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E-GOVERNMENT MATURITY, CORRUPTION, AND ECO-EFFICIENCY

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Abstract

There is growing interest in the role and contribution of e-government to the level of corruption and the eco-efficiency in terms of economic prosperity and environmental degradation of nation states. In this paper, we use publicly available archival data to explore the relationships among e-government maturity, corruption, and eco-efficiency (defined in terms of economic prosperity and environmental degradation). Results substantiate a significant relationship between e-government maturity and corruption, and e-government maturity and eco-efficiency through the mediating effects of corruption. The findings suggest that while e-government maturity did not contribute to eco-efficiency, its value could be realized indirectly via its impacts on corruption, which in turn influences eco-efficiency. Our findings contribute to the theoretical discourse on e-government impact by identifying the role of e-government in a country and provide indications to practice on enhancing its eco-efficiency by managing the level of corruption.

Keywords: E-government maturity, Corruption, Eco-efficiency, Archival data.

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1 INTRODUCTION

E-government can be broadly defined as the use of information and communication technologies (ICTs) and the Internet to enhance the access to and delivery of all aspects of government services and operations for the benefit of citizens, businesses, employees, and other stakeholders (Krishnan & Teo 2012). Srivastava (2011), in his conceptual paper, classified e-government research into three broad streams: (1) evolution and development; (2) adoption and implementation; and (3) impact on stakeholders. While a great deal of research has been conducted in the first two streams, there have been relatively fewer studies on the impact of e-government (Flak et al., 2009) due to "the fuzziness and diversity of the intended goals of e-government projects" (Srivastava 2011, p. 108). Despite such fuzziness and diversity of goals, policy makers, practitioners, and academicians are often intrigued by the payoffs from e-government (Srivastava & Teo 2007).

There has been much debate over two substantial issues pertaining to the impact of e-government maturity, defined as the extent to which a government in a country has established an online presence (West 2005). First, e-government in a country can play a critical role in combating corruption, defined as "the misuse of entrusted power for private gains" (UNDP 2008, p. 8), by improving the enforcement of rules, lessening the discretion of public officials, and increasing transparency (Banerjee & Chau 2004; Cho & Choi 2004; Von Haldenwang 2004). Second, given that public-sector organizations have a wider scope of concern and significance of actions in the "public interest" (Caudle et al. 1991), it is argued that e-government in a country can play a significant role in achieving eco-efficiency (Chen et al. 2008), defined as "the delivery of competitively-priced goods and services that satisfy human needs and bring quality of life, while progressively reducing ecological impacts and resource intensity throughout the life-cycle to a level at least in line with the earth's carrying capacity" (DeSimone & Popoff 1997, p. 47). At the macro-level (i.e., regional- or national-level), eco-efficiency is conceptualized in terms of economic prosperity (e.g., value added of benefit – GDP per capita) and environmental degradation (e.g., pollution emissions – CO_2 intensity) (Seppälä et al. 2005). While the economic dimension of eco-efficiency is related to profit, the environmental aspect is associated with the planet (Elkington 1998). Motivated by the facts that research on e-government impact is still in a nascent stage (Srivastava & Teo 2007), and its relationship with corruption and eco-efficiency has not been adequately addressed in previous research, the key question that we address in this study is:

> ***RQ:*** *What are the relationships among e-government maturity, corruption, and eco-efficiency in a country?*

Emerging research provides contradicting responses to the question of impact of e-government on corruption. For instance, one group of research points to the negative impact of e-government on corruption. Examples include Banerjee and Chau (2004), Cho and Choi (2004), and Wong and Welch (2004), among others. However, others raise doubts if ICTs in general can effectively reduce corruption in reality (e.g., Kim et al. 2009; Mahmood 2004; Wescott 2001). Adding to these contradictions, most investigations into the influence of e-government on corruption have been undertaken via a qualitative case study approach (e.g., Kim et al. 2009). Similarly, we note that research linking e-government and eco-efficiency are limited in three ways. First, most studies remain – except a few recent studies – at best anecdotal, conjectural, and descriptive. Second, among the few recent studies, all focus on only one aspect of eco-efficiency (i.e., either economic aspect or environmental aspect). For instance, a study by Haigh (2004) focused only on the environmental aspect and ignored the economy. On the hand, a study by Srivatsava and Teo (2010) focused only on the economic aspect and ignored the environment. Third, like studies connecting e-government and corruption, we also observe that most of the investigations into the influence of e-government on eco-efficiency have been undertaken via a qualitative case study approach (e.g., Haigh 2004; Haigh & Griffiths 2008). In this paper, we seek to identify if indeed there is a quantitative merit in the relationships among e-government maturity, corruption, and eco-efficiency (in terms of economic prosperity and environmental degradation). While the insights we obtain do not replace the deep

insights obtained from a qualitative assessment of the impacts of e-government within the narrow confines of a single case study or a handful of comparative case studies, we believe that they would illuminate our understanding of the contributions of e-government maturity at the national-level by providing a macro-perspective of its impacts on key national-level growth parameters (i.e., corruption and eco-efficiency).

The rest of the paper is organized as follows. In the ensuing section, we present the research model and hypotheses. This is followed by a section on research design. Thereafter, using archival data from 108 countries (see Appendix for the list of countries), we test the hypothesized model. We then discuss the results and the implications for future research. The final section provides concluding remarks with a restatement of the value of the work.

