(year). We can write the compact expression under expression 9 more specifically as shown in equation 10:

$$dlnY_{it}= \alpha_t + \beta_1 dlnDigserv\_EXP_{it} + \beta_2 dlnDigserv\_IMP_{it} + \beta_3 dlnG\_EXP_{it}+\beta_4 dlnG\_IMP_{it}+\beta_5 dlnINT\_Users_{it}+\beta_5 dlnSEC\_INTSERV_{it}+\mu X_{it}(\mu M_{it})+\omega X_{it}+\omega M_{it}+\varepsilon_{it} \tag{10}$$

Where Y_{it} is GDP per capita in current US Dollars for-ith region at time t, α_t denotes various intercepts for different years in each time series, β_1 $Digserv\_EXP_{it}$ is digital services exports trading for region i at time t, β_2 $Digserv\_IMP_{it}$ denotes digital services trading imports variable for region i at time t, β_3 G_EXP_{it} denotes goods exports trading variable for region i at time t, β_4 G_IMP_{it} refers to the goods imports variable for region i at time t, β_5 Int_Users_{it} refers to the number of internet users measured as per centage points (%) of the population for region i at time t and SEC_SERV_{it} refers to the secure internet servers per 1 million people. ω_{Xit}, ω_{Mit} denote unobservable time fixed effects for exports and imports respectively and, ε_{it} denotes a stochastic disturbance term i at time t. The various intercepts for different years in each time series denoted as α_t accounts for the change in GDP per capita per year. In empirical literature, it is recommended that panel data analyses be done in natural log form to rescale data thus making variance constant, and to reduce the effects of positive skewness. Additionally, data in natural logs transforms non-linear data to linear (Green, 2003; Maune, 2019; Stock and Watson, 2001).

Pvar Versus Pvecm

Despite being widely used in the literature, VAR models (refer to Lutkepohl, 1991, Johansen, 1995 for detailed discussions), we briefly discuss it here highlighting reasons why we employ PVAR models in this study. Lutkepohl (1999) and Green (2003) explain that the use of PVAR models help to capture the dynamic interdependencies in panel data thereby considering the cross-sectional dynamic heterogeneities through the incorporation of time variations in the coefficients and in the variance of innovations or shocks. The same algorithms used to create ordinary VARs are used to create PVAR models, but PVAR models have cross section dimensional features added to them (Green,2003). VAR is a description of the evolution of the set of k (endogenous) variables in the same sample period as a linear function of their past changes. In other words, VAR model can be described as n-equation, with n-variables explained by their own lagged(past) and current values of the remaining n-1 variables (Stock and Watson, 2001). Thus, the basic Panel VAR (PVAR) or PVAR at levels can be expressed as shown in equation 11:

$$y_t = A_0 + A_1 y_{t-1} + \cdots + A_p y_{t-p} + u_t \quad (11)$$

Where p is the number of (lags) parameters, A_0 is a vector of intercepts, y_t is a vector of endogenous variables, A_i is k x k coefficient matrices, implying that, i=1,2,…,p,
U_t = K-dimensional denotes stochastic disturbance non time variant process (15). The basic PVAR model assume a VAR(p) process as the number of lags equals p. It is assumed further that the VAR(p) is generalizable enough to factor in probabilistic trends predicated on the process that is stable given that:

$$\det\left(I_k - A_{1z} - \cdots A_{pz^p}\right) \neq 0 \text{ for } |z| \leq 1 \quad (12)$$

This means that, given that the polynomial determinant in equation 11 has a unit root, implying also z=1, it follows that some or all the variables in the systems may be cointegrated of order 1. Lutkepohl (199) advises that VAR at levels may not be an appropriate estimator for cointegrated system of equations. To this end, this paper employs the vector error correction models (VECM) given that the system of equations in our study are cointegrated.

