E-GOVERNMENT AND ECONOMIC GROWTH: A PANEL DATA ANALYSIS

Dr. M Tariq Majeed[1] and Amna Malik[2]

Abstract

In recent years, the rising importance of e-government has gained the attention of researchers and policy makers. The strategic objective of e-government in a society is to facilitate the efficient provision of services to its citizens. The purpose of this study is to explore e-government and economic growth nexus, by employing large panel data of 154 countries across the world from 2003 to 2010. The results reveal that e-government is an important tool that drives economic growth of a country. The empirical findings of random and fixed effects model show that implementation of e-government causes high per capita GDP. The dynamic panel data model by dealing with the problem of endogeneity also confirms the validity of the results of FEM and REM. The main findings are robust to control variables and different econometric techniques.

Keywords: E-government; Economic Growth; Panel Data
JEL Classification: C23; H1; J24; O40

1. Introduction

Economic growth is a primitive topic and research on economic growth is dated back to Adam Smith. In this digital world the online availability of government web connections and technical power of provincial and federal government contribute in economic growth of a country. Such government refers to e-government that can be defined as the usage of information and communication technologies (ICT) in public administration and policy making (Von Haldenwang, 2004). According to UNDP (2006) e-government refers to the implication of ICT by government for delivering better services and refined information to people. Chen *et al.,* (2009) and Krishnan and Teo (2012) defined e-

[1] Assistant Professor, School of Economics, Quaid-i-Azam University, Islamabad, Pakistan.
[2] Economic Analyst (OG2), State Bank of Pakistan

government as the practice of information and communication technologies (ICT) which improves the provision of all dimensions of government services and activities for the advantages of citizens, employees, stakeholders and businesses.

There are different reasons behind the adoption of e-government and installation of ICT in public sectors (Kumar et al, 2007). One reason is investment in research and development (R & D) because scientific research and technological innovations are driven by the ICT infrastructure. Firth and Mellor (2005) proposed that technological innovation and scientific research depend on information and communication technologies. Titah and Barki (2006) pointed out that political machinery, institutional structure and socio-economic arrangements play an important part during installing ICT in government sectors. There is relatively low chance of corruption in e-government than simple government so chauvinistic politicians will motivated to install ICT in public sectors. E-government sets up the relationship of trust between government and citizens. The achievement of different government's policies depends on the cooperation of citizens that can be achieved by trust on public policies. The trust of public on government policies is a subject of key attention for democratic governments (Tolbert and Mossberger, 2006).

E-government contributes in enhancing the per capita growth of a country by enhancing the efficiency of public sectors. E-government is more efficient and accountable than conventional government. The efficiency of e-government is due to its positive relationship with transparency and accountability, mitigation of corruption, research and development, confidence on government policies and decisions that also contributes in per capita growth of a country (OECD, 2005).

The immense research on e-government demonstrates that e-government benefits a country by enhancing the efficiency of public sectors (Al Kibsi et al., 2001; Von Haldenwang, 2004; and West, 2004) reinforcing the rule of law and democracy (Von Haldenwang, 2004; and West, 2004) and cutting down depravity and corruption in a society by supporting transparency and accountability (Tirole, 1996; Haigh, 2004; Mishra, 2006; Haigh and Griffith, 2008). The administrative reforms caused by e-government also contribute in economic prosperity of a country. These administrative reforms assist government in supervising the activities of administration. In China, e-government contributes in economic development through administration reforms (Ma, Chung, and

Thorson, 2005). Grimes *et al.* (2012) argue that e-government enhances the productivity of output by enhancing the marginal productivity of labor.

The theoretical research on e-government is grouped into three dimensions that are: evolution and development, adoption and implementation and influence on stakeholders. The first two streams of e-government have been theoretically explored by researchers while few theoretical studies on the consequences of e-government have been conducted (Flak *et al.,* 2009). The reason of ignoring research on third dimension of e-government is the diversity of the goals of different project that are pursued by e-government (Srivastava, 2011). According to Heeks and Bailur (2007) the research on e-government is overlooked by researchers due to two main reasons. First the theoretical research on e-government is insufficient to develop a theoretical framework to empirically address the macro-economic consequences of e-government. Second, the insufficient allocation of resources for the research on this area and time constraint are the main obstacle in the way of empirical research on e-government.

