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The importance of Information and Communications Technology in Achieving African Economic Integration

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Abstract:

The present study investigated and tested the influences of Information and Communications Technology (ICT) development on intra-African trade using a panel dataset for 41 African countries during the period 2002–2016. To the best of the authors' knowledge, this is the first empirical study in the Africa continent that investigates the impact of ICT development on Intra-African trade using the Information and Communications Technology Development Index as a comprehensive measurement tool. The Pedroni cointegration tests verified a long-run relationship between the mentioned variables. The results of the Fully Modified Ordinary Least Squares (FMOLS) technique suggested that ICT development plays a marginal impact on intra-African trade, an impact that is significant at 1%. Overall, the results implied that one of the key channels through which the goal towards Continental Free Trade Area (CFTA) is through promoting and investing more in the ICT sector. Thus, governments and development partners should work with other stakeholders progressively to build ICT-enabled trade facilitation in Africa.

Keywords: Information and Communications Technology, Intra-Trade, Africa.

JEL classification: O31, F53, F15.

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Introduction:

The investment in information and communications technology (ICT) infrastructure has increased sharply during the past few decades in many countries. One of the key reasons behind this increase is since ICT has been recognized as the principal mechanism for growth and development in many countries (Nordhaus, 2015; Fajgelbaum and Khandelwal, 2016; Morgan et al.2017' Suedekum,2017). The growth in worldwide ICT has contributed to globalization, enabling several types of integration among groups of countries (WTO, 2017; Dix-Carneiro and Kovak, 2017; Muendler 2017 .). According to WTO (2017) the rise of a more integrated global economy has accelerated the spread of innovation, information and know-how, and has spurred cross-border collaboration and competition, all of which have helped to fuel technological advances. At the same time, these technological advances – from containerization to improvements in air-travel, to the invention of the internet – have helped to bring about today's increasingly integrated global economy.

Since 1910, the initiatives for regional integration in Africa had begun; and the 1970s witnessed the formation of several regional economic communities (Awad and Yussof,2017). Currently, there are 17 regional trade blocs on the continent, of which eight are officially acknowledged by the African Union (Anyanwu,2014). Today, the leaders of Africa committed towards Continental Free Trade Area (CFTA). As well known, there are two critical theoretical motivations for the call for trade blocs, which are the allocation and growth effects of free trade within a regional bloc (Baldwin, 1997). Augmented linkages among African countries, through an expansion of intra-regional business, can be an essential mechanism in producing the required growth spillovers and encourage regional take-off. Despite the efforts that have been allocated to facilitate intra-African trade, however, recent evidence suggests that only about 10 -15 percent of Africa's trade is exchanged within the continent, a much lower proportion than in other world regions (African Development Bank,2013). Small domestic markets, landlocked status, limited natural resources and political instability restrict the trade potential of many countries (Yonazi et al 2012). One of the vital factors that have been identified as crucial sources of Africa's trade problem

is trade costs that making African exports less competitive both on the continent and globally. In this respect, prominent works have already been done on the international trade costs matters during recent years, mostly on the role of geographic distance (Hummels, 1999; Limao and Venables, 2001; Micco and Pérez, 2001; Fink et al., 2002; Kumar and Hoffmann, 2002; Francois and Manchin 2013). In most of these studies, geographic distance has been identified as a critical determinant of trade given its positive effect on trade costs. Disdier and Head (2008), adopting a meta-analysis on 1,467 estimated gravity equations in 103 papers, detected that the magnitude of the coefficient linked to the distance in these equations had been slightly on the rise since 1950. For many scholars, the information friction inherent to distance is the critical explanation of the trade reducing-effect of distance (Rauch, 1999; Chaney, 2011; Allen, 2011). Allen (2011) shows, for example, that almost 93 percent of the relationship between trade flows and distance is attributed to information frictions rather than transportation costs.

For this reason, the development of ICT infrastructure is regarded as a means to improve the efficiency of the transactional processes. This argument is supported by both theoretical predictions (see Malone et al., 1987; Rauch, 1999; Jensen, 2007, Aker, 2010, Goyal, 2010; Chaney, 2011; Allen, 2011) and empirical evidences (Limao and Venables, 2001; Freund and Weinhold, 2002, Fink et al.,2002; Freund and Weinhold, 2004; Fink et al., 2005; Clarke and Wallsten, 2006; Francois and Machim, 2007; Vemuri and Siddiqi, 2009; Demirkan et al., 2009; Choi, 2010; Mattes et al., 2012). From the theoretical point of view, ICTs have been suggested as a critical factor to face these challenges by its role in facilitating trade between the countries. Trade facilitation aims to simplify, harmonize and standardize processes to minimize the delays and costs incurred at bottlenecks and to improve reliability for both trading businesses and governments. ICTs are crucial to trade facilitation for three main reasons: First, they improve the efficiency with which trade transactions are handled, enhancing transparency and accountability, reducing the cost of human interfaces, eliminating delays and reducing the scope for corrupt interactions between traders and officials. Second, they strengthen the coordination between different actors in the trade management process, particularly between

government agencies within individual countries, and across national borders. Third, they enhance the information and knowledge about trade processes and markets that are available to businesses, enabling them to manage consignments more efficiently and to enter new markets at lower risk (Yonazi et al 2012.). ICTs are therefore essential inputs to the enabling environment for cross-border and regional trade.

However, as we can see later, the latest information from International Telecommunication Union (ITU) regarding the ICTs infrastructure in Africa is so disappointing (International Telecommunication Union (ITU), volume 1;2017). Given the association between intra-trade and ICT, the present study seeks to identify the role of ICT development in explaining intra-African trade. Despite the frequent call for integration in Africa by policy leaders, the role of ICT in this matter is neglected or insufficiently addressed. To the best of the authors' knowledge, only one study conducted by Bankole et al (2015) to address the impact of ICT development on the Intra- African trade. Using factor analysis as well as partial least square (PLS) techniques, Bankole et al (2015) examine the impact of three different proxies for ICT development (primary telephone line subscribers per 100 inhabitants (MTL), Internet users per 100 inhabitants (IU) and mobile cellular subscribers (MCS) per 100 inhabitants) on intra-trade for 28 African countries during the period 1998-2007. The empirical analysis shows that the Telecommunications Infrastructure has a significant impact on intra-African trade. .Besides, even for currently existence regional economic communities (REC) such as COMESA, SADC, EAC UMA, ECCAS, ECOWAS, IGAD, there is no empirical studies addressed the role of ICT development in explaining the success or the failure of these RECs (Foroutan and Pritchett (1993a, b), Elbadawi (1997), Lyakurwa et al. (1997), Longo and Sekkat (2001) and Ogunkola (1994); Carmignani, (2006) Gedaa and Kebret (2008); UNCTAD 2009; Anyanwu,2014; Iheduru,2014; Murine 2017; Awad and Yussof,2017)(1).

