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Donors' Supply of Aid for Information and Communication Technologies: Do Recipient-Countries' Level of Access to the Internet Matter?

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In light of the importance of Internet access for developing countries in today's world, this article investigates whether donors' aid supply for the development of the Information and Communication technologies (ICT) sector in developing countries depends on the latter's level of access to the Internet. The analysis is conducted using a set of 88 countries, over the period 2004-2016. Empirical results show that donors allocate higher aid for ICT to countries with a higher Internet usage and higher fixed broadband subscriptions. Specifically, least developed countries benefit much more from aid for ICT than other countries when they make an effort to increase either the access of their population to the Internet or fixed broadband.
Keywords: Internet usage, Broadband subscriptions, Development aid for the ICT sector

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INTRODUCTION

The increasing digitalization of the world economy and incipient fourth industrial revolution presents serious challenges for developing countries, in particular least developed countries (LDCs)[1], that suffer from insufficient access to the Internet. Several studies have underlined the positive impact of access to the Internet, including on international trade of goods and services (e.g., Freund and Weinhold, 2002; 2004; Clarke and Wallsten, 2006; Choi, 2010; Lin, 2015, and Gnangnon and Iyer, 2017). Others have looked at the effect of Internet access on other macroeconomic indicators such as inflation (e.g., Yi and Choi, 2005), economic growth (e.g., Choi and Yi, 2009), economic development (e.g., Evans, 2019a), well-being (Evans, 2019b), public revenue (e.g., Gnangnon and Brun, 2018), corruption (e.g., Lio et al., 2011), and poverty reduction (e.g., Galperin and Viecens, 2017). In addition, studies such as Kamel (2005), Qureshi (2009), Samoilenko and Osei-Bryson (2018) and de la Hoz-Rosales et al. (2019) have discussed the social and economic perspectives on the role of information and communication technology (ICT) for development.

The 2016 World Development Report (World Bank, 2016) has also provided an extensive discussion on the importance of ICT for economic growth, poverty reduction and development. This report has particularly focused on global cooperation to ensure digital dividends around the world, including by highlighting the role that development aid could play to help achieve this objective. The importance that the international community ac-

[1]Least developed countries (LDCs) are designated as such by the United Nations as the poorest and most vulnerable countries in the world. See online at http://unohrlls.org/about-ldcs/.

cords to development of information and communication technologies (ICT) in developing countries (including LDCs), is reflected in the amount of the development aid that donors, notably developed countries allocate to the ICT sector in developing countries. Development aid allocated to this sector is part of the so-called "Aid for Trade", which is itself a category of development aid (for the trade sector in developing countries) agreed to by the Members of the World Trade Organization (WTO) in 2005.

Indeed, in view of the low level of developing countries' integration into the global trading system, WTO Members launched the Aid for Trade (AfT) Initiative at the 2005 WTO Ministerial Conference in Hong Kong, China. This initiative aims to "help developing countries, particularly LDCs, to build the supply-side capacity and trade-related infrastructure that they need to assist them to implement and benefit from WTO Agreements and more broadly to expand their trade" (see Paragraph 57 of the Hong Kong Ministerial Declaration, 2005 - WTO, 2005).

The Organization for Economic Cooperation and Development (OECD) has distinguished three main categories of AfT, namely AfT for Economic Infrastructure, AfT for productive capacity building and AfT for trade policies and regulations. Aid for ICT is a component of AfT for Economic Infrastructure. In 2006, the Director-General of the WTO set up a Task Force to provide recommendations on how to "operationalize" the Aid for Trade Initiative. Among the Task Force's recommendations[2] was that a monitoring body be established in the WTO, with a view to undertaking a periodic global review based on reports from stakeholders. This monitoring and evaluation exercise was expected to build confidence in both donors and recipients that increased Aid for Trade will be delivered and used effectively. The implementation of this recommendation has, *inter alia*, translated into the organization of Global Reviews on Aid for Trade, which take place every two years. So far six Global Reviews on Aid for Trade have been organized since the first edition in 2007. Interestingly, the theme of the Global Review on Aid for Trade that was held in 2017 was "Promoting trade, inclusiveness and connectivity for sustainable development", dealing directly with the issue of digital connectivity.

Among other findings, the joint report by the OECD and WTO (OECD/WTO, 2017) showed that e-commerce or digital issues are part of the dialogue between developing countries (aid recipient-countries) and their partner-countries and regional partners. The report has also highlighted that ICT should be a donor's first area of priority[3] when supporting digital connectivity in developing countries. In a very recent study, Gnangnon (2018) has shown that Aid for Trade allocated to the ICT sector (henceforth AfT for ICT) helps reduce the digital divide that developing countries experience. The question that therefore arises is whether countries that benefit from AfT for ICT are those that endeavour to improve access to the Internet for their population or whether it is the other way around. To the best of our knowledge, no previous study relating to ICT, including among those highlighted above, has addressed this question. The present work complements the literature on ICT development, and aims to provide scholars and policymakers with an empirical analysis on the relationship between donor-countries' behaviour in terms of aid supply in favour of the ICT sector in developing countries and the latter's level of the access to the Internet.