The need for the exploring the macroeconomic consequences of e-government is also stressed in literature (Srivastava, 2011). Given these reasons and encouraged by the reality that research on e-government is still on embryonic stage we have empirically explored economic growth and e-government nexus in our study using archive data of 154 countries across the world. In this paper we have employed traditional growth model to empirically investigate the impact of e-government on economic growth.

The next section presents review of the literature. Empirical framework and data is described in section 3 and 4 respectively. Results are presented in section 5 and Section 6 gives conclusions of the study.

2. Review of Literature

In the literature most of the studies have examined the impact of diffusion of ICT on economic development of a country, while few studies have examined the contribution of internet and broadband for economic growth. Choi and Yi (2009) empirically investigated the contribution of internet in economic growth using a panel data of 217 countries from 1991 to 2000. Findings of the study illustrate that 1% increase in internet subscription bolsters growth about 0.05% due to diffusion of knowledge and information. Czernich*et al.* (2011) also empirically investigated the

broadband growth nexus for OECD countries over the period 1996-2007. The results of their study also support the positive association between broadband and economic growth.

Mahyideen*et al.* (2012) emphasized that ICT enhances the economic performance of a country increasing the productivity of labor and input and decreasing cost of production. They used archive data of 5 ASEAN countries from 1976 to 2010 and found positive impact of fixed telephones line and mobile phone subscription on economic growth. Krishnan *et al.* (2013) empirically examined the relationship between e-government, economic growth, corruption and environmental degradation using a cross sectional data of 205 countries from 2004 to 2008. The structural equation modeling was employed in the study. The results showed that the impact of e-government on economic growth was coming due to decrease in corruption by e-government. Bhuiyan (2010) studied the growth effects of e-government in Kazakhstan. The study indicates that the government of Kazakhstan is adopting e-government to assure transparency and accountability and economic prosperity. Vu (2011) argued that ICT penetration contributes in economic growth through three channels: (1) technological progress and innovation; (2) improving the efficiency of firms and household in decision making and (3) boosting up the output level by increasing demand of good and mitigating the cost of production. He provided the evidence that ICT penetration played an importance role in enhancing the economic growth of 85 countries across the world during the period from 1996 to 2005.

Vu (2013) confirms that ICT played a key role in economic growth of Singapore in 1990-2008. The study documents that ICT is positively associated with increasing the marginal productivity of labor and contributed up to 1% in the GDP of Singapore during 1990-2008. Jung et al. (2013) examined the role of ICT in Korea's economic growth using a panel data of 27 Korean industries. The findings of the study approve that broadband network contributes significantly in technological convergence.

The most of the studies have empirically explored the relationship between ICT and economic growth, while empirical studies on e-government have been virtually ignored in the literature. This study contributes into the emerging literature on growth and ICT by empirically analyzing the growth effect of e-government adoption using a large panel data of 154 countries.

3. Empirical Model

The Empirical Framework of the study is developed from Cobb-Douglas production function of Mankiw, Romer and Weil given (1992). The production function has three inputs that are: physical capital, human capital and labor

$Y_{it} = A_{it}K_{it}^{\alpha_{it}}HC_{it}^{\beta_{it}}L_{it}^{\gamma_{it}}(1)$

i stands for cross section units, i=1,2,3……..n

t stands for time period, t=1,2,3…….t

By taking the natural log of the equation 6.1 we have equation 6.2

$logy_{it} = logA_{it} + \beta_1 logk_{it} + \beta_2 logHC_{it} + \beta_3 logL_{it}(1.1)$

Where A is given state of technology in a country, y stands for real per capita GDP growth, K stands for capital stock, HC stands for human capital and L stands for labor force participation. Technological growth drives economic growth of a country. The convergence of per capita growth of economies not merely depends on initial per capital but also depends on diffusion of technology in a country. We have expressed our growth model by technological progress that drives the economic growth of a country. Following Czernich et al. (2009) we have also supposed that technology is exponentially evolving over the time which can be expressed as:

$Ai = A(0)e^{\theta it}(2)$

Taking log of equation 2 gives us

$logA_{it} = logA_0 + \theta_{it}(2.1)$

θ shows technological growth of country.

