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Impact of Digital Services Trade on Economic Growth of Developing, Emerging and Developed Countries: P-VAR Approach.

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Abstract

Purpose: The objective of this study was to evaluate the impact of digital services trade on economic growth of a panel of developing, emerging and developed countries for the period 2005-2019.

Methodology: Panel-Vector Auto-Regression (P-VAR) and Fixed Effects models (FE) were employed to evaluate the impact of digital services trade on a panel of 32 developing, 45 emerging and 24 developed countries respectively.

Findings: The Vector Error Correction Models (VECM) indicated that digital services exports have a significant long run positive impact on GDP in all the country panels. Specifically, a 1% increase in digital service exports increased per capita GDP by 0.88%, 0.78% and 0.34% in developed, emerging and developing countries respectively. Moreover, there was a long run causality running from digital services export models to GDP in all the three country panels. The study found that for every 1% increase in the number of people using the internet, GDP increased by 0.62%, 0.75% and 0.02% in developed, emerging and developing country panels respectively. Fixed Effects (FE) models showed that digital services trade had a significant positive impact on GDP of 0.07% only in developed countries. In terms of adjustment to a long run equilibrium, results indicated that the speed of adjustment was fastest in emerging countries panel at 0.81% followed by developing countries panel at 0.75%, and it was slowest in developed countries panel at 0.29%.These preliminary results clearly indicated that the panel of developing countries were trailing behind in digital services trade.

Recommendations: Given that developing countries panel was trailing behind in digital services trade relative to emerging and developed countries panels, it was recommended that developing countries governments and other stakeholders should increase investments in both institutional and physical digital infrastructure that would enable more people, especially small and medium enterprises (SMEs) and those in rural areas to access and participate in digital trade related services. Access to stable, high speed and affordable internet services should be prioritized. This study contributes to the evolving literature on digital services trade and economic growth.

Keywords: *P-VAR, Digital Services Trade, Economic Growth, Emerging and Developing countries.*

1. Introduction

Digital trade is an integral part of global digital economy and Fourth Industrial Revolution (4IR). Digital trade comprises digitally ordered trade in goods and services. It is also called cross border e-commerce (United Nations Conference on Trade and Development, 2020). Formally, digital trade is defined as "All trade that is digitally ordered and/or digitally delivered."(UNCTAD Handbook for measuring digital trade, 2020, Organization for Economic Cooperation and Development, 2022). "Digitally delivered trade" refers to International transactions delivered remotely in an electronic format using computer networks while" digitally ordered trade" refers to the international sale or purchase of goods and services over computer networks specifically designed for the purpose of receiving or placing orders(OECD policy brief, 2022: 1). Digitization continues to radically change "the way business is conducted at both national and international levels.

The supply side has been impacted by digital trade in that the digital tools and digital platforms make it easier for service providers to significantly change the modes of digital services supply and exponentially expand their customer base way beyond their boundaries. For instance, by utilizing online market platforms such as Air BnB for accommodation, Uber for transportation, eBay and Amazon for digital trade, firms of varying sizes are able to reach potential suppliers and customers globally (UNCTAD, 2017; OECD, 2020). On the demand side, digitalization makes it possible for consumers to have access to a variety of services at competitive prices (UNCTAD, 2022).

Compared to conventional or analogue trade, digital trade driven by the digital communication networks makes it easy to coordinate global supply chains thereby making digital trade relatively quicker, cheaper and increases trade volumes. Consequently, digital trade results in higher economies of scale, reduced trade time, reduced search costs and lowers the venerated variable costs by lowering entry barriers (OECD, 2020, DFID, 2020, OECD, 2018b). The geographical distance which is a big factor in conventional trade is not an important factor when it comes to digital trade because trading via digital platforms significantly compresses overall distance and its related costs (UNCTAD, 2020). In addition, Digital trade has increased the capacity to save on search and travelling costs to potential trading partners. The digital trade's ability to compress distance makes it easy for small open economies and start- up businesses such as Small and Medium Enterprises (SMEs) to fully participate in the international trade ecosystem previously dominated by large multinational corporations (MNCs) (OECD policy brief, 2022). This leads to increased job creation, competitive prices, increased industrial and economic growth and amplifies consumer welfare effect. (DFID, 2020). The Covid-19 pandemic has further increased the importance of digital trade. The Covid-19 period saw an exponential increase in the use and development of online platforms to buy goods and services. UNCTAD (2022) reports that traditional global services exports fell by 20 percent compared with 2019 but digitally delivered services were relatively resilient because they only declined by 1.8 percent amidst the economic meltdown caused by the COVID-19 pandemic.

However, there is a great variation among countries in terms of their readiness for digital trade. The level of preparedness for digital trade determines the potential benefits of countries from digital trade (UNCTAD, 2022, OECD, 2020). In addition, from the review of related literature, it was observed that a significant portion of literature focuses on the impact of digital economy

and/or proxies of digital economy on economic growth. Thus, it seems there is a gap regarding studies focusing specifically on the impact of digital services trade on the economic growth of developing, emerging and developed countries. The objective of this study therefore, was to fill this gap by assessing and comparing the impact of digital services trade on the economic growth of developing, emerging and developed countries by employing the Panel Vector Auto Regression (P-VAR) Approach.

2. Literature Review

The concept of digital trade is broad and embodies many terminologies including digital economy, the digital transformation, sharing economy and gig economy among others. It involves the use of the Internet to search for products, purchase them, and deliver them online (Katz & Koutroumpis, 2013; OECD, 2020). Although digitalization is virtually almost everywhere, it is also almost invisible in country official national accounting statistics of trade and GDP computations. "… This lack of visibility is largely a function, or perhaps legacy of the fact that the core economic production accounts still remain largely constructed around firms and tangible products." (Measuring Digital Trade OECD, 2020:10). This makes the distinguishing line between digital services trade and general or traditional services trade very thin. However, digital trade continues to grow exponentially. McKinsey (2016:1,2) aptly explains; "…the Internet is now a global network instantly connecting billions of people and countless companies around the world. Flows of physical goods and finance were the hallmarks of the 20th-century global economy, but today those flows have flattened. Global flows of goods, Foreign Direct Investment (FDI), and data have increased current global GDP by roughly 10 percent compared to what would have occurred in a world without any flows.

2.1 Barriers to Digital Trade

Although digital trade promotes job creation, industrial growth and economic growth, barriers to digital trade impinge on the optimal realization of potential benefits of digital trade. These include among others, tariffs and quotas on imports of information and communication technology equipment such as routers and servers, localization requirements that compel the conduct of digital trade-related activities within a country as prerequisite for doing business, cross-border data flow restrictions that prohibit the export of data outside a country; Intellectual property infringement, online sale and distribution of counterfeits, and online theft of intellectual property; discriminatory national and local standards that deviate from recognized international standards or impose redundant conformity assessment and testing requirements; and filtering and blocking restrictions that impede access to foreign websites and data flows (Wiley, 2022; World Economic Forum, 2020).

2.2 Mitigating Barriers to Digital Trade

The 2020 World Economic Forum (WEF, 2020: 6-7) suggests the following measures, among others, to mitigate the negative effects of digital trade barriers: Accelerate e-commerce trade preparedness to benefit small businesses and developing economies, build interoperability for global data flows, including through trade frameworks and regulatory cooperation, and explore the effects and requirements of rapidly expanding digital trade in services, map new trade technologies – including cloud services, 3D printing and digital economy discussion on policies to balance gains versus risks and support the international functionality of payment systems and

related supply chain information flow. Zhang et al., (2021) assert that the advantages of digital economy which include high economic growth can only be fully realized in regions with well-developed digital infrastructure.