The theoretical hypotheses are as follows. According to the report of the 2017 Global Review on Aid for Trade (see OECD/WTO 2017: page 307), AfT support for ICT is actually mostly provided in the form of technical assistance for institutional and human capacity building in the area of ICT regulations and, the investments in physical ICT infrastructure are mostly undertaken by the private sector, once the regulatory framework is in place and operating effectively. Thus, AfT for ICT can be expected to help develop the regulatory ICT framework that could, in turn, incentivize the private sector to increase investments in physical ICT, notably in access to the Internet. Against this background, we argue that it is likely that countries would receive higher AfT for ICT when they increase their level of access to the Internet (*Hypothesis 1*). If we measure the access to the Internet by the number of individuals that have access to the Internet in a country, or by the fixed broadband subscriptions,

[2]The recommendations of the Task Force are contained in the WTO document WT/AFT/1.

[3]The other priority areas included, inter alia, E-government, E-commerce development, Broadband development and Telecommunications strategy.

we should expect that a rise in both indicators would be associated with higher AfT for ICT. Notwithstanding this, one could postulate that donors may supply higher amounts of AfT for ICT to countries that have low levels of access to the Internet. In this context, higher access to the Internet or a rise in fixed broadband subscriptions would be associated with lower AfT for ICT (*Hypothesis 2*).

The study tests empirically which hypothesis among these two holds, by employing the two-step system Generalized Methods of Moments (GMM) approach. The empirical analysis is performed on an unbalanced sample of 88 countries over the period 2004-2016. Results suggest that both Internet usage and fixed broadband subscriptions influence positively AfT for ICT, which confirms the expectation in hypothesis 1. In addition, these positive impacts appear to be higher in LDCs than in non-LDCs.

The rest of the article is structured in four sections. Section 2 lays down the model specification to investigate the issue. Section 3 performs some data analysis. Section 4 discusses the econometric approach to conduct the empirical exercise. Section 5 interprets the empirical outcomes, and Section 6 concludes.

MODEL SPECIFICATION

To examine empirically whether the level of the Internet access in recipient-countries matters for the amount of AfT for ICT that accrues to these countries, we rely on the relatively limited literature on the macroeconomic determinants of AfT inflows (e.g., Gamberoni and Newfarmer, 2009; Tadasse and Fayissa, 2009; Gamberoni and Newfarmer, 2014; Lee et al., 2015; Gnangnon, 2016a; 2016b; 2017). The reliance on this literature to perform the empirical exercise is dictated by the fact that as noted above, AfT for ICT is part of total AfT flows. Therefore, we postulate the following model:

$$Log(AfTICT)_{it} = +\beta_0 + \beta_1 Log(AfTICT)_{it-1} + \beta_2 Log(INT)_{it} + \beta_3 Log(AfTNONICT)_{it} + \beta_4 Log(GDPC)_{it} + \beta_5 \mathrm{TP}_{it} + \beta_6 REGQUAL_{it} + \beta_7 Log(POP) + \mu_i + \beta_8 Trend + \omega_{it} \quad (1)$$

Where i represents the index associated with a given recipient country of AfT for ICT; t is the time-period. The unbalanced panel dataset comprises 88 recipient-countries of AfT for ICT over the period 2004-2016. The parameters β_0 to β_8 should be estimated. μ_i are countries' fixed effects. "Trend" represents a trend variable. ω_{it} is the error term. The description and source of all variables contained in model (1) are reported in Appendix 1. Appendices 2, and 3 display respectively the list of countries and descriptive statistics on variables contained in model (1).

The dependent variable "AfTICT" represents the total amount (constant 2015 US dollar prices) of AfT for ICT commitments by donors vis-à-vis a recipient-country i in year t. The use of the one-year lagged value of this variable as a regressor is explained by the fact that many aid projects are implemented over several years. Hence, AfT could show some persistence over time (e.g., Lee et al. 2015; Gnangnon, 2016b; 2017). In addition, the literature has recommended that studies on the determinants of development aid use aid commitments instead of aid disbursements (e.g., Neumayer, 2003b; Berthelemy, 2006; Boussalis and Peiffer, 2011; Stubbs et al., 2016). The reason is that aid commitments reflect more accurately donors' decision-making behaviour, and donors control much more aid commitments, while the disbursements of aid disbursements depends, *inter alia*, on certain characteristics of recipients, including for example their administrative capacity to meet donors' conditions.

