MODERATING EFFECTS OF ENVIRONMENTAL FACTORS ON E-GOVERNMENT, E-BUSINESS, AND ENVIRONMENTAL SUSTAINABILITY

Completed Research Paper

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Abstract

Utilizing the resource complementarity perspective of the resource based view (RBV) of a firm, and the literature on information technology (IT) and environmental sustainability as the guiding theoretical lenses, we posit that the relationships of electronic-government (e-government) development and electronic-business (e-business) development in a country with its environmental sustainability are contingent on national environmental factors (i.e., complementary assets): (1) human capital; (2) public institutions; (3) macro-economic stability; and (4) gross domestic product (GDP) per capita. Based on publicly available archival data from 122 countries, results showed that both e-government development and e-business development had no direct effect on environmental sustainability. However, e-government development and e-business development interacted with other variables to affect environmental sustainability. Specifically, while human capital and public institutions positively moderated the relationship of e-government development with environmental sustainability, the relationship of e-business development with environmental sustainability was contingent on them in the negative direction. Also, while macro-economic stability positively moderated the relationship of e-government development with environmental sustainability, the relationship of e-business development with environmental sustainability was not contingent on it. Finally, the relationships of e-government development and e-business development with environmental sustainability were contingent on GDP per capita in the negative direction. Our findings contribute to the theoretical discourse on the resource complementarity perspective by identifying the roles of national complementary assets and provide indications to practice on improvements in environmental sustainability by effectively managing those assets.

Keywords: E-government, e-business, environmental sustainability, complementary assets, archival data

Introduction

There has been much debate over the phenomenal growth of IT investments by organizations and nations, and the ability of these investments to provide them with competitive advantage. This debate is reflected in a number of firm- and country-level studies that have examined the strategic and operational value of IT and its effect on firm performance (Bharadwaj 2000; Melville et al. 2004) and national competitiveness (Meso et al. 2009; Srivastava and Teo 2008; 2010). Concurrent with this rise in arguments on IT investments and their ability to engender value in terms of innovative and competitive strategies, an equally important debate has been taking place regarding the urgent need for governments and businesses to tackle issues concerning national environmental sustainability. This recent surge across public- and private-sector organizations in countries has motivated them to take proactive roles in managing environmental sustainability by lowering their energy consumptions and carbon footprints.

According to the World Commission on Economic Development (Brundtland 1987, p.43), sustainable development is "development that meets the needs of the present generation without compromising the ability of future generations to meet their own needs." This definition is related to triple-bottom-line (TBL), a broad conceptualization of organizational and national sustainability encompassing three principles namely, (1) economic prosperity; (2) environmental integrity; and (3) social equity (Bansal 2005). Whereas the economic prosperity principle promotes a reasonable quality of life through the productive capacity of organizations and individuals in society (Holliday et al. 2002), the environmental integrity principle ensures that human activities do not erode the earth's land, air, and water resources (Bansal 2005). The social equity principle ensures that all members of society have equal access to resources and opportunities (Bansal 2005). In other words, while the economic dimension relates to issues concerning profit, the environmental and social dimensions pertains to issues relevant to planet and people respectively (Elkington 1998). In this paper, of the three dimensions, we focus on the environmental dimension of TBL. Given the fact that no single set of measures can adequately describe the multifaceted nature of the environment or fully capture transboundary effects and pollution consequences (Ansuategi and Perrings 2000), we, consistent with existing studies (e.g., Grafton and Knowles 2004) use secondary indicators of environmental sustainability. Specifically, we define environmental sustainability in terms of climate change, comprising three aspects: (1) greenhouse gas (GHG) emissions per capita (including emissions from land use change); (2) CO_2 emissions per unit of electricity generation; and (3) industrial GHG emissions intensity (Yale 2010).

Unlike in information systems (IS) discipline, environmental sustainability is a relatively well researched topic in the areas of operations, marketing, business economy, and management (Melville 2010). Existing studies on environmental sustainability incorporating IS perspectives can be broadly classified into three streams. First, descriptive and anecdotal studies, while offering benchmarks for practitioners to assess and evaluate their environmental sustainability practices and to progress against their peers, provide little value to theory (e.g., Molla 2009). Second, case studies that are micro in orientation, while capturing the richness of the context in which the researched object is embedded in, cannot possibly address the broad macro-level issues (e.g., Haigh 2004; Haigh and Griffiths 2008). The third stream of research is conceptual studies that lay the theoretical foundations for future empirical exploration (e.g., Elliot 2011; Melville 2010; Watson et al. 2010). This classification of existing studies reveals that there is a dearth of quantitative empirical studies examining "IT-environmental sustainability" linkage from a global perspective. Hence, the prime motivation of this research is to fill this void by examining the impact of national IS innovations in a country on its environmental sustainability.

Two major stakeholders in a country who are "ultimate keys" to respond to issues concerning environmental sustainability are governments and businesses (i.e., public- and private-sector organizations). By (1) adopting and using initiatives such as clean technologies that lowers their energy consumptions and carbon footprints; (2) implementing energy management systems that helps in monitoring and reporting of energy usage and emissions; and (3) adopting effective waste management methods, governments and businesses can reframe their aspiration towards managing environmental sustainability. In this study, we center upon adoption and usage of the "objective technology", the Internet, common to both sectors. By doing this, we not only strive to overcome the "academic disconnect" that is created when researchers looks at either one of the "enacted domains" in their study,

but also help policy makers and practitioners in understanding the holistic view of developing the IS for managing environmental sustainability.

The emergence and rise of the Internet has enabled a massive amount of information to be aggregated and has substantially transformed the way the governments and businesses conduct their transactions and operations, which in turn is brought about by e-government development and e-business development respectively. E-government is defined as the provision and enhancement of government services and operations to the stakeholders in a country using online channels. E-business, on the other hand, is defined as the use of the Internet by commercial firms for improving their business operations and customer service. These two innovation deployments in a country are seen as the major initiatives that will serve the environmental objectives of its government and businesses. For instance, 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 GHG emissions (Ausgov 2007). It also states that connected government provides greater opportunities for agencies to share and re-use technology, reducing overall infrastructure costs.

However, our review of existing literature found that the findings of prior studies examining the relationships of e-government development and e-business development with environmental sustainability are mixed. That is, while one set of studies found a positive relationship of e-government development and e-business development with environmental sustainability (e.g., Box 2002; Choucri 2001; Cohen 1999), the rest, found a negative relationship or none at all (e.g., Haigh 2004; Roth 2001; Yang 2000). A possible explanation for the contradictory results is that most studies have not examined the factors that may moderate the strength of the relationships of e-government development and e-business development with environmental sustainability. Given the paramount importance of contingency factors in IS research (Sambamurthy et al. 1994; Teo and Pian 2003), the lack of studies investigating the effect of contingency factors on the relationships of e-government development and e-business development with environmental sustainability is an important research gap.

