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

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Abstract :

This paper aims to analyze the effect of digitalization on government effectiveness in developing and developed countries. Our study uses panel data from 138 countries from 2006 to 2016. To conduct this study, we use a panel methodology with fixed effects. The results suggest that governments use of ICTs improves their effectiveness in both developing and developed countries. However, this positive effect is higher in developed countries than in developing countries. Besides, we find that the effect of the aggregate use of ICT by individuals, businesses, and government on government effectiveness has a greater effect than the single-use by government, individuals, or businesses. Furthermore, when testing for geographical heterogeneity, the effect remains positive, except for countries in the Americas. We also investigate further analysis which confirm the validity and the robustness of our results. These findings highlight the fact that governments could fully benefit from digitalization by adopting policies that would foster the access and use of ICTs at all levels of the economy, i.e., from government itself, businesses and individuals.

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

JEL Codes: D73, H11, O33, O38, O57

1. Introduction

The economic literature has shown that governance is a key factor in economic growth, poverty reduction, and economic development (Khan, 2009; Kraay and Kaufmann, 2002; Kaufmann et al., 2009; Scully, 1988; Knack and Keefer, 1995; Barro, 1996; Mauro, 1995). However, if governance is so important for economic development, then one wonders how to foster effective governance? In this sense, Al-Marhubi (2004) and Garcia-Sanchez et al. (2013) analyze the determinants of government effectiveness. These studies find a set of factors that are important in explaining the effectiveness of a government. In addition to these factors, digital transformation has become an inevitable factor of good governance. Since the 2000s, ICTs have taken an important turn in the lives of individuals as well as in the functioning of various economies. This is due to the diversity of its offer in terms of services and the usefulness they provide to their users. These services are of several kinds and interest both private and public sector actors. One can thus speak about the use of the ICT by the companies, by the public administrations, and by the individuals as promoters of productivity gains (Brambilla and Tortarolo, 2018; Colombo et al. 2013; Dedrick, et al. 2013). For example, for several years now, 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 phenomenon is part of the digitalization of public administrations. Janssen and Estevez (2013) and Effah and Nuhu (2017) define digitalization as the transition from a traditional management of procedures, bureaucracy, and paperwork to a management via digital platforms. Irani et al (2008) adds that digitalization represents an advanced level of e-government procedures, which allows governments to improve their efficiency and effectiveness. More broadly, digital transformation is the integration and promotion of ICTs in daily activities. Therefore, we cannot imagine talking about governance today without talking about the role of digital transformation.

There are several ways in which digitalization can promote government effectiveness. First, it facilitates both internal and external collaboration between different segments of the administration (Islam et al., 2016). For example, the transmission and treatment of documents and reports can be done instantaneously, whereas in a non-digitized context, it will require a longer transmission time. Second, digitalizing administrations offers them a higher storage capacity for documents and archives, giving them a 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). In fact, through mobile phones, tablets, the internet, and social media, the way citizens interact with each other, with their administrations, and the way they take part in their country's governance has changed significantly. For their part, governments recognize the power of ICTs, social networks, and e-government to

advance and transform the public sector and potentially improve the quality of public services supply. They know that today, good governance cannot take place without considering ICTs. With this in mind, the United Nations (UN) is promoting the development of e-government for responsible, efficient, effective, and fair delivery of public services to all citizens. The UN argues that this enhances public confidence and ensures a transparent, participating, and collaborative development process.

The digital transformation in the mode of governance is topical in public debates and for international institutions such as the UN, the World Bank (WB) and regional institutions. Most of the existing studies on this issue focus instead on the link between ICTs and corruption or transparency (Bhattacherjee and Shrivastava, 2018; Sturges, 2004). Besides, Chen and Aklikokou (2019) use cluster analysis to assess the link between e-government and government effectiveness. Dobrolyubova et al. (2019) find that there is a positive correlation between government digitalization and the quality of public administration in 19 Europe and Central Asia countries. Others are more interested in linking the internet and corruption (Elbahnasawy, 2014; Kanyam et al, 2017; Chen and Aklikokou, 2019), bearing in mind that ICTs are not limited to the internet. Furthermore, many studies address the effect of ICTs on trust between citizens and government (Parent et al., 2005; Gracia and Arino, 2015; Porumbescu, 2016; Guriev et al., 2019). However, digitizing public administration's primary objective is to increase the supply of public services, encourage citizen participation in decision-making, and facilitate access to information on public management. The achievement of these objectives will help to build and increase trust in the government. Accordingly, Welch et al. 2005 find that the use of online services increases citizen satisfaction, increasing citizen confidence in the government. Furthermore, Santa et al. (2019) show that there is not a direct link between the availability of online public services and the operational effectiveness of government. They find that the link is between the availability of the system and its quality and citizen satisfaction. Tolbert and Mossberger (2006) explain that online services increase trust in government and its effectiveness. Nonetheless, these studies each examine individual country cases rather than a set of countries.