2.3 Conceptual Framework

A new concept in the recent world trade is the rise of digital trade in services conducted internationally over the internet (WEF, 2020). This concept is impacting traditional or conventional international trade in highly disruptive ways and radically altering the nature of consumer and business transactions. Conceptually, the rise in digital services trade is driven by fragmentation of production processes (Shiozawa, 2017). Fragmentation in production has resulted in rapid decrease of trade costs augmented by the revolutionary development of Information and Communication Technologies (Jones & Kierzkowski, 1990; Shiozawa, 2017).

This study's conceptual framework consists of per capita GDP as the dependent variable. Digital Services Exports, Digital Services Imports and the Number of People using the Internet are independent variables. Goods Exports and Goods Imports are control variables in the analysis.

2.4 Review of Related Empirical Literature.

Zhang et al., (2021) did a study on the effect of digital economy on high quality economic development in China using panel data from 30 provinces from 2015 to 2019 using the direct effect model or the Solow residual model. They used the economic index (total factor productivity) as proxy for high quality economic development while technological progress, level of technological development, financial development, research and development (R&D) among others were used as independent and control variables. The results indicated that digital infrastructure (technological progress), digital industry (level of technological development) and regional factor productivity (research and development and financial development) all had significant positive impact on high quality economic development.

Wang and Choi (2019) did a study on the impact of digital economy on economic growth of (Brazil, Russia, India, China and South Africa) BRICS countries. They used Information Communication Technology, ICT, as proxy for digital economy on trade for a panel of 5 BRICS Countries for the period 2000 to 2016 using the Gravity, Fixed Effects (FE) and Random Effects (RE) models. They found that digital economy had a significant positive impact on trade through reduced information search costs and improved production efficiency. They recommended that developing and emerging countries in general and the BRICS countries should invest in digital trade infrastructure to fully realize the benefits of digital economy. Specifically, they recommended that BRICS countries should invest more in fixed broadband and internet infrastructure to augment their export volumes.

Simon and Pingfang (2021) evaluated the impact of digital economy on the international trade and growth in Africa using cross sectional data of 53 countries from 2000 to 2018. They used a vector of digital economy variables as proxy for digital economy index. They employed System General Method of Moments (Sys-GMM) as dynamic models and Fixed Effects and Random effects Estimators as static models. The findings of the study showed that digital economy had a significant positive effect on international trade and growth in Africa. They recommended that increased investment in digital technology be enhanced to promote digital trade led economic growth in Africa.

Saleem et al., (2021) analyzed the impact of digital trade on the economic growth of Jordan. They used annual panel data from 2010-2019 on four variables namely digital trade, real GDP, per capita GDP and trade openness. They employed the limits tests for Cointegration model. The findings showed that a long run Cointegration existed between digital trade and other variables. Specifically, a positive relationship existed between digital trade and economic growth in Jordan.

Thomas (2018) investigated the impact of Information Communication Technologies (ICT) on economic growth on a panel of developing, emerging and developed countries for the period 1995-2010. He employed Panel Vector Auto-Regression (P-VAR) models. His findings showed and corroborated earlier studies that ICT had a positive impact on economic growth. However, subsample panel regressions rejected the hypothesis that developing and emerging countries benefited more (that ICT 'leap frog' growth in developing and emerging countries) from ICT capital investment than developed countries.

Maune (2019) analyzed the impact of trade in services on economic growth of a panel of ten (10) Southern Africa Development Community (SADC) countries using Vector Auto-Regression (VAR) approach. He found that trade in services had a positive impact while trade in goods exports had a negative impact on economic growth. He recommended that there was need to develop strategies to augment trade in services which has few barriers. Bahrini and Qaffas (2019) studied the impact of Information and Communication Technology on Economic Growth on a panel of developing countries, using a Panel Generalized Method of Moment (P-GMM) growth model. They found that Information and Communication Technologies (ICT) such as mobile phones, Internet usage, and broadband adoption were the main drivers of economic growth in the selected panel of developing countries.

Mini (2018) did a study on impact of services trade on economic growth and current account balance: Evidence from India using the Balance of Payments Constrained Growth (BPCG) model and Autoregressive Distributed Lag Co-Integration (ARDL) to estimate the balance of payments equilibrium growth rate for India's service sector. He found that India's service sector grew at a rate nearly equal to its balance of payment equilibrium. It is noted that this study was skewed more to the goods sector on account of availability of more data on goods trade than services trade. Xiaoying Li et al (2003) did a study regarding the impact of the imports of services on economic growth using a Dynamic Panel Approach on a panel of 82 countries. They found that import services had a significant positive impact on economic growth in developed countries and a negative impact in developing countries.

Pan et al., (2022) used Pooled Regression Models to evaluate the impact of digital economy on panel data for total factor productivity (TFP) in China. They find that although digital economy index has a positive impact on the economy of China, there were regional diversity impacts of digital economy on provincial growth conditioned on regional digital infrastructure development. They recommended integration of digital economy development among all regions in China to reduce the economic disparities of digital economy effects.

2.5 Theoretical Framework: Augmented Solow Total Factor Productivity Growth.

From the theoretical stand point, digital trade seem to be predicated on the New Trade Theory (NTT), a label that summarizes a range of theories that attempt to explain international trade in terms of the rapid changes and disruptive nature of digital technologies on global data flows and trade in an imperfectly competitive environment (Dirk & Michael, 2012).The New Trade Theory (NTT) framework of international trade supplants the theory of comparative advantage to a large extent because it emphasizes that digital trade generally allows market participants to behave like monopolistically competitive firms. International trade fragmentation or international dispersion of service or production blocks results in trade cost reduction and augments efficiency in resource allocation (Helpman & Krugman, 1985). Digital trade in services (digitally enabled trade in services) is similar but not identical to trade in services. Theoretically, the development of digital economy and digital infrastructure can be envisioned as augmenting total factor productivity (TFP) in the augmented Solow Growth Model (Zhang et al., 2021; Thomas, 2018; Pan et al., 2022). The augmented growth model is defined as in Mankiw, Romer and Weil (1992).

$$(TFP)_{it} = Y_{it} = K_{it}^{\alpha} H_{it}^{\beta} (AL)_{it}^{\,1-\alpha_K-\beta_H} \quad (1)$$

Where Y_t is GDP growth over time (t) in response to changes in physical capital(K),i denotes the economy or country, H is human capital, L is labor, and total factor productivity (TFP) or technology (A) over time (t). Human capital (H) is different from labor(L). Labor involves the skills that humans naturally possess whereas human capital refers to skills obtained through experience, training and education (Mankiw, Romer & Weil, 1992). Thus, labor productivity can be expressed as:

$$\frac{Y_{it}}{L_{it}} = A_{it}^{\,1-\alpha-\beta} \left(\frac{K_{it}}{L_{it}}\right)^{\alpha} \left(\frac{H_{it}}{L_{it}}\right)^{\beta} \quad (2)$$

Which can be expressed in logarithms:

$$\ln\left(\frac{Y_{it}}{L_{it}}\right) = (1-\alpha-\beta) + \ln(A_{it}) + \alpha\ln\left(\frac{K_{it}}{L_{it}}\right) + \beta\ln\left(\frac{H_{it}}{L_{it}}\right) \quad (3)$$

According to equations 2 and 3, labor productivity is a function of capital-labor ratio $\left(\frac{K}{L}\right)$ at time t in country i, human per capital unit labor ratio$\left(\frac{H}{L}\right)$ and the residual term $(1-\alpha-\beta)\ln(A)$, that essentially captures the level of technology. The residual term represents the total factor productivity (TFP) which measures the efficiency or effective use of technology by labor and capital in promoting growth output (Erken et al., 2018). In this study, the residual term represents the country level digital technological development. Erken et al (2018) explained that among the major drivers of total factor productivity (TFP) and by extension, growth output were technological catch up, research and development (R&D) capital, labor participation and entrepreneurship. They explained further that the process of technological catch up involves the absorption by technologically behind regions of the knowledge from technologically advanced regions.

