The Relationship between Internet Environment and Life Expectancy in Asia

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ABSTRACT

This study examines the effects of three factors related to the Internet environment (broadband, mobile phone, and Internet security) on life expectancy based on panel data on sixteen Asian countries between 2009 and 2014. The findings show that each of the three factors has a slightly positive relationship with life expectancy, and this fits the views of the existing literature. Our findings provide preliminary concepts for the relationship between the Internet environment and life expectancy, and could serve as the basis for policy making such as allocation of infrastructure investment for social welfare. This research is noteworthy given the paucity of materials on life expectancy related to the Internet environment.

Keywords: Life expectancy, Internet environment, Panel data, Asia.

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1. INTRODUCTION

Life expectancy is the number of years that one is expected to live (Bezy, 2008). It is commonly used to measure socioeconomic indices such as education, income, and occupation (Chang et al., 2011; Obrizan & Wehby, 2018). In the past decades, life expectancy has attracted a certain amount of attention. These broad interests have led to a great deal of research on factors affecting life expectancy. But many studies on life expectancy have been dominated by a focus on social and economic factors. This research attempts to look into the effects of factors related to the Internet environment on life expectancy. Internet connectivity has changed many aspects of life since the emergence of the Internet in the early 1990s (Alzaid, Komal, Al-Maraghi, & Alsulami, 2014; Deloitte, 2014; Ho, Kluver, & Yang, 2003). With the improvement of digital technology, the Internet has accelerated worldwide connectivity, and consequently the increase in network activity has led to a change in the way of doing the majority of activities (Deloitte, 2014). The Internet has also played a crucial role in economic, political, and social areas in Asia (Ho et al., 2003). Many Asian countries have

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committed to developing internet-based technology as they have recognized the Internet as engine of social progress (Ho et al., 2003).

The research will build on data from sixteen Asian countries: Republic of Korea, People's Republic of China, Republic of India, Kingdom of Saudi Arabia, Japan, Malaysia, Socialist Republic of Vietnam, Republic of Indonesia, United Arab Emirates, Mongolia, Republic of Uzbekistan, State of Qatar, Republic of Singapore, Hong Kong Special Administrative Region of the People's Republic of China, Kingdom of Thailand, and State of Kuwait. These countries show diversity in politics, society, economy, and culture in each Asian region. Because the expanded Internet environment has accelerated transformation in entire sectors across Asian countries, it would be meaningful to observe the effects of the Internet environment on life expectancy.

The research is conducted on three factors representing the Internet environment: broadband, mobile phone, and Internet security. The aim of the research is to explore the relationship between the Internet environment and life expectancy and to thereby provide primary data for those who formulate government policy.

2. LITERATURE REVIEW

As Internet environment has taken on importance in the past few decades, research concerning the effects of the Internet environment has dramatically increased. The literature review focused on three factors to represent the Internet environment: broadband, mobile phone, and Internet security.

2.1 Broadband

The term broadband commonly refers to high-speed Internet access, and it is widely used to measure the level of technology developed for the transmission of data communication services (National Research Council, 2002). Speed of Internet connection is considered as an essential for economic development, as the importance of information and communication in business has been increased (Davison & Cotten, 2009; Picot & Wernick, 2007). According to Czernich, Falck, Kretschmer, and Woessmann (2011), GDP per capita of countries with broadband is higher on average than countries without broadband. They found that a 10% increase in broadband penetration rate led to annual growth rate of 0.9-1.5% in GDP per capita (Czernich, Falck, Kretschmer, & Woessmann, 2011). The potential economic benefits from extending Internet access could stimulate socio-economic development and thereby improve quality of life to enable people to live longer and healthier lives (Deloitte, 2014).

Neuberger (2007) noted that broadband accords opportunity for better health care and cost saving. Broadband allows medical professionals to make faster treatment decisions by enabling information-sharing among facilities, practitioners, and patients (Neuberger, 2007). Broadband also confers a benefit to people who live in places far from medical facilities through “telemedicine” to provide health care service from a distance (Davidson, Santorelli, & Kamber, 2009; Neuberger, 2007). Viewed in this light, it is highly probable that broadband contributes to life expectancy by being a vehicle for health care.

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2.2 Mobile phones

With the progress of technology, mobile phones have not only provided basic function of enabling real-time voice communication but also have provided various functions such as Internet access and video calling that can be applied to personal health care (Patrick, Griswold, Raab, & Intille, 2008). One of benefits of mobile phone is the connectivity with no restrictions on time and place. Medical practitioners can connect with patients who have difficulty in getting medical services, and the patients can also have medical coverage due to the characteristic of mobile phone (Patrick et al., 2008). Vergados (2010) noted elderly people who live alone can have access to health care service with mobile phones whenever they are in need. Specialized health care applications provided by mobile phone assist elderly people in sustaining independent living by providing just-in-time solutions (Lai, Lee, Hsiao, Liu, & Chen, 2009; Vergados, 2010).