Giving the existing literature, the objective of this paper is to investigate the effect of digitalization on government effectiveness using data on 138 developing and developed countries over the period 2006 to 2016. We therefore contribute to this literature on government effectiveness on several points. First, we investigate the effect of digitalization on government effectiveness, providing an empirical analysis of the influence of digital transformation on governance, which differs to the approach used by Dobrolyubova et al. (2019). Second, unlike

many studies on digitalization, we use a different measure of digitalization extracted from Global Information Technology Reports (GITR) and which is a complete measure of digital transformation, considering variables related to ICTs access and uses. The advantage of using an index that includes many indicators is that it captures all digitalization dimensions and makes the index more exhaustive. Third, we offer a comparative analysis of the effect of digitalization on government effectiveness regarding countries development level or geographical location. We use a panel model with fixed effects. Our baseline results suggest that government use of ICTs improves its effectiveness. Moreover, we found that the effect is greater for developed countries. Besides, we found that the overall use of ICTs affects government effectiveness more than individual, business, or government usage separately. Our results are robust to alternative measures of digitalization, additional control variables, and endogeneity concerns.

The rest of the paper is structured as follows. In section 2, we describe the data and the identification strategy. We discuss the main results in section 3. Section 4 focus on testing the robustness of our results. Finally, we provide a conclusion of the study and economic policy implications in section 5.

2. Data and methodology

2.1. Variables and data description

To assess the effect of digitalization on government effectiveness, we use data for 138 countries, including 88 developing and 50 developed countries.[1] The study covers 11-years, from 2006 to 2016. The dependent variable is government effectiveness from Worldwide Governance Indicators (WGI) 2019, and the main explanatory variable is government ICTs usage that we collected from the Global Information Technology Report (GITR)[2] from 2006 edition to 2016.[3] Based on existing literature on the determinants of government effectiveness (La Porta, 1999; Garcia-Sanchez and Cuadrado-Ballesteros, 2013, 2016; Montes and Paschoal, 2016; Duho et al., 2020), we retain a set of control variables (GDP per capita, population size, stability and absence of violence). The institutional variables are sourced from the International Country Risk Guide (ICRG) and WGI, while the other variables are from the World Development Index 2020 (WDI).

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

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.

ICT usage: ICTs usage index aims to measure the extent to which ICTs are used and integrated into people's lives in a country. Also, it indicates changes in behavior, lifestyle, and other economic and non-economic benefits associated with its adoption. The index includes sub-indexes of use by individuals, businesses, and governments. Each sub-index is composed of several ICTs variables, and the index is the average of these sub-indexes. The index and sub-indexes values range from 0 to 7, with 7 being the best score. In this study, we are especially focused on the government use of ICTs sub-index. We expect a positive effect of government usage of ICTs on its effectiveness.

GDP per capita: It measures the share of GDP an individual hold (it is the ratio of annual GDP to the number of inhabitants) and the country's level of development. The more developed a country is, the more effective the government appears to be. Moreover, development tends to be accompanied by more involvement in public management. Therefore, we expect a positive effect of GDP per capita on government effectiveness.

Total population: The total population estimates the number of people living legally on the territory of a country in the middle year. An abundant population means more work for the government and more people to satisfy through the supply of public goods and services. Also, it will be difficult for the government to take individual preferences into account to adjust the supply of goods and services. It is therefore difficult for a government to satisfy an abundant population. Otherwise, when the population increases, the government will find it difficult to be effective. Nonetheless, large populations can be an incentive for policymakers to improve the supply and quality of services and to simplify procedures. It thus appears difficult to predict the effect of this variable on government effectiveness.

