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Determining the dynamic co-diffusion of four e-services using country-level panel data

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DETERMINING THE DYNAMIC CO-DIFFUSION OF FOUR E-SERVICES USING COUNTRY-LEVEL PANEL DATA

A Dissertation

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ABSTRACT

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Motivated by the slow diffusion of e-services in many countries in the world, and Rogers' call for researching related innovation as a cluster, this study investigates the co-diffusion among e-services. To our knowledge this study is the first to examine the co-diffusion effects among e-services. It extends prior studies from the e-services diffusion literature, and the technology co-diffusion literature by examining co-diffusion among four e-services; e-banking, e-shopping, e-government, and e-learning. It also examined the co-diffusion mediation effects, moderation effects, and country-level factors' effects. Using panel data of 28 European countries, and applying dynamic GMM econometric technique, this study's findings were supporting the suggested hypotheses. The findings are discussed, and the conclusions, significant theoretical and practical implications of the findings, limitations, and recommendations for future research are presented.

DEDICATION

This dissertation is dedicated to my father Mohammad Takieddine, my mother Oussama El Jurdi, and my friend Wacharee-Eva Tungjaroenkul who contributed to my doctoral achievement by offering their unconditional love and support. Nevertheless, I dedicate this dissertation to my dissertation Chair Dr. Jun Sun, and committee members Dr. Diego Escobari, Dr. Francis Kofi Andoh-Baidoo, and Dr. Bin Wang who contributed to my successful dissertation by offering guidance using their expertise and knowledge.

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CHAPTER I

INTRODUCTION

Extensive work has been done in the field of diffusion of innovations. The original work of Rogers presented the theoretical foundations of this line of research (Rogers, 2003). Motivated by Rogers' theory, Bass (1969) proposed a diffusion of innovation model that identified two forces of diffusion, innovation and imitation. Innovation captures the adoption based on external influences (i.e., mass media), whereas imitation captures the adoption based on internal influences (i.e., word of mouth). Bass's diffusion of innovation model has fed a long tradition in the diffusion of innovation literature. Chandrasekaran and Tellis (2006), and Teng et al. (2002) presented surveys of diffusion research and concluded that the research community agrees that innovations do not spread in a vacuum. Rogers (2003) states that the adoption of an innovation depends on the presence of related technologies that extend or amplify its value. Thus, the co-diffusion line of research came into existence to investigate related products' diffusion. The first co-diffusion model was presented by Mahajan and Peterson (1978).

Co-diffusion is the complementarities in the diffusion of two information technologies as one information technology's diffusion affects or enhances the diffusion of another information technology (Dewan, et al, 2010). Bucklin and Sengupta (1993) defined co-diffusion as "the positive interaction between the demands for complementary innovations that have separate adoption tracks" (P. 149). The idea behind investigating the co-diffusion phenomenon is to understand the interrelationship between the diffusion of two products or services. It is often referred to as co-diffusion by cross product effects, multiproduct growth, or multiproduct

interactions (Niculescu & Whang, 2012; Jin-Xing, et al, 2013). Bayus, et al (2000) highlighted the importance of co-diffusion or multiproduct interactions through the following statement: "The general topic of multiproduct interactions is both interesting and important. It is interesting because the underlying dynamic between products is associated with some rich and complex firm and consumer behavior. It is important because understanding the interproduct relationships should lead to better product forecasting as well as a more effective allocation of marketing resources." (P. 143).

Among many technological innovations, electronic services (e-services) are increasingly available to consumers. E-services refer to a variety of Internet based electronic interactions that "involve various types, delivery systems, advanced information technologies, methodologies and applications of online services that are provided by e-government, e-business, e-commerce, e-market, e-finance, and e-learning systems" (Lu, et al, 2007; P. 1). Wada & Odulaja (2012) defined an e-service as a service that allows consumers to access specific information and possibly conduct transactions from a remote location using some sort of a computer. In this study I adopt that definition of an e-service.

E-services adoption and use is growing continuously worldwide due to their ease of use as well as the convenience they offer to consumers. In the US, consumers spent on e-shopping 202 billion dollars in 2011, 226 billion dollars in 2012; it is forecasted that consumers will spend 327 billion dollars (up 62%) in 2016 (Rueter, 2012). In Europe, consumers spent on e-shopping 130 billion dollars in 2011, and will spend 231 billion dollars in 2016. By 2016, e-retail sales in UK and Germany will account for 14% and 10% of total retail sales respectively. It is expected that the fastest growth of e-commerce will be in Southern Europe where e-retail diffusion is at low rates (Davis, 2012).

E-services have been distinguished by the advantages they provide to benefit both service providers and consumers. They offer convenience, accessibility of services, and information to consumers and organizations (Ndou 2004; Southard and Siau 2004). They allow services providers to reduce their costs (i.e., transactions costs), increase their management and operations' efficiency, and increase competition (Kalakota and Winston 1996; Angelakopoulos and Mihiotis, 2011). Therefore, this dissertation is using e-services as the context of this co-diffusion study due to the advantages and benefits of the diffusion of e-services.

1.1 Research Motivation

Motivation 1: this dissertation was motivated by Rogers (1995) call for studying the diffusion of innovations by grouping different innovations instead of studying them independently. Rogers (1995) stated that it is easier for researchers to treat each innovation's adoption as independent of other innovations, but that is not realistic. He continues by insisting that it is important to understand the interactions between and among different innovations. Dewan, et al. (2010) who responded to Rogers' call examined the interactions between personal computers and Internet diffusion. Dewan, et al. (2010) stated that combining different innovations make adoption easier, which lead to increasing the rate of adoption. I argue that the response to these calls for research was poorly received in the literature of diffusion of innovations as well as the adoption of e-services. Therefore, this dissertation comes along to act upon these calls and empirically study an under-searched area in the IS field represented by the co-diffusion of technologies, and in particular the co-diffusion of e-services. Furthermore, Bayus, et al (2000) stated that multiproduct interactions (co-diffusion) are very important because the dynamic between products or services is associated with rich and complex consumer behavior. This means that investigating the interrelationships between products or services reveal

richer and clearer information about consumers' perceptions in regard of using those products or services. Moreover, Bayus, et al (2000) consider this topic important "because understanding the interproduct relationships should lead to better product forecasting as well as a more effective allocation of marketing resources." (P. 143).

Prior studies investigated the co-diffusion phenomenon to solve problems related to ICT diffusion. For example, Dewan, et al (2010) studied the co-diffusion of PC and Internet while seeking to use their findings to help solve the digital divide problems. Motivated by such studies and their promising findings, this dissertation is studying the co-diffusion of e-services to use our findings to help solve the problems related to e-services diffusion and consumers' rejection to e-services adoptions.

Motivation 2: The diffusion of e-services in many countries is facing many barriers that are driving consumers to resist adopting and using them. Previous empirical studies identified the following as barriers for e-services adoption: security, privacy, self-efficacy, computer experience, Internet experience, complexity, lack of awareness, lack of knowledge, trust, risk, legal support, governmental support, perceived credibility, availability, fees and charges (Poon, 2007; Jahangir & Begum, 2008; Reid & Levy, 2008; Qureshi, et al, 2008; Al-Somali, et al, 2009; Azouzi, 2009; AbuShanab, et al, 2010; Adesina & Ayo, 2010, Sadeghi & Farokhian, 2010; Chong, et al, 2010, Alam, et al, 2010; Zhao, et al, 2010; Mansumitrchai & AL-Malkawi, 2011).

The literature on e-services diffusion (e.g., e-banking, e-government, e-shopping, etc.) has extensively examined the determinants and barriers of e-services adoption by consumers. The results of these studies include many common findings. For example, Rotchanakitumnuai and Speece (2003) examined e-banking diffusion in Thailand while Laosethakul and Boulton (2007) examined the e-commerce diffusion in Thailand. Both found that trust, security and

privacy concerns to be major barriers to both e-services diffusion. Folorunso, et al (2006) examined the e-commerce diffusion in Nigeria while Auta (2010) examined e-banking diffusion in Nigeria, and both found that security concerns and accessibility are the major barriers to both e-services diffusion. Also, Easten (2002) examined the diffusion of four e-services – e-shopping, e-banking, e-investing, and e-payment – and found that they share six common attributes. The diffusion of different e-services share common determinants and barriers, which motivated this dissertation to investigate the diffusion of different e-services together instead of investigating the diffusion of each e-service by itself. I combined them in one conceptual model where we can examine the interrelationships between them and investigate potential co-diffusion effects among them.

Motivation 3: Statistics related to Internet usage to conduct e-banking, e-shopping, and e-government activities show the low adoption rates as well as the slow diffusion rates in many countries (Eurostat, 2013):

- The percentage of individuals who used e-banking in 2013 is 4% in Romania, 5% in Bulgaria, 11% in Greece and Turkey, 22% in Italy, and 23% in Cyprus and Portugal.
- The percentage of individuals who used the Internet to purchase online in 2013 is 8% in Romania, 10% in Turkey, 12% in Bulgaria, 20% in Italy, 23% in Estonia, and 25% in Cyprus, Greece, and Portugal.
- The percentage of individuals who used e-government in 2010 is 4% in Serbia, 7% in Romania, 9% in Turkey, 13% in Greece, 15% in Bulgaria, 16% in Croatia, 17% in Czech Republic and Italy, 21% in Poland, and 23% in Portugal.

- The percentage of individuals who used e-learning in 2013 is less than 10% in the following countries: Bulgaria, Croatia, Cyprus, Czech Republic, Estonia, Greece, Italy, Latvia, Lithuania, Portugal, Romania, Slovenia, and Turkey.

Also, the e-service adoption and diffusion literature reported that the following countries have high resistance to use e-services: Thailand, Jamaica, Bangladesh, Pakistan, Iran, Saudi Arabia, Jordan, Tunisia, Malaysia, Sudan, Nigeria, Vietnam, China, and Mexico (Poon, 2007; Jahangir & Begum, 2008; Reid & Levy, 2008; Qureshi, et al, 2008; Al-Somali, et al, 2009; Azouzi, 2009; AbuShanab, et al, 2010; Adesina & Ayo, 2010, Sadeghi & Farokhian, 2010; Chong, et al, 2010, Alam, et al, 2010; Zhao, et al, 2010; Mansumitrchai & AL-Malkawi, 2011).

The aforementioned statistics show that the diffusion of e-services is not problematic to some e-services than others (e.g., e-shopping v/s e-banking). Simultaneously all e-services are highly diffused in some countries or all e-services have low diffusion in other countries. For example, in Finland e-banking diffusion rate is 84%, e-shopping 65%, and e-government 70%. Therefore, in Finland the diffusion of all e-services is high. On the other hand, in Romania e-banking diffusion rate is 4%, e-shopping 6%, e-learning 3%, and e-government 4%. Therefore, in Romania the diffusion of all e-services is low.

To solve the low diffusion of e-services, previous literature focused on identifying the determinants/barriers of e-services adoption or diffusion individually while ignoring the interrelationship among them. To my knowledge no previous work realized the similarities in the diffusion rates of several e-services, which explains the lack of investigating the interaction phenomenon between different e-services. It is problematic not to recognize the interactions and interrelationships among different e-services' diffusion. Ignoring such important aspects of e-services diffusion by previous literature is a gap in the literature that this study aims to cover and

present new knowledge that might help researchers and practitioners to better provide solutions to e-services diffusion. This gap in the e-services diffusion literature motivated this dissertation to examine the possible co-diffusion effects between different e-services. Such investigation might help solve e-services diffusion problems by presenting new knowledge and understanding related to the drivers and determinants of e-services diffusion, which can enrich the theories presented in the literature.

Motivation 4: To investigate and study the co-diffusion phenomenon, there is a challenge of using the right methodology including the data type and statistical technique(s). Due to the nature of the co-diffusion phenomenon, cross-sectional data is not useful while only longitudinal data can be used to explore the dynamic effects of the co-diffusion among different e-services. However, there is a limited amount of longitudinal type of secondary data available to the IS researchers due to the fact that most artifacts and technologies such as e-services have been developed and available for use by consumers within the last two decades. Also, the available secondary data are collected on an annual basis, which posits limitations towards the sample size. Furthermore, the original or primary data collection using the survey method can be very time consuming and expensive to build longitudinal data. Therefore, the majority of e-services diffusion studies use cross-sectional type of data to validate theories, which in turn created a gap in the e-services diffusion literature because of the lack of studying e-services' co-diffusion. Moreover, the traditional statistical techniques (e.g., multiple regressions) that are vastly applied in the IS research field would not generate accurate results when using longitudinal type of data due to the lack of control over results' accuracy. The four research motivations I presented shaped the objective of this dissertation to seek addressing the gap in the literature and solving e-

services diffusion problems by introducing the co-diffusion phenomenon in the context of e-services diffusion.

1.2 Statement of Objective

The objective of this dissertation is to recognize and study the interaction among different e-services such as e-government, e-banking, e-shopping, e-learning, etc. and describe the interrelationships (co-diffusion) phenomenon that exists between them. Finding results supporting the existence of the co-diffusion occurrence among different e-services is not the only objective and focus of this dissertation. Its objective is also to understand and test if the co-diffusion effect between any two e-services is balanced or not; and if unbalanced then which direction should be stronger and why. Unbalanced co-diffusion effect means that the effect of e-service 1 on e-service 2 is stronger than the effect of e-service 2 on e-service 1. This dissertation also investigates if the co-diffusions among e-services are strictly direct relationships or indirect relationships could exist. Therefore, this dissertation's objective is to examine the co-diffusion mediation among three e-services.

Furthermore, to overcome the methodological obstacles presented in the research motivation section, my goal is to collect secondary data of a longitudinal type so I capture the dynamics of the co-diffusion effect among different e-services. However, most secondary data are at the country level, which is a different aggregation level than what e-services adoption and diffusion studies use (e.g., consumer level or organizational level). Therefore, this dissertation extended its previous objectives by testing for the country-level factors that might affect the co-diffusion of e-services. This dissertation does not limit its investigation to the significance of the country-level factors' effect on e-services co-diffusion but also how they affect co-diffusion by testing for their moderating effects.

To serve my dissertation's objectives, I seek to answer the following research questions:

1. Are there any interrelationships among the diffusions of different e-services?
2. What are the directions of these interrelationships (balanced vs unbalanced)?
3. What are the factors that may influence the co-diffusions at the country level?

1.3 Research Contributions

The contributions of this dissertation are two folds, contribution to research and contribution to practice. The contributions to research are the following: 1) to my knowledge this this dissertation is the first study that suggests the existence of interactions and interrelationships among the diffusion of different e-services by studying the co-diffusion phenomenon in the context of e-services. I found significant support for the existence of co-diffusion among e-services. Such finding should work as a motivation to IS researchers to investigate the co-diffusion existence among other technologies to reveal a better understanding of the problem and provide practical solutions for it.

2) This dissertation is to the best of my knowledge the first in the e-services diffusion line of research to study the dynamic effects among different technologies by using panel data, a combination of cross-sectional and longitudinal time series data.

3) This dissertation is the first in the e-services diffusion literature to use an econometric technique GMM (Generalized Method of Moments) that is compatible with dynamic panel data. That econometric technique is reported to provide less bias results and findings compared to traditional statistical techniques such as multiple regressions (Soto 2009). Therefore, I believe that I am not only trying to contribute to research by investigating the co-diffusion of e-services but also I might be presenting more accurate findings than those presented in prior studies.

4) This dissertation is the first e-service study to conduct a country level type of analysis. Previous e-services adoption and diffusion studies are limited to the consumer or organizational level of analysis type. Applying the country level analysis is recommended in research because findings are more generalizable than at other levels especially that the studied sample is usually in one country (Whettens 1989). Whettens (1989) stated that the "Where" condition places limitations on researches' propositions, and considered contextual factors such as the targeted location of a study (one country) set boundaries of generalizability, and constitute the range of the findings.

The following are this dissertation's contributions to practice: Even though, there is an extensive work of research in the diffusion of e-services (e.g., e-banking, e-commerce, e-government) the contribution of these researches presented information and knowledge on what might help solve e-services diffusion problems but not a strategy that can make solutions realistically possible to be implemented. Still many of the countries where many researches have been conducted to understand the determinants and barriers of e-services' adoption have low rates of adoption with no realistic progress throughout the years. The literature of e-services diffusion suggests that the major problems with e-services adoption are related to poor IT infrastructure (i.e., Internet accessibility, fast Internet speed availability, and Internet security) and absence of regulations and laws that organize and protect the participants in e-services (Rotchanakitumnuai and Speece 2003; Laosethakul and Boulton 2007; Folorunso, et al 2006; Auta 2010). As long as these issues are not solved high adoption of e-services will never be achieved in developing countries. Nevertheless, solving e-services diffusion problems could be more effective if we present not only the solutions but also strategies to guide practitioners into implementing the solutions suggested in the findings of e-services diffusion studies. Practitioners

from the different areas of e-services do not have the resources necessary to build the IT infrastructure, develop and design laws and regulations in a specific country. E-services are staying at enfant stages in most developing countries. Therefore, this dissertation came along to help solve that worldwide dilemma/problem, and maybe help reduce the digital divide in the world. To the best of my knowledge this dissertation is the first to introduce the co-diffusion in the e-services context. This dissertation's findings suggest that e-services are not independent from each other, and if practitioners want to solve every e-service's problem alone, they will not succeed because their e-service diffusion is influenced by other e-services and influence the diffusion of other e-services. This means that for them to have a successful e-service, they should think how to make other e-services successful as well.

This dissertation is addressed to governments, retailers, banks, firms, hospitals' management, universities boards, organizations, and researchers in the business and computer information systems fields. These addressees can benefit from my dissertation to realize the existence of interrelationships among different technologies and in particular electronic services. Such awareness could reflect shift in the research and practice within the business and technology environments. Once these addressees put their efforts and resources together, they might succeed improving the IT infrastructure and producing regulations and laws. The findings of my dissertation is a global call for establishing a network of actions that combines the efforts of all e-services stakeholders to put pressure on governments to act seriously on making changes in that regard. Network of actions have been proved to successfully implement technologies in developing countries. Braa et al (2004) conducted an action research about implementing health information systems in several developing countries in Africa using network of actions. That network included participants from governments (ministers, employees), international agencies

(World Bank, United Nations, European Union, US Aid), local and international universities, local hospitals and medical centers, local and international application developers, and researchers. As a result health information systems were successfully implemented in South Africa and Mozambique at the national level (i.e., big cities, and rural provinces). However, in our case and without building a theoretical connection among these different e-services, none will be motivated to start such a movement. Therefore, this dissertation is a first step towards starting such a move for change in the developing world by establishing theoretical propositions and supportive findings that present a clearer image and better understanding of the phenomenon of e-services diffusion to practitioners. Furthermore, this is the first step towards solving e-services providers' problems in developing countries. Building the required ICT infrastructure including national Internet accessibility will not only motivate consumers to use e-services but also can help mitigate the digital divide.

1.4 Structure of the Dissertation

Chapter 2 is the literature review which contains a thorough review of the main theory of this study, the innovation diffusion theory. The review of the theory is followed by reviewing other relevant theories that can explain co-diffusion such as push and pull theory, cluster diffusion theory, and general systems theory. Then, I review previous co-diffusion studies followed by reviewing the diffusion of four e-services – e-banking, e-shopping, e-government, and e-learning– including the history of each e-service, diffusion status along the years, and main obstacles. Last but not least, I review the factors that may influence e-services diffusion.

Chapter 3 is the research model, which includes the general theoretical model of the co-diffusion of two e-services. Then I describe how every e-service influences the diffusion of the other, followed by explaining if the co-diffusion effect between every two e-services is balanced

or not and why. I proceed with presenting possible mediating relationships among the different e-services, and suggest a conceptual path model that includes the four e-services listed above. I continue presenting the country-level factors that may influence co-diffusion followed by the moderating effects on e-services co-diffusion. Finally, I suggest the relevant hypotheses that this dissertation is seeking to test.

Chapter 4 is the methodology, which includes comparison between longitudinal analysis versus cross-sectional, Generalized Method of Moments (GMM) dynamic panels versus Ordinary Least Squares (OLS) technique and the different statistical analysis I will use to test this dissertation's hypotheses, and data collection and power analysis.

Chapter 5 includes the co-diffusion, mediation, country-level factors, and moderating results followed by the discussion of this dissertation's findings.

Chapter 6 includes the conclusion, theoretical and practical implications, research limitations and recommendations for future research.

