The Impact of ICT and Value-Added Exports on Per Capita GDP in Cameroon

Accepted 15th July, 2020

ABSTRACT

Information Communication Technology (ICT) forms the basis of sustainable and value-centric economic growth. This study investigates the linkages and value-added from goods and services exports to on per capita GDP in Cameroon between 1999 to 2018. By constructing an algorithm using machine learning, the study finds a positive and statistically significant relationship between ICT goods and services exports and per capita GDP. It also finds a positive, albeit marginal contribution from Brent crude. Finally, it contributes to the literature by outlining a rigorous empirical framework, noting greater considerations for the value-added from services. It recommends quantifiable policy changes to boost ICT exports and service spanning fintech, artificial intelligence, machine learning, mobile money payments, and renewable energy technologies.

Key words: Information communication technology (ICT), per capital GDP, value added from goods and services.

INTRODUCTION

Productivity and higher value-added exports form the basis of sustainable economic growth in developing economies. In connection to that, exports of goods and services in information communication and technology (ICT) reduces structural vulnerabilities, bolster economic growth, macroeconomic resilience and competitiveness. Studies such as Dedrick et al. (2013) and Alege and Ogundipe (2013) investigates the relationships and implications for ICT trade on economic growth, whereas Ballamoune-Lutz (2011) finds that exports is vital for economic growth. The neo-classical and novel economic growth theories find exports and technology as proponents of economic growth, Albiman (2016). Meanwhile, the linkages between exports, technology and economic growth are found by contemporary researchers such as Dollar (1986), Franke and Romer (1999) and Hesse (2008). Similarly, Khawar, 2003, according to their findings, exports and technology can stimulate external demand and bolster employment in developing economies. While the economic implications of ICT and value-driven trade are heterogeneous among developing and emerging economies, Edemeyovwi and Osabuchein (2018) and Sineenat Sermcheep (2019), found that a distinction between consumption-driven and export-led model of economic growth is notable vis-à-vis information, communication and technology (ICT). The former has formed the basis for a great deal of research spanning (Adeleye and Ebougu, 2019; Röller and Waverman, 2001; Bahrini and Qaffas, 2018), whereas Mishra et al. (2011) undertook empirical investigations pertaining to the economic and growth causing effects of ICT-related exports in advanced economies. The increased production and use of ICT products improves output, bolsters employment and value-added export, while increasing productivity and competitiveness in tandem (Christine Zhen-Wei Qiang, Alexander Pitt and Seth Ayers, 2004). This is consistent with findings from Solow’s (1956) neoclassical growth model, which noted that exports enhance GDP growth. The difference in quality of growth between developing and emerging market economies are honestly symptomatic of varying exports basket compositions, with ICT penetration playing an indispensable role in determining long-term competitiveness, productivity and employment. As such, Isola and Alani (2012) arguments facilitate the diffusion of the economic growth over a larger section of the workforce, exacerbating positive spillovers on economic structures.
The projection of an empirically-driven analysis of the implications for ICT and value added in intangible exports are held significant, which implies implications. It is, therefore vital to investigate the implications of ICT exports on per capita GDP as the latter notes the extent of pass-through over a time-specific sample of countries.

Studies carried out and still ongoing suggest that innovation and technology are indispensable to economic growth in developed countries (Niebel, 2014) and there is a relationship between productivity growth and technological progress (Steinmuller, 2001). The implications of ICT exports or investments are contingent on the extent of human capital and the ability of the current workforce to leverage improvements in ICT. This could span process innovations and internet-centric business models that address long term structural macroeconomic vulnerabilities while boosting the potential growth rate. Admittedly, the literature details a net positive contribution from ICT exports to economic growth in developing economies (Yousefi, 2011). Nevertheless, the rapid growth of technology, ICT and transportability have increased the competitiveness and growth contributions from the service sector (Mishra et al., 2011). The study investigates the contribution of goods and services exports on per capita GDP to capture the unique growth-effects of value-added services such as communication and internet services, tourism and hospitality and business services.