Mobile phones are a promising tool for health interventions (Klasnja & Pratt, 2012). Klasnja and Pratt (2012) indicated that improved technologies of mobile phone have widened the range of involvement of practitioners. Touch screen technology allows measurement of a patient's stress level coupled with physiological factors (Morris & Guilak, 2009). Mobile feedback based on this technology enables people to know signs of stress earlier and prevent potential damages caused by stress from occurring (Morris & Guilak, 2009). Various mobile-based applications can provide information regarding preventive health care (Deloitte, 2014). Patients who are under treatment can also be continually monitored by mobile-based applications, and this process affords practitioner a chance to offer effective treatments (Deloitte, 2014).

2.3 Internet security

As the medical sector has incorporated Internet technology into the process of health care, paper-based patient records have been converted into electronic formats so that practitioners and patients can have much easier access to the records via the Internet (Meingast, Roosta, & Sastry, 2006). However, although technology has conferred benefits on health care, issues related to privacy and security have developed (Meingast et al., 2006). Because patient records include highly private and sensitive information, if the information is exploited and modified illegally, it could have effects on patients financially, psychologically, as well as physically (Rindfleisch, 1997). Rindfleisch (1997) noted that practitioners should have access to accurate medical record so as to diagnose diseases correctly and to provide effective treatments. However, without guarantee of privacy and security of medical data, patients may avoid providing private information, which may affect diagnosis and treatment, and practitioners may also not input all the medical information into electronic patient records (Rindfleisch, 1997). Thus, it is essential to ensure medical network security in order that optimal health care can be provided and implemented (Kasztelowicz, Czubenko, & Zieba, 2003; Meingast et al., 2006; Rindfleisch, 1997).

3. DATA DESCRIPTION AND METHODOLOGY

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3.1 Data description

This research draws on statistical data on sixteen Asian countries collected from the World Bank databank and observes a relationship between each factor and life expectancy. Sixteen Asian countries selected for the research are Republic of Korea, People's Republic of China, Republic of India, Kingdom of Saudi Arabia, Japan, Malaysia, Socialist Republic of Vietnam, Republic of Indonesia, United Arab Emirates, Mongolia, Republic of Uzbekistan, State of Qatar, Republic of Singapore, Hong Kong Special Administrative Region of the People's Republic of China, Kingdom of Thailand, and State of Kuwait. The period for data analysis is set between 2009 and 2014 because data for the period are mostly available, and data for a period since 2014 are including missing observations.

Three specific variables employed here are Fixed broadband subscriptions (per 100 people), Mobile cellular subscriptions (per 100 people), and Secure Internet servers (per 1 million people). The following descriptions of each specific variable are from the World Bank databank.

3.1.1 Fixed broadband subscriptions (per 100 people)

Fixed broadband subscriptions refer to fixed subscriptions to high-speed access to the public Internet (a transmission control protocol/Internet protocol connection). This includes cable modems, digital subscriber lines (DSL), fiber-to-the-home/building, other wired-broadband subscriptions, satellite broadband, and terrestrial fixed wireless broadband. This total is measured irrespective of the method of payment. It excludes subscriptions that have access to data communications (including the Internet) via mobile-cellular networks. It also excludes technologies listed under the wireless-broadband category.

The data on fixed broadband subscriptions per 100 people were obtained by dividing the number of fixed broadband Internet subscribers by the population and then multiplying by 100. In the process of analysis, the term *broadband* will stand for fixed broadband subscriptions (per 100 people).

3.1.2 Mobile cellular subscriptions (per 100 people)

Mobile cellular subscriptions refer to subscriptions to a public mobile telephone service that provides access to Public Switched Telephone Network (PSTN) using cellular technology. The indicator includes the number of postpaid subscriptions, and the number of active prepaid accounts that have been used during the last three months. It also includes all mobile cellular subscriptions that offer voice communications. It excludes subscriptions via data card or USB modems, subscriptions to public mobile data services, private trunked mobile radio, telepoint, radio paging, and telemetry services.

The mobile cellular subscriptions (per 100 people) indicator is derived from all mobile subscriptions divided by the population and multiplied by 100. In the process of analysis, the term *mobile* will stand for mobile cellular subscriptions (per 100 people).

3.1.3 Secure Internet servers (per 1 million people)

Secure Internet servers refer to servers using encryption technology in Internet

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transactions.

The data indicator for secure Internet servers per one million people is obtained by dividing the number of secure Internet servers by the population and then multiplying by one million. In the process of analysis, the term *internet security* will stand for secure Internet servers (per 1 million people).

