# BEYOND ECONOMY: IMPACT OF NATIONAL CULTURAL VALUES ON NATIONWIDE BROADBAND DIFFUSION

by

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## ABSTRACT

This study examines how the non-conventional factors of national cultural values and government involvement affect the diffusion of broadband Internet technologies in various nations around the world. An innovative element of the study was the examination of the influence patterns at different stages of diffusion, which was measured by the number of years taken to pass a certain threshold level of diffusion.

Hierarchical multiple regression analysis was conducted on data from 64 countries that was collected from 1996 to 2006. Prominent national cultural value variables were constructed using survey data from Hofstede and Inglehart's cross-national surveys. The overall findings of this study indicate that non-conventional factors are significantly correlated with both broadband Internet diffusion level and broadband Internet diffusion speed at each diffusion stage. Furthermore, analysis of broadband Internet diffusion level confirmed that the models explaining nationwide broadband Internet diffusion for developing and developing countries are markedly different.

The analysis concludes with implications for further research and public policy in the realm of information and communication technology.

# CHAPTER 1

# INTRODUCTION

## Background

Since the early 1980s, following the emergence of the "information society" and the beginning of the globalization era, the development and diffusion of new information and communication technologies (ICTs) came to the forefront as major policy issues worldwide. The widely held belief that ICTs have the potential to enable national development and build the global business environment without national boundaries provided a basis for this phenomenon (Hanna, 1994; ITU, 2003a). Given the fact that ICTs are essential tools for the manipulation, organization, and optimization of available resources, including information, it is a corollary that a growing need exists to adopt and utilize ICTs in many areas of human endeavors.

ICTs enable a country's development in many ways. In terms of economic development, the ICT products alone are major export/import items for trade. In addition, various ICT applications in the production process can provide an effective opportunity for enhancing productivity by reducing unnecessary transaction and coordination costs, which have up to now been a major impediment to economic development for many countries.

Following this line of reasoning, studies on ICT development have mostly focused on the adoption and use of specific IC technologies and infrastructure in the domains of economic activities within different size business organizations. However, the economy is not the only area that may benefit from ICTs. In addition to economic benefits, the use of ICTs in a non-economic field can also promote social and political development. By allowing access to information in various sectors and services within a society, such as distance learning, telemedicine, e-government, and ecommerce, ICT applications can provide opportunities to improve the overall standard of living (Bauer, Gai, Kim, Muth & Wildman, 2002; Frieden, 2005; Hanna, 1994; Qiang, 2003; Sein, 2004).

Thanks to these potential benefits, many countries—regardless of their current level of economic development—have invested substantial resources in developing ICT sectors in a variety of forms, such as nationwide structural changes in telecommunications, legal reforms, and more active policy initiatives. This effort has been even more prominent among many developing countries since they view ICTs as an important catalyst for rapid industrialization and economic development. In other words, their efforts reflect the belief that ICTs have the potential to provide a major means of "leapfrogging" to help them skip over certain stages of development and hopefully accelerate their entry into the postindustrial era (ITU 2001, 2003a; OECD, 2001, 2002; Steinmueller, 2001).

However, as evident in many cases, the order, speed, and range of nationwide ICT adoption and diffusion will vary by country. For instance, it is well known that despite its global reach Internet penetration and use are uneven throughout the world. The world Internet population reached 1.46 billion by mid-2008 (Internet World Stats, 2008).

However, among the 133 countries that the International Telecommunication Union (ITU) surveyed in 2007, as many as 22 countries reported that their nationwide Internet adoption rates were below 1 percent; meanwhile, countries such as the United States showed figures that were well above 70 percent (ITU, 2008).

The numerous statistics on Internet diffusion all indicate that the rate and magnitude of Internet diffusion can vary significantly. Among the many plausible implications of these statistics, what looks challenging to many countries is the high correlation between the level of economic development and ICT adoption. Considering the potential of ICTs then, such uneven diffusion can lead to the reinforcement of existing social and economic inequalities among nations. The results of available empirical studies on cross-national ICT adoption suggest that existing economic development levels, frequently measured by such indices as gross national product (GDP) are often found to be significant factors that are both predicting and limiting ICT adoption and diffusion potential of a nation. In other words, those countries who view ICTs as a means to leap from their current under-developed economy are again placed within the constraint of existing conditions. Is there any way to introduce ICTs and successfully disperse them that is not bound by such existing constraints? Does any factor other than the existing economic development level explain the variation in the different ICT penetration levels and, at the same time, perhaps work in favor of a country trying to achieve nationwide ICT adoption and diffusion? Finding answers to these questions is the underlying purpose of this study.

The recent success stories of ICT adoption and diffusion in several nations may help achieve the goal. Broadband Internet diffusion in Korea is one such case. Korea has succeeded in quickly deploying nationwide broadband Internet service, with its rate of adoption far exceeding that of other developed countries (ITU, 2003a, 2003b; Lee, 2002; OECD, 2001). The Organization for Economic Cooperation and Development (OECD) reported in 2004 that of its member nations Korea ranked first in broadband Internet penetration, averaging 25 broadband Internet subscribers per 100 inhabitants. The Korean case is also intriguing because Korea was not the nation best suited for ICT adoption and development in terms of existing conditions. Until the mid-1980s, Korea was one of many developing countries coming out of nation-building efforts after a civil war just 30 years ago, an event occurred immediately following 35 years of Japanese colonization. Despite its rapid economic development since the late 1970s, Korea did not have the best qualifications for fast development of ICTs in many respects. For instance, of the 214 countries participating in the ITU, Korea ranked 26th in terms of economy as of 2004. In addition, although its population density was higher in several metropolitan areas due to uneven development, neither teledensity nor overall market size as measured by the territory size were sufficiently high, ranking 27th and 36th, respectively. Nevertheless, the 2005 ITU survey still indicated that Korea ranked among the top five nations (or administrative regions such as Hong Kong, China) that have succeeded in the adoption of broadband Internet (ITU, 2005); indeed, the percentage of broadband Internet users among all Internet users in Korea still remains highest (OECD, 2006).

Accordingly, the Korean case has drawn huge attention across the world, raising a series of ICT diffusion-related questions. In essence, studies examining the Korean case and other nations' success stories suggest that certain factors may work in favor of a country's ICT deployment effort, despite known determining factors (Aizu, 2002;

Choudrie & Lee, 2004; Fransman, 2006; Frieden, 2005; ITU, 2003a, 2003b; Lee & Chan-Olmsted, 2004; Lee & Choudrie, 2002). In essence, successful ICT adoption and diffusion stories in several countries such as Canada, Japand and Korea, appear to indicate that socio-cultural factors, represented by the prominent cultural values of a nation and active government involvement, play an important role in the process.

These studies suggest that an ICT adoption/diffusion model that heavily relies on economic development level needs revision. Furthermore, a universal policy for successful ICT adoption and diffusion may not even exist. This conclusion echoes the call made by researchers like Norris (2000) and Kiiski and Pohjola, (2002), who assert that significant differences do exist between nation states, and thus, social or cultural factors should be included in future research. These studies suggest that only a small number of research exist that systematically examines the prominent cultural values of a nation in the diffusion of ICTs, an aspect thus far neglected in the ICT research tradition from a comparative perspective. Further, the available studies examining the relationship between technological innovation and culture have been biased toward the influence and changes brought about by a technological innovation on a culture (Herbig & Miller 1992). The present study will diverge from that research tradition by examining the opposite flow to illuminate the influence of prominent national cultural values on ICT diffusion in a society.

Among the many types of ICTs, this study focuses primarily on the diffusion of broadband Internet. Since its introduction to the general public in the 1990s, the Internet has been known to have the potential to advance economic and social development. It is evident that the social and economic benefit of the Internet can be realized much more effectively if provided at high speed through broadband Internet connection. Compared to the narrow band Internet that relies on dial-up connection, broadband Internet provides high-speed, always-on connections for large numbers of residential and business subscribers. These features facilitate the contribution of Internet to innovation, increase in productivity, and social and economic development at a much faster pace and also more effectively (Crandall, 2005; ITU, 2003b). The difference between the narrow and broadband Internet can be even compared to the difference between "a screwdriver and an electric drill" (Goel, 2007).

Consequently, broadband Internet has not only become one of the most popular topics in the media, but also one of the highest priorities for public policy and political agendas at the global level (ITU, 2001; OECD, 2001). Many governments around the world are becoming more committed than ever to extending broadband networks to their citizens (Broadband Advisory Group, 2003; Office of the e-Minister and Office of e-Envoy, 2001) and propagating the use of this technology to contribute to economic and social development.

However, getting an innovation adopted in a nation is a complex process involving various factors, and an ICT-like broadband Internet is no exception. The Australian case offers a good example of the discrepancy between the economy, network infrastructure, and actual access, by having a 90 percent of ADSL penetration rate, but then only 6 percent of the population being home users (Lee et al., 2003). Stated simply, broadband Internet adoption has to do with factors above and beyond an economy and technological prowess. And this is the major focus of this study.

## Significance of the Study

In summary, several questions have arisen from observations of recent ICT development, especially broadband Internet, and they have motivated the current study: Why has broadband Internet been deployed more quickly in several countries than in other? Do the prominent cultural values of a country play an important role in nationwide ICT diffusion as recent studies suggest? If so, which cultural values affect the process either positively or negatively? Do the prominent national cultural values influence ICT diffusion always in the same direction? If not, under what condition will these prominent national cultural values accelerate the process?

Answering these questions will provide distinct explanatory and predictive perspectives on the phenomenon of ICT diffusion and the influence of non-conventional influence factors, such as cultural values, on the process. More specifically, the current study will extend the ICT and diffusion research tradition in several aspects. First, this study incorporates a set of non-conventional influence factors into the existing ICT diffusion model that are important but have been traditionally left out. Among those factors, this study is focused on the role of prominent cultural values of a country, which is a collective set of values that can differentiate one country from another by influencing the attitude and behavior of its members. Despite its importance, the understanding of how culture influences technology acceptance has been limited to date, and studies examining the role of culture in nationwide technology diffusion are rare.

Next, the current study further intends to explore the condition under which the degree and direction of cultural influence on the process of ICT diffusion varies. In essence, given the different characteristics of adopters in diffusion stages, it is presumed that same cultural values influence the process with different strength and direction in different diffusion stages.

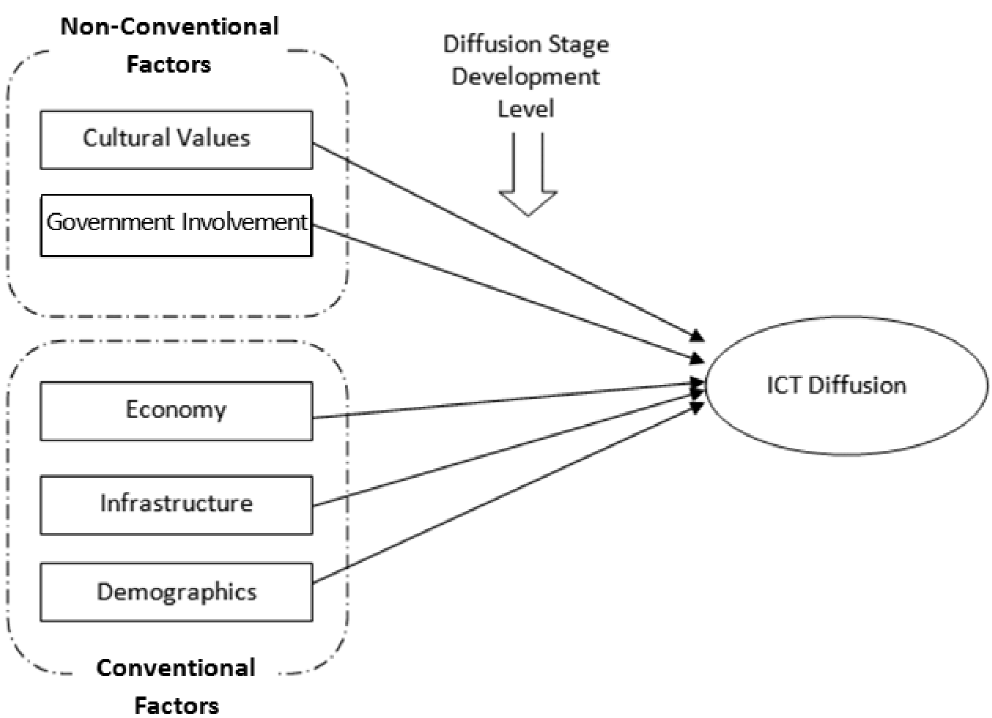
In addition, this study examines influence of government policy and initiatives. Recent research on leading nations in innovative ICT adoption began to notice the role of the government as an important factor related to successful diffusion of ICTs in a nation. In particular, the role of the government has been emphasized in the case of broadband Internet diffusion (Fransman, 2006; Frieden, 2005; Hee & Choudrie, 2002; Lee et al., 2003). However, this factor has rarely been incorporated in actual empirical studies due to difficulties in measurement. This study will expand the research tradition by incorporating a set of variables reflecting ICT-related proactive government involvement.

Furthermore, this study examines the influence of prominent cultural values of a country on ICT diffusion in both developed and developing countries. One of the plausible reasons why the cultural values of a country have not been examined in the prior body of ICT literature is that available cross-national studies have only focused on innovation diffusion in the mostly high-income, developed countries, such as the OECD members who are mostly from Europe and North America and thus naturally share similar cultural traditions.

Finally, as an extension of the previous reasoning, this study adopts a cross-national approach to analyze the effect of prominent national cultural values on the ICT diffusion process. A review of the literature points to the fact that existing studies on ICT diffusion with a comparative perspective have indeed been limited to either individual differences in technology acceptance or diffusion of technology within just business organizations or only across a handful of countries.

Figure 1.1 summarizes the major variables and their relationships, which this study aims to examine at a conceptual level. In essence, the major focus of this study is on the influence of non-conventional factors on ICT diffusion as represented by broadband Internet diffusion. Furthermore, this relationship is examined at different diffusion stages and economic development levels.

Figure 1.1 Theoretical Framework: Impact of Non-conventional Influence Factors on Broadband Internet Diffusion




The remainder of this study is organized as follows. Chapter 2 contains the literature review on ICT adoption and diffusion. More specifically, literature on the diffusion of the innovation theory, the effect of existing macro-level influence factors on ICT adoption, the role of ICT-related government involvement, and the effect of prominent cultural values of a country are discussed, providing the basis for specific hypotheses to be tested in the following chapter. Chapter 3 describes the research design of the current study and explains what research approach, data, and analytical method are employed for this study. Chapter 4 presents the results of analysis for the research question and the hypotheses. Furthermore, given the complex nature of analysis, discussion about results will be provided in this chapter as well. Chapter 5 summarizes the findings of that analysis, the limitations of the study and suggestion for future research.

# CHAPTER 2

# LITERATURE REVIEW

## Information Communication Technologies and Development

The last half of the 20th century witnessed to dramatic advancement in information and communication technologies (ICTs). ICT in the modern society is viewed as both a means and an end for development. Compared to those past leading industries that were responsible for industrial growth and development, such as steel, chemicals, and machinery, ICTs are unique in a number of ways. The conditions of entry for using and producing ICTs do not require massive investment in fixed plant capacity or infrastructure or the accumulation of experience (Steinmueller, 2001). Moreover, using ICT applications provides relatively simple tools to improve both productivity and expand the capacity of existing methods for producing goods or delivering services; thus ICT application offers a compensating advantage against existing shortcomings in production capacities (Lal, 2000). Further, virtually all components and many of the systems embodying these technologies are internationally available and easily transportable to whichever country can make productive use of them (Steinmueller, 2001).

In addition to the development of the ICT sector in an economy, by utilizing ICT applications for gathering, storing, and analyzing information more effectively, people can discover new approaches for a range of social and physical problems, thereby reaching development goals in many vital areas, such as education, gender equality, minority empowerment, health, and even the environment (Hanna, 1994; ITU, 2003a, 2003b). Put differently, ICTs can provide the tools to help people entirely restructure the ways in which they interact; these new ways can then bypass the construction of human and machine systems that would have otherwise been the only alternative. As a result, knowledge of ICTs can offer a different perspective of the world and become a building block for further innovative capacity in the future (Steinmueller, 2001).

All of these features of ICTs suggest that ICTs have the potential to support the development strategy of "leapfrogging"—that is, bypassing some of the stages of accumulation of human capacity and fixed investment that developing countries were previously required to undergo during their process of economic development as earlier suggested by Rostow (1960). "Leapfrogging development" also reflects the belief among policymakers and scholars that ICTs and especially telecommunication technologies, can help developing countries accelerate their pace of development and/or narrow the gaps in productivity and output that separate them from developing countries (Singh, 1999). This belief has led to the modernization and expansion of telecommunication infrastructures in many developing countries. Considering that two-thirds of the world economy is now based on service sectors, of which ICTs are an essential part, and watching several previously developing countries become global IT players, it is no surprise that many developing countries are continuing to adopt ICT development and deployment as a national priority (Tongia et al., 2005).

Despite many nations' having aspirations and making major efforts, however, many of the ongoing statistics report that ICTs have unevenly developed across the world with the order, speed, and range of nationwide ICT development and its deployment rates varying sizably by country. For instance, according to ITU data (2008), 23 percent of the world population was estimated to be Internet users in 2006. Among the 211 countries surveyed by the ITU effort, as many as 21 nations reported that their estimates of Internet users fell below 1 percent. On the other hand, 32 countries reported that the majority of their populations, namely, 50 percent or higher, were Internet users in the same year.

The situation is not much different for broadband Internet. As of 2006, an average of 7 percent of the world's population was subscribing to broadband Internet. The same data indicated that in 59 nations, broadband Internet adoption level was below 1 percent, meaning that less than 1 out of 100 people were broadband Internet subscribers. Meanwhile, 18 countries reported that more than 20 of every 100 people were subscribing to broadband Internet with Denmark showing the highest adoption rate with an average 32 Internet users per 100 inhabitants (ITU, 2008).

This same variation appears by region as well. For instance, when not totaling the number of actual users, the Internet penetration rate of 5.3 percent in Africa falls far below the world average of 21.9 percent. The same data indicate that North America and Oceania go well beyond a 50 percent rate of usage (see Table 2.1; *Internet World Stats*, 2008). This uneven deployment of the Internet is evident even within each region. For instance, Asia ranks first in the world in terms of actual number of Internet users according to *Internet World Stats*. However, according to the ITU data, within the Asia-Pacific region, 70 percent of South Koreans used the Internet in 2007, while less than 1 percent of the Bangladeshi population did the same (ITU, 2008).

There may be many plausible causes for such uneven dispersion of ICTs across

Table 2.1 World Internet Penetration Rates and Users by Regions (June 2008)

| | Internet Users | Users % of World | Penetration (%) |
|---|---|---|---|
| Africa | 51,065,630 | 3.5% | 5.3% |
| Asia | 578,538,257 | 39.5% | 15.3% |
| Europe | 384,633,765 | 26.3% | 48.1% |
| Latin America/Caribbean | 139,009,209 | 9.5% | 24.1% |
| Middle East | 41,939,200 | 2.9% | 21.3% |
| North America | 248,241,969 | 17.0% | 73.6% |
| Oceania/Australia | 20,204,331 | 1.4% | 59.5% |
| World Total | 1,463,632,361 | 100% | 21.9% |

Source: Internet World Stats (2008)

nations and regions. Among these, what is most challenging to many countries is the high correlation between the level of economic development and ICT adoption. Given the potential of ICTs as discussed herein, such uneven diffusion may translate to the need for further reinforcement—or perpetuation in the worst case—of existing social and economic inequalities in some nations. Indeed, the results of available empirical studies on cross-national ICT adoption suggest that existing economic conditions, frequently measured by GDP, are often found to be significant factors for predicting as well as limiting ICT adoption and the diffusion potential of a nation.

Figure 2.1 shows a simplified version of this relationship between the nation's economic development level and Internet deployment. The scatter plot presented in Figure 2.1 is based on the ITU data from 64 nations in this study and shows that GDP per capita (PPP) is positively related to the number of Internet users in the nation. The trend line in figure suggests that GDP level has a highly positive association with Internet diffusion level with Pearson correlation coefficient of .80 ($p < .001$). To put it differently, GDP alone can explain about 63 percent of variance in the number of Internet users among 64 nations studied. OECD data on broadband Internet penetration also provides a similar picture by reporting that the simple zero-order correlation between GDP per capita and OECD members' broadband Internet penetration is .67 (OECD, 2008).

Figure 2.1 Relationship between GDP Per Capita (PPP)
and Estimated Internet Users

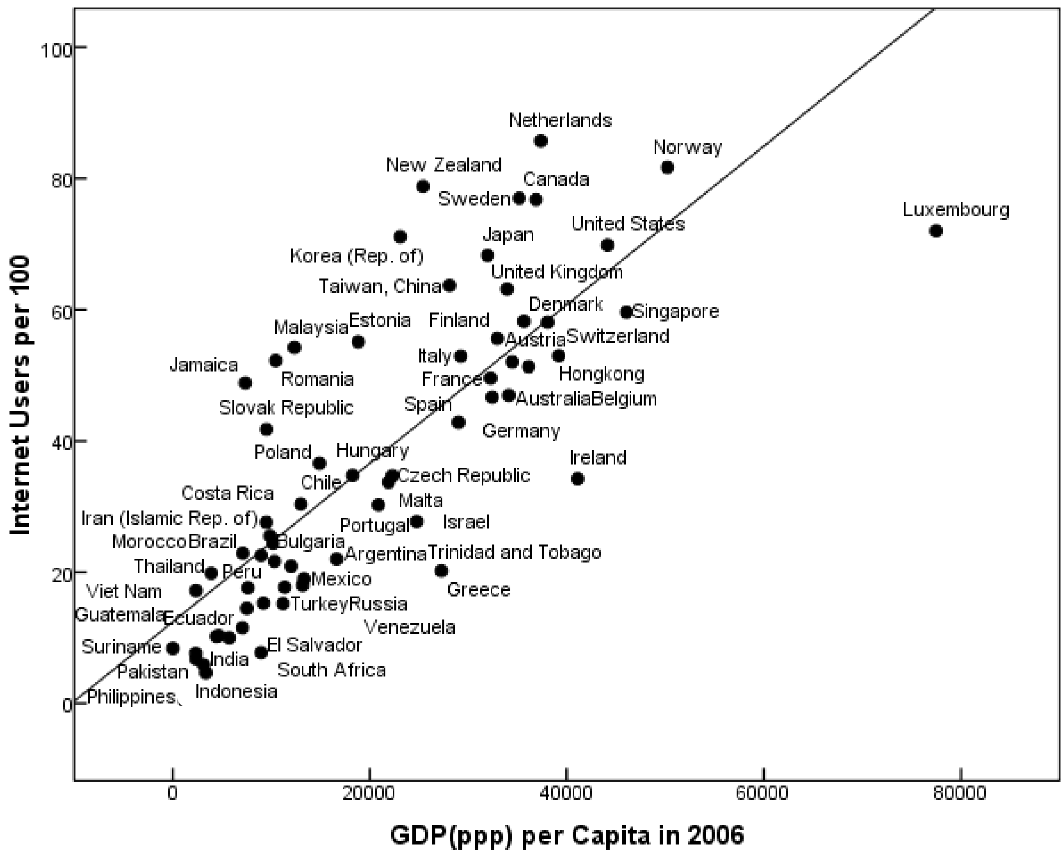



Figure 2.1 depicts just one example of positive association between an economy and ICT development. In essence, prior research providing that evidence implies a rather gloomy conclusion for many developing countries: those countries who view ICTs as a means to leapfrog from their current under-developed economy may not be able to actually leap outside the boundary defined by their existing status. Does this finding

suggest that no other way exists to introduce ICTs and successfully disperse them in a manner where they are less, if not at all, bound by existing constraints? Does any factor other than a country's existing economic development level work in favor of a country attempting to nationwide ICT adoption and diffusion?