CHAPTER II

LITERATURE REVIEW

2.1 Diffusion of Innovation Theory

The Diffusion of Innovation (DoI) is the theory base of this dissertation's e-services co-diffusion model. Rogers (2003) defined an innovation as an object, practice, or idea that individuals perceive as new. E-services such as e-banking, e-shopping, e-government, and e-learning fit the definition of an innovation (Andoh-Baidoo, et al. 2012) considering them to be still an idea that consumers perceive as new, or a practice that some consumers perceive as new to them but not to some of their friends and family. The DoI theory has been one of the most applied theories in the e-services literature as it presents important determinants of e-services adoption (Tan & Teo, 2000; Christou & Kassianidis, 2002; Carter & Belanger, 2004; Kolodinsky, et al., 2004; Ndubisi & Sinti, 2006; Hernandez & Mazzon, 2007; Carter & Weerakkody, 2008; Sang, et al., 2010; Zhang, et al., 2010; Liang & Lu, 2013).

The diffusion of an innovation depends on individuals' decision to accept it following a process that starts with individuals' initial knowledge about that innovation followed with developing attitude towards that innovation, which leads to their decision to adopt or reject it, otherwise postponing that decision. The first phase in Rogers' DoI adoption process is the initial knowledge about the innovation, which is affected by several antecedents such as prior conditions including previous experience, perceived need of the innovation to solve or ease a problem, innovativeness, and norms of the social systems. In addition, the decision maker attributes also characterize the initial knowledge of an individual including socioeconomic

variables, personality variables (e.g., general attitude towards change), and communication behavior.

The second phase is the persuasion, which is represented by the innovation's characteristics including relative advantage, complexity, compatibility, trialability, and observability. The persuasion phase mediates the initial knowledge and the decision phase, which is the third phase. The individual's characteristics affect the innovation characteristics, which in turn affect the decision making towards adopting or rejecting the innovation. The fourth phase is the implementation phase, which means that after an individual has decided to adopt an innovation, the next step would be using it. Once the individual started to use an innovation, the confirmation phase starts as the individual will evaluate the innovation, which will result in confirming the continuous of use or the discontinuous.

According to Rogers (2003), the adoption of a new idea is very difficult regardless of the advantages that this innovation may provide, which explains the long time an innovation takes before it is widely adopted. The DoI adoption is a long and difficult process because it usually takes place through the appropriate channels within the social system (Rogers, 2003). Diffusion is the passive spread by which an innovation is communicated through certain channels within the social system over time, while dissemination is the active process that increases the awareness and adoption (Rogers, 2003). Rogers (2003) states that mass media channels are more effective in generating knowledge about the innovation, whereas interpersonal channels are more effective in establishing and altering attitudes towards a new idea.

Rogers' DoI theory lists five categories of innovativeness including innovators, early adopters, early majority, late majority, and laggards. Innovativeness is the degree to which an individual adopts new ideas as compared to other members of their social system. These

categories are distinguished by the rate of adoption as well as the time an innovation takes to be adopted by individuals. The rate of adoption is affected by the perceived characteristics of the innovation, while the time of adoption is affected by the decision maker's characteristics. An innovator is an adventurous individual who likes trying new ideas or experiencing new practices. The decision made by innovators within the implementation and confirmation phases is important to the subsequent decisions of other potential adopters. Early adopters' decision is influenced by the innovator's decision. If they perceive great benefit of the innovation on the innovators, then their decision will settle on adopting the innovation. The early adopters are considered the leaders of a social system as they are respected for their educated opinions and well informed decision makings by the early majority, and late majority (Rogers, 2003). Therefore, the early majority and late majority trust the early adopters' decision and follow their steps similar to how the mass follow their leaders. So when the early adopters adopt an innovation, the rest follows, which results in a fast increase of adoption among the early majority followed by the late majority. That leaves us with the last group that are called the laggards who are described as old fashioned and probably isolated from the rest of the social system, which reflects their low rate of adoption of an innovation (Rogers, 2003).

The logic presented by Rogers' DoI theory makes it easier to understand the e-services co-diffusion mechanism, especially in the first two phases – initial knowledge and persuasion. The initial knowledge is affected by prior conditions including previous experience, perceived need of the innovation to solve or ease a problem, innovativeness, and norms of the social systems. In addition, the decision maker attributes also characterize the initial knowledge of an individual including socioeconomic variables, personality variables (e.g., general attitude towards change), and communication behavior.

- Previous experience: The awareness of an innovation is a condition that precedes the adoption of that innovation (Sathye, 1999; Al-Somali, et al, 2009; Azouzi, 2009). Previous experience was reported to shape individuals' perceptions and attitudes formation (Ram, 1987). Therefore, a positive previous innovative experience influences positively the adoption of an innovation. In the context of e-services co-diffusion, I argue that in countries where consumers have positive experiences using an e-service like e-banking (e.g., saving money/expenses, and convenience), most likely consumers in those countries are willing to use other e-services such as e-shopping, and e-government. However, in countries where cyber-attacks are high and affected large population of consumers to suffer from having their e-banking accounts hacked and resulted in theft of their money, more than likely consumers in those countries lack trust in purchasing items online (e-shopping) or paying vendors and bills online (e-payment). Eastin (2002) identified "risk" as one of the common attributes that determine the adoption of e-shopping, e-banking, and e-payment. Also, security concerns have been reported as a major barrier of e-services adoption (e.g., e-government, e-banking, e-shopping, and so on).
- Perceived need of innovation: another condition that precedes the adoption of an innovation would be the need for an innovation (Ram, 1987). The need for an innovation can be generated to solve or ease a problem. For example, in countries where e-services are available for consumers to bank, shop, or file official documents, they do not need to stop by the bank, mall, or governmental office during business hours. Hence, more than likely e-banking, e-shopping, or e-government are perceived to be very convenient services. If one e-service like e-banking is perceived very convenient by the consumers

because it solves the problem of their lack of time to perform activities offline, then in those countries consumers will seek other innovations such as e-government, e-shopping and e-payment to solve the problem of finding time to stop by a CPA service provider to file for tax return, a DMV to renew the driver's license, or a city hall to pay the bills.

- Innovativeness: it is the degree to which consumers are willing to adopt an innovation compared to their society members (Rogers, 2003). The higher the degree of innovativeness in a country the greater and faster an innovation is diffused. I believe that in such countries with high innovativeness the speed and direction of the diffusion of similar technologies like e-services will be parallel.
- Norms of society: they are the behavioral patterns of society members that influence the adoption of innovations (Rogers, 2003). For example, cash-based countries where consumers use cash as the primary and main method of payment, most likely the diffusion of e-services that include monetary exchange (e.g., e-payment, e-shopping, e-banking, etc.) would be low.
- Socioeconomic characteristics: according to Rogers (2003) the adoption of innovation depends on the availability of resources, which in turn depends on the individuals' educational level (knowledge and computer/Internet skills/experiences), and income level (computer prices, Internet fees, power of purchase). For instance, "the individuals or other units in a system who most need the benefits of a new idea (the less educated, less wealthy, and the like) are generally the last to adopt an innovation" (Rogers, 2003, p. 295). Moreover, at the country level it is reflected by the country's infrastructure (literacy level, internet accessibility, internet high speed availability, internet security, etc.).

- Personality variables: "Personality refers to the cognitive and affective structures maintained by individuals to facilitate adjustments to events, people, and situations encountered. Personality variables believed to strongly influence IS usage include locus of control, dogmatism, ambiguity tolerance, extroversion/introversion, need for achievement, risk-taking propensity, evaluative defensiveness, and anxiety level" (Argawal, 2000, P.95). I believe that the personality characteristics of an individual would influence the use of any e-service similarly due to the fact that most e-services are alike in regard of usability, profitability, and mechanism (Eastin 2002).
- Communication behavior: Rogers (2003) states that mass media channels are more effective in generating knowledge about the innovation, whereas interpersonal channels are more effective in establishing and altering attitudes towards a new idea.

The persuasion is represented by the innovation's characteristics including relative advantage, complexity, compatibility, trialability, and observability.

- Relative advantage: is the degree to which an innovation provides benefits that supersede those of its predecessor and may be in the form of economic benefits, convenience and satisfaction. Innovations with low relative advantages tend to have low adoption (Rogers, 2003). E-services have been found to project high relative advantages such as convenience (e.g., 24/7 access to services), lower cost (e.g., save on gas from driving, pay bills on time which saves penalties such as late fees, etc.) (Anguelov, et al, 2004). Therefore, e-services help improve the life of individuals by providing them the ability to take control of their life activities and manage their time efficiently and effectively (Batagan et al, 2009; Tohidi, 2011).

- Compatibility: is the degree to which an innovation fits with the individual's existing values (e.g., traditional and cultural), previous experiences and current needs (Rogers, 2003). Innovations that are perceived with high compatibility tend to have high adoption. We argue that most e-services would share similar levels of compatibility perceived by consumers due to the similarity among them in concept, functionality, experience, advantages, etc.
- Complexity: is the degree to which an innovation is perceived to be easy to use. As complexity decreases, attitude towards e-services usage should become more positive.
- Trialability: is the degree to which an innovation is perceived trialable before adoption as well as trialable in stages (Rogers, 2003). The less the trialability an innovation is perceived the lower its adoption.
- Observability: is the degree to which an innovation is visible to consumers (Rogers, 2003).

The DoI theory focuses a single innovation or a cluster of innovations. However, it does not explain the relationship between these innovations and in particular the co-diffusion of innovations, how the diffusion of one innovation affect the diffusion of another innovation. That is why this dissertation will use another theory to address these relationships.

2.2 Push-Pull Theory

The push-pull theory was developed in the engineering/R&D literature to explain project success or failure. This theory includes two phenomena, the technology-push and the need-pull innovations. Zmud (1984) explained the push-pull theory by stating "that innovation is most likely to occur when a need and a means to resolve that need are simultaneously recognized" (p. 727). He also stated that a commercial success is more likely to occur as a result of the need-pull

innovations than the technology-push innovations. In this dissertation, I agree with Zmud (1984) because I believe that no matter how much e-services providers push e-services, consumers will never adopt e-services if they do not recognize the need for them (e.g., convenience). Therefore, in many developing countries innovations like e-services are not recognized because the "need" factor is poorly addressed or requested by consumers, which makes the means unrecognized by them as well.

The push-pull theory has been recognized in the IT diffusion literature as diffusion takes place as a result of technology push or business pull (Prescott & Van Slyke, 1997). In this latter paper, the authors argued that the Internet was pushed from technologies such as the web in general and the web browser in particular. Such technologies pushed the Internet and established its diffusion to make these technologies available for individuals and organizations. On the other hand, the business pulled the Internet as nowadays organizations' business strategy include or require establishing online presence using the web technology, which is available through the Internet medium. Businesses spend lots of resources to establish a strong presence online as a response to competition among their rivalries. For example, UPS matched FedEx's online presence to allow customers monitor their package status through the Internet using their official website. Such business pull contributed to speeding the diffusion process of the Internet (Prescott & Van Slyke, 1997).

Also, the push-pull theory has been applied in the e-learning literature. Parikh & Verma (2002) suggested that the combination of push technologies and pull technologies generates better results and more benefits. They defined the push technologies as "the software that enables Internet, Intranet, and Extranet users to customize automatic delivery of information directly to their computers from a variety of sources" (p. 30). They distinguished between push and pull

technologies by considering that push technologies are based on publish and subscribe model, while pull technologies are based on request and reply model. They also stated that push technologies offer many advantages over pull technologies. Push technologies allow secure delivery of time-sensitive information directly to intended group of recipients. Also, they allow customization as the systems modify the content of messages to match consumers' needs. They protect consumers' privacy by delivering information specifically to the intended recipients, which helps to avoid exposing sensitive information to a third party. And, they keep records of the information sent to recipients and when they viewed them.

This dissertation recognizes the push-pull theory to explain the co-diffusion of e-services. It presents the push and pull innovations in the e-services context slightly different from what was presented above. It suggests that business-pull and business-push both exist in the e-service environment due to the fact that e-services are used by consumers and organizations. At the organizational level, we recognize business-pull as organizations tend to exist online to mitigate any differentiation advantage for their competitors. For example, banks that do not offer e-banking services will not survive in the long term as they will lose many of their customers who prefer to bank online than at a physical branch. Most likely they will look for competitor banks that offer online banking services, to satisfy their needs of banking online. Also, this dissertation recognizes business-push in e-services context, for example, banks push e-banking to increase profit and reduce expenses because the online banking cost the bank 40% less than banking operations at a physical branch. Therefore, banks push e-banking by charging their customers fees for conducting banking activities at a physical branch (checking account maintenance fee). However, at the individual/consumer level this dissertation recognizes the need-pull innovations. For example, customers pull e-banking to take advantage of the convenience that it offers to

consumers because it can save them time and money and allow them 24/7 banking services. Therefore, this dissertation proposes that e-banking diffusion is driven by the business-push, business-pull, and consumers' need-pull.

Furthermore, this dissertation proposes that the push-pull theory even exists between the different types of e-services. One e-service can push or pull another e-service. For example, e-shopping pulls e-payment because e-shopping needs e-payment to be able to conduct an online purchase transaction. E-government pulls e-payment as citizens can pay their taxes or utility bills (e.g., water, and sewers) electronically. Also, e-payment pushes e-banking because e-banking is a means to monitor e-payments, especially when a customer conducts multiple online purchases for big amounts such as purchasing an online flight ticket. And, e-payment pushes e-banking as e-payment is one of the services offered by e-banking which allows customers to pay their bill electronically (Jayawardhena & Foley, 2000; Goi, 2005).

2.3 Co-Diffusion

Several types of interproduct relationships have been reported in the literature on co-diffusion:

- Contingent relationship (Niculescu & Whang, 2012): two products are contingent when one product use or consumption is dependent on adopting or using the other.
    - If that relationship is symmetric between the two contingent products, i.e., the products are useless without one another, then they are called captive (e.g., razor blades and blade holders, coffee makers and paper filters, computers and operating systems).
    - If the relationship is asymmetric between the two contingent products, i.e., one product is a standalone product while the other is optional (one product cannot be

used without prior adoption of the former), then they are called add-on or complementary products (e.g., washer and dryer, TV and DVD player). According to Niculescu & Whang (2012) the market potential for the optional product is a subset of the market potential for the stand-alone product due to the fact that the adopters of the optional product come from among the adopters of the standalone product.

- Substitution relationship (Jin-Xing, et al, 2013): two products that are not contingent as one substitute the other (e.g., older technologies are gradually replaced by newer technologies, overlapping of technological innovations).
- Parallel adoption (Niculescu & Whang, 2012): Each product acts as a promoter to the adoption of the other. The market potentials for parallel adopted products are not necessarily related. Their co-diffusion takes place at the hazard function level, which mainly influences the speed of adoption.

Identifying co-diffusion among different products or innovations has been a great help for business growth. Based on the complementarities in the diffusion of several products or innovations, researchers and practitioners were able to forecast the sales of one product/innovation using the sales numbers of another. For example, Bayus (1987) forecasted the sales of hardware from the sales of software due to the interrelationship between both hardware and software. Also, the interaction in the diffusion of complementary innovations is very important for business strategy because organizations, firms, vendors, and service providers can enhance the diffusion of one innovation by supporting another complementary innovation(s) (Bucklin & Sengupta, 1993). This dissertation proposes that by recognizing the co-diffusion among electronic services we can forecast the adoption rate of one electronic service from the

actual adoption rate of another e-service. For example, we can forecast the adoption rate of e-banking in Thailand from the actual adoption rate of e-payments there (e.g., number of credit cards in circulation in Thailand, debit card per capita, etc.).

The co-diffusion phenomenon is of special importance as the interaction between overlapping innovations take place because the adoption of one innovation improves the value of the other to the consumer (Bucklin & Sengupta, 1993). Therefore, this dissertation proposes that when a consumer adopts e-banking and takes advantage of the convenience of accessing his/her banking information and conduct transaction 24/7, he/she will more likely assign a high value for adopting e-shopping. The same concept is valid among other e-services such as e-government, e-banking, and e-shopping. Eastin (2002) captured such similarity between four e-services – electronic shopping, electronic banking, electronic investing, and electronic payments.

Mahajan and Peterson's (1978) research was among the first studies that formally proposed a hazard rate co-diffusion model for contingent products. The majority of studies that investigated the co-diffusion of multiple innovations focused on their complementarities. Bayus (1987) investigated the complementarities among the sales of hardware and software. Bucklin and Sengupta (1993) investigated the complementary co-diffusion and parallel adoption of laser scanners by retailers and Universal Product Code (UPC) bar codes by manufacturers. They found asymmetric two-way co-diffusion effects between both innovations. Their results showed the co-diffusion effects to be stronger than innovation effects. This means that certain products or services diffuse slower in a certain market or country if they existed without their complementary products or services. Guevara and Putis (2014) and Dewan et al. (2010) described the parallel market growth for PCs and the Internet by combining cross-product and cross-country effects. Guevara and Putis (2014) extended Dewan et al. (2010) by including

cross-market effects. However, Dewan, et al. (2010) investigated the complementarities in the diffusion of personal computers and Internet in the context of global digital divide. Niculescu and Whang (2012) investigated the complementary co-diffusion effects between wireless voice service and wireless data service. Recently, Jin-Xing, et al. (2013) investigated co-diffusion effects between the mobile IM service and the desktop IM service.

Furthermore, Niculescu and Whang (2012) reported that very little research has been done on the co-diffusion of IT products and services, and the primary focus of previous studies was on interactions between hardware and software. Different hardware products or platforms have been considered, such as personal digital assistants (Nair et al. 2004), compact disc players (Bayus 1987, Gandal et al. 2000), or video game consoles (Clements and Ohashi 2005). According to Niculescu and Whang (2012), these studies tend to examine the evolution of software over time for every specific hardware or platform.

Table 1.1 Summary of co-diffusion studies

Citation	Co-diffusion	Theories	Variables	Data Sample	Findings
Bayus (1987)	hardware (CD player) & software	n/a - previous studies	CD player sales CD software sales Number of households Market segments CD player purchase intentions average price of CD players CD software price Time after purchase of CD player	USA	Co-diffusion not supported
Bucklin & Sengupta (1993)	laser scanners & UPC bar codes	Diffusion of Innovation theory of consumer behavior Bass Model	purchases of UPC code rights scanner purchases	USA	Co-diffusion supported
Gandal, et al. (2000)	hardware (CD players) & software	n/a - previous studies	Quarters Sales Price CD availability Compatibility Market size	USA	Co-diffusion supported

Nair et al (2004)	hardware & software (personal digital assistant)	n/a - previous studies	PDA sales Software sales Software brand Price RAM Clock-speed Area Weight Color Eslots Modem Lithium Holiday	USA	Co-diffusion supported
Clements & Ohashi (2005)	hardware & software (video game consoles)	n/a - previous studies	Console sales Console price number of game titles Installed base by format Within-group market share Age of console system CPU/GPU (bits) Clock speed (MHz) RAM (mega bytes) exchange rate of $U.S./Japanese Yen console price in Japan Average age of software titles Average lifetime of software titles	USA	Static co-diffusion supported
Dewan, et al. (2010)	PC & Internet	Diffusion of Innovation Bass Model	penetration levels of PCs penetration levels of Internet average PC unit price cost of telephone access GDP per capita - PPP	26 countries	Co-diffusion supported
Niculescu & Whang (2012)	wireless voice & wireless data	Bass Model	Voice subscribers Data subscribers Japanese population Number of researchers R&D expenditure GDP price	Japan	Co-diffusion supported
Jin-Xing, et al. (2013)	mobile IM & desktop IM	Bass Model	percentage of adoption of mobile IM	China	Co-diffusion supported

		Diffusion of Innovation Uses and Gratifications Theory	percentage of adoption of desktop IM		
Guevara and Putis (2014)	PC & Internet	Bass Model	number of households owning a PC number of home Internet users number of households total population size GDP per capita - PPP index of prices Market size	19 countries	Limited co-diffusion support (PC on Internet)

While previous co-diffusion studies (Table 1.1) paired contingent products that depend on each other such as hardware and software, PC and Internet, and so on, my work differentiates itself from these previous studies by pairing products that do not directly and necessarily depend on each other and can be used as standalone products. For example, to access internet or software we need to access hardware first, but to use e-government we do not need to use e-banking first or vice versa. I believe that different e-services complement each other, and each e-service's adoption promotes the adoption of another e-service due to the similarity among their use (e.g., experience), process/platform (e.g., online through a website using some sort of a computer), benefit (e.g., convenience), and functionality (access information and possibly conduct transactions). Therefore, I argue that the adoption of every e-service is parallel to the other's adoption, which make their market growth (e.g., diffusion) to be parallel as well. In this dissertation, my general focus is the analysis of the parallel adoption of e-services (i.e., e-banking, e-shopping, e-government, and e-learning), while I intend to capture e-services' cross-product and cross-country effects at the speed of adoption level.

