THE FACTORS AFFECTING LIFE EXPECTANCY IN SOUTH KOREA

Cheng-Wen LEE
Department of International Business, Chung Yuan Christian University, No. 200, Chung Pei Rd., Chung Li 320, Taiwan
chengwen@cycu.edu.tw
Min-Sun KIM
CYCU P.H.D. Program in Business, Chung Yuan Christian University, No. 200, Chung Pei Rd., Chung Li 320, Taiwan
esperodh1@gmail.com

Abstract
The aim of the research is to examine the relationship between each of four factors affecting life expectancy and life expectancy and thereby provide primary data for government policy. First, the research chose four factors among many factors affecting life expectancy. The four factors chosen are as follows: infant mortality, educational attainment, electric power consumption, and internet. And multiple regression analysis was conducted with data of South Korea drawn from World Bank databank. Regression specification error test (RESET) also conducted so as to check whether a regression model specified is adequate. The findings show that life expectancy has a positive relationship with educational attainment, electric power consumption, and education, while there is a negative relationship between infant mortality and life expectancy. It also shows that an effect of electric power consumption on life expectancy is so weak. But infant mortality has the strongest effect on life expectancy in the four factors. Given that infant mortality reflects a level of health care, it could be assumed that life expectancy in South Korea would be much mediated by health care.

Key words: *life expectancy, infant mortality, educational attainment, electric power consumption, internet*

JEL Classification: C01, I00

I. INTRODUCTION

Life expectancy refers to the number of years that one is expected to live as determined by statistics. The life expectancy for each individual or group is influenced by several variables such as their lifestyle, access to healthcare, economical status, and the relevant mortality and morbidity.

The question about how long a person can live has received much attention from antiquity. The attention with respect to life expectancy has been reflected in a large number of researches with the progress of technology. As researches pertaining to life expectancy progress, the research methods has shown specific and scientific tendency. The researches conducted in the recent decades revealed that various factors as well as physical health would exert an influence on life expectancy. Many factors affect life expectancy in its own way. Above all, the development of science technology and medical technique has contributed much to life extension.

South Korea has shown a remarkable increase in life expectancy in the last few decades (Yang et al., 2010). According to Yang et al. (2010), an average life expectancy of South Korean had increased from 52.4 years in 1960 to 78.5 years in 2005. They noted that the major reason for the improvement in life expectancy of South Korean is rapid economic growth beginning in the 1960s (Yang et al., 2010). The rapid economic growth has facilitated industrialization and urbanization, and the consequent betterment in living condition has led to better access to health care service and sanitary facilities (Yang et al., 2010). The better accessibility to health care service and sanitary facilities has directly contributed to amelioration of life expectancy as a result (Yang et al., 2010).

Fundamentally, the lifespan of human being is directly connected to health. Namely, the issue about how long each individual will live is dictated by each health condition. Health is integral to taking account of life expectancy. According to Shkolnikov, Jdanov, Andreev and Vaupel (2011), the highest life expectancy is a corollary to “the best health experience.” Also, Husain (2002) noted that life expectancy is generally regarded as a good criterion of the health status of the people and by extension, is employed as the yardstick of national development. The existing literature on life expectancy has pointed out that the health status is mediated by social and economic factors as well as health care (Morales, Lara, Kington, Valdez & Escarce, 2002).

This research will use four factors chosen among many factors affecting life expectancy. Four factors chosen here are as follows: infant mortality, educational attainment, electric power consumption, and internet.

Each factor employed has by and large represented a level of development and social evolution in its way. Also, each of the four factors conduces to change in life expectancy, directly or indirectly influencing the health status as barometer of socio-economic conditions. In connection with the four factors, this research will observe how each factor is related with life expectancy in South Korea.

South Korean government has made an effort to improve the quality of life through pursuing better health and welfare policy while promoting economic development. In a trend that interest in the quality of life is growing, it would be informative to understand the relationship between each of the four factors stated above and life expectancy. The aim of the research is to examine the relationship between each of the four factors and life expectancy and thereby provide primary data for government policy.

II. LITERATURE REVIEW

Life expectancy is an important research topic that has attracted the attention of scholars in the past decades. A great number of researches concerning life expectancy have been conducted, and through such researches, it has been found that various factors are related to life expectancy in its own different way. With the consideration in mind, this research shall focus only on the four factors stated above. Before embarking upon the research, it may be useful to start out by examining how each factor was addressed in previous researches.

1. Infant mortality

Infant death has an association with a level of health service. Infants between birth and one year of age are yet to have immune system to overcome germs which adults may not be affected. It is absolutely essential for infant who is vulnerable to infectious diseases and external environmental factors to get enough healthcare service timely.