There is a significant number of studies that have examined the relationship from export growth led hypothesis (EGL) and growth led exports hypothesis (GLE) in the backdrop of neoclassical growth models (Lee & Huang, 2002; Chia, 2016; Smith, 2001).

Generally, the impact of technology on economic growth has been empirically proven to be significant (Bahrini & Qaffas, 2019; Thomas, 2018). Given that this study evaluated the impact of digital trade services on economic growth of countries as whole, it was envisaged that theoretically it implies taking the general equilibrium (GE) approaches. A general equilibrium (GE) strategy is ideal for studies like ours because it takes into account the effects of multilateral trade because many countries and markets are involved in the analysis. Figure 1 presents an overview of digital services trade among the three (3) subsample country panels for the period 2005-2019

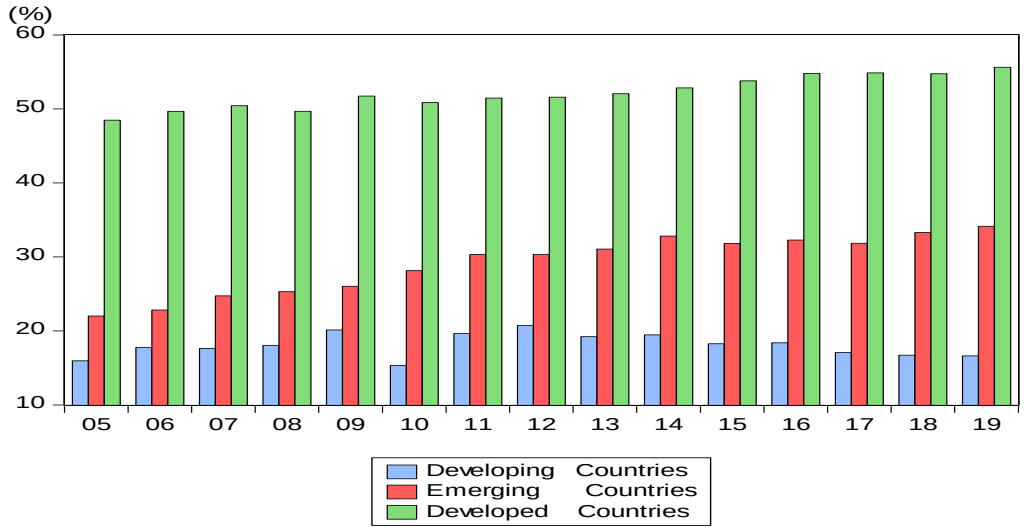

Figure 1: International Digital Services Trade Trajectories 2005-2019

Source: Authors' elaboration on data from UNCTAD. Available at UNCTADSTAT

Notes: Digital services trade is measured as percentage of total trade in services displayed on the vertical axis and the years of trade (2005-2019) are displayed on the horizontal axis.

On the whole, it appears that international trade in digitally deliverable services has been growing in all the three country panels for the period 2005-2019. However, it seems that the panel of emerging countries' growth in digital trade in services grew at a higher rate than other country panels. Specifically, it was 22% in 2005 in emerging countries and rose to 34.2% in 2019. For the developed countries panel, it was 48.5% in 2005 and rose marginally to 55.6% in 2019. In the case of developing countries, it was 15.9% in 2005 and rose to 20.7% in 2012 but later declined to 16.6% in 2019.

3. Methodology and Data

This section describes the methodology used in the study and the data and their sources.

3.1 Research Design

This study employed panel experimental quantitative study design. Annual panel data for 46 Middle Income, 32 Low Income and 24 High Income countries for the period 2005-2019 were used. Gross Domestic Product per capita at current US$ (GDP per capita current US$) panel data obtained from World Bank's World Development Indicators (WDI) database was the dependent variable. The panel data on independent variables of digital services exports and digital services imports measured as percentage (%) of total in trade services data were obtained from UNCTAD

databases. A third independent variable panel data regarding the number of individuals using the internet measured as percentage (%) of total population were obtained from World Bank's World Development Indicators (WDI) database. The control variables of digital services trade namely goods exports (BoP, current US$) and goods imports (BoP, current US$) panel data were also obtained from World Bank's World Development Indicators (WDI) database. This study adopted the World Bank's categorization of Low Income, Middle Income and High Income Countries[1]

3.2 Methodology

3.2.1 Panel Unit Root and Stationarity Tests

Economic data is frequently non stationary in nature. Using data with unit roots results in spurious regressions, spurious inferences and spurious policy recommendations (Green, 2003). Therefore, to eliminate these data problems, consequently, four (4) categories of panel data unit root tests were done: Common root- Levin, Lin & Chu (2002), Individual root-Im, Pesaran & Shin (2003) Individual root-Augmented Dickey Fuller, ADF (1979) and Individual root- Phillips and Peron (1988). Panel unit root tests can be classified on the basis of whether there are restrictions on the auto regressive process (AR) across the sections of panel data series (Woodridge, 2000, ADF, 1979). Consider the following autoregressive, $AR(1)$ process:

$$\Delta y_{it} = \alpha_i + \rho_i y_{it-1} + X_{it}\delta_i + \theta_t + \varepsilon_{it} \quad (4)$$

Where α_i is a vector of intercepts, $i = 1,2,\dots,N$ cross sectional series observed over periods, $t = 1,2,\dots,T_i$. The $X_{it}\delta_i$ is a vector of exogenous panel of variables in the model such as fixed effects and individual trends, θ_t is unit specific time trends, ρ_i represent autoregressive coefficients, and ε_{it} is a vector of error terms assumed to be mutually independent idiosyncratic disturbance. If $|\rho_i| < 1$, y_i (time series,i) is weakly (trend) stationary. Conversely, if $|\rho_i| = 1$, then y_i has a unit root (Lutkepohl, 1991). Two assumptions may be taken about ρ_i during panel unit root testing: The first assumption assumes that persistence parameter are common across-sections so that $\rho_i = \rho$ for all i. The common root-Levin, Lin & Chu (2002) panel unit uses this assumption. The second assumption allows ρ_i to vary across sections. The individual root-Im, Pesaran &Shin (2003), individual root-Augmented Dickey Fuller, ADF (1979) and individual root- Phillips and Peroni (1988) use this assumption.

Levin & Lin (1993) prescribe the use of Augmented Dickey Fuller (ADF, 1979) as the starting point for panel unit root test which can be expressed as:

$$\Delta y_{it} = \rho_{it} y_{it-1} + \sum_{j=1}^{p_i} \theta_{ij} \Delta y_{it-j} + X'_{it}\delta + \alpha_i + \varepsilon_{it} \quad t = 1,2,\dots,T \quad (5)$$

The test assumes that $\alpha = \rho - 1$, the lag order for the difference terms, ρ_i varies freely across the sections. The null and alternative hypotheses can be expressed respectively as:

$H_0: \rho_i = 0$, (There is no unit root) against the alternative,

$H_1: \rho_i < 0$ (There is no unit root) for $i = 1,2,\dots,N$

The main theorems in Levin and Lin (1993) relate to deriving the asymptotic distributions of the panel estimator of ρ under different assumptions on the existence of fixed effects or heterogeneous time trends. The simplest cases to consider are for $\varepsilon_{it} \sim i.i.d(0, \sigma^2)$. For example, if $\alpha_i = \delta_i = 0$, then asymptotic distribution of the ordinary least squares (OLS) pooled panel estimator, $\hat{\rho}$ is given by:

$$T\sqrt{N\hat{\rho}} \Rightarrow N(0,2), T, N \to \infty$$

$$t_\rho \Rightarrow N(0,1) \tag{6}$$

The final step involves estimating the panel regression which makes use of all i and t :

$$\hat{e}_{it} = \rho \hat{V}_{it-1} + \hat{\varepsilon}_{it} \tag{7}$$

And the computed panel test-statistic is: $t_{\rho=0} = \frac{\hat{\rho}}{RSE(\hat{\rho})}$

Given that all the four(4) panel unit root tests conducted generally begun with the basic panel ADF unit root test as expressed in equation 5, to conserve space, the study only showed the test statistics expressions for each unit root test in the following subsequent discussions.