We follow Lutkepohl (1999) in expressing the panel-VECM (PVECM) model as shown in equation 13:

$$\Delta y_{it} = \pi_{yit-1} + \Gamma_1 \Delta y_{it} + \cdots \Gamma_{p-1} \Delta y_{it-p+1} + \mu_{it} \quad (13)$$

Where $\pi = -(I_{(k)} - A_{(1)} - \ldots - A_p)$, and $\Gamma_i = -(A_{(i+1)} + \cdots + A_p)$ for i=1,…p-1

It is assumed that the expression: $\Delta y_{(it)}$, contains no stochastic trends. All the variables are thus integrated of order one, (I(1)) implying that the presence of cointegration relations is manifested by the term, $\pi_{(yit-1)}$ be I(0).When $y_{(it)}$ is cointegrated with cointegration rank, r, rank(π)=r<K and π=αÁ' where α and A are Kx r matrices. The term $\Gamma_{(j)}$ (j=1,…,p-1) is interpreted as short run parameters while $\pi_{(yit-1)}$ term is the long run association part of the P-VECM. The unknown VAR order p in equations 11 and 13 is estimated using the Akaike Information Criterion (AIC). In estimating the fixed effects, we employ the model which can be expressed generally as shown in equation 14:

$$y_{it} = \beta_0 + \beta_1 X_{it} + \gamma_2 D2_i + \gamma_2 D3_i + \cdots + \gamma_n Dn_i + u_{it} \quad (14)$$

Where; γ is a vector of dependent variables, β_0 are intercepts, $\beta_{(1)}$ are coefficient estimates, X is a vector of regressors,
i=1,2,…n, D represents dummy variables,t denotes time,u_{it} is the white noise error term for region i at time,t.

RESULTS AND DISCUSSION

Diagnostic Tests and Choice of Models

The author employed Hausman tests to determine whether to estimate Fixed or Random effects models. The Hausman test rejected the null hypothesis of estimating Random Effects (RE). Thus, this author used the Fixed Effects (FE) estimator or Least Squares dummy variable (LSDV) models static estimators. We follow Kao (1999) and Pedroni (1999) in conducting regional panel data cointegration tests. Both Kao (1999) and Pedroni (1999) confirmed that regional panel data were cointegrated. Consequently, we used the PVECM as dynamic models.

Summary Descriptive Statistics

Table 1 reports summary descriptive statistics for the five (5) sub-panel world regions surveyed in this study.

Table 1: Descriptive Statistics of Five Regions

	Mean	Max	Min	Std. Dev	Obs.
Panel 1: African Region (SSA)					
GDP_CAP	16.57	29.34	6.13	7.02	121
DIG_EXP	24454.85	30268.34	18565.59	3560.73	121
DIG_IMP	35.77	42.99	32.43	2.38	121
G_EXP	3.58	4.35	2.68	5.36	121
G_IMP	3.53	3.96	2.96	3.04	121
INT_USERS	16.57	29.34	6.13	7.02	121
SEC_INTSERV	257.75	787.44	3.63	323.39	121

Panel 2: Asian Region (SOUTH ASIA)					
GDP_CAP	5303.88	6553.21	4057.73	804.70	132
DIG_EXP	446727.01	634458.50	277006.31	106447.94	132
DIG_IMP	49.62	56.94	41.64	3.911	132
G_EXP	3.65	4.11	2.82	3.61	132
G_IMP	5.67	6.77	4.42	6.56	132
INT_USERS	16.76	38.53	7.17	8.77	132
SEC_INTSERV	3.02	5.94	0.33	1.98	132
Latin American Region					
GDP_CAP	14663.39	15972.73	12904.98	857.51	132
DIG_EXP	55599.11	61069.64	41868.39	5484.09	132
DIG_IMP	26.98	35.14	24.98	2.63	132
G_EXP	8.60	9.45	7.19	6.86	132
G_IMP	8.73	9.68	7.19	7.49	132
INT_USERS	53.19	73.39	34.01	12.24	132
SEC_INTSERV	508.19	1676.19	19.15	599.25	132
Panel 4: European Region (EASTERN)					
GDP_CAP	9133.79	10962.47	7640.69	1063.64	132
DIG_EXP	82019.53	109716.44	57255.33	16289.40	132
DIG_IMP	29.02	38.97	25.95	3.34	132
G_EXP	1.12	1.26	8.81	1.34	132
G_IMP	1.06	1.19	8.73	1.12	132
INT_USERS	60.78	80.25	40.07	12.39	132
SEC_INTSERV	94.67	381.76	1.39	130.78	132
Panel 5: OECD Region					
GDP_CAP	9133.79	10962.47	7640.69	1063.64	132
DIG_EXP	82019.53	109716.41	57255.33	16289.40	132
DIG_IMP	29.02	38.97	25.96	3.34	132
G_EXP	1.12	1.26	8.81	1.34	132
G_IMP	1.06	1.19	8.73	1.12	132
INT_USERS	60.78	80.25	40.064	12.39	132
SEC_INTSERV	94.66	381.75	1.39	130.78	132