**Political Stability and Absence of Violence/Terrorism:** It reflects the degree of stability and absence of insecurity in a country. In a country plagued by violence and instability, development efforts will fail. The priority will therefore be to create a climate of peace and stability. Under such conditions, the government can be economically efficient because political stability and peace are

prerequisites for economic development. We therefore expect that this variable will have a positive effect on government effectiveness.[4]

2.2. Stylised fact

Figure 1 shows the evolution and level of government effectiveness for developed and developing countries over the research period regarding the stylized fact. It indicates that government effectiveness is negative in developing countries, meaning that governments have a poor level of effectiveness. In contrast, in developed countries, the level of effectiveness is better as 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 has gradually improved while it has remained relatively stable in developed countries.

Figure 1: Average effectiveness by country group
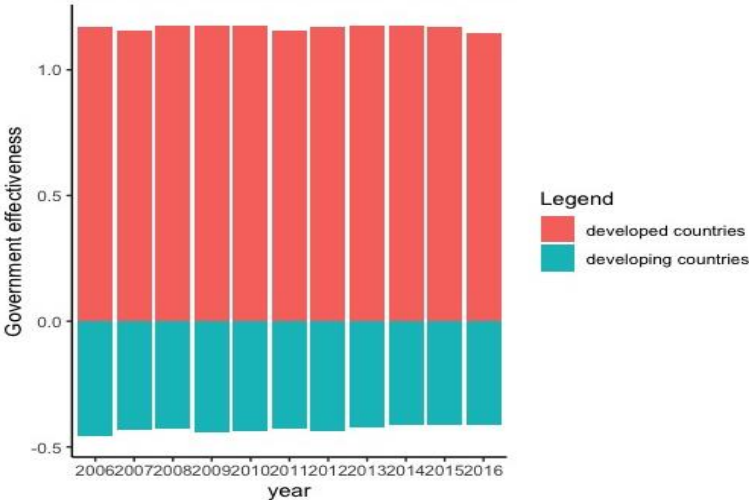
Source: Author construction with WGI data

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[4] Appendix B presents extensive definitions and sources of all variables used in this study, while Appendix C gives summary statistics.

Figure 2: Trend of ICT usage by component from 2006 to 2016
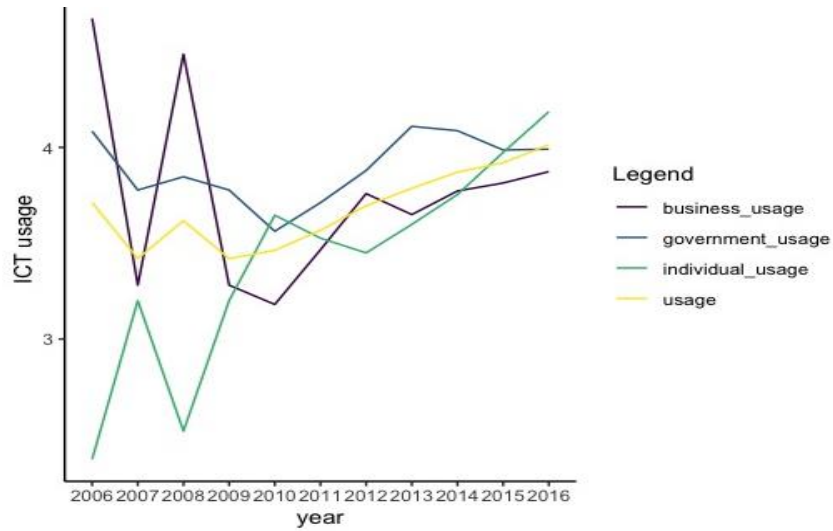
Concerning digitalization, we constructed a trend graph of ICTs use and its sub-indexes (Figure 2). We can see that ICTs use and its sub-indexes are on the rise in general. However, government use of ICTs is the highest in the first years of the study. Over the last three years, we observe that individual usage exceeds business and government usages.

