

# A LONGITUDINAL STUDY OF E-GOVERNMENT MATURITY

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## Abstract

*Extending the findings of prior cross-sectional studies, this paper presents a longitudinal analysis of the drivers of e-Government maturity. We constructed a panel dataset for the period from 2003 to 2007 using data published by various authoritative sources. We fitted a mixed-effects regression model to the data to study how the growth of e-Government around the globe is influenced by changing levels of affluence, ICT infrastructure, human capital, and governance. We found that countries' e-Government matures as they become more affluent (in terms of GDP per capita) and as their ICT infrastructure improves. Human capital and the quality of governance have no significant effect on the development of e-Government maturity. The results suggest that countries investing in leading-edge ICT infrastructure can maintain or improve their global standing in e-Government without substantial changes to human capital or governance. We put forward plausible reasons to explain our findings, and their implications for future research and the practice of e-government.*

*Keywords: e-Government maturity, ICT infrastructure, human capital index, governance, longitudinal analysis, panel data analysis, random effects models.*

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## INTRODUCTION

e-Government has been studied extensively over the past decade, and the research so far can be organized into four broad areas: e-readiness (the drivers of e-Government development, such as political support, citizens' skills, and technological infrastructure), supply-side (the types of e-Government services offered and the role of back-office integration), demand-side (the use of e-Government services and the satisfaction of users), and impacts (the financial and non-financial outcomes of e-Government projects) (Waksberg-Guerrini and Aibar, 2007). In terms of e-readiness, large-scale empirical studies have explored how a variety of factors influence e-Government maturity. Factors that have been found to be significant in this relationship include a country's income (GDP), the munificence of its macro-economic environment, the quality of its ICT infrastructure, the level of trust in the society, and the quality of its public institutions and civic life (e.g. Azad et al. 2010; Das et al. 2009; Singh et al. 2007; Srivastava & Teo, 2007; Srivastava & Teo, 2010). Demand-side studies have examined how e-Government use has affected firms and citizens (e.g. Badri & Alshare, 2008;), while supply-side researchers have studied the obstacles e-Government projects have faced in achieving their goals (Tate et al., 2007; Goldkuhl, 2009) and the impact on back-office functions (Almutairi, 2010). From an impact perspective, e-Government has been found to be positively associated with business competitiveness, national economic performance and environmental protection, among other outcomes (Das & DiRienzo, 2010; Srivastava & Teo, 2007, 2008, 2010).

Almost all of the studies that have so far examined e-government maturity use cross-sectional data (e.g. Singh et al. 2007; Srivastava and Teo 2007) or within-country analyses (e.g. Karokola and Yngstrom 2009; Rakhmanov 2009). These studies provide useful snapshots of e-Government activity in different countries at particular points in time. However, e-Government evolves over time, and such evolution or drivers thereof are not accounted for in cross-sectional studies. An additional concern with cross-sectional studies is the bias in coefficient estimates introduced by the mis-specification of models, particularly the omission of potentially relevant predictors. Thus, such cross-sectional studies, while being informative about the state of play at a particular point in time, provide a weak basis for decisive guidance to public administrators who direct e-Government activity and investments. Should they focus on improving their governance processes, their infrastructure, or the skill level of their citizens (Kim & Grant, 2010)? Since extant studies only identify factors that co-exist with high levels of e-Government maturity, how should public administrators proceed in terms of harnessing these factors? Should researchers developing in-depth case studies of e-Government projects spend more effort understanding the technology of the government's ICT systems, or the education of the populace and the overall quality of governance in the country?

Driven by these twin concerns, stronger causal inference and robustness to model mis-specification errors, we develop and use panel data to examine the drivers of e-Government maturity. Our research question is: how does the maturity of a country's e-Government services change over time as it improves its income level, ICT infrastructure, its human capital, and its governance institutions and processes? We fit a random-effects model to our panel data to overcome the limitations of cross-sectional studies. Since our panel includes countries that start at different levels of e-Government delivery and also have different rates of growth, we construct our model to accommodate both of these characteristics through random components in both intercepts and slopes with respect to time. The next section of the paper presents in brief the conceptual arguments supporting our choice of variables that bear on e-Government maturity. Next, we describe our methodology and data, before presenting our results. We conclude with a short discussion of our findings, possible limitations, and avenues for future research.