3.2 Methodology

Based on data on sixteen Asian countries from the World Bank databank, multiple regression analysis is conducted in order to examine what relationship each variable has with life expectancy. The data range in the period from 2009 to 2014. EViews will be used for analysis. In each regression model, the name of each country will be written in simplified form as follows:

KOR (Republic of Korea), CHN (People's Republic of China), IND (Republic of India), SAU (Kingdom of Saudi Arabia), JPN (Japan), MYS (Malaysia), VNM (Socialist Republic of Vietnam), IDN (Republic of Indonesia), ARE (United Arab Emirates), MNG (Mongolia), UZB (Republic of Uzbekistan), QAT (State of Qatar), SGP (Republic of Singapore), HKG (Hong Kong Special Administrative Region of the People's Republic of China), THA (Kingdom of Thailand), and KWT (State of Kuwait).

3.2.1 Panel data

The data have three variables for sixteen different countries and for six different years. The data have a panel data set. The use of panel data needs to set some notations. The subscript *i* indicates different countries in a cross-sectional data set, so X_i indicates X for an observation of the *i*th country. Analogously, the subscript *t* indicates different time periods in a time-series data set, so X_t indicates X for an observation of the *t*th time period. In a panel data set, however, variables have both a cross-sectional and time-series component, so variables use both subscripts. Therefore, X_{it} indicates X for an observation for the *i*th country and *t*th time period. This notation will apply to independent variables and error terms. Also, in the analysis, dummy variables are used to differentiate between countries.

3.2.2 Hausman test

Equations involving panel data can be estimated using the fixed effects model and the random effects model. The Hausman test is formulated to identify which model is appropriate between the fixed effects or random effects model. The choice of model involves examining whether the variables are correlated with the country effect. If the fixed effects model is appropriate, it implies that there is significant country effect in the data. But if the random effects model is appropriate, it denotes that the country effect is randomly distributed across cross-sectional units. The hypotheses for the Hausman test are as follows:

H_0: The random effects model is appropriate.
H_1: The fixed effects model is appropriate.

3.2.3 The fixed effects model

Before proceeding with the analysis, the Hausman test was conducted to

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identify which model is appropriate.

Table 1: The Hausman test

Test summary	*Chi-Sq.*	*Chi-Sq. df*	*p*
Cross-section random	15.988482	3	0.0011

As shown in Table 1, the null hypothesis is rejected because the p-value of 0.0011 is less than the 1% significance level. The result shows that the fixed effects model is the appropriate model for the panel estimation. Also it implies that there is significant country effect in the data. The fixed effects model is specified as follows:

$$\mathrm{LE}_{it} = \alpha_i + \beta_1 broadband_{it} + \beta_2 mobile_{it} + \beta_3 internet\ security_{it} + \varepsilon_{it} \quad (1)$$

α_i is the intercept term representing the fixed country effect. In the model, it is assumed that intercept term varies across sixteen countries.

3.2.4 The Wald test

To identify the validity of country dummy variables, the least squares dummy variable model is formulated as follows:

$$\mathrm{LE}_{it} = \beta_1 broadband_{it} + \beta_2 mobile_{it} + \beta_3 internet\ security_{it} + \sum_{i=1}^{16} \delta_i \cdot country_i + \varepsilon_{it} \quad (2)$$

In the least squares dummy variable model, dummy variables were included for each of sixteen countries, and the constant term is omitted. Coefficients of the dummy variables are equal to the country intercepts and are treated as country fixed effects.

The dummy variables shows different country-specific estimates, thus the dummy variables is applied to testing an assumption of the heterogeneity (country effect).

The Wald test is used to check the fixed effects against the simple common constant ordinary least squares method (pooled model).

The hypotheses for the Wald test are as follows:

H_0: All coefficients of country dummy variables are equal (homogeneity).

H_1: Coefficients of country dummy variables are not all equal (heterogeneity).

4. EMPIRICAL ANALYSIS

4.1 The fixed effects model

The fixed effects regression results for the relationship between life expectancy and broadband, mobile, and Internet security are shown in Table 2.

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Table 2: Regression results from the fixed effects model

	Fixed effects
Constant	72.15*** (0.28)
Broadband	0.18*** (0.03)
Mobile	0.008*** (0.002)
Internet security	0.0003* (0.0002)
R^2	0.9977
F	1880.72***

Note. * indicates significance at the 10% level, ** at the 5% level, and *** at the 1% level, respectively.
Figures in parenthesis refer to standard error.

4.2 The Wald test

The Wald test is used to assess the validity of the fixed effects model. To conduct the Wald test, the least squares dummy variable model was formulated. The results from the estimation are shown in Table 3.