The Levin, Lin & Chu (2002) common unit panel unit root test show that under the null, a modified t-statistic for the resulting $\hat{\alpha}$ is asymptotically normally distributed:

$$t_\rho^* = \frac{t_{\rho=0} - (N\tilde{T})\hat{S}_{N_{\hat{\varepsilon}}^{\hat{\sigma}^{-2}}} RSE(\hat{\rho})\mu^*_{m\tilde{T}}}{\sigma^*_{m\tilde{T}}} \tag{8}$$

Where $\hat{t}^*$, represent the standard test-statistic for $\hat{\rho} = 0$. $\hat{\sigma}^2$ is the estimated variance of the error term, ε_{it} $RSE(\widehat{\rho})$ is the relative standard error of $\hat{\rho}$, and $T = t - \left(\sum i \frac{\rho_i}{N}\right) - 1$. The terms $\mu^*_{m\tilde{T}}$, and $\sigma^*_{m\tilde{T}}$ are adjustments for the mean and variance respectively.

The null and alternative hypotheses for *individual root-Im, Pesaran &Shin (2003) panel unit root test* can be written respectively as:

$H_0 : \rho_i = 0$ for all i

$$H_1: \begin{cases} \rho_i < 0 & for\ i = 1, 2, \dots N_1 \\ \rho_i = 0 & for\ i = N+1, N+2, \dots, N \end{cases} \quad with\ 0 < N_1 \leq N \tag{9}$$

The average of the t-statistics ρ_i from the individual ADF regressions $t_{i_{T_i}}(\rho_i)$:

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

Im, Pesaran &Shin (2003) show that a properly standardized $\overline{t_{NT}}$ has an asymptotic standard normal distribution, $N(0,1)$

An alternative to panel unit root tests uses Fisher's (1932) results to obtain tests that combine $p-values$ from individual unit root tests. Madala and Wu (1999) propose that if we define π_i as the $p-value$ for any individual unit root test for cross section i, it follows that under the null unit root for all N.

$H_0: \rho_i = 1$ for all i (unit root non-stationary) against the alternative;

$H_1: |\rho_i| < 0$ (stationary variable) for some $i's$ for infinite N. Madala and Wu (1999) show that for all cross sections, the asymptotic result can be expressed as:

$$-2\sum_{i=1}^{N}\log(\pi_i) \rightarrow X_N^2 \qquad (10)$$

They show further that; $z = \frac{1}{\sqrt{N}}\sum_{i=1}^{N}\Phi^{-1}(\pi_i) \rightarrow N(0,1)$,

Where Φ^{-1} is the inverse of the standard normal cumulative distribution function (CDF).

Eviews 9 statistical software reports the asymptotic Fisher chi-squared (X^2) and the standard normal statistics using *ADF and Phillips Peron (PP) individual panel unit root tests*. The null and alternative hypotheses are the same as those in *individual root-Im, Pesaran &Shin (2003)* panel unit root test given equation 9. The panel unit roots results are reported in Table 2.

3.2.2 The Empirical Econometric Model: Panel- VAR

The study followed Thomas (2018) and Maune (2019) in constructing the panel vector auto-regression (P-VAR) empirical econometric model. However, this paper differs from Thomas (2018) in that it focused on the impact of digital services trade on economic growth as opposed to impact of ICT on economic growth in Thomas (2018). In addition, whereas Maune (2019) uses P-VAR on a panel of countries from one region on traditional services trade, this study evaluates the effect of digital services trade on growth on three (3) sub panels: Developing, Emerging and Developed countries. In compact log-difference form, the econometric model, can be expressed as:

$$dlnY_{it} = \alpha_t + \beta_1 dlnX_{it} + \beta_2 dlnX_{it} + \cdots \beta_k\, dlnX_{kt} + \mu X_{it}(\mu M_{it}) + \omega X_{it} + \omega M_{it} + \varepsilon_{it} \quad (11)$$

Where the variables $X_{it},\ldots,X_{ikt}$ are a set of explanatory variables which influence $\gamma_{it,}$ and the coefficient estimates $\beta_1, \beta_2, \ldots, \beta_k$ are the parameters which quantify the impact of each of these explanatory variables on γ_{it} (Economic growth), i denotes country i, t denotes time and μx_{it}, $(\mu M_{it},)$ is country i unobservable individual effects on export (import) equation, ω_{Xit} , ω_{Mit} unobservable time invariant effects for exports and imports respectively and, $\varepsilon_{it,}$, represent the white noise error term. The parameters α_t represent different intercepts in each year and allows for aggregate economic growth change over time. Equation 9 can be expressed more specifically as:

$$dlnY_{it} = \alpha_t + \beta_1 dlnDigserv\_EXP_{it} + \beta_2 dlnDigserv\_IMP_{it} + \beta_3\, dlnG\_EXP_{it} + \beta_4\, dlnG\_IMP_{it} + \beta_5 dlnINT\_Users_{it} + \mu X_{it}(\mu M_{it}) + \omega X_{it} + \omega M_{it} + \varepsilon_{it} \quad (12)$$

Where Y_{it} is GDP per capita (current US$, GDP_C) for-$ith$ country at time t, α_t is different intercepts in each year, $\beta_1 Digserv\_EXP_{it}$ is digital services exports for country i at time t, $\beta_2 Digserv\_IMP_{it}$ is digital services imports for country i at time t, $\beta_3 G\_EXP_{it}$ is *goods exports* for country i at time t, $\beta_4 G\_IMP_{it}$ is *goods imports* for country i at time t, $\beta_5\ Int\_Users_{it}$ is the number of internet users as percentage (%) of population for county i at time t. The remainder of

the terms of equation 10 are as explained in equation 9. The study took log difference approach so that the calculations are symmetrical both forward and backward (Green, 2003). There are several reasons advanced in the literature for analyzing data in logarithmic format: First, logarithms help to rescale data thereby making variance constant. Second logarithmic transformations mitigate the positive skewness in the data. Thirdly, logarithmic transformations convert non -linear data into linear format (Maune, 2019, Stock and Watson, 2001, Green, 2003)

3.2.3 P-VAR and VECM

VAR models are well established in the literature (see for example, Lutkepohl, 1991, Johansen, 1995). Panel vector auto-regression (P-VAR)) models are built with the same logic of standard VARs but P-VARs have cross section dimensional features added to them(Green,2003). P-VAR models are better suited for our study because they capture both static and dynamic interdependencies, incorporate time variations in the coefficients and in the variance of the shocks and account for cross sectional dynamic heterogeneities (Green, 2003, Lutkepohl, 1999). 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 may be envisioned as *n*-equation, with *n*-variables explained by their own lagged values and current and past values of the remaining *n-1* variables (Stock and Watson, 2001). The basic Panel VAR (P-VAR) or P-VAR model of order p $(VAR(p))$ for a set of K time series variables can be expressed as:

$$y_{it} = A_{i0} + A_1 y_{it-1} + \cdots + A_p y_{it-p} + u_{it} \quad (13)$$

Where;$y_t = (_{1t'\ldots}, y_{Kt})'$ endogeneous variables, p is the number of (lags) parameters, A_0 is a vector of intercepts, y_t = a vector of endogenous variables, A_i = k x k coefficient matrices, implying that, $i = 1, 2, \ldots, \mathrm{p}$, U_t = K-dimensional white noise disturbance time invariant process(Lutkepohl, 1991). The basic VAR assume a $VAR(p)$ process as the number of lags equals p and is general enough to accommodate variables with stochastic trends on condition that the process is stable given that:

$$\det(I_k - A_{1z} - \cdots A_{pz^p}) \neq 0 \text{ for } |z| \leq 1 \quad (14)$$

That is, if the polynomial determinant in equation 11 has unit root, meaning that $z = 1$, then some or all of the variables are integrated of the order $I(1)$ and may be cointegrated.