Figure 3: Scatter plot between ICT usage and government effectiveness
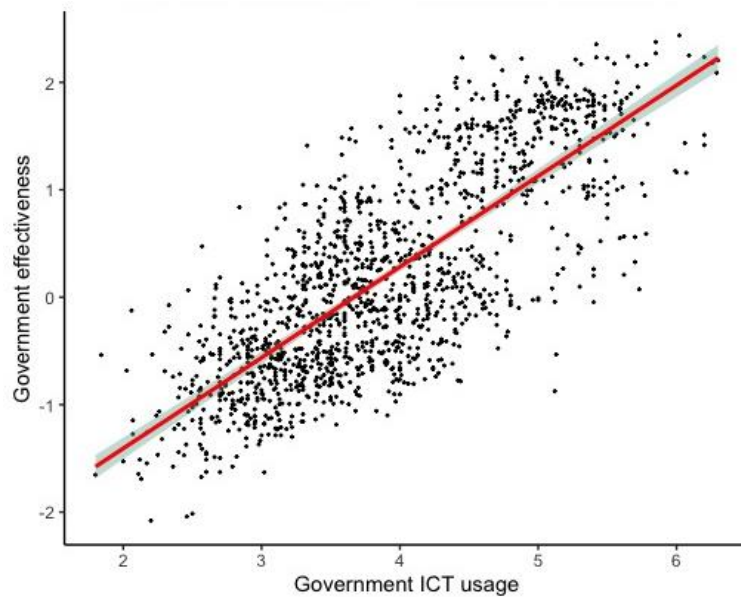
Figure 3 presents a scatter plot and a correlation between ICTs use by governments and their effectiveness. There is a positive correlation between digitalization and effectiveness. A positive effect of ICTs use on government effectiveness can therefore be expected. However, this graph does not confirm it because correlation does not necessarily mean causality.

2.2. Identification strategy

To assess the effect of ICTs usages on government effectiveness in developed and developing countries, we specified a panel fixed effects model. We present the model in the equation below (eq.1), where GEE is the government effectiveness. In the right size, ICT_{it} indicates digitalization for country i in year t. α_i, γ_t, X_{it}, and ε_{it} refers to country and time fixed effects, the set of control variables, and the error-term, respectively. In addition, φ is the constant term of the model and δ represents our coefficient of interest.

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

3. Empirical results

Table 1 presents the impact of ICTs use by the government on its effectiveness. In column 1, we estimate the effect using only government ICTs usage (GIU) as an explanatory variable. The results show a positive and significant effect of GIU on government effectiveness at the 1 percent level. However, this specification surely suffers from omission variables bias. We then estimate the model using additional explanatory variables that can affect the effectiveness of a government. The random-effects results in column 2 show a positive effect of GIU on government effectiveness. Nevertheless, since each country has its own individual characteristics that may or may not influence the predictors, we add country fixed effect. Results in column 3 remain the same as for random effect estimation. We finally estimate it by adding time fixed effects. Moreover, we control both time and country fixed effects simultaneously (columns 4 and 5, respectively). The effect of GIU on effectiveness is still significant at the 1 percent level and increases passing from 0.075 (column 3) to 0.1095 (column 4) point and 0.1004 (column 5). These results mean that an increase in the government's ICTs usage by 1-point leads to improvement of its effectiveness by 0.1 points.

The coefficient of Political stability and absence of violence or (and) terrorism is significant at the 1 percent level and is positive. This indicates that stability and absence of violence are determinants for a government to be effective as expected. In a country with an important level of violence, government tends to be ineffective. The results show that if stability increase by 1 point,

government effectiveness will be improved by approximately 0.093, ceteris paribus. We also find that GDP per capita positively and significantly affects government effectiveness. For total population, we find a non-significant effect on government effectiveness.[5]

Moreover, since our sample includes developing and developed countries, one might think that a specific group rather drives the positive and significant effect. Furthermore, it would be interesting to compare the effect of digitalization on government effectiveness in each country group. We, therefore, split our sample into two group, i.e., developing, and developed countries. The results are presented in table 2. We found that public administration's digitalization has a positive and significant impact on government effectiveness in both developed (column 1) and developing (column 2) countries. However, the effect seems to be higher in developed countries compared to developing countries. Several factors could explain this result. In fact, partial digitization[6] and an institutional culture of paperwork are common in developing countries (Schuppan, 2009; Wiredu, 2012; Effah and Nuhu, 2017). This could limit their ability to fully benefit from the effects of digitalization.