Suppose that e-government boosts up technological progress in a country through ICT by facilitating spillover of knowledge, R&D and production of new technologies, so θ can be defined as:

$\theta_{it}=\alpha_1 + \alpha_2 E\_government_{it}(3)$

Substitution equation 3 in equation 2.1

$logA_{it}= \alpha_0 + \alpha_1 + \alpha_2 E\_government_{it}(3.1)$

Where $\alpha_0 + \alpha_1 = \beta_0$

$logA_{it}= \beta_0 + \beta_1 E\_government_{it}(2.2)$

By substituting equation 2.2 in equation 1.1 we have equation 1.3

$logy_{it} = \beta_0 + \beta_1 E\_government_{it} + \beta_2 logk_{it} + \beta_3 logHC_{it} + \beta_4 logL_{it} + e_{it}$ (1.3)

Following Barro (1991) in order to check convergence hypothesis we have incorporated initial per capita income into equation 1.3 as a determinant of economic growth.

$$\log y_{it} = \beta_0 + \beta_1 y_{it-1} + \beta_2 E\_government_{it} + \beta_3 \log capital_{it} + \beta_4 \log Human\_capital_{it} + \beta_5 \log Labor_{it} + \beta_6 \log X_{it} + e_{it} \quad (1.4)$$

The robustness of our results is also checked by using control variables. Where X_{it} is a matrix of control variables that are: inflation, government consumption and trade openness.

4. Data Description

We have employed the unbalance panel data set of 154 countries across the world from 2003 to 2010. The explained variable is per capita GDP measured by natural log of GDP per capita at 2005 constant prices. The explanatory variables are initial per capita, human capital, labor force participation, physical capital, and e-government. For sensitivity analysis, the control variables inflation, trade openness and government consumption are also used.

Table 1: Explanation of the E-government and its components

Web Connection and Online Service: It estimate the extant of web content approachability of a country and evolving online presence in simple websites which improves information provision by arrangement of multimedia content, bilateral interactions between government and citizens and online transaction service.

Telecommunication Service: It is based on the number of personnel computers, mobile phone and fixed telephone subscription and internet users.

Human Capital: It measures the adult literacy rate and gross enrollment of primary, secondary and tertiary education.

From e-government development index (EGDI) the data of e-government is extracted that is composed in 2008. It reflects the online presence of government administration and installation of telecom infrastructure in a country. E-government is the weighted average of web connectivity and online service of government, human capital and telecom infrastructure. The data lies in the range of 0 to1 that indicates low to high quality of e-government.

Table 2: Summary of Variables

Variable	Definition	Source
Economic Growth	Natural log of the GDP per capita at the 2005 constant prices	[1]
E-government	Extent of online availability of government, telecom infrastructure, & human capital.	[2]
Online service	Extent of the online availability of the government.	[2]
Telecom service	Extent of telecom infrastructure of the government.	[2]
Human capital	Gross secondary school enrollment of total population.	[3]
Physical capital	Gross fixed capital formation in percentage of GDP.	[3]
Labor force	Share of labor force participation in total population.	[3]
Government consumption	Government spending in the share of Gross domestic product at 2005 constant prices.	[1]
Urban population (Instrument)	Natural log of initial Urban population.	[3]
Fix_Telephone (Instrument)	Fixed telephone lines per 100 inhabitant.	[4]

Data Sources: Penn World Tables (version 7.1) [1]; Global E-governance Reports [2]; World Development Indicators (2014) [3]; Internation Telecommunication Union (2014) [4].