We address this research gap by drawing from the resource complementarity perspective (Teece 1986), and propose that the relationships of e-government development and e-business development in a country with its environmental sustainability are contingent on national environmental factors (i.e., complementary assets) encompassing three dimensions: (1) social (quality of human capital); (2) institutional (quality of public institutions); and (3) economic (macro-economic stability and GDP per capita). While the quality of human capital indicates how well educated are the citizens in a nation, the quality of public institutions is determined by the legal and administrative framework within which individuals, firms, and governments interact to generate income and wealth in an economy. The macro-economic stability and GDP per capita are pointers that signify the economic conditions of a nation. We empirically test the proposed model using archival data from 122 countries (see Appendix for the list of countries). In sum, the specific research question we strive to address in this study is:

RQ: *How do a nation's complementary assets (i.e., human capital, public institutions, macro-economic stability and GDP per capita) interact with national IS innovations (i.e., e-government and e-business) in predicting its environmental sustainability?*

The rest of the paper is organized as follows. First, by using the resource complementarity perspective and the literature on "IT and environmental sustainability as the guiding theoretical lenses, we explicate the significance of national complementary assets (i.e., human capital, public institutions, and macro-economic stability and GDP per capita) on the relationships of e-government development and e-business development with environmental sustainability. Thereafter, using archival data from 122 countries, we test the hypothesized model. Subsequently, we discuss the findings and their contributions to the knowledge base in "IT-environmental sustainability" research. Lastly, we highlight the major limitations of our study and offer future research directions.

Theoretical Background

The resource based view of a firm is an influential framework within the field of strategic management that positions firms as a specific collection of resources and capabilities that can be deployed to achieve competitive advantage over their competitors (Barney 1991). It suggests that differences in firm

performance are primarily the result of resource heterogeneity across firms. That is, firms that are able to accumulate resources and capabilities which are rare, valuable, non-substitutable, and imperfectly imitable will achieve an advantage over competitors (Barney 1991; Wade and Hulland 2004). Firm resources are defined as tangible and intangible assets and competencies owned or controlled by the firm that can be used to conceive and implement competitive strategies (Jarvenpaa and Leidner 1998). Capabilities, in contrast, refer to a firm's capacity to deploy resources using organizational processes (Amit and Schoemaker 1993).

Porter (1990) highlights the significance of a country's resource configurations in terms of factor conditions, demand conditions, competitive environment and the presence of supporting industries, for achieving its competitive advantage. Specifically, for nations to gain competitive advantage, he highlights the significance of "advanced and specialized" factors such as information and communication networks and skilled labors which are valuable, rare, imperfectly imitable, and non-substitutable rather than "basic and general" factors such as foreign capital and unskilled labor. For instance, countries like Singapore, which are devoid of basic and general resources, have become very competitive due to the proactive focus on advanced and specialized resources like skilled manpower and IS innovations (Srivastava and Teo 2008; Teo and Lim 1998).

Extending Porter's line of reasoning, Friedman (2005) argues that IT configurations within the knowledge economy play a substantial role in making nations more competitive. This trend is also observed in a large-scale study by Dutta and Jain (2005). Specifically, they indicate that IT readiness and ICT usage by households, governments, and businesses in a nation are important factors facilitating its prosperity. In a similar vein, Srivastava and Teo (2008) indicate that e-government, a significant national resource, facilitates the enhancement of national competitiveness. Another study by them highlights the intertwined role of e-government development and e-business development in a country in managing national economic performance (Srivastava and Teo 2010). A large scale study conducted by the World Economic Forum (WEF) highlights that if IS innovations plays a central role in ensuring economic prosperity, it can and must play an equally central role in promoting environmental integrity and social equity (Dutta and Mia 2009). In line with this reasoning and consistent with Srivastava and Teo (2008), it is logical to presume that national IS innovations (i.e., e-government and e-business) as valuable resources of a country (as their developments require carefully melding technology components with the help of skilled human resources and relationships, and valuable managerial knowledge to fit country needs and priorities) will significantly contribute to national competitive advantage in terms of environmental sustainability.

Researchers have noted the contribution of new applications and combinations of existing resources to competitive advantage (Grant 1996). Teece (1986) introduced the concept of complementary assets, which are resources or capabilities that allow firms to capture the profits associated with a strategy, technology, or innovation. He suggested that for commercializing the design for a new product in a profitable way, a firm needs access to complementary manufacturing and distribution facilities on favorable terms. Even if other firms can imitate the new product, they will not be able to gain competitive advantage from this imitation if they do not have access to the necessary complementary assets. In the RBV literature, resource complementarities have been conceptualized in two different ways (Ravichandran and Lertwongsatien 2005). First, according to the resource copresence view (or interaction perspective), firm resources are considered complementary when the presence of one resource enhances the value or effect of another resource. That is, a resource produces greater returns if certain other resources are present than it would produce by itself. Second, the resource channeling view argues that complementarities arise when resources and capabilities are used in mutually reinforcing manner. This is based on how resources are channelized and utilized in a firm.

An application of the concept of complementary assets (i.e., resource copresence view) to our study can explain why only some countries may be able to derive environmental sustainability from national IS innovations (i.e., e-government and e-business). In our study context, complementary assets can be defined as assets that are required to gain environmental sustainability from e-government and e-business developments. If successful development of these IS innovations requires complementary assets, only countries that possess such assets will be able to derive environmental sustainability from developing such innovations. That is, complementary assets will moderate the relationship between national IS innovations and environmental sustainability. In this study, we consider four national complementary

assets namely, (1) human capital; (2) public institutions; (3) macro-economic stability; and (4) GDP per capita. Srivastava and Teo (2008) established the importance of these factors in the context of e-government development and national business competitiveness. It should be noted that these factors are likely to be common to development of all national IS innovations (including e-business development) in a country (Porter and Schwab 2009).

Hypotheses Development

From the literature, we note that while some authors argue that e-government development and e-business development can potentially deliver eco-efficiencies (e.g., Box 2002; Choucri 2001; Cohen 1999), others argue their potential for negative ecological impacts (e.g., Haigh 2004; Roth 2001; Yang 2000). For instance, Yang (2000) found that while e-business systems may reduce resource consumption, they can also enable more transactions to be performed; thus, leading to more overall consumption. Haigh (2004), in her exploratory study found that (1) e-business (and e-government) innovations to be exporting resource consumption; and (2) economic growth enabled by e-business (and e-government) innovations could erode eco-efficiencies. Other studies by Box (2002) and Choucri (2001) highlights that e-business, by enabling decision support, serves to enhance both economic and environmental goals. Results from a recent study by Haigh and Griffiths (2008) indicate that while positive outcomes for the natural environment were sought in strategies at higher governmental levels (i.e., Level 1: Government priorities; Level 2: Departmental priorities and strategies), they dissipated as they made their way down to lower levels (i.e., Level 3: Organizational strategies; Level 4: IS/E-Government priorities and strategies).

Given the mixed findings, a possible explanation for the contradictory results is that most studies have not examined factors that may moderate the strength of the relationships of e-government development and e-business development with environmental sustainability. Haigh (2004), in her study stated that "a conclusion can be drawn that e-business (and e-government) innovations have a definite impact on the natural environment (however) the question of what size and whether it is positive or negative need to be answered" (p. 245). Her conclusion calls for development of models that posit linkages among IS innovations and environmental sustainability via contingency factors that would influence the strength of the relationships. Hence, in our study, rather than focusing on direct effects of e-government development and e-business development on environmental sustainability, we center upon hypothesizing the interaction effects of national complementary assets on the relationships between (1) e-government development and environmental sustainability; and (2) e-business development and environmental sustainability. Our reasoning of investigating only the moderating effects and not the direct effects (when the results of extant studies are mixed) is in line with prior studies in strategy and business (e.g., Li and Atuahene-Gima 2001). Indeed, this fact has also been observed by Elliot (2011, p. 228) in his recent conceptual paper linking "IT and environmental sustainability", where he explicitly stated that "researchers may find numerous situations in which the moderation is significant, but the direct effect is not."