Infant mortality is a powerful barometer of health status of the people. Reidpath and Allotey (2003) noted that the causes of infant mortality is significantly correlated with "structural factors like economic development, general living conditions, social wellbeing, and the quality of the environment, that affect the health of entire populations" (pp. 345-346). On the whole, as economy improves, more money could be spent on health care. High quality health service drawn from such investment ameliorates the quality of life and removes risk factors and determinants of infant death. Low levels of infant mortality, a safe living environment, a high quality health service system, sufficient provisions and preventive treatments would lead to a high level of life expectancy (Reidpath & Allotey, 2003).

According to Stengos, Thompson, and Wu (2009), there is an increase in average life expectancy by 15 years, whereas there is a decrease in infant mortality by over 50 percent around the globe between 1960 and 2000. Taylor (2015) indicated that between 1990 and 2013, an increase from 65 years to 71.5years in the world's average lifespan is largely caused by reductions in infant mortality. It corroborates that a decline in infant mortality has relevance to an increase in life expectancy (Yang et al., 2010).

2. Educational attainment

According to Organization for Economic Cooperation and Development (OECD, 2013), "life expectancy in OECD countries varies not only by gender, but also by socio-economic status as measured for instance by education level" (p. 26). OECD (2013) noted that well-educated individuals have more opportunities to improve the socio-economic conditions than less-educated individuals, and the improved socio-economic status would lead to healthier lifestyle and facilitate access to high quality health care.

Olshansky et al. (2012) indicated that a disparity in educational attainment would generate health inequality. Educational attainment could determine economic and social characteristics such as occupational status and income, and the ingredients would determine a level of health care which each individual gains (Olshansky et al., 2012).

According to De Vogli, Mistry, Gnesotto, and Cornia (2005), in the case of Italy, "regions with a higher proportion of persons 19 years old having a high school diploma performed better in terms of life expectancy compared with regions where a lower proportion of young adults of the same age has a high school diploma" (p. 160).

3. Electric power consumption

There is a positive relationship between electric power consumption and economic growth (Chen, Kuo, & Chen, 2007). The growing demand for the supply of electricity is mediated by urbanization and industrialization, and urbanization and industrialization are generated by economic growth. By and large, urbanization and industrialization with economic growth affords convenience in life and effective resources to sustain healthy living.

Markandya and Wilkinson (2007) noted that electric power has improved energy efficiency, and the improved energy efficiency has accelerated economic growth through industrialization and rapid technological change. Lack of access to electric power would cause a negative effect on economic development across the board and furthermore, undermine social stability and welfare (Ebinger & Banks, 2013). Ebinger and Banks (2013) indicated that per capita consumption of electric power has relevance to "a variety of human development

indicators such as life expectancy, school enrollment, the empowerment of women and girls, availability of life saving vaccines, and access to clean water" (p. 5).

According to Palmer (2001):

> Countries with higher electricity usage (10,000 kilowatt-hour (kwh) per capita), such as the United States, Japan, and Germany, have longer average life spans per capita - approximately 70 years. Countries that have low (100 kwh/capita) electricity usage, such as Zambia and Bangladesh, have an average life span per capita of only 40 years. (para. 5)

4. Internet

The digital and information revolution has changed the way the world learns, communicates, does business, and treats illnesses. New information and communications technologies from internet service have offered vast opportunities for progress in all walks of life for many years. Availability of internet has improved many aspects of the lives of individuals, and internet service has provided benefits in all strata of society. In terms of health, Access to internet has ameliorated "health conditions by reducing the incidence of diseases through better information for both patients and health practitioners" (Deloitte, 2014, p. 4). Internet environment has led to betterment in health care system and changed in "delivery of medical service" (Deloitte, 2014). Internet-based devices have changed the way healthcare professionals work "by allowing remote diagnosis and more efficient ways of treatment," and these changes have contributed to improvement in life expectancy (Deloitte, 2014, p.4).

Alzaid, Komal, Al-Maraghi, and Alsulami (2014) found the following facts:

> In 1999 there was a 0.53 year change in average life expectancy based on a 1% increase of the number of internet user. In another word, for each unit increase in internet use, expected average life increases with around half a year (unit). In 2005, the prediction increased to 0.657 year and in 2010 it was expected that with every 1% increase in internet users, there would be an increase of 0.766 years in the average life expectancy. (p. 1145)

III. DATA DESCRIPTON AND METHODOLOGY

1. Data description

Proceeding from what has been observed above, it can be assumed that each of four factors has an association with life expectancy, each one at a different level.

This research shall draw on statistical data of South Korea collected from World Bank databank and observe a relationship between each factor and life expectancy. Four specific variables employed here are mortality rate, infant (per 1,000 live births), school enrollment, tertiary (% gross), electric power consumption (kWh per capita), and Individuals using the Internet (% of population).

