Does digitalization improve government effectiveness ? Evidence from developing and developed countries

Abdoul-Akim Wandaogo

Does digitalization improve government effectiveness? Evidence from developing and developed countries

Abdoul-Akim Wandaogo[a,b]

[a]Université Clermont-Auvergne, CNRS, IRD, CERDI, F-63000 Clermont-Ferrand, France
[b]Université Thomas Sankara, Ouagadougou, Burkina Faso

e-mail: a-akim.wandaogo@etu.uca.fr / abdoul.wandang@gmail.com

Abstract:

This study aims to analyze the effect of digitalization on government effectiveness in developing and developed countries. It uses a panel methodology with data from 138 countries between 2006 and 2016. The results suggest that a government's use of information and communication technologies (ICT) improves its effectiveness in both developing and developed countries. However, this effect is stronger in developed than in developing countries. Moreover, we find that the effect of aggregate ICT use by individuals, businesses, and government on overall government effectiveness is greater than that of individual use by each individually. The results are robust after several tests (reverse causality, dynamic effect, sensitivity analysis, heterogeneities, and alternative measurements). These results highlight the fact that governments could fully benefit from digitalization by adopting policies that promote access to and use of ICT at all levels of the economy, that is, the government itself, businesses, and individuals.

Keywords: Digitalization, government effectiveness, developed countries, developing countries

JEL Codes : H1, H4, H7, O3, O5

1. Introduction

The economic literature shows that governance is a key factor in economic growth, poverty reduction, and economic development (Khan, 2009; Kaufmann et al., 2009; Kraay & Kaufmann, 2002; Scully, 1988; Barro, 1996; Knack & Keefer, 1995; Mauro, 1995). However, if governance is so important for economic development, then the question of how to foster effective governance arises. In this sense, Montes et al. (2019), Garcia-Sanchez et al. (2013), Adsera et al. (2003), and Al-Marhubi (2004) analyzed the determinants of government effectiveness. These studies reveal a set of factors that are important in explaining the effectiveness of a government. These include natural resources, per capita income, population, and political and social conditions.

However, digitalization is an essential factor of good governance. Effah & Nuhu (2017) and Janssen & Estevez (2013) define digitalization as the transition from a traditional management of procedures, bureaucracy, and paperwork to management via digital platforms. Irani et al. (2008) argued that digitalization represents an advanced level of e-government procedures, which allows governments to improve their effectiveness and efficiency. More broadly, digital transformation or digitalization is the integration and promotion of information and communication technologies (ICT) in daily activities. Thus, many researchers argue that the use of ICT by companies, public administrations, and individuals promotes productivity gains (Brambilla & Tortarolo, 2018; Colombo et al. 2013; Dedrick et al. 2013). For example, for several years many public administrations have been offering services that can be accessed from a telephone or a computer, which allows them to better manage their tasks and improve the quality of their service offer, as well as to improve the well-being of citizens. This trend is part of the digitalization of public administration. It would therefore be meaningless to talk about governance today without mentioning the role of digital transformation.

There are several ways in which digitalization can promote government effectiveness. First, it facilitates internal and external collaboration between different segments of administration (Islam et al., 2016). For example, the transmission and treatment of documents and reports can be performed instantaneously, whereas in a non-digitalized context, it will require a longer transmission time with risks of loss. Second, digitalizing offers a higher storage capacity for documents and archives, allowing more effective facility of action insofar as the storage remains centralized (Fichman et al., 2014). Third, digitalization allows the administration to improve and facilitate its interaction and engagement with individuals and companies while modernizing, thereby promoting transparency, democracy, and freedom of action (Falk et al., 2017).

Furthermore, since the 2000s, ICT has taken an important place in the lives of individuals as well as in the functioning of different economies (Evangelista, 2014; Van Reenen et al., 2010; Davison et al., 2000). This could be due to the diversity of services offered and their usefulness to its users, including individuals, enterprises, and public administrations. Through mobile phones, tablets, the Internet, and social media, the way citizens interact with each other and their administrations, and the way they take part in their country's governance, has changed significantly (Smorgunov, 2019; Bird & Zolt, 2008; Fleming, 2002). Governments are realizing the power and key roles of ICTs, in general, in advancing and transforming the public sector and improving the quality of public service delivery and governance (Cordella & Bonina, 2012; Ndou, 2004; Davison et al., 2000). In this regard, the United Nations (UN) encourages the development of e-government for accountable, effective, efficient, and equitable delivery of public services to all citizens. The UN argues that this enhances public confidence and ensures a transparent, participatory, and collaborative development process.

Digital transformation in the mode of governance is topical in public debates, among researchers and in international institutions such as the UN, the World Bank (WB), and regional institutions. Most of the existing studies on this issue focus on the link between ICTs and corruption or transparency (Bhattacherjee & Shrivastava, 2018; Sturges, 2004). Dobrolyubova et al. (2019) find that there is a positive correlation between government digitalization and the quality of public administration in 19 European and Central Asian countries. Others are more interested in the effect of the Internet on corruption (Kanyam et al, 2017; Elbahnasawy, 2014). Nevertheless, it is important to note that ICT is not limited to the Internet. Chen & Aklikokou (2019) used cluster analysis to assess the relationship between e-government and government effectiveness. Furthermore, some studies have addressed the effect of ICTs on trust between citizens and the government (Guriev et al., 2019; Porumbescu, 2016; Gracia & Arino, 2015; Parent et al., 2005). However, the primary objective of public administration digitalization is not to increase citizens' trust, but rather to increase the supply of public services, to encourage citizen participation in decision-making, and to facilitate access to public management information. It is the achievement of these objectives that will build and increase trust in government. As such, Welch et al. (2005) find that the use of online services increases citizens' satisfaction, which in turn increases their trust in government. Tolbert & Mossberger (2006) explain that the effect of e-government on trust in government is through improved interactions with citizens and perceived responsiveness.

Given the existing literature, the objective of this paper is, with a more exhaustive measure of digitalization, to study the effect of digitalization on government effectiveness using data on 138

developing and developed countries over the period 2006 to 2016. This study contributes to the literature on government effectiveness in several ways. First, it investigates the effect of digitalization on government effectiveness, providing an empirical analysis of the influence of digital transformation on governance, which differs from the approach used by Dobrolyubova et al. (2019).[1] Second, unlike many studies on digitalization, it uses a different measure of digitalization extracted from Global Information Technology Reports (GITR). This index is a comprehensive measure of digital transformation, considering several variables related to ICT access and use. The advantage of using an index that includes many indicators is that it captures all digitalization dimensions and makes the index more exhaustive. In fact, the GITR allows for measures of digitalization according to the use that is made of it. This allows us to capture government usage, which is more appropriate for assessing the effect of ICTs on government effectiveness. In addition, unlike Dobrolyubova et al. (2019),[2] the government ICT usage from GITR takes into consideration aspects such as the importance of ICT to government vision of the future, government prioritization and its success in ICT promotion, which makes this index more relevant. Third, there are heterogeneities according to several factors regarding digitalization and governance.

Using the panel fixed-effects methodology, we find that digitalization improves the effectiveness of government. Moreover, this effect is greater in developed countries. Moreover, the overall use of ICT affects government effectiveness more than individual, business, or government usage separately. These results are robust to alternative measures of digitalization, additional control variables, and endogeneity concerns.

The remainder of this paper proceeds as follows. In Section 2, the data and identification strategies are described. The main results are presented in section 3. Section 4 focuses on further

[1] To analyze the effect of government digitalization on the quality of governance, Dobrolyubova et al. (2019) first performed a correlation test and then a Granger causality test. The limitations of this approach are that, first, correlation does not necessarily explain the existence of an effect or causality. This is confirmed by the causality test carried out by the author, which shows an absence of causality between digitalization and the quality of governance. Correlation measures the strength of the link between the variables. Furthermore, Granger causality does not test for a true cause-and-effect relationship; it tests the order of arrival of one variable relative to another in the time series. Thus, Granger causality does not necessarily imply a causal relationship in the real sense. Finally, although these two methods allow the identification of a possible correlation as well as a causal link, it is impossible to determine the extent of the effect of a factor on another. Therefore, despite having the same objective as our study, this study is limited by the methodologies used.

[2] It should also be noted that Dobrolyubova et al. (2019) also consider the government digitalization, using E-government development, Online Service, and E-participation indexes, along with the proportion of citizens using the Internet to submit completed forms via government websites.

analysis and robustness checks of the results. Finally, in Section 5, we present our conclusions and the policy implications.

2. Data and methodology

2.1. Variables and data description

To assess the effect of digitalization on government effectiveness, this study uses data from 138 countries, including 88 developing (low-income countries, lower-middle-income countries, and upper-middle-income countries) and 50 developed (high-income countries) countries based on the World Bank income group for 2019-2020[3] over 11 years from 2006 to 2016. The dependent variable is government effectiveness according to the Worldwide Governance Indicators (WGI), and the main explanatory variable is the government use of ICT collected from the Global Information Technology Report (GITR).[4] The time period and countries were chosen based on the availability of digitalization and government effectiveness data. Following the existing literature on the determinants of government effectiveness (Duho et al., 2020; Montes & Paschoal, 2016; Garcia-Sanchez & Cuadrado-Ballesteros, 2016, 2013; La Porta, 1999), a set of control variables (GDP per capita, population size, stability, and absence of violence) are applied. The institutional variables used in this study are taken from the International Country Risk Guide (ICRG) and the WGI, while the other variables are mainly from the World Development Index 2020 (WDI).

Government effectiveness: According to Kraay et al. (2010), it refers to the perception of the quality of public services, the quality of the civil service and its degree of independence from political pressure, the quality of policy formulation and implementation, and finally, the credibility of the government's commitment to these policies. The values of the indicator range from -2.5 to 2.5 (-2.5 meaning the country is very ineffective, while 2.5 meaning it is very effective).