Furthermore, AfT for ICT commitment in real terms (constant 2015 prices, US dollars) is preferred over aid in per capita terms (the ratio of the real AfT for ICT to the recipient-countries' population size) (e.g., Feeny and McGillivray, 2008; Nunnemkamp and Öhler, 2011; Stubbs et al., 2016). Nevertheless, even though the variable representing AfT for ICT commitment has not been deflated by the recipient-country's population size in model (1), the variable representing the population size has been considered as an explanatory variable in model (1). In addition, in model (1), we have controlled for the AfT component which is not dedicated to ICT, i.e., the Aid for Trade dedicated to other trade and trade-related sectors of the economy. This variable is denoted "AfTNONICT".

The purpose of introducing this variable in model (1) is to ensure that the effect of the Internet access variable on AfT for ICT does not translate through AfT for Non-ICT sectors. In addition, this helps capture the complementarity or substitutability between AfT for ICT commitments and the commitments of AfT for Non-ICT sectors.

The variable "INT" is the measure of the Internet access. The latter could be either the Internet usage, i.e., the share of the number of individuals using the Internet to the population size - variable denoted "INTERNET" - or the fixed broadband subscriptions per 100 people, denoted "BROADBAND". Statistics reported in Appendix 3 show that the values of the variable "INTERNET" are strictly higher than 0, whereas the values of the "BROADBAND" variable range between 0 and 33.3. It therefore appears that while the variable "INTERNET" could enter into natural logarithm (Logs) in model (1), this could not be the case for the variable "BROADBAND". Therefore, we consider the latter without 'Logs' in model (1). It is also worth noting that the 'Logs' has not been applied to the variables "TP" and "REGQUAL" (which we describe below) because the former variable contains "0" values, whereas the latter variable have negative values.

"GDPC" is the real per capita income of an AfT for ICT recipient-country. Its represents the development level of a recipient-country. As among these countries, more advanced economies are likely in less need of AfT for ICT than less advanced economies, we expect that less advanced countries (including poor countries) would benefit from higher AfT for ICT compared to relatively more advanced countries. In this context, we hypothesize that a higher real per capita income would induce a decline in the amounts of AfT for ICT. In contrast with some other studies (e.g., Gounder and Doessel, 1994; Lee et al., 2015), we have not included the square[4] term of "GDPC" in the model (1), because the coefficient of this variable is not statistically significant at the 10% level.

"TP" is the measure of trade policy implemented by a given recipient country. Trade policy liberalization in recipient-countries could lead to higher AfT for ICT inflows to these countries, as the latter may be in the greatest need for AfT for ICT to develop their ICT sector, which can, in turn, help recipient-countries better integrate into the global trading system (see for example Lee et al., 2015 on the impact of trade openness on AfT). Similarly, recipient-countries that make an effort to undertake domestic trade reforms could receive higher amounts of total AfT, including AfT for ICT from donors, as the latter might be willing to assist such countries in addressing structural impediments to their integration into the multilateral trading system. In this case, trade policy liberalization would generate higher AfT for ICT inflows. However, one could still argue that donors would supply higher AfT, including AfT for ICT to developing countries that experience lower levels of trade policy liberalization, in order to help them further liberalize their trade regimes. This is because the liberalization of trade regimes—including through lower trade barriers on ICT products—could facilitate the transfer of technology, and increase foreign investment in the developing countries' ICT sectors. In this case, lower levels of trade policy liberalization in developing countries would be associated with higher AfT for ICT inflows.

"REGQUAL" is the index of regulatory quality in an AfT-recipient country. According to Kaufman et al. (2010), this index reflects perceptions of the ability of a government to formulate and implement sound policies and regulations that permit and promote private sector development. The role of the institutional and governance quality for AfT allocation has been underlined in studies[5] such as Lee et al. (2015) and Gnangnon (2016a; 2016b; 2017). Donors could be willing to provide higher amounts of AfT for ICT to recipient-countries that have good regulatory quality policies, with a view to encouraging them to develop their ICT system, and to take full advantage of the latter. In this context, we hypothesize that good quality regulatory policies would be positively associated with AfT for ICT flows to recipient-countries. Similarly, countries with low quality regulatory policies could benefit from higher amounts of AfT for ICT on the ground that such aid would help them develop their ICT

[4]Authors such as Gounder and Doessel (1994) and Lee et al. (2015) have introduced the square term of the real per capita income variable in their analysis of the determinants of development aid in order to take into account the middle-income bias or the tendency of foreign aid to rise as the per capita income of a recipient-country rises, and falls as the recipient-country's per capita income reaches a relatively high level.
[5]Some studies (e.g., Alesina and Weder, 2002; Bandyopadhyay and Wall, 2007; In'airat, 2014) have underlined how institutional quality affects the amount of development aid that accrues to recipient-countries.

system. It is noteworthy that the values of the variable "REGQUAL" range from –2.5 to 2.5, with lower values reflecting "worse" regulatory quality, and higher values indicating "better" regulatory quality.