Equation 13 can be re-expressed as:

$$Y_{it} = \Gamma_0 + \Gamma(L)Y_{it-1} + v_i + d_{ct} + \varepsilon_{it} \quad i = 1, \ldots N \;\; t = 1, \ldots, T_i \quad (15)$$

Where**;** Y_{it} is a vector of endogenous variables, Γ_0 is a vector of constants, $\Gamma(L)$ is matrix polynomial in the matrix operator, v_i are country specific fixed effects, d_{ct} are country specific time effects, ε_{it} is a vector of error terms and T_i is a vector of time periods. This basic VAR or VAR at levels is not a suitable estimator for cointegrated relations (Luitkepohl, 1999). Given the limitations of the basic VAR, we use restricted VAR models appropriately called panel Vector Error Correction Models (P-VECM) to analyze cointegrated panel variables in this study. We follow Luitkepohl (1999) to estimate VECM models. The VECM can be expressed as:

$$\Delta y_{it} = \pi_{yit-1} + \Gamma_1 \Delta y_{it-1} + \cdots \Gamma_{p-1} \Delta Y_{it-p+1} + \mu_{it} \quad (16)$$

Where $\pi = -(I_k - A_1 - \cdots - A_p)$, and $\Gamma_i = -(A_{i+1} + \cdots + A_p)$ for $i = 1, \ldots p-1$

It is assumed that $\Delta\, y_t$ 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, π_{yt-1} be $I(0)$.When y_t is cointegrated with cointegration rank, r, $rank(\pi)=r < K$ and $\pi = \alpha A'$ where α and A are $Kx\, r$ matrices. The term Γ_j $(j = 1, \dots, p-1)$ is interpreted as short run parameters while π_{yt-1} term is the long run association part of the VECM. The unknown VAR order p in (11 and 13 is estimated using the Akaike Information Criterion (AIC).

4.0 Results and Discussions

4.1 Summary Statistics

Table 1 reports summary descriptive statistics for the three (3) sub-panel data in our study.

Table 1: Panel Summary Statistics

	Mean	Max.	Min.	Std. Dev.	Obs.
Panel A: Developing Countries					
GDP_C	2089.18	5408.41	126.341	1093.24	452
$Digserv\_EXP$	23.51	90.581	1.987	17.66	452
$Digserv\_IMP$	27.13	76.451	7.348	10.89	452
$Goods\_EXP$	2.87E+03	3.32E+11	9853671	5.58E+02	452
$Goods\_IMP$	3.44E+02	5.19E+02	92599764	7.29E+02	452
Int_Users	21.55	84.12	0.24	18.96	452
Panel B: Emerging Countries					
GDP_C	6411.22	15974.64	1578.402	2782.093	555
$Digserv\_EXP$	25.049	205.44	0.392047	24.31361	555
$Digserv\_IMP$	41.87	616.11	6.410847	63.46889	555
$Goods\_EXP$	1.01E+02	2.42E+02	9722235	3.02E+11	555
$Goods\_IMP$	8.72E+02	2.04E+02	1.10E+08	2.45E+11	555
Int_Users	39.35	89.56	0.9	22.7483	555
Panel C: High Income Countries					
GDP_C	36488.59	102913.51	3083.834	21966.79	337
$Digserv\_EXP$	38.12	74.11	3.35	18.64826	337
$Digserv\_IMP$	39.83	70.32	1.927	12.65939	337
$Goods\_EXP$	3.08E+02	1.68E+02	45715381	3.76E+02	337
$Goods\_IMP$	3.14E+02	2.56E+02	4.31E+02	4.66E+02	337
Int_Users	69.31	99.59	3.69	23.028	337

Source: Authors' elaboration on data from UNCTAD and World Bank's World Development Indicators.

4.2 Panel Unit Root Test Results.

Table 2 reports a summary of unit root tests conducted using equations 4 to 10. The results indicated that variables in developing countries panel had unit roots while emerging and developed countries indicated a mixture of the presence and absence of unit roots at levels.

Table 2: Panel Unit root Test for Developing, Emerging and Developed Countries.

Variable	Levin, Lin & Chu (t-statistics)	Im, Pesaran &Shin W-t-stat	ADF - Fisher X^2	PP - Fisher X	Order of Integration
Panel A: Developing Countries					
GDP_C	1.64**	-0.73**	87.43**	133.65**	I(1)
Digserv_EXP	-3.18**	-0.94**	86.66**	127.51**	I(1)
Digserv_IMP	-6.44**	-7.16**	170.88**	392.89**	I(1)
Goods_EXP	-11.03**	-8.36**	188.95**	321.64**	I(1)
Goods_IMP	-2.90**	-1.52**	89.06**	106.18**	I(1)
Int_Users	-2.55*	-0.93*	74.02*	130.69*	I(1)
Panel B: Emerging Countries					
GDP_C	-5.55*	-1.92*	114.81*	171.97*	I(1)
Digserv_EXP	-8.35***	-2.95***	134.61***	192.11***	I(0)
Digserv_IMP	-5.48**	-1.192**	111.26**	124.21**	I(1)
Goods_EXP	-4.43**	-1.14**	94.087**	127.74*	I(1)
Goods_IMP	-8.72***	-4.33***	137.21***	151.99***	I(0)
Int_Users	-4.48**	-3.03**	127.09**	240.08**	I(1)
Panel C: Developed Countries					
GDP_C	-3.02**	-2.51**	78.16**	83.50**	I(0)
Digserv_EXP	-2.57**	-6.02**	123.27**	240.20**	I(1)
Digserv_IMP	-6.57**	-4.08**	90.75**	112.17**	I(1)
Goods_EXP	-6.57***	-4.09***	90.85***	112.17***	I(0)
Goods_IMP	-7.14***	-4.26***	93.78***	111.45***	I(1)
Int_Users	-4.84**	-3.52**	85**	206.25**	I(1)

*Notes: Fisher tests are computed using an asymptotic Chi-square(X^2) distribution. All other tests assume asymptotic normality. The null hypothesis assumes common unit root process. *, **, ***, denote panel data variable is stationary at 10%, 5% and 1% significance levels respectively (rejection of the null of presence of unit root in the panel variable). Tests include individual intercept only. ADF is Augmented Dickey Fuller test, PP is Phillips and Peroni test.*

4.3 Test for Correlations

The study sought to unravel the linear relationships among panel data variables. Table 3 reports a summary of the correlation test results.

Table 3: Panel Correlation Matrix

	GDP_C	Digserv_EXP	Digserv_IMP	Goods_EXP	Digserv_IMP	Int_Users
Panel A: Developing Countries						
GDP_C	1					
Digserv_EXP	-0.03	1				
Digserv_IMP	0.38	0.41	1			
Goods_EXP	0.08	0.33	0.19	1		
Goods_IMP	0.02	0.43	0.17	0.95	1	
Int_Users	0.38	-0.11	-0.05	0.09	0.08	1
Panel B: Emerging Countries						
GDP_C	1					
Digserv_EXP	0.08	1				
Digserv_IMP	-0.01	0.03	1			
Goods_EXP	0.19	0.11	-0.05	1		
Goods_IMP	0.22	0.09	-0.05	0.99	1	
Int_Users	0.52	0.14	0.21	0.12	0.13	1
Panel C: High Income Countries						
GDP_C	1					
Digserv_EXP	0.55	1				
Digserv_IMP	0.31	0.51	1			
Goods_EXP	0.31	0.51	0.34	1		
Goods_IMP	0.27	0.48	0.36	0.94	1	
Int_Users	0.68	0.46	0.34	0.33	0.28	1

Source: Authors' elaboration on data from UNCTAD and World Bank's World Development Indicators.