Table 3: Dummy variable estimation of fixed effects model

Variable	Coefficient	*SD*	*t*	*p*
D1	73.12	0.84	87.31	0.000
D2	72.83	0.29	254.30	0.000
D3	66.46	0.16	415.21	0.000
D4	71.01	0.33	213.09	0.000
D5	76.94	0.64	120.89	0.000
D6	71.93	0.27	267.67	0.000
D7	73.26	0.25	289.14	0.000
D8	67.37	0.22	307.87	0.000
D9	73.83	0.30	246.61	0.000
D10	66.47	0.20	324.40	0.000
D11	69.59	0.17	404.06	0.000

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D12	75.12	0.27	275.43	0.000
D13	75.70	0.60	127.02	0.000
D14	75.89	0.70	108.97	0.000
D15	72.14	0.24	299.58	0.000
D16	72.72	0.31	236.72	0.000
Broadband	0.18	0.03	6.97	0.000
Mobile	0.008	0.002	4.24	0.000
Internet security	0.0003	0.0002	1.67	0.0997

SSE = 5.590699
Note. Dummy variables representing each country are shown as symbols from D1 to D16.

All of the dummy variables show statistical significance. As mentioned above, dummy variables are used to test for the presence of individual country effect.

Table 4: The Wald test

Test statistic	Value	*df*	*p*
F	378.40	(15.77)	0.000
Chi-Sq.	5676.00	15	0.000

Note. Restrictions are linear in coefficients.

As shown in Table 4, the null hypothesis is rejected because the p-value of the F-test is less than the 1% significance level. Also the 5% critical value for the F-test is $F_c = F_{(0.95,15,77)} = 1.7982$, giving a rejection region of $F \geq 1.7982$. Since $F = 378.40 > F_c = 1.7982$, the null hypothesis is rejected. This denotes that country-specific dummy variables are included in the model. As a result, the fixed effects model is more appropriate than the pooled model.

Based on the results, the panel data model is estimated as follows:

$$\text{LE}_{it} = 72.15 + 0.18 broadband_{it} + 0.008 mobile_{it} + 0.0003 intenet\ security_{it} + \varepsilon_{it} \quad (3)$$

As can be seen from the estimated model, all estimated coefficients have a plus sign as expected, which shows that there is a positive relationship between life expectancy and each of three variables. These results are consistent with the idea inferred from literature. Each coefficient denotes the elasticity of life expectancy with

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respect to each variable. In other words, each coefficient shows a change in life expectancy as a variable corresponding to the coefficient increasing by one unit, with other variables held constant. Given the estimated model, life expectancy increases by 0.18 years with each additional broadband. A one unit increase in mobile yields an increase of 0.008 years in life expectancy. Each additional internet security also leads to an increase of 0.0003 years in life expectancy. Given that the value of each coefficient is less than 1, this corroborates that there is a weak relationship between each variable and life expectancy. Especially, the coefficient of internet security is 0.0003, denoting that an effect of internet security on life expectancy is extremely weak. Broadband and mobile are statistically significant at the 1% level, whereas internet security shows statistical significance at the 10% level.

5. DISCUSSION

This research has observed the effects of Internet-related factors on life expectancy based on data from sixteen Asian countries between 2009 and 2014. The findings show that each factor has a positive effect on life expectancy. This finding is in line with the views that can be inferred from literature. However, we found that the effect of each factor on life expectancy is quite small. This may be because Internet accessibility builds on development of telecommunication infrastructure, which is established by financial investment. Not only does the Internet environment affect economic growth, but the Internet environment is also affected by economic growth (Pradhan, Arvin, & Norman, 2015). The existing literature shows that both the Internet environment and economic growth have significant positive influences on life expectancy (Deloitte, 2014; Fioroni & Fiaschi, 2007). Given that the data used for the research include sixteen Asian countries that each reflects different levels of economic development, it can be assumed that some countries have not yet developed enough to create advanced telecommunication infrastructure. In addition, it appears likely that the finding of a weak relationship between Internet environment and life expectancy has been somewhat influenced by the lack of consideration for the disparity in levels of economic development between sixteen countries. This means that to reach a fuller explanation of the relationship between the Internet environment and life expectancy in Asian countries, further research should consider different levels of economic development between countries to obtain more accurate outcomes.

Such shortcoming notwithstanding, the research provides a useful reference. As noted earlier, most studies on life expectancy have mostly discussed issues of social and economic factors. Given the paucity of materials on life expectancy related to the Internet environment, the research is noteworthy and even with the tentative conclusion, the research has some value for its reasonable introduction. The findings of the research provide preliminary concepts for the relationship between the Internet environment and life expectancy, and it could serve as the basis for policy making such as allocation of infrastructure investments for social welfare.

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