# 1 CONCEPTUAL MODEL AND HYPOTHESES DEVELOPMENT

## 1.1 e-Government Maturity

e-Government maturity is defined as the extent to which a government has established an online presence (West, 2005). Prior research on e-Government has conceptualized maturity using an evolutionary approach (Layne and Lee, 2001; Andersen and Henriksen, 2006). In this view, governments are seen to progress through a series of stages as a function of integration and complexity or as a function of increasing levels of online activity and customer centricity (Layne and Lee, 2001, Andersen and Henriksen, 2006). Such maturity models are useful because they act as guides for practitioners, help employees understand the development of e-Government, and can be used as a communication tool to explain e-Government to third parties (Kim & Grant, 2010).

Operationally, the extent to which a government develops an online presence is characterized by the features implemented in government websites, such as the provision of online publications, access to various government-related databases, the use of audio and video, support for non-native languages or foreign language translation, free (as opposed to paid) access, commercial advertising (a “negative” feature), disability access, privacy policy, security features, the presence and breadth of online services, support for digital signatures and credit card payments, an email address for questions / concerns, comment forms, provision of automatic email updates, website personalization, and access from non-PC devices, such as personal digital assistants (PDA) (West 2000). Implicitly, e-Government maturity represents a continuum of developmental stages, from publishing information to supporting transactions, with some having progressed further than others (West 2007). Many of West’s criteria - databases, security features, and support for digital signatures and credit card payments - bear directly on this capability to deliver service transactions. This conceptualization of e-Government maturity is focused more on technological sophistication than political activity (Kim & Grant, 2010). Given the wide variation among countries, transaction capability appears to be, in the time frame of the study, a common denominator on which e-Government can be compared across countries.

While our conceptualization of e-government maturity reflects demonstrated behavior, other measures assess the *potential* of a country to achieve e-Government. A well-known example is the UN’s e-Government Readiness Index, which includes among other components, a telecommunication infrastructure index and a human capital index ( UNPAN, United Nations Public Administration Network: 2003, 2004, 2005, 2008, 2010). Other measures of e-Government potential include the World Economic Forum’s Networked Readiness Index (World Economic Forum:2004, 2005, 2007, 2008, 2009, 2010, 2011) which covers about half to two-thirds of all countries. Most of these latter indices indicate the capacity of a country to engage in e-Government programs, but do not explicitly address its success in implementing them.

## 1.2 Determinants of e-Government Maturity

The determinants of e-Government maturity examined in this study are national affluence (in terms of a country’s gross domestic product), ICT infrastructure, human capital, and governance. These factors have been extensively used in prior studies (e.g. Azad et al. 2010; Das et al. 2009; Singh et al. 2007; Srivastava & Teo, 2007; Srivastava & Teo, 2010) and shown to correlate positively with the development of e-Government internationally.

National affluence refers to a country’s overall level of wealth, as measured by its gross domestic product. (GDP). Countries that are well-off might have spare resources to invest in enhancing their administrative capabilities, including increasing the use of ICT to support government functions. In contrast, less developed countries must focus on improving the traditional modes and channels of government. The relationship between affluence and e-Government has been found in previous research (Das et al. 2009; Srivastava & Teo, 2010). However, Azad et al. (2010) did not find a significant relationship. They conjectured that this might be due to most countries adopting e-

Government only symbolically and not progressing beyond the creation of “Potemkin villages”. We argue that as a country becomes richer, it will provide more and more complex e-Government services, as the efficiency gains will outweigh any inclination to remain a symbolic adopter of this innovation. Hence:

*Hypothesis 1: Increases in a country’s gross domestic product are associated with an increase in e-Government maturity over time.*