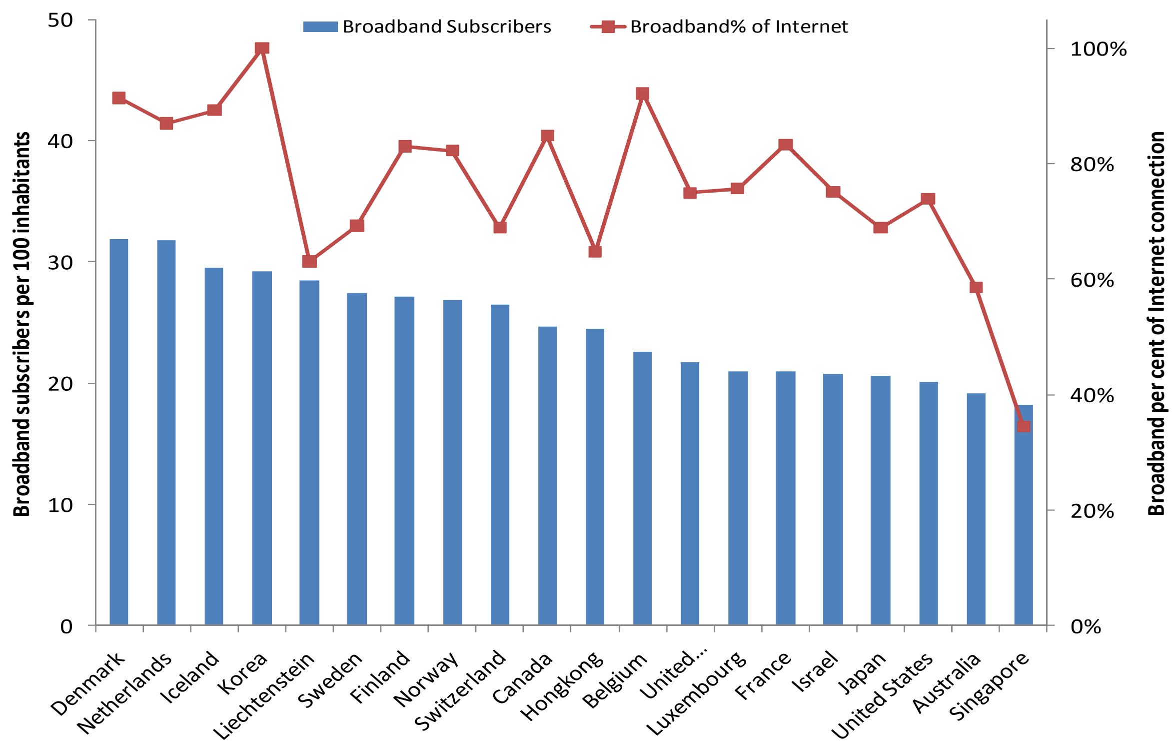
### Beyond economy

Korea recently succeeded in the fast deployment of a nationwide broadband Internet network with its rate of adoption far exceeding that of other developed countries (ITU, 2003b; Lee, 2002; OECD, 2001). The OECD reported in 2004 that, among its member nations, Korea ranked first in broadband Internet penetration, with an average of 25 broadband Internet subscribers per 100 inhabitants (OECD, 2004).

As of 2006, other developed countries had caught up with Korea, with Denmark, the Netherlands, and Iceland surpassing Korea by 2 to 3 percent in nationwide broadband Internet subscriptions. However, Korea still ranks first in terms of broadband percentage of Internet connection. In other words, narrowband Internet no longer exists in Korea; all Internet connection is today broadband with the proportion of broadband Internet connection reaching 100 percent (see Figure 2.2; OECD, 2006). In addition to mobile services, broadband services in Korea are also at a mature stage in terms of technology and diffusion; thus, broadband Internet has become close to a basic information services to the extent that there are discussions today seeking to redefine universal services to include these two services (Kim, 2008). Furthermore, the Korea Communications Commission (KCC) recently announced that it is working on plans to boost wired broadband Internet speeds to 1Gbps by 2012, 200 times faster than the typical 5 Mbps

DSL connection sold in the U.S., Korean is also planning a 10 Mbps wireless broadband service (Malik, 2009).

Figure 2.2 Top 20 Nations in Broadband Internet (2006)




* Source: OECD (2006)

** The line chart is based on the proportion of broadband Internet subscribers over all Internet subscribers.

In terms of conventional indicators of innovative technology development, such as economic development level and resources, Korea has not been the best-suited country. Therefore, it is no wonder that the Korean case has drawn significant attention across the world and raised many ICT policy-related questions: Why has broadband Internet caught on in Korea so much faster than in other countries, such as the U.S.—the birthplace of the Internet? Why did several countries succeed in faster deployment of broadband Internet when doing so was not the best -suited circumstance in terms of their economy and other factors? Given the industrial policy tradition in Korea and other newly developed economies, was government involvement one of the main reasons for this success? Is the high rate of broadband Internet adoption in certain countries, such as Korea, an reflection of unique circumstances, such as high-rise buildings and a dense urban population? Does the public in those countries have a uniquely different attitude or perception toward broadband Internet? Ultimately, the answers to these questions will provide many useful insights for other countries that are seeking more effective ICT development and adoption.

The inquiries into recent ICT adoption and diffusion in several countries, such Korea, Canada and Japan, suggest that socio-cultural factors have influenced the adoption process, although each country to a different extent (Bagchi & Cerveny, 2000; Fransman, 2006; Hargittai, 1999; ITU, 2003; Lee & Choudrie, 2002; Lee, O'Keef, & Yun, 2003; Maitland & Bauer, 2001; Robison & Crenshaw, 1999). While trying to answer the ICT-policy related questions mentioned above, this study also attempts to expand the discussion into a more generalizable model that will encompass the findings of these research efforts and forge a workable strategy for other countries.

## Why Broadband?

Among many ICT technologies, this study focuses on one recent consumer technology—namely, broadband Internet. Narrowband Internet was first introduced to the public with the web in the early 1990s and has now reached near saturation in many countries with more than 50 percent of the population in 34 countries being Internet users according to recent ITU data (2006). Broadband Internet emerged a few years later, and as of 2006, it reached 6.9 percent of the world's population who subscribe to the service (ITU 2006). The extraordinary global level of interest in broadband among nations is presumably due to the understanding that broadband is becoming the dominant mode of connection and will bring social and economic benefits (Firth & Kelly, 2001; Xavier, 2003). This understanding labels broadband as the infrastructure of the knowledge economy or in other words what we now have dubbed "the information society" (Reynolds & Sacks, 2005).

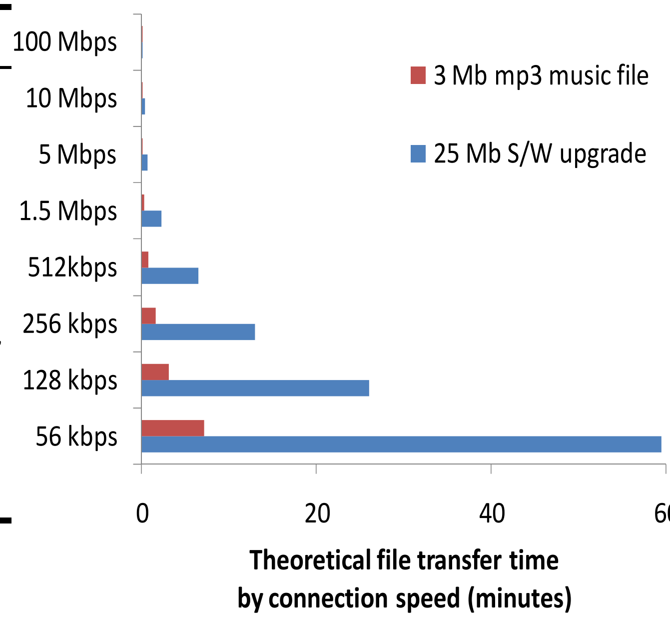
Several technical features do differentiate broadband Internet from narrowband Internet. Broadband is a loosely defined term with some definitions accepting any speed over dialup as being broadband. Broadband is also called high-speed Internet because it usually has a high rate of data transmission compared to dial-up connections; those are commonly offered at up to 56 Kbs bandwidth. The ITU Standardization Sector (ITU-T) recommendation has defined broadband as a transmission capacity faster than primary rate ISDN, at 1.5 to 2 Mbps. OECD has defined broadband as any connection to the customer of 256 kbps or more, which is the most common baseline marketed as "broadband" around the world. Although the definition of broadband has recently changed to 768 Kbps, until late 2008, the FCC definition of broadband was 200 Kbit/s in one direction, and advanced broadband at least 200 Kbit/s in both directions. Regardless of the speed, however, some additional features are attractive to users, and these include always-on connectivity and , potentially, flat-rate pricing independent of the time spent connected (see Figure 2.3; Bauer et al., 2002). These attributes allow users efficiently perform various activities, such as teleworking, e-gaming, e-gambling, e-learning, e-health, e-commerce, and e-government, more efficiently and with higher levels of interactivity (Bauer et al., 2002).

Communication applications, such as e-mail and instant messaging, have been major recent drivers of Internet usage. Previously mentioned features of broadband enhance the effectiveness of these applications, implementation of faster speeds, more graphical interfaces, and higher interactivity, all of which require a much higher bandwidth than does the simple transmission of plain text alone. In addition, broadband does not tie up a telephone line as a typical dial-up connection does, increasing the availability of existing communication channels. These features bestowed broadband Internet the title, “infrastructure of the information society” (Firth et al., 2002b; Tongia, 2005).

Figure 2.3 Comparison of Narrowband vs. Broadband Internet

| Features | Narrowband | Broadband |
|---|---|---|
| Speed | Up to 56 Kbps | More than 256 Kbps |
| Switching | Circuit-switching | Mainly packet-switching |
| Connection Method | Dial-up | Always-on; ADSL, Cable, Mobile |
| Available Services | Voice, Low-rate Data | Voice, Data, Streaming Video |

Source: Adapted from Bauer et al. (2002)




Due to these advantageous technological features, as well as the applications they allow, broadband Internet has the potential to achieve development goals at many different levels. At the individual level, broadband offers the subscriber improved educational opportunities, entertainment diversity, and improved access to peers and information as well as LAN networking options (Wales, Sacks, & Firth, 2003) For organizations, broadband offers improved efficiency, improved connectivity, and access to operation-specific applications that enable new ways of doing business, and new business models that can influence the location of company in much the same way as transport networks did in the 20$^{th}$ century (OECD, 2001). For a whole nation, broadband Internet has the potential to offer improved quality of educational and health services, improved connectedness of government with society, jobs whether technical or otherwise, and increased prosperity. Together, these potential benefits contribute to the consensual view that broadband should be promoted wherever possible (Xavier, 2003).

On another note, however, it is true that Internet access costs may be prohibitively high in many developing countries. Upgrading to broadband Internet at $6 per month in India corresponds to a week's salary in that country (Reddy et al., 2004). As a result, scholars like Noam (2003) question the need for broadband in developing countries and hold instead that broadband Internet should not be the top priority in these countries. Instead, developing countries should first expand basic network connectivity—both wired and wireless—through pubic investment and market structures that encourage private investment. Based on the growth stage theory (Rostow, 1960), scholars with this perspective hold that, given the IT development stages in developed countries where countries embarked on technical upgrades only after they had already succeeded in expanding their basic services across the country, building universal connectivity via low-rate infrastructure is a better strategy for most developing countries.

Indeed, although broadband may not be a necessary condition for accessing a service like email or web-surfing, it does yield significant quality improvements, the effect of which on individual welfare is often difficult to measure (Bauer et al., 2002). Furthermore, expanding basic telephone service and increasing access to broadband are not mutually exclusive options, especially when the goal is broadband for every settlement, not every household (Hudson, 2003; Reynolds, 2003; Tongia, 2005). This approach is becoming increasingly feasible in developing countries thanks to advanced wireless and satellite technologies. In such a case, broadband may be added through upgrades to existing wireless networks or delivered via small satellite terminals to a whole region and then by fixed wireless to cover villages or neighborhoods. By doing so, broadband can offer developing economies the chance to build a single network that can be used for all three different, valuable services—voice, data, and video—and make the most efficient use of a country's scarce resources. Taking the same line of reasoning forward, Reynolds(2003) holds that, given that developing economies are not as tied down to an inefficient legacy network as are their counterparts, if new wired or wireless networks are undergoing construction in developing countries, they should be built to be capable of handling other high-speed traffic as well because investing in a network that can only be used to transport voice may be a waste of resources both now and in the longer term.

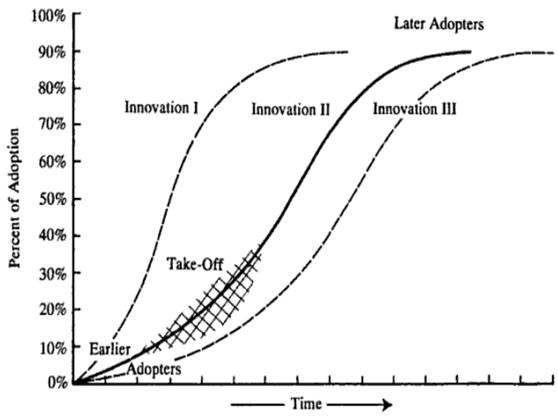
The innovativeness/need paradox argues that that those who will most benefit from this new technology are in fact those who adopt the innovation the latest due to their socio-economic status (Rogers, 2003). Considering this argument alone, few reasons exist for building a simple phone network when new more complex networks can offer voice, data, and video for the same cost or less (Reynolds, 2003).

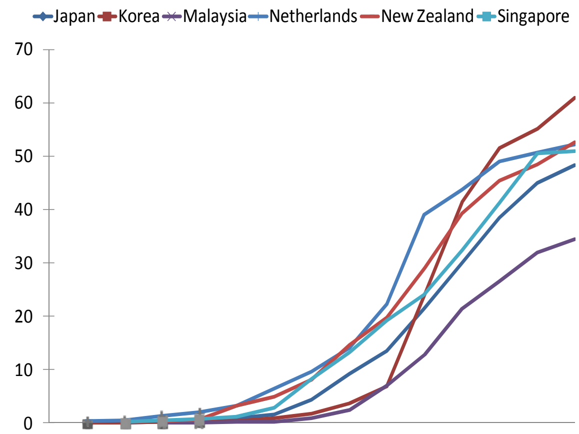
## Diffusion of Innovation Theory

Any study of the adoption of innovative technology needs to relate to the diffusion of innovation theory offered by Rogers. According to Rogers (1962, 1983, 2003), an innovation is “an idea, practice, or object that is perceived as new by an individual or other unit of adoption,” while diffusion of innovation is the process by which “the innovation is communicated [or adopted] through certain channels over a period of time among the members of a social system” (2003,p. 12). Following this line of thinking regarding the definition of innovation, any ICT can be considered an innovation as long as it allows people to create, gather, and manipulate information in a new way; broadband Internet is no exception.

Studies on the process of diffusion of innovation date back to the 1940s, when sociologists conducted research on the adoption of hybrid seed corn among farmers in Iowa (Lowery, 1995). Later in the 1960s, Everett Rogers summarized findings of various innovation studies and incorporated an S-shaped diffusion curve that charted the diffusion of most types of innovations. The diffusion rate of the Internet over time also shows that the Internet is following the same S-shaped diffusion curve because the rate of its adoption increases slowly until it reaches a tipping point, after which the adoption accelerates rapidly. After the take-off stage producing a growth rate of 50 percent or higher (Tellis, Stremersch & Yin, 2003), the adoption rate plateaus and increases only slowly as it reaches out to the last adopters (see Figure 2.4).

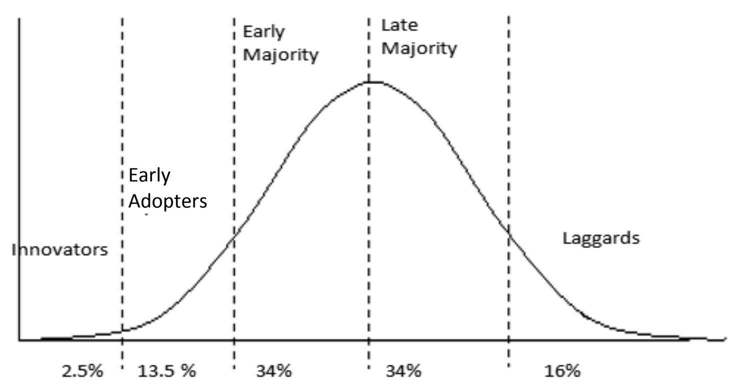
Figure 2.4 S-shaped Diffusion Curve and Internet Diffusion among Selected Countries




This shape reflects the normal distribution of adopters based on the time of their innovation adoption. This cure provides a basis on which the adopters are divided into several groups of patterns: Innovators, Early Adopters, Take-offs, Late Majority and Laggards (Rogers, 2003; See Figure 2.5).

Figure 2.5 Innovation Adopter Groups




Source: Rogers (2003)

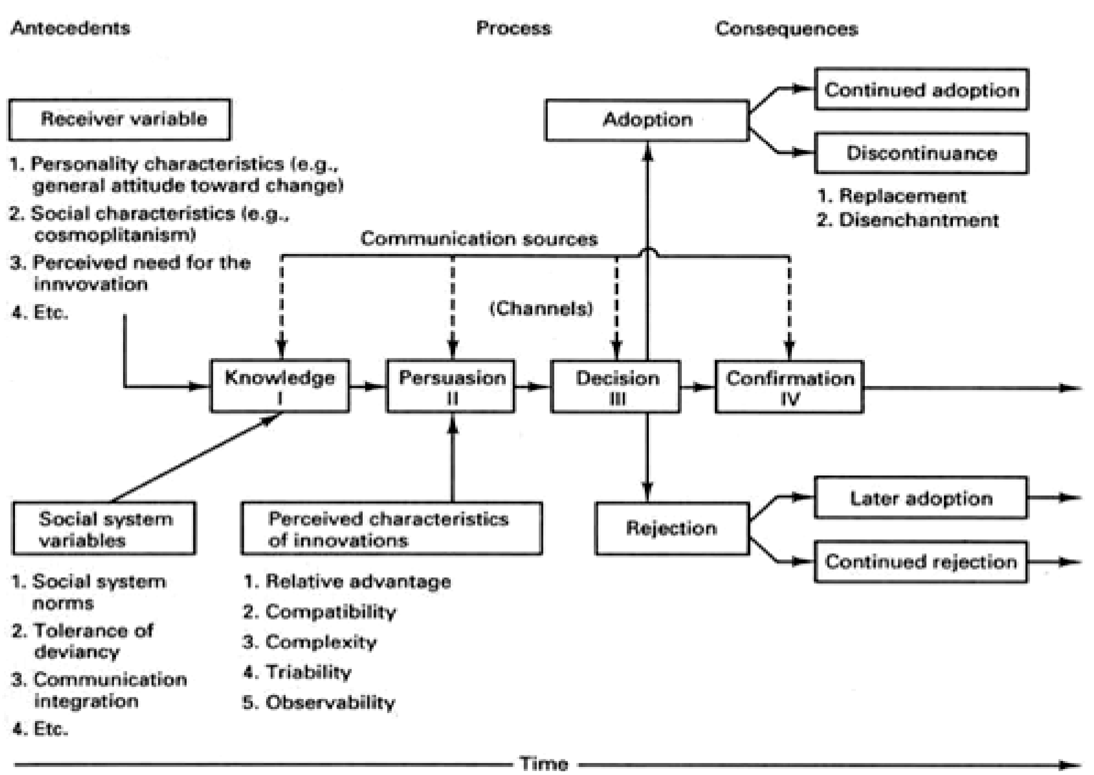
As presented in Figure 2.5, Innovators are the first 2.5 percent of members in a system that introduce and then adopt an innovation. In addition, they play the role of gatekeeper for the flow of new ideas into a system. The next 13.5 percent of members to adopt an innovation are called early adopters. Early adopters play an important role to the diffusion of the innovation, as they are the ones who provide a role model for many other members of a social system and decrease their uncertainty about a new idea by adopting the innovation and then conveying a subjective evaluation of it to other members. In other words, early adopters play the role of opinion leader in the system.

The next 34 percent of adopters are called early majority, which refers to those people who adopts new ideas just before the average member of a system does. By the time the early majority has finished their adoption, the first half of members in the system has adopted the innovation. Therefore, the early majority holds a unique position of becoming an interconnecting link between the very early adopters and the relatively late adopters. Following the early majority, the late majority makes up another 34 percent who adopt the new idea. These are the people who do not adopt the innovation until most others in their system have already done so. The last 16 percent of adopters are called laggards. They adopt an innovation at the last, if they adopt it at all.

In his book, *Diffusion of Innovations*, Rogers (2003) states that the diffusion of innovation is composed of a series of factors (see Figure 2.6). These factors include the characteristics of change agents and adopters (labeled receivers in the diagram), the perceived characteristics of the innovation, the communication channels through which information about the benefits of the innovation are spread, the social system in which the diffusion of the innovation occurs, and the temporal stages of that diffusion process—namely, the time that has elapsed since the introduction of the innovation (see Rogers, 2003 for details on each factor).

As identified by Rogers personally with the term *pro-innovation bias*, much of the diffusion research has since been aimed at identifying those conditions that can increase or decrease the likelihood of adoption in a given society. The majority of these studies have focused on characteristics of the early adopters and the innovation. Prior research has shown that early adopters differ from later adopters in terms of socio-economic status, personality, and communication behavior. For innovation, trialability, observabililty, and perceived relative advantage are known to be success factors that can lead to adoption (Rogers, 2003; Tornatzky & Klein, 1982).

Figure 2.6 Conceptual Model of Diffusion of Innovation




Source: Rogers (2003)

This research tradition does have serious shortcomings because it ignores broader, contextual factors that either precede the perceived characteristics of innovation or moderate the whole process. The conceptual model of innovation diffusion clearly shows that the focal point of prior diffusion research centers exclusively on one stage, persuasion, but neglects other factors and stages that occur in the process (see Figure 2.6).

Recent variations in diffusion research in business and information systems fields are the theory of reasoned action (TRA: Ajzen & Fishbein, 1980) and the technology acceptance model (TAM: Davis, 1989). As an extension of TRA, TAM employs perceived ease-of-use, influences (PEUI), and perceived usefulness (PU) as antecedents of the behavioral intention to use a specific IT (BI) (Srite & Karahanna, 2006, p. 682). Although TAM is considered the most parsimonious and widely accepted model of technology acceptance at the individual level, in its initial conceptualization, it also failed to incorporate the effect of social environment on behavioral intention.