The present study employs a panel cointegration technique for 41 African countries during the period 2002-2016 to answer the following questions: Is the lower level of ICT development could explain the low

(1) The list of the abbreviations is listed in Table 1A in the appendixes .

level of intra-African trade? To what extent ICT development contributed to Intra -African trade? This article seeks to address the experience of Africa with this issue and expects to add to the existing literature in two principal fashions. First, to the best of the authors' knowledge, this is the first empirical study in the Africa continent that investigates the impact of ICT development on the Intra -African trade using comprehensive measurement. More specifically, instead of using these in proxies in a separate way to reflect ICT improvement, the present study uses Information and Communication Technology Development Index or IDI after that we will use IDI). This index calculated using three sub-indices related to ICT development which are access, usage and skills. Therefore, using only one or two of these sub-indices may underestimate or overestimate the results. Second, given the heterogeneity among the countries included in the sample, the present study uses the most appropriate and recent long-run panel techniques including the panel cointegration tests proposed by Pedroni (1999). The findings of this study are highly substantial and acquire profound policy implications for economies included in the panels, as well as for international trade and ICTs organizations and regional economic blocks. It is also imperative for researchers 'work since it is anticipated to open future directions of this research. The next section outlines the theoretical background. Section 3 presents the econometric model, data and method of estimation while Section 4 discusses the results. Section 5concludes with some policy implications

1. Review of Intra- trade and ICT Development in Africa

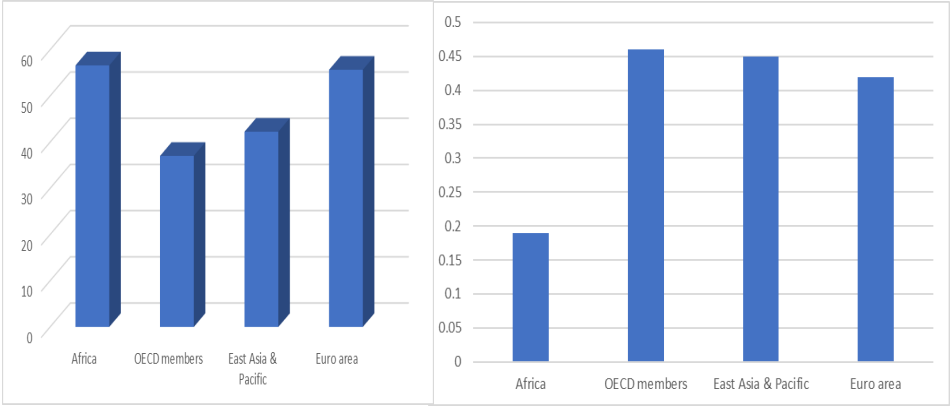
This section describes the situation of intra-trade ICT Development in Africa during a different period. First, we will illustrate the situation of intra trade and thereafter we assess ICT Development.

2.1 Review of Intra- trade in Africa

The analysis will start by explaining the importance of trade in terms of exports and imports for Africa compared to another region. Subsequently we discuss the general pattern of trade between Africa and the rest of the world. Then we outline the main feature of Africa's exports and imports. Next, we deal with the trend in intra-African trade. Figure 1 summarizes

the current situation for African trade for more than half a century. The figure on the left-hand side reflects the trade average (% GDP) while the figure in the right-hand side the average annual growth rate. The figures show that despite the relatively higher proportion of trade in Africa's GDP (approximately the same as that of European area), it registered a lower average annual growth rate for trade during the same period. More specifically, the average yearly growth rate in other regions is almost more than two times of that of the African region. Interestingly, although the OECD region reported a low share of trade in its GDP, the region enjoys a higher average annual growth rate in the share of trade in its GDP. Thus, it is inaccurate to look at the absolute value of trade (% GDP) to evaluate the importance of trade for the African economy since it does not reflect progress or failure over time.

Figure 1 Trade Average (%GDP) and average annual growth rate for choosing regions, 1960-2016.

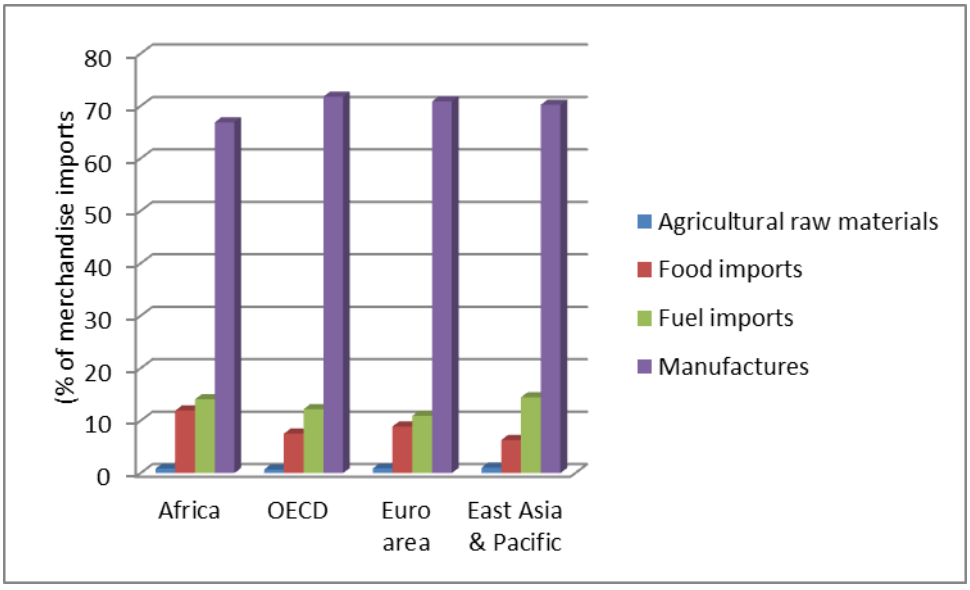


Sources: World Bank, World Integrated Trade Solution.

In terms of exports, the composition of Africa's export compared to other regions as shown in Figure 2 demonstrates that the structure of Africa's export is unlike that of other regions. While exports for manufactured goods constitute a higher proportion in the other regions' exports, for Africa, the export of fuel accounts for nearly 40%. In other words, in other regions, exports of manufactured goods account for approximately more than 70% of merchandise exports, while for Africa it is only 25%.