2 THEORY AND HYPOTHESES

In this section, we describe the theoretical linkages among e-government maturity, corruption, and eco-efficiency in terms of economic prosperity and environmental degradation. The diagrammatic representation of the research model with hypotheses indicated is presented in Figure 1.

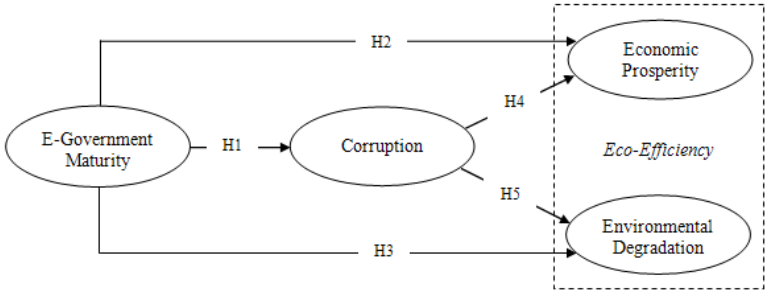


Figure 1. Research model and hypotheses.

2.1 Relating E-Government Maturity to Corruption

E-government maturity is defined as the extent to which a government in a country has established an online presence (West 2005). Prior research on e-government has conceptualized maturity using an evolutionary approach (Andersen & Henriksen 2006; Layne & Lee 2001). According to this approach, governments are believed to progress through a series of stages either as a function of integration and complexity or as a function of increasing levels of online activity and customer centricity. From an operational view, the extent to which a government develops an online presence is characterized by the features (e.g., provision of online publications, access to various government-related databases, and support digital signatures and credit card payments) implemented on its websites (West 2008). Implicitly, e-government maturity represents a continuum of developmental stages, from publishing information to supporting transactions, with some countries having progressed further than the others (West 2007). This conceptualization of e-government maturity is focused more on technological sophistication than political activity (Kim & Grant 2010). Reflecting the demonstrated behaviour of e-government in a country (Singh et al. 2007), e-government maturity is believed to reduce corruption in a country, among other benefits such as improved service delivery and cost reductions.

Corruption is a complex term having various connotations (Ojha et al. 2008). Jain (2001) defined corruption as the acts in which the power of public officials is used for personal gains in a manner that contravenes the rules of the game. Such acts can take many forms, including bribery, embezzlement, theft, extortion, abuse of discretion, favouritism, exploiting conflicting interests, and improper political contributions (UNDOC 2004). Corruption can be broadly classified into three types based on the corrupt relationships between the populace and the political, administrative, and judicial elite: (1) grand corruption; (2) bureaucratic corruption; and (3) legislative corruption (Jain 2001). Grand

corruption refers to acts of political elite, wherein they change either the national policies or the implementation of national policies to serve their own interest. Whereas bureaucratic corruption refers to corrupt acts of the appointed bureaucrats in their dealings with either their superiors (the political elite) or with the public, legislative corruption refers to the manner and degree to which the voting behaviour of legislators can be influenced.

Klitgaard (1988) argued that corruption is a problem of asymmetric information and incentives, which can be explained by the principal–agent–client model (based on agency theory). According to this model, the principals are the honest public officials within a government, in-charge of public servants (the agents) responsible for service delivery to businesses and citizens (the clients). The model predicts that corruption is more likely to occur when a public official possesses access to a monopoly, has discretion in administering it, and operates with a lack of accountability. That is, the problem of corruption arises in situations where there is a problem of asymmetric information, in which the agents know far more about the administration than either the principals or the clients. In such situations, the agents exploit their position as go-betweens and take advantage of the power entrusted to them to act more in their own interest, commonly through bribery, extortion, fraud, nepotism, or embezzlement (UNDP 2008).

An important implication of this model is that, in order to reduce corruption, it is crucial to restructure the principal–agent–client relationship to alter the amount of monopoly, discretion, and accountability with which the agent is endowed (Klitgaard 1988). Mohmood (2004), employing a similar line of thought, explained that ICTs (in specific, the Internet) has the potential to reduce corruption when adequately used to alter the principal–agent–client relationship in the public-sector–citizen interface through e-government. As highlighted in Lio et al. (2011), the maturity of e-government in a country can reduce the level of corruption by (1) increasing transparency and lessening the asymmetric information problem by enhancing access to information; (2) curbing the agent's chances for arbitrary activities by reducing discretion; and (3) advancing accountability as it enhances the ability of citizens to track the decisions and actions of individual officials and emboldens citizens and businesses to question unreasonable procedures and their arbitrary application by making rules simpler and more transparent.

UNDP (2008) uses several cases to exemplify how governments can use ICTs to increase transparency and accountability. For instance, the Indian Government has formulated plans to computerize all court complexes, create a database of new and pending cases, and digitalize the law libraries and court archives, all of which can help combat corruption in the judiciary. Further, India's Central Vigilance Commission has published on its website the names of officers against whom corruption investigations have been ordered or on whom penalties have been imposed, and on this website any citizen can lodge a complaint. Another well-known case is, since 1999, the Seoul Metropolitan Government has used ICTs to minimize corruption in applications for licenses and other permits by launching an Online Procedure Enhancement for Civil Applications (OPEN) system covering 54 common procedures, which enables citizens to monitor the progress of their applications as those responsible officials have to upload reports and documents (Kim et al. 2009; UNDP 2008). In summary, there are strong theoretical grounds to believe that e-government can promote transparency and accountability, and evidence from the above cases indicates that as e-government matures, the lower is the level of corruption in a country. Therefore, we posit:

H1: *E-government maturity is negatively associated with corruption.*

2.2 Relating E-Government Maturity to Eco-Efficiency

Eco-efficiency, identified as a key sustainability goal in the sustainability literature (Dyllick & Hockerts 2002) was originally proposed to encourage businesses "to become more competitive and more environmentally responsible at the same time" (Seppälä et al. 2005, p.118). Literally, efficiency means "doing more with less" (Chen et al. 2008). While the goal of producing more from less is not limited to businesses, governments are increasingly interested in achieving eco-efficiency as such

practices are likely to engender long-term advantages like international competitiveness (Seppälä et al. 2005). According to Chen et al.'s (2008) model of information systems (IS) and ecological sustainability, IS has the potential to enable organizations to achieve eco-efficiency through automation, defined as the operation and control of business processes via electronic means. Extending this argument to the context of public-sector organizations, governments can achieve eco-efficiency by providing public services online. Such automation or ICT-led transformation of the public-sector can bring forth eco-efficient practices through what Shrivastava (1995) called as "an information technology (IT) nature swap," which involves practices such as digitalization (Chen et al. 2008). Digitizing documents and e-filing can help in achieving energy savings by saving paper, the manufacture of which is energy intensive and generates large amounts of waste. To illustrate, a service agenda released by the Australian Government in 2006, notes that electronic delivery serves the government's environmental objectives by helping to reduce paper, energy consumption and greenhouse gas emissions (Ausgov 2007). The agenda also states that connected government provides greater opportunities for agencies to share and reuse technology, thereby reducing overall infrastructure costs.

At the macro-level, eco-efficiency is measured in terms of economic prosperity (e.g., GDP per capita) and environmental degradation (i.e., CO_2 emissions) (Seppälä et al. 2005). In simple terms, eco-efficiency at the macro-level can be seen as a way to contribute to sustainable development by simultaneously increasing economic gains and lowering environmental degradation. Research indicates that ICTs' role in enabling economic prosperity has become more significant (e.g., Dedrick et al. 2003). For instance, Clark et al. (2002) highlighted how the use of Internet technologies at the local government level led to a proliferation of e-government resulting in economic welfare of the country. Also, Moynihan (2004), Von Haldenwang (2004), and West (2004) established that growth and development of e-government had an impact on the efficiency of a country in a number of ways, thereby improving its economic prosperity. Recent studies by Srivatsava and Teo (2008; 2010) established that national economic performance and business competiveness in terms of GDP per capita were dependent on the growth and maturity of e-government in a country.

In a similar vein, it has been argued that governments can bring their ICT-led innovations (such as e-government) and environmental objectives together so that the growth and maturity of such innovations can lower the degradation of environment through service and cost efficiencies (Prahalad & Hammond 2002). E-government has the potential to deliver positive environmental outcomes by (1) disseminating environmental issues faster and with broader coverage throughout the nation (Cormier & Magnan 2004; Judge & Douglas 1998); and (2) developing real-time decision support systems that integrate with governmental ICT-led innovations, and enable policy makers to make operational decisions that are aligned with environmental goals (Box 2002). The information processing capabilities of ICT-led innovations in the public-sector helps government agencies and nations in achieving environmentally sustainable outcomes (Box 2002; Chen et al. 2008). Clearly, environmental degradation that indicates the environmental conditions of a nation (e.g., pollution emissions and climate change variations) is dependent on the growth and maturity of technological developments (Dutta & Mia 2009) by government agencies, among others. Taken together, e-government maturity in a country will have significant impact on its eco-efficiency by enhancing economic prosperity and lowering environmental degradation. Hence, we propose:

H2: *E-government maturity is positively associated with economic prosperity.*

H3: *E-government maturity is negatively associated with environmental degradation.*

2.3 Relating Corruption to Eco-Efficiency

Corruption has often been touted as one of the biggest threats to growth and development of nations (Robertson & Watson 2004). The latest Transparency International (2011) report indicates that the vast majority of the 183 nations surveyed had a score less than five, on a scale from 10 (very clean) to 0 (highly corrupt), signaling a serious corruption problem. Taking an economic perspective, while

some scholars have attempted to defend corruption as a pragmatic action that actually accelerates economic prosperity and benefits the society in which corruption occurs (e.g., Nas et al. 1986; Nye 1979), others have asserted that corruption is costly (e.g., Rose-Ackerman 1999). However, studies supporting the notion that corruption accelerates economic prosperity are often criticized for its methodology and model development. For instance, Goudie and Stasavage (1997) criticized Brunetti's (1995) study that argued for positive associations between corruption and economic prosperity. Specifically, they noted flaws in Brunetti's methodology and model development, and concluded that the effects of corruption depend in part on how corruption is organized and on the country's level of efficiency at the outset. Further, Getz and Volkema (2001, p. 11) indicate that "the arguments asserting that corruption adversely affects economic development are more recent and more compelling." Scholars have developed two fundamental arguments against corruption. First, corruption has *disincentive effects* on economic prosperity, since it increases the risk and uncertainty faced by potential investors (Getz & Volkema 2001), as well as adding bribes and other dubious expenses to the costs of doing business (Robertson & Watson 2004). Mauro (1995), for instance, found that corruption has a negative effect on investment, thus resulting in less economic growth. Second, corruption has *distortionary effects* on economic prosperity (Goudie & Stasavage 1997), since monies paid for bribery are inefficiently allocated resources. Furthermore, the secrecy surrounding bribery may lead government officials to bias their activities toward companies with the lowest risk of detection. Shleifer and Vishny (1993, p. 599) argue that corruption is "much more distortionary and costly than its sister activity, taxation." This highlights the managerial relevance of corruption in a country; "in assessing the cost of doing business in a particular country, firms and their managers should consider the level of corruption even more carefully than the level of taxation" (Robertson & Watson 2004, p. 386). In sum, by advancing unproductive and manipulative behavior, corruption in nations leads to uncertainty and inefficiency resulting in low levels of economic prosperity.

