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E-GOVERNMENT AND ECONOMIC GROWTH: A CROSS-COUNTRY ANALYSIS

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Abstract

The strategic objective of e-government is to promote efficient provision of public services. This study explores the effect of e-government on economic growth. A macroeconomic production function is used to examine the impact of e-government on economic growth. The archive data of 147 nations across the world over the years of 2003 to 2012 is employed and OLS and IV econometric techniques are used. The results exhibit that an increase in e-government adaption leads to high economic growth. The empirical findings of this research are robust to various control variables, to endogeneity problem and to different specifications of the model.

Key Words: *Economic Growth, E-government, ICT, Global Data*
JEL Classification: C23; H10; O40

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Introduction

Economic growth is very primitive topic which has been under discussion since 17th century and theories on economic growth are dated back to Adam smith. It has widespread consequences on well-being of mankind. The researchers have explored different determinants of economic growth such as capital stock, human capital, trade, technological progress and political stability. Recently, another factor e-government is considered a key factor of increasing economic prosperity of the nations. E-government is an important tool that promotes economic development in a country by assuring accountability and transparency in a country (Bhatnagar, 2003; OECD, 2005).

E-government is defined as "the use of Information and Communication Technology (ICT) by government for delivering and sharing of information and better services to the people" (Chen *et al.* 2009; Krishnan and Teo, 2012). The World Bank defines e-government as an area of exercising ideas and concepts of ICT in governance and empowering civilians, improving delivery of services, increasing transparency and accountability, and enhancing the efficiency of government sectors.

The formulation of e-government can be classified into three dimensions: development and evolution, adaption and implementation, and effect on stakeholders. The first two dimensions have captured the attention of researchers and third stage is not yet explored significantly by researchers (Srivastava, 2011). Most of the countries around the world have adapted e-government up to some extent. The implementation of e-government is influenced by various socio-economic and political factors.

Titah and Barki (2006) demonstrated that political situation, administrative and institutional structures and socio-economic infrastructure are the main factors that influence adaption of ICT by government. There is low probability of corruption and improbity in e-government machinery than outdated government machinery so jingoistic political leaders will incline to adopt ICT to impede malpractices in country (Majeed and Malik, 2016a).

The massive theoretical literature on e-government infers that e-government provides various benefits to country. For example, it improves the quality and efficiency public sector services (Al Kibsi *et al.*, 2001; West, 2004; Majeed and Malik, 2016b; Majeed and Khan, 2018) strengthens rule of law and democratic norms (Von Haldenwang, 2004), and mitigates malpractices and corruption (Mishra, 2006; Haigh and Griffith, 2008).

The literature also enlightens the fact that administration reforms held by e-government upsurge economic prosperity of a country (Majeed and Malik, 2016c; Majeed and Shah, 2018). The administration reform facilitates government to look after the deeds of administration. The e-government develops trust of public on government policies and strategies. The success of various policies launched by government needs the collaboration of citizens and collaboration of the citizens with government is

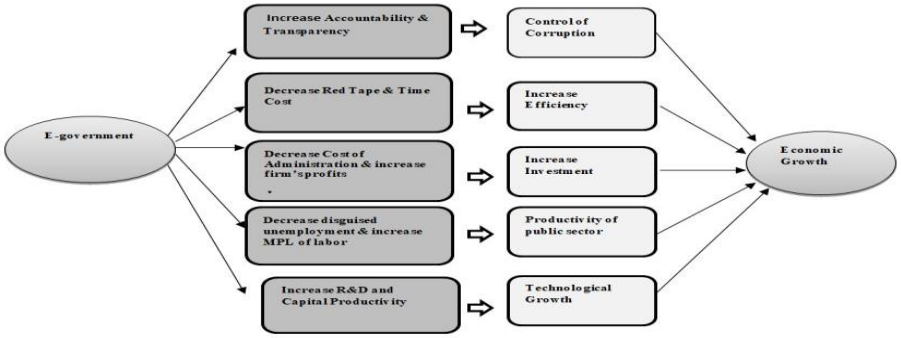
strengthened if the citizens trust on government. Tolbert and Mossberger (2006) proposed that e-government through it efficient provision of services to public can improve its credibility, citizen's trust and citizen's judgments about government.

Welch, Hinnant and Moon (2005) proposed that the provision of websites by the government improves citizen's satisfaction from the government and they trust more on government. Teo, Srivastava, and Jiang (2008) enunciated that public will satisfy with government websites if only they are satisfied with government. The confidence on government policies is actually driving force of trust on e-government not e-government is driving trust on government. They have used survey data of 214 government websites user from Singapore. They concluded that trust on government is not determined by technology but by effectiveness of government policies.

Some review studies indicate that e-government enhances the productive capacity of labor by increasing it marginal productivity (Grimes, Ren, and Steven, 2011). Bhuiyan (2010) studied the development consequences of ICT use by government in the case of Kazakhstan. He illustrated that Kazakhstan is also moving towards e-government to assure transparency, accountability and economic development. He asserted that e-government helps to resolve different predicament in government of Kazakhstan by cutting red tape cost, corruption, disguised unemployment in organization, administration cost of government and monitoring cost of public servants. E-government improves functioning of economy by improving relationship between internal administrations and international communities, fostering economic growth of economy, and strengthening social cohesion.

There are many channels that explain e-government and economic performance nexus. The flow chart given below illustrates the diverse mechanisms that link e-government with economic performance, but due to paucity of data and to avoid complexity in the paper we have avoided to find empirically the indirect association of e-government with growth through these channels. However, these channels provide the strong reasoning for the growth impact of e-government.