Table 1: Effect of GIU on government effectiveness

	1	2	3	4	5
Dependent variable: Government effectiveness					
Government ICT usage	**0.1239*****	**0.0749*****	**0.0750*****	**0.1095*****	**0.1004*****
	(0.0149)	**(0.0147)**	**(0.0152)**	**(0.0182)**	**(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
Observations	1437	1437	1437	1437	1437
Number 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*

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[5] This variable is tacked in logarithm for interpretation facilities.

[6] Partial digitization refers to the fact that it is effective for a part of the actors and not effective for other parts who are therefore excluded because of a lack of access to internet or electricity for example.

	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
Observations	542	895
Number 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 issues

First, we suspect a possible reverse causal effect between GIU and government effectiveness. In fact, we are assuming here that digitalization impacts government effective. However, an effective government will tend to increase the ICTs usage to deliver online services or improve its effectiveness and services quality. To deal with this possible reverse causality, we follow Datta and Agarwal (2004) by estimating the model lagging in GIU. We therefore replace in our specification the digitalization variable by its one, two- and three-year(s) lag, respectively. Table 3 presents the results. The effect of digitalization on government effectiveness stays positive and significant at the conventional thresholds in these three specifications. According to Datta and Agarwal (2004), these results mean that the impact of digitalization on government effectiveness is not only due to the two-way causality.

Second, reverse causality could come 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 create more wealth. We, therefore, suspect a possible endogeneity of these variables. To address this endogeneity problem, we estimate a panel two-step system GMM (Blundell and Bond, 1998).[7] To overcome instrument proliferation bias, we restrict and collapse the set of instruments (Roodman, 2009). We aslso use Windmeijer's (2005) standard errors to correct the finite sample bias. The AR(2) and the Hansen tests p-values support our results' validity

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[7] We also consider digitalization variable as endogenous in the system GMM.

as the p-values are higher than all conventional thresholds (Table 4). We found that the effect of digitalization on government effectiveness remains positive and significant at the 1 percent thresholds (Table 4, columns 1 to 3). Besides, the magnitude of the coefficients have increased, which may result from the potential endogeneity bias correction.

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

	1	2	3
Dependent variable: Government effectiveness			
Government ICT usage (t-1)	0.0652***		
	(0.0194)		
Government ICT usage (t-2)		0.0469**	
		(0.0197)	
Government ICT usage (t-3)			0.0320*
			(0.0162)
Political Stability and Absence of Violence/Terrorism	0.0970***	0.0985***	0.0947**
	(0.0322)	(0.0351)	(0.0391)
Log (GDP per capita)	0.2604***	0.3408***	0.4122***
	(0.0883)	(0.0907)	(0.1063)
Log (Total population)	-0.2182	-0.2686	-0.3440*
	(0.2261)	(0.2032)	(0.1988)
Country fixed effect	Yes	Yes	Yes
Time Fixed effect	Yes	Yes	Yes
Observations	1308	1174	1037
Number of countries	138	138	138
R-Squared	0.15	0.15	0.14

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

Table 4: Panel two-step system GMM estimation results

	1 Full sample	2 Developed countries	3 Developing countries
Dependent variable: Government effectiveness			
Government ICT usage	0.318***	0.227***	0.272***
	(0.0371)	(0.0589)	(0.0392)
Political Stability and Absence of Violence/Terrorism	0.290***	0.443**	0.189***
	(0.0507)	(0.2106)	(0.0419)
Log (GDP per capita)	0.345***	0.411***	0.211***
	(0.0351)	(0.1397)	(0.0364)
Log (Total population)	0.025	0.009	0.029
	(0.0217)	(0.0387)	(0.0218)
Time fixed effect	Yes	Yes	Yes
Observations	1437	542	895
Number of countries	138	50	88
Instruments	80	23	23
AR1-pvalue	0.00	0.00	0.00
AR2-pvalue	0.92	0.80	0.99
Hansen-P-value	0.11	0.16	0.74

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

4.2. Sensitivity analysis

To test the sensitivity of our results, we add more variables that could affect government effectiveness. They are education, control of corruption, the rule of law, voice and accountability, regulatory quality, government stability, government size, and the proportion of women in parliament.[8] After adding these new variables (table 5, columns 1 to 9), the effect of GIU on government effectiveness remains positive and significant at the 1 percent level, confirming the robustness of our results. Regarding additional variables, we found that better control of corruption, the rule of law, regulatory quality (respectively in columns 2 to 4), and government stability (column 6) all improves government effectiveness. As for education (column 1), voice and accountability (column 5), government size, and the proportion of women in parliament (columns 8 and 9 respectively), their effects on government effectiveness are not significant at the conventional thresholds. We also found that more natural resource revenue negatively and significantly impacts government effectiveness (column 7). The Dutch disease theory can explain this effect.