Economic Commission for Africa (2013) stated that the relatively high share of primary products (food and fuel) in Africa's export is mainly due to the rising trend in international commodity prices. Rising commodity prices explain around two-thirds of recent primary product export growth given the persistent commodity concentration of exports in the continent. The reports conclude that the concentration of fuel and food in Africa's export portfolio is likely to manifest in a significant surplus in the trade of these products. This surplus can be allocated to finance Africa's imports of manufactured goods as well as building productive capacities for structural transformation. Looking at the second part of the story, we can look at Africa's imports compared to other regions as shown in figure 2.

Figure 2: Agricultural raw material, food, fuel and manufactured imports (% of merchandise imports), average 1995-2016.

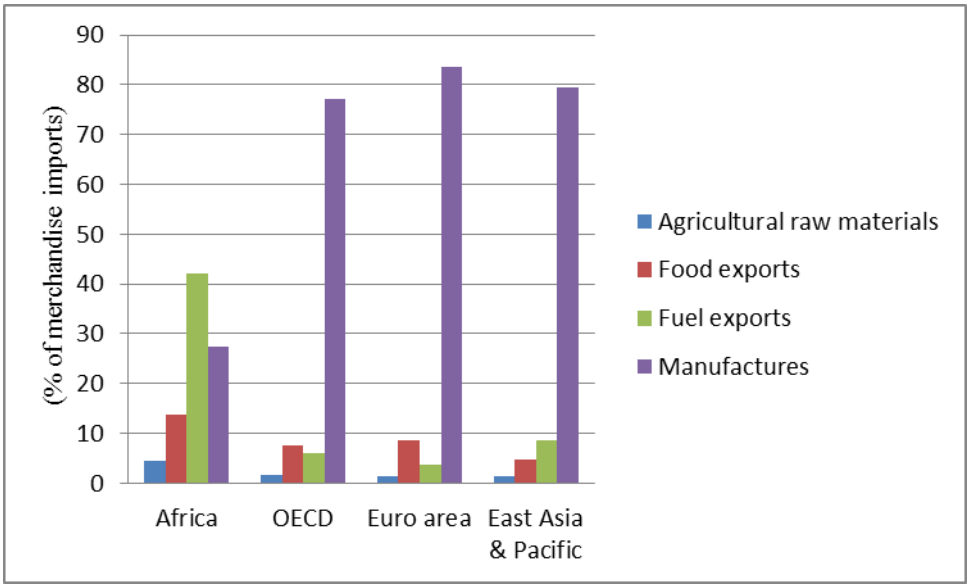


Sources: World Bank, World Integrated Trade Solution.

Interestingly, the structure of Africa's imports seems to be identical to that of other regions. That is to say, similar to the other regions, in Africa, the import of manufactured products, followed by fuel, food and agricultural raw material are top in the import menu. Furthermore, the continent is

suffering a deficit in manufactured products since there are more imports than exports of this item (deficit equal to 40% during 1995-2012).

Figure 3: Agricultural raw material, food, fuel and manufactured exports (% of merchandise exports), average 1995-2016.



Sources: World Bank, World Integrated Trade Solution.

Now we move to illustrate the intra-African trade pattern, which is the fundamental interest of this study. At the aggregate level, Tables 1 and 2 below describe the intra-African trade (exports and imports) during the period 2000-2016. Table 1 shows Africa exports (% to total exports) during 1990-2017. Clearly although intra-African export increased significantly between 1990 - 2017, but remain relatively low compared with trade with other regions. For example, by 2017 most of the African export tend toward advanced economies (46%). The same pattern is observed when we look for the imports as shown in Table 2. Both tables reflect a disappointing fact about the regional integration in Africa. This information to some extent same as what reported by the African Development Bank (2013) estimates that the trade between African countries is about 10%-12% of the continent's total, compared to 48% for trade within North American

countries, 72% of European trade between the countries and 52% for Asia Continent. In the same respect, the Economic Commission for Africa (EC 2004), conducted a study to measure progress in integration in Africa and they concluded that the regional integration in Africa is weak in general and across sectors, countries and regional communities in particular. However, figures on Intra- African trade do not include the unrecorded trade between countries that has common borders. According to the UNDP (2011) the unreported trade constitutes a substantial proportion of the total intra-African trade, and most likely that the growing integration has not been incorporated into the official figures.

Table (1): African Exports (% total Export) , to selected region and countries,1990-2017

Years	Africa	Advance Countries	Asia	EURO Area	UK	USA
1990	7	71	2	40	4	17
1991	7	69	3	42	4	14
1992	8	73	3	41	5	16
1993	8	72	4	36	4	18
1994	9	69	4	37	5	15
1995	10	69	5	38	5	14
1996	10	69	5	36	6	16
1997	10	69	5	35	6	16
1998	11	67	5	37	5	15
1999	10	70	7	39	5	14
2000	13	69	9	34	6	19
2001	12	65	7	34	7	15
2002	13	65	8	35	6	13
2003	13	67	9	33	6	17

2004	12	66	11	33	6	17
2005	11	67	12	30	5	21
2006	11	68	12	29	5	22
2007	12	68	13	28	4	21
2008	11	65	15	28	4	19
2009	15	60	17	27	3	16
2010	16	56	18	24	3	16
2011	15	56	19	24	3	16
2012	15	52	22	25	4	10
2013	17	50	22	26	5	7
2014	17	48	23	27	3	5
2015	19	48	22	27	3	5
2016	20	47	21	27	3	6
2017	18	46	25	26	2	7

Source: International Monetary Fund, DOTS

Table (2): African Imports (% total import), from selected region and countries,1990-2017

Years	Africa	Asia	EURO Area	Advance Countries	UK	USA
1990	8	3	52	73	8	7
1991	8	4	49	74	8	6
1992	8	5	49	75	8	6
1993	8	6	48	76	9	7
1994	9	5	47	74	10	7
1995	9	6	48	73	8	7

1996	10	6	47	70	9	7
1997	11	6	45	69	8	7
1998	9	7	48	70	8	6
1999	10	8	49	70	8	6
2000	13	7	44	64	7	6
2001	13	7	44	64	8	6
2002	14	8	43	63	7	6
2003	13	10	42	61	7	5
2004	13	10	40	58	7	5
2005	14	12	37	57	6	4
2006	13	13	36	54	6	4
2007	13	14	37	54	6	4
2008	13	15	34	51	6	3
2009	13	18	34	51	6	3
2010	14	18	32	50	6	3
2011	14	18	31	48	6	3
2012	15	19	30	47	6	3
2013	15	20	30	46	6	3
2014	14	22	30	45	6	3
2015	14	24	30	43	5	2
2016	13	24	31	44	5	2
2017	13	24	30	43	5	2

Source: International Monetary Fu

Clearly, aggregate data on African trade as shown in Table 2 do not represent a large share of total African trade. This is because there is variation among African countries in intra-African trade and the aggregate data ignore

such variation. Table 3 illustrates the intra-African trade by the country during 2002-2016. Clearly as suggested by The UNCTAD (2009) there is substantial variation in intra-African trade when we look for this matter by country. For instance, the top five countries that trade more within African countries include Comoros, Mali, Zimbabwe, Zambia and Malawi respectively. At the same time, the top five countries with the lowest trade with African countries include, Libya, Algeria, Sudan, Cabo Verde and Egypt.