Figure 1: Effect of E-government on Economic Performance via Different Channels



In this regard, this study contributes to the literature by conducting a rigorous analysis for a panel of 147 countries. As there is a probability of reverse causality between growth and e-government because higher growth improves the quality of ICT use by government as well. Thus, e-government is an endogenous variable. The issue of endogeneity is resolved using internal and external instruments.

The remaining paper is structured in following parts: Section 2 comprises the relevant literature. Section 3 explains the data and empirical framework use in study. Section 5 and section 6 present the results of empirical study attained by OLS and instrumental variable techniques. Conclusion and policy recommendations are provided in Section 7.

Literature Review

Krishnan, Teo, and Lim (2013) argued that e-government increases growth by lowering corrupt practices and improving environmental quality. Using a cross-country data of 105 countries from 2004 to 2008, Their study confirmed e-government's positive contribution to growth of 105 economies from time spanning over 2004-2008. Choi and Yi (2009) empirically investigated the contribution of internet in economic performance for large set of 217 economies from 1991 to 2000. Findings of their research illustrate that 1% incline in internet subscriptions increases growth around 0.05% due to diffusion of knowledge and information.

Czernich *at al.* (2011) investigated the effect of broadband subscriptions on growth of OECD economies over the period 1996-2007. The production function employed in the study was stemmed from Mankiw *et al.* (1992). They used two models to measure the technology: In first model technology was measured by dummy variable that is one if broadband is adopted and zero otherwise and in the second model technology was proxied by the installation of broadband. The results validated the positive influence of broadband subscriptions on growth.

Andrianaivo and Kpodar (2011) demonstrated that dispersion of communication technology tools such as mobile and fixed telephone play a central role in economic prosperities of the nations. They argued that contribution of ICT to growth is mediated by capital accumulation, financial inclusion, rural development, and market efficiency. The results of their study showed positive influence of ICT on growth of 44 African economies from 1988 to 2007.

In a recent empirical research, Majeed and Ayub (2018) estimated the influence of ICT on growth of 149 countries over the time period 1980-2015. They also validated the positive effect of ICT on growth. They also conducted a disaggregated analysis of ICT-economic growth nexus. Their findings suggest that the developing world is benefitting more from ICT.

The literature has picked merely the online component of e-government and relied on the use of internet. The internet is just a part of e-government; whereas e-government is a

comprehensive measure that contains "all information and communication technologies, web structure, and skilled labor that help in the functioning of e-government". This paper extends the empirical literature on ICT-growth relationships by examining the growth effect of e-government for 147 countries.

Empirical Framework and Data Description

We employed macroeconomic "Cobb-Douglas production function" of Mankiw *et al.* (1992) having constant return to scale and three input such as labor, capital, and human capital.

$$Y = AK^{\alpha}HC^{\beta}L^{1-\alpha-\beta} \qquad \textbf{(1)}$$

Taking the natural log of the above equation will give us

$$logy_i = logA_i + \beta_1 logK_i + \beta_2 logHC_i + \beta_3 logL_i \qquad \textbf{(2)}$$

A is given technology, Y is real per-capita income, K is capital stock, HC is human capital and L is labor force. The capital stock has been considered as a key factor of growth in literature and productive capacity of country depends on capital stock (Lucas, 1998). The research on labor and economic growth nexus has been dated back to Adam smith. Increase in labor force enhances marginal productivity of physical capital that upsurges output and economic growth (Mankiw *et al.*, 1992). Human capital is the skilled labor force that is equipped with scientific knowledge, modern skill, and education. The advocates of endogenous growth model emphasize on importance of human capital in determining the growth (Lucas, 1998).

In our study we are considering the impacts of neutral technological progress on economic growth. In order to avoid complexity in the study by employing labor augmented or capital augmented technological progress we have employed neutral technological progress. Our study is based on the panel data of different countries so it is difficult of bifurcate the labor or capital augmented technological progress. Technological progress proxied by e-government augments the marginal productivity of labor and capital at the same time. Marginal productivity of labor increases due to increase in efficiency and marginal productivity of capital increases due to decrease in disguised unemployment by layoff in the firms.

The technological growth sets the fate of economic growth. We suppose that technology is exponentially evolving over time because when we explain technology with ICT the growth of ICT is slow at initial stages but once it gets momentum then it grows rapidly. Consider the tremendous power of the exponential growth of computers, mobile phones, and internet. Competition among MNCS leads to latest version of computers, android phones, ICT infrastructure that led the exponential growth of ICT. Similarly e-

government has inertia, it does not develop at once but once it captures the momentum then its start developing rapidly. So A can be express as

$$A_i = A_{0e^{\theta}} \qquad \textbf{(3)}$$

Taking log of equation

$$logA_i = logA_0 + \theta \qquad \textbf{(4)}$$

θ shows technological growth of country.