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[8] We capture the size of government using the final consumption of government relative to GDP, while the proportion of women in parliament is used to capture the gender composition of government.

	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 by geographic region

We carry out a heterogeneity analysis to test if the effect of digitalization on government effectiveness differs across geographic regions. For this purpose, we divided the database into four sub-samples according to the continent of each country.[9] The results displayed in table 6 show that GUI positively and significantly affects government effectiveness of African (column 1), Asian and European countries (Column 3 and 4). However, the effect is not significant for American countries, although it is positive (column 3).[10]

Table 6: Geographical heterogeneity

	1 Africa	2 America	3 Asia	4 Europa
Dependent variable: Government 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*

4.4. Disaggregating ICT usage Index

While there is an evidence that public administration's digitalization has a positive effect on government effectiveness, this effect could appear to be only partial. Indeed, ICTs use by the government alone could only affect its internal effectiveness, particularly in terms of management and current activities. However, the use of ICTs by other actors such as individuals and businesses

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[9] We have assigned the continent for each country according to the football confederation to which it is affiliated. This allows us to easily classify countries that straddle two continents. In addition, there are two countries of Oceania (namely Australia and New Zealand) that we do not consider in this heterogeneity analysis due to the low number of observations.

[10] When we disaggregate into South and North American countries, we find that the effect remains positive and non-significant for North American countries while it is positive and significant for Southern countries. Therefore, it could be assumed that the non-significant effect comes from North American countries. This could be explained by the fact that some American people lack trust in the government. In addition, some Americans are suspicious of digitalization because they think it is a way to control them and get private information about them. Furthermore, the countries of North America are forerunners and much more advanced in terms of digitalization. Moreover, these countries are already quite efficient without digitalization. Thus, an increase in the level of digitalization will have a negligible marginal effect.

can also improve government effectiveness. For example, suppose the government introduces individuals' possibility to conduct their administrative procedures online to reduce delays and ease procedures, while individuals do not use this alternative or do not have access to a connection device and internet, and prefer physical procedures. In that case, the government's goals will not be achieved. In this sense, Brun et al. (2019) argue that the implementation of e-procedure for tax returns and tracking VAT credit refunds for businesses in some countries have certainly reduced the burden related to revenues collection and have increased tax revenues. However, it is possible if the taxpayer has access to, and uses ICTs. This is undoubtedly facilitated by the fact that businesses and individuals already have access to and use ICTs. To test these issues, we assess the effect of individual, business, and overall use of ICTs on government effectiveness. The results displayed in Table 7 found that Individuals (column 1), businesses (Column 2), and overall (column 3) uses of ICTs positively and significantly affect government effectiveness.

Moreover, in line with our intuition, we find that the effect of overall usage (0.1665) is higher. This underlines the importance of making ICT available to all actors and encouraging them to make full use of it to make the most of digitalization. We also compare the effects of these disaggregated variables on government effectiveness for both groups of developed and developing countries. The results are still positive and significant for both groups, except for business usage in developed countries. Moreover, these results support our 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 to promote digitalization at all levels. The results tables are displays in appendix D.1 and D.2, for developed and developing countries, respectively.

Table 7: Effect of ICT usage components 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***	0.1047***	0.0968***
	(0.0305)	(0.0295)	(0.0288)
Log (GDP per capita)	0.3102***	0.2836***	0.2545***
	(0.0829)	(0.0864)	(0.0837)
Log (Total population)	-0.0797	-0.1157	-0.1368
	(0.1839)	(0.2035)	(0.1713)
Country fixed effect	Yes	Yes	Yes
Time Fixed effect	Yes	Yes	Yes
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 digitalization measures: The E-Government Development Index (EGDI) from the United Nations E-Government Survey. EGDI is a composite indicator that consists of the Online Service Index, Telecommunication Index, and Human Capital Index.[11] These indexes are equally weighted and cover a broad range of topics that are relevant for e-government.[12] We consider, in addition, E-participation and online service. Table 7, columns 1 to 3 show that all considered indicators positively and significantly affect government effectiveness at conventional threshold. These results suggest that the increase in government effectiveness following ICTs usages does not change with the ICTs measures. The comparison between developed and developing countries groups presented in Appendix E.1 and E.2, reveals that the positive effects of digitalization variables for each of these groups still hold, although they are not significant for developing countries. This result for developing countries can be explained by the fact that there are many factors previously explained as partial digitalization, the lack of institutional reforms consisting to the substitution of paperwork-based management to digitalized-based management, and the low access to necessary infrastructures (Schuppan, 2009; Effah and Nuhu, 2017).