For the successful diffusion of any innovation, all contextual factors in Figure 2.6 should be considered in addition to any innovation characteristics. The existence of these factors implies that the diffusion of innovation is a complicated process where the mere introduction of an innovative product alone does not guarantee its successful adoption and diffusion across the system. In addition to identifying what factors exert influence in the process, understanding the conditions under which the magnitude or direction of the impact of the innovation is modified will provide a useful tool to use to compare the diffusion rates as well as the relative extent to which the innovation is adopted across different systems.

Another criticism of the diffusion study tradition is its lack of a macro-level cross-national approach, which may be a corollary of simply overlooking non-innovation factors, such as social system. Critics of the classical diffusion of innovation theory argue that the theory is weak in its explanatory power and not very useful in actual prediction of outcomes. This criticism is partially due to the fact that many of the essential elements discussed in the diffusion process are overly specific to individual or small organizations from which the diffusion related factors were originally derived, leading the findings then to be non-applicable to other systems or cultures. In addition, from its outset, the diffusion of innovation theory has been predominantly studied at the individual level, exploring why certain people accept innovations easily and early while it takes more time for others to adopt the innovation. Therefore, the concept was frequently out of focus in terms of addressing how external or macro-level factors affect the diffusion process across larger systems, such as an entire nation.

In his work, Rogers (2003) groups diffusion research into several types according to their research purpose and major findings. These include the earliness of knowing about an innovation, the rate of adoption of different innovations into a system, innovativeness, opinion leadership, diffusion networks, rate of adoption, and consequences of adopting innovations in different social systems. Of these 7 categories, Rogers found that only 2 percent of diffusion publication fell in to the last category where the characteristics of the system affect the rate of adoption. This aspect is a significant flaw since macro-level factors, such as economy or policy, do indeed influence the overall adoption process, limiting the affordability, accessibility, and availability of innovations—even when the main focus is adoption at the individual level. The issue becomes more important when considering that many countries have tried to adopt and diffuse ICTs at the national level. In a similar vein, Rai et al. (1998) showed that ignoring external factors (or the system variables in the conceptual model in Figure 2.6) will lead to a poor model for global Internet diffusion.

Recent studies in business management and information system (IS) fields have noted this flaw and begun to incorporate external factors into their diffusion of innovative consumer products. Yet, because of its short history and partially due to the difficulty in quantifying macro-level factors other than economic indicators, many non-conventional influence factors, such as government policy and prominent national cultural values, have rarely been examined in studies to date. When these macro level factors were incorporated into the study, different researchers adopted different measurements even when examining the impact of the macro level factor on the same dependent variable (Gong, Li & Stump, 2007).

Inevitably, contradictions were thus frequently found among different study results even when the researchers had similar research questions as starting points. For example, in a study on eight consumer products from five nations, Takada and Jain (1991) reported that the diffusion of consumer products was culture-specific, indicating that successful diffusion of a certain product is determined by whether that product corresponds to the nation’s cultural characteristics. As one indicator of the national culture, they applied the high/low context culture argument suggested by Hall (1976). According to their findings, countries characterized by high context culture - where much of the information involved in communication resides within context, without much actually being explicitly spoken or written - show a higher rate of adoption than those characterized by low context culture and heterophilous communications do. Yet in a subsequent study conducted by Helsen, Jedidi, and Desarbo (1993), the diffusion of innovative consumer products was found to be rather product-specific and not influenced by macro-level factors. Such contradictions, however, do call for the inclusion of macro-level factors as well as more consistent measurements based on the theory across various studies of different products.

Until recently, despite the importance of ICT, only a handful of scholars paid any attention to the adoption of ICT and ICT-related innovations. The study by Zhao et al. provides supporting evidence for this claim (Zhao, Kim, Suh & Du, 2007). Zhao et al. searched related literature on Internet diffusion/adoption in academic and peer-reviewed journals as far back as 1995 but were able to retrieve only 46 academic articles using the key words *Internet diffusion* or *Internet adoption*. Of the 46 articles found, only 14 were quantitative studies, and the number of studies adopting a cross-country approach were but a mere 5. Needless to say, the classical problem of overlooking macro-level factors was common even among those few quantitative studies. Kwon and Zmud's study (1987) is one of the early studies on ICT adoption that exemplifies this research trend. In their study, Kwon and his colleague proposed a diffusion model that focused on IT and examined a range of variables, including innovation characteristics, individual characteristics, environmental characteristics, task characteristics, and organizational characteristics. Although this model is considered more comprehensive than earlier models of innovation diffusion studies and does include environmental characteristics, it is more suited to an organizational atmosphere than it to the influence of broader national-level factors.

To respond to the criticisms discussed above, the current study investigates the importance of national-level factors on the adoption of ICT, specifically broadband

Internet. Expanding the scope of research and adopting various macro-level factors allows this study to construct a more appropriate diffusion model across different levels of systems. This approach is especially necessary when considering the characteristics and widespread impact of modern ICT on the entire society or even on a global scale. Here, we include national-level variables and both conventional factors and non-conventional macro-level factors. Conventional influence factors in the current study refer to various socio-economic variables, such as economy, demographics, and infrastructure, which have been found in previous research to correlate with the adoption of consumer products. Non-conventional, macro-level influence factors refer to the variables that were left out in previous studies despite their importance. The following sections discuss the current literature on these factors in detail and provide a basis for the research questions and the hypotheses for this study.

## Conventional Influence Factors in Nationwide ICT Diffusion

The diffusion literature indicates that the adoption and diffusion of new products and ideas are influenced by socio-economic factors, although the impact of these factors is not always consistent. Recent research suggests that various socio-economic factors operate at either the individual or national level, including GDP per capita, education/literacy level of the population, mobility, number of women in the labor force, urbanization, access to mass media, service sector development, PC ownership, electricity consumption, telephones per capita, life expectancy, physicians per capita, and so on (Gatignon et al., 1989; Helsen et al., 1993; Lee, 1990; Maitland & Bauer, 2001; Robison & Crenshaw, 2002; Takada & Jain, 1991; Tellefsen & Takada, 1999; Yeniyurt

& Townsed, 2003). The measures representing socio-economic factors need to be included in any current study of ICD adoption, not only to control explicitly for their effect on broadband Internet diffusion, but also to recognize of the possibility that these factors may also moderate the effects of non-traditional macro-level variables, especially the prominent cultural values of a nation and ICT-related government involvement. Conventional influence factors in this study can be categorized into three groups, each with several variables in it: Economy, demographics, and Infrastructure.

*Economy*

It is well known that the economy and innovative capacity correlate, although no clear-cut causal relationship has yet been proven. For instance, researchers like Shmookler (1972) and Beniger (1986) argue that an increase in sales stimulates investment in innovation efforts, which are then commonly extended to economic growth, implying a circular relationship. On another note, scholars, such as DeLong and Summers (1991), have found evidence to support the notion moving in an opposite direction, indicating that innovation precedes productivity, which then leads to economic growth.

Similar reasoning applies to the relationship between innovative technology and the economy. A few available studies in the literature on the relationship between technology and productivity and economic development have provided still another set of mixed results (Brynjolfsson & Hitt, 1993; Romer, 1990). Technological growth may be dependent on the degree of economic development, but the introduction of innovative technology may also emanate from the attempts by firms to earn more profit in the future. The market incentive of targeting potential extra profit induced by using new technology may result in increased productivity and subsequent economic growth. The presence of conflicting study results thus do not allow researchers to assume a clear-cut causality regarding the direction of the influence. As a result, it is commonly hypothesized that economic status—as measured by GDP per capita—is positively "related" to ICT adoption, instead of simply using the term "caused."

Rogers (2003) stated that socioeconomic factors, which are commonly measured by education and income level, are the determinants of the diffusion of innovations. Rogers has found in a study of technology diffusion that economic wealth strongly predicts a population's adoption of new technologies. The level of economic development of a nation is usually closely related to the level of Internet diffusion since a wealthier country can afford other communications tools and a well-developed telecommunications network, which then provides the basis for and lower initial cost of Internet diffusion (Oh, 2000). In other words, at a country level, overall economic strength will affect Internet diffusion in that the necessary resources are more likely to be present and the capital required for the expansion of the technology will be more available in richer countries (Bazar & Boalch, 1997; Harigittai, 1999). In the case of global broadband diffusion, this discussion suggests that countries with a higher level of economic development will be more likely to show higher diffusion rates than will nations with less wealth.

*Demographics*

Education is considered one of the main components of the human capital for productivity and also ICT use. Research in economics has indicated that a positive relationship exists between education and economic growth (e.g., Barro & Lee, 1993; Granato, Inglehart, & Leblang 1996; Summers & Heston, 1988). Education promotes socio-economic development through facilitating the movement of workers between sectors by providing them with necessary skills and attitudes and encouraging rapid rural-to-urban migration. Consequently, an educated workforce reduces training costs and simultaneously allows for an accelerated pace of technological change in the workplace. This relationship between education and socio-economic development is mutually related as each fosters the growth of the other. As a result, the more affluent nations have a higher level of literacy, considerable public and private support for education, and extensive arrays of educational institutions. Thus, it is logical to expect that the demand for technological innovations and related skills will be driven, at least in part, by the degree of education in a population (Robison & Crenshaw, 2002).

Rogers (2003) also reports that 73 percent of prior studies support a positive relationship between education and innovativeness. Individuals with higher education levels are likely more aware of the importance of information and may have more actual need for innovations. As a result, highly educated people are quicker to adopt new innovations. Studies on ICT adoption at the individual level have also demonstrated that new ICT users, such as Internet adopters, are likely to be both highly educated and relatively young. Even in the United States, results from a nationwide survey indicate that the respondents' education level is an important indicator of Internet adoption, along with other variables, such as gender and income (Lenhart, 2000) since in order to use ICT products like the Internet, an individual needs certain level of literacy and some reasonable computer knowledge. Based on the discussion in this section, a positive relationship is assumed for the effect of education on innovation diffusion.

Several recent studies on successful broadband Internet diffusion have started to include other macro-level factors that were overlooked in the previous research—namely, geography and demographics (Aizu, 2002; ITU, 2003b; Wong, 2003). Although using different terms, Frieden (2005) also listed a number of "localized characteristics" that affect nationwide broadband Internet penetration. By localized characteristics, he means various factors that either promote or hinder the diffusion of broadband Internet. He states that these localized factors can be measured based on nation size, population density, percentage of high-rise housing, size of households, and other related indicators.

Inevitably, nations and administrative regions with relatively small land territory, such as Singapore and Hong Kong, may be able to succeed in ICT adoption and diffusion more easily than other countries. Given the fact that a wired IT infrastructure is required for adoption and diffusion of new ICTs like the Internet, telecommunication carriers in these societies have a relative advantage by having to install fewer lines and serving more people with a single line. Furthermore, if the population of a nation is highly concentrated in small areas, new services can be more readily introduced with comparatively higher correlated penetration rates within a shorter period of time (ITU, 2003b).

In other words, whether it is geography, demographics, or living conditions, physical proximity between potential users of ICT is another important factor for successful ICT adoption and diffusion. Singapore and Korea are good examples and illustrate the advantage of close physical proximity—here represented by high urban population density. In the same context, reports on the Korean case mention housing patterns as another important success factor, pointing to high-rise multiple-dwelling units

(MDUs) in metropolitan areas (ITU, 2003; Lee, 2001). In 2003 when an ITU report on the Korean case was published, 82% of Koreans lived in urban areas, and 48% of total Korean housing stock was high-density dwelling units, such as apartments. Moreover, about 90% of Korean households were within a radius of 4 km from a local exchange, making "the last/first mile" question a less serious problem for the deployment of ADSL in Korea than in similar countries. These factors may also interact with the economy factor because, geographically speaking, small nations with high incomes—as evident in many countries in Europe—may not need to subsidize rural and low-income residential areas nor establish a substantial amount of funding for ICT deployment to begin.

The reality then is that obtaining data on housing patterns to compare each country's ICT diffusion is difficult, which is probably why some researchers have not mentioning these factors and not actually undertaken an empirical analysis to examine the degree of influence the factors have on ICT adoption and the diffusion process. Considering this real-world practical limitation, population density and urban population have been frequently adopted in previous research as a proxy and a positive relationship between these factors and the adoption of a product has been tested.

In summary, for broadband diffusion, the above discussion suggests that countries with better educated people, high population density, and small territory will be more likely to show higher rates of broadband Internet diffusion.

Unlike in prior research, Ethinic-linguistic fractionalization (ELF) was considered as one of the demographic variables in this study. Critics of Hofstede's work or other cultural indices have argued that the use of aggregated personal traits to characterize a national culture is an oversimplification of culture since different subcultures are not well represented in the aggregation (Søndergaard, 1994). It is true that most comparative work on cultural values is based on the assumption that there is a large degree of homogeneity within nation states as opposed to large differences between nation states. However, as we can see in the case of the U.S. or in other nations where multi ethnic groups coexist, assuming homogeneous belief and value system across the whole population may be misleading.

In this respect, Ethnic-Linguistic Fractionalization (ELF) index may offer a useful tool to control for diversity within a society. ELF index represents heterogeneity of a population by calculating the probability of two people in a society coming from different ethnic, linguistic, or religious background. Therefore, the larger the number of heterogeneous groups in a country, the higher the value of the resulting ELF index (Annett, 2001). For example, ELF index score for Korea is virtually zero as its population is mostly composed of single ethnic group, and only one official language, Korean, is used throughout the country. A number of researchers have presented different indices of the ethnic-linguistic fractionalization in the past (Mauro, 1995; Roberts, 1962; Taylor & Hudson, 1972). Until recently, the index based on the data surveyed by Soviet scholars in the 1960s has been frequently used due to its larger sample size and extensive inclusion of subgroups within each country.

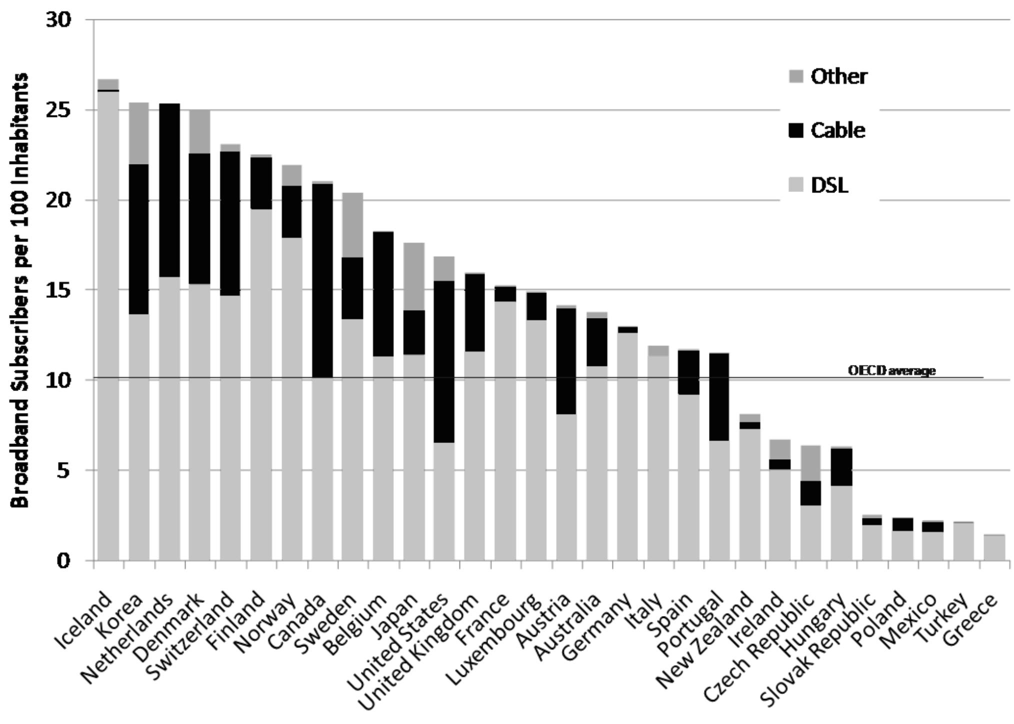
Although it may not be the perfect measure of the relative strength of competing subculture groups within a society, ELF index has been used in economics and political science as a proxy for deterrent to economic growth or political stability. In economics, higher fractionalization has been related to lower productivity growth. In political science, it has been found empirically that higher fractionalization leads to higher instability, and higher instability leads to higher government corruption (Annett, 2001). Given the fact that ELF index is reflecting the heterogeneity of members within a nation, this index may become another controlling factor of ICT adoption and diffusion since it is easier for an innovation to be diffused within a homogeneous society once it is introduced.

*Infrastructure*

Although technical infrastructure requirements vary for different ICT products, ICT adoption in general should positively relate to IT infrastructure, as a physical infrastructure is required to support ICT. Given that the Internet is a network-based innovation, existing infrastructure could be a crucial factor influencing its diffusion because potential users must have access to the network before they can make their adoption decisions. For instance, Maitland(1998) and Ahn and Lee(1999) report that the number of fixed lines per capita does have a positive influence on the adoption of mobile telephone service, another network-based innovation similar to the Internet. Thomas (1988) state that the diffusion of technology is highly related to having certain technological and infrastructural factors present in the target nation. On another note, the level of Internet diffusion may be limited in countries with a poor telecommunication infrastructure (Kelly & Petranzzini, 1997; Hargittai, 1999 ). For example, Bazar and colleague report that, except for South Africa, Internet connectivity in most African countries is still very limited because of their poor telecommunications infrastructure which also highly correlates with the lack of enough capital investment (Bazar & Boalch, 1997).

As the previous discussion indicates, an existing IT infrastructure base, such as electrical power supplies or telephone lines, are important factors to consider in any ICT adoption studies (Gurbaxani et al., 1990; Moore & Benbasat, 1991). In the case of technology like broadband Internet, the existing wired IT infrastructure is more important because the majority of the connections are is still achieve through ADSL in many countries (see Figure 2.7).

Figure 2.7 Broadband Internet Penetration by Technology (OECD, 2005)




Several infrastructure requirements must exist for Internet connection. Considering that broadband Internet connection via ADSL takes up a greater proportion of broadband Internet connection methods, the telephone line is the most important infrastructure for the diffusion of broadband Internet. In addition, the number of cable networks should also be considered, as more people are now connecting to high-speed Internet via cable modems. The last but not least infrastructure requirement, which may not be fully important yet, but will become more so in the future, is the wireless infrastructure. In countries where information and telecommunication infrastructure is lacking and building conventional landline-based infrastructures is not an available option, whether because of geographical obstacles or scarce resources, the ICT adoption level may not relate to (or even negatively relate to) the existing IT infrastructure, especially when a new ICT provides an effective substitute for the more expensive, more conventional ICT. This may be the case for mobile technology, which does not heavily depend on then existing wired, landline-based infrastructure of older technologies. The proportion of the mobile network is increasing as an additional conduit, especially in several Eastern European and African countries.

OECD data collection has begun to reflect this change by choosing broadband Internet subscriptions over wireless networks, especially where a large number of fixed wireless broadband connections are provided over mobile networks, such as in the Czech Republic (OECD, 2008). For the Internet, other measures directly related to actual Internet use, such as Internet-enabled computer ownership, may be another considered form of infrastructure, as it is a necessary pre-requisite for broadband subscription in particular. In addition, Internet speed, number of secure servers, and locally relevant content are also thought to drive demand.

Another important predictor for innovative ICT diffusion is price or usage cost, again influenced by both the economy and the level of IT infrastructure development in a country. At the individual level, the cost to purchase or use certain ICT products may affect the adoption and diffusion of the technology more directly. Therefore, it is assumed that the diffusion of broadband Internet will be higher in those countries with low broadband Internet usage fees. The main issue for this predictor is reality. It is difficult to obtain a standardized data set for costs across the world, as each country has a different level of IT infrastructure based, which then determines both speed and price of connection. In addition, in the case of broadband Internet, cross-national time-series data is almost totally absent, as that type of data has not been surveyed systematically over time. For example, as of 2008, ITU still offers data on broadband Internet cost only for 2003 and 2006.

### Culture as a Non-Conventional Influence Factor

Many scholars agree that culture is one of the most important, yet at the same time, extremely abstract constructs affecting people's attitudes and behavior. Consequently, culture is defined in many different ways.[1] In 1952, Kroeber defined culture as "the historically differentiated and variable mass of customary ways of functioning of human societies" (p. 157). Culture was further formulated by Kroeber and Parsons as being "transmitted and created content and patterns of value, ideas, and other symbolic meaningful systems as factors in the shaping of human behavior and the artifacts produced through behavior" (1958, p. 583). In a more recent work, Herbig and Dunphy (1998) define culture as the sum total of a way of life, which encompasses the values, traits, or behaviors shared by people within a region. These researchers also note the function of culture, which is to reduce uncertainty, increase predictability, and thereby promote survival of members by providing modes of conducts and standards of

[1] In the current study "culture" does not refer to the culture of the arts, theater, or refinements of one's social group that make individuals appear acceptable or higher up on the social status when executed or enjoyed.

performance. Other scholars also define culture as shared characteristics of a social system or the shared values of a particular group of people (Erez & Earley, 1993; Parsons & Shils, 1951). The common element of most definitions of culture is that culture reflects the core values and belief system that influence, if not actually determine, individuals' attitudes and behaviors as both are formed and reinforced throughout life (Lachman, 1983; Triandis, 1995).

Just as there are numerous definitions of culture, different models have also been established to map out differences in the prominent cultural values of a nation. Many scholars have turned to "dimensions," or specific "traits" of culture to distinguish different systems of cultural values among different nations. One of the most widely used models for defining cultural dimension was developed by Hofstede (1980, 2001) in the field of international business management. According to Hofstede, prominent national cultural values [national culture] are the set of collective beliefs and values that distinguishes people of one nationality from those of another. Unlike other theorists who presume the transformation or a change of culture over time, Hofstede's definition of culture assumes stability. Hofstede claims that the reinforcement of cultural patterns by socio-economic institutions within a nation makes these patterns less vulnerable to drastic change. Even if cultures shift in the long term he believes that "they shift in formation, so that the differences between them [still] remain intact" (Hofstede, 2001, p. 255). This point has something in common with Inglehart and Baker's (2000) work, another well-known, cultural value- related research in political science, in that these researchers confirmed the presence of distinguishable cultural zones across the world over time, although these authors are initially better known for upholding the generational cultural shift.

*Culture and Innovation Diffusion Research*

Just as an individual's characteristics are an important factor in the adoption of any innovation, prominent national cultural values play an important role in the adoption and diffusion of ICTs. Research on culture and innovation has shown that a significant association exists between national culture and national capabilities for innovation generation, adoption, and diffusion.