The government possessed with ICT infrastructure enhances technological progress of the country by facilitating spillover of knowledge, research and development, and production of new technologies so θ can be defined in terms of e-government:

$$\theta = \alpha_1 + \alpha_2 EG_i \qquad \textbf{(5)}$$

Putting equation 5 in equation 4

$$logA_i = \alpha_0 + \alpha_1 + \alpha_2 EG_i \quad \textbf{(6)}$$

Where $\alpha_0 + \alpha_1 = \alpha$

$$logA_i = \alpha + \alpha_2 y_i \qquad \textbf{(7)}$$

By substituting equation 7 in equation 2 we get equation 8

$$logy_i = \alpha + \alpha_2 EG_i + \beta_1 logK_i + \beta_2 logHC_i + \beta_3 logL_i \qquad \textbf{(8)}$$

The catch up effect" alternatively named "convergence theory" is also advocated by Solow in 1956 in his famous "Solow model" which proposed that growth of the country having low per-capita income is higher than that of having high per-capita income. The convergence theory advocate the convergence in per-capita income of rich and poor countries due to opposite difference in growth rate of per-capita in rich and poor countries. Following Barro (1991), an initial level of per-capita income is inserted into equation 8.

$$logy_i = \alpha + \alpha_1 logY_{initial,i} + \alpha_2 EG_i + \beta_1 logK_i + \beta_2 logHC_i + \beta_3 logL_i \qquad \textbf{(9)}$$

To check the sensitivity of empirical findings, we have incorporated inflation, government consumption, and trade as control variables. Inflation, government consumption and trade are important factors of growth. Inflation a "continuous increase in prices" influenced the economic growth of country (De Gregorio, 1992; Barro, 1991).

The advocates of macroeconomic efficiency of government consumption and trade on economic growth are Barro (1991), Majeed and Ahamd (2006) and Majeed (2016).

$$Logy_i = \alpha + \alpha_1 logy_{initial,i} + \alpha_2 EG_i + \beta_1 logK_i + \beta_2 logHC_i + \beta_3 \log L_i + \beta_4 \log X_i + U_i \quad \textbf{(10)}$$

Equation 10 is key equation of empirical model. EG represents the e-government, X is the matrix of control variables, and U is error terms.
Where I stands for countries i=1, 2, 3 ….n

3.2 Data

We are dealing with cross sectional data set derived from taking averages of data over the year of 2003 to 2012. The multiyear averages of data produced more efficient and robust results than single year data (Hair, Anderson, and Tatham, 1995) because single year data may provide us misleading results so multiyear averages preclude the possibility of biasness in results due to some particular event or year.
The dependent variable is per-capita GDP and independent variables are human capital, physical capital stock, initial value of GDP per-capita, and e-government. The control variables are inflation, government consumption, and trade. The data on e-government is taken from EGDI also called E-government Readiness Index composed by the United Nations (2008).
E-government variable is weighted average of three indexes: human capacity, scope and quality of online service, and telecommunication service. The reason of putting online service and telecommunication service in e-government index is that it covers the ICT (information and telecommunication Technology) that is the main constituent of e-government. Without knowing the extant of ICT in a country we cannot measure e-government quality. Similarly the intuition of putting human capital in e-government index comes from the ability of human to use ICT technology also defines e-government accessibility in a country.
The data ranges from zero to one: where one shows the best quality of e-government and zero shows the worst quality of e-government. Table 1 presents the description of E-government components.
Table 1: Description of the E-government and its Components

Online service: Online service measures "the level of web content accessibility of each country and based on emerging online presence with simple websites that enhances information service due to deployment of multimedia content and two way interactions, online provision of transactional service, and connected websites through which government communicates with their citizens using interactive tools."

Telecommunication service: Telecommunication service is based on personnel computers, internet users, telephones line, mobile phone subscription and fixed telephone subscription.

Human capital: Human capital index of e-government is based on "adult literacy rate and gross enrollment of primary, secondary, and tertiary education."

The growth is measured by taking the natural log of "GDP per capital at current $ prices", human capital is proxied by "gross secondary school enrollments", physical capital is measured by "gross capital formation in percentage of GDP", and labor force is proxied by share of labor ages above 15 years in total population. We have taken 1990 as a base year in order to measure initial per-capita income. The control variables such as inflation, trade, government consumption is proxied by GDP deflator, export plus import in percentage of GDP, and general expenditure of government at current $ prices. The data source is World development indicators (WDI) 2014.

Table 2 shows that there is positive correlation between e-government and GDP per capita income. The e-government components such as online service and telecom infrastructure are positively correlated with per capita income. The correlation among almost all the variables is less than 0.8 so we are not likely to confront with severe multicollinearity (Gujarati, 2012). We applied formal test of multicollinearity namely VIF (variance Inflating Factor).The VIF takes into account of the impacts of independent variables on standard errors of regression coefficients (Hair *et al.*,1995). The finding illustrates that values of VIF ranges from 1.03 to 4.5 and mean value of VIF is 2.66 which indicates that there is no serious concern of multicollinearity in our model.

Table 2: Correlation Matrix

Variable	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
1. Y	1.000									
2.Kapital	-0.100	1.000								
3. Labor	-0.099	0.0508	1.000							
4. HC	0.5769	0.009	-0.441	1.000						

5. EG	0.7518	-0.0618	-0.2983	1.000					
6. OS	0.5489	-0.0175	-0.3243	0.8773	0.8948	1.000			
7. Tele	0.8688	-0.0916	-0.2345	0.7295	0.9283	0.7347	1.000		
8. INF	-0.1493	0.0643	-0.1899	0.0704	-0.0888	0.0108	-0.1320	1.000	
9. GC	0.3628	-0.0214	-0.0555	0.2107	0.3833	0.2413	0.3857	-0.0699	1.000
10. Trade	0.2345	0.1833	-0.1426	0.1686	0.1372	0.1873	0.1496	-0.0681	-0.2311	1.000