Table (3): Intra-African trade (% total trade) by country , Mean, 2002-2016

Country	%	Country	%
Algeria	2.18	Madagascar	9.12
Angola	4.47	Malawi	43.65
Benin	25.66	Mali	77.95
Burkina Faso	33.29	Mauritania	7.57
Cabo Verde	2.63	Mauritius	12.39
Cameroon	19.38	Morocco	4.59
Central African Republic (CAR)	14.90	Mozambique	31.53
Chad	7.02	Niger	25.35
Comoros	92.20	Nigeria	7.85
The Democratic Republic of the Congo	32.01	Rwanda	39.23
Republic of the Congo	21.69	Senegal	26.05
Djibouti	12.16	Seychelles	8.39
Egypt	4.35	South Africa	13.92
Ethiopia	4.98	Sudan	2.57
Gabon	7.13	Tanzania	20.36

The Gambia	25.29	Togo	32.47
Ghana	22.64	Tunisia	4.55
Guinea-Bissau	22.29	Uganda	29.16
Kenya	20.58	Zambia	43.92
Liberia	13.06	Zimbabwe	70.08
Libya	2.16		

Source: International Monetary Fund, DOTS

Regarding the general composition of intra-African trade (exports by main sectors), Awad and Yussof (2017) show that a high share of intra-African exports is in the form of manufactured goods (more than 45%), and this is followed primary commodities. Between 2004 and 2008, the trade-in both product categories account for almost 40%. They clarify that the absence of any evidence of diversion in the intra-African trade since manufactured goods and primary commodities have the lion share in such trade. In contrast, intra-African trade in agricultural products and food is relatively low (nearly 15%). We can summarize the above discussion on African trade and/ or intra-African trade by arguing that for half a century, the progress made in trade in general as reflected in the low average trade growth rate (figure 1) is meager. In addition to that, by the end of 2016, on average 85% of Africa trade (export + import) is coming from outside the continent.

2.2 ICT Development in Africa

Evidence regarding ICT development as measured through the Information and Communication Technology Development Index or IDI as shown in Table 4 indicates that Africa far behind all the regions in the World(1). Even though some improvements occurred during 2016/2017 the same to that of Europe, but the level of ICT in the region still relatively low. As in previous years, the Africa region records by far the lowest average IDI value, up 0.16 points on the year, from an IDI 2016 value of 2.48 to an

(1) In the methodology section, more detailed information regarding IDI will be provided.

IDI 2017 value of 2.64, not much more than half the global average (5.11).

Table (4): Average IDI values, world and regions, 2017 IDI 2016

Region	IDI 2017	IDI 2016	Change in IDI 2017- 2016
Africa	2.64	2.48	0.16
Arab State	2.84	4.71	0.13
Asia and the pacific	4.83	4.60	0.24
CIS	6.5	5.84	0.21
Europe	7.50	7.34	0.16
The Americas	5.21	5.01	0.20
World	5.11	4.93	0.18

Source; International Telecommunication Union (ITU) , volume 1(2017)

In term of countries, as described in Table5 only one country in the region – Mauritius – falls into the top half of the IDI distribution or exceeds the global average value for IDI 2017, while only four more countries – Seychelles, South Africa, Cape Verde and Botswana – exceed the average amount of 4.26 for developing countries. By contrast, 28 of the 38 countries in the Africa region that are included in the Index rank as LCCs in the lowest quartile of the distribution, including 9 of the 10 countries at the bottom of the global rankings. The average improvement in IDI value for African least developed countries (LDCs), 0.12 points, was also significantly lower than that for non-LDCs within the region (0.23 points) These findings illustrate the extent to which Africa continues to lag behind other regions in ICT development, as well as the importance of addressing the region's ongoing digital divide. All but three countries in the region (Angola, Madagascar and Eritrea) showed some improvement in IDI value between 2016 and 2017, although in 11 countries this improvement was marginal (less than 0.10 points). The average improvement recorded was 0.16 points, less than the average gain of 0.20 points for all developing countries

The most dynamic nations in Africa, by IDI ranking and value, are identified in Table 6 The most considerable improvements in the overall

IDI were made by Namibia (up 0.57 points), Gabon (up 0.50 points) and Mauritius (up 0.36 points). The greatest improvements in the access sub-index were made by the Central African Republic, Mauritius and Malawi, and in the use sub-index by Namibia, Gabon and Zambia. As in other regions, there was relatively little movement in regional rankings between IDI 2016 and IDI 2017. At the top of the distribution, Seychelles moved from fourth to the second position, at the expense of South Africa and Cabo Verde, while Gabon moved above Ghana, from seventh to sixth. The biggest gain in the regional rankings was made by Uganda, which moved from 24th to 20th position.

The ten countries at the top of the African rankings achieved an average improvement in their IDI values of 0.25 points, well above the global average of 0.18, thanks to substantial improvements by the region's three most dynamic countries (Namibia, Gabon and Mauritius), while the remaining countries in the region, all but one of which are in the LCC quartile, managed an average improvement of just 0.13 points Uganda was only the seventh most dynamic country in the region in terms of IDI value, rising by 0.29 points, but made the most massive upward movement in the regional rankings because it improved significantly more than almost every other country in the third quartile of the regional distribution. It also saw its use sub-index value rise by more than 50 percent, driven by mobile-broadband subscriptions, and it enjoyed significant improvements in the mobile-cellular subscriptions and the proportion of Internet users within the population.