ICT usage: ICT usage is a subindex of the network readiness index (NRI) from the GITR. The NRI measures the ability of countries to profit from ICTs to increase their competitiveness and well-being, but also the trends in innovation in recent years. The NRI is an indicator composed mainly of four subindexes (the environment for ICT, the readiness of a society to use ICT, the

[3] A list of countries with income group is provided in Appendix A.
[4] Dutta et al. (2007, 2008, 2009, 2010, 2011, 2012, 2015, 2016) ; Bilbao-Osorio et al. (2013, 2014). The report was published with a one-year delay before 2012. However, from 2012 onwards, each report covers the year of its publication. Because of the lack of data for 2011, we have estimated it by using the average of 2010 and 2012.

actual use of all key stakeholders, and, finally, the impacts that ICT generates in the economy and society). Each subindex is composed of pillars constructed using indicators. The ICT usage subindex includes the individual, government, and business usage pillars.[5] The indexes,' subindexes,' and pillar's values are ranked from 0 to 7, with 7 being the best score. This study focuses on the pillars of ICT use by governments. The research hypothesis is that the use of ICT by the government has a positive effect on its effectiveness.

GDP per capita: This is the ratio of annual gross domestic product divided by the number of inhabitants at midyear. It is used to capture the level of development of a country and its wealth. The more developed a country is, the more effective the government appears to be. Moreover, development tends to be accompanied by greater involvement in public management. Therefore, it is reasonable to expect a positive effect of GDP per capita on government effectiveness.

Total population: The total population estimates the number of people living legally in the territory of a country in the middle year. A large population means that more people are satisfied through the provision of public goods and services, and more work for the government. In addition, it will be difficult for it to take individual preferences into account when adjusting the supply of public goods and services. Therefore, it may be difficult for it to satisfy an abundant population. Otherwise, when the population increases, the government will find it difficult to be effective. Nevertheless, large populations can motivate policymakers to improve the supply and quality of services and simplify procedures, which will improve their effectiveness. Therefore, it is not evident to anticipate this variable effect on government effectiveness.

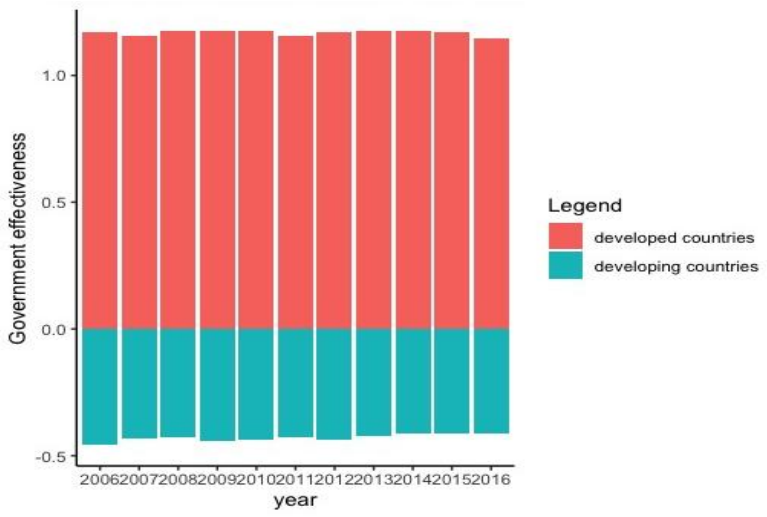
Political Stability and Absence of Violence/Terrorism: It reflects the degree of stability and the absence of insecurity and violence in a country. Indeed, in a country plagued by violence and instability, development efforts are doomed to fail. Adsera et al. (2003) also argue that the ineffectiveness of government increases with political instability. Therefore, the priority will be to create a climate of peace and stability. Political stability and peace are prerequisites for economic development. It is only under such conditions that the government can be economically effective. Therefore, this variable is expected to have a positive effect on the effectiveness of a government.[6]

2.2. Representation of information

[5] Appendix B.1 presents the ICT variables uses for each usage sub-index.
[6] Appendix B.2 presents definitions and sources of all variables used in this study, while Appendix B.3 gives summary statistics.

Figure 1 shows the evolution and level of government effectiveness for developed and developing countries during the research period. This indicates that government effectiveness is negative in developing countries. In contrast, in developed countries, the level of effectiveness is better when the index is greater than zero. The graph also indicates that the gap between government effectiveness in developed and developing countries is remarkably high. However, this gap tends to narrow over time as the level of effectiveness in developing countries gradually improves.

Figure 1: Average effectiveness by country group



Source: Author construction with WGI data

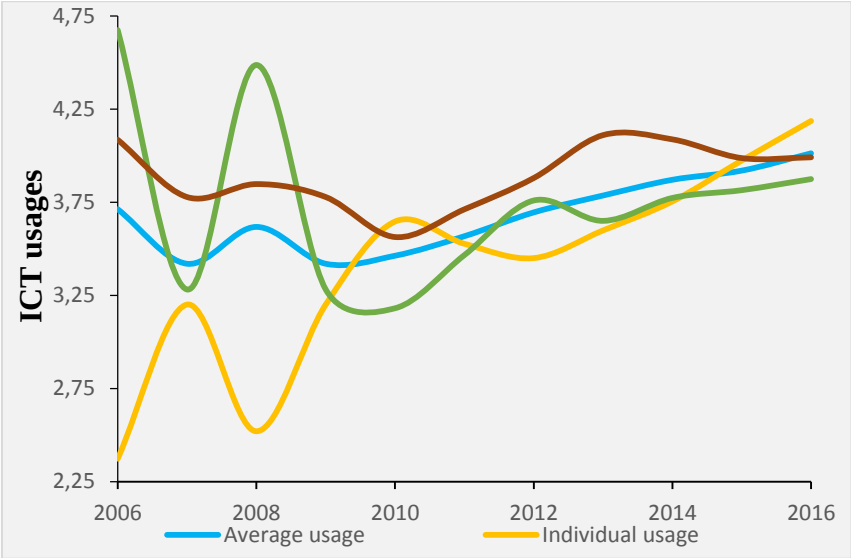
The descriptive analysis also showed that the level of effectiveness is a matter of development. The high-income countries had the highest effectiveness scores. On average, these countries have an effectiveness index of 1.75, while they are negative for countries in other groups (-0.116, -0.563, and -0.823, respectively).

Regarding digitalization, a trend graph of ICT use and its sub-indices was constructed (Figure 2). In general, the overall use of ICT and its sub-indexes is increasing. However, government and business ICT use was higher in the early years of the study. In recent years individual use has exceeded business and government use.

When analyzing government ICT usage by income group, we found that digitalization correlates to income level. Indeed, we observe that the higher the income level, the higher the average ICT

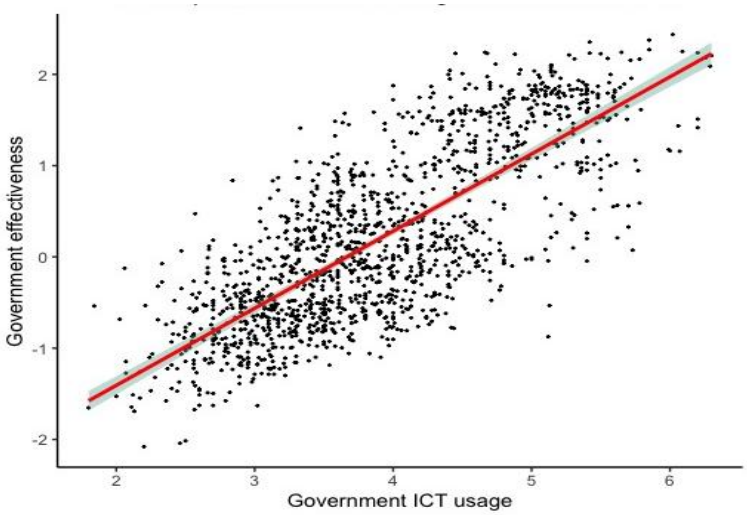
usage score. In fact, the average score is 4.57 for high-income countries, 3.64 for upper-middle income countries, while it is 3.43 and 3.21 respectively for lower-middle and low-income countries, respectively.

Figure 2: Trend of ICT usage by component from 2006 to 2016



Source: Author construction using data from GITR

Figure 3: Scatter plot between ICT usage and government effectiveness

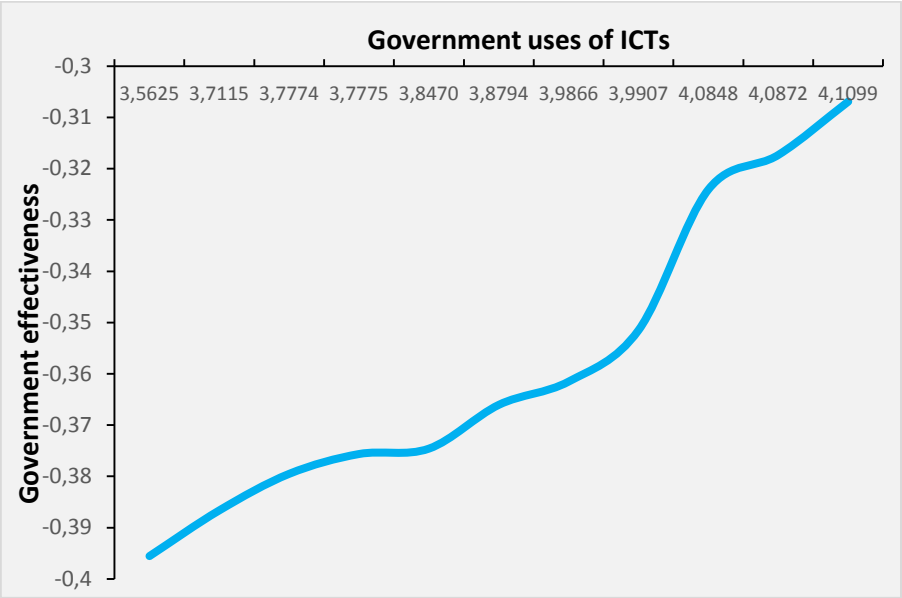


Source: Author construction using data from WGI and GITR

In figure 3, the scatter plot and the correlation line between ICT use by governments and their effectiveness are presented. There is a positive correlation between digitalization and government

effectiveness. Furthermore, Figure 4 shows a positive relationship between the average level of ICT use and the average effectiveness of government. Therefore, a positive effect of ICT use on government effectiveness can be expected. However, this graph does not confirm this because correlation does not necessarily indicate a significant effect.