Source: Authors computations using data from UNCTADstat & the World Bank's World Development Indicators

Table 2 reports the panel unit test results. We observe in Table 2 that the variables in the African, Asian, Latin American, and European regions show that some data have unit roots while the other data is stationary at levels. However, all the variables in the OECD regional data are all integrated of order 1.

Note that Fisher tests were computed using an asymptotic Chi-squared distribution. All other tests assume asymptotic normality. The null hypothesis assumes a common unit root process. *, **, ***, imply that the respective regional panel data variable is stationary at 10%, 5% and 1% significance levels. Root tests included individual intercepts only. ADF denotes is Augmented Dickey Fuller test, PP refers to Phillips and Peron unit root tests whereas LLC refers to Levin, Lin and Chu unit root tests and IPS denotes Im, Pesaran and Shin unit root tests.

Table 2: Panel Unit Root Test Results

Variable	LLC (t-stat)	IPS (W-t-stat)	ADF-Fisher X^2	PP-Fisher X^2	Order of Integration
Panel 1: African Region					
GDP_CAP	-3.10*	-2.51**	56.43**	145.78**	I(0)
DIG_EXP	-2.12**	-1.13**	80.79*	145.22**	I(1)
DIG_IMP	-3.14*	-1.11**	51.12**	123.78*	I(1)
G_EXP	-4.07*	-2.8**	69.17**	419.37**	I(1)

G_IMP	-2.97**	-2.32**	190.10*	401.207**	I(0)
INT_USERS	-3.01**	-2.31**	45.05**	201.92**	I(1)
SEC_INTSERV	-3.01**	-1.02**	69.17*	117.75**	I(1)
Panel 2: Asian Region					
GDP_CAP	-5.09***	-4.67**	90.34*	201.61***	I(1)
DIG_EXP	-2.79**	-1.54***	112.89*	173.71***	I(1)
DIG_IMP	-4.67**	-3.72*	144.78*	69.17**	I(1)
G_EXP	-2.73*	-1.79**	95.11**	130.10**	I(1)
G_IMP	-7.91**	-6.09**	86.45**	88.95***	I(1)
INT_USERS	-3.22**	-5.79***	111.23*	71.09**	I(1)
SEC_INTSERV	-5.13***	-4.67***	205.12*	91.65**	I(0)
Panel 3: Latin America Region					
GDP_CAP	-4.67**	-2.028*	79.67*	319.37**	I(1)
DIG_EXP	-2.73**	-1.78**	290.14*	201.21*	I(1)
DIG_IMP	-9.09**	-6.71**	45.05*	201.92**	I(1)
G_EXP	-8.79*	-7.00**	169.17*	174.78**	I(0)
G_IMP	-4.67*	-3.50*	98.45 **	209.56**	I(0)
INT_USERS	-4.67*	-2.79**	79.14**	86.45*	I(1)
SEC_INTSERV	-5.66**	-4.71**	211.57*	208.78*	I(1)
Panel 4: European Region					
GDP_CAP	-9.66*	-7.91**	204.23*	312.97**	I(1)
DIG_EXP	-11.21*	-7.79**	117.89*	214.78*	I(0)
DIG_IMP	-8.96**	-6.47**	211.56*	305.11***	I(0)
G_EXP	-7.11**	-4.67**	189.2*	86.45***	I(1)
G_IMP	-10.71*	-3.44**	156.3*	121.38*	I(1)
INT_USERS	-12.79**	-5.62**	94.9*	79.19**	I(1)
SEC_INTSERV	-8.76**	-4.02*	78.9**	87.23**	I(1)
Panel 5: OECD Region					
GDP_CAP	-6.34***	-4.89**	82.29*	122.99**	I(1)
DIG_EXP	-8.79**	-5.71*	101.34*	164.78**	I(1)
DIG_IMP	-4.26*	-1.54**	98.27*	95.11**	I(1)
G_EXP	-6.93**	-3.72*	120.23*	86.45**	I(1)
G_IMP	-7.91***	-1.79**	107.18	111.23**	I(1)
INT_USERS	-4.71*	-6.09***	69.27*	97.0***	I(1)
SEC_INTSERV	-3.76**	-1.67**	98.14*	133.99***	I(1)