The majority of the research on the interplay between culture and technological innovation follows the classical view that says that, as a result of technological innovation, cultural attributes within a society will shift or be modified (Herbig & Miller, 1992, p. 77). The current study, however, considers the opposite flow—namely, that cultural traits of a society/nation will influence the capabilities of that society to adopt and diffuse technological innovations. This approach derives from the observation that it is not uncommon for a new product or technological innovation to gain rapid acceptance in certain countries, whereas it takes a substantially longer time to penetrate other countries (Dwyer et al., 2005; Gatignon et al., 1989; Kumar & Krishnan, 2002; La Ferle et al., 2002; Mahajan & Muller, 1994; Maitland & Bauer 2001; Takada & Jain, 1991; Tellefsen & Takada, 1999; Tellis et al., 2003; Van Everdingen & Waarts, 2003; Yeniyurt & Townsend, 2003).

Although not empirically tested yet, earlier works on technological innovation have noted the importance of culture and how it is influencing the adoption and diffusion process through social environmental factors. Barnett (1953) states that a number of cultural, psychological, social, and institutional arrangements need to be in place before people will be persuaded to adopt and use technologies. Saxon (1954) also notes that "if the behavior, ideas, and material apparatus which must accompany the use of innovation can affect improvements along lines already laid down in the culture, the possibilities of acceptance are much greater" (as cited in Herbig & Dunphy, 1998, p. 14). Despite its significance and research call, culture has not frequently been incorporated into actual studies due to the difficulty involved in actual operationalization and measurement. When examined in any comparative study, that examination was done most frequently in the context of business practices or just one or two non-ICT consumer products, such as (Brewer, 1998; Child, 1980).

Recent studies that have attempted to employ culture indicate that cultural characteristics, including religion and ideology, do influence national-level innovations (Ruttan, 1988). More specifically, Mokyr (1991) indicates that cultural values, such as openness to new information, willingness to take risks, religion, and value of education to a society, do indeed matter in generating technological progress. Herbig and Miller (1991) report that cultural attributes are the primary factor explaining different innovative expertise seen in the United States and Japan. In a later study, Herbig and Dunphy (1998) even hold that existing cultural conditions "determine" whether, when, how, and in what form a new innovation will be adopted (p. 14).

What is commonly found among all these studies is evidence supporting the idea that prominent cultural values of a nation influence its innovative capacity to adopt as well as generate innovations. Inconsistency in the study results does not necessarily mean that culture has an unsubstantial effect on adoption and diffusion of innovative ICTs.

Instead, inconsistent findings may indeed derive from the interplay between culture and other factors in the diffusion process.

Referring to the various adopter categories suggested by Rogers, Lee (1990) indicates that, although early adopters were clearly innovative, laggards or non-adopters did not have the necessary traits conducive to innovation. This view implies that perhaps different mechanics should be applied to innovators and laggards. In other words, although the diffusion of innovation may be considered as the extension or accumulation of single adoptions over time, diffusion is more than just a sum of individual adoptions and the same cultural traits may be more (or less) favorable for different stages of diffusion. For instance, cultural values that positively affect innovative capability, such as individualism, heterogeneity, and risk-taking, may be more important in the early stage of diffusion, whereas those that are deemed to hinder innovation, such as collectivism and homogeneity, may be more conducive to diffusion. The following sections discuss in detail two national cultural value measures that have been employed in various studies.

*Hofstede's Cultural Dimensions*

One of the more frequently used national cultural value measures was developed from Hofstede's value survey (1980; 1991; 2001). His cultural dimensions were constructed based on survey data gathered from employees working in 66 subsidiaries of the IBM Corporation throughout the world. According to Hofstede (1980, 2001), prominent national cultural values measured by his cultural dimensions explained 50 percent of the variance in employees' attitudes and behaviors at IBM. From the survey results, he identified five dimensions of culture that affect attitude and the behavior of individuals in each nation: [acceptance of uneven] power distance, individualism-collectivism, uncertainty avoidance, masculinity-femininity, and long-term orientation. Among those five categories, the first three dimensions—acceptance of uneven power distance, individualism, and uncertainty avoidance—are the ones most frequently discussed in regard to ICT adoption and diffusion, as they were found to be more closely related to innovativeness and decision- making within organizations.[2]

The *power distance dimension* (PDI) is defined as "the extent to which the less powerful members of institutions and organizations within a country expect and accept that power is distributed unequally" in the system (Hofstede, 1991, p. 27). This dimension relates to maintaining the status quo and conservatism. Consequently, in high-power distance cultures, decisions are often hierarchical and centralized with subordinates being less likely to disagree with their superiors. Meanwhile, cultures exemplifying low- power distance are more participative and have more tolerance for any lack of conformity to authority.

Within the context of innovation diffusion, people from low-power distance cultures are expected to be more innovative and willing to try new things, as they are less bound by an existing hierarchy, the status quo, and authority. A culture readily accepting uneven power distribution among members [a high- power distance culture] does not

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[2] Long-term orientation refers to upholding values that are oriented toward future rewards, such as perseverance and thrift, having a sense of shame, and support for ordering relationship by status (Hofstede, 2005). This value dimension appears to be more relevant for examining the difference between East Asian countries and others, as Far East Asian countries rank high in terms of dimension score. Yet, due to the limitation of available data (n=39), this particular cultural dimension was not included in this study. Furthermore, it was observed that countries with a higher level of broadband Internet diffusion are not positioned in clusters in the ranking, implying that this variable may not be a significant indicator of broadband Internet diffusion. Indeed a zero-order correlation analysis indicates that this value measure does not correlate with measures of overall Internet diffusion or broadband Internet diffusion.

provide any condition under which innovation is easily generated or accepted. In other words, societies exhibiting large power distances are less innovative because people in such cultures are encouraged to respect authority, follow directions, and avoid standing out through original thinking (Herbig & Miller, 1991)

The Internet or other high- tech innovations are more likely to be viewed as being primarily available to a society's elites and be their possessions; thus, the innovations reflect their high socio-economic status (Gong et al., 2007; Hofstede, 2001). In high-power-distance cultures, the less powerful members are more apt to depend on opinion leaders and those with power when making decisions to adopt new innovations. Therefore, the adoption of a new innovation by the powerful members in a high-power-distance society has a stronger influence on the purchase decisions of the less powerful members. Further, Hofstede (2001) indicates that members of high-power-distance countries have a much greater level of confidence in the press or mainstream media. Individuals in this culture may take less initiative in considering and discussing the introduction of new products on their own and tend to wait for signals from authority figures or opinion leaders regarding innovation adoption. They pay closer attention to and place greater trust in news media for product information. Given the scale, speed, and efficiency of information transmission among today's media, once the message becomes clear that a certain innovation is being adopted by authority figures, new product diffusion rates will be faster in high-power-distance countries (Dwyer et al., 2005). Therefore, the direction of the effect of power distance dimensions may be different in early and later stages of diffusion.

The *individualism-collectivism dimension* (IDV) relates to the way that people interact with each other and live together. This dimension essentially describes the relation between the group and the individual (Hofstede, 2001). Highly individualistic societies are characterized by loose or weak ties between its individuals. In other words, everyone is expected to look after himself and his immediate family in a highly individualistic-oriented society. Personal freedom is valued, and individual decision - making is encouraged in individualistic societies (Singh et al., 2003). On the other hand, collectivism is used when describing societies in which people from birth onwards are integrated into strong, cohesive groups that protect their members in exchange for their members' loyalty to the group.

Thus, following Hofstede's argument, in countries where collectivism is prevalent, loyalty to the group to which one belongs is considered more important than efficiency . In the same vein, obligations and group harmony come before individual aspirations or goals in these collective cultures. This view is in contrast to countries that exemplify high individualism, where personal time and achievement are more valued. It is thus a corollary that, to the extent that ICT products, such as PDAs and cellular technologies, promote individual performance and fulfill obligations to oneself, their diffusion would be greater in countries whose cultures are characterized by individualism than in those countries characterized by collectivism.

It has been argued that members of highly individualistic cultures tend to exhibit more favorable attitudes toward differentiation and uniqueness, while members of collectivist cultures tend to show more favorable attitudes toward building and maintaining relationships with people within their determined social structure (Gong et al., 2005). Therefore, people in individualist cultures seem to have more freedom to develop or try new things on their own than do those in collectivist societies. This mechanism is reflected in the results of studies that report that patents are more often granted in individualistic countries than in collectivistic countries (Hofstede, 2001). Other research on innovation has also indicated that a positive correlation exists between individualism and the potential for innovation . However, as indicated in the previous section, the diffusion process requires additional speculation.

In his work, Hofstede (2001) states that the individualism-collectivism dimension of culture corresponds closely to Hall's (1976) high/low-context typology. Collectivism is comparable to Hall's high-context cultures, where much of the information involved in communication resides within context, without much actually being explicitly spoken or written. As mentioned in the discussion of high versus low power distance cultures, the rate of innovation diffusion is highly dependent on the communication process. Therefore, factors that enhance the efficiency of this communication process should positively affect the rate of innovation diffusion throughout a population. In highly individualistic cultures, the ties between people are relatively loose, and individuals are not integrated as much they are in collectivist cultures. This reduces the flow of information on new innovation. In highly collectivistic cultures, opinions established by the group are highly valued and easily conveyed among already tightly networked people. Therefore, once a new innovative product is accepted and approved by innovative members of the group, that product is likely to gain more rapid acceptance by its conformity-minded members in a collectivist society (Gong et al., 2005). In summary, innovation sourcing or generation may be more likely to occur in individualistic cultures, while high collectivism provides a better ground for subsequent diffusion of an accepted innovation by offering a more efficient communication context in which the acceptance of new product innovation can be enhanced.

The *uncertainty avoidance dimension* (UAI) refers to "the extent to which the members of a culture feel threatened by uncertain or unknown situations" (Hofstede, 1991, p. 113). In other words, the dimension indicates the degree to which societies can tolerate uncertainty and ambiguity. Individuals from cultures where an uncertainty avoidance tendency is high are more rule-oriented and have less tolerance for different opinions and behaviors. They further have a tendency to avoid risk and reinforce mechanisms to reduce risk. Considering that cultural characteristics are known to be more conducive to innovation, high-uncertainty avoidance cultures are expected to be less innovative and less accepting of new innovations.

Cultures with low uncertainty avoidance exhibit a greater tolerance for different opinions, and people in such societies tend to more willing to take risks and try new things, thereby becoming more innovative and entrepreneurial. For instance, Lynch and Beck (2001) report that Asian consumers are less secure when shopping online, which may be a manifestation of the high uncertainty avoidance in these countries (e.g., China, Japan, and Taiwan). Rogers (1999) also acknowledges that uncertainty influences the diffusion of innovations. Hofstede likewise notes that low-uncertainty avoidance cultures make greater use of the Internet than do high-uncertainty avoidance oriented societies. Similarly, several recent studies have found evidence of a negative relationship between a country's degree of uncertainty avoidance and the penetration of the Internet and other technological innovations (La Ferle et al., 2002; Lynn & Gelb, 1996; Yeniyurt & Townsend, 2003).

In high-uncertainty-avoidance cultures, the tendency to avoid probable failure caused by risk- taking is relatively great. Since any new technology is associated with at least some initial uncertainty, ICT adoption would likely be slower in these societies, especially when the functions that the ICT is performing are fairly new. Over time, however, people get used to the new innovative technology, and that sense of acceptance will contribute more to reducing the initial uncertainty and ambiguity in daily tasks. Therefore, if technology adoption reaches a certain point where the initial uncertainty aspect has been resolved, the influence of high or low uncertainty avoidance may diminish. [3]

Despite criticism, Hofstede's framework has remained useful for future theory development and validation in cross-cultural studies. His framework is widely cited in the fields of international business management, psychology, and sociology research (Barkema & Vermeulen, 1997; Hoppe, 1992; Sondergaard, 1994, Steenkamp, Hofstede, & Weddles, 1999). Until recently, however, studies' utilizing Hofstede's cultural dimension indices focused mostly on the innovative capacity of small business organizations and non-ICT consumer products. Therefore, by employing Hofstede's cultural dimensions in the study of cross-national broadband Internet diffusion and adoption, the current study will contribute to the evolution of this research tradition and expand its useful application scope to ICT as well .

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[3] At the same time, the pace of adoption after this threshold may change due to the combination with other factors. For instance, in a society characterized by collectivism and high uncertainty avoidance, individuals are less inclined to take responsibility or assume risk and tend to delay innovation adoption at the initial stage. However, if the decision for ICT adoption is presented in a way that emphasizes the group or other members' decision, perceived uncertainty is reduced,and the specific innovation may be accepted and diffused more swiftly.

*Inglehart's World Values Survey*

Another widely used system for measuring cultural differences between nations was developed by Inglehart (1997) in the field of political science. Opponents of Hofstede's framework contend that his conclusion may not be valid in the long term for several reasons (Igbaria, Iivari, & Maragahh, 1995; Kamel & Davison, 1998; Myers & Tan, 2002; O'Reilly, 1993). In addition to issues with its assumed stability, one of the major criticisms of Hofstede's framework centers on the fact that the survey was done on employees of a specific business organization; thus, the results lack generalizability. In this respect, Inglehart's (1995, 1998, 2000, 2005) framework may offer a viable alternative, as his World Values Survey utilized representative national surveys from 81 countries.

Employing Inglehart's value measures has another implication. Because of its origin, researchers in business management, psychology, and organizational studies have extensively used Hofstede's index, whereas researchers in political science prefer Inglehart's. As a result, Inglehart's value measures are scarcely used in innovation-related studies, even though they are based on questions more applicable to the general public. A few recent studies employing Inglehart's value measures in ICT-related research include the works of Bagchi (2004) and Skoric (2006). However, both studies employ different value measures, and the dependent ICT technology does not include broadband Internet. In addition, other important macro-level variables, such as ICT-related government involvement and unique demographics, were not incorporated into their analysis.

Contrary to Hofstede's approach, which is informed by cultural theory and emphasizes path dependency, Inglehart's study is based on modernization theory, which argues that the processes of economic and social development also lead to cultural change over time. Using cross-national surveys spanning more than two decades, Inglehart provides empirical support for the notion that culture has an independent influence on economic development and political structure. The cultural map of the world constructed by Inglehart represents closely correlated basic values that are charted along two major dimensions of cross-cultural variation: Traditional versus Secular-rational values and Survival versus Self-expression values (1995; 1998; 2000; 2005).

According to the analyses by Inglehart and his colleagues, these two cultural dimensions explain more than 70 percent of the cross-national variance in a factor analysis that uses ten indicators of economic and political orientations (Inglehart & Baker, 2000). Based on the data from four waves of surveys extending from the early 1980s to the early 2000s, the researchers found evidence that cultural orientations have shifted from traditional toward secular-rational values in almost all industrial societies. At the same time, they also report that modernization is not a linear development; thus, when a society has completed its industrialization and starts becoming a knowledge society, it moves in a new direction—from survival values toward increasing emphasis on self-expression values. Although Inglehart and his colleagues' World Values Survey results provide evidence of a cultural shift, they also present a cultural map that indicate that distinctive cultural traditions continue to exist among different countries. Also, countries of similar cultural values and tradition tend to cluster together.

According to Inglehart, traditional value-oriented societies emphasize the importance of God, national pride, respect for parents, family, and authority. In addition, societies at the end of the traditional pole of cultural dimension emphasize social conformity rather than individualistic striving, support deference to authority, and have a nationalistic outlook. These values typically represent pre-industrial values. To the contrary, societies that score high on secular-rational values prefer the opposite of traditional values, namely, secular-ration value, represent post-industrial values.

Self-expression values emphasize subjective well-being, quality of life, freedom in work, civic activism, and interpersonal trust, of all of which emerge in post-industrial societies where relatively high levels of existential security and individual autonomy have already been achieved. Survival values emphasize the opposite of self-expression values, that is, economic and physical security. In addition, societies that are oriented toward survival values can feel threatened by foreigners, ethnic diversity, and cultural change.

The survival versus self-expression values dimension involves a polarization between materialistic and post-materialist values. When these two value dimensions are discussed within the context of innovation diffusion, new ICT may be adopted more carefully in a society with highly traditional values, as the innovation may be deemed to be a threat to the existing social system. Furthermore, characteristics of new ICT that promote quality of life and freedom in work may correspond to a desire for/acceptance of self-expressive values. Thus diffusion rates for such ICT will be higher in societies that score high in the survival value dimension versus the self-expression values dimension.[4]

[4] The relationship may be different when the innovative technology of inquiry has different characteristics. For instance, societies with a strong survival value orientation may emphasize production-related ICT as a means to promote economic development. However, the current study is limited to the discussion of consumer ICT products that are used by consumers on a daily basis, not the innovative product in domains of economic activities, although use of

There are other researchers who studied cultural values in a cross- national setting (Schwarz et al., 1990, 1995; Smith, Dugan, & Trompenaars, 1996; Trompensaars & Hampden-Turner, 1998). Although each of their expansions on cultural dimension is intriguing and potentially useful, the current study here adopts the value dimensions identified by Hofstede and Inglehart. This decision reflects the fact that the work of these two scholars has been more extensively used and confirmed in multiple studies in various fields, and their data allow for testing of the relationships between prominent national cultural values and ICT adoptions across a greater number of countries. Hofstede (2001) showed that how his value dimensions are related to other researchers' measures. According to his analysis, the Individualism-collectivism dimension and the Power-distance dimension strongly correlate with the Survival vs. Self-expression value measure developed by Inglehart(1997). In light of this observation, these three value measures will be considered as indicators of a broader concept, which the researcher referred to as "Individualism orientation" in this study.

### Government Involvement as a Non-conventional Influence Factor

Recent research on leading nations having ICT adoption has noted the role of government as an important success factor for innovative ICT adoption like the Internet (Ferguson, 2002; Fransman, 2006; Frieden, 2005; ITU, 2003; Park, 2000). Based on several in-depth case studies and comparisons of broadband Internet adoption in East Asian countries, European countries, and the United States, these research efforts suggest that deep-rooted institutional processes play an important role in determining the nature

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broadband will obviously have an economic impact.

and potential impact of broadband policy. The work of these researchers indicates that the reason Canada, Japan, and Korea have deployed broadband more quickly at the early 2000s has less to do with technological prowess and more to with policy. Emphasizing the role of active government in ICT incubation, Frieden (2005) identified areas where those nations' government has played an expansive role in ICT development and succeeded from developing a vision and strategy, promoting digital literacy, creating incentives for private investment, to revising and reforming governmental safeguards to promote online activity.

For some nations, active government involvement is not something that is totally new. Korea is a prime example. This practice of industrial policy and government involvement dates back to the industrial policy tradition from the early 1970s to the 1990s, during which time both the public and private sectors were mobilized to coordinate their efforts under direction of the government for economic development. Besides protectionist measures against importation, the most typical government intervention in industrial development was carried out through direct subsidies, tax credits, and government-run and-operated banks. Since the 1970s, several East Asian countries have shown dramatic economic growth, even though they were initially lacking in natural resources, technology, and/or capital. Studies of East Asian countries in the 1980s and early 1990s have attributed the economic success of these countries to several factors. One of these success factors, state-led resource mobilization— characterized by a unique political system and the active role of the government or strong leadership in industrial policy—has been considered a prominent feature in East Asian economic growth (Johnson, 1982; Lim, 2001; Woo-Cumings, 1999).

With globalization, liberalization, and deregulation movements occurring from the late 1980s through 1990s, many countries with this tradition had to change their policies, regulatory system, and even industry structures to merge into the international market. This change was inevitable because measures of industrial policies like trade control and protection of infant industries are no longer allowed within the framework set for international trade and established by such institutions as the World Trade Organization (WTO) and the most recent General Agreement on Tariffs and Trade (GATT).

Unlike the initial expectations, however, researchers found that many East Asian countries maintained many of their developmental state characteristics. As a result, rather unique forms of government intervention appeared, that is, the active role of government was still an important factor, with market mechanism intertwined into the process (Audretsch, 1989; Chu, 2002; Deyo, 1987; Hwang, 1993; Jho, 2003; Kim, 2008; Weiss, 1998; Woo-Cumings, 1999). For instance, Park (2000) listed five factors for the rapid growth of Internet users in Korea: Government policy, social factors, technical aspects, business aspects, and competition. However, closer scrutiny of these factors reveals that his discussion of 'technical aspects' and 'business aspects' was indeed about government involvement in each area, for example, building a ICT technology research consortium initiated by the government and establishing competition and open access-related rules and regulations. In a similar vein, describing the success factors of Internet diffusion in Korea, Kim (2008) claimed that the government played the most critical role.

Despite criticism of the government for intervening directly in the IT market in a way that could distort market mechanisms, the Korean government has played a key role as a provider of information strategy and vision. The government has actively sought strategies stimulating demand and usage beyond just simple access to networks. At the same time, using interventionist policies, the Korean government adopted specific market principles to encourage platform competition in both broadband and mobile services.

It is worth mentioning that the argument upholding government involvement in the ICT sector does not necessarily imply that all countries with an industrial policy tradition will surpass other countries in terms of Internet and broadband Internet adoption. Rather, it is more reasonable to understand the whole discussion here in terms of a direction wherein countries place high priority on ICT and have special programs that promote the use of ICT as well as laws/institutions related to ICT. For instance, beside Korea, nations like Canada and Japan stand as examples of successful government efforts where the government provided a clear plan and stated goals focused on ICT development in the late 1990s to the early 2000s , and then employed various strategies in both supply and demand sides (Frieden, 2005). In that fashion they will have a greater chance of successfully adopt and diffuse ICT and broadband Internet in their countries.

As an effort to reflect this viewpoint and translate it into empirical research, recent studies have focused on policies and strategies that are concerned more explicitly with broadband competition, such as unbundling, inter-platform competition, universal service obligation, and other concerns. For instance, Lee (2007) reports that government policy initiatives and local loop unbundling and facility-based competition may be more closely related to the diffusion of broadband Internet, thus confirming previous study efforts done by OECD (2003). Local loop unbundling has been considered to stimulate intro-modal competition, whereas facility-based competition is thought to be crucial for inter-modal competition (*DotEcon & Criterion Economics*, 2003). By focusing on very specific policies, these studies often overlooked the significant role of government beyond a few completion policies, and their conclusion cannot be applied to a greater number of countries as they were conducted within developed countries in the OECD where these specific policy related data were available.

As a response to this research void, this study attempts to examine the influence of government involvement in broadband Internet diffusion in a broader sense and thus expand the scope of analysis to include developing countries as well as developed countries.

## Study Questions and Research Hypotheses

Based on the literature review in the prior section, several study questions emerged, asking about the overall impact of non-conventional influence factors on the broadband Internet diffusion and the variation of their effect:

> **Q1**. Do the non-conventional influence factors have unique contribution in explaining cross-national diffusion of broadband Internet?
>
> **Q2**. Do developing and developed countries have a different model explaining their nationwide broadband Internet diffusion?
>
> **Q3**. Does the effect of non-conventional influence factors vary in different diffusion stages?

These questions guide specific research hypotheses listed below, which assume that economic development level, infrastructure and demographics are controlled.

The first set of hypotheses drives from the first study question that is concerned with the impact of non-conventional factors on the overall diffusion level of broadband

Internet. Specifically, these hypotheses examine the cross-sectional diffusion rates.

> **H1**. Countries supporting individualism orientation are likely to have higher levels of broadband Internet diffusion.
>
> **H2**. Countries supporting secular-rational values are likely to have higher levels of broadband Internet diffusion.
>
> **H3**. Countries characterized by low uncertainty avoidance are likely to have higher levels of broadband Internet diffusion.
>
> **H4**. Countries with a higher level of ICT-related government involvement are likely to have higher levels of broadband Internet diffusion.

