Contemporary Engineering Sciences, Vol. 7, 2014, no. 24, 1445 - 1453
HIKARI Ltd, www.m-hikari.com
http://dx.doi.org/10.12988/ces.2014.49177

Application of Multi-State Life Table Technique to Measuring Education Level in the Case of South Korea

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Abstract

This study aimed at measuring the educational attainment for the South Koreans as a whole as of 2010, by applying a multi-state life table technique. The results from application can be evaluated to describe South Koreans' educational progress and attainment successfully. The lifetime transition probabilities appeared to be almost 100 percent for elementary school and middle school, 70 percent for high school, 6.5 percent for university, and 11.9 percent for master's course for both sexes. The lifetime graduate probabilities appeared to continuously decrease for both sexes, being higher for females than for males in all levels of education. The lifetime dropout probabilities appeared to increase with level of education for both males and females. For future studies, it is recommended that the application of multi-life table techniques to education be made in time-series and for cross-countries.

Keywords: Multi-state Life Table, Education, Transition

1 Introduction

The education has important impacts on socio-economic development through increase in knowledge and skills, which affect labor productivity, invention, etc. The education has also impacts on individuals' demographic behaviors such as fertility, mortality, and migration, which changes size and structure of population at both national and regional levels.

Despite of its importance, the methods of measuring the level of education seem to be poor; the school enrollment rate and the proportion of people with a certain level of education as conventional education indicators refer only to a specific time or age of life cycle for different cohorts.

This study aims at exploring a better way of measuring the education level by applying a multi-state life table technique, which can provide rather comprehensive and detailed indicators to analyze various characteristics of educational attainment. Such an attempt may be helpful for academic progress in methodology of analyzing the education level and development of social policies.

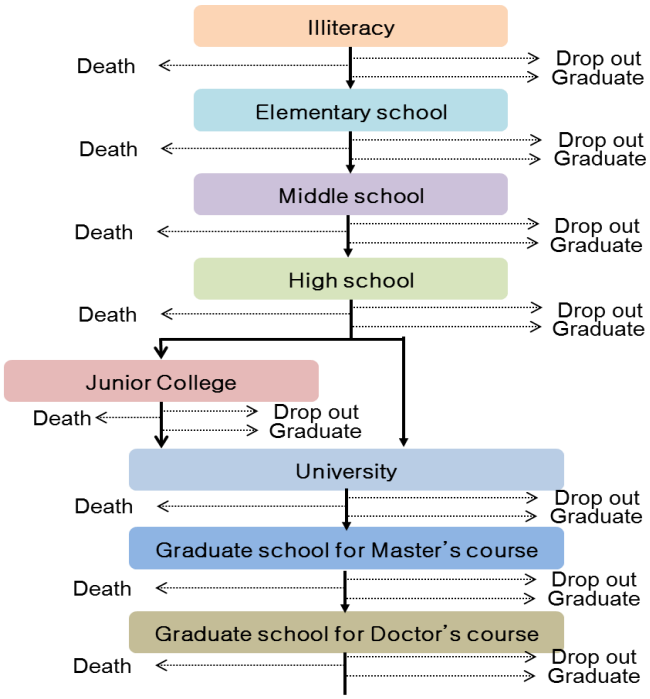
2 Method and Data

The conventional life table concerns only two states of life cycle, namely life and death. Life table has been expanded to multiple decrement models which allow for more than two states-life and various status of lifecycle (Siegel and Swanson, 2004): the school-life table, as an example of multiple decrement life table, combines mortality rates and school enrollment rates to estimate the average number of years of school life for the total population and the enrolled population (Shryock, et. al., 1976). Unlike conventional tables or multiple decrement tables, multi-state life tables allow for all possible movements among various types of active states, for which multistate models have been applied to various areas such as marital status, labor force behavior, interregional migration, and health status (Siegel and Swanson, 2004). Multi-state models also do not have a standard table format with a small set of measures and instead, measures are selectively calculated according to the requirements of the analysis (Siegel and Swanson, 2004).

The multi-state model in this study includes various states, including death and various categories of education, which are mutually exclusive and discrete. For South Korea, the education consists of 21 states after excluding death as shown in Figure 1. The education level in South Korea consists of illiteracy, elementary school (ES), middle school (MS), high school (HS), junior college (JC), university

(UN), graduate school for master's course (MA), and graduate school for doctor's course (DR). The junior college, into which the graduates from high school can enter, has two or three years' curriculum. Some of graduates from junior college have entered into universities. Each of education level has three sub-states, namely dropout (OUT), graduate without entry into a school of higher grade (GRA), graduate with entry into a school of higher grade (ENT). Illiteracy and graduate school for doctor's course permit only exists, while death as a type of absorbing state only permits entries. The others are transient states which allow both entries and exits. .