Table 3 indicates that e-government has positive correlation with economic growth, physical capital, human capital and trade openness and negative correlation with labor force participation, inflation and government consumption. The negative correlation of e-government with labor force is due to the mitigation of over employment in organization.

Table 4 shows that GDP per capita is highest in Qatar and lowest in Congo democratic. The quality of e-government is poor in most of the African countries such as Congo democratic, Somalia, Central African, Chad. The highest value of e-government is 0.927 that belongs to United States.

Table 3: Correlation Matrix

Variables	1	2	3	4	5	6	7	8
1. Per capita GDP	-							
2. Labor	-0.0136	-						
3. Capital	0.0355	0.0280	-					
4. Human capital	0.6068	-0.3514	0.0557	-				
5. E-government	0.6833	-0.2027	0.0050	0.7994	-			
6. Trade	0.2173	-0.1829	0.1053	0.1992	0.1743	-		
7. Govt_Consump	-0.2885	0.0993	0.0670	-0.4011	-0.4818	-0.1014	-	
8. Inflation	-0.2375	0.0889	-0.0218	-0.2004	-0.2843	-0.0499	0.0588	-

Table 4: Summary Statistics of Data

Variable	Observation	Mean	Min	Max
Y	147	11692.31	179.401	94654.22
$Y_{initial}$	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

Figure 1 illustrates quality of e-government increases gradually over time. Online service drastically decreased in 2008 to 2009 then became constant whereas telecom infrastructure is increased in 2008 to 2009. Decreased in online service may be due to shift in resources from information technology to telecommunication technology.

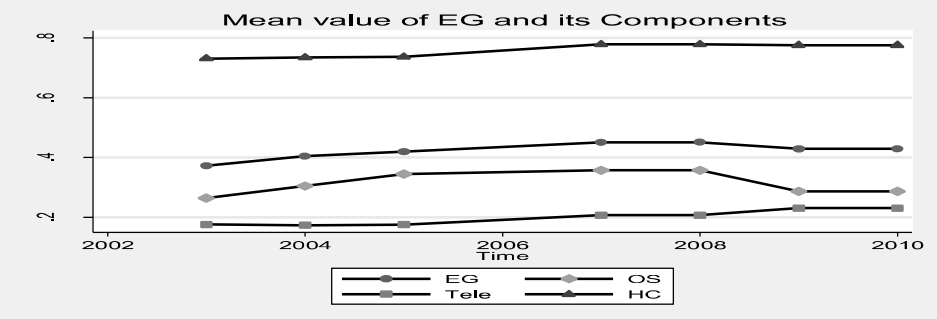

Figure 1: Time Trend of E-government (EG) Components across the World

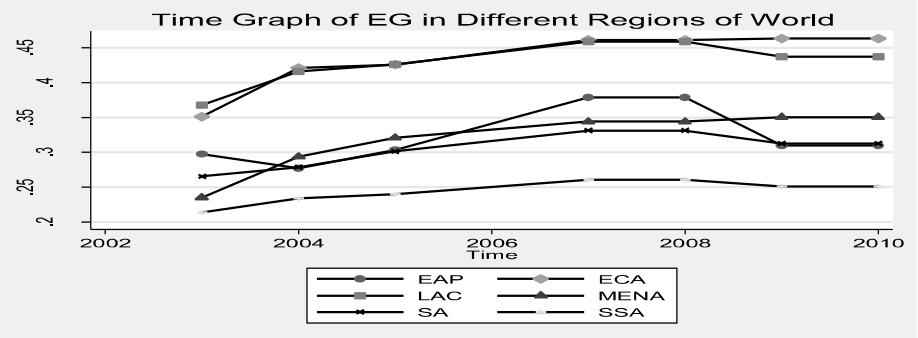

Figure 2: Time Graph of E-government in Different Geographical Regions of the World

Figure 2 shows that average quality of e-government is poorest in Sub-Saharan African (SSA) countries. Mean value of e-government in South Asia (SA) was 0.27 in 2003 and increased till 2008. In European and Central Asian countries (EAP) average quality of e-government is increased from 2004 to 2007 and from 2007 to 2008 it remained stagnant, from 2008 to 2009 it decreased considerably and from 2009 to 2010 it again became stagnant.