Moderating Influence of Human Capital

Human capital refers to the knowledge, skills, and abilities embodied in people (Coff 2002). Schultz (1961) and Lewis (1955) in their human capital theory have stressed the critical role of human capital in growth and development of individuals and nations. Specifically, Schultz (1961) argued that human capital is one of the critical reasons that explain the differences in growth (e.g., income and productivity) between human beings as well as nations. Realizing the significance of human capital, IS innovation studies have established citizens as an important stakeholder group influencing the implementation of such innovations and their knowledge as a vital resource base for initial acceptance and continual usage of the IT developments (Flak and Rose 2005). Studies have also highlighted the importance of educated and trained citizens as one of the major enablers for growth of IS innovations in a country. For instance, a study by Singh et al. (2007) found that human capital among others is a significant determinant of e-government maturity. Another study by Srivastava and Teo (2010) found that the quality of human capital (in terms of education and training) in a country is positively associated with the level of its e-government and e-business developments.

In a similar vein, studies in the context of sustainability development suggests that human capital is a critical determinant of long-term sustainability and the efforts to stimulate the evolution of human consciousness and emergence of mentally self-conscious individuals will be the most effective approach for ensuring an environmentally sustainable future (Slaus and Jacobs 2011). Another study by Paavola (2003) indicates that human capital is an important source of vulnerability to climate change, an important dimension of environmental sustainability (Yale 2010). In addition to this, Gifford (2008) indicates that human ingenuity is the "ultimate resource" to reframe aspiration toward climate change amelioration. Further, the World Health Organization Report on Climate Change and Human Health states that "countries with more 'human capital' or knowledge have greater adaptive capacity (and) illiteracy increases a population's vulnerability to many problems (including environmental issues)."

Given the significant role of human capital in developing national IS innovations and in building environmentally sustainable future, we argue that the human capital in a country as a national complementary asset will influence its environmental sustainability in copresence with e-government and e-business developments. Hence, we posit:

H1: *The relationships between (H1a) e-government development and (H1b) e-business development in a country and its environmental sustainability are moderated by human capital. The relationships become stronger when the quality of human capital is high, and becomes weaker when the quality is low.*

Moderating Influence of Public Institutions

The institutional environment is determined by the legal and administrative framework within which individuals, firms, and governments interact to generate income and wealth in the economy (Porter and Schwab 2009). The quality of public institutions has a strong bearing on competitiveness and growth of nations (Blanchard and Cottarelli 2010). It not only influences the investment decisions and the organization of production but also plays a key role in the ways in which societies distribute the benefits and bear the cost of development strategies and policies (Schwab 2011). The necessity of sound institutions for effective e-government and e-business developments is emphasized largely in public administration literature. For instance, Moon (2002) identified that institutional factors contribute to the adoption of e-government among municipalities. Von Haldenwang (2004) and West (2004) also stressed the significance of having a sound institutional base for effective e-government implementation. Another study by Morris and Moon (2005) found that e-government adoption and sophistication are correlated with the presence of well-developed institutional factors. In the context of e-business development, Srivastava and Teo (2010) demonstrated the importance of public institutions as a major enabler for growth of e-business in nations. This fact is also observed in several large-scale studies conducted by the WEF and the United Nations (UN).

Given this, the review of literature on public institutions and sustainability indicates that public institutions have an impact on all three dimensions of sustainable development. For instance, Kaufmann et al. (1999) established that there is a positive causal connection between public institutions (in form of governance) and economic development. Jessop (1998), Dutta (2001), and Kazancigil (1998) indicates that the quality of public institutions affects the rate of economic development. Prior research has established that the quality of public institutions impacts the rate of a nation's socio-economic development (Jessop 1998; Kazancigil 1998; Leftwich 1995; Meso et al. 2009). Similarly, a recent study by Chen et al. (2009) showed that institutional forces in form of mimetic and coercive pressures significantly drive the adoption of environmentally sustainable products and practices. Another study by Paavola (2003) indicates that quality of public institutions among others is an important source of vulnerability to climate change. Thus, taken together, it is logical to presume that as the level of e-government and e-business developments rises in copresence with the quality of public institutions, so does the level of environmental sustainability. Hence, we posit:

H2: *The relationships between (H2a) e-government development and (H2b) e-business development in a country and its environmental sustainability are moderated by public institutions. The relationships become stronger when the quality of public institutions is high, and becomes weaker when the quality is low.*

Moderating Influence of Macro-Economic Stability

Macro-economic stability signifies a situation in which a country has low inflation accompanied by falling budget and trade deficits and a low rate of expansion of the money supply (Porter and Schwab 2009). Von Haldenwang (2004) and West (2004) highlighted that advanced countries with stable macro-economic conditions are more likely to implement e-government effectively. Srivastava and Teo (2010), in their country-level study, found that countries with healthier macro-economic environment will have resources and policies for e-business development. In a similar vein, studies linking macro-economy and sustainable development argue that a nation cannot grow in an environmentally sustainable manner unless its macro-economic environment is stable. For instance, a study by Harris (2001) highlighted that radical and proactive macro-economic policies are required to achieve development that is socially just and environmentally sound. Alvarez et al. (2005), in a panel of European countries from 1990 to 2000, established the role of macro-economic performance in shaping the evolution of air pollutants. Another large scale study by WEF argues that when government in a country has to make high-interest payments on its past debts, and when firms' macro-economic conditions are out of hand, they cannot operate efficiently and offer services in an efficient way (Porter and Schwab 2009). As a result, the nation cannot grow in an environmentally sustainable manner.

Given the significant role of macro-economic stability in developing national IS innovations and in building environmentally sustainable future, we argue that the macro-economic stability in a country as a complementary asset will influence its environmental sustainability in copresence with e-government and e-business developments. Hence, we posit:

H3: *The relationships between (H3a) e-government development and (H3b) e-business development in a country and its environmental sustainability are moderated by macro-economic stability. The relationships become stronger when the stability of macro-economy is high, and becomes weaker when the stability is low.*

Moderating Influence of GDP per Capita

GDP is defined as the total flow of goods and services produced by an economy over a specified time period, usually a year. GDP per capita (valued at purchasing power parity, PPP) is an indicator of a nation's economic well being. Das et al. (2011), in their longitudinal panel study, showed that a country's e-Government matures as they become more affluent in terms of GDP per capita. Another study by Singh et al. (2007) found that the positive influence of GDP on e-government maturity occurs through national ICT infrastructure. In a similar vein, Srivastava and Teo (2010) found that the national economic performance in terms of GDP per capita is a significant correlate of e-business development.

Given this, traditional economic theories (e.g., Meadows et al. 1972) posit a "trade-off" between economic growth and environmental quality. Such theories argued a "zero-growth" or "steady-state" economy to avoid dramatic environmental scenarios in the future. While this debate has remained on a purely theoretical basis for a long time due to the lack of availability of environmental data, the causal relationship between economic development and different indicators of environmental quality has been extensively explored for over past two decades. For instance, a study by Arrow et al. (1996) established that the accumulation of stocks of waste or pollutants involving long-term and more dispersed costs such as CO_2 often increased with rising GDP per capita. An econometric and decomposition analysis of economic growth and environmental quality, by Cialani (2007), indicate that there is a positive relationship between economic growth and CO_2 emissions. A recent panel data study by Asici (2011) reveals that there is a positive relationship between income and pressure on nature. In addition, the study highlights that the relationship is stronger in middle-income countries than in low and high-income countries. Thus, taken together, it is logical to presume that as the level of GDP per capita increases, the strength of the relationships of e-government development and e-business development with environmental sustainability decreases. Hence, we posit:

H4: *The relationships between (H4a) e-government development and (H4b) e-business development in a country and its environmental sustainability are moderated by GDP per capita. The relationships become stronger when GDP per capita is low, and becomes weaker when it is high.*

Control Variables

Control variables are used to account for factors other than the theoretical constructs of interest, which could explain variance in the dependent variable. First, as population density gives the direct measurement of a country's population pressure on its natural environment, and as it is a good proxy for the degree of urbanization and environmental stress coming from the population (Vachon and Mao 2008), we controlled for its effect in our study. Specifically, we used the population density scores for year 2007, the values for which were obtained from the 2010 Environmental Performance Index Report (Yale 2010). Second, we also controlled for the effect of ICT infrastructure in our study. This construct was measured by the infrastructure index, the values for which were taken from the UN E-government Survey Report 2008. This index is a composite weighted average of five primary indicators: (1) PCs/100 persons; (2) Internet users/100 persons; (3) Telephone lines/100 persons; (4) Mobile phones/100 persons; and (5) Broadband users/100 persons.