2.4 History of E-services Diffusion

E-services are the last step of the development of distance services (Hultén, et al., 2002). Distance services existed pre-Internet since the 1980s with the existence of VideoTex system

technology that used telephone lines, which was used for services such as home banking services and teleshopping (Edwards, 1984; Cornin, 1997). In 1981, four of New York main banks – Citibank, Chase Manhattan, Chemical, and Manufacturers Hanover – offered home banking services, which increased in 1985 to 37 banks (Edwards, 1984; Cornin, 1997; Pennings & Harianto, 1992). In 1982, Minitel succeeded Videotext as a distance service that allows checking share market, distance purchases/shopping, searching telephone directory, and chatting. Minitel, the French Teletel system, was one of the most successful distance services before the existence of the Internet and World Wide Web (WWW) using telephone lines (Hultén, et al., 2002). Merita bank in Finland offered the telephone bank service in 1982, and in 1984 it offered its customers the ability to connect a PC over a telephone line to the bank's payment system (Hultén, et al., 2002). In 1984-85 Société Générale, a French bank, offered its clients the possibility to check their bank accounts balance; in 1987 clients had the option to make transfers between their accounts, and in 1989 Société Générale added a telephone bank service (Audiotel) to the Minitel service to make services available to customers 24 hours a day and seven days a week (Hultén, et al., 2002).

The first WWW server and browser, created in 1990, opened for commercial use in 1991 (Kasana & Chaudhary, 2014). In 1994, Netscape released Navigator browser, and introduced Secure Sockets Layer (SSL) encryption to secure online transactions, and that was followed by the start of e-services such as e-banking, e-shopping, e-government, and e-learning (Kasana & Chaudhary, 2014). In October 1994, Stanford Federal Credit Union was the first to offer its customers e-banking services (Gandy, 1995). Also, during that same year Pizza Hut started online ordering, while other products were available for sale on the Internet such as cars, bikes, and adult contents (Kasana & Chaudhary, 2014). Moreover, the first online high school,

CompuHigh, started in 1994 (Murphy, 2005). Furthermore, in that same year the Estonian government started its e-government services by launching its government webpage (Peedu & Lamas, 2011). In 1995, Amazon.com started selling wide variety of products online, and eBay started with online auctions (Kasana & Chaudhary, 2014).

Previous studies reported that the diffusion rate of an innovation is impacted by an older innovation, especially the one that is based on the older one (Dekimpe, et al., 2000; Dewan, et al., 2010). Therefore, by revisiting the history of different e-services including their start date for consumption and use, and identifying their penetration rates through the years I can draw a trend map that expresses the co-diffusion relationship among different e-services. Also, this would help me identify the type of co-diffusion relationship that exists between every two e-services, if they are balanced or unbalanced, and if unbalanced which direction would be stronger. The literature of co-diffusion found that technology-base innovations have stronger co-diffusion effect on the new innovation than vice versa. For example, Dewan, et al. (2010) found that PC co-diffusion effect on Internet was greater than vice versa because PC is older than the Internet and form the technology base to access and use Internet. Similar support exists within the "substitution" stream within the co-diffusion and multiproduct literature (Peterson & Mahajan, 1978; Norton & Bass, 1987; Islam & Meade, 1997; Mahajan & Muller, 1996; Danaher et al., 2001; and Meade & Islam, 2006).

2.5 E-services Advantages

E-services such as e-shopping, e-banking, e-government, and e-learning offer consumers the convenience of requesting services by being able to access information and conduct transactions 24/7. Also, they benefit services providers by reducing their costs (i.e., transactions

costs), increasing their management and operations' efficiency, and improving their customer service.

Offering e-banking services is a critical condition for the survival of banks and/or maintain the strongest competitive advantage because it helps them to improve their customer services and customer satisfaction (Southard and Siau, 2004). Compared with developed countries in which most commercial banks provide e-banking services, such competitive advantage is still salient in developing countries such as Vietnam and Sudan where e-banking is at the infancy stage (Chong et al., 2010; Alam et al, 2010). E-banking provides customers with an easy access to their banking information and allows them to perform financial transactions 24/7 at their own convenience (Dawes & Rowley, 1998; Tan & Teo, 2000).

Furthermore, banks that offer e-banking services are able to decrease their costs and increase their profits. For example, the average transaction cost at a physical bank branch is $1.07, while the same transaction conducted at a bank's website costs the bank only one cent (Angelakopoulos and Mihiotis, 2011). The cost of running E-banking is 40 percent less than the cost of operating a physical branch (Tan & Teo, 2000; Nath, et al, 2001). Also, as more and more customers turn to e-banking, banks do not need as many physical branches as they used to. For example in 2009, Bank of America closed approximately ten percent of its branches (600 locations) in the US (IB, 2009).

E-government services increase the convenience of government services to citizens, and offer a greater public access to government information (Carter & Belanger, 2005a). Citizens can file tax returns or applications for permits and licenses 24/7 at their own convenience (Litan & Rivlin, 2001). Also, these services improve governments' accountability to their citizens, and in some cases they help citizens avoid corruptive practices by government officials, which are quite

common in developing countries such as in Middle East, Africa, Latin America, and so on (Carter & Belanger, 2005a; Bwalya & Healy, 2010). Moreover, e-government services offer efficiency and cost-effectiveness to governments by decreasing the cost of public services delivery (e.g., filing tax returns), and increasing the accuracy of governmental information provided to citizens (Litan & Rivlin, 2001; Carter & Belanger, 2005a; Bwalya & Healy, 2010). The government sector in the US saves over 12 billion dollars annually using e-government services (Litan & Rivlin, 2001). As a summary, the following are the advantages of e-government: "1) Cost reduction and efficiency gains, 2) Quality of service delivery to businesses and customers, 3) Transparency, anticorruption, accountability, 4) Increase the capacity of government, 5) Network and community creation, 6) Improve the quality of decision making, 7) Promote use of ICT in other sectors of the society" (Ndou, 2004, p. 8).

The major benefits that e-shopping brings to consumers include convenience, competitive pricing, and greater access to information (Ha & Stoel, 2009). First, e-shopping offers consumers the convenience of shopping online as that saves time for them to search for products, especially e-shopping allows consumers accessing a wide range of products selection available online (Willis, 2004). In addition, Chang, et al (2005) suggested that e-shopping offers consumers increased product value, defined as "a measure of the shopping medium's potential to offer a variety of products/services that are competitively priced and are of good quality" (Vijayasarathy & Jones,2000 p. 193).

Similar to e-shopping, e-retailing reduces transaction and delivery costs, increases management and operations' efficiency, and increases competition (Litan & Rivlin, 2001). E-retailing has advantage on brick-and-mortar retailing as the transaction cost is way lower due to low real estate costs (Schlauch and Laposa, 2001). Whereas most e-retailers only need warehouse

space for inventory, brick-and-mortar retailers spend high costs to rent or purchase storefronts in commercial zones that are usually located at expensive downtown areas. Also, e-retailers reduce workforce cost compared with brick-and-mortar retailers because shop assistants are generally not required. Furthermore, businesses that use e-commerce can take advantage from reducing the delivery expenses, especially for digital goods such as software, music, movies, books, and so on. By being able to deliver products and/or services electronically to consumers, e-retailers save the cost of printing and mailing (Willis, 2004).

E-services can also contribute to driving nations' economic growth because they are part of information and communication technology (ICT) goods and services that are generated by ICT investments. The results of Hoon's (2003) investigation of the effect of ICT investments on economic growth in 56 developing countries suggest that ICT investments have a positive impact on economic growth. Therefore, it is very important to push the diffusion of e-services in most developing countries that are late adopters. Despite the importance and benefits of e-services, their availability and use differ from one country to another. This motivates this study to seek the understanding of the factors associated with the diffusion and co-diffusion of e-services. Such an understanding may provide some insights on how to promote the balanced development of e-services in different countries.

2.6 Factors that may Influence E-Services Diffusion

The other foundation for my research is the IS literature on the country-level, which is represented by the ICT international diffusion, and ICT digital divide literature. The focus of this literature is on describing and clarifying cross-country penetration of e-services. Dewan and Riggins (2005) presented a comprehensive summary of the factors that affect technology penetration (i.e., ICT, Internet, and digital wireless penetrations) by reviewing the literature on

digital divide at the global level. Their findings include two umbrellas of factors, socio-economic and infrastructural. Examples of the studies that Dewan and Riggins (2005) reviewed are Quibria et al. (2003) from the computer or ICT penetration literature, Hargittai (1999), Kiiski and Pohjola (2002), Wallsten (2003), Chinn and Fairlie (2004), Dewan et al. (2005), and Ganley et al. (2005) from the Internet penetration literature, and Kauffman and Techatassanasoontorn (2005a, 2005b, 2005c) from the digital wireless penetration literature. According to Dewan and Riggins (2005)'s summary of these studies' key significant findings are socio-economic factors such as economic wealth or national income (GDP per Capita), structure of the economy (e.g., importance of international trade), telephone access cost, digital wireless prices (e.g., Internet access prices), education or human capital (e.g., years of schooling), and infrastructural factors such as telecommunication infrastructure (e.g., phone density).

Also, Cuervo and Menendez (2006) analyzed the digital disparities between nations by focusing mainly on the ICT infrastructural factors such as number of computers, telephone lines, and broadband connections per 100 inhabitants, number of secure servers per million inhabitants, percentage of businesses with a website, percentage of businesses buying online, percentage of households connected to the Internet, percentage of public services online, and percentage of active population using a computer for professional purposes. Even though Cuervo and Menendez (2006) stated that the international digital divide is the result of socio-economic (income and education) imbalances between countries, they only used Internet dial up access costs for a residential user while discarding income and education in their analysis probably because of their European sample that consists mostly of developed countries with alike socio-economic measures.

From the literature of e-services diffusion at the country level, Oxley and Yeung (2001) and Shih et al (2005) conducted a cross-country analysis to determine the factors that influence the diffusion of e-commerce. To better understand e-commerce diffusion, they also used socio-economic and infrastructure factors. Oxley and Yeung (2001) argued that the variation of e-commerce activities between different countries is explained by the variation of ICT infrastructural factors such as Internet users per capita, Internet hosts per capita, phone lines per capita, mobile phones per capita, and personal computers per capita. In addition, they argued that socio-economic factors such as GDP per capita, telephone charges, Rule of Law, and payment channels (i.e., Credit cards per capita, and Card transactions per capita) also determine the cross-country variation of e-commerce activities. On the other hand, Shih et al (2005) argue that firms and consumers cannot migrate from traditional supply chains to electronic markets without access to technological infrastructure. Therefore, to better understand the international diffusion of e-commerce, they examined Internet penetration, the number of secure servers available in a country, and the total amount of investment made in information technology. In addition, Shih et al (2005) also examined socio-economic factors including GDP per capita, market capitalization per capita, private loans/credit per capita, direct market revenue per capita, number of credit cards per capita, and rule of law. In addition to e-commerce, Li, et al. (2002) studied the cross-country diffusion of e-banking by examining electronic connectivity (i.e., personal computer use, internet connectivity, and percentage of inhabitants with mobile phones). Only internet connectivity was found important to the adoption of e-banking. Also, Al-Adawi, et al (2005) studied e-government diffusion among 30 countries and identified GDP per capita and Internet access to be associated with e-government services use.

Yunis and Koong (2009) examined the ICT drivers that would help in the attainment of sustainable global competitiveness at the country level by identifying the differences of ICT

maturity among different countries, and explaining how ICT maturity pushes global competitiveness. Their ICT maturity model that explained the ICT level of use included environmental factors (e.g., Culture, and government policies), ICT readiness (e.g., human development, and education), technology achievement, ICT quality (e.g., security), ICT infrastructure (e.g., PC access, Internet connectivity, and high bandwidth access), and economic factors such as Internet access affordability, GDP per capita, and Research and Development (R&D) spending (% of GDP). Yan, et al (2006) also used the economic development and information infrastructure factors to explain the differences of SMS diffusion or acceptance between China and Hong Kong. They identified two variables from the economic and infrastructural factors, GDP per capita and Internet access respectively. Bagchi et al (2004) examined national economic (i.e., GDP per capita, and the level of income inequality of a nation), and national cultural to predict the adoption of six information technologies – PC, telephone, cell phone, fax, Internet, and pager – over a ten year period in thirty one nations.

Table 2.1 Summary of the country-level factors affecting e-services diffusion

Factors	Citations	Factors	Citations
ICT infrastructure		Socio-economic	
Internet access and use	Oxley and Yeung (2001) Li, et al. (2002) Bagchi et al (2004) Al-Adawi, et al (2005) Dewan and Riggins (2005) Shih et al (2005) Yan, et al (2006) Cuervo and Menendez (2006) Yunis and Koong (2009)	GDP per Capita	Oxley and Yeung (2001) Bagchi et al (2004) Al-Adawi, et al (2005) Dewan and Riggins (2005) Shih et al (2005) Yan, et al (2006) Cuervo and Menendez (2006) Yunis and Koong (2009)
Internet speed	Cuervo and Menendez (2006) Yunis and Koong (2009)	Telephone cost	Oxley and Yeung (2001) Dewan and Riggins (2005)
Internet security	Shih et al (2005) Cuervo and Menendez (2006) Yunis and Koong (2009)	Internet cost	Dewan and Riggins (2005) Cuervo and Menendez (2006) Yunis and Koong (2009)
		International trade	Dewan and Riggins (2005)
Internet host	Oxley and Yeung (2001)	Education	Dewan and Riggins (2005)

Phone density	Oxley and Yeung (2001) Dewan and Riggins (2005) Cuervo and Menendez (2006)
Mobile	Oxley and Yeung (2001)
PC	Oxley and Yeung (2001) Cuervo and Menendez (2006) Yunis and Koong (2009)
businesses with website	Cuervo and Menendez (2006)
businesses buying online	Cuervo and Menendez (2006)
public services online	Cuervo and Menendez (2006)
Investments in IT	Shih et al (2005) Yunis and Koong (2009)

	Cuervo and Menendez (2006) Yunis and Koong (2009)
Income	Bagchi et al (2004) Dewan and Riggins (2005) Cuervo and Menendez (2006)
Rule of law	Oxley and Yeung (2001) Shih et al (2005) Yunis and Koong (2009)
Payement channels	Oxley and Yeung (2001) Shih et al (2005)
Culture	Bagchi et al (2004) Yunis and Koong (2009)

Based on the aforementioned literature review findings of factors used in previous cross-country studies to explain the diffusion and use of different types of technologies, I used some of them in this dissertation to examine the co-diffusion of e-services. I say some of them because some of the studies I reviewed examined some technologies that are no longer used nowadays or were used differently due to the development and improvements that occurred in the last decade. For example, telecommunication infrastructure, telephone density or number of telephone lines, telephone cost and prices, and so on are no longer relevant to be considered as potential factors influencing the diffusion of e-services due to the fact that we no longer use telephone lines or dial-up modems to connect and access the Internet. The next chapter, research model, includes listing and explanation of the factors chosen in this dissertation to examine the co-diffusion of e-services. Table 2.1 includes a summary of the country-level factors affecting e-services diffusion.

CHAPTER III

RESEARCH MODEL

The literature review of aforementioned theories provides some clues on the co-diffusion of e-services. First, the Diffusion of Innovation (DoI) Theory suggests that people's predispositions toward new innovations largely depend on their experiences with similar innovations before (Rogers 1995). In the same way, if an individual finds an e-service easy to use, useful, convenient and/or beneficial, the person may get motivated to try other e-services. On the other hand, if an individual experienced a security or privacy breach of an e-service he or she is using and resulted in loss of personal sensitive information (e.g., social security number, credit card number) or financial loss (e.g., third party charging his/her credit card), most likely that person will no longer trust conducting online activities particularly e-services that require personal information. Also, if an individual conducted an online transaction such as paying credit card, paying taxes, or purchasing a product, and realizes later on that the transaction did not go through or he/she is been charged without receiving the intended reward (e.g., product, charged late fee on credit card, etc.), that person will more likely not trust the vendor (e-retailer, bank, government, etc.) as a responsible partner that is capable to satisfy competence, benevolence, and integrity (McKnight, et al, 2002). This in turn will affect the consumer's choice of the medium to conduct activities, from online to offline (face-to-face) (Carter and Belanger 2005b). Moreover, one bad experience with an e-service can result in consumer discontinuation of it (Dixit and Datta 2010). Therefore, one bad experience with one e-service can affect negatively

another e-service adoption or continuance of use. E-services co-diffusion is a dynamic process as the diffusion of most e-services increases or decreases jointly (Niculescu & Whang 2012).

In this sense, people's previous experiences in using certain e-services largely determine how likely they are going to use other e-services. This proposition is supported by empirical findings. For example, in a study to determine why students prefer purchasing their books online than from a bookstore, it was found that previous online purchases were the major driver for purchasing books online (Foucault & Scheufele, 2002). Also, Atchariyachanvanich and Okada (2006) investigated the reasons behind customers' continuance of purchasing online and they found that their satisfaction level from previous experiences is one of the important factors that explain online repurchase behavior.

Moreover, Rogers (1995) not just discussed the diffusion of a single innovation, but examined how a cluster of innovations diffuse together. His argument is that users typically perceive related innovations as an interrelated bundle of new ideas, rather than viewing them separately. This leads to the definition of technology cluster as "one or more distinguishable elements of technology that are perceived as being closely interrelated" (Rogers, 1995, p. 235). In this sense, the boundaries of different e-services are not necessarily clear to users, who may perceive them closely-related to one another. Once people adopt and use one e-service, they have the natural tendency to get exposed to other related innovations and use them.

There is a high likelihood for individuals or organizations who adopt one innovation to adopt another related one if both innovations are members of a technology cluster (Prescott & Van Slyke, 1997; Van Slyke et al 2004). What makes two innovations complementary is the fact that they offer a similar function or share a common platform (Prescott & Van Slyke, 1997; Van Slyke et al 2004). Such complementary relationships exist among electronic services as they

share common platform, the Internet (Parikh & Verma, 2002), and offer similar functions, seek information and conduct transactions (Wada & Odulaja, 2012). For instance, people who find e-banking convenient to access their banking information or/and conduct banking transactions are more likely to adopt other e-services such as e-shopping and e-government to take advantage of their convenience as well. Users may view different e-services as members of a family because they share the same Internet platform. It is quite straightforward for people who use Internet to conduct one e-service activity such as e-banking, to adopt another activity such as e-shopping. When users subscribe the Internet service to conduct online activities, they do not need to pay the subscription again for other online activities. In the same way, the needed hardware such as modem or router is already in place so that people do not need to repurchase and reconfigure it.

Therefore, this dissertation claims that all Internet-based e-services can be treated as one technology cluster based on the common platform of hardware and software. In terms of the innovations based on common hardware, researchers have studied the case of car electric door locks and the electric window: they share the same platform "the wiring", which make it easier and cheaper to install one after installing the other as the required wiring is already in place (Chin and Moore, 1991; Prescott & Van Slyke, 1997). Regarding the ICT innovations based on common software for report generation, database management, and information retrieval, researchers found that they tend to be adopted as a cluster (Chin and Moore, 1991; Prescott & Van Slyke, 1997).

Second, the Push-Pull Theory suggests that innovations success depends on the need-pull innovations and the technology-push innovations (Zmud 1984). E-services are need-pull innovations as they offer consumers convenience, and technology-push innovations as they push each-other to make them available for consumers. According to Prescott & Van Slyke (1997) the

web browser pushed the Internet to help establish the web and have it available for individuals. Similarly, e-shopping pushes e-payment to help establish e-retailing and have e-shopping available to consumers as without e-payment consumers cannot conduct online shopping. Also, e-payment pushes e-shopping to help establish e-money and have online payments or purchases available for consumers.

In this sense, the success in implementing an e-service in a certain industry or sector is pushing and promoting e-services use in other industries or sectors. Ndou (2004) listed the advantages of e-government and stated that it promoted the use of ICT in other sectors of the society. In India, the adoption and implementation of e-government promoted the ICT use in the education industry or sector as universities initiated e-education development programs. The promotion of e-education in schools was a result of the Gyandoot project – a government-to-citizen intranet project – which was pushed by the Indian parliament through allocating resources to set up kiosks on campuses to develop models for e-education (Bhatnagar and Vyas, 2001). Similar scenarios exist in other sectors including retailing and banking. Once an e-service is adopted by a sector or industry and succeeded to diffuse nationally, most likely other sectors or industries would imitate such move by pushing e-services to their customers. For example, if in a specific country the government initiated the e-government services and succeeded to motivate citizens to use them nationally, most likely we will see banks initiating e-banking, and retails initiating e-shopping to benefit from such an opportunity to attract new customers and satisfy existing customers who seek online services. Shanmugam and Supramaniam (2010) found that e-banking has a significant effect on the success of e-society, which represents a society of Internet users who widely adopt e-technologies including e-services.