Table (5): IDI rankings and values, Africa, IDI 2017 and IDI 2016

Country	Regional rank 2017	Global rank 2017	IDI 2017	Regional rank 2016	Global rank 2016	IDI 2016	Global rank change 2017 -2016	Regional rank change 2017-2016
Angola	24	160	1.94	22	156	2	-4	-2
Benin	25	161	1.94	23	157	1.92	-4	-2
Burkina Faso	26	162	1.9	27	163	1.74	1	1
Cabo Verde	4	93	4.92	3	91	4.83	-2	-1
Cameroon	18	149	2.38	19	150	2.14	1	1
Cen. Afr. Rep	37	175	1.04	38	176	0.89	1	1
Chad	36	174	1.27	36	174	1.06	0	0
De. Rep Congo	33	171	1.55	32	170	1.48	-1	-1
Ethiopia	32	170	1.65	33	171	1.42	1	1
Gabon	6	114	4.11	7	118	3.62	4	1
Gambia	16	144	2.59	16	145	2.43	1	0
Ghana	7	116	4.05	6	113	3.88	-3	-1
Guinea-Bissau	35	173	1.48	35	173	1.38	0	0
Kenya	13	138	2091	13	137	2.67	-1	0
Madagascar	31	169	1.68	30	167	1.7	-2	-1
Malawi	30	167	1.74	31	169	1.58	2	1
Mali	22	155	2.16	21	153	2.05	-2	-1
Mauritius	1	72	5.88	1	75	5.51	3	0
Mozambique	19	150	2.32	17	147	2.23	-3	-2

Nigeria	15	143	2.6	15	143	2.44	0	0
Rwanda	21	153	2018	20	151	2.1	-2	-1
Senegal	14	142	2.66	14	142	2.48	0	0
Seychelles	2	90	5.03	4	92	4.8	2	2
South Africa	3	92	4.96	2	88	4.91	-4	-1
Tanzania	28	165	1.81	28	164	1.73	-1	0
Togo	23	156	2.15	25	159	1.86	3	2
Uganda	20	152	2.19	24	158	1.9	6	4
Zambia	17	146	2.54	18	149	2.19	3	1
Average			2.64			2.48		

Source; International Telecommunication Union (ITU) , volume 1(2017)

Table (6): Most dynamic countries by IDI ranking and IDI value, Africa, 2016–2017

change in IDI ranking				Change in IDI value (absolute)			
IDI rank 2017	Rank region	Country	IDI rank change	IDI rank 2017	Rank region	Country	IDI rank change
2	20	Uganda	6	118	8	Namibia	0.57
4	8	Namibia	5	114	6	Gabon	0.50
4	6	Gabon	4	72	1	Mauritius	0.36
6	1	Mauritius	3	146	17	Zambia	0.35
3	9	cote dlvoire	3	131	9	cote dlvoire	0.3
3	17	Zambia	3				
2	23	Togo	3				

Source; International Telecommunication Union (ITU) , volume 1(2017)

2. Methodology:

In this section, we describe the framework and data that were used for the empirical analysis of the impact of ICT development on the Intra-African trade. In the presents study, following Bankole et al (2015) the selection of factors that facilities intra-African trade was based on the Trade Competitiveness Index (TCI) (Chikhasu, 2007; UNECA, 2004, 2006) that formulated through Partnership for Africa's Development and the UNECA as an attempt to measuring trade facilitation factors. The TCI has three dimensions, where each captures a different aspect of trade competitiveness. These dimensions are: enabling trade environment (e.g. institutional quality and macro policy), productive resources (e.g. labor force and geography) and infrastructure (e.g. transport networks, energy, telecommunications and access to information) (UNECA, 2004). These dimensions are vital determinants of trade, and hence intra-African trade as already supported by different theories and empirical evidence. In the present study, for each dimension, a key proxy is selected, and their influence on intra-African trade is postulated. Equation 1 represents the critical determinants of intra-African trade

$$logTR_{it} = \beta_0 + \beta_1 logIDI_{it} + \beta_2 logGDP_{it} + \beta_3 logPR_{it} + \beta_4 logED_{it} + \varepsilon_{it} \quad (1)$$

Where TR is intra-African trade measured as the total exports of a country to other African countries plus the total imports of that country from other African countries scaled by the worldwide total export and import of that country (all in terms of US$). IDI is the Information and Communication Technology Development Index. GDP is the real GDP per capita in constant 2010 US$ and its introduced here as a convenient proxy for the level development, which reflects the trade intensity of the country. The higher the level of economic development the greater is the country's intensity to trade (Longo and Sekkat (2004). PR is the political right that measures the quality of domestic governance and institutions using the country score provided by Freedom House from the data on political rights.

The score ranges from one to seven. A rating of one implies "there are competitive parties or other political groupings, the opposition plays a vital

role and has actual power" and a score of seven indicates that political rights are absent. Is ED Education attainment (EDU): The educational attainment construct consists of three variables – gross primary school enrollments, secondary enrollments and tertiary enrollments, respectively. It is computed as: EDU ¼ (primary + 2∗ secondary + 3∗ tertiary)/6 (Orbicom, 2005). The Human-Capital Augmented Solow Model (Mankiw et al. 1992) and the endogenous growth theory by Romer (1990) acknowledged the role of the human capital of not just in facilitating the adoption of existing technologies, but the creation of new ones as well. This view supports the argument that human capital is necessary for achieving economic development based on export's substitution or/ and expansion strategy. Many scholars in general have documented the importance of human capital for export expansion and developing countries in particular (Chuang 2000; Narayan and Smyth 2004; Contractor and Mudambi 2008). For instance, Wood and Mayer (2001), utilizing the cross-section regression, show that the concentration of Africa's exports on primary goods in Africa is caused by a combination of the low level of education and abundance of natural resources.

Thus, the introduction of the human capital variable as a basic form of infrastructure in our explanation for the low intra-African trade integration might help in understanding part of this story. Data related to the variables GDP, ED is collected form the World Bank Development Indicator. Data on TR is from the International Monetary Fund (IMF, DOTS). Data on PR is collected from the Freedom House database. Data on IDI is obtained from the International Telecommunication Union (ITU) different reports. The data covers 41 African countries (see the list of these countries in Table 2A in the appendix) for the period 2002-2016.