Research Design

To empirically test the hypotheses in this study, 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 (Srivastava and Teo 2008; 2010). 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 and Nathan 1985); and (3) robust to the threat of common method bias (Woszczynski and Whitman 2004).

Hypotheses were tested via a cross-sectional analysis of 122 countries (see Appendix for the list of countries). To obtain consistent estimates, we lagged the independent and moderating variables at least by a year prior to the base-year. The primary sources of data were the WEF Global Competitiveness Report (Porter and Schwab 2009), the WEF Global IT Report (Dutta and Mia 2009), the UN E-government Survey Report (UNReport 2008), and the 2010 Environmental Performance Index Report (Yale 2010). All the four data sources are considered to be reliable reports and have been widely used in past academic research. For instance, data from the Global Competitiveness Report have been used in studies such as Delios and Beamish (1999), Gaur and Lu (2007), and Srivastava and Teo (2008; 2010). Similarly, data from the Global IT Report have been used in studies such as Srivastava and Teo (2010). The data from UN E-government Survey Report have been used in studies such as Siau and Long (2006), Singh et al. (2007), and Srivastava and Teo (2008; 2010). And, data from the Yale Environmental Performance Index Report have been used in studies such as Feroz et al. (2009) and George (2007).

Operationalization of Constructs

There are seven main constructs (excluding the control variables) in this study: e-government development, e-business development, human capital, public institutions, macro-economic stability, GDP per capita, and environmental sustainability. E-government development was measured by the web measure index, the values for which were taken from the UN E-government Survey Report 2008. This index is an indicator of the sophistication and development of the e-government websites of countries, and is based upon a five-stage model: emerging presence, enhanced presence, interactive presence, transactional presence and connected presence. As a country migrates upwards through the various stages, it is ranked higher in the web measure index. This index have been used in past studies such as Siau and Long (2006) and Srivastava and Teo (2010).

E-business development construct was measured by the extent of business Internet use, the values for which were adopted from the WEF Global IT Report (Dutta and Mia 2009). E-business development represents the maturity of nations' businesses in using the Internet for conducting their transactions. It indicates whether the Internet use by businesses in a particular country to conduct its transactions is widespread or is low. This construct was measured by asking the respondents, "Companies in your country use the Internet extensively for buying and selling goods, and for interacting with customers and suppliers," and was anchored on a 1-to-7 scale with (1) representing "strongly disagree" and (7)

representing "strongly agree". This measure has been used in past studies such as Srivastava and Teo (2010).

Human capital construct was measured by the human capital index, the values for which were taken from the UN E-government Survey Report (UNReport 2008). This index is a composite of the adult literacy rate and the combined primary, secondary and tertiary gross enrolment ratio, with two thirds weight given to the adult literacy rate and one third to the gross enrolment ratio. The UN Report defines adult literacy as the percentage of people aged 15 years and above who can, with understanding, both read and write a short simple statement on their everyday life. As per the UN Report, combined primary, secondary and tertiary gross enrolment ratio is indicated by the total number of students enrolled at the primary, secondary and tertiary level, irrespective of age, as a percentage of the population of school age for that level (UNReport 2008). This index have been used in past academic studies like Siau and Long (2006) and Srivastava and Teo (2008).

Public institutions construct was measured by the public institutions index, the values for which were obtained from the WEF Global Competitiveness Report (Porter and Schwab 2009). This index is a composite weighted average of five variables: (1) property rights (e.g., intellectual property protection); (2) ethics and corruption (e.g., public trust of politicians); (3) undue influence (e.g., judicial independence); (4) government inefficiency (e.g., efficiency of legal framework); and (5) security (e.g., business cost of crime). This index has been used in past academic studies like Srivastava and Teo (2008).

Macro-economic stability was measured by the macroeconomic stability index, the values for which were adopted from the Global Competitiveness Report (Porter and Schwab 2009). This index is a composite measure of five variables: (1) government surplus/deficit; (2) national savings rate; (3) inflation; (4) interest rate spread; and (5) government debt. This index is based on hard objective data and has been used in past studies like Srivastava and Teo (2008). Economic prosperity, according to Porter (2005), depends both on the value of 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. Consistent with extant studies (e.g., Srivastava and Teo 2010), we use Porter's productivity paradigm for operationalizing economic prosperity in terms of GDP per capita (adjusted for PPP), the values for which were taken from the WEF Global Competitiveness Report (Porter and Schwab 2009).

Environmental sustainability construct captures three main aspects of climate change: (1) GHG emissions per capita (including emissions from land use change); (2) CO_2 emissions per unit of electricity generation; and (3) industrial GHG emissions intensity (Yale 2010). This index is a composite of above three aspects with 50% of weight given to GHG emissions per capita, 25% of weight given to carbon intensity of electricity generation, and remaining 25% to industrial GHG emissions. The GHGs in this calculation include CO_2 from fossil fuels, land use change emissions, and non-CO_2 gasses like methane and nitrous oxide (NOX), and are measured in metric tons of CO_2 equivalents. The lower the per capita emissions, the less the average person in a given country contributes to climate change.

Analysis and Results

Descriptive Statistics and Correlations

Figure 1 presents the descriptive statistics and correlations for all variables in the research model. From the table, it is evident that most correlations among variables were significant at $p<0.001$. In addition, as correlations among independent and moderating variables were below the threshold value of 0.8, multicollinearity may not be a problem (Gujarati 2003). Nevertheless, we tested for multicollinearity by examining the variance inflation factor (VIF). VIF assesses the effect that the other independent (and moderating) variables have on the standard error of a regression coefficient (Hair et al. 2006). In other words, it measures the degree to which collinearity among the predictors degrades the precision of an estimate. Although there is no universally agreed threshold point for values of VIF, most researchers are of the view that if VIF is below 5, then the problem of multicollinearity does not exist (Pedhazur 1973). Some researchers suggest that multicollinearity is not a significant problem if the value of VIF is below 10 (Hair et al. 2006). In our case, the independent and moderator variables had VIF values below the conservative value of 5, thereby indicating that there was no significant problem of multicollinearity.