Table 3: Summary Statistics of Data

Variable	Observation	Mean	Min	Max
Y	147	11692.31	179.401	94654.22
Y_{inital}	145	5342.72	182.797	36337.09
Capital	147	23.4887	9.85652	68.78322
Labor	147	63.29	41.42	86.63
HC	147	76.3208	11.7616	135.829
E-government	147	0.44781	0.08738	0 .87
Online_service	147	0.72186	0.20911	0 .98432
Telecom_infras	147	0 .22639	0 .00478	0 .77418
Inflation	147	212.8189	61.9757	2815.721
Gov_consump	147	6.22e+10	5.83e+07	2.23e+12
Trade	147	89.4306	27.0795	303.446
Urban _population	147	55.85076	9.5005	100
Fix_Telephone	147	19.6930	0 .04629	65.9294
$EG_{initial}$	145	0.40274	0.0000	0 .92706

We checked the function form of our variables by Link test and Ramsey omitted values test. The results confirm correct function form and no omitted variables in model. The p-value of hat square is 0.189 which implies that function from is correct. The p-value of Ramey test is 0.252 which infers that there are no omitted variables in model (see appendix). Table 3 presents the statistical description of dataset of variables.

Results

We have estimated our model with ordinary least squares (OLS) estimation because it is most efficient technique than any other technique. The findings illustrate that e-government has positive significant impact on economic growth. We have estimated five regressions in order to check the sensitivity of baseline findings. Nevertheless, we have also estimated our model with heteroscedasticity consistent regression (HCR) in order to produce unbiased results because there is a possibility of heteroscedasticity in panel data. The HCR also supports the positive impact of e-government on economic growth.

The coefficient of e-government in first regression indicates that 1% increase in e-government brings 2.18% increase in economic growth. The variable physical capital has an expected positive and significant suggesting that 1% increase in capital stock will bring 0.367% increment in growth. The result is consistent with economic literature (Lucas, 1998; Siddique and Majeed, 2015; Majeed, 2017; Majeed, 2019). The coefficient of labor force participation remains insignificant. The sign of coefficient of labor force consistent with empirical estimation of (Mankiw *et al.*,1992) but contrary to economics literature. The reason behind negative coefficient of labor participation is diminishing marginal productivity of labor.

The convergence term, initial per capita GDP, is highly significant and positive. We have taken data from across the world but most of the countries are under developing so that positive sign dominated. According to convergence theory, the country having low per capita income will eventually catch up the income of rich countries because of rapid growth in output due to high marginal productivity of labor. The coefficient of human capital indicates that 1% increase in skilled labor in country will enhance per capita income about 0.31%.

Table 4: E-government and Economic Growth -*OLS*

Growth	(1)	(2)	(3)	(4)	(5)	(6)
dependent	OLS	HCR	OLS	OLS	OLS	OLS
$Y_{initial}$	0.650***	0.650***	0.644***	0.645***	0.631***	0.616***
	(0.0532)	(0.126)	(0.0528)	(0.0528)	(0.0510)	(0.0601)
Kapital	0.367**	0.367	0.363**	0.358**	0.247*	0.271*
	(0.147)	(0.362)	(0.145)	(0.145)	(0.143)	(0.142)
Labor	-0.250	-0.250	-0.330	-0.246	-0.0227	-0.0983
	(0.307)	(0.339)	(0.307)	(0.316)	(0.311)	(0.307)
HC	0.312**	0.312*	0.392**	0.444***	0.446***	0.266
	(0.147)	(0.170)	(0.151)	(0.158)	(0.152)	(0.188)
Inflation			-0.140*	-0.152**	-0.160**	-0.156**
			(0.0718)	(0.0727)	(0.0700)	(0.0685)

GC				0.0313	0.0891***	0.0875***
				(0.0284)	(0.0321)	(0.0282)
Trade					0.398***	0.368***
					(0.116)	(0.114)
Online_service						1.153**
						(0.529)
Telecom_infras						0.577
						(0.442)
E-government	2.184***	2.184***	1.969***	1.583***	1.094*	
	(0.478)	(1.025)	(0.486)	(0.599)	(0.594)	
Constant	1.048	1.048	1.906	0.877	-2.387	-1.599
	(1.603)	(2.546)	(1.648)	(1.892)	(2.055)	(1.975)
Countries	145	145	145	145	145	145
R-squared	0.894	0.894	0.897	0.898	0.906	0.910

Note: "*** p<0.01, ** p<0.05, * p<0.1 (Standard errors in parentheses)"

In 3rd to 5th regression we have introduced inflation, government consumption, and trade successively to investigate the robustness of our findings. The coefficients of trade and government consumption infer the positive impact of trade and government consumption on economic growth whereas coefficient of inflation denotes the negative impact of inflation on economic growth. In 6th regression we have decomposed e-government into its components and results indicate that web connectivity or online service is contributing significantly in per-capita growth whereas telecom infrastructure has positive but insignificant impacts on growth.

There is a possibility of reverse causality from economic growth to e-government. Quality of e-government depends on economic growth of country because installation of ICT depends on economic performance. Czernich *et al.* (2009) proposed that successful penetration of broadband depends on economic performance of the country. Comin and Hobjin (2004) also inferred that 20 famous technologies had first adopted by developed countries. The other possible reason of reverse causality between e-government and economic growth is state intervention. The penetration and subscription of technology depends on extent of state intervention in economic decisions and technology further depends on economic growth of the country. We have applied two stage least squares (2SLS) and generalized method of moments (GMM) to fix the problem of possible endogeneity and reverse causality in the model.