Generally, the digital trade variables appear to be weakly correlated with per capita Gross Domestic Product (GDP_C, GDP hereafter) in all panels. Digital services export correlation coefficient of 0.679 is fairly strong and positively correlated with GDP in developed countries. It is 0.083 for emerging countries, where it also positive but weakly correlated with GDP. The digital service exports variable in developing countries is -0.034. It is weakly and negatively correlated with GDP in developing countries. The individuals using the internet variable is 0.679 for developed countries is fairly strong and positively correlated with GDP. It also fairly strong and positive (0.527) in emerging countries but weakly positively correlated (0.378) with GDP in

developing countries. However, Goods exports and goods imports are strongly positively correlated in all the panels.

Kao (1999) and Pedroni (1999) developed methodologies for testing Cointegration in panel data. Their proposed statistical test the null hypothesis of no Cointegration against the alternative of evidence of cointegrated panel data variables. Both the Kao (Engle –Granger) and Pedroni tests confirmed that data variables in all the panels have a long run association. The summary results of Kao and Pedroni Cointegration tests are given in the appendix. Given the result that variables are cointegrated, we therefore conducted vector error correction (VEC) models using equation 16. Table 4 reports the vector error correction models (VECM) estimates.

4.4 Panel VECM Results: Impact of Digital services trade variables on Economic Growth

Table 4 shows the long run Cointegration coefficients and short run coefficients and respective test statistics of the P-VAR estimates obtained using equation 13. We used variables in log form since Eviews algorithms take 1st difference.

4.4.1 Panel A (Developing Countries)

The VECM results for developing countries panel indicate that, in the long run, digital services exports have a positive and statistically significant impact on GDP at 5% level. Specifically, a 1% increase in digital services exports causes 0.34% increase in GDP. However, the number of internet users has a positive but statistically insignificant impact on GDP. Digital services import have a negative statistically significant impact on GDP. A 1% increase in digital services imports decreases GDP in the panel of developing countries by 0.55%. The number of people using the internet has a positive but insignificant impact on GDP in the short run. The control variables of goods exports and imports have a positive and negative significant long run impact on GDP of 0.96% and 1.77% respectively.

In terms of speed of adjustment given by error correction coefficients, we observe that there is no long run convergence in the GDP model. However, the digital services exports model shows evidence of long run convergence at the speed of adjustment of 0.75% and there is a long run causality running from digital services exports to other variables given that it has a significant test-statistic of 3.56 at 5% level. There appears to be a long run causality running from digital services and goods imports respectively to other variables because the respective coefficients of 2.41 and 6.14 are significant. However, there is no evidence of long run convergence in these two models. In terms of short run effects (reported in the appendix) digital services exports have a positive but insignificant effect on GDP of 0.013% at 5% level at a lag of 1 period. The number of internet Users variable has a significant short run positive impact on GDP of 0.06% ceteris paribus. The other variables indicate a positive but insignificant impact on GDP.

4.4.2 Panel B (Emerging Countries)

For emerging countries panel, the VECM results show that, the digital services exports and goods exports variables have a statistically significant positive long run impact on GDP respectively at 5% level. Specifically, a 1% increase in digital services exports and goods exports result in an increase in GDP of 0.78% and 0.92 % respectively. Digital services imports and goods imports have respective significant negative long run impact on GDP growth of emerging countries panel. Specifically, a 1 unit increase in digital services imports results in decrease of GDP by 0.93% and a 1% increase in goods imports decreases GDP growth by 1.33%. Similarly, the number of internet

Users variable in this panel has a significant positive impact on GDP growth at 5% significance level. In specific terms, a 1% unit increase in the people using the internet results in GDP growth of 0.47%.

With regards to the speed of adjustment, the GDP models show that the system is able to return to long run equilibrium at the speed of adjustment of 0.35%. Moreover, there is a long run causality running from GDP to other variables at 5% significance level. Digital services imports models also show that there is convergence to the long run equilibrium at the speed of adjustment of 0.81% and a long run causality running from digital services exports to other variables given that its test-statistic of 13.29 is statistically significant at 5% level. Although goods exports and goods imports models show long run causality, there is no evidence of long run equilibrium convergence because the respective coefficients of 0.39 and 0.62 are positive.

In terms of short run effects of regressors on GDP, digital services exports have a significant positive short run effect on GDP growth. Specifically, 1% increase in digital services trade in the short run results in 0.15% increase in GDP ceteris paribus (see appendix) at 5% level. A 1% increase digital services imports results in decrease of GDP by 0.35%. However, a 1% increase goods exports significantly increases GDP growth by 0.32% holding other factors constant. A 1% increase in goods imports makes GDP shrink significantly by 0.61% in the short run. A 1% rise in the number of internet users have a short run significant increase in GDP of 0.37% ceteris paribus.

4.4.3 Panel C (Developed Countries)

In the case of developed countries panel, we observe that all regressors have a significant long run impact on GDP at 5% significance level. Specifically, a 1% increase in digital services results in GDP growth of 0.88% whereas a 1% increase in goods exports causes GDP to grow by 1.69%. A 1% increase in digital services imports and goods imports cause GDP growth to fall by 1.88% and 5.54% respectively. Finally, a 1% rise in the number of people using the internet causes GDP growth of 0. 62%.

In terms of speed of adjustment, the GDP models show that the system is able to adjust to the long run equilibrium at the speed of adjustment of 0.29%, and there is a statistically significant long causality running from GDP to other variables at 5% level. There is evidence of long run equilibrium converge in digital service exports models with a speed of adjustment of 0.37% and along significant long causality runs from digital services exports to other variables. The goods imports models exhibit a significant long run causality running from goods import to other variables but there is no evidence of long run equilibrium convergence.

In terms of short run impact of regressors on GDP at 1 period lag, we found that digital services exports have a positive but statistically insignificant impact on GDP of 0.24%. For every 1% increase digital services imports GDP significantly increase by 0.56% in the short run ceteris paribus. Goods export have a negative insignificant impact on GDP of 0.36% in the short run. Incidentally, for every 1% increase in goods imports, GDP significantly increases by 1.18% in the short run. A 1% increase in the number of people using the internet has a significant positive impact on GDP by 0.56% at 5% level of significance.

Table 4: Panel Vector Error Correction (VEC) Estimates

	Long Run cointegration estimate			Speed of adjustment Estimates			
Variables	**ECT Coeff.**	**t-statistics**	**Std. Errors**	**Coeff.**	**t-statistics**	**Std. Errors**	**R^2**
Panel A: Developing Countries							
dlnGDP_C(depended)	1			0.03	0.41	0.08	0.43
dlnDigserv_EXP	0.34	5.94**	0.57	-0.75	-3.56**	0.21	0.57
dlnDigserv_IMP	-0.55	-5.72**	0.96	0.33	2.41**	0.14	0.76
dlnGoods_EXP	.96	8.53**	0.11	-0.18	-1.25	0.14	0.51
dlnGoods_IMP	-1.77	-14.12**	0.12	0.69	6.14**	0.11	0.58
dlnInt_Users	0.02	0.48	0.05	0.03	0.15	0.18	0.28
Panel B: Emerging Countries							
dlnGDP_C(depender	1			-0.35	8.54**	0.04	0.48
dlnDigserv_EXP	0.78	15.01**	0.05	-0.81	-13.29**	0.06	0.63
dlnDigserv_IMP	-0.93	-5.87**	0.35	-0.06	-1.07	0.05	0.31
dlnGoods_EXP	0.92	6.09**	0.15	0.39	5.43**	0.07	0.32
dlnGoods_IMP	-1.33	-8.62**	0.01	0.62	11.47**	0.05	0.41
dlnInt_Users	0.47	2.37**		-0.08	-1.79	0.04	0.36
Panel C: High Income Countries							
dlnGDP_C	1			-0.29	2.71**	0.11	0.89
dlnDigserv_EXP	0.88	2.04**	0.43	-0.37	-2.01**	0.18	0.91
dlnDigserv_IMP	-1.88	-2.85**	0.66	-0.18	-1.74	0.13	0.93
dlnGoods_EXP	1.69	2.92**	0.58	0.06	0.46	0.13	0.95
dlnGoods_IMP	-4.54	-5.25**	0.85	0.39	4.31**	0.08	0.95
dlnInt_Users	0.62	3.41**	0.64	0.08	0.12	0.06	0.76