Table 8: Alternative ICT usage indexes effects 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*

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

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

5. Conclusion

Our study aims to investigate the impact of digitalization on government effectiveness using a panel fixed effects methodology. We consider a dataset for a sample of 138 developing and developed countries from 2006 to 2016. The results suggest that there is a positive and significant effect of digitalization on government effectiveness. This effect is greater for developed countries than for developing countries. Moreover, we find that the effect remains significant, positive, and approximately the same for countries on all continents except for American countries where the effect is non-significant. Besides, the results show that the effect is larger when we consider the overall uses of ICTs. Furthermore, the effect is still valid when examining their sensitivity to several political, institutional, and macroeconomic conditions.

Our results highlight the fact that government in developing and developed countries could improve their effectiveness through digital transformation. Furthermore, to benefit from the full returns of digitalization, they should adopt some policies that would foster the use of ICTs at all levels of the economy, i.e., from government itself, businesses and individuals. These policies should more concentrate on increasing the coverage of ICTs and the internet in the population. Furthermore, they have to build and improve infrastructure related to modern technologies, particularly for developing countries. Also, they need to adopt some policy reforms aiming to modernize public administrations. Besides, they should offer more services online and digitize most administrative procedures. They should also promote engagement and collaboration through participating governance via ICTs.

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.

Acknowledgments

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Appendices

Appendix A: Countries list

No.	Country	Region	Income group	No.	Country	Region	Income group
1	Albania	Europe	Upper middle income	70	Latvia	Europe	High income
2	Algeria	Africa	Upper middle income	71	Lebanon	Asia	Upper middle income
3	Angola	Africa	Lower middle income	72	Lesotho	Africa	Lower middle income
4	Argentina	South America	Upper middle income	73	Libya	Africa	Upper middle income
5	Armenia	Europe	Upper middle income	74	Lithuania	Europe	High income
6	Australia	Oceania	High income	75	Luxembourg	Europe	High income
7	Austria	Europe	High income	76	Madagascar	Africa	Low income
8	Azerbaijan	Europe	Upper middle income	77	Malawi	Africa	Low income
9	Bahrain	Asia	High income	78	Malaysia	Asia	Upper middle income
10	Bangladesh	Asia	Lower middle income	79	Mali	Africa	Low income
11	Barbados	North America	High income	80	Malta	Europe	High income
12	Belgium	Europe	High income	81	Mauritania	Africa	Lower middle income
13	Benin	Africa	Low income	82	Mauritius	Africa	Upper middle income
14	Bosnia and Herzegovina	Europe	Upper middle income	83	Mexico	North America	Upper middle income
15	Botswana	Africa	Upper middle income	84	Moldova	Europe	Lower middle income
16	Brazil	South America	Upper middle income	85	Mongolia	Asia	Lower middle income
17	Brunei Darussalam	Asia	High income	86	Montenegro	Europe	Upper middle income
18	Bulgaria	Europe	Upper middle income	87	Morocco	Africa	Lower middle income
19	Burkina Faso	Africa	Low income	88	Mozambique	Africa	Low income
20	Burundi	Africa	Low income	89	Namibia	Africa	Upper middle income
21	Cambodia	Asia	Lower middle income	90	Netherlands	Europe	High income
22	Cameroon	Africa	Lower middle income	91	New Zealand	Oceania	High income
23	Canada	North America	High income	92	Nicaragua	North America	Lower middle income
24	Cape Verde	Africa	Lower middle income	93	Nigeria	Africa	Lower middle income
25	Chad	Africa	Low income	94	Norway	Europe	High income
26	Chile	South America	High income	95	Oman	Asia	High income
27	China	Asia	Upper middle income	96	Pakistan	Asia	Lower middle income
28	Colombia	South America	Upper middle income	97	Panama	North America	High income
29	Costa Rica	North America	Upper middle income	98	Paraguay	South America	Upper middle income
30	Cote d'Ivoire	Africa	Lower middle income	99	Peru	South America	Upper middle income
31	Croatia	Europe	High income	100	Philippines	Asia	Lower middle income
32	Cyprus	Asia	High income	101	Poland	Europe	High income
33	Czech Republic	Europe	High income	102	Portugal	Europe	High income
34	Denmark	Europe	High income	103	Puerto Rico	North America	High income
35	Dominican Republic	North America	Upper middle income	104	Qatar	Asia	High income
36	Ecuador	South America	Upper middle income	105	Romania	Europe	Upper middle income
37	Egypt, Arab Rep.	Africa	Lower middle income	106	Russian Federation	Europe	Upper middle income
38	El Salvador	North America	Lower middle income	107	Rwanda	Africa	Low income
39	Estonia	Europe	High income	108	Saudi Arabia	Asia	High income
40	Ethiopia	Africa	Low income	109	Senegal	Africa	Lower middle income
41	Finland	Europe	High income	110	Serbia	Europe	Upper middle income
42	France	Europe	High income	111	Singapore	Asia	High income
43	Gabon	Africa	Upper middle income	112	Slovak Republic	Europe	High income
44	The Gambia, The	Africa	Low income	113	Slovenia	Europe	High income
45	Georgia	Europe	Upper middle income	114	South Africa	Africa	Upper middle income
46	Germany	Europe	High income	115	Spain	Europe	High income
47	Ghana	Africa	Lower middle income	116	Sri Lanka	Asia	Upper middle income
48	Greece	Europe	High income	117	Suriname	South America	Upper middle income
49	Guatemala	North America	Upper middle income	118	Swaziland	Africa	Lower middle income
50	Guinea	Africa	Low income	119	Sweden	Europe	High income
51	Guyana	South America	Upper middle income	120	Switzerland	Europe	High income
52	Haiti	North America	Low income	121	Tajikistan	Asia	Low income
53	Honduras	North America	Lower middle income	122	Tanzania	Africa	Low income
54	Hong Kong	Asia	High income	123	Thailand	Asia	Upper middle income