Table (7): Descriptive statistic

	LTR	LIDI	LEA	LGDP	LPR
Mean	2.612352	1.136078	12.94215	7.089540	1.382005
Median	2.794880	0.741937	13.27380	6.841541	1.609438
Maximum	4.721932	3.914990	16.34806	9.920047	1.945910
Minimum	-0.064998	-0.673345	8.272485	5.267172	0.000000
Std. Dev.	1.049876	1.055419	1.676173	1.058145	0.533659
Skewness	-0.260945	0.983498	-0.736571	0.737634	-1.307399
Kurtosis	2.235381	2.899873	3.216812	2.679071	3.970563
Jarque-Bera	21.96090	97.94721	56.81453	57.84005	199.3409
Probability	0.000017	0.000000	0.000000	0.000000	0.000000
Sum	1606.597	688.4632	7959.425	4317.530	849.9329
Sum Sq. Dev.	676.7750	673.9151	1725.067	680.7596	174.8625
Observations	615	606	615	609	615

Source: author calculation

Table (8): Correlation matrix

Variables	LDE	LEA	LGDP	LIDI	LT
LPR	1	0.15	-0.13	-0.06	-0.27
LEA	0.15	1	-0.22	-0.12	-0.11
LGDP	-0.13	-0.22	1	0.13	-0.51
LIDI	-0.06	-0.12	0.13	1	-0.13
LTR	-0.27	-0.11	-0.51	-0.13	1

Source: author calculation

3.1 Estimation approaches

This section illustrates the steps that have been implemented to obtain the objective of the study. The steps commenced with the cross-sectional dependence test, followed by unit root testing and after that panel cointegration testing and then, as the last step, estimating the long-run relationship. Nonetheless, the first step, the cross-sectional dependence test, remains the critical step since it determines the appropriate analysis and methods in the following steps.

3.1.1 Cross-sectional dependence

As intra-trade suggests an increasing and resilient interdependence between nations, it is crucial to consider the influence of cross-sectional dependence in cross-nation panels. Shahbaz et al. (2017) observed that the existence of cross-sectional dependence in cross-nation panels might be due to unobserved common shocks that turn out to be an element of the error terms. Therefore, according to (Driscoll and Kraay, 2001), should cross-sectional dependence exist in the data but not be accounted for in the investigation, it may lead to inconsistent standard errors of the estimated parameters. For robustness purposes, four different tests we used to verify cross-sectional dependence. The tests used were the Breusch and Pagan (1980) LM test, the Pesaran (2004) scaled LM test, the Pesaran (2004) CD test and the Baltagi et al. (2012) bias-corrected scaled LM test. The results of the cross-sectional independence tests are displayed in Table 9, the tests were applied to all of the variables. The results clearly show that, for each selected variable, the null hypothesis of cross-sectional independence was rejected. Thus, the existence of cross-sectional dependence under a fixed effect (FE) specification was implied. We continued by performing panel unit root tests considering cross-sectional dependence.

Table (9): cross-sectional dependence test

Variable	Breuch-Pagan LM	Pesaran scaled LM	Bias-correlated scaled LM	Peraran CD
LTR	2099.45*** (0.000)	31.59*** (0.0000)	30.13*** (0.000)	1.22 (0.22)
LIDI	8665.35*** (0.000)	193.73*** (0.000)	192.38*** (0.000)	82.13*** (0.000)
LGDP	7358.43*** (0.000)	161.46*** (0.000)	159.99*** (0.000)	64.23*** (0.000)
LPR	8328.73*** (0.000)	211.48*** (0.000)	177.11*** (0.000)	73.54*** (0.000)
LED	10368.64*** (0.000)	235.64*** (0.000)	234.67*** (0.000)	87.94*** (0.000)
Note: The p-values are in parentheses and reject the independence null hypothesis. **** Shows significance at the 1% level of significance				

3.1. 2 Panel unit root tests

We only utilized the panel unit root tests that allowed us to handle the issue of cross-sectional dependence in our panel dataset. We employed two unconventional unit root tests, specifically, the LLC statistic of Levin et al. (2002) and the CADF statistic of Pesaran (2007). The LLC test was used to assess the null hypothesis that each cross-section in the panel had a unit root as opposed to the alternative hypothesis that all cross-sections were stationary. The test yielded effective results for reasonably sized panels and was sufficiently generalized to allow for "fixed effects, individual deterministic trends and heterogeneous serially correlated errors" (Baltagi, 2009). In the presence of cross-sectional dependence, the cross-sectional dependence problem was controlled by subtracting the cross-sectional averages from the data, Levin et al. (2002). Pesaran (2007) proposed the use of the cross-sectional augmented Dickey-Fuller (CADF) test statistic in heterogeneous panels with cross-sectional dependence. The standard

ADF regressions are enhanced in the CADF test with the cross-sectional averages and their first differences to overcome the influence of cross-sectional dependence. The null hypothesis assumes that all of the series are non-stationary against the alternative hypothesis that only a fraction of the series is stationary.

3-1.3 Panel cointegration test

The extension of time-series cointegration to panel data, in a similar way to the use of the panel unit root tests, is also a recent introduction. The panel cointegration tests suggested up until now may be categorized into two sets: the first set was created based upon the null hypothesis of the presence of cointegration (McCoskey and Kao, 1998; Westerlund, 2007), while the second set presumed no cointegration at the null hypothesis (Pedroni, 1999; Kao, 1999; Larsson et al., 2001, Groen and Kleibergen, 2003). In this analysis, we employed the Pedroni (1999) panel cointegration method. Seven dissimilar statistics were suggested by Pedroni (1999, 2004) to test for the cointegration relationship in a heterogeneous panel. The bias that is created by potentially endogenous regressors were corrected for in these tests. Pedroni's seven test statistics were grouped into the "between dimension" and the "within dimension" statistics. The between dimension statistics belong to the group mean panel cointegration statistics, while the within dimension statistics belong to the panel cointegration statistics. The test statistics for cointegration were constructed as an extension of the two-step residual-based strategy of Engle and Granger (1987).

3.1.4 Panel cointegration estimates

When the presence of a panel unit root was identified, the question was asked, if a long-run equilibrium relationship existed between the analyzed variables and between two or more variables (Ahmed et al. 2017) Each of the methods, fixed effects, random effects and GMM may lead to misleading and unreliable coefficients once applied against the cointegrated panel data (Shahbaz et al. 2017). Due to this scenario, we estimated the long-run models using the Fully Modified Ordinary Least Squares (FMOLS) estimator. Pedroni (2000) developed the FMOLS method to take into account heterogeneous cointegrated panel data. The estimator combines both the

problems of simultaneity bias and non-stationary regressors. Pedroni further developed the methodology of Phillips and Hansen (1990) and overcame the second-order bias generated by the endogeneity of the regressors which established a semi-parametric correction to the OLS estimator. The FMOLS estimator corrects the dependent variable by utilizing the long-run covariance matrices, this has the intention of eliminating the nuisance parameters, the estimator then uses a simple Ordinary Least Squares (OLS) method to estimate the variables corrected for endogeneity.