"POP" represents the size of the population in AfT-recipient-country. Many studies (e.g., Trumbull and Wall, 1994; Wall, 1995; Alesina and Dollar, 2000; Bandyopadhyay and Wall, 2007; Gnangnon, 2016a, 2016b) have underlined the importance of this variable for donors' aid allocation. The literature has shown that countries with a relatively small population usually lack the administrative expertise to absorb large amounts of aid. Additionally, donors find it relatively easier to exert an influence over smaller countries (see Younas, 2008). Against this background, we argue that the size of population in the recipient-country could be positively related to AfT for ICT.

DATA ANALYSIS

We provide here some insights into the evolution (over the period under study—2004-2016) of the share (%) of AfT allocated to the ICT sector in total AfT, denoted "SHAfTICT1" and the share of AfT for ICT in the AfT allocated for Communication[6], denoted "SHAfTICT2", over the full sample (see Figure 1). We also present in Figure 2 the evolution of AfT for ICT (over the period 2004-2016), the Internet usage, and the fixed broadband subscriptions (per 100 people) over the full sample.

Figure 1 shows that both "SHAfTICT1" and "SHAfTICT2" have fluctuated over the considered period. In particular, the share of AfT for ICT in total AfT moved from 0.9% in 2004 to 0.7% in 2016. At the same time, the share of AfT for ICT in the overall AfT allocated to Communication has also fluctuated over the period, but lesser than "SHAfTICT1", from 29.8% in 2004 to 42.6% in 2016. This evolution hides a rising trend of "SHAfTICT2" from 26.8% in 2005 to 54% in 2009, and up-and down movements from 2010 to 2016.

Figure 2 suggests that both the Internet usage and the fixed broadband subscriptions (per 100 people) in-

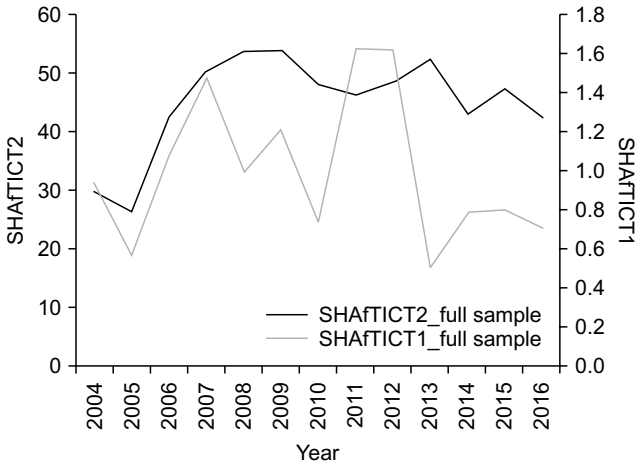

Fig. 1. Evolution of shares of AfTICT over the entire sample. Source: Author. Note: "SHAfTICT1" denotes the share of AfT allocated to ICT sector in total AfT. Note: "SHAfTICT2" denotes the share of AfT allocated to ICT sector in AfT allocated for Communication. AfT for Communication includes aid allocated respectively to "Communications policy and administrative management"; "Telecommunications"; "Radio/television/print media"; and "Information and communication technology (ICT)".

[6]Note that the total AfT allocated to Communication includes development allocated respectively to "Communications policy and administrative management"; "Telecommunications"; "Radio/television/print media"; and "Information and communication technology (ICT)" (see OECD/WTO, 2017).

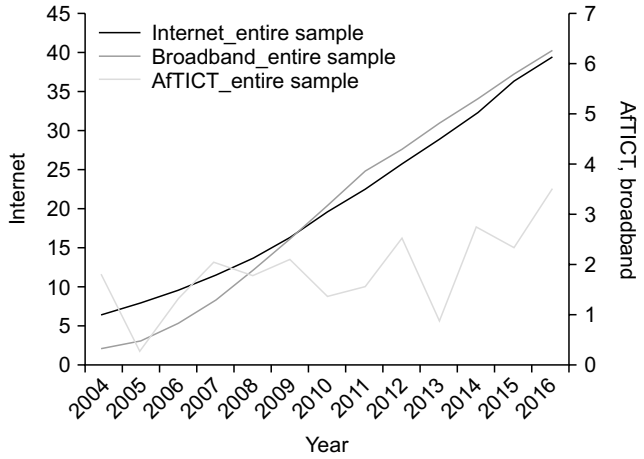

Fig. 2. Evolution of Internet usage and fixed broadband subscriptions per 100 people over the entire sample. Source: Authors. Note: AfT is expressed in millions, constant 2015 prices US dollars.

creased over time. The Internet usage rose from 6.6% in 2004 to 39.4% in 2016, and the fixed broadband subscriptions (per 100 people) increased from 0.34% in 2004 to 6.25%. In the meantime, AfT for ICT (expressed in millions of constant 2015 US dollars prices) fluctuated over the period, from 1.8% in 2004 to 3.5% in 2016.