Test for Linear Correlations among the Regional Panel Data Variables

The author conducted the correlational relationships so that we identify the linear relationships among the variables. We report the results in Table 3.

For the African Region, digital services exports, digital services imports, goods exports, and secure Internet Servers variables exhibit a strong positive correlation with economic growth (GDP). The number of people using the internet variable is positively and perfectly correlated with GDP. However, goods imports variable is weakly correlated with GDP. For the Asian Region, all the variables show a strong positive correlation with GDP except the goods exports variable which is weakly correlated with GDP. The Latin American Region shows that all the variables have a strong positive correlation with GDP except the goods export variable which shows a weak negative correlation. In terms of the European Region, all the variables are weakly correlated with GDP, with digital exports, goods exports, goods imports and the number of people using the internet variables being positively correlated. Digital services imports and secure internet servers have a negative correlation. Finally, in the OECD Region, all the variables have a positive and strong correlation with GDP except digital imports and goods imports variables which show a strong negative correlation with GDP.

Table 3: Correlations Matrix

	GDP_ CAPITA	DIG_EXP	DIG_IMP	G_EXP	G_IMP	INT_USE	SECURE_ INTSER
Panel 1- Africa Region							
GDP_CAPITA	1						
DIG_EXP	0.98	1					
DIG_IMP	0.95	0.87	1				
G_EXP	0.66	-0.56	-0.66	1			
G_IMP	-0.41	-0.31	-0.46	0.8	1		
INT_USERS	1	0.98	0.95	-0.66	-0.39	1	
SECURE_INTSERV	0.91	0.933	0.85	-0.39	-0.32	0.67	1
Panel 2-Asia Region							
GDP_CAPITA	1						
DIG_EXP	0.96	1					
DIG_IMP	0.82	0.82	1				
G_EXP	0.52	0.5	0.06	1			
G_IMP	0.91	0.33	-0.03	0.93	1		
INT_USERS	0.84	0.93	0.83	0.26	0.07	1	
SECURE_INTSERV	0.98	0.96	0.87	0.44	0.31	0.89	1
Panel 3-Latin America Region							
GDP_CAPITA	1						
DIG_EXP	0.90	1					
DIG_IMP	0.14	0.01	1				
G_EXP	-0.62	0.66	-0.06	1			
G_IMP	0.59	0.77	-0.32	0.92	1		
INT_USERS	0.88	0.68	0.59	0.35	0.22	1	
SECURE_INTSERV	0.73	0.45	0.65	0.38	0.14	0.91	1
Panel 4-Europe Region							
GDP_CAPITA	1						
DIG_EXP	0.14	1					
DIG_IMP	-0.29	0.51	1				
G_EXP	0.37	0.28	-0.08	1			
G_IMP	0.44	0.37	0.07	0.98	1		
INT_USERS	0.35	0.96	0.45	0.05	0.15	1	
SECURE_INTSERV	-0.42	0.93	0.41	-0.01	0.09	0.98	1
Panel 5-OECD Region							
GDP_CAPITA	1						
DIG_EXP	0.98	1					
DIG_IMP	-0.73	0.79	1				
G_EXP	0.82	0.74	0.45	1			
G_IMP	-0.77	0.68	0.39	0.99	1		
INT_USERS	0.99	0.96	0.80	0.81	0.77	1	
SECURE_INTSERV	0.84	0.88	0.82	0.54	0.48	0.84	1