3. Results and their discussion

It was essential to understand the integrating features of the data before commencing the econometric modeling. As mentioned earlier, for this reason, the CADF and LLC panel unit root tests were used for each of the series. These test results are reported in Table 10 and the results of CADF and LLC tests at the level for all variables are not consistent. However, at the first difference, both analysis suggests that all the variables are I(1). These results implied that intra-trade, ICT development, per capita income, political right measurement together with education attainment have a unique order of integration for each panel. There was no indication that any of the variables were I(2), however, at the same time, I(1) integration could not be ruled out for any of the variables.

Table (10): Panel root test

Variables	Level			First-difference		
	None	Intercept	Intercept and trend	None	Intercept	Intercept and trend
LLC test						
LTR	-0.68 (0.28)	-1.14 (0.99)	-1.06 (0.99)	-24.78 (0.000)	-19.56 (0.000)	-2.75 (0.000)
LIDI	-7.06*** (0.000)	-3.81*** (0.000)	-3.57*** (0.000)	-40.42*** (0.000)	-36.93*** (0.000)	-41.22*** (0.000)
LGDP	14.97 (1.000)	-5.60*** (0.000)	-1.47 (0.10)	-9.77*** (0.000)	-17.24*** (0.000)	-20.08*** (0.000)
LPR	0.30) (0.61	-4.30*** (0.0000)	-5.68*** (0.000)	-15.99*** (0.000)	-11.25*** (0.000)	-18.61*** (0.000)

LED	14.60*** (0.000)	-19.35*** (0.000)	-8.41*** (0.000)	-8.60*** (0.000)	-21.27*** (0.000)	-26.11*** (0.000)
CADF-Fisher Chi-square test						
LTR	59.78 (0.97)	110.55 (0.99)	106.37 (0.99)	618.64*** (0.000)	404.71*** (0.000)	324.54*** (0.000)
LIDI	162.58*** (0.000)	166.92*** (0.000)	165.86*** (0.000)	821.64*** (0.000)	664.97*** (0.000)	570.18*** (0.000)
LGDP	12.26 (1.000)	115.02*** (0.000)	100.63*** (0.11)	249.64*** (0.000)	272.94*** (0.000)	241.87*** (0.000)
LPR	52.88 (1.000)	68.19*** (0.000)	70.90*** (0.000)	284.64*** (0.000)	177.59*** (0.000)	233.39*** (0.000)
LED	10.25 (1.000)	261.30*** (0.000)	125.64*** (0.000)	179.54*** (0.000)	228.54*** (0.000)	209.28*** (0.000)
Note: * **denotes significance at the 1% level of significance.						

We applied the panel cointegration technique, due to the unique order of integration of the variables. We, therefore, examined the long-run relationship between the variables in each panel Table 11 reports the results of the Pedroni (1999, 2004) panel cointegration tests. The Pedroni tests used three between dimension (group) test statistics and four within dimension (panel) test statistics to examine whether the designated panel data were cointegrated. The "within dimension" statistics contained the estimated values of the test statistics based on the estimators that pooled the autoregressive coefficients across the different cross-sections for the unit root test on the estimated residuals. The "within dimension" tests and the "between dimension" tests advocated that there was sufficient evidence to reject the null hypothesis of no cointegration in each panel. We thus concluded that the variables TR, IDI, GDP, PR and ED TEC would move together in the long run. This result can perhaps be described by the essential channels by which ICT development can influence the intra-trade, including improving trade transactions, enhancing coordination between different actors and enriching information and knowledge about trade processes and markets.

Table (11): Pedroni Residual Cointegration Test

Alternative hypothesis: common AR coefs. (within-dimension		
	Statistic	Weighted Statistic
Panel v-Statistic	-0.832182	-4.267025
Panel rho-Statistic	3.951849***	4.564348***
Panel PP-Statistic	-8.358456***	-11.22540***
Panel ADF-Statistic	-6.470955***	-8.444670***
Alternative hypothesis: individual AR coefs. (between-dimension)		
	Statistic	
Group rho-Statistic	6.556540***	
Group PP-Statistic	-21.12858***	
Group ADF-Statistic	-7.725807***	
Note: *** indicates rejection of the null hypothesis of no cointegration at 1%.		

The long-run elasticity estimates from the FMOLS model are reported in Table 12. Before discussing the results, we checked for the potential multicollinearity problem between regressors in the model. Table 13 shows the results of the Variance Inflation Factors (VIF) test that was performed in each specification. The findings did not show such a problem in our analysis(1). Since our model was safe, we moved forward and looked for the FMOLS model result as reported in Table 12. For the variable of interest, ICT development, the results showed that in the long run ICT development contributed positively and significantly to intra-trade in the region.

(1) We employed the Coefficient Variance Decomposition (CVD) test to help diagnose potential collinearity problems amongst the regressors, again the results, which are not reported here but are available upon request, show the absence of any collinearity problem in our analysis.

Nonetheless, the magnitude of this effect is small. As mentioned earlier, ICTs are crucial to trade facilitation for three main reasons: First, they improve the efficiency with which trade transactions are handled, enhancing transparency and accountability, reducing the cost of human interfaces, eliminating delays and reducing the scope for corrupt interactions between traders and officials. Second, they improve coordination between different actors in the trade management process, particularly between government agencies within individual countries, and across national borders. Third, they enhance the information and knowledge about trade processes and markets that are available to businesses, enabling them to manage consignments more efficiently and to enter new markets at lower risk (Yonazi et al 2012.). In the context of Africa, the finding of this study is consistent with the result of Bankole et al (2015) that discussed earlier, although our finding reflects the long-run impact. Likewise, the outcome of this study is similar to several empirical studies addressed same issue (Limao and Venables, 2001; Freund and Weinhold, 2002, Fink et al.,2002; Freund and Weinhold, 2004; Fink et al., 2005; Clarke and Wallsten, 2006; Francois and Machim, 2007; Vemuri and Siddiqi, 2009; Demirkan et al., 2009; Choi, 2010; Mattes et al., 2012). Thus, ICTs can alleviate some of the constraints undermining Africa's trade performance, opening new opportunities for trade to generate employment, investment and growth. Countries with very low intra-trade with African countries such as Libya, Algeria, Sudan, Cabo Verde and Egypt must improve their ICT sector to achieve the goal of integration.