ECONOMETRIC APPROACH

The dynamic nature of model (1) in a context of a panel dataset with a limited time period (T = 13) and relatively large cross-section (N = 88) requires the use an appropriate estimator to deal with the potential endogeneity concerns. The first endogeneity issue arises from the fact that the dependent variable is a regressor in model (1), and could lead to biased estimates, a phenomenon also referred to as the Nickell bias (see Nickell, 1981). The second endogeneity concern relates to the possible bi-directional causality between some regressors and the dependent variable. These regressors include our variables of interest, namely "INT" (i.e., the "INTERNET" and "BROADBAND") variable and the "REGQUAL" variable. To resolve these endogeneity problems, we use the Generalized Methods of Moments (GMM) estimator in the context of dynamic panel data. The GMM approach has two main variants, including the first difference GMM of Arellano and Bond (1991) and the system GMM estimator by Blundell and Bond (1998). The system GMM technique, in turn, encompasses the one-step system GMM and the two-step system GMM estimators. The present analysis uses the two-step system GMM approach. Using the two-step system GMM approach amounts to estimating a system of equations, which contains an equation in levels, and an equation in difference (where all regressors are transformed through differencing). In this system of equations, the difference equation uses lagged levels of the regressors as instruments, while the equation in levels employs lagged differences of the regressors as instruments. The two-step system GMM estimator performs better than the first difference GMM and the first-step system GMM estimators, notably if cross-sectional variability dominates time variability, and when there is strong persistence in the time series under investigation (Blundell and Bond, 1998). In the current analysis, we handle the endogeneity of the variables highlighted above by utilizing two lags as instruments for the moment conditions (that use lagged differences of the explanatory variables as instruments in the model) derived from model (1).

Overall, model (1) and its different variants (described below) are estimated using the two-step system GMM approach. We assess the validity of this estimator by means of several diagnostic tests. These include the Arellano–Bond (AB) test of first-order serial correlation in the error term (denoted AR(1)), and no second-order (denoted AR(2)) in the error term. We additionally report the outcome of the test of the third-order autocorrela-

tion in the error term (denoted AR(3)), as the rejection of the hypothesis of absence of the third-order autocorrelation in the error term (if the p-value associated with AR(3) test is lower than 0.10, i.e., the 10% level of statistical significance) could signal a problem of omitted variables in the model. The last diagnostic test is the Sargan test of over-identifying restrictions, which determines whether the instruments employed in the estimations are valid. Incidentally, as noted by Roodman (2009), the GMM estimator may lose power if the number of countries is higher than the number of instruments. As a result, we also report the number of instruments used in the regressions.

Against this background, the empirical estimations proceed as follows. First, we estimate model (1) as it stands. The results are reported in Table 1: columns [1] and [2] of this table present the outcome of the estimation of model (1) where the "INT" variable is represented either by the "INTERNET" and "BROADBAND" variables. Second, we further investigate whether there is a differentiated impact of the impact of the "INT" variable on AfT for ICT in LDCs versus non-LDCs. To perform this analysis, we estimate two variants of model (1) (including with respectively the "INTERNET" and "BROADBAND" variables) in which we introduce a dummy variable, denoted "LDC", along with its interaction with the "INT" variable. The dummy variable takes the value "0" when a country belongs to the category[7] of LDCs, and "0" otherwise. The estimation of these two variants of model (1) are reported in Table 2: column [1] presents the outcome of the estimation of the variant of model (1) where the variable "INT" is measured by "INTERNET", and column [2] displays the outcome of the estimation of the variant of the model where the variable "INT" is measured by "BROADBAND".

Table 1. Impact of Internet Usage and Fixed Broadband Subscriptions on AfT for ICT *Estimator*: Two-Step System GMM

Variables	Log(AfTICT)	Log(AfTICT)
	(1)	(2)
$Log(AfTICT)_{t-1}$	0.156*** (0.0303)	0.104*** (0.0311)
$Log(AfTICT)_{t-2}$	0.253*** (0.0318)	0.179*** (0.0293)
INTERNET	0.0141** (0.00577)	
BROADBAND		0.0934*** (0.0223)
Log(AfTNONICT)	0.154*** (0.0509)	0.282*** (0.0392)
Log(GDPC)	–0.591*** (0.0977)	–0.499*** (0.108)
TP	–0.00977 (0.00948)	–0.0206*** (0.00740)
REGQUAL	1.472*** (0.245)	0.177 (0.221)
Log(POP)	0.0203 (0.0793)	0.00759 (0.0890)
Trend	–0.110*** (0.0229)	–0.143*** (0.0235)
Constant	231.6*** (45.71)	297.3*** (47.03)
Observations - Countries	579 - 88	567 - 87
Number of Instruments	69	69
AR1 (p-Value)	0.0001	0.0000
AR2 (p-Value)	0.2972	0.6569
AR3 (p-Value)	0.4060	0.8120
Sargan (p-Value)	0.5353	0.5069

Note: *p-value < 0.1; **p-value < 0.05; ***p-value < 0.01. Robust Standard Errors are in parenthesis. In the two-step system GMM estimations, the variables "INTERNET", "BROADBAND" and "REGQUAL" have been considered as endogenous. Time dummies have been included in the regressions.