ICT infrastructure in this study refers to the extent of information and communication technology development in a given country. The extent of ICT development directly facilitates (or limits) the development and delivery of e-government services to its citizenry (Shareef et al. 2011; Srivastava and Teo 2010). Citizens in countries with higher levels of ICT access are also more likely to conduct their government-related affairs online (Singh et al. 2007). Over time as national ICT infrastructures develop, more complex services (e.g. those requiring more bandwidth or those supporting mobile devices) may be implemented. The success of such services sets up a virtuous cycle of positive feedback justifying further investment in e-government. Hence:

*Hypothesis 2: Improvements in a country’s ICT infrastructure are associated with an increase in e-Government maturity over time.*

The development of human capital mirrors closely the extent to which the population is literate and has attained an adequate level of education. Literacy here refers to the percentage of adult citizens who can read and write with understanding, while education refers to the proportion of the school-going age population that is enrolled in primary, secondary or tertiary educational institutions (Singh et al. 2007). e-Government services are mostly useful to those who can to read, understand and navigate such services. A review (Jaeger 2006) of the role of education in internet use supports the argument that higher the development of human capital in a country, the greater the demand for e-government services. Hence:

*Hypothesis 3: Increases in a country’s human capital are associated with an increase in e-Government maturity over time.*

Governance refers to the accountability and transparency of incumbent governments (Ciborra and Navarra 2003). Given that e-Government is essentially the embedding of digital technology in the thoroughly social process of governing a country, we expect that a nation’s e-Government maturity reflects how it is governed (Huang 2007). e-Government provides interested governments a way to engage citizens (e.g. through consultation, feedback, or dialogue) who might have earlier kept away from participation due to concerns about ease of use and public visibility (Shareef et al. 2011). e-Government also demands government transparency because it requires business rules to be codified. In this way, responsibility for policy execution shifts from the discretion of street-level civil servants towards impartial “processors”, reducing the potential for arbitrary interpretation (Reddick, 2004). It thus stands to reason that only countries committed to good governance would seek and achieve higher levels of development of e-Government.

When governments are unstable, corrupt or do not enjoy the widespread mandate of the people, it is unlikely that e-government services would progress beyond basic information publishing (mainly propaganda) (Tolbert and Mossberger 2006). Good governance (stability, accountability, freedom from corruption), on the other hand, is also often associated with increasing professionalization of the civil service and closer links with the citizenry (Kaufmann et al. 2008). Hence:

*Hypothesis 4: Improvements in a country’s governance quality are associated with an increase in e-Government maturity over time.*

Figure 1 below depicts the conceptual model we test in this paper using mixed-effects regression.

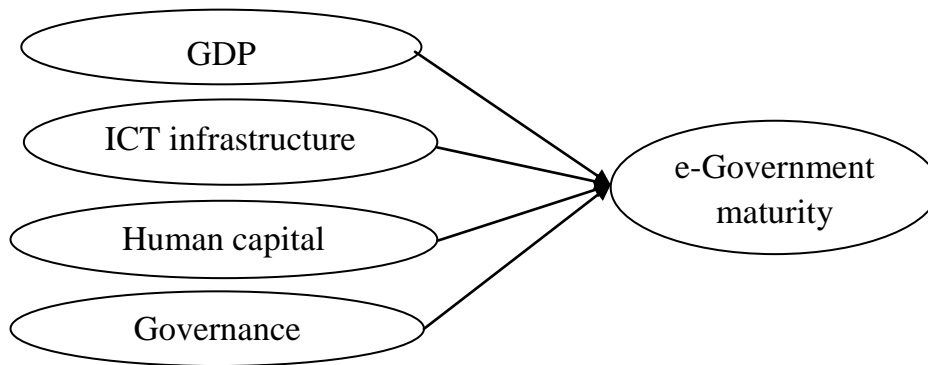


Figure 1. Proposed Conceptual Model.

## 2 METHOD

### 2.1 Data and Measures

Countries form the natural unit of analysis in this study. Accordingly, we assembled data for 177 countries using established secondary data sources. The nature of the data used in this study offers two important advantages - replicability and generalizability. Replicability is established by the use of publicly and widely used data in e-government research. Generalizability is assured by including almost all the countries in the world. The process of assembling the data set is described next.