A period for data analysis is set between 1995 and 2013 because data for the period in question are mostly available, and data for a period since 2013 are including missing observations.

1.1. Mortality rate, infant (per 1,000 live births)

Data for infant mortality rate used in the research refer to the number of infants dying before reaching one year of age, per 1,000 live births in a given year. In the process of analysis, the term infant death shall stand for mortality rate, infant (per 1,000 live births).

1.2. School enrollment, tertiary (% gross)

Gross enrollment ratio refers to the ratio of total enrollment, regardless of age, to the population of the age group that officially corresponds to the level of education shown. Tertiary education, whether or not to an advanced research qualification, normally requires, as a minimum condition of admission, the successful completion of education at the secondary level. In the process of analysis, the term school enrollment shall stand for school enrollment, tertiary (% gross).

1.3. Electric power consumption (kWh per capita)

Electric power consumption per capita (kWh) is the production of power plants and combined heat and power plants less transmission, distribution, and transformation losses and own use by heat and power plants, divided by midyear population. In the process of analysis, the term electric power shall stand for electric power consumption (kWh per capita).

1.4. Individuals using the Internet (% of population)

Internet users are individuals who have used the Internet (from any location) in the last 3 months. The Internet can be used via a computer, mobile phone, personal digital assistant, games machine, digital TV and so forth. In the process of analysis, the term internet user shall stand for individuals using the Internet (% of population).

2. Methodology

Based on data of South Korea drawn from World Bank databank, multiple regression analysis shall be conducted in order to observe what relationship each variable has with life expectancy. The data range in period from 1995 to 2013. EViews shall be used for analysis.

2.1. Multiple regression analysis

Regression analysis shall be conducted gradually adding each independent variable, one at a time, in order to observe changes in R-squared after each addition.

$$LE_t = \beta_1 + \beta_2 \text{infant death}_t + e_t \quad (1)$$

$$LE_t = \beta_1 + \beta_2 \text{infant death}_t + \beta_3 \text{school enrollment}_t + e_t \quad (2)$$

$$LE_t = \beta_1 + \beta_2 \text{infant death}_t + \beta_3 \text{school enrollment}_t + \beta_4 \text{electric power}_t + e_t \quad (3)$$

$$LE_t = \beta_1 + \beta_2 \text{infant death}_t + \beta_3 \text{school enrollment}_t + \beta_4 \text{electric power}_t + \beta_5 \text{internet user}_t + e_t \quad (4)$$

The term t stands for the period from 1995 to 2013.

2.2. Regression specification error test (RESET)

Regression specification error test (RESET) shall be conducted so as to check whether a model specified is adequate.

$$LE_t = \beta_1 + \beta_2 \text{infant death}_t + \beta_3 \text{school enrollment}_t + \beta_4 \text{eγlectric power}_t + \beta_5 \text{internet user}_t \quad (5)$$

In other to conduct RESET, artificial model is set as follows.

$$LE_t = \beta_1 + \beta_2 \text{infant death}_t + \beta_3 \text{school enrollment}_t + \beta_4 \text{electric power}_t + \beta_5 \text{internet user}_t + \gamma_1 y^2 + e_t \quad (6)$$

A test for misspecification with equation (6) is a test of H_0: $\gamma_1 = 0$against the alternative H_1: $\gamma_1 \neq 0$.

IV. EMPIRICAL ANALYSIS

1. Multiple regression analysis

In four phase processes, it shows that a numerical value of R-squared increases in every phase, though the increment is different at each phase. For better understanding, change of R-squared is tabulated as Table 1.

Table 1. Incremental R-squared

The number of variable	R^2	F	Increment
1	0.4815	15.7868***	
2	0.9594	189.2023***	0.4779
3	0.9912	565.4008***	0.0318
4	0.9946	642.1649***	0.0034

Note. 1 = infant death; 2 = infant death + school enrollment; 3 = infant death + school enrollment + electric power; 4 = infant death + school enrollment + electric power + internet user
* indicates significance at the 10% level, ** at the 5% level, and *** at the 1% level, respectively.

An increment in R-squared corroborates that all variables contribute to an explanatory power of the model in its degree as all the F-statistics prove.

Table 2. The empirical results from multiple regression analysis

	Constant	Infant death	School enrollment	Electric power	Internet user
1	88.4427*** (32.36)	-2.4049*** (-3.97)			
2	71.6701*** (49.30)	-1.2560*** (-6.49)	0.1382*** (13.73)		
3	69.4228***	-0.3008*	0.0332**	0.0009***	

	(91.16)	(-1.89)	(2.21)	(7.38)	
4	74.2721*** (42.14)	-0.7985*** (-3.74)	0.0238* (1.88)	0.0004** (2.26)	0.0314** (2.94)

Note. * indicates significance at the 10% level, ** at the 5% level, and *** at the 1% level, respectively. Figure in parenthesis refer to *t*-statistic.