The next set of hypotheses is the extension of the first question in that they concern the relationship between prominent national cultural values and the time of introduction of broadband Internet. In other words, these hypotheses test the assumption that nations with a certain value orientation tend to adopt broadband Internet earlier than other countries will and, therefore have a longer history of broadband Internet.

> **H5**. Countries supporting individualism orientation are likely to adopt broadband Internet earlier.
>
> **H6**. Countries supporting secular-rational values are likely to adopt broadband Internet earlier.
>
> **H7**. Countries characterized by low uncertainty avoidance are likely to adopt broadband Internet earlier.
>
> **H8**. Countries with a higher level of ICT-related government involvement are likely to adopt broadband Internet earlier.

The last set of hypotheses derives from the third question and examines how prominent national cultural values play out for or against broadband Internet diffusion during the specific phase of diffusion. In essence, the researcher assumed that for the early phase of broadband Internet diffusion, cultural values that conform to innovation will facilitate the introduction of broadband Internet in a nation, more specifically, by reducing the time to complete the initial adoption stage. On the other hand, prominent cultural values that touch upon group consensus and collective behaviors are assumed to benefit the remaining stages of nationwide broadband Internet diffusion by reducing the time to complete later stages of diffusion after introduction.

**H9**. After the introduction stage, countries that are less supportive of individualism orientation are likely to diffuse broadband Internet at a faster pace.

**H10**. After the introduction stage, countries that are less supportive of secular-rational values are likely to diffuse broadband Internet at a faster pace.

**H11**. After the introduction stage, countries characterized by high uncertainty avoidance are likely to diffuse broadband Internet at a faster pace.

**H12**. After the introduction stage, countries with higher levels of ICT-related government involvement are likely to diffuse broadband Internet at a faster pace.

The following chapter describes data sources for the variables and the specific research design of the current study to test the above mentioned hypotheses in detail.

# CHAPTER 3

# RESEARCH METHOD

## Variables and Data Source

The primary purpose of this study is to examine how non-conventional influence factors affect the diffusion of an ICT. More specifically, as non-conventional factors, prominent cultural values of a nation and the ICT-related government involvement are the major focus of this study. Also, broadband Internet is examined as an innovative ICT. Furthermore, this study explores how the degree and direction of influence vary in different stages of broadband Internet adoption and diffusion.

In short, to test the research hypotheses and provide answers to the study questions raised in the previous chapter, standard multiple regression, hierarchical regression, and additional non-parametric analyses were conducted on a set of variables obtained from several cross-national databases. As initiating data collection for multivariate analysis on a global scale is challenging, secondary data analyses on multiple reputable data from the 1996 to 2006 time period was conducted in the current study (see Table 3.5 presented at the end of this chapter for detailed data sources).

Since not all data sources present the same list of countries for their inquiry, this study used data from a total of 64 countries that are commonly included in many surveys. The major constraint stemmed from a limited availability of prominent national cultural value data and broadband Internet related statistics. For instance, Bangladesh, a nation that was initially included in the study pool, was removed because the nation's broadband Internet related data were unavailable until 2007.

For the 64 countries of this study, country profiles and data on major variables were obtained from the *Global Market Information Database* (Euromonitor International, 2008), the *World Development Indicator Database* (World Bank, 2008) and the *World Telecommunication/ICT Indicator Database* (ITU, 2008). Table 3.4, which is presented at the end of this chapter, provides a list of countries in this study along with their GDP and geographic distributions.

## Conventional Influence Factors

In this study three types of influence factors frequently studied in previous research were employed to test research hypotheses: Economy; Demographics; and Infrastructure.

### *Economy*

For the economy variable, gross domestic product (GDP) per capita based on purchasing power parity (PPP) was used because GDP PPP takes into account the relative cost of living and the inflation rates of different countries, thereby providing a better indicator for comparison between countries. When applying the country classification presented by the World Bank to 64 countries in this study, 2 countries fall into the low-income group with their GDP per capita as $935 or lower; 12 countries belonged to the lower-middle income group with their incomes ranging between $936 and $3,705; 17

countries were the upper-middle income group with their incomes between $3,706 and $11,455, and 33 countries belonged to the high-income group with their incomes being $11,456 or higher (see Table 3.1).

Different institutions and research organizations adopt different definitions for developed and developing countries. The current study follows the definition of the World Bank country classification system (2008). According to this classification, high-income countries (or economies with over 30,000 people) whose GDP per capita is $11,456 or higher, are considered as developed countries. All other countries with a GDP per capita at $11,455 or lower are considered to be developing countries in this study. Overall, about half of the 64 countries in this study are developing countries (33 developed countries, 31 developing countries).

Table 3.1. The Economy and Regional Distribution of 64 Countries

| | Developed* | Developing | | | |
|---|---|---|---|---|---|
| Region | High | Upper-Middle | Lower-Middle | Low | Total |
| Middle East & Africa | 1 | 1 | 2 | | 4 |
| Asia & Pacific | 5 | 1 | 5 | 2 | 13 |
| Australia & New Zealand | 2 | | | | 2 |
| East Europe | 4 | 4 | | | 8 |
| Latin America & Caribbean | 1 | 10 | 5 | | 16 |
| North America | 2 | | | | 2 |
| West Europe | 18 | 1 | | | 19 |
| Total | 33 | 17 | 12 | 2 | 64 |

* GDP per capita $11,456 or higher, regardless of their membership with OECD.
Source: Adapted from World Bank, 2008.

*Demographics*

In this study, several variables were considered and included to represent demographics of a nation: Education level; Population density; Urban population; and Ethnic-linguistic fractionalization index.

For education level, a composite index was created using standardized scores for adult literacy rates and gross secondary and tertiary school enrollments. Specifically, the education level variable was computed by multiplying adult literacy rate by secondary and tertiary school enrollment rates in each country. The inclusion of these higher levels of education attendants seems appropriate given that Internet use is known to be positively associated with the level of education, especially secondary or higher levels of education. Data on education levels was obtained from the *World Development Indicators Database* (World Bank, 2008) and the *Global Market Information Database* (Euromonitor International, 2008). For several countries where current data was missing, data from previous years was substituted.

Recent case studies on fast broadband Internet adoption and diffusion in several countries note the role of demographics and geography as success factors, suggesting that those countries with a high population density and a high proportion of multi-dwelling units (e.g. high-rise apartment buildings) have an advantage because it costs less to build the network and provide service (ITU, 2003; Lee, 2007).

In a supplementary analysis, however, type of housing units, as measured by apartment household percentage, turned out not to correlate with the overall Internet or broadband Internet diffusion. Type of housing units was not a significant correlate, probably due to the fact that the most closely related measure - apartment living - does not necessarily measure the number of household living in high-rise population-dense dwelling units. These unites are quite common in the metropolitan areas of several countries, such as Korea and Singapore where this type of dwelling units might have served as a major cause for a higher level of broadband Internet diffusion. Therefore type of housing was excluded from further analysis and two other geography related demographics, urban population and population density, were considered for the present study. Urban population was measured by proportion of population living in metropolitan areas, and population density was measured by the number of people living in 1 $km^2$ (see Table 3.8 for the variables of this study and data sources).

Unlike other research on Internet and Broadband adoption, the Ethnic-Linguistic Fractionalization Index (ELF) was also employed in the analysis and treated as one of the control factors, representing heterogeneity of the population, which may be a significant deterrent in broadband Internet diffusion. It is true that ethnic and linguistic composition of a nation does not change dramatically over a short period of time. But most frequently used ELF index value developed in the Soviet Union is over 30 years old already. Thus this study employs a more recent index developed by Annett (2001), which was calculated using the data from 150 countries in the *World Christian Encyclopedia* (Barrett, 1982).

*Infrastructure*

For infrastructure variable, two types of infrastructure were considered and used for different analyses depending on the type of dependent variable: Overall telecommunication infrastructure represented by teledensity, cable network, and mobile network; and Internet infrastructure represented by personal computer (PC) ownership, Internet bandwidth and number of secure servers. In addition, broadband Internet cost was considered as another infrastructure variable that more directly affects the decision to adopt or reject broadband Internet.

By 2006, ADSL and cable networks have been the major connection methods for the Internet. The results of a supplemental correlation analysis between infrastructures and broadband Internet diffusion rates also reflects the current status of broadband Internet connection provision, in which ADSL utilizing telephone lines ranks highest, followed by cable networks (see Table 3.2). In addition to telephone and cable networks, broadband Internet connection via wireless network is increasing especially where the existing infrastructure has not been successfully offering the Internet connection venue. To reflect this change in the connection method, since 2004, OECD has been including broadband Internet connection via mobile network in their broadband Internet statistics, especially for several East European countries. Therefore, any discussion on broadband Internet connection should include all three networks. This study also considers the level of all three network infrastructures, namely, teledensity, cable penetration, and mobile network coverage. Furthermore, given the small number of cases as compared to the relatively large number of predictor variables, these variables were standardized and averaged to be used as one single variable representing overall telecommunication infrastructure variable.

Table 3.2. The Correlation between Infrastructure and Internet Diffusion

| | Power Consumption | Teledensity | Mobile Network | Cable TV Households |
|---|---|---|---|---|
| Internet Users per 100 | .79 | .75 | .48 | .51 |
| Broadband Internet Users per 100 | .78 | .85 | .48 | .66 |

Note: All correlations are significant at $p < .01$

It has been noted that power consumption level can be considered another proxy for the overall infrastructure level based on which ICT equipment is able to operate. However, this variable was found to be highly correlated with the GDP measure ($r = .94$, $p < .01$), causing a high multicollinearity problem in multiple regression analysis, which is essentially based on correlation matrix of all variables in the equation. As a result, the power consumption level was dropped from the further analysis, and GDP measure can be considered as a proxy for power consumption level, if necessary.

Usage cost for broadband Internet connection may represent a more meaningful indicator for predicting broadband Internet diffusion since price is a major factor to consider in the actual decision to adopt or reject broadband Internet at individual level. In reality, however, it is difficult to compare the actual usage cost between nations as each country has a different level of infrastructure based on which the connection speed and price vary substantially. In addition, in many databases, broadband Internet connection price over time has not been systematically surveyed or archived, making these data unavailable for rigorous analysis and not applicable to this study.

Initially Internet usage cost, as measured by the average price for 20 hours of dial-up Internet access per month in US dollars, was considered to be used as a proxy for the broadband Internet usage cost variable, since this data has been archived for a longer period of time. However, in a preliminary analysis Internet usage cost proved to be a poor measure to be used for the broadband Internet cost. As a result, average cost for 100 kbits/second per month, only broadband Internet price data available for more countries in the ITU, was used as the broadband Internet cost (ITU, 2008). Further this data is available for 2003 and 2006 only. Therefore, broadband Internet cost was used only for the cross-sectional analysis of broadband Internet diffusion level in the year 2006.

Especially for the cross-sectional analysis utilizing data in the year 2006, Internet infrastructure variable was added to the analysis. Internet infrastructure variable reflects factors more directly related to actual Internet use by including Internet hardware, that is personal computer ownership, Internet bandwidth per person and the number of secure Internet servers.

## Non-conventional Influence Factors

The main purpose of this study is to examine the effect of non-conventional factors that have been frequently discussed in descriptive studies as important factors affecting recent ICT diffusion, but have rarely been studied in empirical research. In the current study, the effect of two types of non-conventional factors – prominent national cultural values, and ICT-related government involvement – are analyzed in statistical models.

### *Prominent National Cultural Values*

One of the non-conventional influence factors of this study is prominent national cultural value. Data for prominent national cultural values were obtained from two index scores of the *World Values Survey*—Traditional versus Secular-rational values, Survival versus Self-expression values (Inglehart et al., 2000, 2005)—and three cultural dimension scores from the *Cultural Dimension Survey*—Power distance index, representing acceptance of uneven power distribution among members, Uncertainty avoidance index, and Individualism index (Hofstede, 2001).

As was the case for the infrastructure variables, given the small number of cases available, the creation of composite measures deemed necessary to perform multiple regression analyses. In his own work, Hofstede examined the relationship between his cultural dimensions and other scholars' cultural values measures. He indicated that the Power distance dimension and the Individualism-collectivism dimension substantially correlate with Inglehart's Survival versus self-expression value index with correlation coefficients of -.72 ($p < .001$) and .74 ($p < .001$), respectively. Pearson correlation analysis on data in the current study also indicated that these three variables were significantly correlated with each other. Based on these relationships, a composite measure entitled "Individualism orientation" was constructed, using standardized scores for these three variables, with Cronbach's alpha of .76 for the scale.

Thus, multiple regression analyses were performed employing only three cultural values measures: Individualism orientation— a composite measure of three variables, namely, Power distance dimension, Individualism-collectivism dimension, and Survival versus self-expression value index; Uncertainty avoidance dimension; and Traditional versus Secular-rational value index.

*Government Involvement in ICT Diffusion*

The active involvement of government and its relationship with other sectors of a country have been mentioned in recent descriptive studies, but rarely empirically tested in a cross-national study. Rather than employing a very specific supply-side policy such as local loop unbundling (Lee, 2007), the current study incorporated government involvement with a broader perspective. More specifically, three indicators were introduced to measure the effect of government involvement in the ICT sector: Government priority in ICT; Government programs in ICT promotion; and Development and enforcement of ICT-related laws.

Data on these indicators is based on Executive Opinion Survey results that were included in the *Global Competitiveness Report* (World Economic Forum, 2006). In this survey, approximately 8,000 top executive respondents from 117 countries provided their expert opinions on questions related to their country's competitiveness.[5] Among the survey's 150 questions, data on the following three items were used to represent the ICT-related government involvement level, measured by a seven-point scale.

> **Government prioritization of ICT**: Information and communication technologies (ICT) are an overall priority for the government (1=strongly disagree, 7=strongly agree)
>
> **Government success in ICT promotion**: Government programs promoting the use of information and communication technologies (ICT) are (1=not very successful, 7=highly successful)
>
> **Laws relating to ICT**: Laws relating to the use of information and communication technologies (ICT) (e.g. electronic commerce, digital signatures, consumer protection) are (1=nonexistent, 7=well developed and enforced)

A rigorous analysis should employ all of these three variables separately. However, due to the limited number of cases available, unless it is deemed necessary, the three scores were standardized and averaged into one index variable that represents the overall level of ICT-related government involvement. Construction of a composite measure was also deemed appropriate because these three variables were highly

[5] Top executives are those who hold the position of Chief Executive Office, or equivalent, or those who hold any of the company's top five management positions in a company with over 500 employees. See World Economic Forum (2006) for details of the survey.

correlated. Cronbach's alpha for this scale was .90.

## Dependent Variables

The two dependent variables of this study are broadband Internet diffusion level (as of 2006) and broadband Internet diffusion speed over time in each diffusion stage.

### *Broadband diffusion level*

Broadband diffusion level was measured by the estimated number of broadband users per 100 inhabitants. Most available databases report broadband Internet diffusion level by surveying the number of people actually subscribing to broadband Internet service in a given year. Considering the fact that broadband Internet is still a household-based decision and usually households include more than one person, the actual number of broadband Internet users or the proportion of broadband Internet users relative to total population will be much greater than the basic number of broadband Internet subscribers. To incorporate such statistics closer to actual broadband user figures, the number of broadband users per 100 was calculated by multiplying estimated Internet users per 100 by the proportion of broadband Internet subscribers over total Internet subscribers as presented in an equation below. In the 64 countries of the current study, an average 26 out of 100 people were broadband Internet users in 2006.

$$\text{Broadband Users per 100 Inhabitants} = \text{Overall Internet Users per 100} \times \frac{\text{Number of Broadband Subscribers}}{\text{Total Number of Internet Subscribers}}$$

Table 3.4 presented in the last part of this chapter shows the broadband Internet diffusion level for 64 countries in this study as estimated using the above equation. The same table also presents each country's per capita income level categorized by the World Bank country classification(2008).

*Broadband Internet Diffusion Speed*

Another dependent variable of this study is broadband Internet diffusion speed over time in each diffusion stage. This variable was measured by the number of years required for broadband Internet diffusion level to reach certain percentage thresholds.

Diffusion of innovation theory indicates that characteristics of adopters differ by diffusion stage (Rogers, 2003). Early adopters are different from adopters in later stages of diffusion in that they are more innovative, more individualistic, and less dogmatic. Early adopters also have a higher social status and a greater ability to cope with uncertainty and risk, thereby being more favorable to change. Given these different adopter characteristics in different diffusion stages, it is a corollary to assume that the influence of prominent national cultural values will also vary in each stage of broadband Internet diffusion.

It is assumed in business that 20 percent of adoption is a tipping-off point beyond which a product will be diffused to the public (Tellis, Stremersch, and Yin, 2003). Taking this practice into consideration in combination with Rogers' original five categories of adopters, this study slightly adjusts five stages of a nationwide diffusion of innovation as as follows:

**Introduction stage**: Innovation reaches the first 3 percent of the population

**Early adoption stage**: Innovation is adopted and diffused among the population until it reaches 20 percent of the population

**Take-off stage**: Innovation takes off and is diffused to 50 percent of the population, thus reaching a majority threshold.

**Maturity stage**: Innovation is diffused among the remaining half of the population until it reaches 80 percent of the population

**Saturation stage**: Innovation is diffused to the entire population and adopted by more than 80 percent of population.

An ideal study then should examine broadband Internet adoption from all stages of diffusion. However, the current level of broadband Internet diffusion across the world imposes a serious limitation because, as of 2006, the overall broadband Internet diffusion level in the 64 countries in this study was 25.7 percent, with only 22 countries either currently being in or surpassing the 50 percent threshold, which defines the take-off stage (see Table 3.3). As a result, this study focuses on the first three categories of diffusion stage—namely, introduction, early adoption, and take-off stage only.

Since each country has a different level of broadband Internet diffusion, the number of countries belonging to each stage also varies. Table 3.3 shows that for overall Internet diffusion, from the 64 countries in this study, 45 countries surpassed the 20 percent threshold, after which the innovation is assumed to diffuse to the majority of the population over time (Rogers, 2003).

In the case of broadband Internet diffusion, 32 countries reached this level. Meanwhile, 34 countries remained in either the introduction or the early adopter stage. As of 2006, 22 out of the 64 countries in this study have entered the late majority stage of Internet diffusion. In regards to broadband Internet, however, only 9 countries have surpassed the 50 percent diffusion level by the end of 2006. For the Take-off stage, the actual number of countries who have passed through the stage by the end of 2006 is 16, with 7 countries still moving forward to reach 50 percent threshold. Therefore, statistical analysis on Take-off stage will be done on 16 countries, not on 22 countries.

Table 3.3 The Number of Countries in Each Diffusion Stage (2006)

| Diffusion Stage | Overall Internet | Broadband Internet |
|---|---|---|
| Introduction (~3%) | 0 | 10 |
| Early Adoption (~20%) | 19 | 22 |
| Take-off (~50%) | 23 | 23 |
| Maturity (~80%) | 20 | 9 |
| Saturation (~100%) | 2 | 0 |
| Total | 64 | 64 |

Tables 3.4 through 3.7 presented at the end of this chapter provide the summary of variables and data sources, descriptive statistics, and the correlation matrix for the major variables.

## Model Building and Analysis

Research methods texts advise against building a complex model when a dataset is small (Agresti & Finlay, 1997). The presence of too many parameters to be estimated relative to a small sample size will lead to inflation of standard errors of the estimates, which will make it difficult to assess the unique partial contribution of the variables that may be theoretically important. (Allison, 1999). At the same time, however, a model should also include enough variables with theoretical importance to have a good predictive power. Considering both points, the general guideline of the analysis in this study was to keep the model simple (parsimonious) while trying to obtain good predictive power as measured by a reasonably high $R^2$. Following this guideline, stepwise regression and hierarchical regression were conducted to test the research questions and hypotheses.

The following equation represents a baseline regression model of this study which was be used to test the effect of non-conventional factors while controlling for conventional factors.

$$Y= \alpha + [\beta_1 X_1 + \beta_2 X_2 + \ldots + \beta_7 X_7] + [\beta_8 X_8 + \beta_9 X_9 + \beta_{10} X_{10} + \beta_{11} X_{11}] + \varepsilon$$

Conventional factors Non-conventional factors

In the model presented above, Y is the broadband Internet diffusion level as of 2006; $\alpha$ is an intercept; $X_1$ is the nation's economic development level measured by GDP; $X_2$ is the nation's education level; $X_3$ is the nation's urban population; $X_4$ is the nation's population density; $X_5$ is the nation's Ethnic-linguistic fractionalization level; $X_6$ is the year broadband Internet was introduced to the country; $X_7$ is the broadband Internet cost; $X_8$ is individualism orientation scale score of the country; $X_9$ is traditional vs. secular-rational value score of the country; $X_{10}$ is uncertainty avoidance score of the country; $X_{11}$ is government involvement index score of the country. In this equation, the first bracket encompassing $X_1$ through $X_7$ contains conventional influence factors, whereas the second bracket including $X_8$ through $X_{11}$ contains non-conventional influence factors.

There are several different ways of performing multiple regression under different circumstances. In this study, two regression methods, hierarchical regression and backward stepwise regression were used considering their characteristics. Hierarchical regression is performed when the researcher has an idea about the order to enter predictors and wants to know how prediction by certain variables improves the overall fit of the model by entering these predictors after other controlling variables (Leech, Barrett and Morgan, 2008). In the model presented above, the variables $X_1$ thorugh $X_7$ are conventional control factors which were entered first, and then the non-conventional variables $X_8$ through $X_{11}$ were entered to assess their unique contribution to the overall explanatory power of the model.

The backward elimination is one of the several stepwise regression methods, in which all variables of interest are entered first, then non-significant variables are sequentially removed based on their associated *p*-value, without having a substantial effect on the overall model fit. The elimination process is repeated until only statistically significant variables are left in the equation, thereby resulting in a parsimonious model. The backward elimination is preferred to the forward method because the latter has a higher risk of making a Type II error. A predictor is involved in "suppressor effects" when its significant effect shows only when another variable is held constant, and the forward method is more likely than the backward elimination to exclude predictors involved in such a relationship (Field, 2009, p.272).

In this study, hierarchical regression will show how certain variables have a unique contribution to the overall fit of the model when all other variables of theoretical importance are present and controlled. The backward stepwise regression was conducted following the hierarchical regression in an attempt to find a parsimonious model. The model obtained from the backward elimination explains the equivalent amount of variance in the dependent variable, while employing significant predictors only.

Furthermore, a stricter rule for multicollinearity was adopted in regression analysis in this study. One of the indicators of multicollinearity is the variance inflation factor (VIF). The traditional rule of thumb guideline for VIF is 10, suggesting that any variable with a VIF score higher than 10 should be dropped from the analysis as it highly correlates with another variable and thus, making estimates of both variables highly unstable, either by over or underestimating the coefficients. This study follows Cohen and colleague's recommendation that smaller VIF threshold should be adopted for a small sample size (Cohen, Cohen, West, & Aiken, 2003), and thus those variables with VIF over 5 were dropped from the equation.