Figure 4: Trend in government effectiveness in relation to government use of ICT



Source: Author construction using data from WGI and GITR

2.3. Identification strategy

To assess the effect of ICT usage on government effectiveness in developed and developing countries, a panel model with fixed effects was specified. The model is presented in equation (eq.1) below, where GEE is government effectiveness. In the right size, ICT_{it} indicates government digitalization for country i in year t. In addition, α_i, γ_t, X_{it}, and ε_{it} refer to country- and time-fixed effects, set of control variables, and error term, respectively. Moreover, φ is the constant term of the model and δ represents the coefficient of ICT usage.

$$GEE_{it} = \varphi + \delta ICT_{it} + \beta X_{it} + \alpha_i + \gamma_t + \varepsilon_{it} \qquad \text{(eq.1)}$$

3. Empirical results

Table 1 presents the impact of digitalization on government effectiveness. In column 1, we estimated the effect using only the government's use of ICT as an explanatory variable. The

results show a positive and significant effect of digitalization on government effectiveness at the one percent level. However, this specification suffers from an omission variable bias. We then iterated the model using additional explanatory variables that may affect government effectiveness based on the literature. The random-effects results in column 2 show a positive effect of digitalization on government effectiveness. Nevertheless, since each country has its own individual characteristics that may or may not influence the predictors, we added country fixed effects to control for this. In addition, we applied the time-fixed effect. The effect of digitalization on government effectiveness remains positive and significant at the conventional level (columns 3 & 4).

To choose the best estimation strategy, we proceeded with specification tests. First, the Hausman specification test (Hausman, 1978) allowed us to determine the appropriate model by comparing the random effects model (column 2) and the fixed effects model (column 3). Second, for the time fixed effects (columns 4 & 5), we used a parametric test for time-fixed effects to determine whether it is necessary to consider the time-fixed effects.

The probability of the Hausman specification test (Prob > chi2 = 0.0000) was less than one percent. Therefore, the null hypothesis of no correlation between errors and regressors is rejected. The fixed-effect model is preferred over the random-effect model. The time fixed effects test is a joint test that assesses whether the dummy variables for all years are equal to zero. If they are zero, the time fixed effect is not required; otherwise, they are relevant to the model. The probability value (Prob > F = 0.0069) of the test was below the conventional levels. Therefore, H0 is rejected, and we cannot confirm that the year dummies are jointly equal to zero. Therefore, the time-fixed effect is preferred[7] and we retain the specifications in column 5 which includes country and time-fixed effects.

The results in column 5 indicate that, on average, for the countries in the sample, an increase in digitalization level by one point leads to an improvement of government effectiveness by 0.1 points. These results can be explained by the fact that digitalization facilitates access to certain public services as well as the interaction between citizens and the government. Moreover, by enabling good management of tasks and the acceleration of procedures, digitalization can save time, considerably reduce costs, and therefore improve effectiveness.

[7] See Torres-Reyna. (2007) for more details about the Hausman test and the time fixed effect test.

The coefficient of political stability and absence of violence and/or terrorism is positive and significant at the one percent level. This indicates that stability and the absence of violence are determinants of a government's effectiveness. The results show that if stability increases by one point, government effectiveness will be improved by approximately 0.093-points. We also found that GDP per capita positively and significantly influenced government effectiveness. An increase in GDP per capita of one percent is associated with an improvement in effectiveness of 0.0021 points.[8] GDP per capita is generally used as a measure of a country's level of development and economic stability. Economic stability allows for a better selection of public administration staff and the sustainability of good government policies and practices (García-Sánchez et al. 2016 and Lee & Whitford, 2009). Furthermore, it can be expected that citizens with higher incomes will be less dependent on public services (such as health, education, social aid). Therefore, these services will be more oriented towards low-income citizens. These factors can be sources of improvement in the level of effectiveness of public administrations and/or government effectiveness. As for the total population, the effect is not significant.

Table 1: Effect of digitalization on government effectiveness

	1	2	3	4	5
Dependent variable: Government effectiveness					
government ICT usage	**0.1239*** (0.0149)**	**0.0749*** (0.0147)**	**0.0750*** (0.0152)**	**0.1095*** (0.0182)**	**0.1004*** (0.0187)**
Political Stability and Absence of Violence/Terrorism		0.1096***	0.0963***	0.0978***	0.0928***
		(0.0301)	(0.0303)	(0.0308)	(0.0296)
log (GDP per capita)		0.3927***	0.2260***	0.4166***	0.2109**
		(0.0326)	(0.0812)	(0.0332)	(0.0861)
log (Total population)		-0.0256	-0.1619	-0.0053	-0.1681
		(0.0247)	(0.1592)	(0.0242)	(0.1999)
Country fixed effect	No	No	Yes	No	Yes
Time fixed effect	No	No	No	Yes	Yes
No. of Obs.	1437	1437	1437	1437	1437
No. of countries	138	138	138	138	138
R-Squared	0.69	0.78	0.16	0.79	0.18

Note: Robust standard errors in parentheses * p < 0.10, ** p < 0.05, *** p < 0.01

Since the sample includes developing and developed countries, one would assume that a specific group drives the positive and significant effect of digitalization. In addition, it would be interesting to explore heterogeneity by level of development (as measured by income level).

[8] Here, the interpretation is done considering that the variable is taken in logarithm. An increase of the explanatory variable of 1% leads to a variation of the explanatory variable of $\beta/100$ units.

Therefore, we have split the sample into two groups: developing and developed countries. The results are shown in Table 2.

For both developing (column 1) and developed (column 2) countries, the results suggest that digitalization has a positive and significant impact on government effectiveness. However, the effect is larger in developed countries than in developing countries. Several factors may explain this result. In fact, partial digitalization and an institutional culture of paperwork are common in developing countries (Effah & Nuhu, 2017; Wiredu, 2012; Schuppan, 2009). This may limit their ability to benefit fully from the effects of digitalization. Furthermore, developed countries have more experience with digitalization. In addition, there is the issue of human capital for digitalization, which is less qualified in developing countries.

Table 2: Effect of digitalization on government effectiveness by income groups

	1 Developed Countries	**2 Developing Countries**
Dependent variable: Government effectiveness		
government ICT usage	**0.1368*** **	**0.0647*** **
	(0.0273)	**(0.0233)**
Political Stability and Absence of Violence/Terrorism	0.1352**	0.0908***
	(0.0512)	(0.0308)
log (GDP per capita)	0.2665	0.1996**
	(0.1640)	(0.0931)
log (Total population)	0.0337	-0.6417***
	(0.2467)	(0.1920)
Country fixed effect	Yes	Yes
Time Fixed effect	Yes	Yes
No. of Obs.	542	895
No. of countries	50	88
R-Squared	0.19	0.22

Note: Robust standard errors in parentheses * p < 0.10, ** p < 0.05, *** p < 0.01

4. Further analysis

4.1. Addressing reverse causality issue

First, a possible reverse causal effect between digitalization and government effectiveness was suspected. Here, we assume that digitalization impacts government effectiveness. On the other hand, an effective government will tend to increase the use of ICT to provide online services or improve its effectiveness and service quality. This is a source of reverse causality and, therefore,

endogeneity. To deal with this potential reverse causality, following Datta and Agarwal (2004), we estimated one, and then two lags in the digitalization variable.

Table 3 presents the results with lags in government ICT usage. The effect of digitalization on government effectiveness remains positive and significant at the conventional level. According to Datta and Agarwal (2004), this means that the impact of digitalization on government effectiveness is not only due to two-way causality. This result also shows that the effect of the level of digitalization in a given year can extend over several more years.

Table 3: Effect of digitalization on the effectiveness with lags in digitalization

	Full sample		**Developed countries**		**Developing countries**	
	1	2	3	4	5	6
Dependent variable: Government effectiveness						
government ICT usage (t-1)	**0.065*** **		**0.089*** **		**0.033** **	
	(0.019)		**(0.031)**		**(0.015)**	
government ICT usage (t-2)		**0.047** **		**0.060***		**0.026**
		(0.020)		**(0.033)**		**(0.026)**
pve	0.097***	0.099***	0.114**	0.110*	0.097***	0.101***
	(0.032)	(0.035)	(0.054)	(0.057)	(0.015)	(0.038)
lngdp	0.260***	0.341***	0.320*	0.436**	0.276***	0.311***
	(0.088)	(0.091)	(0.187)	(0.210)	(0.063)	(0.103)
lnPop	-0.218	-0.269	0.023	-0.049	-0.683***	-0.639**
	(0.226)	(0.203)	(0.308)	(0.302)	(0.126)	(0.252)
No. of Obs.	1308	1174	495	446	813	728
No. of group	138	138	50	50		88
R-Squared	0.150	0.151	0.116	0.099	0.206	0.206

Note: Robust standard errors in parentheses * p < 0.10, ** p < 0.05, *** p < 0.01

Second, reverse causality could arise from wealth and the absence of political violence and/or terrorism. Indeed, an effective government is expected to be able to avoid political crises and social tensions and enable wealth creation. In addition, government efficiency is expected to improve the supply and quality of healthcare services. This could lead to a decrease in mortality rates (infant, maternal, and total) and an increase in life expectancy, thus affecting the population size. Therefore, we assumed a possible endogeneity for all control variables and to addresses this

endogeneity issue, we utilized a two-step system GMM (Blundell and Bond, 1998).[9] The collapse option was applied to overcome instrument proliferation bias (Roodman, 2009). To correct the finite sample bias, we used Windmeijer's (2005) standard errors.