Figure 1. Composition of States for Education



Multi-state life tables are mathematically a type of Markov process, which assume that transition probabilities depend only on age and current state and the probabilities is independent of the previous state (Siegel and Swanson, 2004). Markov chain transition probability matrix is denoted as follows;

$$M(x) = \begin{bmatrix} \sum_{j \neq i}^{5} {}_1M_x^{1j} & -{}_1M_x^{21} & -{}_1M_x^{31} & -{}_1M_x^{41} & 0 \\ -{}_1M_x^{12} & \sum_{j \neq i}^{5} {}_1M_x^{2j} & -{}_1M_x^{32} & -{}_1M_x^{42} & 0 \\ -{}_1M_x^{13} & -{}_1M_x^{23} & \sum_{j \neq i}^{5} {}_1M_x^{3j} & -{}_1M_x^{43} & 0 \\ -{}_1M_x^{14} & -{}_1M_x^{24} & -{}_1M_x^{34} & \sum_{j \neq i}^{5} {}_1M_x^{4j} & 0 \\ -{}_1M_x^{15} & -{}_1M_x^{25} & -{}_1M_x^{35} & -{}_1M_x^{45} & 0 \end{bmatrix}$$

To construct multi-state life tables, the basic transition probabilities between the states of education are derived from various sources; they include 2010 population census, 2010 vital statistics for death, 2010 residential registration population, and 2010 and 2011 education administrative statistics.

3 Results

The transition probabilities between the states, implying the number of transitions to each state per person, showed similarities among levels and states of education as can be seen in Appendix Figure 1. The transition probabilities from entry to dropout appeared to be high at younger ages and become low after a certain proper age for both sexes in all levels of education. The transition probabilities from entry to graduate without entry into a school of higher grade (GRA) and entry into a school of higher grade (ENT) appeared to increase with age but to fall sharply after a proper age both sexes in all levels of education; however, such probabilities for junior college, university, graduate school for master's course, and graduate school for doctor's course appeared to maintain at more or less high rate or show increasing trends even after a proper age. The transition probabilities from entry to graduate without entry into a school of higher grade (GRA) appeared to be higher than those from entry to graduate and entry into a school of higher grade (ENT) for high school or lower level of education. But they appeared to be opposite for junior college or higher levels of education. The transition probabilities for males seemed to change up and down earlier than those for females after graduate from high school, which may be due to the compulsory military service starting from around 20th years old. The transition probabilities of graduate without entry into a school of higher grade (GRA) and graduate and entry to graduate and entry into a school of higher grade (ENT) seemed to be higher for females than those for males but it is opposite for the transition probabilities of dropout.

The lifetime transition probabilities from graduate to entry into a school of higher level can be calculated by the following formula;

$$\sum_{a=1}^{\infty} e_{i,a} / \sum_{a=1}^{\infty} g_{i-1,a}$$

Here, i=level of education (i=1, 2, 3,,,,), a=age(single year old), e=number of entries into i level of school, g=number of graduates from i level of school.

The lifetime transition probabilities from graduate to entry into a school of higher level were almost 100 percent for elementary school and middle school since South Korea adopted the compulsory education for elementary school and middle school. The lifetime transition probability from high school to university appeared to be 45.7 percent for males and 47.4 percent for females. The lifetime transition probability from high school to junior college or university appeared to be 70.1 percent for males and 75.0 percent for females, being slightly higher for females than for males. The lifetime transition probability from university to graduate school for master's course appeared to be 8.5 percent for males and 4.8 percent for females. The lifetime transition probability from master's course to doctor's course of graduate school appeared to be 14.1 percent for males and 10.3 percent for females. Unlike junior college and university, those lifetime transition probabilities for entering graduate schools for master's course and doctor's course appeared to be higher for males than for females.

Table 1. Lifetime Transition Probabilities from Graduate to Entry into a School of Higher Level for South Koreans (as of 2010)

(unit: %)

	ES→MS	MS→HS	HS→JC	HI→UN	JC→UN	UN→MA	MA→DR
Both	99.82	99.85	26.05	46.54	3.12	6.51	11.87
Male	99.79	99.80	24.44	45.72	3.45	8.54	14.06
Female	99.84	99.89	27.66	47.35	2.89	4.80	10.29

Note : Elementary school (ES), Middle school (MS), High school (HS), Junior college (JC), University (UN), Graduate school for Master's course (MA), and Graduate school for Doctor's course (DR).