Table 3.4 The Broadband Internet Diffusion Level(%) for 64 Countries (2006)

| Region/Country Name | | (GDP)* | Region /Country Name | | (GDP)* |
|---|---|---|---|---|---|
| Middle East & Africa | | | Latin America | | |
| Iran | 0 | (LMD) | Argentina | 12.1 | (UPMD) |
| Israel | 20.9 | (HI) | Brazil | 6.8 | (UPMD) |
| Morocco | 19.5 | (LMD) | Chile | 27.1 | (UPMD) |
| South Africa | 1.4 | (UPMD) | Colombia | 10.2 | LMD |
| Asia Pacific | | | Costa Rica | 19.1 | (UPMD) |
| China | 6.8 | (LMD) | Ecuador | 9.9 | (LMD) |
| Hong Kong | 34.3 | (HI) | El Salvador | 8.8 | (LMD) |
| India | 1.2 | (LMD) | Guatemala | 0 | LMD |
| Indonesia | 0.4 | (LMD) | Jamaica | 45.4 | (UPMD) |
| Japan | 47.1 | (HI) | Mexico | 12.2 | (UPMD) |
| Korea | 71.1 | (HI) | Panama | 4.5 | (UPMD) |
| Malaysia | 10.8 | (UPMD) | Peru | 10.8 | (LMD) |
| Pakistan | 0.2 | (LOW) | Suriname | 2.7 | (UPMD) |
| Philippines | 1.0 | (LMD) | Trinidad | 5.6 | (HI) |
| Singapore | 20.6 | (HI) | Uruguay | 12.2 | (UPMD) |
| Taiwan | 40.8 | (HI) | Venezuela | 10.8 | (UPMD) |
| Thailand | 1.3 | (LMD) | Western Europe | | |
| Vietnam | 2.2 | (LOW) | Austria | 31.3 | (HI) |
| Australia & New Zealand | | | Belgium | 43.3 | (HI) |
| Australia | 30.5 | (HI) | Denmark | 53.2 | (HI) |
| New Zealand | 32.8 | (HI) | Finland | 46.2 | (HI) |
| Eastern Europe | | | France | 41.3 | (HI) |
| Bulgaria | 17.9 | (UPMD) | Germany | 32.7 | (HI) |
| Czech Rep. | 27.4 | (HI) | Greece | 10.4 | (HI) |
| Estonia | 52.6 | (HI) | Ireland | 19.7 | (HI) |
| Hungary | 32.2 | (HI) | Italy | 45.4 | (HI) |
| Poland | 32.8 | (UPMD) | Luxembourg | 54.5 | (HI) |
| Romania | 17.9 | (UPMD) | Malta | 18.7 | (HI) |
| Russia | 4.6 | (UPMD) | Netherlands | 74.5 | (HI) |
| Slovakia | 33.5 | (HI) | Norway | 67.2 | (HI) |
| North America | | | Portugal | 27.3 | (HI) |
| Canada | 65.1 | (HI) | Spain | 39.9 | (HI) |
| USA | 52 | (HI) | Sweden | 53.3 | (HI) |
| | | | Switzerland | 40 | (HI) |
| | | | Turkey | 15.5 | (UPMD) |
| | | | UK | 47.4 | (HI) |

*HI: high income, UPMID: upper-middle income, LMD: low-middle income, LOW: low-income according to World Bank country classification (2008).

Table 3.5 Major Variables and Data Sources for this Study

| Variables | Measures | Source |
|---|---|---|
| Economy | GDP (PPP) per capita in US$ | ITU (2008)<br>World Bank (2008)<br>Euromonitor International (2008) |
| Education level | Adult literacy multiplied by the gross secondary and tertiary school enrollment rates | |
| Ethnic-Linguistic fractionalization index | The degree of socio-cultural heterogeneity of the population (Annett, 2001) | |
| Population density | Number of people living within 1 $km^2$ | |
| Urban population | Percentage of people leaving in urban areas | |
| Broadband internet Cost (2006) | Monthly cost for 100 Kbits/sec in US$ | |
| Telecommunication infrastructure | Standardized composite measure of:<br>- Teledensity<br>- Cable penetration<br>- Mobile Network penetration | |
| Internet Infrastructure (2006) | Standardized composite measure of<br>- PC ownership per 100 people<br>- Internet bandwidth per person (bit/second)<br>- Number of Secure Internet Servers per 1 million people | |
| Individualism orientation | Composite measure of :<br>- Individualism Index<br>- Power Distance Index<br>- Survival vs. Self-expression Value Index | Inglehart et al. (1998)<br>Hofstede (2001) |
| Secular-rational value | Traditional vs. Secular-rational value index | |
| Uncertainty avoidance | Uncertainty avoidance index | |
| Government Involvement in ICT diffusion | Composite measure of:<br>- Government priority on ICT<br>- Government programs in ICT promotion<br>- ICT-related laws and policy | World Economic Forum (2006) |
| Diffusion Level | Number of broadband Internet users per 100 in habitants | Calculated from ITU (2008)<br>World Bank (2008) |
| Diffusion Speed | Years to complete each diffusion stage | |

Table 3.6 Descriptive Statistics for the Major Variables (1996~2006, N=64)

| Variable | Minimum | Maximum | Mean | Std. Deviation |
|---|---|---|---|---|
| Economy | 6.90 | 65829.68 | 17261.62 | 12861.69 |
| Education level | .25 | 6.73 | 3.35 | 1.61 |
| Ethnic-Linguistic fractionalization | .00 | .89 | .36 | .24 |
| Population density | 2.56 | 6450.19 | 344.75 | 1090.04 |
| Urban population | 11.94 | 100.00 | 68.83 | 18.55 |
| Broadband Internet cost (2006) [a] | .03 | 28.13 | 3.50 | 4.17 |
| Broadband internet introduction year | 1996 | 2006 | 2000 | 2.03 |
| Internet infrastructure (2006) | -.85 | 2.50 | .00 | .90 |
| Telecommunication infrastructure index | -1.63 | 1.49 | .00 | .82 |
| Government involvement index | -2.22 | 1.99 | .00 | .91 |
| Individualism orientation scale | -1.09 | 1.41 | .02 | .71 |
| Secular-rational value | -.82 | 1.24 | .06 | .56 |
| Uncertainty avoidance | -2.43 | 1.87 | .00 | 1.00 |
| Broadband Internet diffusion Level (%) | .00 | 44.41 | 9.87 | 8.95 |

[a] N=62, as Broadband Internet cost data were not available for Pakistan and Vietnam.

Table 3.7. Correlation matrix for the major Variables (1996~2006)

| | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. Economy | 0.36*** | -0.44*** | 0.22* | 0.48*** | -0.32** | -0.46*** | 0.83*** | 0.81*** | 0.52*** | 0.71*** | 0.51*** | -0.20 | 0.59*** |
| 2. Education level | | -0.36*** | -0.08 | 0.46*** | 0.01 | -0.39*** | 0.35*** | 0.57*** | 0.25** | 0.38*** | 0.38*** | 0.09 | 0.44*** |
| 3. Ethnic-Linguistic fractionalization | | | -0.10 | -0.28** | 0.25* | 0.10 | -0.32** | -0.53*** | -0.20 | -0.30** | -0.41*** | -0.13 | -0.40*** |
| 4. Population density | | | | 0.31** | -0.17 | -0.22* | 0.18 | 0.21* | 0.33*** | -0.14 | 0.09 | -0.34*** | 0.10 |
| 5. Urban population | | | | | -0.10 | -0.44*** | 0.46*** | 0.53*** | 0.23* | 0.35*** | 0.25** | 0.10 | 0.39*** |
| 6. Broadband Internet cost (2006)[a] | | | | | | 0.36*** | -0.39*** | -0.37*** | -0.40*** | -0.31** | -0.17 | 0.24* | -0.38*** |
| 7. Broadband internet introduction year | | | | | | | -0.49*** | -0.56*** | -0.44*** | -0.39*** | -0.35*** | 0.18 | -0.45*** |
| 8. Internet Infrastructure (2006) | | | | | | | | 0.80*** | 0.57*** | 0.79*** | 0.54*** | -0.42*** | 0.68*** |
| 9. Telecommunication infrastructure index | | | | | | | | | 0.59*** | 0.66*** | 0.70*** | -0.14 | 0.75*** |
| 10. Government involvement index | | | | | | | | | | 0.41*** | 0.37*** | -0.43*** | 0.54*** |
| 11. Individualism orientation | | | | | | | | | | | 0.41*** | -0.25** | 0.52*** |
| 12. Secular-rational value | | | | | | | | | | | | -0.10 | 0.58*** |
| 13. Uncertainty avoidance | | | | | | | | | | | | | -0.15 |
| 14. Broadband Internet Diffusion Level | | | | | | | | | | | | | |

N=62 as Broadband Internet cost data were not available for Pakistan and Vietnam.
* $p < .10$. ** $p < .05$. *** $p < .01$.

# CHAPTER 4

# RESULTS AND DISCUSSION[6]

This chapter provides the results of the data analysis and related discussion. The first part discusses the results of the analysis examining the relationship between influence factors, both conventional and non-conventional, and the broadband Internet diffusion level using cross-sectional data from 2006. The remaining sections provide the results of the analysis of each diffusion stage. As indicated in Chapter 3, due to the limitation of available data, only the first three stages, namely the Introduction, Early adoption and Take-off stages of broadband Internet diffusion were analyzed.

## Broadband Internet Diffusion Level

This section provides the results of the analysis of cross-sectional broadband Internet diffusion using 2006 data. First, hierarchical regression analysis was performed to see if non-conventional influence factors significantly improve the explanatory power of a model of factors associated with broadband Internet diffusion, which concerns first

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[6] Usually a discussion chapter is placed after the result chapter wherein the results of statistical analyses are presented without further discussion or interpretation. In this study, similar analysis is repeatedly performed, with the coefficient for the same variable changing in each model. Under this circumstance, providing a discussion and interpretation of the results in a separate chapter as usual may be confusing to the reader. Thus the interpretation and discussion of the statistical analysis results are provided in this chapter, and the following chapter will present a summary of the results and suggestions for future research.

study question and Hypotheses 1 through 4. Then an additional round of analysis was performed to examine whether there is any significant difference between developing and developed countries with respect to the predictors of broadband Internet diffusion, and this analysis is specifically related to the second question.

Economy, as measured by GDP, is known to be closely associated with other indicators of development, such as education level, telecommunication infrastructure, and technology ownership, all of which provide a basis for broadband adoption and diffusion. Preliminary analyses of the 2006 data revealed that GDP level explains 62 percent of the variance in Telecommunication infrastructure and 83 percent of the variance in the Internet infrastructure variable. As discussed in the previous chapter, the telecommunication infrastructure variable is composed of three indicators, that is, the number of telephone lines, cable network penetration, and mobile network penetration. Internet infrastructure was constructed using three indicators, namely, the number of secure Internet servers, Internet bandwidth per person, and PC ownership. Given the small number of cases in this study, and high VIF scores indicating substantial correlation between GDP and the other two infrastructure measures, only GDP level was introduced to the regression analysis as an economic indicator. Thus, in the analysis where the GDP variable is utilized, GDP also serves as a proxy for the two types of infrastructures.

Table 4.1 shows the summary result from a hierarchical multiple regression analysis in which socio-economic variables were controlled for by employing them in multiple steps. In this analysis, socio-economic variables are entered first, and then a non-conventional influence factor block that included prominent national cultural values and the Government Involvement index is entered to examine whether the latter block significantly improves the fit of the model explaining nationwide broadband Internet diffusion.

According to the results displayed under Step 1 in Table 4.1, Economy alone explains about 52 percent of the variance in the broadband Internet diffusion level among 62 countries, and it was a significant contributor ($F_{(1,60)} = 64.03$, $p < .001$).[7] Other socio-economic variables and infrastructure variables in Step 2 also significantly increased the variance explained by 15 percentage points ($p < .01$). In addition to Economy, Population density, Broadband Internet introduction year, and Broadband Internet cost were also significant predictors of the broadband Internet diffusion level, and this result is consistent with prior research wherein the importance of these factors were confirmed. The negative sign for Broadband Internet introduction year indicates that those countries who adopted broadband Internet earlier will show a higher level of broadband Internet diffusion, which also confirm the previous research. Surprisingly, however, Population density was negatively related with the diffusion level of broadband Internet, which go against the findings of the prior literature, wherein population density positively correlated with diffusion of innovative ICT such as PC and Internet.

When prominent national cultural variables and the ICT-related government involvement level are finally entered into the regression equation in Step 3, the amount of variance explained increased by 6 percentage points.[8] Although the magnitude seems small, this improvement is statically significant with the associated *p*-value being smaller than .05, thus confirming the hypothesized relationship that non-conventional factors

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[7] Pakistan and Vietnam were dropped from the analysis due to missing data for Broadband Internet cost variable.

[8] Although not presented here, a model with non-conventional influence factors alone could explain 62 percent of the variance (adjusted $R^2 = .59$, $F_{(4,59)} = 24.08$ , $p < .01$)

Table 4.1. Summary of Hierarchical Multiple Regression Analysis for Nationwide Broadband Internet Diffusion Level (2006)

| | HIERARCHICAL MODEL | | | | | | REDUCED MODEL | |
|---|---|---|---|---|---|---|---|---|
| | Step1 | | Step 2 | | Step3 | | | |
| Variable | B | *Beta* | B | *Beta* | B | *Beta* | B | *Beta* |
| Constant | 6.09<br>(3.09) | | 3851.61<br>(2227.20) | | 3158.84<br>(2135.03) | | 4494.11<br>(1920.00) | |
| Economy | .00<br>(.00) | .72*** | .00<br>(.00) | .52*** | .00<br>(.00) | .32** | .00<br>(.00) | .47*** |
| Education | | | 1.75<br>(1.20) | .14 | .99<br>(1.17) | .08 | | |
| Urban Population | | | .00<br>(.11) | .00 | .07<br>(.12) | .06 | | |
| Population Density | | | .00<br>(.00) | -.18** | .00<br>(.00) | -.19* | .00<br>(.00) | -.19** |
| Ethnic-Linguistic Fractionalization | | | -12.70<br>(7.72) | -.15 | -10.77<br>(8.04) | -.13 | | |
| Broadband Internet Introduction Year | | | -1.92<br>(1.11) | -.17* | -1.57<br>(1.07) | -.14 | -2.24<br>(.96) | -.20** |
| Broadband Internet Cost | | | -.93<br>(.43) | -.19** | -.76<br>(.43) | -.16* | -.88<br>(.39) | -.18** |
| Individualism Orientation | | | | | 2.05<br>(3.66) | .07 | | |
| Secular-Rational Value | | | | | 8.55<br>(3.29) | .24** | 1.82<br>(3.08) | .30*** |
| Uncertainty Avoidance | | | | | -1.78<br>(2.08) | -.09 | | |
| Government Involvement | | | | | 1.45<br>(2.29) | .07 | | |
| $R^2$ (adjusted $R^2$) | .52 (.51) | | .67 (.63) | | .73 (.67) | | .69 (.67) | |
| $R^2$ change | .52*** | | .15*** | | .06** | | | |
| F (df) | 64.03 (1,60) | | 15.77 (7,54) | | 12.23 (11,50) | | 25.43 (5,56) | |
| P | < .001 | | < .001 | | < .001 | | < .001 | |

Note: N=62. Standard errors in parentheses.
* $p$ < .10 ** $p$ < .05. *** $p$ < .01.

significantly improves the explanatory power of the model. Even after non-conventional factor block is incorporated, Economy, Population density and Broadband Internet cost variables remained significant. The broadband Internet introduction year variable became non-significant, but the associated *p*-value (.12) for this variable was getting close to marginal significance. Regarding such results, Abelson (1995) suggested that, *p*-value between .10 and .15 should also be noted as it is leaning toward statistical significance. His argument appears reasonable considering that the coefficient may become significant with a larger sample.

Results for Step 3 in the hierarchical model in Table 4.1 indicate that, among non-conventional influence factors included in the equation, Secular-rational value orientation is positively related to the broadband Internet diffusion level in 2006. The regression coefficient associated with this variable suggests that one unit increase in Secular-rational values leads to approximately a 9 percentage point increase (8.55) in the estimated broadband Internet diffusion level. While the coefficients for other non-conventional factors were in the predicted directions, they didn't reach statistical significance.

In summary, the results presented in Table 4.1 show that the non-conventional factor block composed of prominent national cultural variables and government involvement makes a unique contribution in explaining broadband Internet diffusion level. Of the three cultural variables in the model, only Secular-rational value orientation is a statistically significant predictor of cross-country broadband Internet diffusion level. In other words, the regression analysis results suggest that a model that includes non-conventional influence factors, particularly the secular-rational value orientation, does explain a great share of variance in nationwide broadband Internet diffusion level, thus confirming Hypothesis 2.

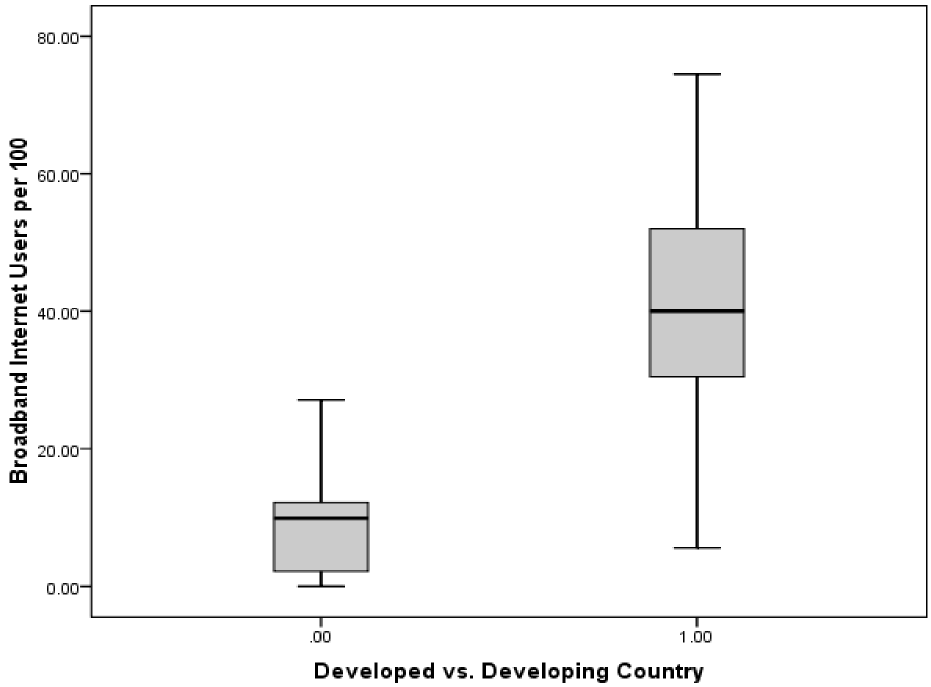
The reduced model in the last column of Table 4.1 is the most parsimonious model and composed solely of variables whose contribution is statistically significant. This model was constructed by removing variables with the highest *p*-value over .1 until no more variables can be eliminated from the model at the significance level. According to the reduced model, in explaining the variances in the broadband Internet diffusion level in 2006, Economy, Population density, Introduction year of broadband Internet, Broadband Internet cost and Secular-rational value variables become significant factors. With these five variables, about 70 percent of the variance was explained.

In the regression analysis that encompasses all 62 countries regardless of their economic development level, Economy measured by GDP was a significant predictor. Then one might ask whether there is any statistically significant difference between developed versus developing countries. This question also has a significant implication since prior research on ICT diffusion has not included developing countries, thus seriously limiting the application ability of their findings to developing countries.

Figure 4.1 illustrates the relationship between economic development level and cross-country broadband Internet diffusion as of 2006 by using a simple box-and-whisker plot to chart the number of broadband Internet subscribers in 100 inhabitants in both developing and developed countries. The boxes in Figure 4.1 define lower (Q1) and upper (Q3) quartiles of these observations. Among developing countries, the range is from 2.2 to 12.2 percent, while the range is much higher—charting from 30.5 to 52 percent—among developed countries.

When compared to developed countries, developing countries have a substantially

Figure 4.1. Broadband Internet Diffusion by GDP level




lower level of broadband Internet diffusion. On average, in terms of actual subscriber numbers, only 2 out of 100 people are subscribing to broadband Internet in developing countries, whereas 19 out of 100 people are doing so in developed countries ($F_{(1,62)}$ = 76.89, $p < .001$). In terms of group mean, in developed countries, average 40 out of 100 people are estimated broadband Internet users as compared to only 10 out of 100 people in developing countries ($F_{(1,62)}$ = 68.58, $p < .001$). This result is consistent with the prior research reporting that economic development level is an important predictor in the diffusion of any ICT.

Table 4.2 provides a summary of the standard multiple regression analysis where developed countries and developing countries are separately analyzed and other variables are controlled. In this analysis Broadband Internet diffusion level variable was regressed on conventional and non-conventional influence factors. In this analysis, the

Infrastructure variable was used in place of the economy variable, since the two groups, developed versus developing countries, were divided based on their economic development level.

As can be seen under the full model columns in Table 4.2, conventional and non-conventional influence factors together could explain 62 percent of the variance in Broadband Internet diffusion level variable among developed countries versus 71 percent among developing countries. The adjusted $R^2$ value was also higher among developing countries (.41 in developed countries vs. .53 in developing countries).

A comparison of regression coefficients between two country clusters indicated that a slightly different set of variables are in operation for developed and developing countries. For instance, among developed countries, Population density, Introduction year of broadband Internet and Secular-rational value variables were significant predictors of Broadband Internet diffusion level variable. The positive regression coefficient for Secular-rational value and the negative coefficient for Introduction year were consistent with prior research: Those countries characterized by high secular-rational values will have higher levels of broadband Internet diffusion; those countries that have adopted and introduced broadband Internet earlier will have an advantage in broadband Internet diffusion because it is a cumulative process that occurs over time.