Third, government effectiveness also tends to be persistent, since the country's current effectiveness may depend on the previous year's effectiveness. If this consideration is not taken into account, the regressions may suffer from the serious problem of a lack of relevant explanatory variables. Therefore, in line with the literature on the dynamic model, we included the one-period lagged value of the dependent variable as an explanatory variable to deal with the potential dynamic issue of government effectiveness. Therefore, the model can be written as follows:

$$GEE_{it} = \varphi + \rho GEE_{i,t-1} + \delta ICT_{it} + \beta X_{it} + \alpha_i + \gamma_t + \varepsilon_{it} \quad \text{(eq.2)}$$

The results of the GMM estimation are presented in Table 4. The AR(2) and the Hansen test p-values support the validity of the results as the p-values are higher than all conventional levels. Furthermore, the high and significant coefficient on the lagged dependent variable validates the relevance of the specified system GMM model and confirms that government effectiveness is persistent. This result suggests the existence of a dynamic in government effectiveness. Therefore, a given government's effectiveness level can be explained by that of previous years. As for the effect of digitalization, it remains positive and significant at the conventional level (Table 4, columns 1 to 3).

Table 4: Two-step system GMM estimation results

	1 Full sample	**2 Developed countries**	**3 Developing countries**
Dependent variable: Government effectiveness			
Government effectiveness (t-1)	**0.832*** **	**0.819*** **	**0.812*** **
	(0.034)	**(0.085)**	**(0.051)**
Government ICT usage	**0.039** **	**0.054***	**0.047***
	(0.019)	(0.029)	(0.025)
Political Stability and Absence of Violence/Terrorism	0.098***	0.078*	0.072**
	(0.022)	(0.040)	(0.028)
Log (GDP per capita)	0.045***	0.054	0.042***
	(0.014)	(0.039)	(0.012)

[9] We also consider digitalization and the lag of dependent variables as endogenous in the system GMM.

Log (Total population)	0.032**	0.009	0.024
	(0.014)	(0.006)	(0.019)
Time fixed effect	Yes	Yes	Yes
No. of Obs.	1287	496	795
No. of countries	138	50	88
Instruments	33	42	53
AR1-pvalue	0.000	0.000	0.000
AR2-pvalue	0.478	0.838	0.455
Hansen-P-value	0.13	0.35	0.14

Note: Robust standard errors in parentheses * p < 0.10, ** p < 0.05, *** p < 0.01

4.2. Sensitivity analysis

To test the sensitivity of the results, we added more variables to explain government effectiveness. They are education, control of corruption, the rule of law, representation and accountability, regulatory quality, stability, government size, and the proportion of women in parliament.[10] After adding these new variables (Table 5, columns 1 to 9), the effect of digitalization on government effectiveness remains positive and significant at the one percent level, confirming the robustness of the results. Regarding additional variables, the results suggest that better control of corruption, rule of law, regulatory quality (columns 2 to 4), and government stability (column 6) all improve government effectiveness. The effect of these variables on government effectiveness was positive and significant. This indicates that the quality of institutions is an important contributor to the explanation of government effectiveness. As for education (column 1), voice and accountability (column 5), the size of government, and the proportion of women in parliament (columns 8 and 9), their effects on government effectiveness are not significant at conventional levels.

In addition, greater natural resource revenue negatively impacted government effectiveness (column 7). This negative effect of natural resources on government effectiveness is consistent with the results of Isham et al. (2005), Bulte et al. (2005), and Sala-i-Martin and Subramanian (2003). This can be explained by the "natural resource curse." Indeed, Clark (1997) and Gause (1995) explained that governments, through revenues from natural resources, can finance security in order to undermine people's aspirations for quality government institutions and services. Following Busse and Gröning (2013), the negative effect of resource revenues can also be

[10] To capture the size of government, the final consumption of government relative to GDP Is used, while the proportion of women in parliament is used to capture the gender composition of government.

explained mainly through three channels. First, with abundant resource revenues, the government will tend to tax taxpayers less than necessary. Second, resource revenues can be used to ease tensions and sow corruption among the population. Finally, these funds can be used to prevent the creation of pressure groups that defend the rights of the population. Thus, without pressure groups or with a repressed population, aspirations for democracy, governance, and quality institutions will be undermined. In addition, a low-taxed population will have a low demand for international quality and public goods. In addition to these explanations, abundant natural resource revenues can be wasteful through excessive, inappropriate, inefficient, and ineffective spending.[11]

[11] For more details on the literature on the effect of natural resources on the quality of governance and institutions, see Busse and Gröning (2013).

Table 5: Sensitivity analysis

	1	2	3	4	5	6	7	8	9
Dependent variable: Government effectiveness									
Government ICT usage	**0.0744*** **	**0.0823*** **	**0.0741*** **	**0.0768*** **	**0.1003*** **	**0.1077*** **	**0.0994*** **	**0.0990*** **	**0.0975*** **
	(0.0199)	**(0.0178)**	**(0.0158)**	**(0.0169)**	**(0.0184)**	**(0.0192)**	**(0.0187)**	**(0.0192)**	**(0.0191)**
Political Stability and Absence of Violence/Terrorism	0.0991***	0.0787***	0.0351	0.0575**	0.0933***	0.0683**	0.0906**	0.1056***	0.0938***
	(0.0337)	(0.0292)	(0.0264)	(0.0270)	(0.0295)	(0.0302)	(0.0383)	(0.0347)	(0.0305)
Log (GDP per capita)	0.3032***	0.1372*	0.1080	0.0642	0.2135**	0.1627*	0.1704*	0.2508***	0.2374***
	(0.0950)	(0.0817)	(0.0714)	(0.0810)	(0.0856)	(0.0874)	(0.0899)	(0.0950)	(0.0903)
Log (Total population)	-0.4671***	0.1303	0.1479	0.1729	0.1710	0.1512	-0.1895	-0.1732	-0.1624
	(0.1572)	(0.1735)	(0.1556)	(0.1679)	(0.2002)	(0.2100)	(0.2134)	(0.2104)	(0.2061)
log (Education)	0.0109								
	(0.0373)								
Control of Corruption		0.2622***							
		(0.0496)							
Rule of Law			0.4340***						
			(0.0473)						
Regulatory Quality				0.3153***					
				(0.0534)					
Voice and Accountability					0.0290				
					(0.0712)				
Government Stability						0.0247***			
						(0.0051)			
Natural resources revenue							-0.0045***		
							(0.0015)		
Government size								0.0043	
								(0.0035)	
Women in parliament									0.0015
									(0.0013)
Country fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time Fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
No. of Obs.	1099	1437	1437	1437	1437	1261	1310	1369	1373
No. of countries	128	138	138	138	138	120	130	133	133
R-Squared	0.19	0.24	0.30	0.26	0.18	0.21	0.16	0.18	0.19

Note: Robust standard errors in parentheses * p < 0.10, ** p < 0.05, *** p < 0.01

4.3. Heterogeneity

We also performed heterogeneity analyses to test whether the effect of digitalization on government effectiveness differs across geographic regions or effectiveness levels. For this purpose, we divided the database into sub-samples according to each country's continent[12] or government effectiveness score.

4.3.1. By geographic region

In this section, we analyze the effect of digitalization by geographical group. The results displayed in Table 6 show that digitalization positively and significantly affects government effectiveness in African (column 1), Asian, and European countries (columns 3 and 4). However, the effect is not significant for American countries, although it is positive (column 3).[13] The coefficient is highest for European countries (column 4), suggesting that European countries benefit most from digitization.[14]

Table 6: Geographical heterogeneity

	1 Africa	2 America	3 Asia	4 Europa
Dependent variable: Governement effectiveness				
Government ICT usage	**0.1043*** **	**0.0312**	**0.0915** **	**0.1155*** **
	(0.0345)	**(0.0384)**	**(0.0347)**	**(0.0328)**
Political Stability and Absence of Violence/Terrorism	0.1363***	0.0989**	0.0363	0.0526
	(0.0369)	(0.0450)	(0.0478)	(0.0648)
Log (GDP per capita)	0.0441	0.5773**	0.4096**	0.4386**
	(0.1769)	(0.2292)	(0.1566)	(0.1651)
Log (Total population)	0.4304	0.5459	0.3515	-1.2000***
	(0.5100)	(0.6587)	(0.2723)	(0.4145)
Country fixed effect	Yes	Yes	Yes	Yes
Time Fixed effect	Yes	Yes	Yes	Yes
No. of Obs.	365	273	318	459
No. of countries	37	26	31	42
R-Squared	0.32	0.26	0.20	0.29

Note: Robust standard errors in parentheses * p < 0.10, ** p < 0.05, *** p < 0.01

[12] For African and European countries, the geographical grouping has been assigned according to the football confederation to which they are affiliated. This allows to easily classify countries that straddle two continents or belong to a region different from their continent. There are two countries in Oceania (namely Australia and New Zealand) that are not considered in this heterogeneity analysis due to the small number of observations. However, the result does not change if they are added to the group of Asian countries.

[13] When disaggregating South and North American countries, the effect remains positive and non-significant for North American countries (there are 15 countries and islands, including the USA and Canada), while it becomes significant for South American countries. Therefore, it is likely that the non-significant effect comes from North American countries.