Third, to better explain the co-diffusion relationships among the e-services in this dissertation's research model I will use the General Systems Theory. The definition of a system is "a set of objects together with relationships between the objects and between their attributes." (Hall & Fagan, 1956, P. 18). Based on that definition I can imply that the Internet is a system that includes objects such as e-services, and one of the relationships between them is the co-diffusion. Within the Internet system plenty of sub-systems exist including all types of e-services. Moreover, a system interacts with its environment by exchanging materials through input-process-output-feedback (Von Bertalanffy, 1950). This dissertation implies that the Internet system and the e-services sub-systems exchange information with their users through input, process, output, and feedback. E-services systems' users input information to be processed and the result(s) represent the output followed by feedback from users such as making a decision or taking actions. Therefore, I can imply that the mechanism of using different e-services systems is identical when it comes to these four functions. The only difference between these systems is their design and map. Also, I argue that the Web 2.0 technology allows different online systems to be connected as users can access one system from another. For example, social networks systems' users can use information from YouTube, Blogs, and/or e-articles to share on Facebook or Twitter, and vice-versa as users can access e-newspapers, music, and/or videos from Facebook. The same concept is valid between different e-services as users can access one e-service from another e-service especially that some e-services act as sub-systems to other e-services systems. For example, while using the e-shopping system users should access the e-payment system to be able to purchase a product or service online, and in this case e-payment acts as a sub-system for the e-shopping system.

Figure 3.1 E-Services Co-Diffusion

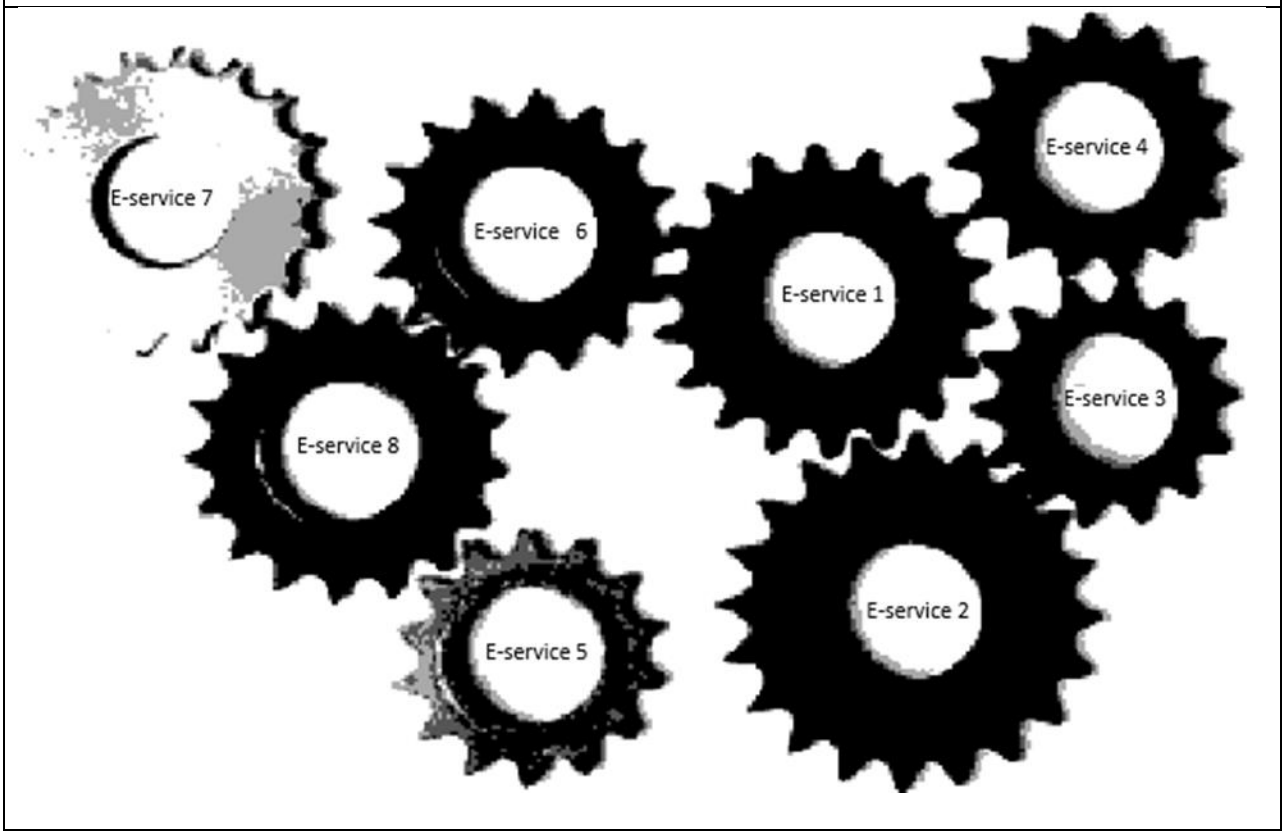


Figure 3.1 shows a visual representation of the co-diffusion phenomenon among different e-services. Every gear represents an e-service, and the move of every gear represents the diffusion of an e-service. Those gears are usually found in a clock, which include gears for seconds, minutes, hours, days, months, and years. These gears move together the way the co-diffusion of e-services move through time. We can see in that figure the paired co-diffusion relationship between two e-services, for example the movement of E-service 1 gear causes the movement of E-service 6 gear and vice-versa, which is similar to the diffusion of E-service 1 causes the diffusion of E-service 6 and vice-versa. Likewise, we can see the mediation co-diffusion relationship between three e-services (e.g., E-service 1, E-service 2 and E-service 3), and moderation co-diffusion relationships between e-services. The environment of the clock mechanics (e.g., battery power, light energy, and heartbeat energy) is equivalent to the socio-

economic and ICT infrastructure environment that affect the diffusion and co-diffusion of e-services (e.g., GDP, Literacy, Internet access, speed and security). The materials and chemicals inside the clock (e.g., Lubricants) are equivalent to co-diffusion moderators like national culture.

3.1 Co-diffusion Relationships

According to the Push-Pull Theory, the diffusion of innovations is influenced by the technology-push and need-pull innovations. E-banking pushes products and services from different e-services systems for customers to use including purchase insurance or discounted vacations/airline tickets/hotels/rental cars (e-shopping), or pay utility bills/taxes (e-government).

E-banking pushes e-shopping as banks (e.g., Discover, Bank of America, Chase Bank, American Express, Capital One Bank) offer their customers cash-back rewards for shopping online using bill payment, e-checks, e-money, smart cards, debit and credit cards. Moreover, e-banking promotes e-shopping using the bank's website. Banks offer more cash-back when customers purchase their travel e-ticket through the bank's website. They offer extra miles as a reward for using the bank's website instead of online travel agencies (e.g., Travelocity and Expedia). Some banks offer different cash-back categories through the year (cash-back calendar). For example, Chase and Discover offer extra cash-back in each quarter of the year (Chase, 2014). Every quarter customers can register to receive 5% cash-back when they order goods and products online (Discover, 2014). On the other hand, some e-retailers such as Amazon and e-bay offer special discounts for customers who would use a specific credit card (e.g., Discover card, American Express card) to purchase their products. Also, some brick-and-mortar retailers such as Lowes offer special discounts for customers who would use a specific credit card for online purchasing.

The interaction and interrelationship between e-banking and e-shopping is also called "cross-selling" as banks while selling e-banking services they also sell e-shopping services (Didehvar and Danaeefard, 2010). Cross-selling encourages customers who have already bought a Product X to also buy a Product Y from the same company or source (Knott, et al, 2002). In Brazil, customers use the bank's website to buy their car insurance (e-shopping), buy stocks (e-investment), and conduct e-commerce (Lipschultz, 2001).

On the other hand, e-shopping pushes e-banking by pushing e-shoppers using e-banking to monitor their online purchases (Takieddine and Andoh-Baidoo, 2014). Also, e-shopping pulls e-banking as e-shoppers use e-banking services such as bill payment, e-checks, e-money, smart cards, debit and credit cards to purchase products and services online (Didehvar and Danaeefard, 2010). Moreover, referring to the "innovativeness" factor presented by Rogers' Diffusion of Innovation theory, the innovativeness of e-shoppers would reflect their perception of using e-banking services to solve a problem represented by the ability to pay for items purchased online. Without e-banking payment services e-shoppers can only find information about products but cannot buy them online.

E-government services have a great influence on the diffusion of e-banking, e-shopping, and e-learning services. E-government services have been found to reduce corruption in the public sector, which help gaining citizens trust in the government (Parent, et al. 2005). Trust has been found to be one of the main determinants of e-services diffusion. For example, countries like Finland, Denmark, and Norway have very low corruption rates and very high diffusion of e-services. This means that with low corruption rates, individuals trust the government into protecting them from any harm or loss even if it resulted from e-commerce transactions. Thus,

trusting the government is reflected into trusting others including individuals, organizations and businesses, which is an important factor for the diffusion of e-services.

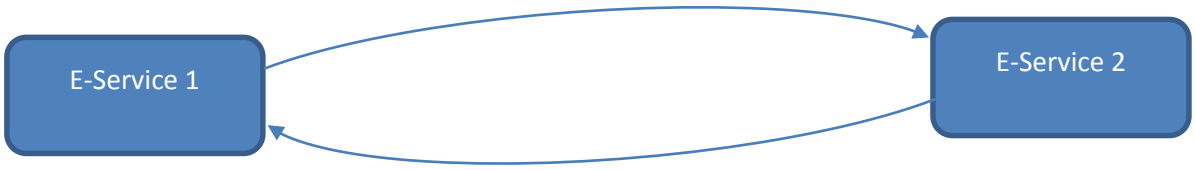
E-government services include three different entities of services, which are transactions, seeking public service, and reaching general information (Bwalya & Healy, 2010). Transactions include paying utility bills, and taxes, and seeking public service includes downloading application forms for example to file tax returns, apply for permits and licenses, apply for a passport, or e-vote (Bwalya & Healy, 2010). To pay a water and sewers bill or taxes, a citizen can use an e-banking service called "bill pay" which will deduct the bill amount from the checking account. Moreover, if an individual did not have previous experience in surfing a website in general and e-services in particular, more likely he/she will find it difficult to use e-government. However, individuals who have already been through similar previous experience such as e-shopping and e-banking will be more likely to transact through e-government. In regard of users' previous experience and familiarity with the electronic process of seeking information and conducting transactions, the Diffusion of Innovation theory presents "previous experience and compatibility" as major determinants of consumers' choice of adopting innovations (Rogers, 2003). E-government and e-shopping are two compatible services, for example, an individual who is seeking a public service or reaching general information (e-government) will go to an online search engine (e.g., Google) to find the public service that he seeks, which is typically a similar process of seeking a store, product, or service (e-shopping). Also, I argue that e-government pushes e-shopping and vice-versa especially when using transactional e-government services such as e-filing for tax. To e-file taxes, citizens should e-shop for tax filing software applications (e.g., TurboTax, TaxAct) or e-filing service providers that are listed on IRS official website. Through the e-filing process citizens are encouraged and

pushed to receive tax back through direct deposit into their bank account (e-banking) or pay owed taxes directly from their bank account (e-banking), which will grant them faster process of their tax filing and save them around six weeks of waiting to be paid taxes back compared to using the offline filing method. Other examples also reflect the co-diffusion between e-government and other e-services like renewing a drivers' license, e-divorce which is filing for divorce online, paying city water and sewers bills.

E-learning services have a great influence in the diffusion of e-banking, e-shopping, and e-government services. Even though e-learning is not limited to individuals who seek education at a university, however, one of the most famous e-learning services is Internet-based distance education. Universities offer online courses to provide students with the convenience of achieving degrees without being limited to the geography or/and while working to bring income. As a result of using e-learning, students must use e-government services such as applying to Financial Aids, e-payment services such as paying their tuition online through credit or debit cards, e-shopping services such as purchasing books online or e-books and software applications related to their studies (e.g., Microsoft Office, MyITlab, Hawkes Learning Systems), and e-banking services such as applying online for student loans.

Figure 3.2 presents this dissertation's general research model that establishes the co-diffusion relationship between two e-services. Based on what I presented above, this dissertation proposes the following hypotheses that suggest co-diffusion between four e-services – e-banking, e-shopping, e-government, and e-learning:

Figure 3.2 General Research Model



H1a: E-Banking has a co-diffusion effect on E-shopping

H1b: E-Banking has a co-diffusion effect on E-Government

H1c: E-Banking has a co-diffusion effect on E-Learning

H2a: E-shopping has a co-diffusion effect on E-Banking

H2b: E-shopping has a co-diffusion effect on E-Government

H2c: E-shopping has a co-diffusion effect on E-Learning

H3a: E-Government has a co-diffusion effect on E-Banking

H3b: E-Government has a co-diffusion effect on E-shopping

H3c: E-Government has a co-diffusion effect on E-Learning

H4a: E-Learning has a co-diffusion effect on E-Banking

H4b: E-Learning has a co-diffusion effect on E-shopping

H4c: E-Learning has a co-diffusion effect on E-Government

3.2 Balanced Versus Unbalanced Co-diffusion

Co-diffusion effect between different e-services is a two-way relationship where the co-diffusion of e-service 1 influences the diffusion of e-service 2 and vice versa. However, I argue

that the co-diffusion of different e-services is not practically and statistically possible to be balanced, which means that the co-diffusion effect of e-service 1 on the diffusion of e-service 2 is equal to the co-diffusion effect of e-service 2 on the diffusion of e-service 1. It is unbalanced due to the fact that the co-diffusion of e-service 1 most likely has a stronger influence towards the diffusion of e-service 2 than the co-diffusion effect of e-service 2 on the diffusion of e-service 1 or vice versa.

The unbalanced co-diffusion effect of an e-service on the diffusion of another e-service might not be similar in different countries. For example, if in a specific country the co-diffusion effect of e-banking on the diffusion of e-shopping is stronger than the co-diffusion effect of e-shopping on the diffusion of e-banking, in another country that might not be the case and the opposite might be true. That difference can be caused by the differences in the environmental and infrastructural elements in different countries. For example, some countries do not have a developed mailing system due to the lack in establishing physical addresses to residential areas as well as not having an advanced mailing system. In some developing countries such as Saudi Arabia, delivering products through mail requires the mailing service provider or e-retailer delivery boy to call the customer on the phone to arrange a meeting time and place due to lack of mail boxes and exact addresses with a house number and street name (AlGhamdi et al, 2011). It has been found that a reliable delivery system such as effective postal services is one of the infrastructural requirements to support the diffusion of e-commerce in developing countries (Travica, 2002).

Also, even if an e-service is established in a specific country, it matters more to know to what extent it is established by looking at the services that it includes. For example, we cannot compare an e-banking service that only allows customers to check their balance and transfer

funds between accounts to an e-banking service that allows customers to check their balance, transfer funds between accounts, apply for loans, purchase insurance, and pay bills. Basically, the more an e-service is established by including more advanced and modern services the greater its co-diffusion effect is to the diffusion of other e-services. Sharma (2011) stated that "offering of more services" is one of the drivers of e-banking adoption by consumers.

To examine the co-diffusion effects between e-banking, e-shopping, e-government, and e-learning we could not find previous literature that report such relationships. However, I present our logic based on temporal, informational, and transactional analysis of those e-services. The importance of the temporal analysis has been presented by Dekimpe, et al (2000) who proposed a new methodology, the coupled-hazard approach, to study the global diffusion of technological innovations. That study states that a country tries an innovation partially and reaches full adoption gradually. That diffusion journey goes through 2 stages; implementation and confirmation stages. The confirmation stage goes through three phases; trial, partial, and complete. According to Dekimpe, et al (2000) the every technology innovation starts its diffusion process in a country with the implementation stage and within a finite time the process reaches the confirmation stage. The confirmation stage take different amount of time to reach its "complete" phase (full adoption) between different countries depending on network externalities that could result in zero duration to complete the confirmation stage. The co-diffusion phenomenon has been presented and explained as network externalities or cross-network effect (Dewan, et al. 2010). Therefore, the temporal analysis could explain the diffusion process of one technology innovation in a country, and the cross-network effect or co-diffusion effect of two or more technology innovations such as e-services. Moreover, the temporal effect has been used to explain the strength direction of a co-diffusion relationship between two technology innovation

by considering that the older technology would have a stronger co-diffusion effect on the newer one than vice-versa as the older becomes the installed-base of the newer (Dekimpe, et al. 2000; Dewan, et al. 2010).

E-shopping's co-diffusion effect on the diffusion of e-banking is unbalanced and particularly it is stronger than the co-diffusion effect of e-banking on the diffusion of e-shopping. From the temporal perspective, even though e-banking and e-shopping services were launched in the same year in 1994 (Kasana & Chaudhary, 2014), but e-banking services were limited geographically and only offered to customers in major cities such as New York City and London (Gandy, 1995). However, e-shopping services were available on a larger scale especially that global businesses were the first to offer them like Pizza Hut, Amazon, and e-bay (Kasana & Chaudhary, 2014). This implies that customers' awareness and use of e-shopping services started before e-banking services because the country adoption process of e-shopping was established before e-banking, which makes e-shopping installation-base effect stronger on e-banking diffusion. From an informational perspective, e-shopping pushes customers to use e-banking simply because consumers who want to shop online or buy a product online can access their e-banking to double check that they got enough money in their account and the purchase will not cause overdraft. From a transactional perspective, before customers e-shop they might want to transfer money from their savings account to their checking account to have enough balance and make sure that their purchase order goes through and do not get rejected by the bank, while avoiding to fall into overdraft and get charged extra fees by the bank. Moreover, e-shopping services became available as part of e-banking services as consumers can find better deals to shop through their bank's website than any other e-retailer website such as flight tickets. This

means if a consumer is not already an e-shopper he or she has less reasons to access and use e-banking and in this case for e-shopping.

H5a: the co-diffusion effect of E-shopping on E-Banking is stronger than the co-diffusion effect of E-Banking on E-shopping.

E-shopping's co-diffusion effect on the diffusion of e-government is unbalanced and particularly it is stronger than the co-diffusion effect of e-government on the diffusion of e-shopping. From a temporal perspective, we could not find any evidence that report the launching of e-government before e-shopping. However, we found evidence of informational type of e-government services availability in Estonia during the same time of e-shopping launching in 1994 (Peedu & Lamas, 2011). But if we think of the usefulness of e-shopping and e-government services, we realize that individuals would have the interest and benefit of using e-shopping services way earlier than e-government services. For example, nowadays kids and teens start using Internet at early age especially to establish online social presence using online social networks such as Facebook. Many of these kids and teens find ads for products that might interest and attract them and lead them to e-shop for products such as video games, movies, toys, electronic devices (e.g., tablets, Xbox, PSP), and other. However, kids have no business to use e-government services at this young age. Therefore, we believe that Internet users develop e-shopping skills and experience that would allow them to be ready and capable to find other informational and transactional e-services such as e-government. Individuals who are searching or seeking e-government services go through the same mechanism of using e-shopping by starting using a search engine to find if their product is available online or where it is available at which retail website or store (e-shopping) as well as if the public service they are seeking is available online or where it is available at which department and in which city (e-government). Referring to Rogers (2003) Diffusion of Innovation theory and in particular to the "previous

experience and compatibility" determinants of consumers' choice of adopting innovations e-government diffusion depends on its compatibility with e-shopping and consumers' previous experience with e-shopping.

Furthermore, the public sector usually follows the private sector's trace especially in the technology innovation and services adoption because governments do not think of citizens in the term of customers, which is the case of the private businesses who seek adopting technologies and innovation to maintain competitive advantage and high revenue (West and Lu 2009). Moreover, countries with high corruption tend to avoid offering their citizens e-government services because it would contribute in lowering corruption and reducing power distance. Therefore, the country adoption process of e-shopping is likely to be established before e-government, which makes e-shopping installation-base effect stronger on e-government diffusion.

H5b: the co-diffusion effect of E-shopping on E-Government is stronger than the co-diffusion effect of E-Government on E-shopping.

E-banking's co-diffusion effect on the diffusion of e-government is unbalanced and particularly is stronger than the co-diffusion effect of e-government on the diffusion of e-banking. Referring to our prior argument in comparing the private sector to the public sector in regard of technology adoption, we believe that banks established electronic presence before governments.

H6: the co-diffusion effect of E-Banking on E-Government is stronger than the co-diffusion effect of E-Government on E-Banking.