However, the negative coefficient associated with Population density indicated that, contrary to the original expectations that were based on previous literature, those countries with lower population density actually have higher levels of broadband Internet diffusion. This puzzling result may be an unstable estimation originating from a relatively large number of predictors in a small sample, or it may be an indication that population

Table 4.2. Multiple Regression Analysis Summary for Broadband Internet Diffusion in Developing vs. Developed Countries

| | Developed Countries | | | | Developing Countries | | | |
|---|---|---|---|---|---|---|---|---|
| | Full Model | | Reduced Model | | Full Model | | Reduced Model | |
| | B | Beta | B | Beta | B | Beta | B | Beta |
| Intercept | 9944.23 (5165.24) | | 12251.09 (2986.42) | | -1275.42 (2002.85) | | 3.62 (3.27) | |
| Infrastructure | 5.57 (6.53) | .15 | | | 1.26 (6.32) | .45 | 8.50 (3.88) | .37** |
| Education | -.42 (2.07) | -.04 | | | -.55 (1.52) | -.08 | | |
| Urban Population | .11 (.20) | .11 | | | -.07 (.14) | -.11 | | |
| Population Density | -.01 (.00) | -.57* | -.00 (.00) | -.40*** | -.01 (.02) | -.08 | | |
| Ethnic-linguistic Fractionalization | -.29 (13.39) | -.00 | | | -34.67 (8.99) | -.75*** | -33.26 (6.93) | -.72*** |
| Broadband Internet Introduction Year | -4.96 (2.58) | -.43* | -6.11 (1.49) | -.53*** | .66 (1.00) | .11 | | |
| Broadband Internet Cost | -.53 (1.65) | -.06 | | | .18 (.32) | .09 | | |
| Individualism Orientation | -3.26 (6.87) | -.12 | | | 3.36 (3.87) | .12 | | |
| Secular-rational value | 9.65 (5.45) | .28* | 12.08 (4.27) | .36*** | -12.83 (5.27) | -.48** | -1.80 (3.42) | -.42*** |
| Uncertainty avoidance | -4.97 (4.13) | -.30 | -4.54 (2.20) | -.28** | -4.39 (2.38) | -.40** | -4.37 (1.42) | -.40** |
| Government Involvement | 1.26 (4.99) | .05 | | | .13 (2.27) | .01 | | |
| $R^2$ | .62 | | .58 | | .71 | | .67 | |
| Adjusted $R^2$ | .41 | | .52 | | .53 | | .61 | |
| F (df) | 3.06 (11,21) | | 9.65 (4,28) | | 3.83 (11,17) | | 12.44 (4,24) | |
| *P* | .01 | | <.001 | | < .01 | | <.001 | |

Note: Standard errors in parentheses. Mean of dependent variable is 39.56 (n=33) for developing countries, 11.10 (n=29) for developing countries.
* $p < .10$. ** $p < .05$. *** $p < .01$.

density is missing what the researcher originally assumed were the variable measures, the distance/proximity between people. Usually, population density is derived by dividing the population by the area. According this equation, a country with a population of 100,000 and an area of 1,000 $km^2$ has the same population density as another country with a population of 1,000 and the area of 10 $km^2$. However, when the average distance per person is compared, the figure for the first country is 10 times bigger.

When the reduced model was constructed by backward elimination, therefore the number of predictors was reduced to four, Uncertainty avoidance emerged as a significant predictor for developed countries. As a result, four indicators, Population density, Introduction year of broadband Internet, Uncertainty avoidance, and Secular-rational value orientation made up the most parsimonious model out of the eleven variables originally introduced. This model performs well, accounting for 58 percent of the variance in the dependent variable (adjusted $R^2 = .52$, $p < .001$). Population density had a negative sign again. The sign of regression coefficients for the remaining three variables is consistent with both the previous literature and the hypotheses.

In developing countries, a different set of conventional variables emerged as either being significant or being close to the marginal significance level: Ethnic-linguistic fractionalization level, which represents how culturally heterogeneous/ homogeneous a population is, and Infrastructure. Infrastructure is approaching the significant *p*-value of .10 (.14), and actually becomes significant in the reduced model. The negative sign of the coefficients for Ethnic-linguistic fractionalization is consistent with previous research reporting that an innovation will more easily diffuse when the target society is homogenous (i.e., smaller score in Ethnic-linguistic fractionalization index).

Among non-conventional factors, Uncertainty avoidance and Secular-rational values are significant predictors. Unlike in developed countries, the direction of the coefficient associated with Secular-rational value in developing countries is negative(-12.83 in developing countries as opposed to 9.65 in developed countries). The negative coefficient for Secular-rational value implies that, among developing countries, those countries that are geared toward traditional values, not secular-rational values, actually have a higher level of broadband Internet diffusion.

Among developing countries, when reduced model was constructed by backward elimination, the infrastructure variable, Ethnic-linguistic fractionalization index, Secular-rational value, and Uncertainty avoidance emerged as significant predictors, explaining 67 percent of the variance in the broadband Internet diffusion level variable (adjusted $R^2$ = .61). Again, negative coefficients indicated that those countries that are oriented toward traditional values, not secular-rational values, have higher levels of broadband Internet diffusion. In addition, countries that have lower levels of uncertainty avoidance (i.e., that encourage risk-taking) have more favorable conditions for broadband Internet diffusion. The negative coefficient associated with the Secular-rational value seems contrary to the previous diffusion literature, and to the positive coefficient among developed countries.

When a one unit increase in the variable is compared, the secular-rational value variable appears to exert more influence than Uncertainty avoidance does. Furthermore, according to the results presented in Table 4.2 under the reduced model column, homogeneity of the population in terms of ethnicity and language (i.e., low score in Ethnic-linguistic fractionalization index), which forms the basis of culture, is the most important predictor of the level of broadband Internet diffusion in developing countries in terms of both unstandardized and standardized coefficient.

To test for interactions between economic development level and cultural value variables, a different procedure was employed. To determine whether the difference in coefficients between developed countries and developing countries was statistically significant, an additional statistical test using the unstandardized coefficients and their respective standard errors was conducted. Cohen et al. (2003) suggested calculating a *z*-statistic by taking the difference of the two unstandardized coefficients and dividing it by the square root of the sum of the squared standard errors. If the resulting *z*-statistic is greater than 1.96, the two coefficients are statistically different at 95 percent confidence level.

Following this procedure, a significant interaction between development level and the Secular-rational value variable was detected ($z = 2.97$). A supplemental hierarchical regression analysis employing a multiplicative term of Development level X Secular-rational value index was found to be significant indicating that development level significantly moderates the relationship between secular-rational value and broadband Internet diffusion. This result indicates that the effect of secular-rational value orientation on broadband Internet diffusion depends on the economic development level, and the effect was stronger for developed countries. However, the difference between two coefficients for Uncertainty avoidance was not statistically significant, indicating no interaction effect between Uncertainty avoidance and economic development level.

In summary, the results of regression analysis indicate that slightly different models offer better explanations for developed and developing countries in regard to their level of broadband Internet diffusion.

## Broadband Internet Adoption History

Table 4.3 shows the tests for hypotheses 5 through 8, asking about the relationship between prominent national cultural values and broadband Internet history. In other words, they ask whether countries with certain cultural value orientation are prone to adopt broadband Internet early, therefore, have a longer history of broadband Internet. In addition to prominent national cultural value variables, ICT-related government involvement index was added to see whether those countries whose government has actively become involved in ICT adoption and promotion have introduced broadband Internet earlier than other countries.

First, a partial correlation analysis was performed to see the relationships between the variables. Given the substantial effect of Economy on broadband Internet diffusion as evidenced in the previous analysis, partial correlation coefficients between original five prominent national cultural value variables and the history of broadband Internet diffusion controlling for GDP level were examined. The results of this analysis are presented in Table 4.3 wherein a positive direction is related to longer history of broadband Internet, meaning broadband Internet was adopted earlier.

For the overall Internet, Individualism, Government involvement, Secular-rational values are significantly related to the time of introduction of Internet in a country with a positive sign, indicating that countries supportive of these national cultural value orientations and a higher level government involvement in ICT development have adopted Internet earlier that other countries. Although not statistically significant with the current set of nations, Power distance (i.e., acceptance of uneven power distribution)

Table 4.3 Partial-correlation between Non-conventional Influence Factors and Broadband Internet History

| | Overall Internet | Broadband Internet |
|---|---|---|
| Individualism | .27*** | .10 |
| Power Distance | -.14 | -.01 |
| Uncertainty Avoidance | .03 | -.11 |
| Secular-rational Value | .31*** | .13[a] |
| Self-expression Value | .01 | .09 |
| Government Involvement | .24** | .25** |

* $p < .10$. ** $p < .05$. *** $p < .01$.

has a negative correlation coefficient (-.14), with the associated *p*-value of .13. As mentioned before, Abelson (1995) recommended to note a variable with its *p*-value falling between .10 and .15 as leaning toward significance, implying that the variable may become significant with an increase in the sample size. Self-expression value was also approaching the significant *p*-value.

Unlike the original expectations, in broadband Internet adoption, only ICT-related government involvement level was significant, with Secular-rational value learning toward a significant level ($p$ =.13). A smaller number of significant coefficients in broadband Internet may be due to the fact that broadband Internet has a relatively short history because it is indeed a subset of overall Internet history, and thus may not have a sufficient variation to yield significant results.

In both overall Internet and broadband Internet, the government involvement level variable was significantly correlated with the dependent variable, although the effect size was rather small. In a supplemental analysis where the three items composing this scale were examined separately, all three categories significantly correlated with the history of broadband Internet among the developed countries. Among the developing countries, however, only one item, whether ICT-related laws are established and enforced, was significantly correlated with the dependent variable.

Table 4.4 summarizes the results of regression analysis for broadband Internet history in developing and developed countries. In this analysis, the infrastructure variable was used in place of GDP, as economic development level was a criterion for distinguishing between developed and developing countries. The overall fit of the full model is not good for both developing and developed countries, with the variance explained by the model being smaller than 50 percent. As a result, only a few variables are significant. Among developed countries, Ethnic-linguistic fractionalization and Uncertainty avoidance were significant, suggesting that countries that are less willing to take risks (i.e., scoring high on Uncertainty avoidance) with a less homogeneous population (i.e., scoring high on Ethnic-linguistic fractionalization index) have adopted broadband Internet earlier. The positive coefficient for Uncertainty avoidance that seems contrary to the prior research, may due to the fact that broadband Internet is no longer considered risky in developed nations where Internet had already been adopted by a substantial number of people. Among developing countries, where the whole phenomenon of Internet is relatively new, Uncertainty avoidance does have a negative sign, indicating that countries characterized by risk-taking (i.e., scoring low on Uncertainty avoidance) have adopted broadband Internet earlier.

The reduced models for each country group was again obtained using backward elimination and provide the most parsimonious model with statistically significant variables only. According to the results in Table 4.4, different factors appear to explain

Table 4.4. Multiple Regression Analysis Summary for Broadband Internet History in Developing vs. Developed Countries

| | Developed Countries | | | | Developing Countries | | | |
|---|---|---|---|---|---|---|---|---|
| | Full Model | | Reduced Model | | Full Model | | Reduced Model | |
| | B | Beta | B | Beta | B | Beta | B | Beta |
| Intercept | 5.04<br>(1.24) | | 6.67<br>(.39) | | 4.82<br>(3.09) | | 7.05<br>(.50) | |
| Infrastructure | .85<br>(.60) | .29 | 1.08<br>(.51) | .37** | .53<br>(1.69) | .12 | | |
| Education | .20<br>(.18) | .20 | | | .28<br>(.33) | .23 | | |
| Urban Population | -.01<br>(.02) | -.06 | | | .02<br>(.03) | .17 | | |
| Population Density | .00<br>(.00) | .52 | | | -.01<br>(.01) | -.30 | -.01<br>(.00) | -.49** |
| Ethnic-linguistic Fractionalization | 2.11<br>(1.23) | .30* | | | -.53<br>(1.78) | -.07 | | |
| Individualism Orientation | .82<br>(.62) | .36 | | | -.60<br>(.92) | -.12 | | |
| Secular-rational value | .45<br>(.52) | .15 | | | -1.28<br>(1.19) | -.28 | | |
| Uncertainty avoidance | .61<br>(.35) | .43* | | | -1.27<br>(.46) | -.68** | -.85<br>(.36) | -.45** |
| Government Involvement | .66<br>(.45) | .32 | .58<br>(.36) | .28* | -.30<br>(.54) | -.13 | | |
| $R^2$ | .47 | | .31 | | .36 | | .22 | |
| Adjusted $R^2$ | .26 | | .27 | | .09 | | .17 | |
| $F$ (df) | 2.24 (9,23) | | 6.87 (2,30) | | 1.34 (9,21) | | 4.00 (2,28) | |
| $P$ | .06 | | <.01 | | .28 | | .03 | |

Note. Standard errors in parentheses. Mean of dependent variable is 7.76 (n=33) for developing countries, and 5.97 (n=31) for developing countries.
* $p < .10$. ** $p < .05$. *** $p < .01$.

the history of broadband Internet in developing and developed countries. Among the developed countries, those nations with a higher level of government involvement and a well-established telecommunication network infrastructure adopted the broadband Internet earlier. However, among the developing countries, neither the government involvement variable nor the infrastructure variable was a significant factor for explaining the introduction time of broadband Internet to the country. Instead, Population density and Uncertainty avoidance were significant predictors, but have signs opposite to those among developed countries.

Again, Population density had a negative coefficient, which does not confirm the previous research on ICT diffusion, as it implies that those countries with a higher population density tend to introduce broadband Internet later. This appears to be contradictory to the commonly hypothesized relationship. This result may indicate that Population density does not well reflect the size of a nation, or the distance between people in other words, as discussed in the previous section. Indeed, in a supplementary analysis where Population density was substituted by the average distance between people, it had a negative sign, indicating that countries with a smaller distance between people adopted the Internet earlier. At the same time, Urban population became a significant predictor with a positive sign, which suggests that countries with a higher urban population tend to adopt broadband Internet earlier. These changes are consistent with the findings of existing literature.

Unlike Population density, the negative coefficient for Uncertainty avoidance is consistent with the previous literature, suggesting that the countries supportive of risk-taking (i.e., lower Uncertainty avoidance) tend to adopt broadband Internet early. As mentioned before, the same variable has a positive sign among developed countries, implying a possible interaction effect between development level and Uncertainty avoidance. The interaction between development level and cultural value variables was examined using *z*-statistics again. Following the suggestion of Cohen et al. (2003), the *z*-statistic was calculated by taking the difference between the two unstandardized coefficients and dividing it by the square root of the sum of the squared standard errors. The resulting *z*-statistic for the Uncertainty avoidance variable was greater than 1.96, indicating a significant interaction between development level and uncertainty avoidance, in regard to broadband Internet history ($z = 3.25$). In other words, the relationship between Uncertainty avoidance and broadband Internet history is moderated by development level.

One problem with the analysis that compares developed and developing countries is that the fundamental difference between the two country groups in terms of broadband Internet diffusion level is not considered. To put it differently, the differences in model may arise from the fact that developing and developed countries are at different stages on the S-shaped diffusion curve. In this respect, the following analyses control this difference by comparing countries within a certain range of broadband Internet diffusion level. As a result, the dependent variable in the following analyses is no longer the overall diffusion level of broadband Internet. Instead, it is the number of years taken to pass certain stages of broadband Internet diffusion, and concern Hypotheses 8 through 12.

## Introduction Stage

Table 4.5 summarizes the results of a hierarchical multiple regressions analysis in which the Introduction stage in years was regressed on an intercept and three blocks of variables: Economy, a demographic variable block, and a non-conventional influence factor block, which is composed of prominent national cultural values and the government involvement variable. In other words, the results presented in Table 4.5 provide an answer to the question that asks whether certain factors accelerate or decelerate a nation's broadband Internet diffusion in the early stage of diffusion. Here the negative sign indicates that the higher the value of a variable, the faster the country passes through the stage.

As can be seen in Table 4.5, when entered alone, Economy, as measured by GDP (PPP) per capita, significantly predicted how many years it took to pass the introduction stage. As indicated by the $R^2$ value in the first step, 23 percent of the variance in the number of years for a nation to pass the introduction stage of broadband Internet diffusion could be predicted by knowing the nation's GDP level alone ($F_{(1,54)} = 16.52$, $p < .001$). It is also worth pointing out that GDP in this model may also captures relevant aspects of telecommunication and Internet infrastructure, as the latter two variables were highly correlated with GDP as mentioned before, and had to be dropped because of multicollinearity issue.[9]

The model with the additional conventional predictor variables in Step 2 is also significant as well, indicating that demographic variables and the broadband Internet introduction year variable significantly improved the prediction. The addition of this block increased the $R^2$ by 21 percentage points, explaining in total 44 percent of variance

[9] In fact VIF index scores for these two variables were smaller than the usual cut-off point of 10. However, given the small number of cases, following Cohen et al.'s suggestion (2003), a more conservative cut-off point of 5 was applied in this study.

Table 4.5. Summary of Hierarchical Multiple Regression Analysis for the Introduction Phase of Broadband Internet Diffusion

| | HIERARCHICAL MODEL | | | | | | REDUCED MODEL | |
|---|---|---|---|---|---|---|---|---|
| | Step 1 | | Step 2 | | Step 3 | | | |
| Variable | B | Beta | B | Beta | B | Beta | B | Beta |
| Intercept | 4.54 | | 781.41 | | 1006.21 | | 892.46 | |
| | (.36) | | (283.02) | | 252.98 | | 230.26 | |
| Economy | .00 | -.48*** | .00 | -.37*** | .00 | -.01 | | |
| | (.00) | | (.00) | | (.00) | | | |
| Education | | | -.05 | -.05 | .06 | .05 | | |
| | | | (.14) | | (.12) | | | |
| Urban Population | | | -.02 | -.24* | -.02 | -.15 | | |
| | | | (.01) | | (.01) | | | |
| Population Density | | | .00 | -.05 | .00 | -.18 | .00 | -.26** |
| | | | (.00) | | (.00) | | (.00) | |
| Ethnic-Linguistic Fractionalization | | | 2.65 | .35*** | 1.33 | .18 | 1.37 | .18* |
| | | | (.88) | | (.86) | | (.79) | |
| Broadband Internet Introduction Year | | | -.39 | -.35*** | -.50 | -.45*** | -.45 | -.40*** |
| | | | (.14) | | (.13) | | (.12) | |
| Individualism Orientation | | | | | -.93 | -.39** | -1.11 | -.47*** |
| | | | | | (.39) | | (.28) | |
| Secular-rational value | | | | | -.33 | -.11 | | |
| | | | | | (.34) | | | |
| Uncertainty Avoidance | | | | | -.52 | -.30** | -.60 | -.35*** |
| | | | | | (.22) | | (.20) | |
| Government Involvement | | | | | -.90 | -.48*** | -.93 | -.50*** |
| | | | | | (.24) | | (.22) | |
| $R^2$ (adjusted) | .23 (.22) | | .44 (.38) | | .62 (.53) | | .60 (.55) | |
| $R^2$ change | .23*** | | .21*** | | .17*** | | | |
| *F* (df) | 16.52 (1,54) | | 6.51 (6,49) | | 7.29 (10,45) | | 12.19 (6,49) | |
| *P* | <.001 | | <.001 | | <.001 | | <.001 | |

Note: Standard errors in parentheses. Mean of dependent variable is 3.15. N=55.
* $p < .10$. ** $p < .5$. *** $p < .01$.

in the dependent variable (adjusted $R^2 = .38$, $F_{(6,49)} = 6.51$, $p < .001$).

In Step 3 of hierarchical model in Table 4.5, the third block, which is composed of prominent national cultural value variables and the government involvement variable, predicted an additional 17 percent of the variance in predicting the number of years taken to pass through the Introduction stage. As a result, the model in Step 3 that encompasses all three blocks of variables can explain 62 percent of the variance in the dependent variable (adjusted $R^2 = .53$, $F_{(10,45)} = 7.29$, $p < .001$). This is a large effect size according to Cohen (1988).

When the contribution of individual factors were compared in Step3, the strongest predictor of the number of years taken to pass the Introduction stage was found to be the ICT-related government involvement, one of the non-conventional factors in this study (*Beta* = -.48, $p$ <.01). Substantively, the negative coefficient associated with this variable indicate that a one-unit increase in this variables leads to about a one-year reduction in the time taken to pass the introduction stage (-.90).

Beside ICT-related government involvement, the introduction year of broadband Internet, Individualism orientation, and Uncertainty avoidance also significantly and negatively related to the dependent variable. When other conditions are held constant, a one-unit increase in Individualism orientation is associated with about a one-year decrease in the duration of Introduction stage (-.93). A one-unit increase in both Uncertainty avoidance orientation and Broadband Internet introduction year will help the country move to the next stage almost a half-year earlier than other (-.52 for Uncertainty avoidance; -.50 for Broadband Internet introduction year). The negative relationship between the introduction year of broadband Internet and the number of years taken to pass the Introduction stage may indicate a late-comer effect in which those who adopt an innovative ICT later in time may benefit from more advanced technology and relatively well-built infrastructure, so their diffusion speed may be faster.

According to the summary results under the reduced model column in Table 4.5, 60 percent of the variance in the number of years taken for a nation to pass the Introduction stage can be predicted by Population density, Ethnic-linguistic fractionalization index, Broadband Internet introduction year, Individualism orientation, Uncertainty avoidance, and Government involvement index.

In summary, a nation will move to the next stage of broadband Internet diffusion more quickly when it has a higher population density, an ethnically and linguistically homogeneous population (low score in the ELF index), and a higher level of government involvement in ICT sector. In terms of prominent national cultural values, more individualistic and less risk-taking countries (high uncertainty avoidance) are in a better position. The latter finding is somewhat contrary to the presumed assumption that high uncertainty avoidance is negatively associated with innovation adoption. One plausible explanation is that broadband Internet is in a way an extension of narrowband Internet, and thus it is well known and no longer perceived as something totally new to be rendered as "risky." The negative relationship between Broadband Internet introduction year and the number of years taken to pass the Introduction stage could reflect a late-comer effect, which means that those countries adopting broadband Internet later in time may be at an advantage due to more advanced technology, which is related to the ease of installation and use, and thus individuals' decision to adopt. Here Population density had a negative sign that is consistent with the presumed relationship.

## Early Adoption Stage

Table 4.6 summarizes the result of hierarchical multiple regressions analysis in which economic development level is introduced first, followed by other conventional control variables and then non-conventional factor block composed of prominent national cultural value variables and the government involvement index variable. In this model, the dependent variable is the early adoption stage in which broadband Internet is diffused from 3 to 20 percent of the population after its initial introduction. It is assumed that after this stage, which is completed at 20 percent of adoption, a new product will be diffused to the rest of society over time.

Surprisingly, unlike in the previous analysis of the Introduction stage, the economic development level measured by GDP is no longer a significant predictor from Step 1 at this stage. Thus the model with this single predictor is not statistically significant. In addition, other conventional influence factors incorporated as a second block in Step 2 failed to substantially increase the amount of explained variance either, even though this variable block could explain additional 24 percentage points of the variance in the observed data (adjusted $R^2$=.10) and the fact that Urban population had a significant regression coefficient. Although this may due to the small number of cases, together with GDP, conventional control variables were not significant predictors of the Early adoption stage, with the associated $F$ value of 1.743 ($p$ = .142).