Variables	Mean	SD	1	2	3	4	5	6	7	8	9
1. Population Density[a]	4.14	1.42	-								
2. ICT Infrastructure	0.26	0.23	0.11	-							
3. E-Government Development	0.44	0.21	0.17	0.77*	-						
4. E-Business Development	4.22	0.89	0.16	0.76*	0.78*	-					
5. Human Capital	0.81	0.17	-0.02	0.66*	0.64*	0.56*	-				
6. Public Institutions	4.02	0.97	0.09	0.74*	0.55*	0.72*	0.39*	-			
7. Macro-Economic Stability	4.88	0.82	-0.04	0.48*	0.42*	0.40*	0.36*	0.48*	-		
8. GDP per Capita[a]	8.53	1.66	0.04	0.76*	0.73*	0.74*	0.73*	0.70*	0.66*		
9. Environmental Performance	53.68	16.34	0.02	-0.41*	-0.38*	-0.36*	-0.52*	-0.32*	-0.58*	-0.39*	-

N=122 *p<0.001 (2-tailed) [a]Log-transformed variables
Note: See pages 8 and 9 for description of variables

Figure 1. Descriptive Statistics and Correlations

Reliability and Validity

All the three agencies (namely WEF, UN, and Yale) followed rigorous procedures for ensuring the reliability and validity of the data. The country-level data were collected by the WEF through a number of partner institutes, who were given a uniform set of guidelines that were strictly followed. Some of these guidelines included taking responses only from CEOs or equivalent rank company officials, facility for the respondents to answer in their preferred language, etc. In addition, the survey was administered in several forms such as face-to-face interviews with business executives, mailed or telephone interviews, and a version administered online as an alternative (Porter and Schwab 2009). Two techniques were adopted to minimize chances of perception bias (a systematic positive or negative bias found among all respondents in a given country. For instance, some might believe that people in a certain country are generally more positive about their own economic environment than people in another country, who might be pessimistic). First, the questions were framed in a way that asked the respondents to compare their own country to world standards, rather than thinking in absolute national terms. Second, wherever possible, the survey data was compared with hard data on similar issues (Dutta and Mia 2009). The collected respondent-level data were subjected to a careful editing process following several rules such as excluding the surveys with a completion rate inferior to 50%. Once the data have been edited, individual answers were aggregated at the country-level. Then, sector weighted country averages were obtained for analyses.

UN also followed similar procedures for ensuring the reliability and validity. For instance, while forming the web measure index, the assessment involved selection of primary website (viz., the national portal or the official government home page of the Member States). Where no official portals were available, other governmental sites were assessed. In addition, the same number of functionalities of the same or similar sites in each country was considered to ensure consistency. Each ministerial site was assessed on the basis of the same set of questions. All the sites were checked several times before the data was validated in order to capture the most recent information and services from these sites.

Yale also adopted similar procedures for ensuring the reliability and validity. For instance, the climate change index was computed based on multiple data sources including (1) official statistics that are measured and formally reported by governments to international organizations; (2) spatial data compiled by research or international organizations; and (3) observations from monitoring stations. All potential datasets were reviewed for quality and verifiability. Those that did not meet baseline quality standards were discarded. The raw data was transformed to proximity-to-target scores ranging from zero (worst) to 100 (at target). To compute the composite index, data aggregation and weighting were performed.

Hypothesis Testing

We used moderated multiple regression, a hierarchical regression analysis technique for testing the research hypotheses as it is an established method for testing the interaction effects and has been used in many similar studies in the fields of information systems, international business, and macro-economics. We adopted the method recommended by Aiken and West (1991) for examining interactions in regression

methods where we first "centered" or "linearly-rescaled" each of the two variables by subtracting the mean from each country's score for each variable to reduce the effect of multicollinearity between the interacting term and the main effect. All interaction terms were assessed simultaneously so that their effects could be seen in the context of the overall model (i.e., in the presence of other interaction effects) (Kankanhalli et al. 2005). Specifically, as a first step, the control variables namely, population density and ICT infrastructure were entered into the regression equation. In steps 2 and 3, we entered independent variables (including moderating variables) and interaction terms respectively into the regression equation. A summary of our results are presented in table 1.

Table 1. Regression Results

Variables	β[a]		
	Step 1	**Step 2**	**Step 3**
Controls			
Population Density	0.07	0.01	0.02
ICT Infrastructure	-0.42***	0.47*	0.13
Main Effects			
E-Gov Dev		0.04	0.03
E-Biz Dev		-0.06	0.07
Human Capital		-0.23*	-0.04
Public Institutions		0.02	0.04
Macro-Economic Stability		0.01	-0.13
GDP per Capita		-0.83***	-0.78***
Interaction Effects			
E-Gov Dev × Human Capital			0.30*
E-Biz Dev × Human Capital			-0.47*
E-Gov Dev × Public Institutions			0.32*
E-Biz Dev × Public Institutions			-0.55**
E-Gov Dev × Macro-Economic Stability			0.39*
E-Biz Dev × Macro-Economic Stability			-0.12
E-Gov Dev × GDP per Capita			-0.59*
E-Biz Dev × GDP per Capita			-0.57*
R^2	0.17	0.40	0.49
Adjusted R^2	0.16	0.36	0.41
F	12.61***	7.14***	2.17*
R^2 Change	-	0.23	0.09
F Change	-	5.47***	4.97*

[a]The betas reported is based on standardized coefficients

N=122 *p < 0.05 **p < 0.01 ***p < 0.001 (2-tailed)

Note: See pages 8 and 9 for description of variables

As shown in Table 1, the R^2 value of 0.49 and adjusted R^2 value of 0.41 ($F=2.17$, $p<0.05$) indicated that the overall model was effective in explaining the variance in environmental sustainability. The change in R^2 value between steps 2 and 3 of regression was 0.09 (change in $F=4.97$, $p<0.05$), indicating that the outcome of the second step (i.e., testing of moderation effects) could be interpreted. Interestingly, the results showed that both e-government development and e-business development had no direct effect on environmental sustainability. However, e-government development and e-business development

interacted with other variables to affect environmental sustainability. First, the relationships of e-government development (β=0.30, p<0.05) and e-business development (β=-0.47, p<0.05) with environmental sustainability were contingent on human capital. While the direction of interaction pattern for e-government development and human capital was consistent with our initial prediction, the direction of interaction pattern for e-business development and human capital was contrary to our prediction. Hence, H1a was supported and H1b was not supported. Second, the relationships of e-government development (β=0.32, p<0.05) and e-business development (β=-0.55, p<0.01) with environmental sustainability were also contingent on public institutions. While the direction of interaction pattern for e-government development and public institutions was consistent with our initial prediction, the direction of interaction pattern for e-business development and public institutions was contrary to our prediction. Hence, H2a was supported and H2b was not supported. Third, while the relationship of e-government development with environmental sustainability was positively moderated by macro-economic stability (β=0.39, p<0.05), the relationship of e-business development with environmental sustainability was not contingent on it (β=-0.12, n.s.). Hence, H3a was supported and H3b was not supported. And finally, the relationships of e-government development (β=-0.59, p<0.05) and e-business development (β=-0.57, p<0.05) with environmental sustainability were contingent on GDP per capita in the negative direction. Hence, both H4a and H4b were supported.

As power calculations are particularly relevant whenever the null hypothesis is rejected (Baroudi and Orlikowski 1989), we performed a power analysis for H3b, the hypothesis that was not supported due to lack of significance. The objective of this analysis was to determine the accuracy of this conclusion that the hypothesis is truly insignificant at the 0.05 alpha level. Power is the likelihood of a Type II error, and it requires parameters for sample size, alpha level and desired effect size (Meso et al. 2009). According to Cohen (1977), an effect size (d) of 0.2 or less is considered small, that of 0.5 is deemed moderate, while an effect size greater than 0.8 is deemed to be strong. Using the Gpower statistical program, the calculated power for the hypothesis was 0.99, with a sample size of 122 and an effect size of 0.5. This, according to Cohen's (1977) threshold of 0.80, allows us to conclude that there is negligible Type II error and the lack of significance can be believed.