E-learning's co-diffusion effect on the diffusion of e-banking, e-shopping, and e-government is unbalanced and particularly is stronger than the co-diffusion effect of e-banking, e-shopping, and e-government on the diffusion of e-learning. From a temporal perspective e-

learning services and particularly distance learning are used at young age for high school or college students who are willing to use other e-services to make their online education possible and successful. Based on Push-Pull Theory, e-learning pushes e-shopping, e-banking, and e-government by pushing students to use e-shopping to purchase items that would help them in their online education such as e-books and online educational software applications, e-banking to pay for their tuition, and e-government to apply for Federal grants, Financial Aid, and Scholarships. Also, students need-pull e-shopping, e-banking, and e-government services to use e-learning services. Based on Rogers (2003) Diffusion of Innovation theory, we believe that the innovativeness of e-learners would reflect their perception of using e-shopping, e-banking, and e-government services to solve or ease problems related to their academic life. From an informational perspective, e-learning users build the skills and capability to learn online, which make them skilled and experienced users to learn e-filing their taxes as it requires learning how to e-file for taxes when using online tax filing services and software applications (e.g., TaxAct and TurboTax).

H7a: the co-diffusion effect of E-Learning on E-Government is stronger than the co-diffusion effect of E-Government on E-Learning.

H7b: the co-diffusion effect of E-Learning on E-Shopping is stronger than the co-diffusion effect of E-Shopping on E-Learning.

H7c: the co-diffusion effect of E-Learning on E-Banking is stronger than the co-diffusion effect of E-Banking on E-Learning.

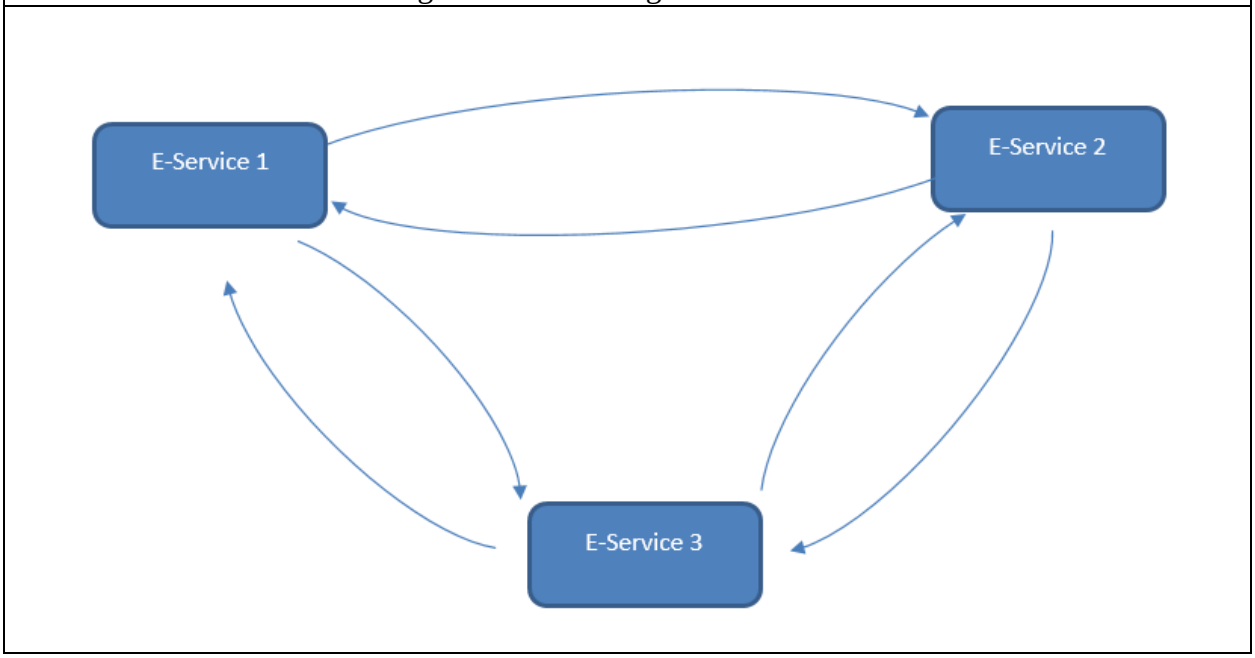
3.3 Mediating Relationships

Co-diffusion relationships between different e-services are not limited to direct relationships, instead I believe that indirect relationships also exist as some e-services mediate other e-services. There is a possibility that the co-diffusion relationship between e-service 1 and e-service 2 is partially mediated by the co-diffusion effect of e-service 3 on the diffusion of both

e-service 1 and e-service 2. Figure 3.3 presents a general representation of the mediating co-diffusion relationships.

Based on the logic presented by the General Systems Theory this dissertation presents the potential co-diffusion mediating relationships. The General Systems Theory presents the system as a set of related objects. In an e-service system some of the objects are imported from another e-service, which make one e-service system function as a sub-system to the second e-service system. An e-service system interacts with its environment by exchanging materials through input-process-output-feedback (Von Bertalanffy, 1950). Those materials represent information (i.e., product or service information, user personal information) and decision making (i.e., conducting transactions). The materials exchange process sequence (input-process-output-feedback) reflects the mechanism of using an e-service where users input information to seek a specific output and make a decision accordingly. Using that mechanism of using e-services like e-shopping, e-banking, e-government, and e-learning I will establish the existence of mediation effects among the co-diffusion of several e-services.

Figure 3.3 Mediating General Model



This study suggests that the co-diffusion relationship between e-learning and e-government is partially mediated by the co-diffusion of two e-services, e-shopping, and e-banking. Best example to explain that mediating relationship would be a citizen seeking to e-file his taxes. First for a citizen to use the e-government service; tax e-filing; he would start by e-learning about tax preparation and filing by downloading or accessing PDF files and documents that include guides and instructions of how to prepare taxes which usually are provided by IRS or private tax advocacy consultants. Second, after the citizen e-learn about tax preparation he would start by e-shopping for online tax preparation service provider. Several providers are available online such as TurboTax and TaxAct. After choosing the tax preparation service provider, a citizen would start by registering at their website to create his username and password. Then for him to e-file, he should get familiarized with the process by e-learning the steps and options (e.g., file single vs married, different types of deductions, etc.), which include e-banking options. E-filing cannot be submitted to IRS for processing before the user decides on using e-banking services in the cases of owing money to the government or receiving money back from it; set up payment method or set up direct deposit respectively.

H8a: The co-diffusion relationship between E-Learning and E-Government is likely to be partially mediated by E-Shopping

H8b: The co-diffusion relationship between E-Learning and E-Government is likely to be partially mediated by E-Banking

This dissertation suggests that the co-diffusion relationship between e-shopping and e-government is partially mediated by the co-diffusion of e-banking. This suggestion is true mostly for the transactional types of e-government services that include financial transactions such as payments – government taxes, city bills, fees for governmental services (e.g., renew ID or DL) – or direct deposit for refunds like tax return, court bond, social security and retirement. As I

mentioned before, citizens start e-shopping for governmental services to find the best product that suites them to conduct the e-government service they seek. For the transactional type of e-government services get processed, they require using e-banking services (Pay or receive payments).

H9: The co-diffusion relationship between e-shopping and e-government is likely to be partially mediated by e-banking

3.4 Factors that may Influence E-Services Co-Diffusion

Consistent with the technology diffusion literature, the technology co-diffusion literature presented the socio-economic and the technology infrastructure as the factors that may influence e-services co-diffusion. Due to the fact that very little research has been done on the co-diffusion of IT products and services (Niculescu and Whang, 2012), I only found two studies that examined co-diffusion in the context of IT products and services – Dewan, et al (2010) and Niculescu and Whang (2012) – but only Dewan, et al (2010) was a cross-country study. Dewan, et al (2010) used the PC unit price, telephone access cost, and per capita GDP – Purchase Power Parity (GDP-PPP) variables to control for the socio-economic factors, while the infrastructural factors – number of PC users and Internet users – were the target variables of the study as its objective was examining the co-diffusion between PC and Internet. As my focus is studying the co-diffusion between different e-services we are using socio-economic and infrastructural factors presented in the e-services diffusion literature. I argue that the factors that may influence e-services co-diffusion are no different than the factors that influence e-services diffusion. In the literature review section I presented the factors that influence e-services diffusion including socio-economic (e.g. education, GNI-PPP) and infrastructural factors (e.g. Internet use, speed,

and security). First, using the empirical support presented by Dewan, et al (2010) that GDP-PPP significantly influences the co-diffusion of two technologies I suggest the following hypothesis:

H10a: GNI-PPP has a significant influence on the co-diffusion effect between E-services

Second, according to the Diffusion of Innovation Theory, education is a socio-economic factor that influences the diffusion of innovations (Rogers, 2003). In the co-diffusion literature education has not been examined. However, Centeno (2004) found that education is an important factor that the development of e-society and e-habits depend on. Different education levels may include training for PC and Internet use and raise students' awareness of different e-services available online (Centeno, 2004). Therefore, the higher the education in a country, the higher the Internet education, and the higher the awareness of different e-services and other technologies available online. Moreover, if an individual is using one e-service and is aware of other available e-services that might influence the individual's use of another complementary e-service. Hence I suggest the following hypothesis:

H10b: Education has a significant influence on the co-diffusion effect between E-services

Third, according to Rogers (2003) Diffusion of Innovation theory Internet access is a major resource for the diffusion of innovations. Also, Internet access and use has been found to significantly influence the diffusion of e-services. However, the co-diffusion literature has not examined its influence on the co-diffusion of different technology innovations. According to Centeno (2004), Internet access and use is the main driver in building or developing the e-society and e-habits. Moreover, the maturity of Internet use develops the positive attitude of consumers towards using technologies such as e-services that are Internet-based technology services, and contribute towards the increase in the numbers of relevant services available online (Centeno, 2004). Nevertheless, Internet access provides consumers with the awareness of different e-

services that are available online (Centeno, 2004). Also, Internet is the common platform between all e-services that make them complementary to each other and result in their co-diffusion (Prescott & Van Slyke, 1997; Van Slyke, et al. 2004). Therefore, I suggest the following hypothesis:

H10c: Internet use has a significant influence on the co-diffusion effect between E-services

Fourth, Internet security has been found to significantly influence the diffusion of e-services. The co-diffusion literature has not examined its influence on the co-diffusion of different technology innovations. However, according to Gupta, et al. (2004) Internet security is more critical and demanded when more online transactions are involved. Johnson (2008) explains that with larger networks and number of users the risk of private personal information leaks increases. Hackers tend to attack systems with large number of users or/and involve large transactions that include personal and financial information (Choi, et al, 2010). In the context of the co-diffusion of e-services, individuals tend to use several complementary e-services systems such as e-shopping, e-banking, and e-government where users have to transact personal information such as social security number, date of birth, ID number, address, and credit card number. The more an e-service system is integrated with other e-services systems, the more the amount of personal information is required in the transaction, and more risk is involved accompanied with more hackers trying to attack such systems. Therefore, I suggest the following hypothesis:

H10d: Internet security has a significant influence on the co-diffusion effect between E-services

Fifth, Internet speed has been found to significantly influence the diffusion of e-services. The co-diffusion literature has not examined its influence on the co-diffusion of different technology innovations. However, when consumers use interacting e-services the amount of

information and graphics is higher than regular individual systems. Too much information and graphics slow down transaction speed (Siu and Mou, 2005), which makes the Internet speed an important factor for the use of interacting e-services. Therefore, I suggest the following hypothesis:

H10e: Internet speed has a significant influence on the co-diffusion effect between E-services

Sixth, payment channels availability has been found to significantly influence the diffusion of e-services (Oxley and Yeung, 2001; Shih, et al, 2005). The co-diffusion literature has not examined its influence on the co-diffusion of different technology innovations. However, Travica (2002) found that payment infrastructure, which includes an effective and widespread credit card system, is one of the infrastructural requirements to support the diffusion of e-services in developing countries. Ayo (2006) reported that the opportunities of e-services in Nigeria are very low because of the lack of the payment infrastructure. Azizi and Javidani (2010) found that one of the major barriers of e-services in Iran is improper payment channels. Oxley and Yeung (2001) found that the country level of e-services activities is determined by the availability of payment mechanisms that facilitate online transactions. Moreover, I believe that without payment channels availability consumers might not be able to shop online, which makes e-shopping strictly an informational service where consumers can look up products and drive to brick-and-mortar stores to buy them. Same case for banks as they might have limited online banking services to check account balance and transfer funds between different accounts. After all, e-banking is less valuable if it does not include different payment channel (i.e., bill payment, e-checks, e-money, smart cards, debit and credit cards). Without the payment channels availability consumers might not perceive several e-services to be related, and thus not perceive higher value of using them. Therefore, I suggest the following hypothesis:

H10f: Payment channels availability has a significant influence on the co-diffusion effect between E-services

As this dissertation is a cross-country study, I found that some variables within the socio-economic factors have never been studied to determine e-services diffusion or technology co-diffusion. First, I suggest that the patent applications reflect one of the socio-economic factors that may influence the co-diffusion of e-services. According to Cohen and Levin (1989), "the quantity of patents is often used to measure national technological advantage" (p. 1063). Second, I suggest that corruption is also one of the socio-economic factors that may influence the co-diffusion of e-services. In the literature of e-services diffusion and in particular the e-government, corruption has been found to be affected by the diffusion of e-government services (Andersen, 2009; Kim, et al, 2009). Also, Benamati and Serva (2007) reported that corruption contributed towards consumers not trusting to use e-banking in developing countries. Therefore, we can imply that e-government diffusion decreases corruption, and lower corruption causes wider and faster diffusion of e-banking. Hence, corruption may influence the co-diffusion between e-government and e-banking. Therefore, I suggest the following hypotheses:

H10g: Patent applications has a significant influence on the co-diffusion effect between E-services

H10h: Corruption has a significant influence on the co-diffusion effect between E-services

3.5 Co-diffusion Moderators

This dissertation is interested in examining the factors that might moderate the co-diffusion between e-services. First, the socio-economic factors include GNI-PPP, education, and corruption.

Polasik & Wisniewski (2009) argue that lower income per capita is a major barrier for e-services diffusion. Also, previous literature found that the wealthier a country is, the faster its IT

diffusion develops (Kolodinsky, et al., 2004; Bagchi, et. al, 2004). Consumers with low income cannot afford buying computers and Internet service, which are the basic and main necessity for the diffusion of e-services. Consumers who could buy a computer and pay for an Internet service might not be able to purchase a fast speed Internet (e.g., broadband). Gerrard et al. (2006) reported that some consumers expressed their concerns for buying a personal computer and pay for Internet connection fee to adopt e-services as they cannot afford them. Internet connection is the platform that e-services share, which is a major condition for e-services to co-diffuse (Prescott & Van Slyke, 1997; Van Slyke, et al. 2004). Therefore, in countries with low income per capita (GNI-PPP) e-services co-diffusion may not exist or the co-diffusion effect could be lower than in wealthy countries (high income per capita).

Researchers also found that economic growth and Internet security are related to each other (Shih, et al, 2005). In the context of this dissertation, economic growth may have an impact on Internet security, which then influences e-services co-diffusion. In general, economic structure has been found to be a major determinant of information system (IS) key issues, which improving information security was found to be the second top issue (Watson, et al. 1997). Also, economic factors have been found to drive the information technology (IT) security (Anderson, 2007). Kenny (2003) reported that only 0.2 % of the secure servers in the world are in low-income countries, which reflects a relationship between the economic growth of a country and its level of Internet security. Based on the aforementioned logic I presented in the previous section that led me to suggest a potential influence of Internet security on e-services co-diffusion, this dissertation implies that in low-income countries Internet security is low, which influences the co-diffusion effect between e-services to be lower than in high-income countries.

Furthermore, poor countries tend to have high corruption levels, which will take us to how much their citizens trust the "other" who they meet face-to-face before they trust dealing with banks electronically, e-vendors or e-retailers. Also, if e-government services tend to reduce corruption (Andersen, 2009; Kim, et al, 2009), corruption affect citizens' trust, and trust affect e-banking and e-shopping adoption. In countries with high corruption, governments tend to avoid offering e-government services or limit them to informational services. Therefore, in such countries e-government may have no co-diffusion effect on other e-services (e.g., e-banking and e-shopping) or low co-diffusion effect in comparison with low corrupted countries. Moreover, as corruption determines the level of consumers' trust in e-services providers, trust determines the availability of related e-services (Centeno, 2004). This makes corruption a socio-economic moderator of the co-diffusion between e-services.

Education and literacy level also can affect the co-diffusion relationship between e-services. Consumers with low education tend to have low knowledge, which is the main condition for the diffusion of a cluster of innovations (Rogers, 2003). Consumers with low education will less likely be interested to learn online (e-learning) and collect knowledge through ICT, or even use the Internet; the platform needed for e-services co-diffusion. They will more likely be blue-collar workers, which as we know they tend to make low income because of cheap labor in poor developing countries (e.g. Bangladesh, Mexico). This brings us back to the previous point in regard to the moderating effect of economy on the co-diffusion of e-services.
H11a: Socio-Economic factors have a moderating effect on the co-diffusion of e-services

Second, infrastructure factors include Internet speed and Internet security. Internet high speed enables customers to explore and manage in a satisfactory way all the features and functions available within e-services adequately, which leads to the co-diffusion of e-services.

Internet speed affects e-services co-diffusion because it affects the speed to download websites' contents (i.e., information, graphics, etc.), which affects the response time after e-interaction. A slow response time leads to delay in service delivery, which makes customers uncertain if the transaction was completed. And, a slow Internet speed on the server's side, affects the upload speed of its website content which affects the quality of the e-service's website and leads to the uncertainty and dissatisfaction of customers. Internet speed determines the usefulness and ease of use in navigating a website, degree of transitions' efficiency (no waiting time), and degree of service availability/service breakdown (Poon, 2007). Furthermore, Brown et al. (2004) argues that the relative advantage of e-services could be improved by faster Internet. However, slow Internet such as telephone line modem was found to discourage Internet users from using e-services (Gerrard, et al, 2006; Polasik & Wisniewski, 2009). Referring to Rogers (2003) diffusion of innovation theory, relative advantage is the core determinant for the diffusion of a cluster of innovations or the co-diffusion of innovations such as e-services.

Al-Wehaibi et al. (2008) examined the barriers of Internet diffusion among faculties in Saudi Arabian universities and found that lack of Internet speed/slow response as the highest rated problem. Moreover, Gerrard et al. (2006) found that consumers who did not subscribe to broadband service, do not access Internet as it would be far too slow for them. Not accessing the Internet platform is a necessary condition for the existence of co-diffusion between e-services. Also, Jochen & Valkenburg (2006) found that adolescents who have fast Internet connections may be more likely to use the Internet for more diverse purposes than the ones with slow Internet connections. Thus, we can conclude that slow internet speed would affect not only the time length consumers spend surfing the Internet, but also the number of activities they conduct online. Therefore, consumers who avoid using the slow internet, and if they do then most likely

they conduct simple tasks such as sending an email, or looking up general information online while avoiding conducting e-transactions. Slow Internet speed causes slow response time, which in turn will cause inconvenient problems such as webpage expiration especially in the case of using interactive e-services as more webpages are used at the same time. This means that more webpages are accessed at the same time which increases the amount of information and graphics downloaded, which in turn requires faster Internet (Siu and Mou, 2005).

In addition to Internet speed, Internet security has been used as an infrastructural measure, and was found to be positively associated with e-services use (Shih, et al, 2005; Cuervo & Menendez, 2006). Also, Internet security has been found to be a major barrier of e-services diffusion (Sathye, 1999; Poon, 2007; Liao & Wong, 2008; Sadeghi & Farokhian, 2010). According to Delone and Mclean IS success model (Delone and Mclean, 2003), information security is positively associated with e-commerce use. Internet security has been an imperative reason for consumers not using e-services that involve sharing their sensitive personal information or financial information (Lee & Turban, 2001; Gummerus et al, 2004). The higher the Internet security, the more the Internet is used for more diverse purposes. Consumers might use e-services as informational medium to search for products and services online (e-shopping or e-government) but never conduct e-transactions such as making payments (e-banking).

Internet access is a critical variable on which e-services diffusion depends (Azouzi, 2009). First, Internet accessibility enables customers to be aware of the services available online. Second, it will allow them to try using them and experience their advantages. E-services awareness, trialability, and relative advantages were found to be major determinants of e-services diffusion (Tan & Teo, 2000; Kolodinsky, et al., 2004; Ndubisi & Sinti, 2006; Hernandez & Mazzon, 2007). Also, several studies found lack of Internet access to be a major obstacle for e-

services diffusion (Gerrard, et al, 2006; Poon, 2007; Polasik & Wisniewski, 2009; Sadeghi & Farokhian, 2010). If an individual has Internet access at work but not at home, he might use the Internet at work to conduct e-banking during lunch break, but he cannot conduct e-services that require time such as e-shopping because it takes the consumer more time to search online for the product he desire and for the best price as well. Without consumers' ability to access the Internet platform, e-services co-diffusion occurrence could be absent or low. Therefore, countries with low Internet access may have no e-services co-diffusion of lower e-services co-diffusion effects in comparison with countries with high Internet access.