Turning now to the relationship between corruption and environmental degradation, while corruption has been recognized as a global problem for the conservation of biodiversity (Barbier et al. 2005; Laurance 2004; Smith et al. 2003), we note that the investigations into the influence of corruption on environmental degradation is still in a nascent stage. Emerging studies have found that the level of corruption in a country is positively associated with environmental degradation. For instance, Carter (1997) undertaking a qualitative approach focused on environmental regulation in the state of New York and how this interacted with organized crime and corruption. Robbins (2000), by introducing a theoretical framework for the analysis of corruption and enforcement of protection for a nature reserve, found that the lack of enforcement, in the empirical context of Rajasthan, India was fuelled by corruption among foresters, which led to substantial habitat destruction. Further, Lopez and Mitra (2000) argued that corruption and environmental policy stringency are characterized by a monotonic (negative) relationship. Extending Lopez and Mitra's arguments, Fredriksson and Millimet (2001) claimed that there is a nonmonotonic correlation between corruption levels and environmental protection. Damania (2002) showed that environmental regulations are ineffective if bureaucrats are highly corrupted. He made the case for complete deregulation if there is no possibility to reduce corruption. Welsch (2004) found that corruption affects environmental quality as it hinders the formation and enforcement of environmental regulations. Also, Morse (2006) established that corruption is bad for environmental sustainability. Taken together, corruption, promotes rewarding unmerited behavior resulting in inefficiencies, which consequently impact the economic prosperity and environmental degradation of the country. Thus, we posit:

H4: *Corruption is negatively associated with economic prosperity.*

H5: *Corruption is positively associated with environmental degradation.*

3 RESEARCH DESIGN

To test the formulated hypotheses, we gathered archival data (for each of the main constructs) for two reasons. First, collecting large scale primary data from over hundred countries is constrained by the

amount of resources and time available for conducting such research (Krishnan & Teo 2012; Srivastava & Teo 2008). Second, archival data, as suggested by some researchers (e.g., Jarvenpaa 1991) offers several advantages namely, (1) easy reproducibility; (2) ability to generalize the results arising from larger datasets (Kiecolt & Nathan 1985); and (3) robust to the threat of common method bias (Woszczynski & Whitman 2004). Hypotheses were tested via a cross-sectional analysis of 108 countries for a period of 2004 to 2008. According to Hair et al. (2006), sample size below 50 may indicate the potential for degrees of freedom and efficiency problems; thus, the concern in our study appeared to be minimal. Further, as multiyear averages provide more accurate and stable estimates than single year datasets (Wiggins & Ruefli 2005); we used a cross-section from 2004 to 2008. The concept of using multiyear averages over single year datasets is consistent with what has been done in previous studies examining corruption and other variables such as investment (e.g., Brouthers et al. 2008; Habib & Zurawicki 2001; Voyer & Beamish 2004). The primary sources of data were the Global E-Government Reports (West 2004; 2005; 2006; 2007; 2008), the Worldwide Governance Indicators database (Kaufmann et al. 2010), and the World Bank's World Development Indicators and Global Development Finance database.

3.1 Operationalization of Constructs

The independent construct, e-government maturity measures the extent to which a government has established an online presence (West 2005). The scores for this construct were obtained from the Global E-Government Reports (West 2004; 2005; 2006; 2007; 2008). These scores are a reflection of a wide variety of features implemented in governmental websites, such as the provision of online publications, access to various government-related databases, and support for non-native languages, among others (West 2008). This measure has been used in past studies like Singh et al. (2007).

The intervening construct, corruption captures the perceptions of the extent to which public power is exercised for private gain, including both petty and grand forms of corruption, as well as "capture" of the state by elites and private interests (Kaufmann et al. 1999). Sample list of concepts measured include (1) public trust in financial honesty of politicians; (2) frequency of household bribery; (3) frequency of corruption among government officials; and (4) level of petty, large-scale and political corruption. The scores for this construct were obtained from the Worldwide Governance Indicators database (Kaufmann et al. 2010) by performing a negative transformation on the original values of the variable "Control of Corruption," with values running between -2.5 and 2.5, with the higher values corresponding to the better control of corruption. In other words, corruption = -control of corruption. This measure has been used in past studies like Krishnan and Teo (2012).

The dependent variable, economic prosperity, according to Porter (2005), depends both on the value of a nation's products and services, measured by the prices they can command in open markets, and also on the efficiency with which they are produced. Hence, consistent with extant studies (e.g., Srivastava & Teo 2010), we used Porter's productivity paradigm for operationalizing economic prosperity in terms of GDP per capita (adjusted for purchasing power parity, PPP), the values for which were obtained from the World Bank's World Development Indicators and Global Development Finance database. Another dependent variable, environmental degradation captures the extent of pollution emissions, measured in terms of carbon dioxide emissions (i.e., CO_2 intensity, kg per kg of oil equivalent energy use), representing the emissions from solid fuel consumption (i.e., emissions from the use of coal as an energy source), the values for which were taken from the World Bank's World Development Indicators and Global Development Finance database. This measure has been used in past studies like Jorgenson et al. (2010).