Meanwhile, the value added from services captures technology-driven improvements in the service sector and enhance broadband connection communication and business services. The study, therefore, takes a more granular approach to investigating the effects of ICT exports and value-adding services on per capita GDP. This study investigates the export-led model for ICT-driven growth in developing economies, that is, it investigates technological spillovers by capturing the impact of value-added in services and ICT goods and services exports on per capita GDP. It contributes to the literature by investigating the contribution from value-added services and ICT goods and services exports, using a distinct algebraic framework to justify the machine learning algorithm. Additionally, it finds a greater contribution from ICT services to per capita GDP than Brent crude in spite of Cameroon being a major commodity exporter. The rest of the study is structured as follows, Chapter two delves into the literature, investigating the effects of ICT trade on GDP growth. Chapter three consists of the methodology and empirical framework. A discussion and interpretation of the results ensues in Chapter four with robustness checks. Chapter five, concludes the study and also outlines policy recommendation and avenues for future research.

LITERATURE REVIEW

A number of studies by Adeleye and Eboagu (2019), Batuo (2015), investigates the impact of ICT penetration and external trade on economic growth, using a variety of techniques to control growth-limiting effects and human capital using the export-growth led hypothesis (Hopestone, 2013; Asongu and Le roux, 2017). This section details the review of literature on ICT exports, noting the contributions from values-added from services trade to GDP growth. Using an ordinary fixed pool and random effects regression panel of 33 Sub-Saharan African countries between 1990 to 2010, Alege and Ogundipe (2013), found both trade in services (imports and exports) to be positively related to economic development. In an attempt to decipher the value added by the service sector, the study disaggregates trade data into transport, travel and other services. Bahrini and Qaffas (2018), examined the impact of ICT exports on GDP growth for the Sub-Sahara and Mena region using a GMM growth model for the period 2007 to 2016. The results show that mobile phones, internet usage and broadband adoption drives economic growth. Meanwhile, Ukwuoma (2019), finds that increases in inflation lessens internet use intensity, although increases in GDP cause internet use to fall in Nigeria. Adeleye and Eboagu (2019), investigated the impact of ICT on economic growth using a pooled ordinary least squared regression with random and fixed effects in Africa. Controlling inflation, the study finds statistically significant results for a positive relationship between internet access, mobile subscriptions, trade openness and fixed telephones. Batuo (2015), found that ICT investments and increases in teledensity causes a 0.8% increase in real GDP on a sample of 44 African countries between 1990 to 2010. The increases in GDP growth are found to occur following an increase in teledensity by 10 people per 100 habitants. Using an endogenous growth model on 149 African Countries, Chavula (2013), demonstrates a positive impact from telephone lines to standards of living, although internet usage do not show statistically significant positive effects on productivity. Asongu and Le roux (2017), notes that policies designed to boost ICT penetration, mobile phone and internet ,will facilitate inclusive economic development. This is consistent with the assertion that knowledge economies as indispensable to sustained economic development. The latter consists of broad based economic growth driven by higher value-added goods and services. Their findings do not, however, capture the contribution of value-added services and Brent crude to per capita GDP despite most African countries being dependent on commodities. Edemeyovwi and Osabuchein (2018), found mobile phone subscriptions to be statistically insignificant on economic growth. Their findings refute the ICT-driven growth hypothesis, but appear to reflect dismal communications infrastructure and low teledensity. The value-added rather than the growth causing effects are a central tenets of this study. A number of micro-level studies investigates the effect of ICT on productivity for developing and emerging economies. The rapid diffusions from ICT
lead to the findings of Aker and Mbati (2010), which indicates that it has driven higher rates of mobile phone penetration in Sub-Saharan.

Based on the panel data from 1980 to 2014, Sermcheep (2019), examined the effect of services export on economic growth in the ASEAN countries. The results found evidence of export-led growth promulgated by the service sector over the last decade. The study separates service exports data into modern and traditional services, and the estimations show strong contributions from both export categories to GDP growth, with a weaker contribution from modern service exports. Admittedly, goods export remain an essential driver to economic growth, they note the increasing salience of the service sector, which has emerged as complement to the existing growth framework. Services tend to be produced for domestic consumption and face-to-face interactions such as tourism and transportation. The rapid growth of technology, ICT and transportability have increased the competitiveness and growth contributions from the service sector (Falk, and Biag, 2015; Mishra et al., 2011).