H11b: ICT infrastructure factors have a moderating effect on the co-diffusion of E-services

In addition to the socio-economic and infrastructural factors, this dissertation explores the national culture potential moderating effect on co-diffusion of e-services. Culture is basically conceptualized as the shared norms, symbols and values in a social collectivity like a country (Walsham, 2002). Also, Hofstede defined culture as "the collective programming of the mind that distinguishes the members of one group or category of people from another" (Hofstede, 2001; P. 9). National culture has been found as a major factor that explain differences in information technology (IT) growth and level of diffusion (Bagchi, et al, 2004).

The impact of national culture on different IT issues has been the interest of practitioners and researchers who have been studying the relationship between culture and IT, because the understanding of culture is necessary to study IT in a specific country and how social groups interact with it, which can influence its successful use (Straub 1994; Walsham 2002; Leidner & Kayworth, 2006). Two levels of cultures have been studied to understand IT adoption, national culture and organizational culture. However, because this study's objective is to conduct a country-level analysis, it only uses national culture.

People in a specific culture or country would use a technology if they find some fit or match between their values and the values represented by the technology or those responsible for developing it (Leidner & Kayworth, 2006). Studies in Arab countries identified many cultural values that affect the diffusion of IT products such as face-to-face communications, commitment to family and kinship obligations, religion, valuing the past, etc. These cultural aspects work sometimes as facilitators and some other times as barriers for technology transfer and diffusion (Hill, et al., 1998; Straub, et al., 2001). Also, the Arab acceptability of computers as a value is positively related to the Internet usage and the benefit from the information it can provide for information seekers, however, language play the role of a barrier in the case of people who do not read other than Arabic language, especially that the number of Arabic useful websites is limited (Loch, et al., 2003).

Hofstede (1980) developed four dimensions of national culture:

- Individualism/collectivism (IDV): Degree to which people in a culture prefer to act as individuals rather than as members of groups
- Power distance (PD): Degree of inequality among people which the population of a culture considers normal
- Uncertainty avoidance (UA): Degree to which people in a culture feel uncomfortable with uncertainty and ambiguity (risk avoidance v/s risk taking).
- Masculinity/femininity (MAS): Degree to which values like performance, success, and competition prevail among people of a culture over gentler values like the quality of life, and maintaining warm personal relationships (achievement orientation v/s emphasizing relationships and communication).

Hofstede's four cultural dimensions have a significant role in determining how potential users would use IT. Leidner and Kayworth (2006) reviewed the culture in information system researches, and found out that 16 studies investigated national culture's influences on IT adoption, and ten of them used Hofstede's cultural dimensions to describe the relationship between culture and information technology diffusion. Nine of those ten studies used the uncertainty avoidance dimension, seven studies used the power distance dimension, four studies used the individualism-collectivism dimension, and three studies used the masculinity-femininity dimension (Leidner and Kayworth, 2006).

People from cultures with low uncertainty avoidance are excited to try new IT ideas, while people from cultures with high uncertainty avoidance are not willing to adopt and use new technologies because they feel that IT is risky and threatening (Thatcher et al., 2003). For example, at the beginning of the 1990s, people and businesses that have high uncertainty avoidance like in the case of Japan were more into using fax than email, while the opposite was true in the case of people and businesses that have low uncertainty avoidance like Americans (Straub, 1994). Based on a survey conducted with 153 companies across 24 countries, businesses in countries with high uncertainty avoidance were less likely adopting frame relay (IT infrastructure) (Png et al., 2001). Also, a survey conducted with 100 students in the US found that cultural dimensions affect personal innovativeness with information technology, where uncertainty avoidance and power distance had a negative significant influence on personal innovativeness with IT (Thatcher et al., 2003). Moreover, a slow Internet speed will lead to slow response time, which in turn will delay online banking service delivery, which makes customers uncertain if the transaction was completed. Therefore, users with slow Internet speed from cultures with high UA tend to avoid conducting online transactions that involves personal private

information. Furthermore, users who perceive low Internet security and belong to cultures with high UA tend as well to avoid conducting online transactions that involve personal private information.

People from cultures with high power distance are less in need for technology because most of them are dependent on somebody else who have greater power. For example, decisions in organizations are centralized and made by one person or group that have the most power such as the CEO, general manager, stockholder board, etc. At home the decision is made by the household head, which is the husband or the father. So when the father controls the family's financials, then e-services would be a breach for his power and authority. Therefore, using e-services in such cultures is less likely to happen. On the other hand, people from cultures with low power distance are independent; therefore they are more likely to adopt technology because it gives them the power of control. Most of these people are living in nations that have innovative technologies and support technology change. Thus, members of low PD cultures are more likely to use e-services.

People from cultures with low individualism prioritize face-to-face communication in maintaining their personal and professional relationships. However, people from cultures with high individualism prefer electronic communication methods. They tend to adopt technologies transferred from Western nations, especially that they have higher purchasing power, so their rates of computer and Internet users are higher than in the low IDV societies. Thus, e-services diffusion is higher and faster in the high IDV countries than the low IDV countries.

People from cultures with low masculinity use technology to serve personal and professional needs. Such societies have higher rates of women in the workforce, which lead for higher rates of technology diffusion. Also, in most of these societies the rates of poverty and

illiteracy are lower than the societies with high MAS. Therefore, diffusion of e-services is more likely to happen in low masculinity societies or nations (Bagchi, et. al, 2004).

Therefore, according to the technology diffusion literature innovations should diffuse wider and fasters in countries with high individualism and low power distance, uncertainty avoidance and masculinity. However, we believe that the opposite is true in the case of the co-diffusion of e-services because the technology diffusion studies examined the diffusion of one standalone technology. However, in our study we are examining a cluster of e-services, and according to Rogers (2003) consumers perceive higher values of a cluster of related technologies than standalone technology. Moreover, Dewan, et al. (2010) found that the co-diffusion effect is stronger than the innovation effect in developing countries, and the innovation effect is stronger than co-diffusion effect in developed countries. Dewan, et al. (2010) analyzed such findings to be related to the "law of diminishing returns" as new technology adopters would derive higher value from bundled technologies when the benefits exceed the cost. Dewan, et al. (2010) specified that derivation of value from bundled technologies is higher in collectivistic (low individualism) because the benefit of a technology innovation is affecting a household in a collectivistic culture while limited to an individual in an individualistic culture. Therefore, we believe that e-services co-diffusion effect is higher in countries with low individualism.

According to the random utility theory (McFadden 1974) customers choose the product that offers them the highest utility given the relative costs and benefits of the product. According to Xue, et al. (2011), consumers who demand interactive services expect greater total benefits from any service innovation. We believe that in a high power distance and masculinity culture if the head of a household expect greater total benefits from interactive e-services, he would force the rest of the household members to use them to capture even greater benefits. For example, a

husband or a father might force his wife or daughter to shop online to save on their gas spending driving to shopping malls and stores. Also, his wife can have more time to do house work like cooking and cleaning instead of spending hours and days shopping at the mall. Therefore, I believe that e-services co-diffusion effect is higher is countries with high power distance and masculinity.

According to Centeno (2004), consumers who use related e-services and particularly transactional ones gain maturity in Internet use, and Internet mature users have less security concerns. As security concerns are the major uncertainty source for using e-services, I believe that e-services co-diffusion effect is higher is countries with low uncertainty avoidance.

H11c: National culture has a moderating effect on the co-diffusion of E-services

CHAPTER IV

METHODOLOGY

4.1 Data

The data was collected from Eurostat, European Central Bank, Transparency International, and the World Bank. I collected the e-banking, e-shopping, e-government, and e-learning data from Eurostat, which generated the data sets annually based on sample surveys from individuals aged 16 to 74. We collected the payment channels data from the European Central Bank, corruption from Transparency International, and GNI-PPP, Education, Patent, Internet, Speed, and Security from the World Bank. Table 4.1 below presents more detailed description of our variables.

Table 4.1 Variables Description

Variables	Descriptions
E-banking	Percentage of population using e-banking services
E-shopping	Percentage of population purchased online in the last 12 months
E-government	Percentage of population who have used the Internet, in the last 3 months, for interaction with public authorities (i.e. having used the Internet for one or more of the following activities: obtaining information from public authorities web sites, downloading official forms, sending filled in forms).
E-learning	Percentage of population using e-learning services (Doing an online course, Purchased e-book or e-learning materials)
Payment Channels	Number of all cards per million inhabitants (Credit, Debit, e-money)
GNI-PPP	GNI per capita based on purchasing power parity
Corruption	Corruption Perceptions Index (perceptions of corruption in the public sector)
Education	Gross enrolment ratio. Tertiary (ISCED 5 and 6).
Patent	Patent applications ratio per million inhabitants
Internet Use	Internet users (per 100 people)
Internet Speed	Fixed broadband Internet subscribers (per 100 people)
Internet Security	Number of secure servers per million inhabitants

The sample I used in this dissertation is the following European countries (N = 28): Austria, Belgium, Bulgaria, Cyprus, Czech Republic, Denmark, Estonia, Finland, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxemburg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, and United Kingdom. For each country the annual data was between 2003 and 2013 (T = 11). Thus, the total number of observations is N*T = 308 observations. In the process of conducting the power analysis to evaluate if our sample size exceeds the minimum sample size required for GMM applications, I found that to my knowledge there are no reports that specify a minimum sample size in the GMM application. Soto (2009) conducted a study to examine the system GMM estimator with a small sample sizes. According to Soto (2009), "The lack of knowledge about the properties of GMM estimators when N is small renders them a sort of a black box" (P. 2). By applying system GMM estimator on a sample composed of N = 35 and T = 12 and found that the system GMM estimator is still the least biased and most efficient estimator in comparison with OLS, within, level and difference GMM. Soto (2009) did not report a minimum sample size required for system GMM to be a valid estimator. Moreover, when reviewing prior studies that applied GMM we found that Goddard et al. (2004) applied GMM using panel data of 32 Banks from Denmark on a time period of 7 years (N = 32 and T = 7), which is four years less than our study's sample size. Barth and Heimeshoff (2014) applied GMM using panel data of 27 European countries on a time period of 7 years (N = 27 and T = 7), which is one country and 4 years less than our sample. Also, Rahayu and Widodo (2012) applied GMM using panel data of 9 countries on a time period of 5 years (N = 9 and T = 5).

4.2 Longitudinal VS Cross-sectional Analysis

For the purpose of this dissertation and to capture the co-diffusion effect between e-services I used panel data, which is a combination of longitudinal and cross-sectional

observations (N & T). N includes different countries, and T includes several years. Panel data analysis offers a great capacity in modeling the complexity of human behavior in comparison with cross-sectional or time series, which contributed towards the growing number of panel data studies (Hsiao, 2007). According to Hsiao (2007), "Panel data, by blending the inter-individual differences and intra-individual dynamics, have several advantages over cross-sectional or time-series data" (P. 3). These advantages include better accuracy and efficiency of estimates than cross-sectional (T = 1) or time series (N = 1). Panel data helps reducing the selection biasness of the sample under study, and the factors used in the study because it allows the observability of the before and after effects, and the possibility of isolating the effects from other factors affecting the outcome. With panel data we can control for the effect of the omitted variables. According to Hsiao (2007), ignoring the effect of one or more variables in a model specification that might be correlated to explanatory variables is a major reason to find or not find certain effects within a research model. Therefore, with panel data identification comes from information on the inter-temporal dynamics and the individuality of the entities. Moreover, our estimation methods control for the effects of missing or unobserved time-invariant variables and is robust to measurement errors.

Panel data allows uncovering dynamic relationships between variables (Nerlove, 2002), which is something this dissertation seeks uncovering between e-services diffusions as co-diffusion. It also helps to generate more accurate predictions for outcomes by pooling data (Hsiao, 2007). In my sample I pooled data from different countries and several years instead of using only one country's data for several years (time-series) or several countries for one year (cross-section).

4.3 Dynamic Panels Generalized Method of Moments

Dynamic panels GMM has been famously and successfully used in the empirical type of researches for the last decade, and has been widely applied in different topics related to growth (Soto, 2009). I interpret growth in the ICT field as the diffusion of innovation. Therefore, I chose applying GMM to study the co-diffusion effect between e-services. This dissertation is not the first study in the co-diffusion of technology innovations literature that applies GMM, Niculescu and Whang (2009) used GMM to test for the co-diffusion of the wireless voice and data services. They used GMM to maintain consistency by accounting for autocorrelation, heteroscedasticity, and simultaneity of equations, and efficiency by allowing for the errors to be correlated across equations. After all, Arellano and Bond (1999) created GMM estimation particularly for panel data, which is the type of data I chose for this dissertation.

When comparing GMM to other types of estimators (e.g., OLS), the latter raised some concerns in regard to estimation accuracy and efficiency. For example, OLS is used to capture the direct and fixed effect of the regressors (x) on the dependent variable (y) while trying to maximize the explanation of y by developing a model that has the highest R-square. OLS also assumes x as exogenous. However, GMM extends OLS by not only capturing the fixed effect of x on y but also controlling for the dynamic feedback effect of y on x as both are potentially jointly determined. This is particularly the case in the e-services co-diffusion context where we do not know which one determines the other first. The goal from using GMM is to find support that the dynamic relationship (co-diffusion) between x and y is valid. Using panel data, Soto (2009) compared different estimator methods to identify which method provides the best estimation accuracy and efficiency. The results show that the system GMM estimator displayed the lowest bias in comparison with OLS, Within, difference GMM, and level GMM estimators.

4.4 Dynamic Co-diffusion

This dissertation estimates the following dynamic specification to answer whether e-service 1 diffusion increases as e-service 2 diffusion increases:

$$\text{E-service } 1_{it} = \alpha \text{ E-service } 1_{it-1} + \beta \text{ E-service } 2_{it} + \nu_i + \varepsilon_{it} \quad [1]$$

The subscript *i* refers to the country, and *t* to the year, while ν_i captures the time-invariant country-specific effects, and ε_{it} denotes the remaining disturbance. The time-invariant ν_i includes not only country characteristics but also unobservable heterogeneity. I assume that this unobservable can be government projects such as dedicating budget to develop better IT infrastructure (e.g., faster Internet, secure Internet), developing new and advanced mailing system and creating organized physical addresses grid, approving new e-commerce laws to organize online transactions and protect online users privacy.

To obtain consistent estimates of the coefficient of interest that reflect the effect of E-service 2 on E-service 1, it is critical to make the right specification and the assumption on the contemporaneous correlation between E-service 2_{it} and ε_{it}. For example, despite the fact that the lagged dependent variable is not of direct interest, including the autoregressive term allows for the presence of dynamics in the underlying process. This will consider the possibility that correlation between E-service 1 and E-service 2 may reflect a dynamic common driving force. I argue that E-service 2 might be affected by previous levels of E-service 1; hence I will treat E-service 2_{it} as endogenous. Maintaining that the error terms ε_{it} are serially uncorrelated, E-service 2*it* is endogenous in the sense that it must not be correlated with future shocks, while allowing it to be correlated with contemporaneous ε_{it} and previous shocks ε_{it-1}.

$$\begin{aligned} &E\,(\text{E-service } 2_{is}\varepsilon_{it}) = 0,\ s < t \\ &\qquad\qquad \text{For all } i \\ &E\,(\text{E-service } 2_{is}\varepsilon_{it}) \neq 0,\ s \geq t \end{aligned} \quad [2]$$

Serially uncorrelated disturbances mean that the error term ε_{it} corresponds to the unexpected changes or the random part of E-service 1 diffusion, and previous unexpected changes in E-service 1 diffusion cannot be used to predict future unexpected changes.

To allow for the dynamic feedback between E-service 1 and E-service 2, and to obtain consistent estimates of the coefficient of interest β Holtz-Eakin *et al*. (1988) and Arellano and Bond (1991) proposed the difference GMM estimator. The difference GMM estimator takes the first differences of Equation 1 to eliminate the unobserved time-invariant country-specific characteristics ν_i as Equation 3 shows:

$$\Delta \text{ E-service } 1_{it} = \alpha \, \Delta \text{ E-service } 1_{it-1} + \beta \, \Delta \text{ E-service } 2_{it} + \Delta \, \varepsilon_{it} \qquad [3]$$

To estimate Equation 3 using GMM we need a vector W of instruments to construct the moments $E(\Delta\varepsilon_{it}W)$. Under the assumptions that E-service 2_{it} is endogenous and disturbances ε_{it} are serially not correlated, E-service 1_{it-2} and E-service 2_{it-1} and earlier lags are valid instruments.

Blundell and Bond (1998) call attention to a statistical shortcoming with the difference GMM estimator. If E-service 1 and E-service 2 are persistent over time, lagged levels of these variables are weak instruments for the equation in first differences. Therefore, I combine Equations 1 and 3 and use the system GMM estimator proposed by Blundell and Bond (1998).

As this dissertation goal is to capture the co-diffusion effect between e-services where the diffusion of E-service 1 and E-service 2 affect each other, same specifications and assumptions I presented above apply when E-service 2 is the dependent variable and E-service 1 is the independent variable. The Equations are:

$$\text{E-service } 2_{it} = \alpha \text{ E-service } 2_{it-1} + \beta \text{ E-service } 1_{it} + \nu_i + \varepsilon_{it} \qquad [4]$$

$$E\,(\text{E-service } 1_{is}\varepsilon_{it}) = 0, \; s < t$$
$$\text{For all } i \qquad [5]$$
$$E\,(\text{E-service } 1_{is}\varepsilon_{it}) \neq 0, \; s \geq t$$

$$\Delta \text{ E-service } 2_{it} = \alpha \Delta \text{ E-service } 2_{it-1} + \beta \Delta \text{ E-service } 1_{it} + \Delta \varepsilon_{it} \quad [6]$$

4.5 Modeling Mediators

To test the mediation hypotheses I augment the specifications above while keeping the assumptions on the error term and instruments. I simply added a third e-service as a regressor and treated it as endogenous as well. The level and difference GMM equations are:

$$\text{E-service } 1_{it} = \alpha \text{ E-service } 1_{it-1} + \beta_1 \text{ E-service } 2_{it} + \beta_2 \text{ E-service } 3_{it} + \nu_i + \varepsilon_{it} \quad [7]$$

$$\Delta \text{ E-service } 1_{it} = \alpha \Delta \text{ E-service } 1_{it-1} + \beta_1 \Delta \text{ E-service } 2_{it} + \Delta \beta_2 \text{ E-service } 3_{it} + \Delta \varepsilon_{it} \quad [8]$$

4.6 Modeling Country-Level Variables

To test the hypotheses related to the factors that may influence e-services co-diffusion the same specifications and assumptions presented above. I simply added a control variable (i.e., GDP-PPP, Education, Internet access, Internet speed, Internet security, Corruption, and Patent applications) as a regressor and treated it as exogenous. The level and difference GMM equations are:

$$\text{E-service } 1_{it} = \alpha \text{ E-service } 1_{it-1} + \beta_1 \text{ E-service } 2_{it} + \beta_2 \text{ CV}_{it} + \nu_i + \varepsilon_{it} \quad [9]$$

$$\Delta \text{ E-service } 1_{it} = \alpha \Delta \text{ E-service } 1_{it-1} + \beta_1 \Delta \text{ E-service } 2_{it} + \Delta \beta_2 \text{ CV}_{it} + \Delta \varepsilon_{it} \quad [10]$$

To validate the causality relationships that reflect the co-diffusion of different e-services I will use the Sargan test and Arrellano and Bond serial correlation test as both are widely used to test if the assumptions of GMM hold. Sargan test validates the instrument list by indicating if the over-identifying restrictions are valid, while the Arrellano and Bond test indicates if the no first-order serial correlation in the residuals assumption is met (Blundell, et al. 2000).

4.7 Moderator Testing Technique

To test for the moderation effect, I applied a multi-group analysis using cluster analysis. Cluster analysis has been applied in previous IS studies to compare results among different

groups of countries (Cyr, 2013). A cluster analysis is a group of multivariate techniques whose primary purpose is to group objects (e.g., countries) based on the characteristics they possess. Clustering methods are widely used among several disciplines such as psychology, biology, sociology, economics, engineering, and business. Clustering methods are a classification according to relationships among objects being clustered. The first advantage of using cluster analysis in research studies is the ability to reduce the data and create meaningful groups out of it. For example, in this dissertation data were reduced from 28 European countries to two clusters or groups. Furthermore, this paper used both hierarchical and non-hierarchical (K-means) cluster analysis to exploit the advantages of both techniques as suggested by Ketchen and Shook (1996). In the hierarchical clustering technique, I used Ward's partitioning method and squared Euclidean distance to determine the most suitable number of clusters. While, the K-means clustering technique was used to assign each country to a cluster. The number of clusters was identified based on the greatest increase in the agglomeration coefficient.