*Source: Authors' elaboration on panel data from UNCTAD and World Bank's World Development Indicators. Notes: ECT denotes error correction term, ** denotes statistically significant at 5% level. VECM models included intercept (no trend). According to the Akaike Information Criterion (AIC) the appropriate length for country panels were: Developing Countries, lag 3, Emerging countries, lag 2 and Developed countries, lag 8 less 1 lag from each lag length in accordance with the guide on VEC modelling(Green, 2003)*

4.5 Panel Fixed Effects Regression Results.

The authors conducted fixed effects test in order to unravel the impact of regressors on GDP when we control for country unobserved heterogeneity factors. We employ variables in logarithmic format as appropriate models for this analysis. Table 5 shows a summary of the test results. From Table 5, it can easily be noted that, in the case of *developing countries panel*, only goods imports variable has a statistically significant negative impact on GDP growth at 5% level. That is, for every 1% increase in goods imports, GDP plummets by 0.54%. For emerging countries panel, a 1% increase digital services exports increases GDP growth by 0.03% whereas a 1% increase in digital services imports significantly causes GDP to fall by 0.24%. However, goods imports have a significant positive impact on GDP in that for every 1% increase in goods imports, GDP increases by 0.45%.

When developed country panel was considered, it was noted that digital services exports, goods exports and the number of people using the internet have positive and significant impact on GDP at 5% level. Specifically, a 1% increase in digital services exports increases GDP growth by 0.07%. GDP grows by 0.44% for every 1% increase in goods exports, and GDP increases by 0.11% when there is a 1% rise in the number of internet users amongst developed countries. However, GDP is significantly impacted negatively by digital services imports and goods imports. Specifically, a 1% increase in imports of digital services results in decrease of GDP by 0.24% whereas an increase of 1% in goods imports causes GDP of developed countries' panel to decrease by 0.36%.

Table 5: Panel Fixed Effects Regression Estimates

	Variable	coeff.	t-statistics	std. errors
Panel A: Developing Countries:				
	lnGDP_C(depended)			
	$lnDigserv\_EXP$	-0.02	-1.83	0.02
	$lnDigserv\_IMP$	0.06	1.96	0.03
	$lnGoods\_EXP$	0.03	0.88	0.04
	$lnGoods\_IMP$	-0.54	-12.78**	0.07
	$lnInt\_Users$	0.01	0.11	0.01
	$R\_sqaured$	0.97		
	$Adj.R.squared$	0.96		
Panel B: Emerging Countries				
	ln GDP_C(depended)			
	$lnDigserv\_EXP$	-0.03	1.2**	0.01
	$lnDigserv\_IMP$	-0.09**	-3.12**	0.05
	$lnGoods\_EXP$	0.23	9.45**	0.02
	$lnGoods\_IMP$	0.45	10.81**	0.01
	$lnInt\_Users$	0.04	1.29	0.05
	$R\_squared$	0.92		
	$Adj.R.squared$	0.91		

Panel C: Developed Countries			
ln GDP_C(depended)			
$lnDigserv\_EXP$	0.07**	3.64	0.02
$lnDigserv\_IMP$	-0.24**	-6.98	0.04
$LnGoods\_EXP$	0.44**	9.76	0.05
$lnGoods\_IMP$	-0.36**	-6.19	0.03
$lnInt\_Users$	0.11**	3.64	0.02
$R\_sqaured$	0.98		
$Adj.R.squared$	0.97		

*Source: Author's elaboration on data from UNCTAD and World Bank's World Development Indicators. Notes: ** denotes statistically significant at 5% level. Fixed effects models control for country unobserved heterogeneity factors in the intercept.*

4.6 Discussion

The preliminary panel VAR results indicate that digital services exports variable has a significant long run positive impact on GDP of all the country panels. Specifically, a 1% increase in digital services results in per capita GDP growth of 0.88% in the panel of developing countries. For emerging countries, a 1% increase in digital services exports causes per capita GDP to increase by of 0.78%. In the case of developed countries panel, a 1% increase in digital services results in GDP growth of 0.88%.Similarly, digital services imports variable has a long run significant negative impact on GDP per capita all panels. For every increase in digital services imports, it causes GDP to fall by 0.55%, 0.93% and 1.88% in developing, emerging and developed country panels respectively. In terms of the number of people using the internet, this study found that the number of internet users has a long run positive but insignificant impact on GDP of 0.02% in developing countries panel, but it has a statistically significant positive impact on GDP of emerging and developed countries. Specifically, for every 1% increase in the number of people using the internet, the long run GDP growth in emerging and developed countries is 0.47% and 0.62% respectively.

In terms of speed of adjustment towards long run convergence, the speed of adjustment is fastest in the digital services exports model for emerging countries panel at 0.81% and it is 0.75% in developing countries and the adjustment speed is slowest in developed countries panel at 0.37%. Moreover, there is a long run causality running from digital services exports models to other to GDP in all panels. A long run causality running from digital services imports to GDP exists only in developing country panel.

In terms of short run effects of digital services trade variables on economic growth, digital services exports have a positive but insignificant impact on GDP in developing country panel. However, digital services exports variable has a short run significant positive impact on GDP in the emerging countries panel of 0.15%. Digital service exports have a positive but insignificant effect on GDP of 0.24% in the developed countries panel. Incidentally, digital services imports have a significant positive short impact on GDP of developed countries of 0.35%. The number of people using the internet variable has a significant short run positive effect on GDP in all the country panels. Specifically, a 1% increase in the number of people using the internet increases GDP by 0.06%, 0.37% and 0.56% of developing, emerging and developed country panels respectively.

The goods exports and imports control variables have the largest significant long run impact on GDP of developed countries. Specifically, a1% increase in goods exports increases GDP in developed countries by 1.69%, 0.96% in developing countries and 0.92% in emerging countries. Conversely, an increase of goods imports by 1% results in long run GDP decrease of 4.54%, 1.77 and 1.33 in developed, developing and emerging countries respectively.

Fixed effects models indicate that digital services exports have a negative insignificant impact on GDP in developing countries of 0.02% and a significant negative impact on GDP of emerging countries of 0.03%. In developed countries, a 1% increase in digital exports increases GDP by 0.07% whereas as 1% increase in digital services imports causes GDP in developed countries to fall by 0.36%. Digital services imports have a positive but insignificant impact on GDP of 0.06 in developing countries but it has a negative significant impact on GDP of emerging countries of 0.09%. The number of people using the internet variable has a positive but insignificant impact of 0.01% and 0.04% in developing and emerging countries respectively but it has a positive significant impact on developed countries' GDP of 0.11%. A unit increase in goods imports significantly reduces GDP of developing countries by 0.54%. In emerging countries, both goods exports and goods import variables have a significant positive impact on GDP growth of 0.23% and 0.45% respectively. We conjecture that the identical signs of goods exports and imports are due to the strong positive correlation between the two variables. In developed countries panel, goods exports have a significant positive impact on GDP of 0.44% while goods imports have a significant negative impact on GDP of 0.36%.