**ICT exports and Economic Growth: Findings from advanced economies**

Mishra et al. (2011) found services increasingly tradable through physical and digital means, which enables direct consumption to foreign countries. By examining the effect of increased export sophistication for 103 countries, for the period 1990 to 2007, their results denotes salience of service sector sophistication as a driver of economic growth. Their findings robustly reflects the economic outcomes in low and middle income countries. A logical consequence of which is continued research as regards service sector contribution to GDP outcomes. What more, ICT diffusion proxies by ICT in volume and frequency, has direct linkages to emerging market GDP and directly increase total factor productivity. Similarly, Steinmuller (2001), argues that less developed countries can achieve higher growth rates through ICTs. The findings suggest increased probability of “leap frogging” by passing obsolete technologies due to higher ICT penetration and human capital. Hodrab et al. (2016) examined the drivers of economic growth for 18 Arab countries between 1995 to 2013. Their findings shows that ICT in conjunction with other factors such as gross fixed capital formation positively impact economic growth, while inflation is inversely related to GDP growth outcomes. Röller and Waverman (2001) and Wolde-Rufael (2007) agree in their findings, positing that investments in ICT causes increase in output. Nevertheless, developing economies find it harder to achieve higher growth rates and/or benefit from ICT spillovers in comparison to OECD countries due to underserved communication infrastructures. A number of growth accounting studies show significant contribution of ICT capital to economic growth in developed economies (Oliner and Sichel, 2000; Jorgenson and Stiroh 2000; Edquist and Henrekson, 2004). Inklaur et al. (2005) find higher contributions of ICT in the US than of France, Germany, the Netherlands and the United Kingdom. Similarly, Niebel (2014) investigates the impact of ICT on economic growth for a sample of 59 countries between 1995 to 2010. The study displayed little differences in output elasticity amongst the sub sample of countries including developing, emerging and advanced economies. Keller 1996 and Henry et al. 2009 find that output elasticities are contingent on absorptive capacity, the ability to apply new technology, such as, human capital.

**A comparative analysis of developing economies and advanced economies**

Yousefi (2011), investigates ICT-driven growth across different economies in an attempt to shed light on the global spillovers. The results confirm significant contributions of ICT in most economies with the exception of developing economies. Conversely, Dedrick, Kraemer and Shih (2011) used their findings to show how developing economies have experienced higher productivity from ICT in recent decades. Meanwhile, Niebel (2014), follows a similar methodology and finds a positive contribution of ICT to economic growth even when controlling for the effects of trade, which are dominated by low value-added products. A priori, it remains unclear whether the effect of ICT on economic growth is larger in developed countries than in developing countries. Dewan and Kraemer (2000) estimated a panel of 36 countries (14 developing and 22 developed countries) between 1985 to 1993. Their results demonstrates the positive effect of ICT stock on GDP in advanced economies, consistent with Hanclova et al. (2015).

Meanwhile, the ICT coefficient for developing countries are not statistically significant due to IT-enhancing and diffusion-centric factors such as human capital. The chosen time frame suggest the start of ICT diffusions in developed economies, which suggest that statistically significant effects in developing economies are unlikely captured in the data. Dedrick et al. (2013) covering 45 upper-income developing and developed countries for the period 1994 to 2007. found evidence of positive contributions of ICT to economic growth. The study, however, notes slightly larger elasticities for output in upper-income countries. Similarly, Dimelis and Papaioannou (2010) equally find a stronger impact of ICT exports on developing economies.

**METHODOLOGY**

The majority of studies investigates the impact of ICT
exports on per capita growth, while noting the need for substantial absorptive capacity and differing proxies for ICT. Additionally, the demand-leading hypothesis culminating domestic consumption have formed the basis of most studies. The study seeks to make a distinction between goods as service exports and the value-added from the latter. In an attempt to capture the diffusion and identify transmission mechanisms, the independent variables are used in conjunction with per capita GDP. The data employed in the study comprises ICT-related data for between 1999 to 2018, the most comprehensive data for Cameroon. The study attempts a regional comparison, but notes structural differences and geographic advantages in the case of emerging Asia, giving credence to a rational, that at the same time controls variables that are growth enhancing and value-depleting. By controlling inflation and Brent crude, the study compensates for greater contributions from the latter in the case of commodity exporters while accounting the deflationary effect of oil prices on yearly outcomes of per capita GDP in emerging and developed Asia.