Source: Author's computations using data from UNCTADstats & the Word Bank's World Development Indicators (WDI) databases

Panel VECM Results-Dynamic Model Estimates

Table 4 reports a summary of the dynamic PVEC model estimates of the long run cointegration coefficients along with their respective speeds of adjustments obtained by employing equation 13. The variables are in natural log format.

The PVECM results for the Africa region panel show that, over the long term, exports of digital services have an impact on GDP that is statistically significant at the 5% level. That is, every 1% increase in exports of digital services results in a 0.82% significant rise in GDP. A 1% increase in the number of internet users and the number of secure internet servers causes an increase in GDP of 0.52% and 0.32%, respectively. Digital services exports variable returns to a long run equilibrium after experiencing a shock with a speed of adjustment of 0.14%.

The PVECM estimates for the Asian region show that digital services exports and digital services imports variables have significant but opposite effects on the regional GDP growth in Asia. In specific terms, every 1% increase in digital services exports, GDP per capita significantly rises by 1.02%, and while digital services imports results in significant decrease of GDP per capita by 0.23% in the long run. Additionally, a rise of 1% in the number of internet users and in the number of secure internet servers increases GDP in the long run by 0.31% and 0.19% respectively. The respective speeds of adjustments for digital exports, goods imports, the number of people using the internet and secure internet servers are 0.12%, 0.07%, 0.16%, 0.16% and 0.13%.

For the Latin American Region, the PVECM estimates indicate that, GDP increases by 2.11% and 0.27%, respectively, for every 1% growth in exports and imports of digital services. Additionally, a 1% increase in internet users results in a long-term significant increase in GDP of 0.34%. Secure internet server variable, however, significantly lowers GDP by 0.08% at a 5% level. Digital services exports, goods exports, goods imports, and Secure Internet Servers demonstrate the speed of adjustment of 0.13%, 0.18%, 0.05%, and 0.15% in terms of long-run convergence or return to equilibrium following a shock.

In the European Region, the PVECM estimates show that the GDP is significantly impacted positively by exports of digital services exports, goods, the number of internet users, and the secure internet servers' variables. For instance, a 1% rise in each of these variables significantly increases long-term GDP by 3.19%, 1.29%, 1.22%, and 1.15%, respectively. However, the GDP significantly declines by 0.13% for every 1% rise in goods imports. The rates of adjustment for the models of digital service exports, imports of digital services, exports of goods, the number internet users, and secure internet servers are 0.17%, 0.13%, 0.33%, 0.27%, and 0.21%, respectively.

According to PVECM estimations from the OECD region, the GDP is significantly augmented by exports in digital services, imports of digital services, goods exports, internet usage, and secure internet servers. In specific terms, GDP rises by 6.75%, 1.43%, 2.25%, 1.81%, and 0.11% for every 1% increase in each of the variables, respectively. On the other hand, the goods imports variable significantly lowers the GDP growth of the OECD region by 1.06%. Digital exports, digital imports, goods imports, and secure internet servers' models all return to long run equilibrium at speeds of 0.37%, 0.49%, 0.27%, and 0.06%, respectively.