However, upon the introduction of prominent national cultural variables, along with the government involvement index, into the equation in Step 3, the variance explained by the model significantly increased by 34 percentage points. As a result, the third model that included non-conventional influence factor block could explain 58

Table 4.6 Summary of Hierarchical Multiple Regression Analysis for the Early Adoption Stage of Broadband Internet Diffusion

| | HIERARCHICAL MODEL | | | | | | REDUCED MODEL | |
|---|---|---|---|---|---|---|---|---|
| | Step 1 | | Step 2 | | Step 3 | | | |
| Variable | B | Beta | B | Beta | B | Beta | B | Beta |
| Intercept | 2.64 (.35) | | -256.23 (233.92) | | -391.65 (208.01) | | -522.07 (193.95) | |
| Economy | .00 (.00) | .12 | .00 (.00) | .01 | .00 (.00) | -.18 | | |
| Education | | | -.11 (.12) | -.15 | .14 (.10) | -.19 | | |
| Urban Population | | | .03 (.02) | .35* | .01 (.01) | .18 | | |
| Population Density | | | .00 (.00) | -.15 | .00 (.00) | .50** | .00 (.00) | .65*** |
| Ethnic-Linguistic Fractionalization | | | -1.33 (.88) | -.25 | -1.13 (.78) | -.21 | | |
| Broadband Internet Introduction Year | | | .13 (.12) | .20 | .20 (.10) | .31* | .26 (.97) | .42** |
| Individualism Orientation | | | | | .88 (.35) | .60** | .86 (.25) | .59*** |
| Secular-Rational value | | | | | -.90 (.34) | -.49*** | -.87 (.23) | -.48*** |
| Uncertainty Avoidance | | | | | .34 (.19) | .35* | .44 (.16) | .45** |
| Government Involvement | | | | | .43 (.23) | .33*** | .44 (.21) | .33** |
| $R^2$ (adjusted) | .02 (.01) | | .24 (.10) | | .58 (.43) | | .52 (.43) | |
| $R^2$ change | .02 | | .22 | | .34*** | | | |
| $F$ (df) | .59 (1,39) | | 1.74 (6,33) | | 4.00 (10,29) | | 5.96 (6,33) | |
| $P$ | .448 | | .142 | | .002 | | <.001 | |

Note: Standard errors in parentheses. Mean of dependent variable is 2.9. N=40.
* $p < .10$. ** $p < .05$. *** $p < .01$.

percent of the variance in the number of years taken to pass the Early adoption stage in the sample for this study (adjusted $R^2 = .43$, $F_{(10,29)} = 4.00$, $p$ =.002). In this model, two conventional factors, namely, Population density and Broadband Internet introduction year, and all four non-conventional influence factors emerged as significant predictors for the duration of the early adoption stage.

The regression coefficients presented in Table 4.6 suggest that, when other variables in this study are held constant, the strongest predictors of the number of years taken for the Early adoption stage is Individualism orientation (.88). Substantively, a one-unit increase in Individualism orientation is also associated with about a year longer in the Early adoption stage. This suggests that that Individualism orientation is less beneficial in passing through the Early adoption stage.

When compared to the results of previous analysis of the Introduction stage, among the six significant predictors of this stage, five variables experienced a change of a sign. Secular-rational value is the only predictor that has a consistently negative coefficient, suggesting that countries supporting secular-rational values, as opposed to traditional values, may pass through this stage more quickly. Specifically, a one-unit increase in secular-rational value index contributes to the almost one-year decrease (-.90) in the number of years that it took to pass through the Early adoption stage.

One puzzling finding is the positive sign for other three variables, Government Involvement, Population Density and Broadband Internet introduction year. Prior research on innovation diffusion indicated that these variables are positively associated with diffusion of innovation. However, positive coefficients associated with these variables suggest that high scores in these variables lead to a longer introduction stage.

This finding could be caused by the difference in the dependent variable, that is, the speed of diffusion as measured by the number of years taken to pass through a certain stage, as opposed to the overall diffusion level, or it may be indicating the presence of other confounding variables yet to be identified. Another plausible explanation is related to measurement issues, as was discussed regarding Population density, which will be dealt with in detail in Chapter 5 under the discussion of limitations of the study.

The backward elimination regression method suggested a reduced model that utilizes six variables identified in Step 3 of hierarchical model: Population density, Broadband Internet introduction time, Individualism orientation, Secular-rational value, Uncertainty avoidance, and Government involvement index. An interesting finding is that except for the first two variables, this model is mostly composed of non-conventional influence factors.

### Take-Off Stage

In this study, the Take-off stage is defined as the time period during which an innovative ICT is diffused from 20 to 50 percent of the population. This stage also corresponds to the steep slope in the S-shaped diffusion curve.

Among the 64 countries in this study, only 16 countries passed through this stage by the end of 2006 and entered the next phase of the Late-majority stage, wherein broadband Internet is expected to diffuse from 50 to 80 percent of the population. Given the small number of cases available for an analysis, standard multiple regression analysis employing all predictor variables included in previous analyses could not be conducted.

Instead, the relationship between the number of years taken to pass the Take-off stage and other influence factors were analyzed using scatter plots and a non-parametric statistical method that doesn't require strict assumptions for sample distribution and variance. Considering the small number of cases and limited analytical methods that does not account for control variables, the findings of the analysis in this specific stage should be interpreted with caution.

On average, for those 16 countries, it took 2.6 years to pass the Take-off stage of broadband Internet diffusion, with the minimum being 1 year and the maximum being 4 years. Considering the small number of cases, Spearman rank order correlation was employed instead of Pearson product moment correlation to explore the relationship between the influence factors and the number of years taken to pass through the Take-off stage. Analysis controlling for a potential confounding variable was not performed, as there was no non-parametric alternative for partial correlation analysis.

Table 4.7 summarizes the results of Spearman rank correlation analysis between influence factors and the number of years taken to pass through the Take-off stage. As can be seen in the table, there are not many significant associations between the number of years for the Take-off stage and other influence factors. Even when the relationship is statistically significant, the strength of the relationship is not strong, especially given the fact that these coefficients represent a strength of bivariate relations without a further control.

According to the results presented in Table 4.7, the number of years taken to pass through the Take-off stage is negatively associated with Economy, Broadband Internet introduction year, Urban population, and Individualism orientation. These observations are inconsistent with the prior analysis in the Early adoption stage and difficult to interpret. Presumably a lower-level analysis and the small sample size might have contributed to these unexpected findings.

The ICT-related government involvement index variable was not significant, although the associated *p*-value was approaching marginal significance. The positive sign associated with this variable is consistent with the results from the Early adoption stage. A supplementary analysis on three component items of this variable indicates that two of this scales' three measures were correlated with the number of years taken to pass the stage: Spearman rank correlation coefficient ($r_s$) for the government priority on ICT development variable was .35 ($p = .09$); Government promotion of ICT had the $r_s$ of .44 ($p = .05$). The positive sign indicates that it takes longer to pass through this stage for the countries scoring high on these two items. The last measure for the government involvement index, namely the establishment of ICT-related law, did not have a statistically significant association with the number of years taken to pass through the Take-off stage, but its coefficient had a negative sign. Differences in signs and the potential contribution of the variable may originate from the fact that, although these items are very general measures of government involvement in ICT development, the wordings for the first two items are more pertinent to the early stage of diffusion, while the latter may relate to the entire diffusion process.

Again, it is puzzling that these measures, which are presumed to support the diffusion of broadband Internet, are positively correlated with the number of years taken to pass the Take-off stage, meaning it takes more years to finish the Take-off stage if a country has a higher score on the ICT-related government involvement index. One plausible explanation is that the observation may be a simple reflection of post hoc measures. Put differently, the positive correlation may indicate a country taking a longer time to diffuse broadband Internet get involved in ICT promotion and establishment of related laws and policies afterwards. In fact, the positive partial correlation between the history of broadband Internet in a country and Government involvement was significant and positive.

Again, since there are only 16 cases, the impact of few outliers might have been even stronger in this round of analysis, implying that future analysis that includes more cases may present different findings.

Table 4.7 Spearman Rank Correlation between Influence Factors and Years Taken to Pass Take-off Stage

| | Mean | SD | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Years Taken for Take-Off stage | 2.56 | 1.03 | -.39* | -.04 | .26 | -.45** | .16 | .13 | -.43** | -.37* | .01 | .10 | .30 |
| 1. Economy | 31575 | 14569 | | -.31 | .07 | -.05 | .32 | -.21 | .26 | .49** | .03 | -.13 | -.14 |
| 2. Education | 4.50 | 1.73 | | | -.06 | -.35* | -.01 | -.24 | .29 | .12 | -.11 | .09 | .49** |
| 3. Ethnic-Linguistic Fractionalization | .27 | .22 | | | | .12 | -.13 | -.25 | -.01 | .27 | -.50** | -.29 | -.24 |
| 4. Broadband Introduction year | 1999 | 1.29 | | | | | -.56** | -.21 | .16 | .03 | -.04 | -.24 | -.38* |
| 5. Infrastructure | .84 | .52 | | | | | | .30 | .08 | .04 | .28a | .11 | .28 |
| 6. Population Density | 195.86 | 211.49 | | | | | | | -.09 | -.45** | .03 | .34* | .14 |
| 7. Urban Population | 75.76 | 10.44 | | | | | | | | .48** | -.06 | -.21 | .13 |
| 8. Individualism Orientation | .71 | .60 | | | | | | | | | -.01 | -.62*** | -.14 |
| 9. Secular-rational Value | .55 | .49 | | | | | | | | | | .29 | .27 |
| 10. Uncertainty Avoidance | -.59 | .88 | | | | | | | | | | | .24 |
| 11. Government Involvement | .76 | .52 | | | | | | | | | | | |

Note: N=16.
* $p < .10$. ** $p < .05$. *** $p < .01$.

# CHAPTER 5

# CONCLUSION AND SUGGESTION

This study examined how the non-conventional influence factors of innovation diffusion, as represented by prominent national cultural values and ICT-related government involvement, affect nationwide diffusion of broadband Internet. What is unique in this study is that additional focus was placed on the conditions under which the direction and strength of that influence change. More specifically, this study examined the influence of those non-conventional variables at each stage of diffusion.

The following section summarizes the results of the empirical analysis. The implications of this study and its limitations are also presented along with the suggestions for future research.

## Summary of Findings

The study question and first four hypotheses of this study specifically focused on the impact of non-conventional factors on the diffusion of broadband Internet. The results of multiple regression analyses on broadband Internet diffusion level suggested that non-conventional influence factors significantly improved the fit of a model explaining nationwide broadband Internet diffusion level. This provides a positive answer to the first question of this study, that asks the impact of non-conventional factors on broadband Internet diffusion.

When conventional influence factors were controlled for, Individualism orientation and the ICT-related government involvement index, were not significant predictors of broadband Internet diffusion level as of 2006. Although in the presumed direction, the coefficient associated with the individualism orientation index was not statistically significant. Similarly, ICT-related government involvement had a positive sign, but failed to add a significant contribution to the overall fit of the model explaining the diffusion level of broadband Internet in 2006. This concludes that both Hypotheses 1 and 4 are not supported.

Among four variables in the non-conventional factor block, Secular-rational values had a statistically significant regression coefficient, with the standardized coefficient being the second largest (*Beta* =.30, $p < .01$) and following that for Economy (*Beta* = .47, $p < .01$). Secular-rational values was have found to be significantly and negatively related to nationwide broadband Internet diffusion, with its standardized coefficient being the second largest, following that for Economy. Substantively, when all other conditions are held constant, a country scoring one unit higher for this variable experiences about a 10 percentage point higher diffusion level, thus Hypothesis 2 was supported, while Hypotheses 3 was not supported.

The second question of this study concerned whether different factors operate between developing and developed countries in broadband Internet diffusion. To address this question, separate regressions were performed for developing and developed countries. The results suggest that indeed a different set of predictors are at work in the two country groups, with corresponding measures also performing differently. For instance, in both country groups, Secular-rational values were a significant predictor of overall broadband Internet diffusion level. However, among developing countries, the coefficient had a negative sign, indicating that traditional value orientation, which emphasizes social conformity, is more favorable to for broadband Internet diffusion in developing countries. In a way, this finding has a thread of connection to the negative regression coefficient of Ethnic-linguistic fractionalization, which represents homogeneity of population. A supplemental analysis indicated that there is a significant interaction effect between development level and the secular-rational value variable. These findings provide a positive answer for the second study question.

Hypotheses 5 through 8 test the assumption that nations with certain value orientations tend to adopt broadband Internet earlier, and thus have a longer history of broadband Internet diffusion. Partial correlation controlling for the economic variable was conducted to examine the relationship between the prominent national cultural values in their original form and broadband Internet history, as represented by the year broadband Internet was first adopted.

Unlike in the case of the overall Internet, under which broadband Internet may be a sub-category, ICT-related government involvement was the only variable among the non-conventional factors in this study that had a statistically significant association with the broadband Internet history. However, given the fact that signs of the correlation coefficients are consistent with the hypothesized relationship and more variables have significant correlation coefficients in the overall Internet diffusion history, a future study may be able to find more significant associations.

Additional multiple regression analysis on developing versus developed countries indicated that two country groups have different models for explaining their history of broadband Internet diffusion. When other variables were controlled, Secular-rational values was the only significant variable in both country groups. This concludes that Hypothesis 6 was supported. An interaction test using *z*-statistics indicated that the effect of the secular-rational value variable on the broadband Internet history is moderated by economic development level. The overall fit of the model is also rather poor, explaining less than 35 percent of the variance in the dependent variable, implying there may be other important variables currently missing in the model specification. Nevertheless, regression analysis results suggest that different models better explain the diffusion of broadband Internet in developing and developed countries.

As discussed in the analysis section, the difference in influence factors between developing and developed countries may be due to the fact that they are indeed at a different stage in the S-shaped broadband Internet diffusion curve. In other words, the model from developed countries may represent factors affecting broadband Internet diffusion after the technology was actually diffused to substantial number of people in the population, since the mean broadband Internet diffusion level for these countries was about 40 percent. On the other hand, the model from developing countries may represent instead the factors influencing introduction or early adoption stages of broadband Internet diffusion, as its mean of 10 percent indicates. In this regard as well, looking at the different stage of broadband Internet diffusion becomes significant.

As a response, the third study question and the last set of hypotheses test the influence of prominent national cultural values in a specific stage/phase of diffusion. In essence, Hypotheses 9 through 12 assume that for the early phase of broadband Internet diffusion, national cultural values that conform to innovativeness, such as high individualism, low power distance, will also facilitate the introduction of broadband Internet in a nation. On the other hand, prominent national cultural values that are related to group consensus and collective behaviors, such as low secular-rational values, high uncertainty avoidance, are presumed to benefit the remaining stages of nationwide broadband Internet diffusion. Furthermore, ICT-related government involvement is assumed to accelerate the diffusion regardless of the stage of the diffusion.

A comparison of the three stages examined in this study indicates that in the Introduction stage, high individualism orientation will lead a country to pass through that stage more quickly (negative sign), while in the Early adoption stage, high individualism orientation actually seems to slow the diffusion process. However, in the Take-off stage, the partial correlation coefficient associated with this variable has the opposite sign than what was presumed in Hypothesis. Thus Hypothesis 9 was partially supported.

Hypotheses 10 assumed that after the Introduction stage where innovativeness related cultural values may be more influential, countries that were characterized by low secular-rational values, in other words, favoring traditional values such as religion, family ties, and national pride, will diffuse broadband Internet more quickly than other countries as conformity may be more important in the full-scale diffusion stage. However, Secular-rational value was not a significant predictor for the number of years taken for the Introduction stage, and high scores in this variable lead to faster diffusion in the Early adoption stage. In the Take-off stage, Spearman's *rho* has a positive sign, but it was not statistically significant. Nevertheless, due to the fact that this variable had a consistently negative coefficient for the first two stages and then changed its sign into a positive, which is the direction of the presumed effect, it can be stated that, although this variable was not a significant predictor throughout three stages, it does have the presumed effect with some time lag. In other words, Secular-rational value negatively affects the speed of broadband Internet diffusion in the first two stages, and then the influence of this variable is much less helpful in the later stages, as demonstrated by its coefficient becoming positive. To rephrase this result substantively, high secular value orientation tends to shorten the duration of the early stages, whereas in the later stage of diffusion, traditional value orientation (i.e., the other end of the original Traditional vs. Secular-rational value continuum) becomes more important and actually helps a country to move more quickly to the next stage. This leads to the conclusion that Hypothesis 10 is partially supported.

Hypothesis 11 concerns the role of uncertainty avoidance on diffusion speed in different stages of broadband Internet diffusion. The regression analysis results indicated that high uncertainty avoidance is a significant predictor in the first two stages. In the Take-off stage, however, the coefficient associated with Uncertainty avoidance becomes non-significant. Yet, the direction of influence remains the same. The results show that Uncertainty avoidance does have different effects on early and later stages of diffusion, but the direction of the influence does not follow the expectations of the hypothesis. Therefore, Hypothesis 11 was not supported.

In essence, the sign change of significant coefficients across three stages of diffusion indicates that the relationship asked about in the third question is confirmed.

In this study, one of the major non-conventional influence factors was ICT-related government involvement. Although the associated zero-order correlation coefficient indicated a positive association between ICT-related government involvement and broadband Internet diffusion level, when all the other variables were controlled in a regression analysis, the ICT-related government involvement index became non-significant, concluding that Hypothesis 4 and 8 were not supported.

However, when speed of diffusion was considered, government involvement was a consistently significant influence factor throughout all three stages of diffusion analyzed in this study. The results show that ICT-related government involvement was especially helpful in the early stage of broadband Internet diffusion with a negative coefficient in the Introduction stage. A supplementary partial correlation analysis, controlling for economic development level, also indicated that all three items composing the government involvement index were negatively correlated with the number of years taken to pass the Introduction stage, with statistical significance. After the Introduction stage, the sign changed to negative, implying that government involvement measures are associated with a slower diffusion speed. These results sound reasonable, given that the components of this index concern promotion and prioritization of ICT which appear to be more pertinent to the early stage of diffusion. Establishment of ICT-related law and policy is the only item among three indicators that may affect the later process. Indeed a negative partial correlation in the Take-off stage indicates that variable is related to a shorter Take-off stage. Thus, Hypothesis 12 was partially supported.

Another plausible explanation regarding the level of government involvement variable is that the observation may be a simple reflection of *post hoc* measures. Put differently, the positive correlation may indicate that a country that takes longer to diffuse broadband Internet gets involved in ICT promotion and establishment of related laws and policies afterwards. A supplementary partial correlation analysis controlling for economy showed that there is a significant positive relationship between the history of broadband

Internet and ICT-related government involvement in the countries of this study. However, proving this assumption requires a clear time line be established between certain actions of government and the changes before and after, which would be a subject of future research.

In summary, although several hypotheses of this study were not supported or the analysis delivered contrary results with opposite signs than what was expected, the overall findings of this study do indicate that non-conventional factors have unique contributions in explaining the variances in broadband Internet diffusion whether for actual diffusion level or diffusion speed. Furthermore, comparison of developed and developing countries showed that the models explaining nationwide broadband Internet diffusion in these two country groups actually differ. Finally, although the directions of several coefficients associated with prominent national cultural values did not always confirm the presumed relationships, analyses of the different diffusion stages showed that prominent national cultural values do influence each process differently.

## Contribution and Implication

The findings of this study have significant theoretical and application implications. In the theoretical aspect, the findings on the conventional factors initially confirm previous research wherein the influence of economic, demographic, and infrastructure variables are significant predictors of innovative technologies.

This study also extends the diffusion and ICT research tradition by providing empirical evidence for the influence of prominent national cultural variables and ICT-related government involvement. Many scholars of diffusion research have mentioned the importance of culture, yet they have rarely tested it in quantitative studies. In this respect, this study contributes significantly by providing empirical evidence of the influence of non-conventional factors in explaining or predicting innovative ICT diffusion and, in particular, broadband Internet diffusion. What is further innovative in this study is that the influences of both conventional and non-conventional factors have been analyzed in different stages of diffusion to show how the strength and direction of that influence changes. As a result, it was found that economy and other conventional factors are no longer significant predictors of broadband Internet diffusion speed in the Early adoption stage. While analyzing coefficients of each variable, it was noted that population density - one of the most frequently employed conventional factors - may not be the best measure for representing geographic characteristics of a nation which substantially affect infrastructure building, cost and provision of actual services. As a result, it was suggested that the average distance between people be used in place of, or in combination with, population density.

There has been a discrepancy in ICT diffusion literature in that the role of government has been discussed and emphasized in descriptive studies, but only a few researchers have conducted empirical studies, and even those only employed a very few specific competition policies. Considering that government involvement in ICT development, as discussed in descriptive case studies, was intended to include more than just a few market policies, this study incorporated broader measures for government involvement. This approach leaves room for criticism as discussed in the following section, and yet succeeded in showing the importance of government involvement in quantitative analysis.

Additionally, this study included both developing and developed countries, thereby expanding the scope of research subjects and the corresponding applicability of the results. In this respect, the results of this study have significant practical and policy implications; they provide a solid basis for disparate approaches for developed and developing countries, and for the different stages of diffusion. In short, the results of this study can be used as a stepping stone for future studies on the effect of cultural values and the role of government.

## Limitations and Suggestions

As with any research, this study has several limitations. First, this study used secondary data, and was seriously affected by data availability and measurement issues. As discussed earlier, one of the reason why cultural values have not been incorporated in empirical studies is that culture is hard to operationalize and measure. This study attempted to get around this issue by employing two well-known indices for prominent national cultural values. However, some items in the indices may not have perfectly measured what the scale was supposed to represent, raising a validity issue. For instance, "justifiability" of homosexuality is one of the items composing Survival versus Self-Expression values. Whether the respondent describes him or herself as not very happy is another item for this scale. As another example, Uncertainty avoidance includes questions about how often the respondent feels nervous at work without presenting any specific condition, and whether a rule should be observed even when the respondent doesn't believe it is right. In addition to the small number of cases in this study, the validity of such indices might have contributed to non-significant or even contradictory findings in this study.

In order to represent ICT-related government involvement, this study adopted three survey questions for the experts in the country asking their evaluations on their government's ICT promotion, prioritization of ICT, and establishment of ICT-related law and policy. Although there were significant findings regarding this variable, the questions in the index are in fact only a very general assessment of government involvement and may be too broad to reveal their actual effect. This issue calls for further evaluation of the existing measures and the development of more valid and specific framework for representing government involvement in ICT development. Then applying this framework to more countries for a longer period of time is also warranted.

Further limitation of this study comes from the availability of broadband Internet related data. Due to the relatively short history and rapid technological advancement, the definition of broadband Internet has been constantly evolving, and consistent data collection over time on important indicators is either absent or difficult to gather. The small number of cases available also put a limit on the inclusion of more diverse independent variables in the regression analysis, which is why some variables were standardized and combined into a single index, blending their unique contribution, or highly correlated variables were dropped even when their VIF was smaller than the usual cut-off point of 10. Limited availability of data also reduced the options for analytical methods, especially toward the latter stages of diffusion. When more cases become available in the future, more rigorous analysis will become possible. At that point, some variables whose coefficients are approaching statistical significance but are not yet significant, may prove to be significant predictors.

Network externalities, a unique variable for any network-based technology like the Internet, was not included in the statistical analysis in this study for the following reason. The current study analyzed the relationships between diffusion speed and a set of predictors separately at each phase of the diffusion process, and that classification represented a different range in broadband adoption and diffusion rate. This classification resulted in grouping cases with similar values, albeit not equal, on their broadband diffusion level, that is, an externality for this case. This whole process of grouping cases with similar diffusion level and then examining the relationship separately at each diffusion level essentially has the same effect of removing the effects of network externalities from the focal relationship.

Finally, this study concerns prominent national cultural values. While national culture is a macro-level phenomenon, the decision to accept the technology by any particular user is an individual level concern. Thus, one should not assume that the cultural characteristics of an entire country under investigation will be the same as the cultural characteristics of the people within that country. This assumption is what Robinson (1950) calls the "ecological fallacy," a tendency to ignore individualistic traits and replace them with a collective stereotype. Individuals may identify with prominent national cultural values to varying degrees, and thus it is inappropriate to use country scores on a cultural dimension to predict individual behavior.

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