**EMPIRICAL FRAMEWORK**

The panel regression reads as follows:

\[
\sum_{t+1} Ict_{gds} + \sum_{t+1} ex + \sum_{t+1} Ict_{svs} + Brent_{t+1} + inf_{t+1}
\]

Where \((gds + svs) = \theta\)

If \(Ict_{(gds+svs)} : (ex_{t+1})^{-\theta}\) \(\Sigma ex^{-\theta} = \Sigma ex(gds + svs)_{Ict} > Ict(gds + svs)_{t+1}\)

\[
\sum Ict(gds + svs)_{t+1} \sum ex - (gds + svs)_{t+1}
\]

The optative inclusion of the argument below serves to distinguish goods and serves exports from Information communication technology. While the contention of bidirectionality is implicit, the algebraic outcomes are consistent with total ICT exports at given time 't'.

\[
\sum Ict - (gds + svs)_{t+1} = \sum ex - (gds + svs)_{t+1}
\]

\[
(svs: Ict - gds = 1 - (\Theta_{gds})_{t+1})
\]

\[
(gds: Ict - svs = 1 - (\Theta_{svs})_{t+1})
\]

Substitutions of a change in ICT exports as a percentage of total services exports in equation (5) yields:

\[
(Ictex)_{t+1}^{svs} = \frac{(Ict_{SV})_{t+1}}{SVS_{exp}}
\]

Based on the findings from the literature, the study also includes value-added from services in a bid to make a distinction between ICT goods and services and other value-added activities that form the basis of sustainable per capita growth. Furthermore, the inclusion of value-added services captures the extent of diffusion and reflects the greater contribution from the service sector at 51.6% of GDP (CIA World Fact Book, 2020).

\[
(Ictex)_{t+1}^{svs} : \frac{svs_{Ict}}{\theta} = \frac{(Ict_{SV})_{t+1}}{svs_{exp}}
\]

\[
(svs_{Ict} - \theta = \frac{(Ict_{SV})_{t+1}}{svs_{exp}}(svs_{Ict})_{t+1} = \frac{(Ict_{SV})_{t+1}}{svs_{exp}}
\]

Substitution in equation (1)

\[
Where: \frac{(Ict_{SV})}{svs_{exp}}_{t+1} = \sum_{t+1} (SvEx)_{Ict}
\]

**Table 1: Descriptive summary statistics.**

<table>
<thead>
<tr>
<th>Per_capita_GDP</th>
<th>ICT goods export</th>
<th>Export of goods and services(% of GDP)</th>
<th>ICT service exports(% of service exports)</th>
<th>Brent</th>
</tr>
</thead>
<tbody>
<tr>
<td>mean</td>
<td>1.750564</td>
<td>0.032164</td>
<td>23.576957</td>
<td>62.425353</td>
</tr>
<tr>
<td>std</td>
<td>0.299268</td>
<td>0.022137</td>
<td>3.054380</td>
<td>30.266022</td>
</tr>
<tr>
<td>min</td>
<td>0.649992</td>
<td>0.003440</td>
<td>18.583916</td>
<td>17.699167</td>
</tr>
<tr>
<td>25%</td>
<td>1.099943</td>
<td>0.020716</td>
<td>21.403265</td>
<td>38.280940</td>
</tr>
<tr>
<td>50%</td>
<td>1.314706</td>
<td>0.028774</td>
<td>24.296900</td>
<td>61.865475</td>
</tr>
<tr>
<td>75%</td>
<td>1.401721</td>
<td>0.039420</td>
<td>25.839396</td>
<td>76.634750</td>
</tr>
<tr>
<td>max</td>
<td>1.540568</td>
<td>0.105746</td>
<td>29.057696</td>
<td>111.959592</td>
</tr>
<tr>
<td>+_std</td>
<td>1.773621</td>
<td>0.076439</td>
<td>29.685717</td>
<td>122.957398</td>
</tr>
<tr>
<td>+_std</td>
<td>1.773621</td>
<td>0.076439</td>
<td>29.685717</td>
<td>122.957398</td>
</tr>
</tbody>
</table>
The regression reads as follows:

\[(P_{gd})_{t+1} = \sum_{i=1}^{\text{ict}_{gds}} + \sum_{t=1}^{\text{ex}} + \frac{\text{ict}_{svs}}{\text{ex}_{sd} + \text{ict}_{svs}} + \text{Brent}_{t+1} + \text{inf}_{t+1}\]

\[
\sum_{i=1}^{\text{ict}_{gds}} + \sum_{t=1}^{\text{ex}} + \sum_{i=1}^{\text{ict}_{svs}} + \text{Brent}_{t+1} + \text{inf}_{t+1}\]

In an attempt to capture complementarities and improve the predictability of the regression model, the study employs artificial intelligence. The latter comprises the isolation of a particular information process problem, the formulation of a computational theory and the construction of an algorithm (Ndikum, 2020). Admittedly, the problem of empirical testing can be classified as a "supervised learning problem". This study constructs a supervised learning model, designed to extract patterns from historical data although the performance of the constructed algorithm is evaluated through a process known as testing.

A supervised learning algorithm given a set of inputs-outputs \((i, \theta)\)

\[
\sum_{i=1}^{N(i, \theta)} = (x_1, y_1, (x_2, y_2, (x_3, y_3), .... (x_n, y_n)) \quad (i)
\]

Assuming \(y\) is generated by a random walk or unknown function modelled by a supervised learning algorithm then:

\[
F(x) = y
\]

Where \(x= (x_1, x_2, .... x_n)\)

Where \(y= (y_1, y_2, .... y_n)\)

A batch prediction with multiple inputs is:

\[
X = x_1 + x_2 + x_3 + ... x_n\]

The performance of the algorithm is evaluated via an accuracy measures. The performance metric is labelled as follows:

\[
P(y - y) \quad \text{where} \quad y \Delta (x_1 + x_2 + x_3 + ... x_n) \quad (ii)
\]

\[
\sum_{i=1}^{\Theta} = (\theta_{i+1})\]

\[
P(|x_1 + x_2 + x_3 - y|) \quad \text{if} (x) = (\theta_{i+1}) \quad (iii)
\]

A logical exclusion of \(y\) from the data set culminating \(x_{n}^f\) and \(y_{n}\) proves equation 8

\[
(x_{n}^f) - y_{n}
\]

If \(x = x_{n}^f, \text{drop} (\text{"y")}

\[
Y = [[y_{t+1}]]
\]

\[
P ((x_1 y_1 + x_2 y_2 + x_3 y_3)) \quad (iv)
\]

**DATA ANALYSIS AND RESULTS**

The study investigates the impact of ICT variables, goods and services exports, services exports and ICT goods exports, on per capita GDP. The study comprises of a time series spanning 1999 to 2019, with Brent used as a control variable to account for structural characteristics. Due to the lack of high quality data spanning and longer time frame, the study constructs an algorithm to investigate the contribution of said variables summarised below. The study constructs an algorithm to investigate the impact of ICT-export variables on per capita GDP. The variables of ICT goods and services exports are measured as a percentage of GDP as the study seeks to investigate the extent of transmissions to consumers. The study finds a positive and statistically significant effect of ICT goods exports and goods and service exports as a percentage of GDP. It is, however, notable that the quantitative contribution from ICT goods exports are significantly higher at 0.81% although exports of goods and services are marginally positive at 0.035%. The findings are consistent with the structural characteristics of the Cameroon’s economy as a net commodity exporter of low value added products. Forgha and Aguas (2015), found a statistically significant relationship between commodity exports and GDP growth. However, this study finds a weak positive contribution from oil prices to per capita growth in Cameroon, noting the priamcy of higher value-added activity and contributions from ICT goods and services exports to per capita growth. The study also finds a marginal, albeit positive relationship between ICT services exports and per capita GDP.