Figure 3 indicates that mean values of e-government in developed, developing and under developed countries at different time periods. It demonstrates that average quality of e-government is highest in developed countries and lowest in under developing countries. Mean value of e-government index in developed countries was 0.6 in 2003 and till 2010 it increased to 0.65. Mean value of e-government index of developing countries increased from 0.32 to 0.4 in 2003 to 2010. In developing

countries e-government quality increased from 0.1 to 0.25 from 2003 to 2010.

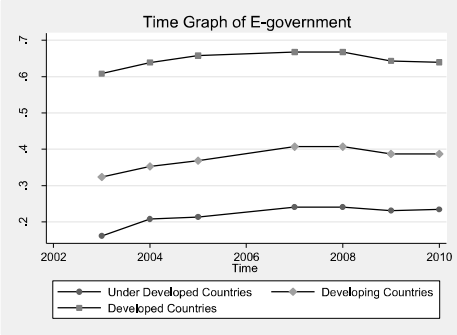

Figure 3: Time Trend of E-government

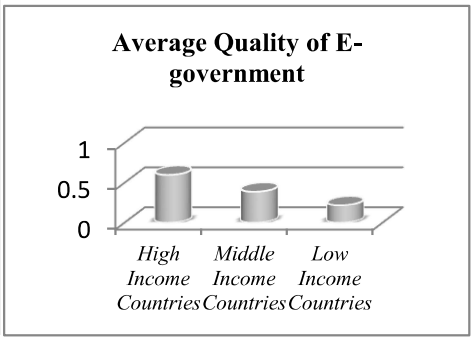

Figure 4: Average Quality of E-government

Figure 4 indicates that average quality of e-government is highest in developed countries. Figure 5 presents the bar chart of average quality of e-government in different geographical regions of the world. The average quality of e-government is poorest in SSA and best in ECA countries.

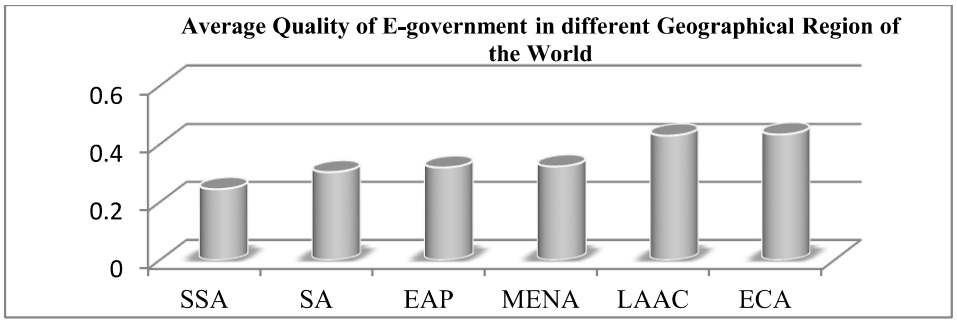

Figure 5: Average Quality of E-government in different Regions of the World

5. Empirical Findings of Panel Data Models

We have employed fixed effects model to capture the time invariant characteristic of cross section units. Fixed effects model tackles unobserved heterogeneity in a model by allowing separate intercept for all the countries to capture country specific characteristics. It deals with problem of unobserved heterogeneity that OLS cannot detect. Unlike OLS it does not camouflage time invariant characteristics into error term but allows heterogeneity that is captured by specific intercept. Batlagi (2001)

pointed out that when there are time invariant characteristics in a model of panel data then OLS gives bias results and such biasness is called omitted variables bias. Ballotage (2005) proposed that error term in fixed effects model is identical and independent with zero mean and constant variance. He further stated that separate intercepts of all the countries subsumed time invariant characteristics of different countries and make error term normally distributed.