[14] We perform an additional geographic analysis based on the WB region groups. The results are presented in the Appendix C

4.3.2. By level of effectiveness

To constitute the effectiveness subgroups, we calculated the average effectiveness rate per country. Next, this value was compared to the median effectiveness value of the entire sample. Countries with an average effectiveness below the median are considered the least effective; otherwise, they are effective.

The results in Table 7 suggest that government effectiveness is positively and significantly affected by digitalization, regardless of the level of effectiveness. The results imply that an additional increase in digitalization of one unit has an average impact on government effectiveness of 0.048 for the least effective group (column 1) and 0.145 for the most effective group (column 2). This result is explained by the same reasons as for developed and developing countries (i.e., experience, technological advancement, and quality of human capital in ICT are higher in developed countries) because the group of least effective countries is mostly composed of developing countries.

Table 7: Heterogeneity by effectiveness level

	1 **Low effectiveness**	**2** **High effectiveness**
Dependent variable: Government effectiveness		
Government ICT usage	**0.0484***	**0.1447*****
	(0.0254)	**(0.0239)**
Political Stability and Absence of Violence/Terrorism	0.0731**	0.1685***
	(0.0322)	(0.0489)
log (GDP per capita)	0.2474**	0.2415**
	(0.1211)	(0.1189)
log (Total population)	-0.6167**	-0.0765
	(0.2332)	(0.2449)
Country fixed effect	Yes	Yes
Time fixed effect	Yes	Yes
No. of Obs.	702	735
No. of countries	70	68
R-Squared	0.20	0.23

Note: Robust standard errors in parentheses * p < 0.10, ** p < 0.05, *** p < 0.01

4.4. Additional ICT usage Indexes

While there is evidence that government digitalization has a positive effect on government effectiveness, this effect appears to be only partial. Indeed, ICT use by the government alone could only affect its internal effectiveness, particularly in terms of management and current activities. However, the use of ICT by other actors, such as individuals and businesses, can also improve government effectiveness. For example, suppose that the government makes it possible for individuals to conduct their administrative procedures online to reduce delays and ease procedures. However, some individuals do not use this alternative or do not have access to a connection device or the Internet and prefer physical procedures. Therefore, we believe that this is only possible if everyone (government, business, and individuals) have access to and use ICT. To investigate this question, we evaluate the effect of ICT use by individuals, businesses, and the entire society on the effectiveness of the government.

The results displayed in Table 8 suggest that use of ICT by individuals (column 1), businesses (column 2), and overall (column 3) increases government effectiveness. In addition, the effect of ICT use in society is higher, with a coefficient of 0.166, while that of business use is 0.04, and that of individual use is 0.065 (note that the coefficient of government use is around 0.1). This underlines the importance of facilitating access to ICT for all and promoting their use to make the most of digitalization. The effects of these variables on government effectiveness for both developed and developing countries were also compared. The impact is still positive and significant for both groups, except for business usage in developed countries. This result supports the baseline results, as the effect is larger in developed countries than in developing countries. The effect of overall usage remains higher for each group, suggesting that it is more helpful in promoting digitalization at all levels.[15]

Table 8: Effect of other type of ICT usage on government effectiveness

	1	2	3
Dependent variable: Government effectiveness			
Individual ICT usage	**0.0652*** (0.0182)**		
business ICT usage		**0.0404** (0.0201)**	
Overall usage			**0.1655*** (0.0301)**
Political Stability and Absence of Violence/Terrorism	0.1113*** (0.0305)	0.1047*** (0.0295)	0.0968*** (0.0288)
Log (GDP per capita)	0.3102*** (0.0829)	0.2836*** (0.0864)	0.2545*** (0.0837)
Log (Total population)	-0.0797 (0.1839)	-0.1157 (0.2035)	-0.1368 (0.1713)
Country fixed effect	Yes	Yes	Yes
Time Fixed effect	Yes	Yes	Yes

[15] The results are displays in appendix D.1 and D.2, for developed and developing countries, respectively.

No. of Obs.	1437	1437	1437
No. of countries	138	138	138
R-Squared	0.1516	0.1309	0.1855

Note: Robust standard errors in parentheses * p < 0.10, ** p < 0.05, *** p < 0.01

4.5. Alternative measurements

We now consider alternative measures of digitalization according to the E-Government Development Index (EGDI) from the United Nations e-Government Survey. The EGDI is a composite indicator that consists of the online services index, telecommunications index, and human capital index. The e-participation index is also considered.[16] These indices are equally weighted and cover a wide range of topics relevant to e-government.[17]

Table 9: Alternative digitalization indexes effect on government effectiveness

	1	2	3
Dependent variable: Government effectiveness			
E-Government	**0.4706*** **		
	(0.1752)		
E-Participation		**0.1347** **	
		(0.0531)	
Online Service			**0.1899** **
			(0.0847)
Political Stability and Absence of Violence/Terrorism	0.1001***	0.0991***	0.0984***
	(0.0302)	(0.0303)	(0.0305)
Log (GDP per capita)	0.3543***	0.3376***	0.3364***
	(0.0903)	(0.0921)	(0.0937)
Log (Total population)	-0.1123	-0.1075	-0.1400
	(0.1929)	(0.1917)	(0.1953)
Country fixed effect	Yes	Yes	Yes
Time Fixed effect	Yes	Yes	Yes
No. of Obs.	1492	1489	1492
No. of countries	136	136	136
R-Squared	0.1603	0.1533	0.1536

Note: Robust standard errors in parentheses * p < 0.10, ** p < 0.05, *** p < 0.01

The results displayed in Table 9, columns 1 to 3, show that all considered indicators positively and significantly affect government effectiveness. They suggest that the increase in government effectiveness following ICT usage does not change with the ICT measures. The results for both groups are presented in Appendices E.1 and E.2. They reveal that e-government, e-participation,

[16] A definition of these indicators is given in appendix B.2.

[17] As EGDI is available over two years, we replaced data for gap year by the mean of the year after and the year before.

and online services positively affect government effectiveness. Nevertheless, this effect is not significant for developing countries.[18]

5. **Conclusion**

This study investigates the impact of digitalization on government effectiveness using panel data methodology. It considered a dataset of 88 developing and 50 developed countries from 2006 to 2016. The results suggest that digitalization has a significant and positive effect on government effectiveness. This effect is greater for developed countries than for developing countries. This effect is more important when considering the overall use of ICT. It remains relevant when sensitivity to several political, institutional, and macroeconomic conditions is tested. Furthermore, it appears that the average effect by geographical group remains significant and positive, apart from the American countries where the effect is non-significant.

The findings of this study highlight how country governments can improve their effectiveness through digital transformation, especially in developing countries. In addition, to reap the full benefits of digitalization, they should adopt policies that would promote the use of ICT at all levels of the economy, that is, the government itself, businesses, and individuals. These policies should focus more on increasing the coverage of ICT and the Internet among the population and in all sectors of activity. This could include building and improving the technological infrastructure, particularly in developing countries. They should also adopt policy reforms to modernize public administration. Furthermore, they could offer more online services and dematerialize most administrative procedures as much as possible. They should also promote engagement and collaboration through participatory governance via ICT. Beyond all these policy recommendations, there is a need for a strong political will from policymakers to promote digitalization and to be more effective.

[18] Several reasons may explain this effect in developing countries. First, most of these countries are in the beginning stages of using these services (e-government, e-services, and e-participation), therefore it takes time for users to adapt and take full advantage of them. Furthermore, Jacobin et al. (2019) and Brun et al. (2019) explain that experience matters in the use of digital services. Second, the implementation of these services needs to be supported by policies to promote and sustain them, and thus by political will. Third, most developing countries face either technical difficulties and/or user reluctance. Thus, even if the services exist, the expected effects will not be achieved. Finally, Dobrolyubova et al. (2017) argue that the insignificant effect of EGID indices can be explained by the fact that in addition to not reflecting the actual level of digitalization, they do not capture all dimensions of digitalization.

Conflict of interest

The author declares that he has no known competing financial interests or personal relationships that could have influenced the work reported in this paper.

References

Adsera, A., Boix, C., & Payne, M. (2003). Are you being served? Political accountability and quality of government. *The Journal of Law, Economics, and Organization*, *19*(2), 445-490.

Al-Marhubi, F. (2004). The determinants of governance: A cross-country analysis. *Contemporary Economic Policy*, *22*(3), 394-406.

Baller, S., Dutta, S. & Lanvin, B. (Eds.) (2016). *Global Information Technology Report 2016. Innovating in the Digital Economy*. Geneva: World Economic Forum and INSEAD. Retrieved July 07, 2016 from http://www3.weforum.org/docs/GITR2016/WEF_GITR_Full_Report.pdf

Barro, R. J. (1996). Determinants of economic growth: A cross-country empirical study (No. w5698). *National Bureau of Economic Research*.

Bhattacherjee, A., & Shrivastava, U. (2018). The effects of ICT use and ICT Laws on corruption: A general deterrence theory perspective. *Government Information Quarterly*, *35*(4), 703-712.

Bilbao-Osorio, B., Dutta, S. & Lanvin, B. (Eds.) (2013). *Global Information Technology Report 2013. Growth and Jobs in a Hyperconnected World*. Geneva: World Economic Forum and INSEAD. Retrieved April 10, 2013 from http://www3.weforum.org/docs/WEF_GITR_Report_2013.pdf

Bilbao-Osorio, B., Dutta, S. & Lanvin, B. (Eds.) (2014). *Global Information Technology Report 2014. Rewards and Risks of Big Data*. Geneva: World Economic Forum and INSEAD. Retrieved April 25, 2014 from http://www3.weforum.org/docs/WEF_GlobalInformationTechnology_Report_2014.pdf

Bird, R. M., & Zolt, E. M. (2008). Technology and taxation in developing countries: From hand to mouse. *National Tax Journal*, *61*(4), 791-821.