The statistically significant results are consistent with findings from Adeleye and Eboagu (2019) and Alege and Ogundipe (2013) which found both trade in services (imports and exports) to be positively related to economic development. The findings also provided greater credence to the possibility of a leap-frog (Steinmueller, 2001), where by the economy can transition from one driven by low value-added products and services, to advanced and tech-centric service such as cloud computing, advanced manufacturing, renewable energy and associated technology, mobile payment services and financial technology. The economic literature finds a greater impact of commodity prices to the economic growth, but this study finds a negative contribution from Brent crude to per capita.
GDP that is, 0.001. Additionally, these findings are consistent with structural changes in the economy where services contribute 51.6% of GDP (CIA World Fact Book, 2020). Rather than emphasize the role of commodities in the Cameroonian economy, this study empirically finds and justifies the contribution from the service sector.

### Robustness checks

The findings of the study do not violate the assumption of instance dependence, which underlies conventional econometric testing. The study tests for serial correlation and dependence using the Breusch-Pagan's test and the White Test. The P-values were 0.1285 and 0.265 confirming the absence of heteroscedasticity. By failing to reject the null hypothesis \( H_0 \), the findings support the contention that the variances are equal and the regression residuals are homoscedastic and evenly distributed. The log of exports are designed to account for an increased probability of multicollinearity, due to the compositional makeup of the variables.

\[
H_0 = \sigma^2_i = \sigma^2 \\
H_1 = \sigma^2_i \neq \sigma^2
\]

The findings, while consistent with the supply-leading hypothesis, nonetheless found a strong and statistically significant relationship of ICT goods exports and services to per capita GDP. The findings suggest a need for policy makers to incentivise investments in Information communication technologies by designing a business friendly climate, indispensable to capital flows for the sector (Batuo (2015)). Meanwhile, fiscal policy should prioritize wage subsidies in an attempt to incentivise hiring in ICT related sectors such as manufacturing, cloud computing, communications, cyber security and the manufacturing of components. Such an approach will bolster the competitiveness of exports, according to Röller and Waverman (2001) and Wolde-Rufael (2007), domestically-generated competitive pressures will at once create synergies and improve the potential growth. While export competitiveness has tended to overstate volumes, higher value-added products will improve external competitiveness while further diversifying the economy away from fossil fuels (Chavula, 2013; Asongu and Le roux, 2017).

### CONCLUSION

This study investigates the growth-leading hypothesis stemming from information communication technologies in Cameroon between 1984 to 2019. Further it investigates the contributions from ICT goods and services and at the same time investigate the impact of perceived structural changes in the economy, while identifying the extent of cross sector contributions between services and goods exports to per capita GDP. The regression reveals positive and statistically significant results for total exports with notable differences between ICT goods and services exports. The smaller output elasticities between ICT goods exports (0.53) and services exports (0.46) are nevertheless notable and suggest structural changes in the economy which appear to be consistent with regional trends. A tests on the robustness of the findings could not be rejected and
there is no statistical indication that the results will be different outside the chosen measurement parameters. As such, the “leapfrogging” hypothesis, however questionable, is not unlikely in the presence of targeted reforms to fiscal policy and the business environment. Another issue worth mentioning is the control variable, Brent crude priced in U.S. dollars which shows marginally positive effects on per capita GDP. The limited nature of the data set suggest that the generalizability of the study while valid, does not account for the demand-leading hypothesis. The emphasis on the supply-leading hypothesis investigates the salience of broader claims of export competitiveness that invariably accrues from ICT exports.

While the literature is consistent with increased contribution from ICT goods, the value-added from services is little covered in the literature. Not only does this study contribute to the literature in that regard, it also reflects the current macroeconomics of the Cameroonian economy. Additional analysis spanning longer periods will help confirm said results, but the study contributes to the literature by positing positive spillovers from ICT exports and the need to invest in non-oil sectors through targeted policy measures. Policy implications emphasize an export-orientated model of ICT development, and tax cuts should be accompanied by wage subsidies that will create sustained employment and increase the value-added of exported products. The emphasis of such an approach, rests in positive spillovers poised to accrue from productivity-driven wage growth and firm-level competitiveness. The former, is a proxy for sustainable economic growth and will form the basis for greater competitiveness in global trade.

REFERENCES


Cite this article as:
Submit your manuscript at
http://www.academiapublishing.org/journals/jbem