Table 2 shows a series of changes in coefficients corresponding to each variable at each phase.

In the case of infant death, a coefficient sign is minus at each phase as expected. It signifies that there is a negative relationship between infant death and life expectancy. But a level of significance decreases as electric power is added.

In the case of school enrollment, a coefficient sign is plus at each phase as expected. It shows that there is a positive relationship between school enrollment and life expectancy. But a level of significance decreases gradually as electric power and internet user are added.

In the case of electric power, a coefficient sign is plus at each phase as expected. It shows that there is a positive relationship between electric power and life expectancy. But a level of significance decreases as internet user is added.

In the case of internet user, a coefficient sign is plus as expected. It indicates that there is a positive relationship between internet user and life expectancy.

Table 3. Correlation matrix for variables

	Infant death	School enrollment	Electric power	Internet user
Infant death	1.0000	-0.4324	-0.6891	-0.4162
School enrollment	-0.4324	1.0000	0.9166	0.9560
Electric power	-0.6891	0.9166	1.0000	0.9355
Internet user	-0.4162	0.9560	0.9355	1.0000

Table 3 shows correlation between variables. Given Table 3, school enrollment is highly correlated with electric power and internet user. It also shows high correlation between electric power and internet user. These correlations may affect the result of multiple regression model, though there is no perfect collinearity between the variables.

For a better description over relationships between variables, a regression model is estimated as follows.

$$LE_t = 74.2721 - 0.7985\,infant\,death_t + 0.0238\,school\,enrollment_t + 0.0004\,electric\,power_t + 0.0314\,internet\,user_t \quad (7)$$

It shows that school enrollment, electric power, and internet user have a positive relationship with life expectancy, whereas infant death has a negative relationship with life expectancy. These results are consistent with the idea inferred from literature. Each coefficient for the regression model measures the elasticity of life expectancy with respect to each variable. Namely, each coefficient indicates an average change in life expectancy as a variable corresponding to the coefficient increases by one unit, with other variables held constant. The estimated regression coefficients might be interpreted that with each additional kWh of electric power consumption per capita, a predicted life expectancy increases by an average of about 0.0004 years old. Similarly, a predicted life expectancy increases by an average of about 0.0314 years old for each additional person in internet user. It also shows that a coefficient of electric power is 0.0004, denoting that an effect of an increase in electric power consumption on life expectancy is so weak. Electric power and internet user denote statistical significance at the 5% level, whereas infant death and school enrollment are statistically significant at the 1% level and the 10% level respectively.

2. Reset

RESET is conducted to check whether a model specified is adequate with artificial model set in 3.2.2. The results of RESET with equation (6) are as follows

Table 4. The results of RESET with equation (6)

	Value	*df*	*p*
t	0.7281	13	0.4795
F	0.5301	(1, 13)	0.4795

The F-value for testing H_0: $\gamma_1 = 0$ against the alternative H_1: $\gamma_1 \neq 0$ is 0.5301, as shown in Table 4. The

5% critical value for the F-test is $F_c = F_{(0.95,1,13)} = 4.6672$, giving a rejection region of $F \geq 4.6672$. Since $F = 0.5301 < F_c = 4.6672$, it fails to reject H_0: $\gamma_1 = 0$.

Given the foregoing test, it signifies that the test has not been able to detect any misspecification.

V. DISCUSSION

Life expectancy has been one of the most significant issues worldwide. As a pattern of life has changed with an evolution in science and technology, a factor affecting life expectancy has diversified, and a scope of related research has been growing wider. There has been quite a bit of recent scholarly effort aiming to understand the causal relationship between life expectancy and factors affecting life expectancy accordingly. Interest in life expectancy is understandably gaining visibility in the process of policy formulation and implementation.

Up to now the research has looked at relationships between life expectancy and each of the following factors: infant mortality, educational attainment, electric power consumption, and internet. The research has placed the links between life expectancy and each factor at its analytic center. Given the findings, it shows that life expectancy has a positive relationship with educational attainment, electric power consumption, and internet. But it also shows that an effect of electric power consumption on life expectancy is feeble. Infant mortality, on the other hand, has the strongest effect on life expectancy in the four factors, though it has a negative relationship with life expectancy. Given that infant mortality reflects a level of health care, it seems reasonable to assume that life expectancy in South Korea would be much mediated by health care.

The ultimate goal of government policies is to improve the quality of life of the people. The findings of the research would be primary data for formulating government policy. But results of the research leave more to be investigated and answered, though the research offers an initial contribution. The research was limited in scope. It also began with limited factual data. Further studies on different large scale assessments are needed. It is to be hoped that this research will be a step toward a richer and more inclusive understanding of the factors affecting life expectancy.

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