Czernich *et al.* (2009) have used fixed telephone lines and cable-TV line per 100 inhabitants as instruments for broadband because broadband service is delivered to

people usually through fixed telephone and cable-TV line. Anderson (2008) used initial urban population and initial population as the instrument of e-government. He proposed that according to UDT (urban density theory) cost of internet and extras gradually alleviates as population of urban areas increases due to knowledge spillover effect, availability of other complementary tools of ICT such as broadband and knowledge of ICT.

Following the above rationale we have also used fixed telephone lines per 100 inhabitant, initial value of e-government (measured by 2003 index of EG), and share of urban population as instruments of e-government. The reasoning behind using initial value of e-government as instrument of e-government is inertia in e-government. The data of fixed telephones lines and share of urban population is taken from ITU (international telecommunication union) and WDI (world development index). Table 5 presents first stage results of model estimated by IV techniques. The results indicate that all external instruments have significant impacts on e-government.

The coefficient of initial level of e-government indicates that 1% increase in initial level of e-government causes 0.45 to 0.55% increases in e-government quality of country. The coefficient of fixed telephones lines indicates that 1% increase in fixed telephones lines will enhance e-government quality about 0.2% whereas coefficient of share of urban population indicates that 1% increase in share of urban population causes 0.04 to 0.05% increase in e-government.

Table 5: Empirical Finding of First stage of IV Techniques

First stage result of 2SLS				
E-government	(1)	(2)	(3)	(4)
(dependent)				
$Y_{initial}$	0.00110	0.00106	0.00182	-0.000715
	(0.00528)	(0.00530)	(0.00508)	(0.00483)
Kapital	0.00981	0.00971	0.00715	-0.00386
	(0.0122)	(0.0123)	(0.0118)	(0.0114)
Labor	0.0441*	0.0435	0.0604**	0.0807***
	(0.0266)	(0.0268)	(0.0261)	(0.0251)
HC	0.0694***	0.0702***	0.0793***	0.0750***
	(0.0114)	(0.0119)	(0.0117)	(0.0111)
Fix_Telephone	0.00223***	0.00223***	0.00218***	0.00220***
	(0.000424)	(0.000425)	(0.000407)	(0.000385)
urban pop	0.000533**	0.000536**	0.000394*	0.000433*
	(0.000243)	(0.000245)	(0.000237)	(0.000224)
$EG_{initial}$	0.551***	0.548***	0.476***	0.454***

	(0.0359)	(0.0378)	(0.0412)	(0.0393)
Inflation		-0.00141	-0.00548	-0.00603
		(0.00623)	(0.00607)	(0.00573)
GC			0.00820***	0.0129***
			(0.00225)	(0.00240)
Trade				0.0375***
				(0.00903)
Constant	-0.359***	-0.352**	-0.583***	-0.856***
	(0.135)	(0.140)	(0.148)	(0.155)
Observations	144	144	144	144
F-stat	392.84	341.34	332.63	337.45
R-squared	0.953	0.953	0.957	0.962

Note: "Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1"

The internal instruments such as government consumption, trade, human capital and labor have positive significant impact on e-government. The F-stats range from 332 to 392 that are very high. Similarly R^2 of first stage results is also very high. The findings of first stage of IV technique indicate that instruments are strong and valid.

Table 6 provides the second stage findings of 2SLS and GMM. The findings of 2SLS and GMM show that e-government significantly increases economic growth. In particular, 1% increase in e-government quality in the country will up surge economic growth about 1.9% to 2.7%. In the second regression we have estimated equation 10 by GMM which also advocates the baseline findings.

Table 6: Empirical findings of Second Stage IV techniques

Second stage results of 2SLS and Results of GMM					
Growth	(1)	(2)	(3)	(4)	(5)
(dependent)	2SLS	GMM	2SLS	2SLS	2SLS
E-government	2.684***	2.161*	2.423***	2.080***	1.862**
	(0.548)	(1.186)	(0.571)	(0.762)	(0.767)
$Y_{initial}$	0.607***	0.680***	0.609***	0.613***	0.594***
	(0.0556)	(0.131)	(0.0552)	(0.0559)	(0.0536)
Kapital	0.367***	0.260	0.364***	0.360***	0.267*
	(0.138)	(0.364)	(0.137)	(0.137)	(0.137)
Labor	-0.366	-0.425	-0.416	-0.345	-0.171
	(0.292)	(0.351)	(0.292)	(0.305)	(0.306)
HC	0.219	0.282*	0.297*	0.346**	0.319*
	(0.147)	(0.145)	(0.155)	(0.172)	(0.166)
Inflation			-0.108	-0.120*	-0.122*
			(0.0695)	(0.0717)	(0.0696)

GC				0.0245	0.0668*
				(0.0296)	(0.0346)
Trade					0.333***
					(0.115)
Constant	2.016	1.999	2.546	1.696	-0.784
	(1.565)	(2.887)	(1.589)	(1.934)	(2.180)
Countries	144	144	144	144	144
R-squared	0.901	0.899	0.903	0.903	0.909

Note: "*** p<0.01, ** p<0.05, * p<0.1 (Standard errors in parentheses)"

The results suggest that 1% increase in initial per-capita income leads to about 0.59% to 0.68% increase in economic growth. The human capital, physical capital, and government consumption have positive impact on growth whereas inflation causes negative and significant effect on growth. The positive effect of government consumption on growth is not robust.