The results indicate that e-government has positive and significant impact on economic growth. The coefficient of e-government implies that one standard deviation increase in e-government will increase GDP per capita of country about 0.12%. In columns (2-4) we have incorporated inflation, government and trade openness, respectively as control variables. The impact of inflation and trade openness is positive and significant on per capita GDP of country. The positive impact of inflation on economic growth is highlighted by Khan and Senhadji (1992). According to them inflation has negative impact on economic growth only after threshold level of inflation whereas before threshold level inflation may have developmental impact on economy. The empirical results of FEM indicate that physical capital significantly contributes in economic growth.

In 5^{th} column we have decomposed e-government into its components: human capital, online service and telecom infrastructure. Human capital and online service cause significant contributing in GDP per capita whereas coefficient of telecom infrastructure is negative. The negative impact of telecom infrastructure on per capita GDP is might be due to the profit repatriation of telecommunication companies. The profit repatriation of MNCS offsets the per capita GDP of a country. However the negative impact is not significant. The significance of F-stat in all regressions of Table 4 implies that overall all the coefficients of model are significant. The value of Rho indicates that variance in errors are coming from cross section units.

Table 4: E-government and Economic Growth: Fixed Effects Models

Economic Growth	Empirical results of fixed effects model				
Dependent	(1)	(2)	(3)	(4)	(5)
$Y_{initial}$	0.745***	0.771***	0.770***	0.763***	0.764***
	(0.0171)	(0.0175)	(0.0175)	(0.0173)	(0.0180)
Labor	-0.0458	-0.0840	-0.0906	-0.111	-0.0478
	(0.0714)	(0.0746)	(0.0746)	(0.0736)	(0.0745)
Capital	0.0746***	0.0680***	0.0670***	0.0512***	0.0468***
	(0.0101)	(0.0107)	(0.0107)	(0.0111)	(0.0110)
Human_capital	0.0196	0.00755	0.0139	0.0185	0.0159
	(0.0172)	(0.0175)	(0.0179)	(0.0176)	(0.0174)
Inflation		0.00505**	0.00484**	0.00398*	0.00364*
		(0.00221)	(0.00220)	(0.00218)	(0.00216)
Govt_Consump			-0.0310*	-0.0407**	-0.0473***
			(0.0179)	(0.0178)	(0.0177)
Trade				0.0691***	0.0693***
				(0.0160)	(0.0158)
Human capital					0.152***
					(0.0330)
Online service					0.0422***
					(0.0157)
Telecom_infras					-0.0349
					(0.0298)
E-government	0.119***	0.111***	0.110***	0.103***	
	(0.0325)	(0.0320)	(0.0319)	(0.0315)	
Constant	2.091***	2.086***	2.166***	2.062***	1.746***
	(0.303)	(0.314)	(0.317)	(0.313)	(0.323)
Observations	760	701	701	701	701
R-squared	0.823	0.843	0.844	0.849	0.854
Number of country	154	152	152	152	152
F-stat	559.61***	485.74***	418.31***	380***	314***
Rho	0.99	0.98	0.98	0.98	0.98

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Fixed effects model causes the loss of degree of freedom. It might worsen the problem of multicollinearity in the model due to dummy

variable trap (Baltagi, 2008; Wooldridge, 2011). Judge *et al.* (1985) also emphasized that if the assumption of random effects model is fulfilled (correlation between error term and explanatory variable is zero) then it is more efficient than FEM when N> T. For this reason we have also employed random effects model (REM).

The empirical findings of REM are consistent with FEM. The coefficient of e-government is positive in all regression except column 1 of Table 5. The results are robust to control variables. The results indicate that initial per capital income has inertia and 1% increase in lag per capita GDP will enhance per capita GDP about 0.984%. The coefficient of physical capital employs that country having rich quality of physical capital enjoys high per capita GDP. Likewise the coefficient of trade openness also implies that open economies are likely to enjoy high growth of per capita GDP. In 5th column of Table 5 we have decomposed e-government into its components. The empirical findings employ that country having skilled labor and online services enjoy having per capita GDP. The coefficient of telecom infrastructure is unexpectedly negative. The sign of the coefficient of telecom infrastructure is consistent to the findings of FEM. The negative sign is due to the profit repatriation of telecommunication companies.