Additional control variables consisted of exports (as % of total GDP), manufacturing (as a % of total GDP), urban population (as % of total population), and population aged 15 to 64 (in %). We selected these particular control variables, since they are both consistent with prior macro-level studies on economic prosperity (e.g., Tiwari & Mutascu 2011) and environmental degradation (e.g., Jorgenson et al. 2010). The values for these variables were taken from the World Bank's World Development

Indicators and Global Development Finance database. Alike the main variables, the control variables are the multiyear average from 2004 to 2008.

4 ANALYSIS AND RESULTS

4.1 Descriptive Statistics and Correlations

Table 1 presents the descriptive statistics and correlations for all variables in the study. As shown in the table, e-government maturity was negatively correlated with corruption, and positively correlated with economic prosperity and environmental degradation. Also, corruption was negatively correlated with both economic prosperity and environmental degradation. Further, as all correlations among variables were below the threshold value of 0.8, the concern for multicollinearity would be minimal (Gujarati 2003; Gujarati & Porter 2009). Nevertheless, we followed up with collinearity test that measure variance inflation factor (VIF), which is provided by the SPSS software. VIF assesses the effect that the other independent variables have on the standard error of a regression coefficient (Hair et al. 2006). The results of these tests revealed that our VIFs ranged from 1.73 to 3.72 (all tolerance levels above 0.27). According to Fox (1991), a VIF of above 4.0, or a tolerance level below 0.25, may indicate the potential for multicollinearity; thus, the concern in our model appeared to be minimal.

Variable	M	SD	1	2	3	4	5	6	7
1. Exports[a]	3.67	0.56	-						
2. Manufacturing	15.84	6.64	16	-					
3. Urban Population	64.42	5.81	35***	33***	-				
4. Population Aged 15 to 64	60.16	20.89	28**	09	44***	-			
5. E-Government Maturity	29.47	5.29	11	24*	45***	52***	-		
6. Corruption	-0.09	1.03	-22*	-14	-44***	-58***	-62***	-	
7. Economic Prosperity[a]	8.08	1.54	34***	17	61***	65***	63***	-74***	-
8. Environmental Degradation[a]	0.61	0.64	28**	27**	65***	45***	31**	-22*	48***

Note.
N = 108. M = Mean. SD = Standard deviation. [a]Log transformed variables. Decimal points omitted for correlations. *p < 0.05 **p < 0.01 ***p < 0.001 (2-tailed).

Table 1. Descriptive statistics and correlations.

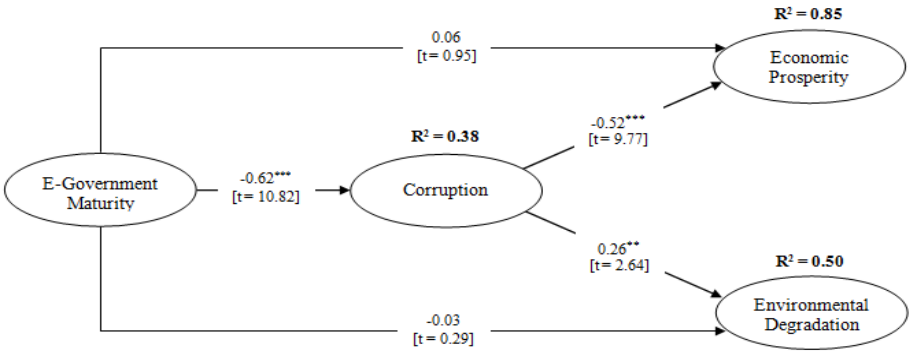
4.2 Reliability and Validity

The reporting agencies followed rigorous procedures for ensuring the reliability and validity of data. For instance, West and his team followed several stringent procedures for ensuring the reliability and validity of their e-government maturity scores that included: (1) choosing appropriate websites for analyses; (2) deciding on the criteria (or features) for analyses; and (3) using foreign language readers to evaluate government websites that are not in English. To illustrate, the latest maturity scores (i.e., for year 2008) were based on the assessment of the sites of executive offices (such as a president, prime minister, party leader), legislative offices (such as congress, parliament or people's assemblies), judicial offices (such as major national courts), cabinet offices and major agencies serving crucial functions of government (such as health, human services, taxation, education, administration, natural resources, foreign affairs and foreign investment, among others). And, the features assessed included online publications, online database, audio and video clips, non-native languages or foreign language translation, commercial advertising, premium fees, user payments, privacy policy, digital signatures, credit card payments, automatic email updates, website personalization, personal digital assistant (PDA) access and an English version of the website, among others (West 2008).

Similarly, the Worldwide Governance Indicators project team led by Kaufmann, followed a three-step procedure to construct the aggregate measure of control of corruption, from which our corruption scores are based on: (1) assigning data from individual sources to aggregate indicator; (2) preliminary rescaling of the individual source data to run from 0 to 1; and (3) using an unobserved components model (a statistical tool) to make the 0-1 rescaled data comparable across sources, and then to construct a weighted average of the data from each source for each country. Further, multiple sources were used to gather the data, which included surveys of (1) households and firms; (2) commercial business information providers; (3) non-governmental organizations; and (4) public sector organization. In summary, we used the data directly from these reports as the data collecting agencies are trustworthy and followed rigorous procedures for ensuring the reliability and validity. Moreover as highlighted earlier, data from these reports has been used by several past studies.