Table 4: Dynamic Panel Vector Error Correction (VEC) Model Estimates

	LR Cointegration Estimates ECT			Speed of Adjustment Estimates			R^2
	Coeff	t-stats	Std.Errors	Coeff	t-stats	Std.Errors	
Panel 1: Africa Region							
lnGDP_Capita (Dependent	1			0.03	3.5**	0.02	0.71
lnDIG_EXP	0.82	-3.1**	0.58	-0.14	-2.9**	0.39	0.53
lnDIG_IMP	0.33	-0.59	0.52	0.01	0.34	0.04	0.67
lnG_EXP	0.13	2.2**	0.71	0.06	1.7*	0.59	0.69
lnG_IMP	-0.17	1.8*	0.45	0.09	1.35	0.93	0.54
lnINT_USERS	0.52	2.8**	0.21	-0.11	-3.2**	0.08	0.49
lnSECURE_INTSERV	0.32	2.5**	0.07	0.03	0.43	0.17	0.51
Panel 2: Asia Region							
lnGDP_Capita (Dependent)	1			0.09	2.1**	0.06	0.43
lnDIG_EXP	1.02	4.8**	0.06	-0.12	-6.2**	0.04	0.74
lnDIG_IMP	-0.23	-2.9**	0.08	0.04	3.5**	0.08	0.63
lnG_EXP	0.29	-1.21	0.08	0.05	2.1**	0.03	0.76
lnG_IMP	-0.57	1.9*	0.17	-0.07	-2.2**	0.34	0.74
lnINT_USERS	0.31	2.2**	0.16	-0.16	-4.6**	0.04	0.56
lnSECURE_INTSERV	0.17	5.1**	0.17	-0.13	-3.1**	0.06	0.71
Panel 3: Latin America Region							
lnGDP_Capita (Dependent	1			-0.32	1.56	0.04	0.41
lnDIG_EXP	2.11	1.8*	0.07	-0.13	-5.3**	0.32	0.68
lnDIG_IMP	0.27	2.4**	0.07	0.23	0.62	0.36	0.71

lnG_EXP	0.09	3.6**	0.16	-0.18	-1.9*	4.38	0.71
lnG_IMP	-0.19	-2.2**	0.23	0.05	4.1**	0.42	0.52
lnINT_USERS	0.34	4.3**	0.09	0.28	0.78	0.32	0.44
lnSECURE_INTSERV	-0.08	-3.1**	0.01	-0.15	-3.2**	0.14	0.59
Panel 4: Europe Region							
lnGDP_Capita (Dependent	1			0.13	1.45	0.01	0.61
lnDIG_EXP	3.19	4.5**	0.06	-0.17	-2.4**	0.06	0.58
lnDIG_IMP	-0.03	-0.58	0.03	-0.13	1.96*	0.08	0.63
lnG_EXP	1.29	3.7**	0.08	0.33	2.5**	0.68	0.79
lnG_IMP	-0.13	-2.1**	0.06	0.05	0.14	0.76	0.73
lnINT_USERS	1.22	6.1**	0.04	-0.27	-2.0**	0.45	0.79
lnSECURE_INTSERV	1.15	2.3**	0.37	-0.21	-3.5**	0.72	0.51
Panel 5: OECD Region							
lnGDP_Capita (Dependent 1	1			-0.41	1.06	0.09	0.65
lnDIG_EXP	6.75	3.7**	0.01	-0.37	-3.3**	0.11	0.84
lnDIG_IMP	1.43	2.2*	0.04	-0.49	-1.9**	0.04	0.74
lnG_EXP	2.25	2.4**	0.03	0.86	0.17	0.39	0.76
lnG_IMP	-1.06	-3.4**	0.01	-0.57	-2.3**	0.05	0.74
lnINT_USERS	1.81	2.1*	0.02	0.27	1.32	0.08	0.57
lnSECURE_INTSERV	0.11	3.9**	0.02	-0.06	-6.3**	0.13	0.61