To investigate the validity of instruments we have applied Hanson test, the p-values have accepted the null hypothesis of over identified restriction. That is, our selected instruments are exogenous and the findings are not biased because of endogeneity problem. The coefficient of e-government remains positive and significant in all regressions of instrumental variables techniques. The coefficients of e-government show that 1% increase in e-government will enhance economic growth about 1.9% to 2.7%.

Conclusion

This study explores the effect of e-government on economic growth using OLS, 2SLS, and GMM estimators. The intuition behind the different econometric techniques to estimate a single equation is to produce unbiased results and to check the sensitivity of results. The positive effect of e-government quality index on economic growth is unanimously supported by all the given econometric techniques. This finding is consistent with the studies which document favorable impact of ICT implementation in public sector (Al Kibsi *et al.,* 2001; Von Haldenwang, 2004; and West, 2004; Majeed and Shah, 2018)

To address the issue of reverse causality from economic growth to e-government we have introduced fixed telephone line per 100 inhabitant, share of urban population, and initial value of e-government as instruments for e-government. The Hanson test and first stage findings of 2SLS confirm the validity and strength of instruments. The coefficient of e-government indicates that 1% increment in e-government quality will bring 1.9% to 2.7% increment in economic growth.

This study recommends that domestic governments need to allocate substantial budget for installation of modern ICT infrastructure and also provide training to public

administration for successful function and operation of e-government. Future research can extend this research using other measure of ICT in public sector such as artificial intelligence and robots. Moreover, the links of ICT with sustainable development need to be explored.

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Appendix:

Table 7: Summary of Variables and their Data Sources

Variables	Description	Data source
Economic growth	"GDP per capita at current US $."	WDI (2014)
E-government	"The extent of the online availability of the government, telecom infrastructure, and human capital."	Global E-government Reports
Online service	"Extent of the web connectivity and online availability of the government."	Global E-government Reports
Telecom service	"Extent of telecom infrastructure of the government."	Global E-government Reports
Human capital	"Gross secondary school enrollment of total population."	WDI (2014)
Physical capital	"Gross fixed capital formation in percentage of GDP."	WDI (2014)
Labor supply	"Share of labor force participation total % of population."	WDI (2014)
Government Consumption	"General Government spending in the current US dollars."	WDI (2014)
Trade	"Exports plus imports as share of GDP"	WDI (2014)
Inflation	"GDP deflator"	WDI (2014)
Urban population	"Percentage of urban population in total population."	WDI (2014)
Fix_Telephone	"Fixed telephone lines per 100 inhabitant."	ITU statistics

Table 8: Linktest

Growth	Coef	Std. Err	t _value	P_value
_hat	1.4292	0.32663	4.38	0.000
_hatsq	-0.0252	0.01914	-1.32	0.189
_cons	-1.7705	1.36391	-1.30	0.196

Table 9: Ramsey Reset Test

	Ho: Model has no omitted values
F-stat	1.38
P_value	0.2526

Table 10: Variance Inflating Factor

Variable	E-government	$Y_{initial}$	HC	Kapital	Labor
VIF	4.58	3.37	3.07	1.24	1.03
1/VIF	0.2185	0.2965	0.3262	0.8051	0.9686