To determine if the patterns characterizing the significant interactions conform to the directions as proposed in the research hypotheses, we graphed the interaction effects (see Figures 2 and 3). This procedure was recommended by Cohen and Cohen (1983) for all interaction cases. In addition, to examine the consistency of the proposed direction throughout the range of independent variables, we performed simple slope analysis as recommended by Aiken and West (1991). This analysis reflects whether the slopes relating the independent and dependent variables differ from zero.

Figures 2a and 2b show the disordinal (or crossover) interaction of human capital on the relationships of e-government development and e-business development with environmental sustainability. A simple slope analysis for the effect of human capital on the relationship of e-government development with environmental sustainability revealed that when the quality of human capital was high, the relationship of e-government development with environmental sustainability was positive and significant (slope=23.66, t=2.01, p<0.05). And when the quality of human capital was low, the relationship was negative and non significant (slope=-18.89, t=-0.20, n.s.). This indicates that the positive relationship of the interaction of e-government development and human capital on environmental sustainability was exhibited only at the higher levels of human capital. By contrast, a simple slope analysis for the effect of human capital on the relationship of e-business development with environmental sustainability revealed that when the quality of human capital was high, the relationship of e-business development with environmental sustainability was negative and significant (slope=-7.51, t=-2.04, p<0.05). And when the quality of human capital was low, the relationship was positive and non significant (slope=9.99, t=0.34, n.s.). This indicates that the positive relationship of the interaction of e-business development and human capital on environmental sustainability was exhibited only at the lower levels of human capital. While unexpected, this finding is interesting and will be discussed in a greater detail in the next section.

Figures 2c and 2d show the disordinal interaction of public institutions on the relationships of e-government development and e-business development with environmental sustainability. A simple slope analysis for the effect of public institutions on the relationship of e-government development with environmental sustainability revealed that when the quality of public institutions was high, the relationship of e-government development with environmental sustainability was positive and significant

(slope=24.75, t=2.43, p<0.05). And when the quality of public institutions was low, the relationship was negative and non significant (slope=-19.97, t=-1.66, n.s.). This indicates that the positive relationship of the interaction of e-government development and public institutions on environmental sustainability was exhibited only at the higher levels of public institutions. By contrast, a simple slope analysis for the effect of public institutions on the relationship of e-business development with environmental sustainability revealed that when the quality of public institutions was high, the relationship of e-business development with environmental sustainability was negative and significant (slope=-10.50, t=-2.20, p<0.05). And when the quality of public institutions was low, the relationship was positive and non significant (slope=8.02, t=1.60, n.s.). This indicates that the positive relationship of the interaction of e-business development and public institutions on environmental sustainability was exhibited only at the lower levels of public institutions. While unexpected, this finding is also interesting and will be discussed in a greater detail in the next section.

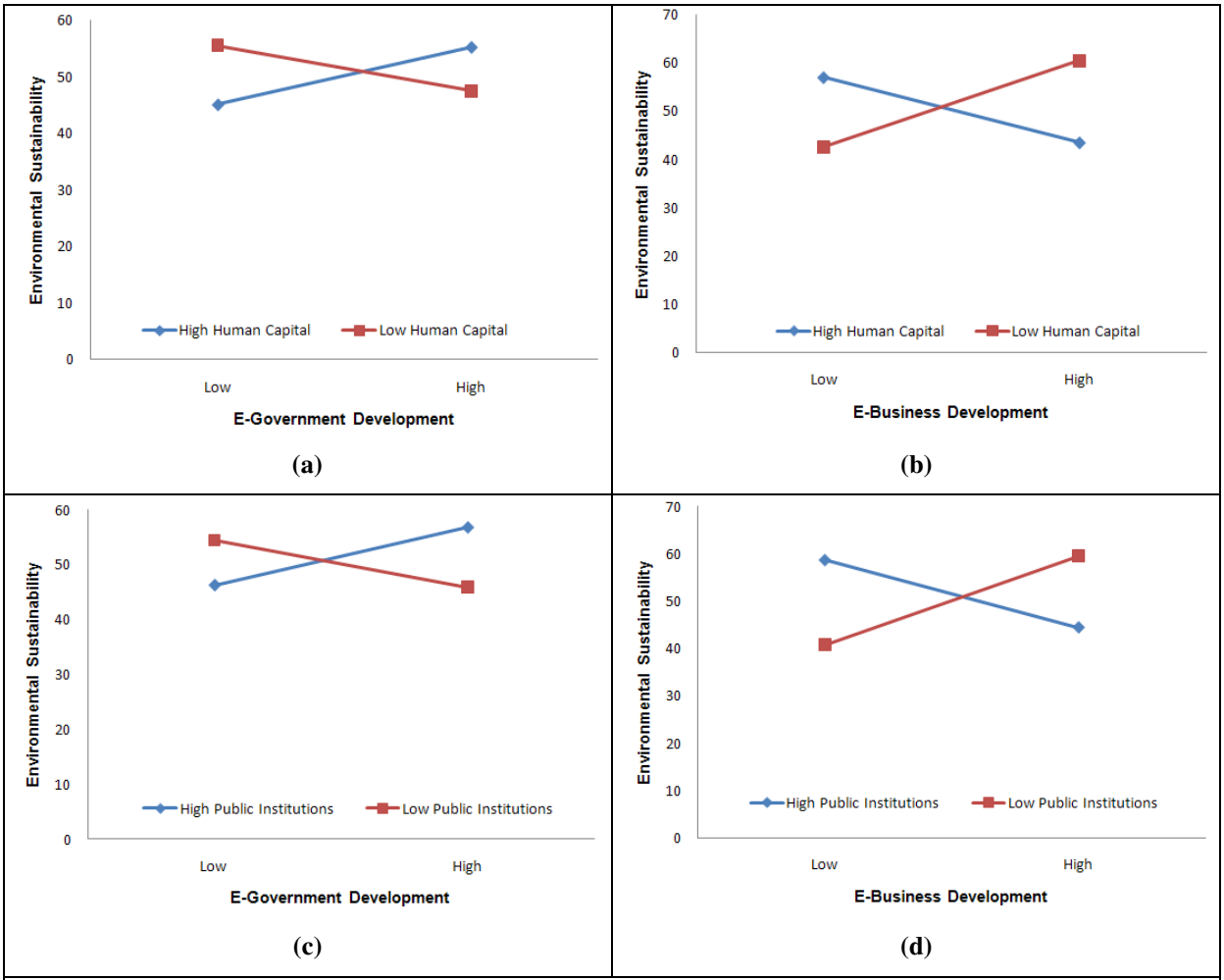

Figure 2. Moderating Influence of Human Capital and Public Institutions

Figure 3a shows the disordinal interaction of macro-economic stability on the relationship of e-government development with environmental sustainability. A simple slope analysis revealed that when the stability of macro-economy was high, the relationship of e-government development with environmental sustainability was positive and significant (slope=29.44, t=1.98, p<0.05). And, when the stability of macro-economy was low, the relationship of e-government development with environmental sustainability was negative and non significant (slope=-24.66, t=-1.50, n.s.). This plot indicates that the positive relationship of the interaction of e-government development and macro-economic stability was exhibited only at higher levels of macro-economic stability. In other words, e-government development

was more strongly related to environmental sustainability of nations with higher levels of macro-economic stability.