It is clear from the analysis of the results that the panel of developing countries is lagging behind in digital services trade relative to emerging and developed countries. We recommend a digital services trade agenda to the developing countries policy makers that they should increase investment in institutional and physical digital trade infrastructure. This will enable more people in rural areas and small medium enterprises (SMEs) access and participate digital services trade thereby augmenting GDP growth.

5.0 Conclusion

The main objective of this paper was to evaluate the impact of Digital Services Trade on Economic Growth of a panel of Developing, Emerging and Developed Countries. The study employed the Panel Vector-Auto Regression (P-VAR) models and Fixed Effects Models. The Vector Error Correction Models (VECM) indicated that digital services exports have a significant long run positive impact on GDP in all the country panels. Specifically, a 1% increase in digital service exports increases long run per capita GDP by 0.88%, 0.78% and 0.34% in developed, emerging and developing countries respectively. Moreover, there was a long run causality running from digital services export models to GDP in all the three country panels. Furthermore, results showed that for every 1% increase in the number of people using the internet, GDP increased by 0.62%, 0.75% and 0.02% in developed, emerging and developing countries respectively. In addition Fixed Effects results showed that digital services trade was statistically significant only in developed countries where a 1% increase in digital services exports increased GDP by 0.07%. In terms of adjustment to a long run equilibrium, emerging countries panel showed the fastest speed of adjustment at 0.81% followed by developing countries at 0.75%, and it was slowest in developed countries at 0.29%. These results clearly indicated that developing countries were trailing behind in digital services trade.

6.0 Recommendations

It is therefore recommend that the governments of developing countries and other stakeholders should increase investments in both institutional and physical digital infrastructure that enable more people, especially small and medium enterprises (SMEs) and those in rural areas to access digital trade related services. Increased access to stable, high speed and affordable internet services is essential in augmenting digital services trade and thus promoting digital service trade led growth. The digital services trade agenda should incorporate and blend different initiatives under a single national strategy designed to prepare developing economies not only to adopt and use digital trade technologies but it should also be reflected in the production of goods with built in digital trade services in an increasingly digital environment.

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APPENDICES

Appendix 1: Summary of Pedroni (Engle-Granger) Residual Cointegration Test.

Sample: 2005-2019
Null Hypothesis: No co-integration
Alternative hypothesis: common AR coefficients(within-dimension)

		Statistic	Statistic	Group Rho stat	Group PP stat	Group ADF stat
Panel A: Developing Countries						
	Panel v-Statistic	-2.81**	-3.79**	7.59**	1.38	5.41**
	Panel rho-Statistic	5.22**	5.42**			
	Panel PP-Statistic	-2.96**	-1.95			
	Panel ADF-Statistic	-1.55	-3.94**			
Panel B: Emerging Countries						
	Panel v-Statistic	-3.19**	-2.53**	1.55	-9.12**	-6.48**
	Panel rho-Statistic	5.91**	-5.43**			
	Panel PP-Statistic	-3.21**	-3.82**			
	Panel ADF-Statistic	1.47	-2.28**			
Panel C:Developed Countries						
	Panel v-Statistic	-0.91	-2.29**	6.07**	-1.82	-4.63**
	Panel rho-Statistic	3.93**	4.43**			
	Panel PP-Statistic	-2.45**	-5.38**			
	Panel ADF-Statistic	-2.49**	-2.39**			

Deterministic trend specification: individual intercept. ** denotes statistically significant at 5% level.

We observe that from the total of 11 tests for panel cointegration, 8 tests reject the null in the developing countries panel, whereas 9 tests reject the null in the emerging countries panel and 9 tests also reject the null in the developed country panel. Thus, it was concluded that variables in all the panel data sets were cointegrated.

Note: To save space, we omit reports on Kao tests because the results and decisions made are similar to Pedroni tests**.**

Appendix 2: Summary VEC Short Run results.

	$Variables$	$coeff.$	$t-stastics$	$std.errors$
Panel A: Developing Countries				
	$dlnGDP\_C(dependent)$	0.36	1.23	0.07
	$dlnDigser\_EXP$	0.01	0.49	0.02
	$dlnDigserv\_IMP$	0.04	1.06	0.04
	$dlnGoods\_EXP$	0.01	0.02	0.06
	$dlnGoods\_IMP$	0.05	0.49	0.11
	$dlnInt\_Users$	0.06	2.51**	0.02
Panel B: Emerging Countries				
	$dlnGDP\_C(dependent)$	-0.42	-4.34**	0.09
	$dlnDigserv\_EXP$	0.15	3.83**	0.04
	$dlnDigserv\_IMP$	0.35	5.71**	0.06
	$dlnGoods\_EXP$	-0.32	-3.96**	0.08
	$dlnGoods\_EXP$	0.61	5.12**	0.11
	$dlnInt\_Users$	0.33	5.08**	0.06
Panel C: Developed Countries				
	$dlnGDP\_C(dependent)$	-1	4.83**	0.21
	$dlnDigserv\_EXP$	-0.24	-2.54**	0.15
	$dlnDigserv\_IMP$	0.56	2.77**	0.21
	$dlnGoods\_EXP$	-0.36	-1.78	0.33
	$dlnGoods\_IMP$	1.18	2.86**	0.41
	$dlnInt\_Users$	0.11	-0.19	0.58

*** denote statistically significance at 5% level.*

Appendix 3: Jarque Bera Residual Normality Test

	J-B statistic	p-value	comment
Panel A: Developing Countries	2.83**	0.24	Residuals are normally distributed
Panel B : Emerging Countries	39.21	0.01	Residuals are not normally distributed
Panel C: Developed Countries	0.96**	0.62	Residuals are normally distributed

The null assumes residuals are normally distributed, alternative assumes residuals are not normally distributed. ** denotes statistically significant at 5% level**.**

Appendix 4: List of Countries in the subsample panels.

Serial No.	**Panel A: Developing Countries**	**Panel B: Emerging Countries**	**Panel C: Developed Countries**
1	Angola	Albania	Antigua and Barbuda
2	Bangladeshi	Algeria	Australia
3	Bolivia	Argentina	Canada
4	Carbo.Verde	Armenia	Chile
5	Cambodia	Azerbaijan	Denmark
6	Cameroon	Belarus	Estonia
7	Comoros	Belize	Germany
8	Cote D'ivore	Bosnia And Herzegovina	Italy
9	Egypt	Botswana	Japan
10	El Savado	Brazil	S. Korea Rep
11	Eswatin	Bulgaria	Kuwait
12	Ghana	China	New Zealand
13	Honduras	Colombia	Norway
14	India	Costa Rica	Panama
15	Indonesia	Dominica	Poland
16	Kenya	Dominican Republic	Portugal
17	Kyrgyzstan	Ecuador	Saudi Arabia
18	Moldova Rep	Fiji	Seychelles
19	Mongolia	Georgia	Singapore
20	Morocco	Grenada	Sweden
21	Nicaragua	Guatemala	Switzerland, Liechtenstein
22	Nigeria	Guyana	United Kingdom
23	Pakistan	Iran Rep.	United States
24	Philippines	Iraq	Uruguay
25	Senegal	Jamaica	
26	Solomon Islands	Jordan	
27	Sri Lanka	Kazakhstan	
28	Tunisia	Lebanon	

29	Ukraine	Libya	
30	Vanuatu	Malaysia	
31	Vietnam	Mauritius	
32	Zambia	Mexico	
33		Namibia	
34		North Macedonia	
35		Paraguay	
36		Peru	
37		Romania	
38		Russian Federation	
39		Samoa	
40		South Africa	
41		St. Vincent & The Grenadines	
42		St.Lucia	
43		Suriname	
44		Thailand	
45		Tonga	
46		Turkey	

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