Mean value of VIF= 2.66

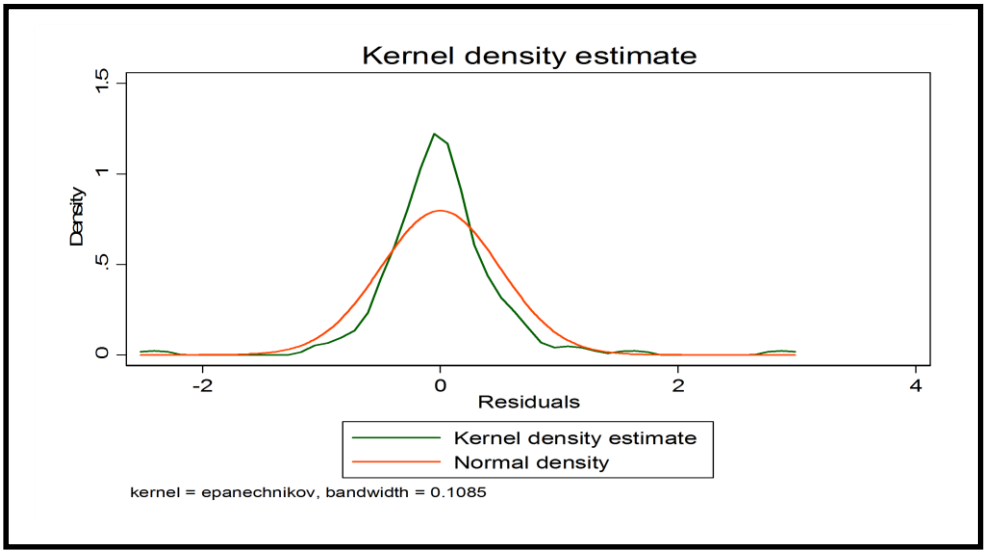


Figure 1: Density function of Residual

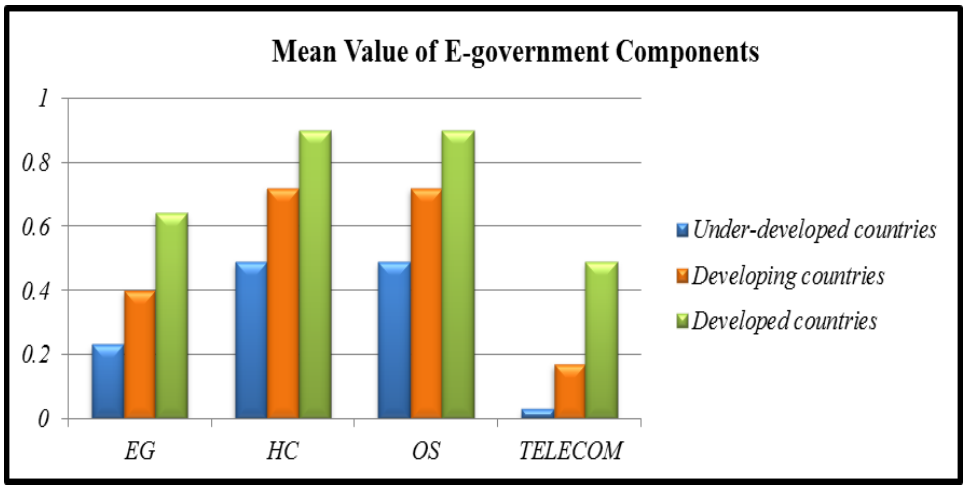


Figure 2: Quality of E-government in Developed, Developing and Under Developed Countries