CHAPTER V

RESULTS AND DISCUSSION

5.1 Results

Before testing research hypotheses with system GMM, it is necessary to examine the moment conditions validity test results and second-order serial correlation in the first-difference residuals test results. This dissertation used the Sargan test for over identifying restrictions to test the validity of the moment conditions, and the Arrellano and Bond serial correlation test to test for the second-order serial correlation in the first-difference residuals. The null hypothesis in the Sargan test is that the errors in the first-difference regression exhibit no significant second-order serial correlation as a sign for valid model specification. The null hypothesis in the Arrellano and Bond serial correlation test is that the instruments are not significantly correlated with the residuals, which is a required assumption.

The results of the Sargan test did not reject the null hypothesis as the p-value is larger than 0.05, indicating that the over-identifying restrictions are met, and the moment conditions are valid. Also, the results of the Arrellano and Bond serial correlation test did not reject the null hypothesis due to the large p-value, which indicate that first-order serial correlation is not significant. The results applied to every research hypothesis tested, and therefore, there is no significant evidence of model misspecification. I present robustness results in Appendix A.

5.1.1 Co-diffusion Results

The co-diffusion results presented in Table 5.1 showed that the co-diffusions among e-banking, e-shopping, e-government, and e-learning were highly significant, which supported the

co-diffusion hypotheses (H_{1abc} – H_{4abc}). Also, the results showed that most co-diffusions were unbalanced. In addition to comparing the coefficients Beta of the independent variables to identify which e-service has stronger co-diffusion effect on the other, this study squared the coefficient Beta. Squaring the coefficient Beta is applied to get the explanatory utility and influential strength of an independent variable on a dependent variable (Clemente and Kleiman, 1977). E-shopping co-diffusion effect on e-banking ($.3038^2 = .0924$) was almost twice as strong as the co-diffusion effect of e-banking on e-shopping ($.2348^2 = .0552$), which supported H_{5a}. E-shopping co-diffusion effect on e-government ($.4675^2 = .2185$) was much stronger than the co-diffusion effect of e-government on e-shopping ($.1697^2 = .0287$), which supported H_{5b}. E-banking co-diffusion effect on e-government ($.6048^2 = .3657$) was much stronger than the co-diffusion effect of e-government on e-banking ($.1557^2 = .0242$), which supported H_6. E-learning co-diffusion effect on e-banking ($.1982^2 = .0392$) was almost three times as stronger than the co-diffusion effect of e-banking on e-learning ($.1366^2 = .0186$), which supported $H_{7a.}$ E-learning co-diffusion effect on e-shopping ($.3021^2 = .0912$) was almost twice as stronger than the co-diffusion effect of e-shopping on e-learning ($.2376^2 = .0564$), which supported H_{7b}. E-learning co-diffusion effect on e-government ($.8694^2 = .7558$) was much stronger than the co-diffusion effect of e-government on e-learning ($.0941^2 = .0088$), which supported H_{7c}.

Table 5.1 Co-diffusion results

IV\DV	E-Banking	E-Shopping	E-Government	E-Learning
E-Banking		.2348 ***	.6048 ***	.1366 ***
E-Shopping	.3037 ***		.4675 ***	.2376 ***
E-Government	.1557 ***	.1697 ***		.0941 ***
E-Learning	.1982 ***	.3021 ***	.8694 ***	

Note: IV: Independent variables; DV: Dependent variables; significance level: *** - $p<0.01$

5.1.2 Mediation Results

According to Mckinnon, et al. (2000), to identify a mediation effect of a third variable (Z) on a relationship between an independent variable (X) and dependent variable (Y), the coefficient Beta of X after Z is added should be closer to zero than the coefficient alpha of X in the original equation before Z is included. Moreover, both alpha and beta should share similar sign to indicate mediation (Mckinnon, et al. 2000).

The results in Table 5.2 indicate a mediation in the co-diffusion relationship between e-learning and e-government.

Table 5.2 Mediation of the co-diffusion between E-learning and E-government

IV\DV	E-Government	E-Government	E-Government	E-Learning	E-Learning	E-Learning
E-Banking		.5762 ***			.1114 ***	
E-Shopping			0.4506 ***			.2555 ***
E-Government				.0941 ***	.0396 ***	.0441 ***
E-Learning	.8694 ***	.1185 ***	.0996 ***			

Note: IV: Independent variables; DV: Dependent variables; significance level: *** - $p<0.01$

In the original co-diffusion equation the coefficient of e-learning co-diffusion effect on e-government is 0.86. After adding the third variable e-banking to the co-diffusion equation the coefficient of e-learning dropped to 0.11. After adding the third variable e-shopping to the co-diffusion equation the coefficient of e-learning dropped to 0.09. On the other hand, in the original co-diffusion equation the coefficient of e-government co-diffusion effect on e-learning is 0.09. After adding the third variable e-banking to the co-diffusion equation the coefficient of e-learning dropped to 0.03. After adding the third variable e-shopping to the co-diffusion equation the coefficient of e-learning dropped to 0.04. The coefficient of the independent variable in the original co-diffusion equation shares same sign with the coefficient of the independent variable after adding the third variables; e-banking and e-shopping. Also, the coefficient of the independent variable decreased as a result of including third variables in the co-diffusion

equation. According to MacKinnon, et al. (2000), this indicates that e-banking and e-shopping are mediators of the co-diffusion relationship between e-learning and e-government and vice-versa. This supports both hypotheses H_{8a} and H_{8b}.

The results in Table 5.3 indicate a mediation in the co-diffusion relationship between e-shopping and e-government.

Table 5.3 Mediation of the co-diffusion between E-shopping and E-government

IV\DV	E-Shopping	E-Shopping	E-Government	E-Government
E-Banking		.2464 ***		.5654 ***
E-Shopping			.4675 ***	.0562 ***
E-Government	.1697 ***	.0992 ***		

Note: IV: Independent variables; DV: Dependent variables; significance level: *** - $p<0.01$

In the original co-diffusion equation the coefficient of e-shopping co-diffusion effect on e-government is 0.46. After adding the third variable e-banking to the co-diffusion equation the coefficient of e-shopping dropped to 0.05. On the other hand, in the original co-diffusion equation the coefficient of e-government co-diffusion effect on e-shopping is 0.16. After adding the third variable e-banking to the co-diffusion equation the coefficient of e-government dropped to 0.09. The coefficient of the independent variable in the original co-diffusion equation shares same sign with the coefficient of the independent variable after adding the third variable e-banking. Also, the coefficient of the independent variable decreased as a result of including third variables in the co-diffusion equation. According to Mckinnon, et al. (2000), this indicates that e-banking mediates the co-diffusion relationship between e-shopping and e-government and vice-versa. This supports hypothesis H_9.

5.1.3 Factors Affecting E-Services Co-Diffusion Results

The results in Tables 5.4 to 5.7 show the country-level factors affecting the co-diffusion of e-services. The results show that education, GNI-PPP, payment channels, Internet use, Internet speed and Internet security are positively associated with the co-diffusion relationships

between e-banking, e-shopping, e-government, and e-learning. On the other hand, corruption is negatively associated with the co-diffusion of e-services. Only patent applications did not have a significant effect on e-services co-diffusion.

Table 5.4 Factors Affecting Co-diffusion of E-shopping on E-services

Covariate	E-Banking	E-Government	E-Learning
Patent	.0276 (.1522)	.0556*** (.5557 ***)	-.0061 (.2604 *)
Education	.01669 *** (.2051 ***)	.1272 *** (.4431 ***)	.0252 ** (.2286 ***)
Corruption	-.3203 *** (.2129 ***)	-.4689 *** (.4731 ***)	-.0834 *** (.2389 ***)
GNI-PPP	.0002 *** (.1892 ***)	-.0002 (.5123 ***)	.00005 ** (.2519 ***)
Internet use	.2317 *** (.0477 ***)	.1723 *** (.3431 ***)	.0689 *** (.2954 ***)
Internet Speed	.1155 * (.1580 ***)	.0976 *** (.5213 ***)	.0376 * (.2503 ***)
Internet Security	.0024 * (.1850 ***)	.0026 *** (.3971 ***)	.0005 *** (.2472 ***)
Payment Channels	1.6322 *** (.1589 ***)	3.0687 *** (.5119 ***)	.3783 *** (.2327 ***)

Note: In parentheses are E-Shopping coefficients; Significance level: *- $p<0.10$, **- $p< 0.05$, and *** - $p<0.01$

Table 5.5 Factors Affecting Co-diffusion of E-government on E-services

Covariate	E-Banking	E-Shopping	E-Learning
Patent	.0191 (.1371)	.0231 *** (.1197)	-.0028 (.1047 **)
Education	.0369 *** (.1547 ***)	.0392 *** (.1659 ***)	.0071 * (.0998 ***)
Corruption	-.8171 *** (.1181 ***)	-.0895 *** (.1047 ***)	-.5514 *** (.0953 ***)
GNI PPP	.00008 *** (.1494 ***)	.00006 *** (.1611 ***)	-.00001 (.1031 ***)
Internet use	.2642 *** (.1284 ***)	.3772 *** (.1538 ***)	.0941 *** (.0548 ***)
Internet Speed	.0208 *** (.1593 ***)	.0964 *** (.1659 ***)	.0475 *** (.1001 ***)
Internet Security	.0023 * (.1635 ***)	.0039 * (.1763 ***)	.0012 *** (.0995 ***)
Payment Channels	2.8737 *** (.1611 ***)	.7751 *** (.1686 ***)	1.5483 *** (.0849 ***)

Note: In parentheses are E-Gov coefficients; Significance level: *- p<0.10, **- p< 0.05, and *** - p<0.01

Table 5.6 Factors Affecting Co-diffusion of E-learning and E-banking

Covariate	E-Banking	E-Shopping	E-Government
Patent	.0272 (-.0399)	.0251 (.5102)	.0359 (.9856 ***)
Education	.0261 *** (.2141 ***)	.0153 *** (.4043 ***)	.2374 *** (.8791 ***)
Corruption	1.2129 (.0413 ***)	-.0817 *** (.5234 ***)	.8714 (.8688 ***)
GNI PPP	.0001 *** (.1848 ***)	.0002 *** (.4649 ***)	-.0001 (.9089 ***)
Internet use	.2581 *** (.1511 *)	.3851 *** (.5894 ***)	.2966 *** (.5379 ***)
Internet Speed	.1789 ** (.1945 ***)	.0926 *** (.3327 ***)	.1753 *** (.6863 ***)
Internet Security	.0028 ** (.0923 ***)	-.0042 (.7548 ***)	.0023 *** (.7328 ***)
Payment Channels	1.0164 *** (.2162 ***)	1.3766 *** (.4258 ***)	1.1475 (.8443 ***)

Note: In parentheses are E-Learning coefficients; Significance level: *- p<0.10, **- p< 0.05, and *** - p<0.01

Table 5.7 Factors Affecting Co-diffusion of E-banking and E-shopping			
Covariate	E-shopping	E-government	E-Learning
Patent	.0239 (.3058)	-.0152 (.6146 ***)	.0017 (.1202)
Education	.0084 *** (.2376 ***)	.0581 *** (.6077 ***)	.0248 *** (.1216 ***)
Corruption	.8727 (.2554 ***)	-.6642 *** (.6125 ***)	-.2675 ** (.1119 ***)
GNI PPP	.0001 *** (.2202 ***)	-.00007 (.6051 ***)	.00003 *** (.1149 ***)
Internet use	.3061 *** (.1314 ***)	.1267 *** (.5988 ***)	.0618 *** (.0832 ***)
Internet Speed	.1422 *** (.2768 ***)	-.1536 (.6954 ***)	.0291 * (.1422 ***)
Internet Security	.0032 ** (.3402 ***)	.0033 *** (.6041 ***)	.0003 * (.1283 ***)
Payment Channels	1.0774 *** (.2512 ***)	1.3714 *** (.6067***)	.6819 *** (.1237 ***)

Note: In parentheses are E-Banking coefficients; Significance level: *- p<0.10, **- p< 0.05, and *** - p<0.01

In the research development chapter this study suggested one hypothesis per country-level variable. However, every hypothesis was tested in 12 different co-diffusion equations. Therefore, we counted the number of co-diffusion equations where the country-level factor was significant and divided it by the total number of co-diffusion equations to come up with the percentage of significance. The summary in Table 5.8 shows the country-level factors association level significance. The results indicate a strong support for hypotheses H_{10a}, H_{10b}, H_{10c}, H_{10d}, H_{10e}, H_{10f}, H_{10g}, and H_{10h}.

Table 5.8 Country-level Factors Summary					
	Not Significant	Significant	Total	Percentage of Significance	Hypothesis Support
Patent	10	2	12	16%	None
Education	0	12	12	100%	Very Strong
Corruption	3	9	12	75%	Strong
GNI PPP	4	8	12	67%	Moderate
Internet use	0	12	12	100%	Very Strong
Internet Speed	1	11	12	92%	Very Strong
Internet Security	1	11	12	92%	Very Strong
Payment Channels	1	11	12	92%	Very Strong

Note: Percentage of significance ≥ 90%: very strong hypothesis support
Percentage of significance 70% - 89%: strong hypothesis support
Percentage of significance 50% - 69%: moderate hypothesis support
Percentage of significance < 50%: marginal hypothesis support

5.1.4 Moderating Results

The results of the cluster analysis indicated a two cluster solution using the socio-economic factors (i.e., Education, Corruption, and GNI-PPP) as the clustering variables. The resulting clusters 1 and 2 contained 11 and 17 cases (countries), which corresponded to 39.28% and 60.27 % respectively. Table 5.9 shows that cluster 1 contained the countries of better socio-economic conditions in terms of education and GNI-PPP, and lower corruption, in contrast to cluster 2 (i.e. lower education and GNI-PPP, and higher corruption).

Table 5.9 Socio-economic Clusters

	Cluster 1	Cluster 2
Education	72.79	57.99
GNI-PPP	58130.00	13700.00
Corruption	8.60	3.60

Table 5.10 Socio-economic Moderating Results

IV\DV	E-Banking	E-Shopping	E-Government	E-Learning
E-Banking		.4214***/2114***	.6071***/.5556***	.1225**/.1262***
E-Shopping	.1907***/.0009		.5623***/.3122***	.2712***/.1691***
E-Government	.0613***/.0106	.2532***/.0273**		.0724***/.1388***
E-Learning	.1182***/.0323	.8201***/.5406***	1.2426***/1.1737***	

Note: On the left and right sides of each slash '/' are Cluster 1 and Cluster 2 estimates respectively; significance level: *- p<0.10, **- p< 0.05, and *** - p<0.01

The socio-economic moderating results in Table 5.10 show that the co-diffusion effects between e-services tend to be stronger in countries characterized with high education and GNI-PPP, and low corruption (cluster 1) than cluster 2 countries. This indicate a strong support for hypothesis H_{11a}. However, two exceptions indicate no support to that hypothesis. First, the co-diffusion effect of e-banking on e-learning was almost the same in both clusters. Second, the co-diffusion effect of e-government on e-learning was stronger in cluster 2 than it was in cluster 1.

The results of the cluster analysis indicated a two cluster solution using the ICT infrastructural factors (i.e., Internet use, Internet speed, and Internet security) as the clustering

variables. The resulting clusters 1 and 2 contained 9 and 19 cases (countries), which corresponded to 32.14% and 67.86 % respectively. Table 5.11 shows that cluster 1 contained the countries that had much better ICT infrastructures in terms of Internet use, Internet speed, and Internet security, in comparison to cluster 2.

Table 5.11 ICT Infrastructure Clusters

	Cluster 1	Cluster 2
Internet Speed	33.42	13.86
Internet Security	2524.83	39.84
Internet Use	93.39	39.93

Table 5.12 ICT Infrastructure Moderating Results

IV\DV	E-Banking	E-Shopping	E-Government	E-Learning
E-Banking		.0531***/.1685	.4456***/.5227***	.0591***/.1346
E-Shopping	.3342***/.0911***		.3759***/.4943***	.2378***/.1893***
E-Government	.2489***/.1555***	.1795***/.0242		.0956***/.0485***
E-Learning	.2273***/.1196	.8771***/.5944***	.6774***/.8448***	

Note: On the left and right sides of each slash '/' are Cluster 1 and Cluster 2 estimates respectively; significance level: *- p<0.10, **- p< 0.05, and *** - p<0.01

The ICT infrastructure moderating results in Table 5.12 show that the co-diffusion effects between e-services tend to be stronger in countries characterized with high Internet use, Internet speed, and Internet security (cluster 1) than cluster 2 countries. This indicates a strong support for hypothesis H_{11b}. However, three exceptions in Table 14 indicate no support to that hypothesis including the co-diffusion effects of e-banking, e-shopping, and e-learning on e-government as they are stronger in cluster 2 than cluster 1.

The results of the cluster analysis indicated a two cluster solution using Hofstede's four cultural measures as the clustering variables. The resulting clusters 1 and 2 contained 15 and 13 cases (countries), which corresponded to 53.57% and 46.43 % respectively. The profiles in Table 5.13 show that cluster 1 characterized cultures of low power distance, masculinity, and

uncertainty avoidance, and high individualism, whereas cluster 2 represented cultures of high power distance, masculinity, and uncertainty avoidance, and low individualism.

Table 5.13 Culture Clusters

	Cluster 1	Cluster 2
PDI	18.00	104.00
IDV	74.00	52.00
MAS	16.00	110.00
UAI	23.00	51.00

Table 5.14 Culture Moderating Results

IV\DV	E-Banking	E-Shopping	E-Government	E-Learning
E-Banking		.0691/.5321***	.6311***/.3716***	.0491**/.2273***
E-Shopping	.2063***/.2516***		.3449***/.4406***	.2474***/.2438***
E-Government	.1143***/.2406***	.0245/.3267***		.0461***/.1671***
E-Learning	.0109/.4415***	.4719***/1.4866***	.6453***/1.4095***	

Note: On the left and right sides of each slash '/' are Cluster 1 and Cluster 2 estimates respectively; significance level: *- p<0.10, **- p< 0.05, and *** - p<0.01

The culture moderating results in Table 5.14 show that the co-diffusion effects between e-services tend to be stronger in countries characterized with high power distance, uncertainty avoidance and masculinity, and low individualism (cluster 2) than in countries otherwise characterized (cluster 1). This indicates a strong support for hypothesis H_{11c}. However, two exceptions indicate no support to that hypothesis. First, the co-diffusion effect of e-shopping on e-learning seems to be equal in both clusters. Second, the co-diffusion effect of e-banking on e-government is stronger in cluster 1 than cluster 2.

Hypotheses $H_{1a} – H_{4c}$ suggested the existence of pairing co-diffusions among e-banking, e-shopping, e-government, and e-learning where every pair of e-services co-diffuse together. The results indicate a highly significant co-diffusion effect between every pairs of e-services. Moreover, the co-diffusion of each pair of e-services was highly significant as well ($H_{5a} – H_{7c}$). This study added to the paired e-services co-diffusion equation a third e-service to examine the

potential mediation effect of one e-service on the co-diffusion of pairs of e-services. The mediation hypotheses H_{8a}, H_{8b}, and H_9 suggested that one or more e-services partially mediate the co-diffusion of paired e-services. The mediation results indicate highly significant mediation effect among paired e-services.

This dissertation added country-level factors to the paired e-services co-diffusion equations to examine their effects on the co-diffusion among e-services. The results of hypotheses H_{10a} – H_{10h} varied between not significant (Patent), moderately significant (GNI-PPP), significant (Corruption) and highly significant (Education, Internet use, Internet speed, and Internet security). In addition, hypotheses H_{11a}, H_{11b}, and H_{11c} that suggested a moderating effect of socio-economic, ICT infrastructure, and national culture on the co-diffusion of e-services were found significant.

5.2 Discussion

According to Bucklin and Sengupta (1993) co-diffusion is "the positive interaction between the demands for complementary innovations that have separate adoption tracks" (P. 149). The research hypotheses of this dissertation regarding the co-diffusion effects among e-services (i.e., e-banking, e-shopping, e-government, and e-learning) are consistent with Bucklin and Sengupta (1993) definition of co-diffusion. The results confirm the positive interactions among the demands for e-banking, e-shopping, e-government, and e-learning, when each one of them has a separate adoption track. These results answered clearly one of this dissertation's research questions by confirming the existence of the co-diffusion associations between different e-services.

Rogers (1995) discussed the diffusion of innovations by examining standalone innovations or a cluster of related innovations. According to Rogers (1995), related innovations

are typically perceived as interrelated bundle of new ideas, rather than viewing them separately. This led him to define a technology cluster as "one or more distinguishable elements of technology that are perceived as being closely interrelated" (Rogers, 1995, p. 235). This dissertation's co-diffusion results present an empirical support and validation to Rogers (1995) cluster diffusion theory. This suggests that users perceive e-services closely-related to one another; when people adopt and use one e-service, they have the natural tendency to get exposed to other related e-services and use them.