*Source: Author's computations using panel data from UNCTADstat and World Bank's World Development Indicators (37) databases. ECT means error correction term. The asterisks: *, ** means that the respective variable is statistically significant at 10% and 5% respectively. The PVECM estimators include intercepts only. According to the guidance by the Akaike Information Criterion (AIC) the appropriate lag length for each regional panels were as follows: Africa - lag 7, Asia -lag 5, Latin America -lag 4, Europe - lag 5, and the OECD-lag 6. We subtracted 1 lag from each lag length as per the VECM modeling techniques (Green, 2003)*

Static Panel Fixed Effects Regression Estimates

After adjusting for regional unobserved heterogeneity factors, the author used fixed effects analyses to assess how each regressor affected the GDP growth of each of the five (5) regions. From Table 5, it is easy to observe that the number of internet users, digital products exports, goods imports, goods exports, and secure internet servers have long-run, significant impact on the GDP in the region of Africa. Specifically, a 1% increase in digital services exports, goods exports, the number of people using the internet and secure internet Servers results in a significant long run GDP increase of 1.01%, 0.43%, 0.17% and 0.12% respectively at 5% levels. However, digital services imports and goods imports cause a significant long run decrease in regional GDP by 0.83% and 0.63% respectively. For the Asian Region, the Fixed Effects (FE) regression estimates indicate that a 1% increase in exports of digital services, imports of goods, and secure internet servers result in GDP growth of 1.42%, 0.31%, and 0.21%, respectively. However, the GDP plummets by 0.19% and 0.22%, respectively, for every 1% rise in goods exports and in the number of internet users. The Latin American Region is significantly positively impacted in the long run by imports of goods, the number of internet users, and the secure Internet server variables. That is, for 1% rise in each of the foregoing variables, the long GDP in the Latin American region correspondingly increase by 1.28%, 0.18%, 0.12% and 0.20% respectively. An increase in digital imports into this region causes significant decrease in the long run GDP o by 0.14%.

Table 5: Static Panel Fixed Effects (FE) Model Estimates

	lnGDP_Capita (Dependent variable)			**Hausman Test Summary**	
	Coeff	**t-stat**	**Std.Errors**	**X^2 Stat**	**X^2 d. f**
Panel 1: Africa Region					
lnDIG_EXP	1.01	2.06**	0.01	19.25**	5
lnDIG_IMP	-0.83	-1.88	0.03	(0.02)	
lnG_EXP	0.43	3.02**	0.05		
lnG_IMP	-0.63	3.96**	0.01		
lnINT_USERS	0.17	2.19**	0.04		

lnSECURE_INTSERV	0.12	4.03**	0.02		
Panel 2: Asia Region					
lnDIG_EXP	1.42	5.16**	0.08	15.05**	5
lnDIG_IMP	-0.19	-1.53	0.08	(0.03)	
lnG_EXP	-0.38	-3.83**	0.09		
lnG_IMP	0.31	4.76**	0.06		
lnINT_USERS	-0.22	-1.66	0.03		
lnSECURE_INTSERV	0.21	6.49**	0.01		
Panel 3: Latin America Region					
lnDIG_EXP	1.28	5.19**	0.02	11.55**	5
lnDIG_IMP	-0.14	-9.73**	0.06	(0.01)	
lnG_EXP	-0.04	-1.21	0.02		
lnG_IMP	0.18	4.96**	0.07		
lnINT_USERS	0.12	5.19**	0.19		
lnSECURE_INTSERV	0.20	6.09**	0.12		
Panel 4: Europe Region					
lnDIG_EXP	1.31	13.74**	0.23	21.55**	5
lnDIG_IMP	-0.51	-6.03**	0.29	(0.00)	
lnG_EXP	0.32	2.02**	0.11		
lnG_IMP	-0.37	-2.98**	0.07		
lnINT_USERS	0.45	3.02**	0.67		
lnSECURE_INTSERV	0.17	1.05	0.53		
Panel 5: OECD Region					
lnGDP_CAPITA				33.21**	5
lnDIG_EXP	2.23	16.74**	0.14	(0.04)	
lnDIG_IMP	-0.18	-16.28**	0.18		
lnG_EXP	1.31	2.02**	0.09		
lnG_IMP	-0.11	-3.78**	0.08		
lnINT_USERS	0.41	16.33**	0.41		
lnSECURE_INTSERV	0.15	5.97**	0.02		