[7]Further information on LDCs, including the list of countries included in this group, can be found online at: http://unohrlls.org/about-ldcs/.

Table 2. Differentiated Impact of Internet Usage and Fixed Broadband Subscriptions on AfT for ICT: LDCs versus non-LDCs *Estimator*: Two-Step System GMM

Variables	Log(AfTICT)	Log(AfTICT)
	(1)	(2)
$Log(AfTICT)_{t-1}$	0.175*** (0.0329)	0.0998*** (0.0333)
$Log(AfTICT)_{t-2}$	0.280*** (0.0376)	0.168*** (0.0339)
INTERNET	0.0248*** (0.00856)	
LDC*INTERNET	0.0745*** (0.0201)	
BROADBAND		0.121*** (0.0237)
LDC*BROADBAND		0.605*** (0.0855)
LDC	0.0998 (0.505)	1.023*** (0.357)
Log(AfTNONICT)	0.136** (0.0530)	0.293*** (0.0372)
Log(GDPC)	–0.633*** (0.127)	–0.244* (0.132)
TP	–0.0134 (0.00959)	–0.0215*** (0.00680)
REGQUAL	1.407*** (0.263)	0.175 (0.227)
Log(POP)	–0.00154 (0.110)	0.0638 (0.0941)
Trend	–0.186*** (0.0315)	–0.175*** (0.0247)
Constant	384.0*** (62.00)	356.5*** (49.34)
Observations - Countries	579 - 88	567 - 87
Number of Instruments	70	70
AR1 (p-Value)	0.0000	0.0000
AR2 (p-Value)	0.2413	0.7358
AR3 (p-Value)	0.3597	0.7593
Sargan (p-Value)	0.5201	0.5199

Note: *p-value < 0.1; **p-value < 0.05; ***p-value < 0.01. Robust Standard Errors are in parenthesis. In the two-step system GMM estimations, the variables "INTERNET", "BROADBAND" and "REGQUAL" have been considered as endogenous. Time dummies have been included in the regressions.

EMPIRICAL OUTCOMES

Before interpreting the estimates presented in Tables 1 and 2, it is important to examine the results of the diagnostic tests that allow checking the validity of the two-step system GMM estimator. It should be noted that we estimate model (1) with the one-year and two-year lags of the dependent variable as a regressors because the use of only the one-year lag of the dependent variable does not help meet the requirements for the validity of the two-step system GMM approach (see for example Lee et al. 2015; and Lee and Lim, 2015 who have proceeded in a similar way in their respective analyses). Results associated with both the one-year and the two-year lags of the dependent variable confirm previous findings (see studies highlighted in section 2) that there is a state dependence in AfT for ICT amounts allocated to recipient-countries. The results of the diagnostic tests that help check the validity of the two-step system GMM approach are reported at the bottom of the table. We observe across all columns of these two tables that the p-values associated with the AR (1) autocorrelation tests amount to zero, while the p-values relating to AR (2) and AR (3) autocorrelation tests are all higher than 10%. Incidentally, the p-values associated with the Sargan test are always higher than 10%, and the number of instruments used in the regressions is always lower than the number of countries. Overall, these results confirm the consistency of the two-step system GMM estimator for undertaking the empirical analysis.

Estimates presented in column [1] of Table 1 suggest that a rise in the Internet usage in recipient-countries influences positively and significantly (at the 5% level) the amount of AfT for ICT that accrues to these countries. In particular, a 1 percentage point increase in the Internet usage leads to 1.4 percentage increase in the amount

of AfT for ICT. At the same time, results in column [2] show that the rise in the fixed broadband subscriptions (per 100 people) exerts a positive and significant impact (at the 1% level) on AfT for ICT. A 1 percentage point increase in the fixed broadband subscriptions (per 100 people) induces a 9.3 percentage rise in AfT for ICT. Across the two columns, we observe that AfT for the non-ICT sectors exerts a positive and significant (at the 1% level) effect on AfT for ICT sector, i.e., these two types of AfT are complementary. Additionally, and as expected, we note that real per capita income is negatively and significantly associated with AfT for ICT. Trade policy liberalization exerts a negative and significant impact on AfT for ICT in column [2], while in column [1], its effect is non-statistically significant at the 10% level. At the same time, better regulatory quality policies are positively and significantly associated with AfT for ICT in column [1], but exert no statistically significant effect on AfT for ICT in column [2]. The size of the population is not significantly associated with AfT for ICT. Finally, we find a declining trend in real AfT for ICT commitments.