The random effect models is merely unbiased if the correlation between error terms and explanatory variables is zero. REM assumes the exogeneity of the explanatory variables. However it is possible that time invariant characteristic is correlated with independent variables. In the lag dependent variable dynamic panel data is more efficient then FEM and REM models. It tackles endogeneity in the model by using the instrumental variables for endogenous variables (Baltagi, 2008; Mundlak, 1978). Arrelano and Bond (1991) proposed generalized method of moment (GMM) by employing orthogonally condition lies between lag dependent variable and error term in order to get the instrument to resolve endogeneity problem.

There is a possibility of reverse causality between e-government and per capita GDP. The installation of e-government depends on the GDP of a country. Comin and Hobjin (2004) also proposed that 20 famous technologies of the world were first adopted by developed countries. Arrelano-Bond (AB) model also allows the external instrument to tackle endogeneity. Following Czernich et al. (2009) and Anderson (2008) fixed telephones lines and initial urban population are used as instruments for e-government in this study.

Table 6: E-government and Economic Growth: Arrelano Bond

Per capita growth model	Empirical findings of Arrelano Bond			
(dependent)	(1)	(2)	(3)	(4)
Y_initial	0.918***	0.851***	0.853***	0.983***
	(0.0155)	(0.0247)	(0.0250)	(0.0368)
Labor	-0.405***	0.0730	-0.0298	-0.411
	(0.131)	(0.189)	(0.233)	(0.272)
Capital	-0.00794	0.00250	0.0156	-0.0343
	(0.0270)	(0.0257)	(0.0310)	(0.0421)
Human_capital	0.0155	0.259***	0.263***	0.00288
	(0.0468)	(0.0851)	(0.0861)	(0.130)
E-government	0.374***	0.351***	0.349***	0.243***
	(0.0575)	(0.0548)	(0.0553)	(0.0920)
Trade		0.0883***	0.0808***	-0.0159
		(0.0264)	(0.0283)	(0.0395)
Govt_Consump			0.0273	0.0972**
			(0.0355)	(0.0389)
Inflation				0.0522***
				(0.0110)
Constant	2.209***	-0.621	-0.295	1.627
	(0.619)	(1.029)	(1.121)	(1.499)
Observations	730	730	730	674
Number of country	150	150	150	148
P-value Sargan	0.000	0.548	0.584	0.844
P-value of AR(2)	0.000	0.001	0.001	0.645

The p-values of Sargan test are accepting the null except in 1st column which implies that instruments are valid.
P-value of AR (2) employs that there is no second order autocorrelation in the model. All the standard errors are in parentheses.
*** symbolizes significance at 1% level
** symbolizes significance at 5% level
* symbolizes significance at 10% level

Czernich et al. (2009) employed fixed telephone lines as instruments for broadband because broadband access is possible through cable-TV lines and fixed telephones line. Anderson (2008) suggested that according to Urban Density Theory (UDT) cost of ICT such as internet

and extras gradually lessen as urban population increases due to knowledge spillover and availability of other complementary tools of ICT. The empirical findings of AB model confirm the validity of the results of FEM and REM. The coefficient of e-government remained positive and significant at 1% significance level in all regression of Table 6.

6. Conclusion

Does e-government increase economic growth? To answer this question, this study assembles a large panel data set of 154 countries from 2003 to 2010. The empirical findings confirm a positive relationship between e-government and economic growth. The coefficient of e-government implies that one standard deviation increase in e-government will increase per capita GDP about 0.1% to 0.35%. The positive growth impact of e-government remains consistent in different specifications, alternative estimation methods and this finding is not sensitive to the problem of endogeneity.

In this digital world it is irrational to rely on obsolete and outdated ways of execution of public services. Instead of relying on primitive techniques government needs to initiate e-commerce, e-procurement and e-tax payment system to enhance the economic growth. In the light of empirical findings it is recommended that government needs to rely more on online services in provision of it responsibilities because it enhances the efficiency of public sectors.

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