The measure for *e-Government Maturity* is obtained from West (2003; 2004; 2005; 2006; 2007). Given our interpretation of e-government maturity as demonstrated behaviors rather than just potential, West's measure is the most thorough quantitative report that matches our requirements. West and his associates examined over 1500 government web sites from over 190 nations in the summer of each year. Included among them were the web sites of the executive, legislative, and judicial branches of government, and sites of cabinet offices and key agencies serving important functions, such as health, taxation, education, interior, economic development, administration, tourism, transportation, military, and business regulation. Web sites for sub-national units and local/regional/municipal government units were not included in their study. Based on a comprehensive examination of the characteristics of government web sites, West and his colleagues at Brown University scored countries on a maximum of 100 points. These characteristics include online publications, online databases, the use of audio and video, support for non-native languages or foreign language translation, free access (as opposed to paid access, a negative "feature"), commercial advertising (another negative feature), access for the disabled, privacy policy, security features, the presence and breadth of online services, support for digital signatures and credit card payments, an e-mail address for questions / concerns, comment forms, provision of automatic e-mail updates, Web site personalization, and access from non-PC devices such as personal digital assistants (PDA) (West 2006). Non-English Web sites were translated by foreign language readers.

To measure the development of e-government in different countries of the globe, we use the ratings produced annually by West and his associates. The methodology behind the ratings – the components and their weights – remained the same from 2004 to 2007, assuring the comparability of the data from year to year. The 2003 measure was computed slightly differently in terms of the component items and their weights, but enough information was available in the publicly available reports of West and associates to re-compute the 2003 ratings with the same items that were retained in later years, and the same weights. We thus have comparable e-government maturity ratings over the five years from 2003 to 2007.

The UN e-government surveys (UNPAN, United Nations Public Administration Network, 2003, 2004, 2005, 2008, 2010) have been evolving their own “web measure” / “online service index” through an evaluation of government websites in different countries. In the time frame of our study, however, the Brown University ratings (West 2003; 2004; 2005; 2006; 2007) provide more consistent and complete coverage of the state of e-government realized in different countries.

The time-series of per-capita PPP-adjusted GDP of different countries (at current prices) were drawn from the International Monetary Fund’s World Economic Outlook database (freely accessible at the IMF website: <http://www.imf.org/external/pubs/ft/weo/2010/02/weodata/index.aspx>).

The measure for *ICT Infrastructure* required the creation of a new index composed of three equally-weighted components: internet subscribers per 1000 people, broadband connections per 1000 people, and mobile subscriptions per 1000 people. This index reflects the broad mix of technologies utilized by most e-Governments and citizenry to access and use government related resources. The raw data are taken from the 2003-2007 publications of the International Telecommunication Union (ITU, 2011). We did not use the technology infrastructure index computed by UNPAN, the United Nations Public Administration Network (2003, 2004, 2005, 2008, 2010) because

- it included (in the earlier years) components such as TV ownership and the density of fixed-line telephones (both being somewhat distant from e-Government), and
- the components of the UNPAN index and their relative weightages underwent changes over the period of our study.

Our measure for *Human Capital* is derived from the “education index” found in the abovementioned UNPAN reports from 2003 to 2007, which in turn draw their data from the UNESCO. The human capital index is a combination of the adult literacy rate (defined as the percentage of people above age 15 who can read and write with understanding a short statement on their everyday life) and the combined gross enrolment ratio of primary, secondary and tertiary schools in a country. The latter refers to the percentage of school-age population enrolled in any educational institution, and contributes one-third of the final HCI measure, with the remaining two-thirds coming from the adult literacy rate. The human capital index ranges from zero to 1.

The time-series measures for *Governance* are developed by Kaufmann, Kraay, and Mastruzzi (2008). These indicators are aggregated from more than two hundred variables, collected from 25 separate data sources created by 18 different organizations, such as Freedom House, the Economist Intelligence Unit and the U.S. State Department. Kaufmann et al define governance broadly as the traditions and institutions by which authority in a country is exercised, and, based on this, cluster the indicators into six components using an unobserved components model. The dimensions of governance they arrive at are: Voice and Accountability, Political Stability, Government Effectiveness, Regulatory Quality, Rule of Law, and Control of Corruption. Across all countries, governance is normally distributed with a mean of zero and a standard deviation of one. Virtually all scores fall between -2.5 and +2.5, with higher scores corresponding to better governance.