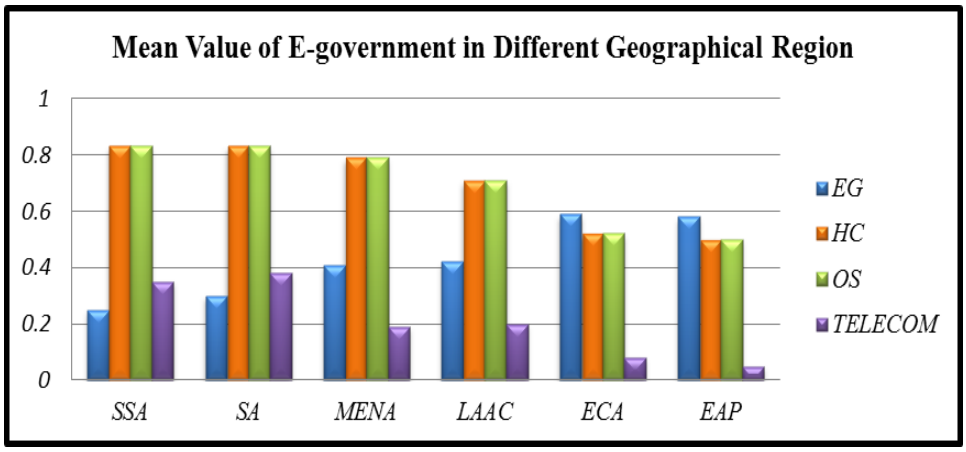


Figure 3: Quality of E-government in Different Geographical Regions of the World

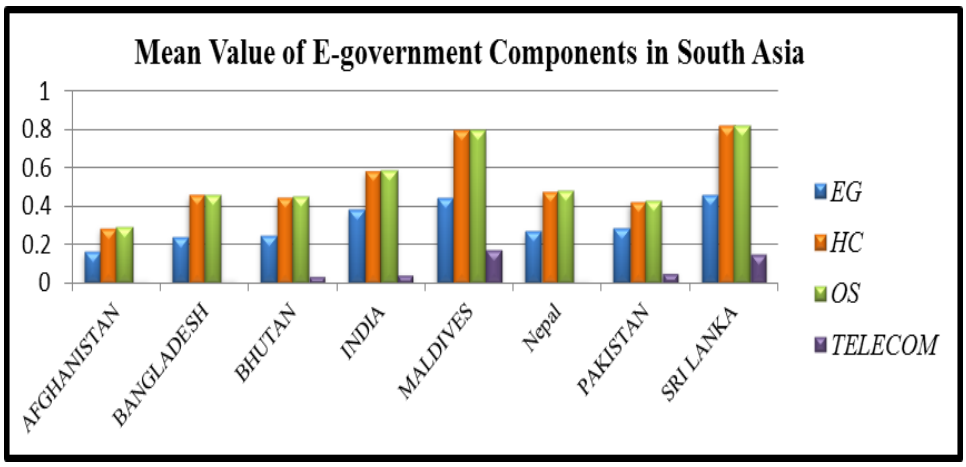


Figure 4: Quality of E-government in South Asia

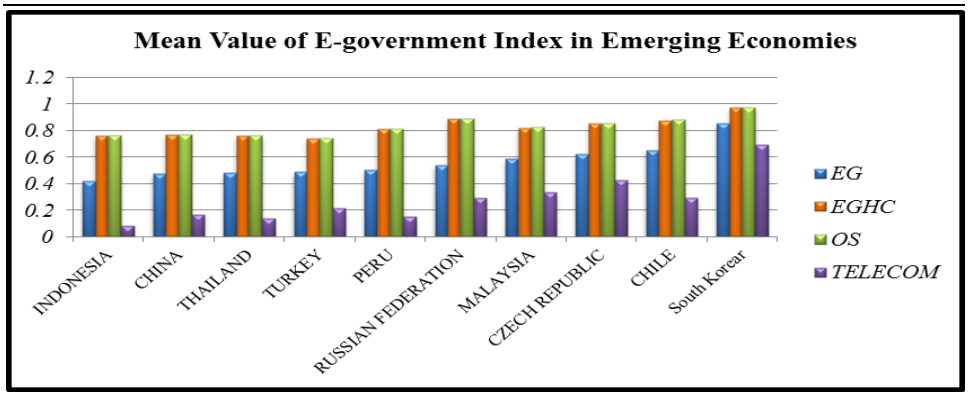


Figure 5: Quality of E-government in Emerging Economies

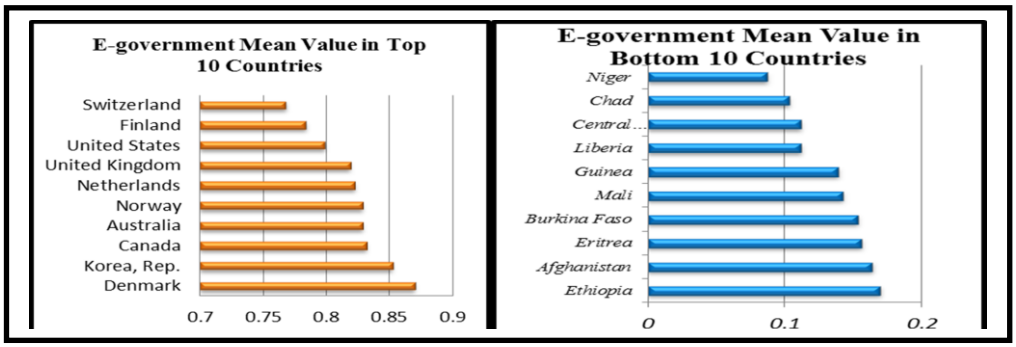


Figure 6: Quality of E-government in Top 10 and Bottom 10 Economies

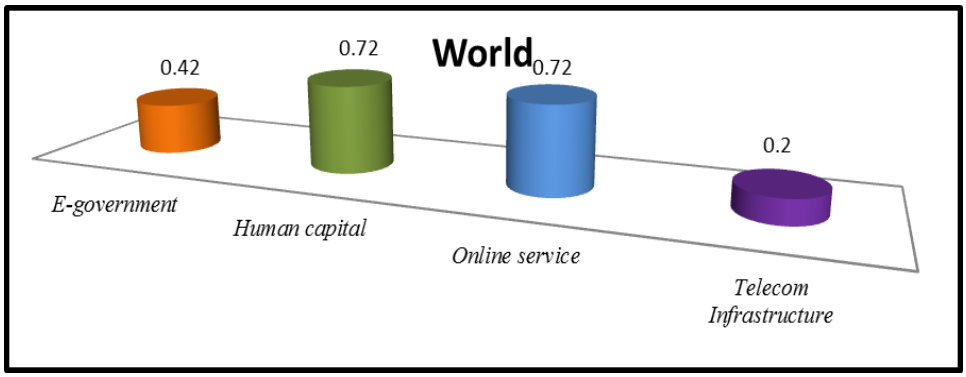


Figure 7: Average Quality of E-government in the World

Table 11: List of Countries

1	Albania	39	Denmark	77	Lesotho	115	Saudi Arabia
2	Algeria	40	Djibouti	78	Liberia	116	Senegal
3	Angola	41	Dominican	79	Lithuania	117	Serbia
4	Argentina	42	Ecuador	80	Luxembourg	118	Slovak Republic
5	Armenia	43	Egypt	81	Macao, China	119	Slovenia
6	Australia	44	El Salvador	82	Macedonia	120	Solomon Islands
7	Austria	45	Equat. Guinea	83	Malawi	121	South Africa
8	Azerbaijan	46	Ethiopia	84	Malaysia	122	Spain
9	Bahamas	47	Fiji	85	Mali	123	Sri Lanka
10	Bahrain	48	Finland	86	Malta	124	St. Lucia
11	Bangladesh	49	France	87	Mauritania	125	St. Vincent
12	Barbados	50	Gambia, The	88	Mauritius	126	Suriname
13	Belarus	51	Georgia	89	Mexico	127	Swaziland
14	Belgium	52	Germany	90	Moldova	128	Sweden
15	Belize	53	Ghana	91	Mongolia	129	Switzerland
16	Benin	54	Greece	92	Montenegro	130	Syria
17	Bhutan	55	Guatemala	93	Morocco	131	Tajikistan
18	Bolivia	56	Guinea	94	Mozambique	132	Thailand
19	Botswana	57	Guyana	95	Namibia	133	Togo
20	Brunei	58	Honduras	96	Nepal	134	Tonga
21	Bulgaria	59	Hungary	97	Netherlands	135	Trinidad & Tobago
22	Burkina Faso	60	Iceland	98	New Zealand	136	Tunisia
23	Burundi	61	India	99	Nicaragua	137	Turkey
24	Cabo Verde	62	Indonesia	100	Niger	138	Uganda
25	Cameroon	63	Iran	101	Nigeria	139	Ukraine
26	Canada	64	Ireland	102	Norway	140	United Kingdom
27	Central Africa	65	Israel	103	Oman	141	United States
28	Chad	66	Italy	104	Pakistan	142	Uruguay
29	Chile	67	Jamaica	105	Panama	143	Uzbekistan
30	China	68	Japan	106	Papua N Guinea	144	Vanuatu
31	Colombia	69	Jordan	107	Paraguay	145	Venezuela, RB
32	Comoros	70	Kazakhstan	108	Peru	146	Yemen, Rep.
33	Congo, Rep.	71	Kenya	109	Philippines	147	Zimbabwe
34	Congo, Rep.	72	Korea, Rep.	110	Poland		
35	Costa Rica	73	Kyrgyz Rep.	111	Portugal		
36	Cuba	74	Lao PDR	112	Romania		
37	Cyprus	75	Latvia	113	Russia		
38	Czech Republic	76	Lebanon	114	Rwanda		