In Table 2, we are particularly interested in assessing whether in LDCs (versus non-LDCs), the Internet usage and the fixed broadband subscriptions exert a differentiated impact on AfT for ICT. Results in column [1] of this table indicate that compared to non-LDCs, LDCs have experienced a higher impact of the Internet usage on AfT for ICT. This is exemplified by the positive and statistically significant coefficient (at the 1% level) associated with the interaction variable "[LDC*INTERNET]". Thus, while for non-LDCs, the net impact of Internet usage on AfT for ICT amounts to 0.025, for LDCs this net impact is given by 0.1 (= 0.0248 + 0.0745). This shows that LDCs experience a higher positive effect of Internet usage on AfT for ICT than do non-LDCs. Specifically, a 1 percentage point rise in Internet usage leads to a 2.5 percentage increase in the real amount of AfT for ICT in non-LDCs, and 10 percentage increase in the real amount of AfT for ICT for LDCs.

Similarly, results reported in column [2] show that LDCs have experienced a higher impact of the fixed broadband subscriptions (per 100 people) on real amount of AfT for ICT than non-LDCs (see the coefficient of the interaction variable "LDC*BROADBAND"). The net impact of Internet usage on AfT for ICT in non-LDCs amounts to 0.12, whereas for LDCs, it amounts to 0.726 (= 0.605 + 0.121). Hence, a 1 percentage point increase in the fixed broadband subscriptions (per 100 people) induces a rise in the value of AfT for ICT by 72.6 percentage in LDCs, and by 12.1 percentage for non-LDCs. Therefore, in terms of Internet usage, these results suggest that the positive effect of the Internet usage on AfT for ICT is stronger in LDCs than in non-LDCs.

Results concerning control variables in columns [1] and [2] of Table 2 are similar to those in Table 1.

CONCLUSION

Various studies in the ICT literature have looked at the economic and social impact of the development of ICT, including in developing countries. However, as many developing countries, including poor countries are highly dependent on development aid for their economic and social development, no study has looked at the extent to which the level of Internet access in developing countries matters for the development aid that these countries receive from donors to promote the Internet access of their population. The current analysis has contributed to filling this gap in the literature by investigating whether donors' supply of development aid to support the ICT sector in developing countries depends on the latter's level of the access to the Internet. The findings of the analysis indicate that developing countries that experience a rise in the Internet usage, or in the number of fixed broadband subscriptions, benefit from a higher AfT for ICT than other developing countries. These results apply particularly to LDCs, which compared to non-LDCs, have experienced a higher positive impact of both the Internet usage and the fixed broadband subscriptions on the amount of ICT-related development aid that they receive from donors.

The results of this study have many implications that could be of interest to both scholars and policymakers. In light of the limited financial resources in developing countries, and LDCs in particular, to address development needs, including reducing the digital gap vis-à-vis developed countries, it would be beneficial for donors to provide higher ICT-related development aid to developing countries that experience low levels of access to the

Internet, rather than increasing aid when countries experience greater access to the Internet. Additionally, according to the OECD/WTO (2017) report associated with the 2017 Global Review on Aid for Trade, donors' financial support to the ICT sector in developing countries tends to be confined to technical assistance for institutional and human capacity building in the area of ICT regulations. The rationale for donors' focus on this area is that such aid would help recipient-countries lay out the regulatory framework that would incentivize the private sector to undertake the requisite physical investments in the ICT sector, including the development of access to the Internet.

In light of the irreversible digitalization of economies around the world, and the impact that ICT—including Internet access—could have on people's livelihoods (e-trade, e-banking etc.), the international community, including both donors (traditional and new), and international investors could examine ways to join efforts in order to mobilize significant additional financial resources for investments in the ICT-related physical infrastructure and the regulatory framework in the developing countries. As the present study has focused on the effect of Internet access on AfT for ICT, a future direction of research could be to deepen the analysis by investigating how ICT tools more generally affect AfT flows for ICT. Such an analysis might be more relevant when data would be available over a longer time-period than the one used in the present analysis.