Figures 3b and 3c show the ordinal interaction of GDP per capita on the relationships of e-government development and e-business development with environmental sustainability. As shown in the figures, e-government development and e-business development predicted environmental sustainability positively at low levels of GDP per capita but negatively at high levels of GDP per capita. In addition, it is evident from the figures that there were little or no differences in environmental sustainability values between low and high levels of GDP per capita when e-government development and e-business development were low but there were substantial differences in environmental sustainability values between low and high levels of GDP per capita in favor of low GDP per capita when e-government development and e-business development were high. Confirming this, a simple slope analysis revealed that when the GDP per capita was high, the relationships of e-government development (slope=-41.31, t=-1.67, n.s.) and e-business development (slope=-9.44, t=-1.45, n.s.) with environmental sustainability were negative and non significant. And, when the GDP per capita was low, the relationships of e-government development (slope=46.08, t=3.53, p<0.001) and e-business development (slope=11.91, t=3.41, p<0.001) with environmental sustainability were positive and significant.

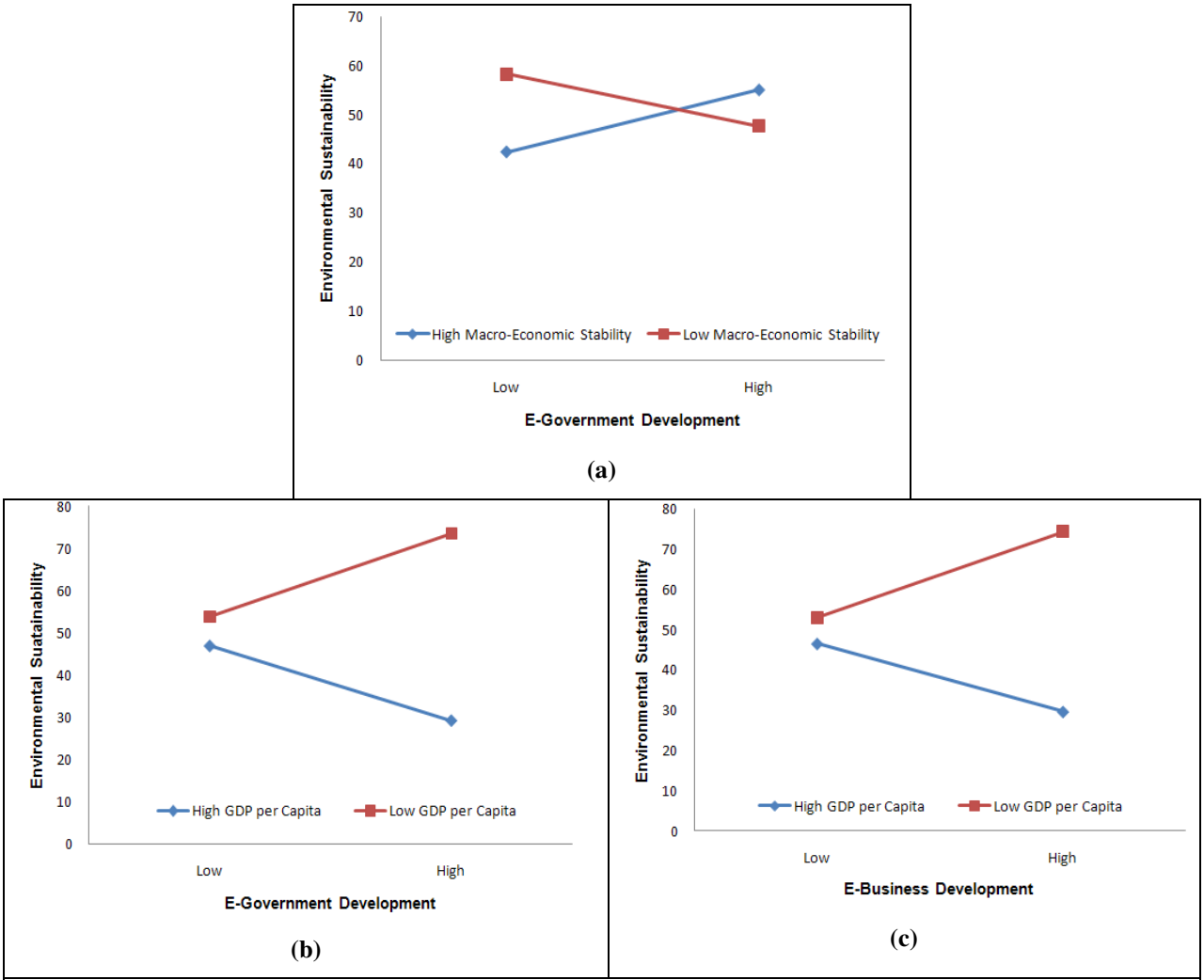

Figure 3. Moderating Influence of Macro-Economic Stability and GDP per Capita

Discussion

The primary objective of this research is to identify and assess a set of environmental factors that affect the relationship of e-government and e-business developments with environmental sustainability. In general, our empirical results provide support for our integrative framework that encompasses the resource complementarity perspective, and the literature on IT and environmental sustainability. Findings from this investigation raise several issues that deserve mention. First, the quality of human capital in a country enhances the effect of e-government development on environmental sustainability. That is, the level of human capital (namely knowledge, skills, and abilities embodied in people) in a country plays an important role in enhancing its environmental sustainability in the presence of e-government facilities. Therefore, stimulating the evolution of human consciousness and emergence of mentally self-conscious individuals in a country via education and training will ensure the development of environmentally sustainable future (Slaus and Jacobs 2011). This finding confirms that the human ingenuity is an "ultimate resource" to reframe aspiration towards improvements in environmental issues (Gifford 2008). Second, the quality of public institutions in a country enhances the effect of e-government development on environmental sustainability. That is, the level of public institutions in form of legal and administrative frameworks, available in a country, plays a critical role in enhancing its environmental sustainability in the presence of e-government facilities. While Srivastava and Teo (2008) established the contingent role of the quality of public institutions on the relationship between e-government development and business competitiveness, our finding highlights the importance of public institutions' influence on the relationship of e-government development with environmental sustainability. This is one reason why governance institutions and strengthening them has become one of the key millennium development goals for the international development agencies (IBRD 2002).

These results may not be true in the context of e-business development. That is, at the higher levels of human capital (Figure 2b) and at the higher levels of public institutions (Figure 2d) e-business development may not affect environmental sustainability (they may affect in negative direction). One possible reason for the difference in results may be due to the relative differences in the characteristics of public- and private-sector firms. That is, compared to private-sector firms, public-sector organizations have a wider scope of concern and significance of actions in the "public interest" (Caudle et al. 1991). In addition, while e-government development is meant for providing services to citizens and businesses, e-business development, dependent on firm's strategies and resources, exists for conducting commercial activities online. As e-government development is driven by the service motive and has a wider scope of concern in the public interest, literate population may expect governments to play a key role in enhancing environmental sustainability. In contrast, as e-business deployment is impelled by the profit motive, private firms may direct human capital more at making money rather than building an environmentally sustainable future. Similarly, despite the availability of high quality public institutions, private firms in order to make money, may develop informal institutions (which may conflict the original legal regulations and prescriptive rules) governing their day-to-day behavior, attitude, and interactions with each other. As a result, self-interest of private functionaries and associated working culture may give rise to self-reinforcing mechanisms which impede institutional changes pertaining to environmental sustainability.