Blundell, R., & Bond, S. (1998). Initial conditions and moment restrictions in dynamic panel data models. *Journal of econometrics*, 87(1), 115-143.

Brambilla, I., & Tortarolo, D. (2018). Investment in ICT, productivity, and labor demand: the case of Argentina. *World Bank Policy Research Working Paper*, (8325).

Brun J-F., Chambas G., Tapsoba J., Wandaogo A-A. (2020) "Are ICT's boosting tax revenues? evidence from developing countries ", *Études et Documents, n°9, CERDI.*

Bulte, E. H., Damania, R., & Deacon, R. T. (2005). Resource intensity, institutions, and development. *World development*, *33*(7), 1029-1044.

Busse, M., & Gröning, S. (2013). The resource curse revisited: governance and natural resources. *Public choice*, *154*(1), 1-20.

Chen, L., & Aklikokou, A. K. (2019). Relating e-government development to government effectiveness and control of corruption: a cluster analysis. *Journal of Chinese Governance*, 1-19.

Clark, J. (1997). Petro-politics in Congo. *Journal of Democracy*, *8*(3), 62-76.

Colombo, M. G., Croce, A., & Grilli, L. (2013). ICT services and small businesses' productivity gains: An analysis of the adoption of broadband Internet technology. *Information Economics and Policy*, 25(3), 171-189.

Cordella, A., & Bonina, C. M. (2012). A public value perspective for ICT enabled public sector reforms: A theoretical reflection. *Government information quarterly*, 29(4), 512-520

Datta*, A., & Agarwal, S. (2004). Telecommunications and economic growth: a panel data approach. *Applied Economics*, *36*(15), 1649-1654.

Davison, R., Vogel, D., Harris, R., & Jones, N. (2000). Technology leapfrogging in developing countries–an inevitable luxury?. *The Electronic Journal of Information Systems in Developing Countries*, *1*(1), 1-10.

Dedrick, J., Kraemer, K. L., & Shih, E. (2013). Information technology and productivity in developed and developing countries. *Journal of Management Information Systems*, 30(1), 97-122.

Dobrolyubova, E., Alexandrov, O., & Yefremov, A. (2017). Is Russia ready for digital transformation?. In *International Conference on Digital Transformation and Global Society* (pp. 431-444). Springer, Cham.

Dobrolyubova, E., Klochkova, E., & Alexandrov, O. (2019). Digitalization and Effective Government: What Is the Cause and What Is the Effect?. *In International Conference on Digital Transformation and Global Society* (pp. 55-67). Springer, Cham.

Duho, K. C., Amankwa, M. O., & Musah-Surugu, J. I. (2020). Determinants and convergence of government effectiveness in Africa and Asia. *Public Administration and Policy*.

Dutta, S. & Bilbao-Osorio, B. (Eds.) (2012). *Global Information Technology Report 2012. Living in a Hyperconnected World*. Geneva: World Economic Forum and INSEAD. Retrieved April 07, 2012 from http://www3.weforum.org/docs/Global_IT_Report_2012.pdf

Dutta, S. & Mia, I. (Eds.) (2007). *Global Information Technology Report 2006-2007: Connecting to the Networked Economy*. Basingstoke: Palgrave Macmillan.

Dutta, S. & Mia, I. (Eds.) (2009). *Global Information Technology Report 2008-2009: Mobility in a Networked World*. Basingstoke: Palgrave Macmillan. Retrieved March 29, 2009 from http://www.weforum.org/pdf/gitr/2009/gitr09fullreport.pdf

Dutta, S. & Mia, I. (Eds.) (2010). *Global Information Technology Report 2009-2010: ICT for Sustainability*. Basingstoke: Palgrave Macmillan. Retrieved March 25, 2010 from http://www.weforum.org/pdf/GITR10/GITR%202009-2010_Full%20Report%20final.pdf

Dutta, S. & Mia, I. (Eds.) (2011). *Global Information Technology Report 2010-2011: Transformations 2.0*. Basingstoke: Palgrave Macmillan. Retrieved April 17, 2011 from http://reports.weforum.org/global-information-technology-report/content/pdf/wef-gitr-2010-2011.pdf

Dutta, S., Geiger, T. & Lanvin, B. (Eds.) (2015). *Global Information Technology Report 2015: ICTs for Inclusive Growth*. Geneva: World Economic Forum and INSEAD. Retrieved April 20, 2015 from http://www3.weforum.org/docs/WEF_Global_IT_Report_2015.pdf

Dutta, S., López-Claros, A. & Mia, I. (Eds.) (2008). *Global Information Technology Report 2007-2008: Fostering Innovation through Networked Readiness*. Basingstoke: Palgrave Macmillan.

Effah, J., & Nuhu, H. (2017). Institutional barriers to digitalization of government budgeting in developing countries: A case study of Ghana. *The Electronic Journal of Information Systems in Developing Countries*, 82(1), 1-17.

Elbahnasawy, N. G. (2014). E-government, internet adoption, and corruption: an empirical investigation. *World Development*, *57*, 114-126.

Evangelista, R., Guerrieri, P., & Meliciani, V. (2014). The economic impact of digital technologies in Europe. *Economics of Innovation and new technology*, *23*(8), 802-824.

Falk, S., Römmele, A., & Silverman, M. (2017). The promise of digital government. In *Digital Government* (pp. 3-23). Springer, Cham.

Fichman, R. G., Dos Santos, B. L., & Zheng, Z. (2014). Digital innovation as a fundamental and powerful concept in the information systems curriculum. *MIS quarterly*, *38*(2), 329-A15.

Fleming, S. (2002). Information and communication technologies (ICTs) and democracy development in the South: Potential and current reality. *The Electronic Journal of Information Systems in Developing Countries*, *10*(1), 1-10.

Garcia-Sanchez, I. M., Cuadrado-Ballesteros, B., & Frias-Aceituno, J. (2013). Determinants of government effectiveness. *International Journal of Public Administration*, *36*(8), 567-577.

García-Sánchez, I. M., Cuadrado-Ballesteros, B., & Frías-Aceituno, J. V. (2016). Does media freedom improve government effectiveness? A comparative cross-country analysis. *European journal of law and economics*, *42*(3), 515-537.

Gause, G. (1995). Regional influences on experiments in political liberalization in the Arab world. *Political liberalization and democratization in the Arab world*, *1*, 283-306.

Gracia, D. B., & Arino, L. C. (2015). Rebuilding public trust in government administrations through e-government actions. *Revista Española de Investigación de Marketing ESIC*, *19*(1), 1-11.

Guriev, S., Melnikov, N., & Zhuravskaya, E. (2019). 3g internet and confidence in government. *Available at SSRN 3456747*.

Hausman, J. A. (1978). Specification tests in econometrics. *Econometrica: Journal of the econometric society*, 1251-1271.

Irani, Z., Love, P. E., & Jones, S. (2008). Learning lessons from evaluating eGovernment: Reflective case experiences that support transformational government. *The Journal of Strategic Information Systems*, *17*(2), 155-164.

Isham, J., Woolcock, M., Pritchett, L., & Busby, G. (2005). The varieties of resource experience: natural resource export structures and the political economy of economic growth. *The World Bank Economic Review*, *19*(2), 141-174.

Islam, N., Trautmann, K., & Buxmann, P. (2016). Tradition Meets Modernity–Learning from Start-ups as a Chance to Create Digital Innovation in Corporations.

Jacolin, L., K. Massil Joseph, and A. Noah (2019). Informal Sector and Mobile Financial Services in Developing Countries: Does Financial Innovation Matter? *Banque de France Working Paper*, 721.

Janssen, M., & Estevez, E. (2013). Lean government and platform-based governance—Doing more with less. *Government Information Quarterly*, *30*, S1-S8.

Kanyam, D. A., Kostandini, G., & Ferreira, S. (2017). The mobile phone revolution: have mobile phones and the internet reduced corruption in Sub-Saharan Africa? *World Development*, *99*, 271-284.

Kaufmann, D., Kraay, A., & Mastruzzi, M. (2009). *Governance matters VIII: Aggregate and individual governance indicators 1996-2008*. The World Bank.

Kaufmann, D., Kraay, A., Lora, E., & Pritchett, L. (2002). Growth without governance [with Comments]. *Economia*, 3(1), 169-229.

Khan, M. H. (2009). *Governance, growth and poverty reduction*.

Knack, S., & Keefer, P. (1995). Institutions and economic performance: cross-country tests using alternative institutional measures. *Economics & Politics*, *7*(3), 207-227.

Kraay, A., Kaufmann, D., & Mastruzzi, M. (2010). The worldwide governance indicators: methodology and analytical issues. *The World Bank*.

La Porta, R., Lopez-de-Silanes, F., Shleifer, A., & Vishny, R. (1999). The quality of government. *The Journal of Law, Economics, and Organization*, *15*(1), 222-279.

Lee, S. Y., & Whitford, A. B. (2009). Government effectiveness in comparative perspective. *Journal of Comparative Policy Analysis*, 11(2), 249-281.

Mauro, P. (1995). Corruption and growth. *The quarterly journal of economics*, *110*(3), 681-712.

Montes, G. C., & Paschoal, P. C. (2016). Corruption: what are the effects on government effectiveness? Empirical evidence considering developed and developing countries. *Applied Economics Letters*, *23*(2), 146-150.

Montes, G.C., Bastos, J.C.A., Oliveira, A.J. (2019). Fiscal transparency, government effectiveness and government spending efficiency: Some international evidence based on panel data approach. *Economic Modelling*, 79, 211-225.

Ndou, V. (2004). E–Government for developing countries: opportunities and challenges. *The electronic journal of information systems in developing countries*, *18*(1), 1-24.