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Appendix 1. Definitions and sources of variables

Variable	Definition	Source
AfTICT	This is the total official development assistance allocated to Information and Communication Technology (ICT) Commitments, expressed in constant values (US dollars constant prices, 2015).	Authors' calculation based on data of official development assistance for Information and Communication Technology (ICT) Commitments in US dollars 2015 constant prices. The data is extracted from the OECD/DAC-CRS (Organization for Economic Cooperation and Development/Donor Assistance Committee)-Credit Reporting System database.
AfTNONICT	This is the difference between total Aid for Trade commitments and the commitments of development assistance allocated to Information and Communication Technology (ICT). The two aid variables are expressed in constant values (US dollars constant prices, 2015).	Total Aid for Trade is defined by the OECD/DAC-CRS as comprising the following three categories (the CRS Codes are in brackets): Economic Infrastructure: transport and storage (210), communications (220), and energy generation and supply (230); Building Productive Capacity: banking and financial services (240), business and other services (250), agriculture (311), forestry (312), fishing (313), industry (321), mineral resources and mining (322), and tourism (332); and Trade policy and regulations: trade policy and regulations and trade-related adjustment (331). Hence, Official development assistance for Information and Communication Technology (ICT) is one component of Aid for Trade for Economic Infrastructure.
INTERNET	This is the Internet usage measured by the number of individuals using the Internet (% of population)	World Development Indicators (WDI) of the World Bank
BROADBAND	Fixed broadband subscriptions (per 100 people)	WDI
GDPC	GDP per capita (constant 2010 US$)	WDI
TP	Trade Policy of the domestic economy = Trade Freedom Score; This is a component of the Economic Freedom Index. It is composite measure of the absence of tariff and non-tariff barriers that affect imports and exports of goods and services. Its computation is based on two components: trade-weighted average tariff rage and non-tariff barriers (NTBs), the extent of latter having been determined on the basis of quantitative and qualitative available information. NTBs include quantity restrictions, price restrictions, regulatory restrictions, investment restrictions, customs restrictions, and direct government interventions. This score is graded on a scale of 0 to 100, with a rise indicating lower trade barriers, i.e., higher trade liberalization, while a decrease reflects rising trade protectionism.	Heritage Foundation (see Miller et al., 2017)
POP	Total population	WDI
REGQUAL	This is the variable capturing regulatory policies quality. This index reflects perceptions of the ability of the government to formulate and implement sound policies and regulations that permit and promote private sector development. In the World Bank database, the values of this index range from –2.5 to 2.5, with the lower values being associated with 'worse' regulatory policy quality, and the higher values being associated with 'better' regulatory policy quality.	Data on the components of the variable "INST" have been extracted from World Bank Governance Indicators developed by Kaufmann et al. (2010) and recently updated.

Appendix 2. List of countries contained in the entire sample

Entire Sample				LDCs	
Albania	Côte d'Ivoire	Kyrgyzstan	Paraguay	Bangladesh	Uganda
Algeria	Cuba	Lao People's Democratic Republic	Peru	Benin	Zambia
Argentina	Democratic Republic of the Congo	Lebanon	Philippines	Burkina Faso	
Armenia	Dominican Republic	Liberia	Rwanda	Cambodia	
Azerbaijan	Ecuador	Malawi	Samoa	Central African Republic	
Bangladesh	Egypt	Malaysia	Senegal	Democratic Republic of the Congo	
Belarus	El Salvador	Mali	Serbia	Equatorial Guinea	
Benin	Equatorial Guinea	Mauritania	South Africa	Ethiopia	
Bolivia	Ethiopia	Mexico	Sri Lanka	Guinea-Bissau	
Bosnia and Herzegovina	Fiji	Moldova	Tanzania	Haiti	
Botswana	Former Yugoslav Republic of Macedonia	Mongolia	Thailand	Lao People's Democratic Republic	
Brazil	Ghana	Montenegro	Timor-Leste	Liberia	
Burkina Faso	Guatemala	Morocco	Tunisia	Malawi	
Cabo Verde	Guinea-Bissau	Mozambique	Turkey	Mali	
Cambodia	Haiti	Myanmar	Uganda	Mauritania	
Cameroon	Honduras	Namibia	Ukraine	Mozambique	
Central African Republic	India	Nepal	Uruguay	Myanmar	
Chile	Indonesia	Nicaragua	Uzbekistan	Nepal	
China (People's Republic of)	Jamaica	Nigeria	Venezuela	Rwanda	
Colombia	Jordan	Pakistan	Viet Nam	Senegal	
Congo	Kazakhstan	Panama	Zambia	Tanzania	
Costa Rica	Kenya	Papua New Guinea	Zimbabwe	Timor-Leste	

Appendix 3. Descriptive statistics on variables used in the analysis

Variable	Observations	Mean	Standard deviation	Minimum	Maximum
AfTICT	876	1861644	6729688	266	7.70e + 07
AfTNONICT	876	3.73e + 08	5.59e + 08	80878	4.70e + 09
INTERNET	1,134	20.956	19.159	0.024	78.790
BROADBAND	1,045	3.298	5.032	0.000	33.295
GDPC	1,129	3844.045	5454.721	214.045	144246.400
POP	1,144	5.90e + 07	1.93e + 08	33314	1.38e + 09
REGQUAL	1,143	–0.413	0.621	–2.344	1.54
TP	1,109	70.427	11.077	0	89