To improve stability of estimation, GDP per capita was expressed in thousands of dollars, and both the human capital index and the governance index were rescaled by a factor of 100 for inclusion in our regression model.

## **2.2 Data analysis approach**

A key issue with cross-sectional studies is endogeneity: the omission of potentially relevant regressors can bias the estimators of both slopes and intercept. We can never be sure that we have included all pertinent variables in our model, so the concern always remains that we have ignored some important unobserved variables. Treating our dependent variable, e-Government maturity, as a country-specific attribute, we could incorporate into our models proxies for individual countries (Cohen et al. 2003). This approach to overcoming endogeneity bias is used in fixed-effects regression, which uses up N-1 degrees of freedom for N units under observation. Random-effects are more efficient in their use of degrees of freedom under the assumption that the unit-specific effects come from the same underlying

distribution. In this paper, we generalize random-effects models further by allowing different countries to have different starting points (intercepts) and different rates of growth (slopes) over time.

To examine the influence of GDP, ICT infrastructure, human capital and governance on e-Governance maturity, we build a random coefficients regression model. In such a model, each country is allowed to have its own intercept and slope (over time) to reflect the reality that different countries start the period of study (2003-2007) at different initial levels of e-government maturity, and also grow at different rates from these initial levels.

In a random coefficient model (also known as a multi-level model or a hierarchical model), the level of the dependent variable  $y_{ij}$  for unit  $i$  in period  $j$  is composed of:

- the fixed intercept  $\beta_0$  for all units,
- the random intercept  $u_i$  for unit  $i$ ,
- the fixed slope  $\beta_1$  (along the independent variable  $x_j$  for each unit  $i$ ),
- the random slope  $b_i$  for each unit  $i$  (along the independent variable  $x_j$  for that unit  $i$ ), and
- the random error  $\varepsilon_{ij}$ ,

where  $u_i \sim N(0, \sigma_u^2)$  and  $\varepsilon_{ij} \sim N(0, \sigma_\varepsilon^2)$ .

Incorporating random effects (of time) and fixed effects (of GDP, infrastructure, human capital, and governance), our mixed-effects model is estimated through an appropriate maximum-likelihood procedure.

### 3 RESULTS

Table 1 presents the means, standard deviations and correlations between the measures in our model.

	Variables	Sample size	Mean	Std. Dev.	1	2	3	4	5
1	egov	952	27.002	6.612	1				
2	gdpk	895	11.268	13.219	0.513***	1			
3	infra	917	36.844	37.739	0.558***	0.785***	1		
4	humcap	883	77.621	19.397	0.374***	0.536***	0.606***	1	
5	govce	955	-5.587	91.297	0.414***	0.753***	0.769***	0.545***	1

\*\*\*  $p < 0.001$

*Note: both the human capital index and the governance index were rescaled by a factor of 100 for inclusion in our regression model*

Table 1. Descriptives and Correlations of Study Measures

We began by running the simplest model, a pooled (all five years) OLS regression, but had to reject that model because the residuals for each country showed significant positive correlations. Table 2 below shows the results of our final random-coefficients mixed-effects model.

We find that only per-capita GDP ( $\beta = 0.113, p < 0.01$ ) and ICT infrastructure ( $\beta = 0.044, p < 0.01$ ) make significant positive contributions towards e-Government maturity. Human capital ( $\beta = 0.024, ns$ ) and governance ( $\beta = 0.003, ns$ ) do not have a significant effect. The passage of time has a broadly positive effect on e-Government maturity, but the growth rate over time also has a significant random component across countries. The initial level of e-Government at the start of the study period varies across countries ( $\beta = 20.347, p < 0.01$ ). The random component of the intercept and that of the slope

are negatively correlated (95% C.I.: [-0.873,-0.603]), i.e. countries that start lower on e-Government tend to improve more quickly over time.