4.3 Hypotheses Testing

Structural equation modeling (SEM) analysis was chosen over regression analysis as SEM can simultaneously analyze all paths in one analysis (Chin 1998). Within SEM, we employed Partial Least Squares (PLS) over covariance-based SEM techniques (such as LISREL, EQS, or AMOS) for four reasons. First, PLS places minimal restrictions on measurement scales, sample size, and residual distributions (Chin 1998). Second, PLS analysis is distribution free and does not assume true independence of the variables, leading to more reliable results (Tobias 1999). Third, PLS is robust against data structural problems such as skew distributions and omissions of regressors (Cassel 1999; Gefen et al. 2000). And fourth, the exploratory theory development stage that "e-government maturity, corruption, and eco-efficiency" research is currently in makes PLS a suitable choice for analyzing data in our study (Barclay et al. 1995; Gefen et al. 2000). In the model tested, all constructs were modeled as reflective as their measurement items were manifestations of intended constructs (Barclay et al. 1995). SmartPLS (version 2.0.M3) was used to analyze the data in this study (Ringle et al. 2005). In specific, we used a PLS bootstrapping technique with 500 resamples to assess the significance of model linkages. The results of PLS analysis for the structural model are shown in Figure 2.



Control Variables	Model Variables	
	Economic Prosperity	Environmental Degradation
Exports	0.06 [t = 1.08]	0.04 [t = 0.48]
Manufacturing	-0.02 [t = 0.35]	0.07 [t = 1.09]
Urban Population	0.20** [t = 3.40]	0.58*** [t = 7.02]
Population Aged 15 to 64	0.32*** [t = 4.90]	0.31** [t = 3.76]

Note.
N = 108. 5000 bootstrap samples. **p < 0.01 ***p < 0.001 (2-tailed).
Control variables were entered simultaneous with model variables.

Figure 2. Results of PLS analysis.

As shown in Figure 2, e-government maturity was negatively associated with corruption (β = -0.62, t = 10.82, p<0.001), and not associated with economic prosperity (β = 0.06, t = 0.95, n.s.) and

environmental degradation (β = -0.03, t = 0.29, n.s.). Hence, H1 was supported, and H2 and H3 were not supported. Further, as expected, corruption was negatively associated with economic prosperity (β = -0.52, t = 9.77, p<0.001) and positively associated with environmental degradation (β = 0.26, t = 2.64, p<0.01). Therefore, H4 and H5 were supported. Further, as shown in the figure, among the control variables, only urban population and population aged 15 to 64 had significant effects on economic prosperity and environmental degradation. The proposed model explained 38% of variance in corruption, 85% in economic prosperity, and 50% in environmental degradation.

4.4 Post-Hoc Assessment of Indirect Effects

As indicated earlier, the relationships of e-government maturity with economic prosperity and environmental degradation were not significant. There can be two plausible reasons for this anomalous result: first, there are actually no relationships among e-government maturity, economic prosperity, and environmental degradation; or second, the effects of e-government maturity on economic prosperity and environmental degradation are mediated by corruption. Therefore, we examined if there are indirect effects via corruption. For this purpose, our study referred to the method that Preacher and Hayes (2008) recommended for testing indirect effects. Preacher and Hayes' method examines the total and direct effects of the independent variable on the dependent variable, and the indirect effects through the mediator. As per Preacher and Hayes' suggestions, we elected the bootstrapping strategy for the tests. Bootstrapping is a nonparametric resample procedure that does not impose the assumption of normality of the sampling distribution. It involves repeatedly sampling from the dataset and estimating the indirect effect of the mediator in each resampled dataset. Based on repeated samplings, an empirical approximation of the indirect effect can be estimated and used to construct confidence intervals (CIs) for the indirect effect. In the current study, we used the bias-corrected (BC) bootstrap, as Preacher and Hayes recommended. Preacher and Hayes, consistent with prior research (e.g., Williams & MacKinnon 2008), have argued that bootstrapping is in general superior to the multivariate product-of-coefficient strategy (i.e., the Sobel test) in small to moderate samples. Their results suggested that the BC bootstrap performs best in terms of both statistical power and Type I error rate.

A Preacher and Hayes analysis (see Table 2) includes an examination of the total and direct effects of the independent variable on the dependent variable, the difference between which is the indirect effect of the independent variable on the dependent variable through the mediator. The analysis also yields an estimation of the indirect effect of the mediator. In addition, the BC bootstrap will generate a 95% CI for the mediator. If the interval for a mediator does not contain zero, it means the indirect effect of the mediator is significantly different from zero.

Total Effect of IV on DV		Direct Effect of IV on DV		Indirect Effects			
Coefficient	T-value	Coefficient	T-value		Point Estimate	BC 95% CI	
						Lower	Upper
Model 1: Economic prosperity as DV (controlling for environmental degradation along with other controls)							
0.4093***	4.0097	0.0808	1.0259	Total	0.3285	0.1496	0.5543
				Corruption	0.3285	0.1496	0.5543
Model 2: Environmental degradation as DV (controlling for economic prosperity along with other controls)							
-0.0424	-0.6788	-0.0044	-0.0730	Total	-0.0468	-0.1281	-0.0036
				Corruption	-0.0468	-0.1281	-0.0036
Note: N=108. 5000 bootstrap samples (as recommended by Preacher and Hayes (2008)). Model 1's R^2 = 86% (Adjusted R^2 = 85%). Model 2's R^2 = 52% (Adjusted R^2 = 49%). IV: Independent Variable. DV: Dependent Variable. BC: Bias-Corrected Bootstrap. CI: Confidence Interval. ***p < 0.001 (2-tailed). 'Total' is the total relation between independent variable and dependent variable without the consideration of other variables.							