55	Hungary	Europe	High income		124	Timor-Leste	Asia	Lower middle income
56	Iceland	Europe	High income		125	Trinidad and Tobago	North America	High income
57	India	Asia	Lower middle income		126	Tunisia	Africa	Lower middle income
58	Indonesia	Asia	Lower middle income		127	Turkey	Europe	Upper middle income
59	Iran, Islamic Rep.	Asia	Upper middle income		128	Uganda	Africa	Low income
60	Ireland	Europe	High income		129	Ukraine	Europe	Lower middle income
61	Israel	Asia	High income		130	United Arab Emirates	Asia	High income
62	Italy	Europe	High income		131	United Kingdom	Europe	High income
63	Jamaica	North America	Upper middle income		132	United States	North America	High income
64	Japan	Asia	High income		133	Uruguay	South America	High income
65	Jordan	Asia	Upper middle income		134	Venezuela, RB	South America	Upper middle income
66	Kazakhstan	Europe	Upper middle income		135	Vietnam	Asia	Lower middle income
67	Kenya	Africa	Lower middle income		136	Yemen, Rep.	Asia	Low income
68	Kuwait	Asia	High income		137	Zambia	Africa	Lower middle income
69	Kyrgyz Republic	Asia	Lower middle income		138	Zimbabwe	Africa	Lower middle income

Source: Author construction with WDI database

Appendix B: 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."	
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."	Worldwide Governance Indicators (WGI) by World Bank
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.	
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.	World Development Indicators (WDI)
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)	Total natural resource tax revenues	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."	
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 ")"	UN E-Government Survey 2020 - United Nations
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.	
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.	Global Information Technology Report (GITR)
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 description from GITR, ICTD, ICRG, WDI, WGI, and UN

Appendix C: Descriptive statistics

Variables	Number of Observations.	Mean	Standard Deviation	Min	Max
Government 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 enrolment, 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 D.1: Effect of ICT usage component on government effectiveness in 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 ICT usage component on government effectiveness in 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 other ICT indices 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*