Mixed-effects ML regression	Number of observations: 860		Group variable: country		Number of groups: 175	
	Observations per group: minimum: 1, maximum: 5, average: 4.9					
Log likelihood = -2571.1328	<b>Wald chi<sup>2</sup>(5)</b>		223.220	<b>Prob &gt; chi<sup>2</sup></b>	0.000	
	<b>Coef.</b>	<b>Std. Err.</b>	<b>z</b>	<b>P&gt; z </b>	<b>[95% Confidence Interval]</b>	
<b>gdpk</b>	0.113	0.035	3.230	0.001**	0.044	0.181
<b>infra</b>	0.044	0.014	3.260	0.001**	0.018	0.071
<b>humcap</b>	0.024	0.017	1.400	0.160	-0.010	0.058
<b>govce</b>	0.003	0.005	0.600	0.549	-0.007	0.013
<b>time</b>	0.517	0.148	3.500	0.000**	0.228	0.807
<b>_cons</b>	20.347	1.419	14.340	0.000**	17.567	23.128
<b>Random-effects parameters</b>						
	<b>Estimate</b>	<b>Std. Err.</b>	<b>[95% Confidence Interval]</b>			
country:						
Unstructured						
<b>sd(time)</b>	0.992	0.153	0.733	1.342		
<b>sd(_cons)</b>	4.781	0.627	3.698	6.182		
<b>corr(time,_cons)</b>	-0.770	0.067	-0.873	-0.603		
<b>sd(Residual)</b>	3.996	0.125	3.758	4.249		

\*\* significant at 0.01 level

Table 2. Results of random-coefficients mixed effects model

## 4 DISCUSSION

We undertook this study to identify factors that are associated with e-Government maturity over time. To do so, we assembled a panel dataset using established secondary data sources. Table 3 below summarizes our significant results.

Variable	Coefficient	What it signifies
Intercept: fixed effect	20.347	This is the average intercept of the e-Government maturity curve on the y-axis, i.e. the average value of e-Government maturity at zero levels of GDP and ICT infrastructure, in year 2003.
Intercept: random effect	4.781	This is the average amount by which the intercept varies among countries.
GDP per capita	0.113	A USD1 increase in a country's GDP per capita is associated with an increase of 0.113 in its e-Government maturity score.
Infrastructure	0.044	A 1 point increase in a country's infrastructure score is associated with an increase of 0.044 in its e-Government maturity score.
Time: fixed effect	0.517	On average, e-Government maturity scores increase by 0.517 every year.
Time: random effect	0.992	This is the average amount by which the slope on time varies among countries.

Table 3. Summary of Results

Our results support Hypotheses 1 (Affluence) and 2 (ICT Infrastructure), but not Hypotheses 3 (Human Capital) and 4 (Governance). In other words, only GDP per capita and ICT Infrastructure are significantly associated with rising e-Government maturity over time. This pattern of results suggests



that ICT infrastructure may be a sufficient condition for e-Government maturity, as measured by West and associates. In other words, it might be possible for a country, through heavy investment in technological capabilities, to move up a traditional e-government maturity model (e.g. Layne and Lee 2001) without necessarily rebuilding public sector processes as described by Andersen and Henrikson (2006). These results lend support to the arguments of who call for e-government maturity models to move away from technology-centric maturity models.

This paper makes the following contributions to research on e-Government. First, by using a carefully-specified mixed-effects model, it shows that changes in ICT infrastructure are the key avenue for a country to improve its e-Government record. This is especially relevant when governments are emphasizing austerity in their fiscal policies. As many countries that lead in e-Government, such as the United States and the United Kingdom, reduce their government expenditure, will their e-Government maturity rankings plateau? A separate point is that since many developed countries already possess high quality ICT infrastructure, the different aspects of infrastructure could be separately analyzed to find out which one is more important. This could help examine whether developing countries could use newer technologies, such as mobile devices or wireless broadband (e.g. WiMax), to accelerate their roll-out of e-Government services, compared to the path taken by developed countries.