Table 2. Summary of tests of mediation effects.

First, model 1 was examined, in which e-government maturity was the independent variable and economic prosperity was the dependent variable with environmental degradation treated as a covariate along other control variables (i.e., exports, manufacturing, urban population, and population aged 15 to 64). As shown in Table 2, e-government maturity had a significant total effect on economic prosperity. When the mediating variable corruption was introduced, the direct effect of e-government maturity on economic prosperity became insignificant. This meant that corruption fully mediated the impact of e-government maturity on economic prosperity. Furthermore, the difference between the total and direct effects was the indirect effect as mediated through corruption with a point estimate of 0.3285 and a 95% BC bootstrap CI of 0.1496 to 0.5543, indicating that the indirect effect of corruption between e-government maturity and economic prosperity was significantly different from zero.

Next, model 2 was examined, in which e-government maturity was the independent variable and environmental degradation was the dependent variable with economic prosperity treated as a covariate along other control variables. As shown in Table 2, e-government maturity did not have a significant total effect on environmental degradation. While some researchers (e.g., Baron & Kenny 1986) suggested that a significant total effect of the independent variable on the dependent variable is a prerequisite for testing the mediating effects, others (e.g., Collins et al. 1998; MacKinnon 2000; Shrout & Bolger 2002) argued that this is not necessary for mediation to occur. Thus, we continued to examine the mediating effect of corruption. As shown in the table, the indirect effect was significant, with a point estimate of -0.0468 and a 95% BC bootstrap CI of -0.1281 to -0.0036, indicating that the indirect effect of corruption on e-government maturity and environmental degradation was significantly different from zero.

In summary, our post-hoc assessment indicates that e-government maturity had indirect effects with economic prosperity and environmental degradation via corruption. In other words, corruption mediated the impact of e-government maturity on economic prosperity and environmental degradation.

5 DISCUSSION

Findings from this study raise several issues that deserve mention. First, e-government maturity in a country negatively contributes to its corruption. While there are strong theoretical grounds to believe that e-government can combat corruption, a handful of studies raised doubts if ICTs in general can effectively reduce corruption in reality. For instance, Heeks (1998) argued that sometimes ICTs has no significant effects on reducing corruption, and even creates new opportunities for corruption. Another study by Wescott (2001) highlighted that ICTs can lead to an upskilling of corruption, and reduces competition for upskilled corrupt civil servants. As an attempt to address their doubts, our study, indeed has established a quantitative merit in the relationship between e-government maturity in a country and its corruption. That is, as e-government matures, the lower is the level of corruption in a country.

Second, our results indicate that e-government maturity did not contribute significantly to eco-efficiency, both in terms of economic prosperity and environmental degradation. While a few studies have found significant relationships among e-government maturity, economic prosperity, and environmental degradation, one possible reason for this result may be due to the fact that the effect of e-government in a country is very small and its value can be fully realized only through intervening factors that would create what Srivastava and Teo (2007) called as "first-order benefits." However, it is gratifying that our observation of (1) positive relationship between e-government maturity and economic prosperity; and (2) negative relationship between e-government maturity and environmental degradation are in the same direction as past studies (e.g., Krishnan & Teo 2011; Srivastava & Teo 2010). Further, we note that published research (e.g., Srivastava and Teo 2010) examining the effect of e-government development on economic performance often used single year datasets. In contrast, we used multiyear averages, which might have caused insignificant results. Nevertheless, considering the fact that multiyear averages provide more accurate and stable estimates than single year datasets

(Wiggins & Ruefi 2005), the lack of significance could be believed. Also, we note that published studies examining the effect of e-government development on environmental degradation found insignificant main effect between e-government development and environmental sustainability but significant interaction effects of national environmental factors (e.g., human capital and public institutions) on e-government development – environmental sustainability relationship (e.g., Krishnan and Teo 2011). Furthermore, our post-hoc assessment showed that e-government maturity is associated with economic prosperity and environmental degradation through the effects of corruption. In other words, the payoffs from e-government could be realized indirectly via its impacts on corruption, which in turn influences eco-efficiency, thereby justifying the fact that e-government payoffs pertaining to eco-efficiency can only be fully realized through first order benefits such as low levels of corruption.

Turning now to the effects of corruption on eco-efficiency, our results indicates that corruption is negatively associated with economic prosperity, and positively associated with environmental degradation. Our findings are consistent with prior empirical research (e.g., Morse 2006, Robertson & Watson 2004, Rose-Ackerman 1999, Welsch 2004) where it has been argued that corruption promotes rewarding unmerited behavior resulting in inefficiencies, which consequently impact the economic prosperity and environmental degradation of the country. In the ensuing section, we discuss the implications and limitations of our research, and offer future research directions.