Table (12): FMOLS technique: Dependent variable LTR

Explanatory variables	Coefficients	Std-Error	Prob
LIDI	0.006***	5.15E-05	0.000
LGDP	0.06***	0.008	0.000
LPR	-0.08***	0.02	0.000
LEA	0.12***	0.008	0.000
Note: * **denotes significance at the 1% level of significance.			

The results of the empirical study are shown in Table 6. They revealed that the real per capita GDP had positive effects on the intra-trade in the region. This finding supports the argument on the importance of trade intensity in explaining intra-trade. The results also show that in the long run human capital as measured by eduction attainment ply key role in promoting intra-African trade. These findings support the argument on the considerable role of human capital in economic development for developing countries. Additionally, the results identify, empirically, one channel through which the call for Africa's economic regionalism can be achieved. Many studies have concluded that growth in human capital is one of the crucial prerequisites to attain sustainable economic development in the African continent (Heyneman 1999; Oketch 2000, 2002; Elu 2000; McMahon 1999). Recently, Oketch (2006) had identified human capital as one of the critical factors in improving the African region's economic productivity. Similarly, the results show that in the long run improvement in the political right plays a vital role in promoting intra-African trade. t. It is well known that one of the key factors behind the backwardness of Africa is attributed to the spread of internal conflict. The results show that an increase in the civil conflict by 1% in the reporter country will reduce its bilateral trade by 3.1%. This finding is consistent with Longo and Sekkat (2004) study in which internal conflict, another face of political instability, constitutes a significant obstacle in the expansion of intra-African trade.

Table (13): Variance Inflation Factors, Dependent Variable LTR

Variable	Coefficient Variance	Uncentered VIF
LIDI	0.002104	1.474206
LEA	6.17E-05	1.764937
LGDP	5.79E-05	1.560258
LPR	0.000235	1.157275

4. Conclusion and recommendations

Despite the efforts that have been allocated to facilitate intra-African trade, however, recent evidence suggests that only about 10 -15 percent of Africa's trade is exchanged within the continent, a much lower proportion than in other world regions (African Development Bank,2013). Small domestic markets, landlocked status, limited natural resources and political instability restrict the trade potential of many countries (Yonazi et al 2012). One of the vital factors that have been identified as crucial sources of Africa's trade problem is trade costs that making African exports less competitive both on the continent and globally. By contrast, digital technology has been recognized as the key facilitators for trade. The present study investigated and tested the effects of ICT development on intra-African trade using a panel dataset for 41 African countries. The study covered the period from 2002–2016, this was the most recent data available to the authors when the study was embarked upon. To the best of the authors' knowledge, this is the first empirical study in the Africa continent that investigates the impact of ICT development on the Intra -African trade using a comprehensive measurement that is Information and Communication Technology Development Index. The Pedroni cointegration tests verified a long-run relationship between the mentioned variables. The FMOLS method suggested that despite the ICT development play a marginal impact in explaining intra-African trade in the long run, but this impact is significant at 1%. In other words, the current low level of economic integration in Africa can be explained, even partly, by the lack of sufficient level of the Information and Communications Technology Infrastructure. Thus, the results implied that one of the key channels through which the goal towards the Continental Free Trade Area (CFTA) is through promoting and invest more in the ICT sector. Thus, a prominent level of commitment is required, at national and regional levels, on the part of both governments and trading businesses. Political leaders must be prepared to address the sovereignty challenges and partnership requirements of regional integration. Within this context, governments, RECs and development partners should work with other stakeholders progressively to build ICT-enabled trade facilitation in Africa.

As we expected, the results of this study are substantial and provide significant policy implications for the economies examined in the panels, as well as for regional economic blocks, international trade and ICT organizations. The results are also imperative for future research as it is anticipated that this study may open further research directions. For example, in the present study we employ Information and Communication Technology Development Index. As mentioned previously, this index calculated using three sub-indices related to ICT development which are access, usage and skills. Further detailed studies are required to identify which of these sub-indices need more effort to be upgraded. For instance, if the value of IDI is low because of relative reduction in access sub-index, initiatives and policies should concentrate on how to increase the access aspect of ICT services. Likewise, furthers studies may consider the same issue but using different formwork like gravity approach that believes distance into account. Similarly, the same issue can be addressed within a comparative framework, for instance, the experience of Africa with ICT compared to other region or regions.

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Appendixes

Table 1A: Abbreviations and Definition

Abbreviations	Definition
ECOWAS	Economic Community of West African States
SADC	Southern African Development Community
EAC	East African Community
UMA	Arab Maghreb Union
ECCAS	Economic Community of Central African States
ECOWAS	Economic Community of West African States
IGAD	Intergovernmental Authority on Development
OECD	The Organisation for Economic Co-operation and Development

Table 2A: countries included in this study

Algeria	Gabon	Niger
Angola	The Gambia	Nigeria
Benin	Ghana	Rwanda
Burkina Faso	Guinea-Bissau	Senegal
Cabo Verd	Kenya	Seychelles
Cameroon	Liberia	South Africa
Cen-Afric, Republic	Libya	Sudan
Chad	Madagascar	Tanzania
Comoros	Malawi	Togo
Congo, Dem. Rep	Mali	Tunisia
Congo, Rep	Mauritania	Uganda
Djibouti	Mauritius	Zambia
Egypt	Morocco	Zimbabwe
Ethiopia	Mozambique	

أهمية التقنية الرقمية فى تحقيق التكامل الاقتصادي بين الدول الأفريقية

عاطف عوض[1]

ملخص البحث:

تهدف هذه الدراسة إلى التعرف على تاثير البنيات التحتية المتمثلة فى نظم المعلومات التقنية فى تطوير التبادل التجاري بين 41 دولة فى أفريقيا خلال الفترة 2002-2016 . هذه أول دراسة من نوعها فى إطار التكامل الأفريقي تأخذ فى الاعتبار أهمية التكنولوجية الرقمية . اعتمدت الدراسة على طريقة المربعات الصغري المعدلة للتعرف على أهمية التقنية الرقمية فى تعزيز التكامل الاقتصادي، وخلصت الدراسة إلى أن التقنية الرقمية كانت لها تاثير هامشي على مستوي التكامل الاقتصادي بين تلك الدول . بالتالى لتسريع التكامل الاقتصادي فى افريقيا على واضعي السياسات فى تلك الدول تخصيص المزيد من الموارد للبنيات التحتية الرقمية .

الكلمات الدالة: التكامل الاقتصادي فى أفريقيا، التكنولوجية الرقمية.

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