*Source: Author's elaboration on data from UNCTAD and World Bank's World Development Indicators. Notes: ** denotes statistically significant at 5% level. P-value are in parentheses (). d.f denotes degrees of freedom. X2 denotes Chi-square*

The Fixed Effects (FE) regression estimates for Europe show that the have a long- impact on GDP. That is, 1% increase in goods exports, digital services trade, and internet users each causes 1.31%, 0.32%, and 0.45% growth in GDP, respectively. Meanwhile, GDP declines by 0.51% and 0.37 in long run when the region's goods imports and digital services both rise by 1%.

We observe that, for every 1% rise in exports of digital services, goods exports, the number of people using the internet, and secure Internet servers, economic growth in the OECD region significantly increases by 2.23%, 1.31%, 0.31, and 0.15%, respectively. Goods Imports and digital services trade imports both have long-run negative impact of 0.18% and 0.11% respectively.

CONCLUSION

The study examines the of digital services trading on the economic growth (Gross Domestic Product per capita, GDP) of panel data from five (5) world regions namely, Africa, Asia, Latin America, Europe and the Organization for Economic Cooperation and Development (OECD) between 2005 and 2021. Quantitative experimental methods are employed. The Panel vector autoregression (PVAR) models are used as dynamic estimators while the Fixed Effects (FE) models are used as static estimators. The dynamic Panel Vector Error Correction (PVEC) model estimates indicate that the export of digital services trade has significant long-run positive impact on GDP per capita (economic growth) in each of the five regions, with the largest magnitude increase in GDP observed in the OECD region at 6.75%, followed by Europe at 3.19%, 2.11% in Latin America, 1.02% in Asia and it is relatively lowest in Africa at 0.82%. In terms of digital services imports, the largest long run positive significant effect is observed again, in the OECD region where a 1% increase in digital imports services trade increases

GDP by 1.43% with the Africa Region ranking second at 0.33%. The findings from the static Fixed Effects (FE) estimates of the impact of digital services exports on the economic growth of the five (5) world regions in our study also indicate a long run significant positive effect in all the world regions. Specifically, with each 1% increase in digital services trade variable, economic growth increases by 2.23% in the OECD region, 1.42% in Asia, 1.31% in the Europe, 1.28% in Latin America and it is lowest in the Africa region where it increases by 1.01%. Digital services imports variable has a long run negative impact on the economic growth in the OECD, Europe, and Latin American regions. These findings confirm the hypothesis that deep internet/digital penetration positively impacts the efficiency of digital services trade. The study, therefore, recommends that policymakers from the developing and emerging world regions should increase investments in digital infrastructure and digital policy development which should include among others, promoting policy and regulatory measures that augment digital infrastructure installations in rural regions, enhancing the digital skills, and promoting the adoption of cutting-edge digital technologies to increase access to relatively cheap digital infrastructure and services.

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Appendix

Foot Notes

[1]Digital Enablers determine the effectiveness and efficiency of digital trade. The level of development of the cohort of digital technologies determine the digital/internet penetration (digital connectivity and digital depth). For a detailed discussion on the effect of internet penetration on digital trade, see, for example, World Bank 2016 , and Brookings, 2017.

[2]Countries in Sub-Saharan Africa (SSA), Eastern Europe, South Asia and Latin America (and the Caribbean) regions are defined as developing regions by the United Nations and the World Bank. For details, see https://www.un.org/en/development/desa/policy/wesp/wesp_current/2014wesp_country_classification.pdf

[3]USD refers to the United States Dollar.