6 IMPLICATIONS, LIMITATIONS AND FUTURE RESEARCH

Our study makes two important theoretical contributions. First, while existing studies on e-government linking corruption and eco-efficiency are often descriptive and mostly undertaken via qualitative case study approach, our study, by making innovative use of publicly available archival data has identified a quantitative merit in the relationships among them. By taking such an approach, our study not only highlights the associations among e-government maturity, corruption, and eco-efficiency but also reiterates the synergistic connections among them. Second, while e-government researchers are constantly struggling with three major dilemmas regarding the research questions pertaining to the impact of e-government namely, (1) variables of interest on which the impact of e-government maturity should be measured (here, eco-efficiency in terms of economic prosperity and environmental degradation); (2) level of analyses (here, cross-country level); and (3) the process through which the value of e-government is realized (here, corruption), our study has clearly shown the research community on how to overcome such dilemmas in their own research.

From a practical standpoint, our study makes three important contributions. First, by examining the influence of e-government maturity on corruption and eco-efficiency, our study, helps practitioners and policy makers to understand why different levels of corruption and eco-efficiency continues to prevail among countries. Second, our study suggests that e-government maturity will have indirect effects on economic prosperity and environmental degradation through corruption. That is, decrease in the levels of corruption in a country will enhance economic prosperity and lower environmental degradation. Therefore, practitioners and policy makers should make concerted efforts in enhancing eco-efficiency by reducing the levels of corruption by focusing on the growth and maturity of e-government. Third, our results serve as a guide to countries striving to manage corruption and elevate eco-efficiency on what to focus their resources and capabilities on.

This study has two limitations. First, we used secondary data obtained from three different sources, and hence, we have to depend on the indices as formulated by the reporting agencies. While primary data might have given us a better control over the definition of variables, it is less feasible for small group of researchers to undertake a large scale cross-country data collection given the limited amount of resources and time. But, taking into consideration that these indices have been formulated by reputable and authorized organizations using several suitable statistical procedures (e.g., use of multiple respondent expert surveys in each nation and correcting the internal consistency before index calculation) for assessing validity and reliability of the instrument, relying upon these secondary

sources provides a cost-effective way for conducting our study. Second, we analyzed data only from the countries commonly available in all the sources. For instance, we could not include countries like Afghanistan, Hong Kong, Taiwan, and so on as these countries were not commonly available in all the sources. Given that we have only 4 main variables and sample size as 108, discarding few countries may not make a significant difference in the results because PLS places minimal restrictions on sample size and residual distributions (Chin 1998). Despite these two potential limitations, our study is one among the few studies with macro-level orientation to examine both the aspects of eco-efficiency cohesively in a unified theoretical framework.

Future research may focus on several directions. First, researchers may consider extending our cross-sectional study to a longitudinal (panel) study. This would help to examine the issues of temporal precedence (leads/lags between independent and dependent variables), as well as the evolution of eco-efficiency as a function of the levels and trends in e-government maturity and corruption variables. Second, while our study has mainly focused on the effect of maturity of e-government in a country on its eco-efficiency, future studies may consider examining the influence of e-business maturity on economic prosperity and environmental degradation. A comparison from this perspective would be interesting and may add value to both theory and practice. Third, given the relationship between e-government maturity and eco-efficiency, and the indirect effects between them via corruption, future research may consider extending our study by formulating moderated-mediation models or multiple-mediation models by including variables such as human capital, government effectiveness and rule of law, and empirically testing them.

7 CONCLUSION

In conclusion, despite an extensive recognition on the influence of e-government in a country on its corruption and eco-efficiency, both research and practitioner communities knows relatively little on how e-government can be effectively utilized to combat corruption, and enhance eco-efficiency by simultaneously increasing economic prosperity and lowering environmental degradation. As an initial step to be taken towards raising awareness for the pivotal role of e-government in managing corruption and eco-efficiency, we have constructed and validated a theoretical model by making innovative use of publicly available archival data. In the post-hoc assessment, we reasoned and demonstrated empirically the indirect relationships among e-government maturity, economic prosperity, and environmental degradation through the effects of corruption. Our study, in sum, reiterates the synergistic connections among e-government, corruption, and eco-efficiency.

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APPENDIX: COUNTRIES ANALYZED

Algeria, Angola, Argentina, Armenia, Australia, Austria, Azerbaijan, Bangladesh, Belarus, Belgium, Bolivia, Bosnia, Botswana, Brazil, Brunei, Bulgaria, Cambodia, Chile, China, Colombia, Congo, Congo Dem Rep, Costa Rica, Croatia, Cuba, Cyprus Republic, Czech Republic, Denmark, Dominican Republic, Ecuador, Egypt, El Salvador, Eritrea, Estonia, Ethiopia, Finland, France, Gabon, Georgia, Germany, Ghana, Guatemala, Honduras, Hungary, Iceland, India, Indonesia, Ireland, Italy, Japan, Jordan, Kazakhstan, Kenya, Kyrgyzstan, Latvia, Lebanon, Libya, Lithuania, Luxembourg, Macedonia, Malaysia, Malta, Mexico, Moldova, Mongolia, Morocco, Mozambique, Namibia, Nepal, Netherlands, Nicaragua, Norway, Pakistan, Panama, Paraguay, Peru, Philippines, Poland, Portugal, Romania, Russia, Saudi Arabia, Senegal, Singapore, Slovakia, Slovenia, South Africa, South Korea, Spain, Sri Lanka, Sudan, Sweden, Switzerland, Tajikistan, Tanzania, Thailand, Trinidad, Tunisia, Turkey, Ukraine, United Arab Emirates, United Kingdom, United States, Uruguay, Uzbekistan, Vietnam, Zambia, Zimbabwe
Total number of countries included for data analysis = 108.