This dissertation extended the objectives of prior technology co-diffusion studies listed in Table 1 to examine the strength direction of the co-diffusion relationships between e-services. Following the recommendations of Dekimpe, et al. (2000) and Dewan, et al. (2010), this dissertation used the temporal effect to distinguish which e-service is installed or used before the other to identify the installed-base e-service (older) for every e-service (newer). The results show that e-learning has stronger co-diffusion effect on other e-services, which indicate that e-learning tend to be the installed-base e-service to e-shopping, e-banking, and e-government. E-shopping has stronger co-diffusion effect on e-banking and e-government, which indicate that e-shopping tend to be the installed-base e-service to e-banking and e-government. E-banking has stronger co-diffusion effect on e-government, which indicates that e-banking tends to be the installed-base e-service to e-government. These results answered one of this study's research questions by disclosing that co-diffusion relationships among most e-services are rather unbalanced than balanced. The findings also suggest the following adoption and use order of e-services: e-learning-e-shopping-e-banking-e-government.

According to West and Lu (2009) the private sector tends to adopt technology innovation before the public sector. This study's results presented an empirical support to this latent

statement as the co-diffusion effect of e-services from the private sector (i.e., e-banking, e-shopping, and e-learning) on the public sector's e-service; e-government were much stronger than the co-diffusion effect of e-government on e-banking, e-shopping, and e-learning.

Prior technology co-diffusion studies listed in Table 1 limited their focus on identifying co-diffusion between a pair of innovations. This dissertation extends their work by examining four innovations, which allowed us to identify mediation effects within the co-diffusion relationships. The results indicate that the co-diffusion between e-learning and e-government is partially mediated by their co-diffusion with e-shopping and e-banking. These results suggest that e-shopping and e-banking facilitate the co-diffusion between e-learning and e-government. E-learning users such as students can use e-shopping services to shop for e-government services such as financial aids. E-government users such as tax e-filers can use e-shopping services to shop for e-learning products such as TurboTax tax preparation applications. Similarly, e-learning users such as students can use e-banking services to pay for e-government services. E-government users such as tax e-filers can use e-banking services to pay for e-learning services.

The results also indicate that the co-diffusion between e-shopping and e-government is partially mediated by their co-diffusion with e-banking. These results suggest that e-banking facilitates the co-diffusion between e-shopping and e-government. E-shopping users can use e-banking services to conduct e-government services transactions such as paying or receiving money from e-filing tax return. These results present an empirical support and validation for the General Systems Theory by suggesting that e-services systems act as sub-systems to other e-services. A system interacts with its environment (input-process-output-feedback) through another complementary system's environment. For example, shopping online for e-government services requires inputting in the e-shopping system to find the available e-government services

(e.g., tax preparation software), processing payments in the e-banking system, and outputting e-government services access to conduct online transactions (e.g., e-file taxes).

The literature of technology co-diffusion listed in Table 1 shows only two studies conducted a cross-country examination of the co-diffusion phenomenon. However, only Dewan, et al. (2010) examined one country-level factor's effect on the co-diffusion of PC and Internet; GDP-PPP. This dissertation went beyond any prior co-diffusion study's objective by investigating several country-level factor's effect on the co-diffusion of e-services. I examined the effect of socio-economic factors (i.e., patent applications, education, GNI-PPP, and corruption), and ICT infrastructure factors (i.e., payment channels, Internet use, Internet speed, and Internet security) on the co-diffusion of e-banking, e-shopping, e-government, and e-learning.

The results (Table 5.8) suggest that all the aforementioned country-level factors but "patent applications" have significant association with the co-diffusion relationships among e-services. This answers one of this study's research questions on determining the factors that may influence the co-diffusion of e-services at the country level. In comparison between all the aforementioned country-level factors, only the GNI-PPP factor has a moderate significant effect on the co-diffusion between e-services, which could be resulted from this study's economical homogenous European country sample that consists of a majority of medium to high income per capita countries. Internet use and payment channels factors have the highest impact on the co-diffusion of all the e-services examined in this study, which is not surprising since e-services are part of Internet use, and payment channels are the infrastructure required to facilitate online transactions and support the diffusion of e-services (Oxley & Yeung, 2001; Travica, 2002). However, the co-diffusion effects were found to have stronger effect than the country-level

factors effects, which indicate that the existence of related innovations may be more crucial to the diffusion of e-services than socio-economic and ICT infrastructural factors.

The country-level socio-economic and ICT infrastructural factors association with e-services co-diffusion indicate the importance of these factors in driving the co-diffusion of e-services but do not present a clear understanding on how they affect the co-diffusion of e-services. Therefore, this dissertation examined the moderating effects of these factors on the co-diffusion of e-services. I also examined the moderating effect of national culture of the co-diffusion of e-services especially that a prior co-diffusion study found that the co-diffusion effect between technologies differs between different cultures (Dewan, et al. 2010).

The socio-economic moderating results indicate that the co-diffusion effects between e-services tend to be stronger in countries characterized with high education and GNI-PPP, and low corruption. Consumers who are not educated are more than likely have low computer and Internet literacy. Consumers who have low income are more than likely unable to afford purchasing a computer or Internet service. Consumers in high corruption countries are more than likely lacking trust in the e-service providers. Therefore, in countries with low education and GNI-PPP, and high corruption, it is less than likely for consumers to perceive e-services as related innovations, which results in lower usefulness perception of e-services as standalone innovations to adopt and use. In countries with low education and GNI-PPP, and high corruption the co-diffusion effect is lower than in the opposite countries, which explains the slow diffusion of e-services in many countries especially developing ones. Thus, this co-diffusion study presented new knowledge about the diffusion of e-services that the diffusion of technology literature lacked on presenting as their focus was on identifying the determinants of the diffusion

without taking into consideration the co-diffusion effect with related innovations which is important to determine the pace of the diffusion.

The moderating effects of ICT infrastructure indicate that the co-diffusion effects among e-services tend to be stronger in countries characterized with high Internet use, Internet speed, and Internet security. Exceptions were found in the co-diffusion effects of e-banking, e-shopping, and e-learning on e-government. These unexpected results might indicate that in countries with low Internet use, Internet speed, and Internet security consumers use e-services as an informational medium rather than transactional. It is expected that in countries with weak ICT infrastructure governments who do not build an up-to-date ICT infrastructure are more than likely limiting their e-government services to informational ones instead of providing full e-government services that includes both informational and transactional services.

The culture moderating results indicate that the co-diffusion effects between e-services tend to be stronger in countries characterized with high power distance, uncertainty avoidance and masculinity, and low individualism. These results present support and validation for Dewan, et al. (2010) argument suggesting a stronger co-diffusion effects in developing countries and in particular in collectivistic cultures. This study extended Dewan, et al. (2010) proposition by including power distance, uncertainty avoidance and masculinity as cultural measures to cluster this study's sample of countries. This study's results are the opposite of the empirical findings in the diffusion of innovation literature which suggests that technology diffusion is wider and faster in countries with low power distance, uncertainty avoidance and masculinity, and high individualism. This study's findings provide new information and knowledge that investigating the diffusion of a technology as a standalone innovation may ignore important knowledge that could be presented by examining its co-diffusion relationship with related innovations.

Table 5.15 presents a summary of the hypotheses findings, which indicate that all suggested hypotheses but H_{10g} are supported by the empirical results.

Table 5.15 Hypotheses Findings Summary

	Hypotheses	Significance
H1a	E-Banking has a co-diffusion effect on E-shopping	Yes
H1b	E-Banking has a co-diffusion effect on E-Government	Yes
H1c	E-Banking has a co-diffusion effect on E-Learning	Yes
H2a	E-shopping has a co-diffusion effect on E-Banking	Yes
H2b	E-shopping has a co-diffusion effect on E-Government	Yes
H2c	E-shopping has a co-diffusion effect on E-Learning	Yes
H3a	E-Government has a co-diffusion effect on E-Banking	Yes
H3b	E-Government has a co-diffusion effect on E-shopping	Yes
H3c	E-Government has a co-diffusion effect on E-Learning	Yes
H4a	E-Learning has a co-diffusion effect on E-Banking	Yes
H4b	E-Learning has a co-diffusion effect on E-shopping	Yes
H4c	E-Learning has a co-diffusion effect on E-Government	Yes
H5a	Co-diffusion effect of E-shopping on E-Banking is stronger than the co-diffusion effect of E-Banking on E-shopping	Yes
H5b	Co-diffusion effect of E-shopping on E-Government is stronger than the co-diffusion effect of E-Government on E-shopping	Yes
H6	Co-diffusion effect of E-Banking on E-Government is stronger than the co-diffusion effect of E-Government on E-Banking	Yes
H7a	Co-diffusion effect of E-Learning on E-Government is stronger than the co-diffusion effect of E-Government on E-Learning	Yes
H7b	Co-diffusion effect of E-Learning on E-Shopping is stronger than the co-diffusion effect of E-Shopping on E-Learning	Yes
H7c	Co-diffusion effect of E-Learning on E-Banking is stronger than the co-diffusion effect of E-Banking on E-Learning	Yes
H8a	Co-diffusion relationship between E-Learning and E-Government is likely to be partially mediated by E-Shopping	Yes
H8b	Co-diffusion relationship between E-Learning and E-Government is likely to be partially mediated by E-Banking	Yes
H9	Co-diffusion relationship between e-shopping and e-government is likely to be partially mediated by e-banking	Yes
H10a	GNI-PPP has a significant influence on the co-diffusion effect between E-services	Marginal
H10b	Education has a significant influence on the co-diffusion effect between E-services	Yes
H10c	Internet use has a significant influence on the co-diffusion effect between E-services	Yes

H10d	Internet security has a significant influence on the co-diffusion effect between E-services	Yes
H10e	Internet speed has a significant influence on the co-diffusion effect between E-services	Yes
H10f	Payment channels availability has a significant influence on the co-diffusion effect between E-services	Yes
H10g	Patent applications has a significant influence on the co-diffusion effect between E-services	No
H10h	Corruption has a significant influence on the co-diffusion effect between E-services	Yes
H11a	Socio-Economic factors have a moderating effect on the co-diffusion of e-services	Yes
H11b	ICT infrastructure factors have a moderating effect on the co-diffusion of E-services	Yes
H11c	National culture has a moderating effect on the co-diffusion of E-services	Yes

CHAPTER VI

CONCLUSION

The diffusion of innovation literature started with Rogers (1962) followed by Bass (1969) Diffusion of Innovation Theories. Since then, these two theories have been the foundation of a large number of studies in different areas in the field of business such as Information Systems and Marketing. Scholars and researchers have been trying to understand how innovations are adopted by consumers and diffuse in countries. Surveys on the diffusion of innovation literature concluded that innovations do not spread in a vacuum. The adoption of an innovation depends on the presence of related technologies that extend and amplify its values. Therefore, the co-diffusion literature started in 1978 to investigate related innovations' diffusion.

E-services such as e-banking, e-shopping, e-government and e-learning are major innovations that had the interest of scholars and researchers. E-services offer consumers the convenience to access information and conduct transactions 24/7. On the other hand, e-services help businesses and services providers to maintain the strongest competitive advantage by reducing their costs and expenses, increasing their management and operations' efficiency, and improving their customer service. However, statistics and prior e-services studies reported low adoption and slow diffusion of e-services in many countries in the world. This motivated this study to examine the factors that determine e-services diffusion. Eastin (2002) found that different e-services share common attributes. Rogers (1995) called for research of related innovations. Inspired by Eastin's findings and Rogers' call, this study examined the co-diffusion of four e-services; e-banking, e-shopping, e-government, and e-learning. Understanding the

dynamic co-diffusion among e-services can help understanding complex consumers' behaviors by revealing richer and clearer information about consumers' perceptions towards using e-services. Such understanding can lead to better e-services forecasting in addition to more effective allocation of marketing resources.

To my knowledge this dissertation is the first study to examine the co-diffusion of e-services. Using panel data of 28 European countries, this dissertation extends the e-services diffusion literature by finding empirical support that co-diffusion exist among e-services; e-banking, e-shopping, e-government, and e-learning. The co-diffusion between a pair of e-services is unbalanced as the co-diffusion effect of e-services 1 on e-services 2 is greater than vice-versa. Co-diffusion effects were found direct and indirect as the co-diffusion between a pair of e-services are partially mediated by a third e-service. This study found that country-level socio-economic factors (i.e., education, corruption, and GNI-PPP) and ICT infrastructural factors (i.e., Internet use, Internet speed, Internet security, and payment channels) are associated with the co-diffusion of e-services. E-services co-diffusion was found to be moderated by countries' socio-economy, ICT infrastructure, and national culture. These aforementioned findings have theoretical and practical implications.

6.1 Theoretical Implications

This dissertation's theoretical implications are: first, it extended the body of knowledge on e-services diffusion by validating the co-diffusion among several e-services, while the literature of e-services diffusion limited their investigations to the diffusion of one e-service at a time using socio-economic and ICT infrastructural determinants. Such e-services literature limitations denied scholars and researchers the knowledge of how related technologies affect each other through co-diffusion. This dissertation validated Rogers' (2003) cluster diffusion of

innovation theory that suggests that the adoption of an innovation depends on the presence of related technologies that extends or amplifies its value. Using the general systems theory and push-pull theory, this study found evidence that e-services belong to one technology cluster as being related and complementary innovations that extend each other's value in comparison with standalone innovations.

Second, this dissertation extends the co-diffusion literature by validating the co-diffusion in the context of e-services. Furthermore, this study validated co-diffusion among several innovations, while the co-diffusion literature was limited to investigating co-diffusion between one pair of innovations. Examining co-diffusion between several innovations provided evidence that co-diffusion effects are not only direct relationships but also indirect as mediation effects exist. This study found that the co-diffusion among four e-services are partially mediated by one or more e-services. The co-diffusion between e-learning and e-government were found partially mediated by e-shopping and e-banking.

Third, this dissertation added to the body of knowledge on e-services diffusion and technology co-diffusion by examining how seven country-level factors including socio-economic and ICT infrastructural factors are associated with the co-diffusion of e-services. Prior e-services diffusion studies were limiting their investigation to consumer-level factors. Prior e-services studies stated the importance of "payment channels" in the diffusion of e-services; however, this dissertation is the first to my knowledge that empirically validated it. On the other hand, this study is the first to investigate the including socio-economic and ICT infrastructural country-level factors association with innovations co-diffusions, when prior co-diffusion studies were limiting their investigation to economic factors (i.e., GDP-PPP, prices, and fees).

Fourth, the co-diffusion effects were found to have stronger effect than the country-level factors effects, which indicate that the existence of related innovations may be more crucial to the diffusion of e-services than socio-economic and ICT infrastructural factors. To better understand how these country-level factors affect the co-diffusion of e-services, this study is the first to examine the moderating effect of national culture of the co-diffusion of e-services using Hofstede's four cultural measures (i.e., power distance, individualism, masculinity, and uncertainty avoidance).

6.2 Practical Implications

In addition to the theoretical contributions, the findings of this study have implications for practice. This study's findings could have practical implications. Banks, vendors and retailers, education institutions, and governments who are spending billions of dollars on developing their e-services and marketing them learn from this study that their efforts can be more promising when joining stakeholders efforts and resources from different industries. A standalone e-service is less valuable without the existence of complementary e-services. E-services providers should make sure that complementary e-services are offered in the geography of their operations to make sure to increase Internet users' perceptions of their values and usefulness. This study presented strong evidence that e-services acceptance and success is difficult without their complementary e-services.

This study's findings presented the country-level factors associated with the co-diffusion of e-services. Using these findings and our research model (GMM mathematical model equation), practitioners can apply the data from the country where they operate to predict consumers' demand for e-services. In countries where some e-services are not yet offered, practitioners can now use existing e-services data to estimate the demand for the new e-service,

which could motivate businesses executives or governments to establish electronic presence for their traditional face-to-face services. Moreover, using the moderating findings, practitioners can now have more accurate understanding of the feasibility to offer e-services depending on their country's similarities with which cluster characteristics (i.e., socio-economic, ICT infrastructure, and national culture). For example, if a bank operates in a country with poor ICT infrastructure, this study's findings suggest that more than likely their customers will not perceive e-banking to be related to other e-services, which will result in lower adoption of e-banking services. Therefore, marketing e-banking services might be useless and waste of money and resources if no parallel projects exist to improve the ICT infrastructure in that country.

Law makers and private consultants depend on macro results generated by country level studies to act upon their recommendations. This study's country-level analysis should help convincing governments and law makers to establish projects to build more advanced and up-to-date ICT infrastructure. Joint efforts and resources by the public and private sectors should implement fast Internet by installing DSL cables that offer faster Internet speed for users at home. Law makers should design laws and regulations that organize the electronic industry and force e-services providers to implement the latest security measures to secure data transactions and protect consumers' personal information.

Financial organizations should ease their restrictions and fees on offering credit cards, debit cards, e-money, smart cards, and so on as payment channels are important to facilitate online transactions and required for e-services diffusion. Alibaba, the largest Chinese e-commerce service provider in the world, had to create its own e-payment system, Alipay, for e-shopping to work and succeed by gaining customers and vendors trust.

6.3 Limitations and Future Research

This study's findings could have limitations of generalizability caused by the limited countries sample. First, this study used countries from Europe only, which limits the sample's economic and cultural heterogeneity. The majority of these countries are developed and/or emerging with few developing countries. The majority of developing countries in the world exist in Africa, Asia, and South America which are not included in this study's countries sample due to the lack of country-level data. Nevertheless, this study's countries sample included 28 countries only. Therefore, we recommend for future research to conduct e-services co-diffusion cross-country studies at the consumer-level while including countries from all the world or have equal representation of developing and developed countries.

Second, this study only examined four e-services; e-banking, e-shopping, e-government, and e-learning due to lack of country-level panel data for other e-services such as e-payment and e-health. Therefore, we recommend for future research to conduct e-services co-diffusion cross-country studies at the consumer-level while including e-services such as e-payment and e-health.

Third, in this study's attempt to test for co-diffusion mediation effects, the mediation model included only three e-services at a time. This study found that both e-banking and e-shopping partially mediate the co-diffusion between e-government and e-learning. It is recommended to test mediation effect while including all the mediators in the model (i.e., e-banking and e-shopping). However, this study's focus was to introduce the co-diffusion effects as indirect relationships (mediation) in addition to the previously known direct relationships. Therefore, the co-diffusion mediation model is presented as a general model that includes three e-services. This study calls future studies to test the mediation effects by including all mediators in the co-diffusion model.

Fourth, this study calls for future studies to validate the proposed co-diffusion model, and mediation model using consumer-level analysis.

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APPENDIX A

APPENDIX A

ROBUSTNESS CHECK

The following tables provide examples of robustness results for the e-services co-diffusion model. Following Blundell and Bond (2000) and Bond, et al. (2005), I ran the robustness check by estimating GMM AR(1) specification for e-banking, e-shopping, e-government, and e-learning, which rejected the unit-root null as the results show that the e-services lagged effects are highly significant. This is important because if e-banking, e-shopping, e-government, and e-learning followed a random walk, their lagged values would be uncorrelated with their first differences and the GMM estimator would not identify α. Moreover, I ran the model with trends by adding "year" to the model. The results in the tables below were qualitatively the same as by adding "year" to the co-diffusion research model, the co-diffusion effects among e-services maintained their significance. However, the results were quantitatively a little different as the slope β slightly changed, for example by adding the "year" to the co-diffusion of e-shopping and e-learning the co-diffusion effect decreased from 0.2376 to 0.1809.

Co-diffusion between e-shopping and e-learning				
	E-shopping	E-shopping	E-learning	E-learning
E-shopping L1	.8252 ***	.9452 ***		
E-shopping			.2376 ***	.1809 ***
E-learning L1			.5439 ***	.6771 ***
E-learning	.3021 ***	.1454 ***		
Year		-0.1629		-0.1159**

Note: Lagged one year (L1)

Co-diffusion between e-banking and e-government				
	E-banking	E-banking	E-government	E-government
E-banking L1	.9159 ***	.9411 ***		
E-banking			.6048 ***	.6744 ***
E-government L1			.1321 ***	.1277 ***
E-government	.1557 ***	.1499 ***		
Year		-0.1422		-0.3421

Note: Lagged one year (L1)

BIOGRAPHICAL SKETCH

Dr. Samer Takieddine earned his Doctor of Philosophy in Business Administration, with a major in Computer Information Systems, from the University of Texas Pan-American (UTPA) in 2015. He received his Master of Business Administration with a concentration in Information Systems, from Emporia State University, in 2008. He earned his Bachelor Degree in Computer Science from Business and Computer University, in 2004.

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