Parent, M., Vandebeek, C. A., & Gemino, A. C. (2005). Building citizen trust through e-government. *Government Information Quarterly*, *22*(4), 720-736.

Porumbescu, G. A. (2016). Linking public sector social media and e-government website use to trust in government. *Government Information Quarterly*, *33*(2), 291-304.

Roodman, D. (2009). How to do xtabond2: An introduction to difference and system GMM in Stata. *The stata journal,* 9(1), 86-136.

Sala-i-Martin, X., & Subramanian, A. (2013). Addressing the natural resource curse: An illustration from Nigeria. *Journal of African Economies*, *22*(4), 570-615.

Schuppan, T. (2009). E-Government in developing countries: Experiences from sub-Saharan Africa. *Government information quarterly*, *26*(1), 118-127.

Scully, G. W. (1988). The institutional framework and economic development. *Journal of Political Economy*, *96*(3), 652-662.

Smorgunov, L. (2019). Government as a Platform: Critics of a Technocratic Culture of Public Governance in Digital Era. In *International Conference on Digital Transformation and Global Society* (pp. 41-54). Springer, Cham.

Sturges, P. (2004). Corruption, transparency and a role for ICT. *International Journal of Information Ethics*, *2*(11), 1-9.

Tolbert, C. J., & Mossberger, K. (2006). The effects of e-government on trust and confidence in government. *Public administration review*, *66*(3), 354-369.

Torres-Reyna, O. (2007). Panel data analysis fixed and random effects using Stata (v. 4.2). *Data & Statistical Services, Priceton University*, *112*.

Van Reenen, J., Bloom, N., Draca, M., Kretschmer, T., Sadun, R., Overman, H., & Schankerman, M. (2010). The economic impact of ICT. *Final report*.

Welch, E. W., Hinnant, C. C., & Moon, M. J. (2005). Linking citizen satisfaction with e-government and trust in government. *Journal of public administration research and theory*, *15*(3), 371-391.

Windmeijer, F. (2005). A finite sample correction for the variance of linear efficient two-step GMM estimators. *Journal of econometrics*, *126*(1), 25-51.

Wiredu, G. O. (2012). Information systems innovation in public organisations: an institutional perspective. *Information Technology & People*.

Appendices

Appendix A: Countries list

No.	Country	Region	Income group
1	Australia	Oceania	High income
2	Austria	Europe	High income
3	Bahrain	Asia	High income
4	Barbados	North America	High income
5	Belgium	Europe	High income
6	Brunei Darussalam	Asia	High income
7	Canada	North America	High income
8	Chile	South America	High income
9	Croatia	Europe	High income
10	Cyprus	Asia	High income
11	Czech Republic	Europe	High income
12	Denmark	Europe	High income
13	Estonia	Europe	High income
14	Finland	Europe	High income
15	France	Europe	High income
16	Germany	Europe	High income
17	Greece	Europe	High income
18	Hong Kong	Asia	High income
19	Hungary	Europe	High income
20	Iceland	Europe	High income
21	Ireland	Europe	High income
22	Israel	Asia	High income
23	Italy	Europe	High income
24	Japan	Asia	High income
25	Kuwait	Asia	High income
26	Latvia	Europe	High income
27	Lithuania	Europe	High income
28	Luxembourg	Europe	High income
29	Malta	Europe	High income
30	Netherlands	Europe	High income
31	New Zealand	Oceania	High income
32	Norway	Europe	High income
33	Oman	Asia	High income
34	Panama	North America	High income
35	Poland	Europe	High income
36	Portugal	Europe	High income
37	Puerto Rico	North America	High income
38	Qatar	Asia	High income
39	Saudi Arabia	Asia	High income
40	Singapore	Asia	High income
41	Slovak Republic	Europe	High income
42	Slovenia	Europe	High income
43	Spain	Europe	High income
44	Sweden	Europe	High income
45	Switzerland	Europe	High income
46	Trinidad and Tobago	North America	High income
47	United Arab Emirates	Asia	High income
48	United Kingdom	Europe	High income
49	United States	North America	High income
50	Uruguay	South America	High income
51	Benin	Africa	Low income
52	Burkina Faso	Africa	Low income
70	Cambodia	Asia	Lower middle income
71	Cameroon	Africa	Lower middle income
72	Cape Verde	Africa	Lower middle income
73	Cote d'Ivoire	Africa	Lower middle income
74	Egypt, Arab Rep.	Africa	Lower middle income
75	El Salvador	North America	Lower middle income
76	Ghana	Africa	Lower middle income
77	Honduras	North America	Lower middle income
78	India	Asia	Lower middle income
79	Indonesia	Asia	Lower middle income
80	Kenya	Africa	Lower middle income
81	Kyrgyz Republic	Asia	Lower middle income
82	Lesotho	Africa	Lower middle income
83	Mauritania	Africa	Lower middle income
84	Moldova	Europe	Lower middle income
85	Mongolia	Asia	Lower middle income
86	Morocco	Africa	Lower middle income
87	Nicaragua	North America	Lower middle income
88	Nigeria	Africa	Lower middle income
89	Pakistan	Asia	Lower middle income
90	Philippines	Asia	Lower middle income
91	Senegal	Africa	Lower middle income
92	Swaziland	Africa	Lower middle income
93	Timor-Leste	Asia	Lower middle income
94	Tunisia	Africa	Lower middle income
95	Ukraine	Europe	Lower middle income
96	Vietnam	Asia	Lower middle income
97	Zambia	Africa	Lower middle income
98	Zimbabwe	Africa	Lower middle income
99	Albania	Europe	Upper middle income
100	Algeria	Africa	Upper middle income
101	Argentina	South America	Upper middle income
102	Armenia	Europe	Upper middle income
103	Azerbaijan	Europe	Upper middle income
104	Bosnia and Herzegovina	Europe	Upper middle income
105	Botswana	Africa	Upper middle income
106	Brazil	South America	Upper middle income
107	Bulgaria	Europe	Upper middle income
108	China	Asia	Upper middle income
109	Colombia	South America	Upper middle income
110	Costa Rica	North America	Upper middle income
111	Dominican Republic	North America	Upper middle income
112	Ecuador	South America	Upper middle income
113	Gabon	Africa	Upper middle income
114	Georgia	Europe	Upper middle income
115	Guatemala	North America	Upper middle income
116	Guyana	South America	Upper middle income
117	Iran, Islamic Rep.	Asia	Upper middle income
118	Jamaica	North America	Upper middle income
119	Jordan	Asia	Upper middle income
120	Kazakhstan	Europe	Upper middle income
121	Lebanon	Asia	Upper middle income

53	Burundi	Africa	Low income	122	Libya	Africa	Upper middle income
54	Chad	Africa	Low income	123	Malaysia	Asia	Upper middle income
55	Ethiopia	Africa	Low income	124	Mauritius	Africa	Upper middle income
56	Gambia, The	Africa	Low income	125	Mexico	North America	Upper middle income
57	Guinea	Africa	Low income	126	Montenegro	Europe	Upper middle income
58	Haiti	North America	Low income	127	Namibia	Africa	Upper middle income
59	Madagascar	Africa	Low income	128	Paraguay	South America	Upper middle income
60	Malawi	Africa	Low income	129	Peru	South America	Upper middle income
61	Mali	Africa	Low income	130	Romania	Europe	Upper middle income
62	Mozambique	Africa	Low income	131	Russian Federation	Europe	Upper middle income
63	Rwanda	Africa	Low income	132	Serbia	Europe	Upper middle income
64	Tajikistan	Asia	Low income	133	South Africa	Africa	Upper middle income
65	Tanzania	Africa	Low income	134	Sri Lanka	Asia	Upper middle income
66	Uganda	Africa	Low income	135	Suriname	South America	Upper middle income
67	Yemen, Rep.	Asia	Low income	136	Thailand	Asia	Upper middle income
68	Angola	Africa	Lower middle income	137	Turkey	Europe	Upper middle income
69	Bangladesh	Asia	Lower middle income	138	Venezuela, RB	South America	Upper middle income

Appendix B.1: List of variables for ICT usage indexes

Government Usage index	**Individual usage index**	**Business usage index**
Importance of ICT to government vision of the future	Mobile phone subscription	Firm-level technology absorption
Government prioritization of ICT	Individual using internet	Capacity for innovation
Government success in ICT promotion	Household with personal computer	Patent Cooperation Treaty (PCT) application
E-Participation Index	Household with internet access	ICT impact on new services and products
Government online services	Fixed broadband internet subscription	ICT impact on new organizational models
	Mobile broadband subscription	High-tech export
	Cellular subscription with data	Prevalence of foreign technology licensing
	Internet access in school	Business-to-business internet uses
	Uses of virtual social network (e.g., Facebook, Twitter, LinkedIn)	Business-to-consumer internet uses
		Extent of staff training