Second, the study finds that changes in a country's wealth have a significant impact on its e-Government maturity. Other researchers, except for Azad et al (2010), have found a similar relationship. This finding supports our argument that the efficiency benefits of e-Government are enough of an incentive to induce countries to engage in it substantively, not just symbolically. The significant relationship between affluence and e-Government maturity also indicates that developing e-Government services is an expensive affair, and the decreasing costs of ICT (e.g. open source software, modularity, commoditized hardware and widely-available skilled labor) have not helped less well-off countries bridge the gap with wealthier countries, who tend to still perform better in e-Government maturity rankings (Singh et al. 2007).

#### **4.1 Limitations**

Some researchers have argued that e-Government rankings, such as the e-Government maturity measure used in this paper from West (2003, 2004, 2005, 2006, 2007) may not accurately depict the performance of public administrators in terms of e-Government. Such rankings focus on the visible elements of e-Government (such as number of services that can be performed online), without exploring the extent to which governments have used technology to transform their internal operations or radically improve outcomes (Bannister, 2007; 2010). These rankings also reflect a technology enactment perspective where progress is measured in stages, ignoring other equally-important models such as organizational collaboration, adaptation, and a shift from bureaucracy to service orientation (Andersen and Henriksen, 2006; Brown, 2007; Dawes, 2010). For example, if some administrations prioritize community links over service delivery, or emphasize local over national government interaction, they might achieve differing levels of maturity in different areas of government (Shackleton, 2004).

In the face of such criticism, new maturity models are being developed that incorporate additional dimensions beyond technology deployment, such as organizational integration and a citizenship orientation (Lee, 2010; Calista & Melitski, 2007; Obi, 2010), although some still retain the stage model. Since this study has relied on West's e-Government rankings as the dependent variable, it is perhaps most relevant for governments who hope to achieve substantive change in public administration by innovating with technology. We see much value in replicating our study with the newer measures being developed which encompass additional aspects of e-Government.

#### **4.2 Future research**

Our modeling approach is flexible for enhancement in the following directions. First, a major opportunity arising from longitudinal data is to examine temporal precedence between variables.

There is a need to clarify the sequencing of variables and the changes in these variables to improve causal inference (Cohen et al. 2003) about the development of e-Government. Since the data in most large-sample e-Government studies is cross-sectional, i.e. the variables have been organized without reference to the sequence in which they occur, any inferences made about relationships between the variables is weak. To this end, we hope to introduce theoretically-justified lags in our independent variables and measure the effect of these lagged independent variables on the dependent variable.

Second, the current level of e-Government in a country might affect its future development in later years. The negative correlation between intercept and slope in the mixed-effects regression model might mean that countries entering the period of study with highly-developed e-government initiatives had less “headroom” to improve during the study period than countries that were at more rudimentary levels of e-government at the start of the period. We plan to include auto-regressive parameters (lagged values of  $y$ ) as predictors in our model to measure this effect. Third, the lack of significance of governance in our model, alongside its theorized importance, indicates that it may be useful to examine broader measures of societal values, such as social capital, as they may capture some aspects of nations that are absent from the governance quality measures.

## 5 CONCLUSION

Existing large-scale empirical research on e-Government is dominated by cross-sectional analyses. This limits the applicability of the findings of these studies and our confidence in them because of concerns over omitted variables, endogeneity, and the common assumption that all countries have the same rate of change. This paper attempts to overcome these challenges by using a mixed effects model on an international panel dataset. Although the analysis can be enhanced (as described in the Further Research section), our findings are generally supportive of the infrastructure-focused point of view: the countries that do better at e-Government are the ones that are richer and have better infrastructure. Thus, e-Government researchers may find it useful to explore the specific technologies that support progress in e-Government and investigate whether less well-off countries can replace them with cheaper alternatives. Comparing high-performing e-Government nations on the four measures explored here may also help explicate the channels through which they help or hinder the development of e-Government. Perhaps, for example, governance does not affect e-Government maturity significantly as it implies time-consuming consultations with civic society and the need to ensure broad access to e-Government services. However, it is important to note that any conclusions made from this study must be made with the caveat that there have been recent calls for the use of broader measures of e-Government. It is possible that these alternative measures may lead to different results.

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