Third, the stability of macro-economy in a country enhances the effect of e-government development on its environmental sustainability. This implies that e-government development in a nation cannot facilitate the enhancement of environmental sustainability, unless its macro-economy is stable. Therefore, as highlighted by Harris (2001), radical and proactive macro-economy policies are required in a country to achieve development that is environmentally sound. However, for businesses, our study found that the effect of e-business development on environmental sustainability was not contingent on macro-economic stability. This could be due to the fact that the effect of macro-economic stability on the relationship between e-business development and environmental sustainability may have been masked by stronger predictors with which it is correlated i.e., human capital, public institutions, and GDP per capita (see Figure 1). Fourth, GDP per capita negatively moderated the relationships of e-government development and e-business development with environmental sustainability. That is, when GDP per capita increased, the strength of the relationships of e-government development and e-business development with environmental sustainability decreased. This finding is consistent with traditional economic theories that posit a "trade-off" between economic growth and environmental quality and implies the urgent need for economic development that is environmentally sound.

Conclusion

Limitations

This study has two major limitations. First, we used archival data obtained from four different sources. While primary data may 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. However, considering the fact that these indices have been formulated by reputable and authorized organizations and several suitable statistical procedures (e.g., use of multiple respondent expert surveys in each nation and correcting the internal consistency before index calculation) have been carried out to ensure the reliability and validity of the instrument, relying on these secondary sources provides a cost-effective way for conducting our study. Indeed, several past studies have relied on the secondary sources that we use in our study (e.g., Delios and Beamish 1999; Feroz et al. 2009; Gaur and Lu 2007; George 2007; Siau and Long 2006; Singh et al. 2007; Srivastava and Teo 2008; Srivastava and Teo 2010).

Second, we analyzed data only from the countries commonly available in all the four sources. For instance, we could not include countries like Afghanistan, Cuba, Hong Kong, Taiwan, and so on as these countries were not commonly available in all the four sources. Given that we have only six independent variables (including the moderating variables and excluding the control variables) and sample size as 122, discarding few countries may not make a significant difference in the results. This is due to the fact that the multiple regression statistical technique with a sample size of 100 and above will detect fairly small R-square values (10%-15%) with up to 10 independent variables and a significance level of 0.05 (Hair et al. 2006). Despite these two potential limitations, our study is among the few studies with macro-level orientation striving to address the knowledge gaps described in the earlier sections of this paper.

Implications and Future Research

Our study makes several important theoretical contributions. Firstly, our study contributes to the knowledge base of resource complementarity perspective of RBV in two ways. First, in contrast to many past studies that have implicitly assumed that IS assets could have direct effects on competitive advantage, our study draws from the resource complementarity perspective and posits that resource produces greater returns if certain other resources are present than it would produce by itself. Second, among the limited work that has been undertaken to investigate the effects of complementarities on competitive advantage, most studies are at the organizational-level. We extend this micro-level argumentation to a macro-level (i.e., cross-country level). Secondly, our study also contributes to the knowledge base of "IT-environmental sustainability" in two ways. First, by identifying and assessing a set of complementary assets (i.e., national environmental factors) that affect the relationships of e-government development and e-business development with environmental sustainability, our study provides a basis for the development of IS related environmental sustainability assessment tools for managerial use. Second, while existing studies examining the "IT-environmental sustainability" linkage are either conceptual or case studies, our study is amongst the few large-scale empirical research, which makes innovative use of publicly available reliable secondary sources of data.

From a practical standpoint, this study makes several contributions. By identifying the complementary assets that would affect the relationships of e-government development and e-business development with environmental sustainability, our study not only helps practitioners, policy makers, and public administrators to understand why differing levels of environmental sustainability continues to prevail despite the developments of e-government and e-business facilities, but also shows directions to increase the levels of environmental sustainability by effectively managing the complementary assets. Specifically, from the interaction plots (Figures 2 and 3) we see that human capital, public institutions, macro-economic stability, and GDP per capita moderated the relationship of e-government development with environmental sustainability. Further, while human capital, public institutions, and GDP per capita moderated the relationship of e-business development with environmental sustainability in the negative direction, the relationship was not contingent on macro-economic stability. The implication from these plots is that policy makers, practitioners, and public administrators should pay increased attention in

managing these complementary resources alongside the development of e-government and e-business facilities.

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, moderating and dependent variables), as well as the evolution of environmental sustainability as a function of the levels and trends in the independent and moderating variables. In regards to this, as the data pertaining to environmental sustainability is available only for 2 years (2008 and 2010) from the Yale Center for Environmental Law and Policy, researchers may consider using other indices like ecological footprint index and environmental vulnerability index. Second, while our study has mainly focused on one main "objective technology" (i.e., the Internet), future studies may consider examining the effect of other technological innovations (in specific, green IS and IT innovations) available with public- and private-sector organizations. A comparison from this perspective would be interesting and may add value to both theory and practice. Third, future researchers, in addition to re-examining our study and confirming the findings, may also identify other complementary resources (e.g., quality of business sophistication, quality of technological innovation, and technological readiness) on which the main effects are contingent on.

In conclusion, despite an extensive recognition on the importance of IT in causing and resolving issues surrounding environmental sustainability, both research and practitioner communities knows relatively little on how national IS resources can be effectively utilized to manage a country's environmental sustainability. As an initial step to be taken towards raising awareness for the pivotal role of IS innovations (i.e., e-government and e-business developments) in a country towards managing its environmental sustainability, we, by drawing from (1) the resource complementarity perspective of the RBV; and (2) the literature on IT and environmental sustainability, constructed a theoretical model and validated it in the light of country-level data obtained from reliable secondary sources. Specifically, we reasoned and demonstrated empirically the moderating roles of environmental factors (i.e., national complementary assets) in terms of social (i.e., quality of human capital), institutional (i.e., quality of public institutions), and economic (i.e., macro-economic stability and GDP per capita) dimensions on the relationships of e-government development and e-business development with environmental sustainability. Our study, in sum, reiterates the synergistic connection between national IS innovations, national complementary assets, and national competitive advantage in terms of environmental sustainability.

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Appendix

Countries Analyzed
Albania, Algeria, Argentina, Armenia, Australia, Austria, Azerbaijan, Bahrain, Bangladesh, Belgium, Benin, Bolivia, Bosnia and Herzegovina, Botswana, Brazil, Brunei Darussalam, Bulgaria, Burkina Faso, Burundi, Cambodia, Cameroon, Canada, Chad, Chile, China, Colombia, Costa Rica, Cote d'Ivoire, Croatia, Cyprus, Czech Republic, Denmark, Dominican Republic, Ecuador, Egypt, El Salvador, Estonia, Ethiopia, Finland, France, Gambia, Georgia, Germany, Ghana, Greece, Guatemala, Guyana, Honduras, Hungary, Iceland, India, Indonesia, Ireland, Israel, Italy, Jamaica, Japan, Jordan, Kazakhstan, Kenya, Kuwait, Kyrgyzstan, Latvia, Libya, Lithuania, Luxembourg, Madagascar, Malawi, Malaysia, Mali, Malta, Mauritania, Mauritius, Mexico, Mongolia, Morocco, Mozambique, Namibia, Nepal, Netherlands, New Zealand, Nicaragua, Nigeria, Norway, Oman, Pakistan, Panama, Paraguay, Peru, Philippines, Poland, Portugal, Qatar, Romania, Russian Federation, Saudi Arabia, Senegal, Serbia, Singapore, Slovakia, Slovenia, South Africa, Spain, Sri Lanka, Sweden, Switzerland, Syria, Tajikistan, Thailand, Trinidad and Tobago, Tunisia, Turkey, Uganda, Ukraine, United Arab Emirates, United Kingdom, United States, Uruguay, Venezuela, Viet Nam, Zambia, Zimbabwe
Total number of countries included for data analysis = 122.