Appendix B.2: Variable descriptions

Variables	Description	Source
Government effectiveness	Perceptions of the quality of public services, the quality of the civil service and the degree of its independence from political pressures, the quality of policy formulation and implementation, and the credibility of the government's commitment to such policies.	Worldwide Governance Indicators (WGI) by World Bank
Political Stability and Absence of Violence/Terrorism	Perceptions of the likelihood that the government will be destabilized or overthrown by unconstitutional or violent means, including politically motivated violence and terrorism.	
Voice and Accountability	Perceptions of the extent to which a country's citizens can participate in selecting their government, as well as freedom of expression, freedom of association, and a free media."	
Regulatory Quality	"Perceptions of the ability of the government to formulate and implement sound policies and regulations that permit and promote private sector development.	
Rule of Law	Perceptions of the extent to which agents have confidence in and abide by the rules of society, and in particular the quality of contract enforcement, property rights, the police, and the courts, as well as the likelihood of crime and violence.	
Control of Corruption	Perceptions of the extent to which public power is exercised for private gain, including both petty and grand forms of corruption, as well as "capture" of the state by elites and private interests.	
Government Stability	The assessment is both an evaluation of the government's ability to carry out its programmed(s) as declared and its ability to stay in office.	the International Country Risk Guide (ICRG)
GDP per capita (constant 2010 USD)	GDP per capita is the gross domestic product divided by the mid-year population. It is used to measure a country's level of wealth, and also its level of development.	World Development Indicators (WDI)
Population, total	It represents all residents regardless of their legal status or citizenship, estimated at mid-year.	
Government size	They include all current expenditure by the general government on purchasing goods and services and compensation of employees. They also include most national defense and security expenditure but exclude general government military expenditure.	
Women in parliament	It measures the percentage of parliamentary seats held by women in a single or lower house.	
School enrolment, secondary (% gross)	Ratio of total enrolment, regardless of age, to the population of the age group that officially corresponds to the level of education shown.	
Total Resource Revenue (% GDP)	Tax revenues from natural resources	The International Centre for Tax and Development (ICTD)
E-Government Index	The E-Government Development Index presents the state of E-Government Development of the United Nations Member States. Along with an assessment of the website development patterns in a country, the E-Government Development index incorporates the access characteristics, such as the infrastructure and educational levels, to reflect how a country is using information technologies to promote access and inclusion of its people.	UN E-Government Survey 2020 - United Nations
E-Participation Index	The e-Participation Index (EPI) focuses on the use of online services to facilitate the provision of information by governments to citizens (e-information Sharing), interaction with stakeholders (e-Consultation), and participation in decision-making processes (e-Decision-making).	
Online Service Index	The Online Services Index assesses the availability and the quality of online government service delivery.	
ICT usage (overall)	Assesses the level of ICT adoption by a society's main stakeholders: government, businesses, and individuals.	Global Information Technology Report (GITR)
Individual ICT usage	Measures the extend of selected ICTs diffusion among a country's population. It takes into account social networks uses	
Business ICT usage	Captures the extent to which businesses in a country use the internet for business-to-business (B2B) and business-to-consumer (B2C) operations and their efforts to integrate ICTs in their operations. It also includes internet uses for Business-to-government operations.	
Government ICT usage	Assesses the leadership and success of the government in developing and implementing strategies for ICT development, as well as in using ICTs, as measured by the availability and quality of online government services	

Source: Author construction with data from GITR, ICTD, ICRG, WDI, WGI, and UN

Appendix B.3: Summary statistics

Variables	Number of Observations.	Mean	Stdard Deviation	Min	Max
Governement effectiveness	1437	0.1931506	0.9464555	-2.078492	2.436975
Political Stability and Absence of Violence/Terrorism	1437	-0.0285954	0.9020166	-2.810035	1.525453
Voice and Accountability	1437	0.0924449	0.9188504	-1.951152	1.737975
Regulatory Quality	1437	0.2410341	0.8979762	-2.232313	2.260543
Rule of Law	1437	0.1189995	0.9757775	-1.916324	2.100273
Control of Corruption	1437	0.0992537	1.025483	-1.616931	2.469991
Government Stability	1261	7.746897	1.48141	4.041667	11.5
GDP per capita	1437	16027.71	20181.22	219.9615	111968.3
Population, total	1437	4.89e+07	1.63e+08	277477	1.38e+09
Government size	1373	20.00763	11.01528	0	63.75
Women in parliament	1369	15.76746	5.330143	2.047121	41.88798
School enrollment, secondary	1099	85.21118	27.6707	14.13834	163.9347
Total Resource Revenue	1310	3.824984	10.09095	0	72.35043
E-Government Index	1415	0.5160066	0.1948272	0	0.91928
E-Participation Index	1412	0.3363908	0.2640916	0	1
Online Service Index	1415	0.4609137	0.2318458	0	1
Overall ICT usage	1437	3.68309	0.9697118	1.99	6.07
Individual ICT usage	1437	3.417053	1.511046	1	6.9
Business ICT usage	1437	3.740884	0.9306428	2.06	6.22
Government ICT usage	1437	3.893114	0.8617827	1.8	6.3

Appendix C: Geographic heterogeneity: WB region groups

	1 Europe & Central Asia	2 Sub-Saharan Africa	3 Latin America & Caribbean	4 Middle East & North Africaa	5 East Asia & Pacific	6 South Asia	7 North America
Dependent variable: Government effectiveness							
Government ICT usage	**0.1137*** (0.0355)**	**0.0680* (0.0381)**	**0.0447 (0.0425)**	**0.1531*** (0.0431)**	**0.0875** (0.0347)**	**0.0358 (0.0648)**	**0.0450 (.)**
Political Stability and Absence of Violence/Terrorism	0.0323	0.1145***	0.0946**	0.1247*	0.1470**	0.1242	-0.1629
	(0.0638)	(0.0380)	(0.0447)	(0.0638)	(0.0635)	(0.1546)	(.)
Log (GDP per capita)	0.5462***	0.2689	0.5363**	0.0819	0.1948	0.9914	-1.8627
	(0.1454)	(0.3007)	(0.2425)	(0.2029)	(0.1343)	(0.9896)	(.)
Log (Total population)	-1.1019***	0.2411	0.5477	0.2383	-1.6963***	2.5731	5.9094
	(0.3258)	(0.5568)	(0.6713)	(0.2603)	(0.5511)	(5.4723)	(.)
Time fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	457	314	251	167	160	44	22
Number of countries	42	32	24	17	15	4	2
R-Squared	0.28	0.21	0.27	0.42	0.44	0.60	0.90

Note: Robust standard errors in parentheses * p < 0.10, ** p < 0.05, *** p < 0.01

Appendix D.1: Effect of other types of ICT usage on government effectiveness: developed countries

	1	2	3
Dependent variable: Government effectiveness			
Individual ICT usage	**0.0633****		
	(0.0254)		
business ICT usage		**0.0088**	
		(0.0282)	
Overall usage			**0.2031*****
			(0.0503)
Political Stability and Absence of Violence/Terrorism	0.1301**	0.1220**	0.1307**
	(0.0551)	(0.0543)	(0.0545)
Log (GDP per capita)	0.3642**	0.3812**	0.2903*
	(0.1595)	(0.1587)	(0.1582)
Log (Total population)	0.1414	0.2358	-0.0061
	(0.2261)	(0.2286)	(0.2239)
Country fixed effect	Yes	Yes	Yes
Time Fixed effect	Yes	Yes	Yes
No. of Obs.	542	542	542
No. of countries	50	50	50
R-Squared	0.1063	0.0828	0.1658

Note: Robust standard errors in parentheses * p < 0.10, ** p < 0.05, *** p < 0.01

Appendix D.2: Effect of other types of ICT usage on government effectiveness: developing countries

	1	2	3
Dependent variable: Government effectiveness			
Individual ICT usage	**0.0481***		
	(0.0279)		
business ICT usage		**0.0657****	
		(0.0297)	
Overall usage			**0.1305*****
			(0.0414)
Political Stability and Absence of Violence/Terrorism	0.1057***	0.0958***	0.0943***
	(0.0324)	(0.0302)	(0.0307)
Log (GDP per capita)	0.2651***	0.2428**	0.2114**
	(0.0899)	(0.0964)	(0.0891)
Log (Total population)	-0.5484**	-0.6973***	-0.5325***
	(0.2149)	(0.1897)	(0.2000)
Country fixed effect	Yes	Yes	Yes
Time Fixed effect	Yes	Yes	Yes
No. of Obs.	895	895	895
No. of countries	88	88	88
R-Squared	0.213	0.213	0.233

Note: Robust standard errors in parentheses * p < 0.10, ** p < 0.05, *** p < 0.01

Appendix E.1: Effect of alternative ICT indexes on government effectiveness in developed countries

	1	2	3
Dependent variable: Government effectiveness			
E-Government	**0.7093****		
	(0.2663)		
E-Participation		**0.1682****	
		(0.0691)	
Online Service			**0.3246*****
			(0.1036)
Political Stability and Absence of Violence/Terrorism	0.1528***	0.1569***	0.1458***
	(0.0520)	(0.0550)	(0.0474)
Log (GDP per capita)	0.3374**	0.3333**	0.3501**
	(0.1670)	(0.1627)	(0.1631)
Log (Total population)	0.1085	0.1612	0.1180
	(0.2360)	(0.2147)	(0.2206)
Country fixed effect	Yes	Yes	Yes
Time Fixed effect	Yes	Yes	Yes
No. of Obs.	528	528	528
No. of countries	48	48	48
R-Squared	0.1237	0.1144	0.1307

Note: Robust standard errors in parentheses * p < 0.10, ** p < 0.05, *** p < 0.01

Appendix E.2: Effect of alternative ICT indexes on government effectiveness in developing countries

	1	2	3
Dependent variable: Government effectiveness			
E-Government	**0.2704**		
	(0.2168)		
E-Participation		**0.0321**	
		(0.0744)	
Online Service			**0.0671**
			(0.1172)
Political Stability and Absence of Violence/Terrorism	0.0878***	0.0868***	0.0867***
	(0.0325)	(0.0328)	(0.0327)
Log (GDP per capita)	0.3949***	0.3966***	0.3904***
	(0.1148)	(0.1196)	(0.1220)
Log (Total population)	-0.5549***	-0.5967***	-0.6060***
	(0.1894)	(0.1936)	(0.1855)
Country fixed effect	Yes	Yes	Yes
Time Fixed effect	Yes	Yes	Yes
No. of Obs.	964	961	964
No. of countries	88	88	88
R-Squared	0.2181	0.2123	0.2134

Note: Robust standard errors in parentheses * p < 0.10, ** p < 0.05, *** p < 0.01