The lifetime graduate probabilities can be calculated by the following formula;

$$\sum_{i=8}^{j} \sum_{a=1}^{\infty} g_{i,a} / 100{,}000$$

Here, i=level of education (i, j=8, 7, 6,,,,1), a=age(single year old), g=number of graduates from I level of school.

The lifetime graduate probabilities appeared to continuously decrease for both males and females; for both sexes, those were over 90 percent for elementary school, middle school, and high school but thereafter the lifetime graduate probability decreased rapidly to 70.2 percent for junior college, 46.2 percent for university, 11.7 percent for graduate school of master's course, and 3.3 percent for graduate school of doctor's course. The lifetime graduate probabilities appeared to be higher for females than for males in all levels of education.

Table 2. Lifetime Graduate Probabilities for South Koreans (as of 2010)

(unit: %)

	ES+	MS+	HS+	JC+	UN+	MA+	DR+
Both	98.72	98.54	96.71	70.23	46.23	11.71	3.33
Male	98.60	98.39	96.25	61.52	42.27	9.77	2.83
Female	98.84	98.68	97.17	78.95	50.19	13.66	3.82

Note : Elementary school (ES), Middle school (MS), High school (HS), Junior college (JC), University (UN), Graduate school for Master's course (MA), and Graduate school for Doctor's course (DR).

The lifetime dropout probabilities can be calculated by the following formula;

$$\sum_{a=1}^{\infty} d_{i,a}/100{,}000$$

Here, i=level of education (i=1, 2, 3,,,7), a=age(single year old), d=number of dropouts from i level of school.

The lifetime dropout probabilities appeared to increase with level of education. Lifetime dropout probabilities were quite low in the courses of elementary school, middle school, and high school but soared up in the courses of junior college and university. In the course of university, lifetime dropout probabilities were 20.7 percent for males and 11.3 percent for females, noting that 16.0 percent of the Korean people experienced dropouts from university. However, lifetime dropout probabilities were low in graduate schools for master's course and doctor's course.

Table 3. Lifetime Dropout Probabilities for South Koreans (as of 2010)

(unit: %)

	ES	MS	HS	JC	UN	MA	DR
Both	0.05	0.20	1.68	8.02	15.99	2.43	0.25
Male	0.05	0.19	1.95	10.68	20.66	1.82	0.24
Female	0.04	0.20	1.40	5.37	11.33	3.04	0.27

Note : Elementary school (ES), Middle school (MS), High school (HS), Junior college (JC), University (UN), Graduate school for Master's course (MA), and Graduate school for Doctor's course (DR).

4 Concluding Remarks

This study aimed at measuring the educational attainment for the South Koreans as a whole as of 2010, by applying a multi-state life table technique. The results from application can be evaluated to describe South Koreans' educational progress and attainment successfully. This study had difficulties in obtaining and fitting the education the data set suitable to multi-life table techniques. Since the application of multi-state life table technique requires a set of education statistics with high accuracy, efforts need to be made for establishing accurate data set with aids of education administrations.

For the future studies, it is recommended that the application of multi-life table techniques to education be made in time-series to measure how the educational evolvement or characteristics change. It is also recommended that the application of multi-life table techniques to education be expanded to other countries because comparative analyses can suggest improvements for the educational system

Acknowledgements. This work was supported by the ICT R&D program of MSIP/IITP. [10047117, Development of Distributed/Parallel Multi-Dimensional Demographic Micro Simulation Technologies for Population Dynamics and Socio-Economic Experimentation].

References

[1] Lee, S. S. and Choi, H. J. (2014). *Analysis on Educational Level Using Multi-state Life Tables Techniques: The Case of Korea*. 2014 Fourth International Workshop Series in August, August 20-24, 2014 at International Center, Jeju National University, Jeju Island, South Korea.

[2] Shryock, H. S., Siegel, J. S. and Associates (1976). *The Methods and Materials of Demography: Condensed Edition by Edward G. Stockwell*. New York: Academic Press.

[3] Siegel, J. S. and Swanson, D. A. (2004). *The Methods and Materials of Demography: second edition*. San Diego, USA: Elsevier Academic Press.

[4] Statistics Korea. *2010 population census*.

[5] Statistics Korea. *2010 vital statistics for death*.

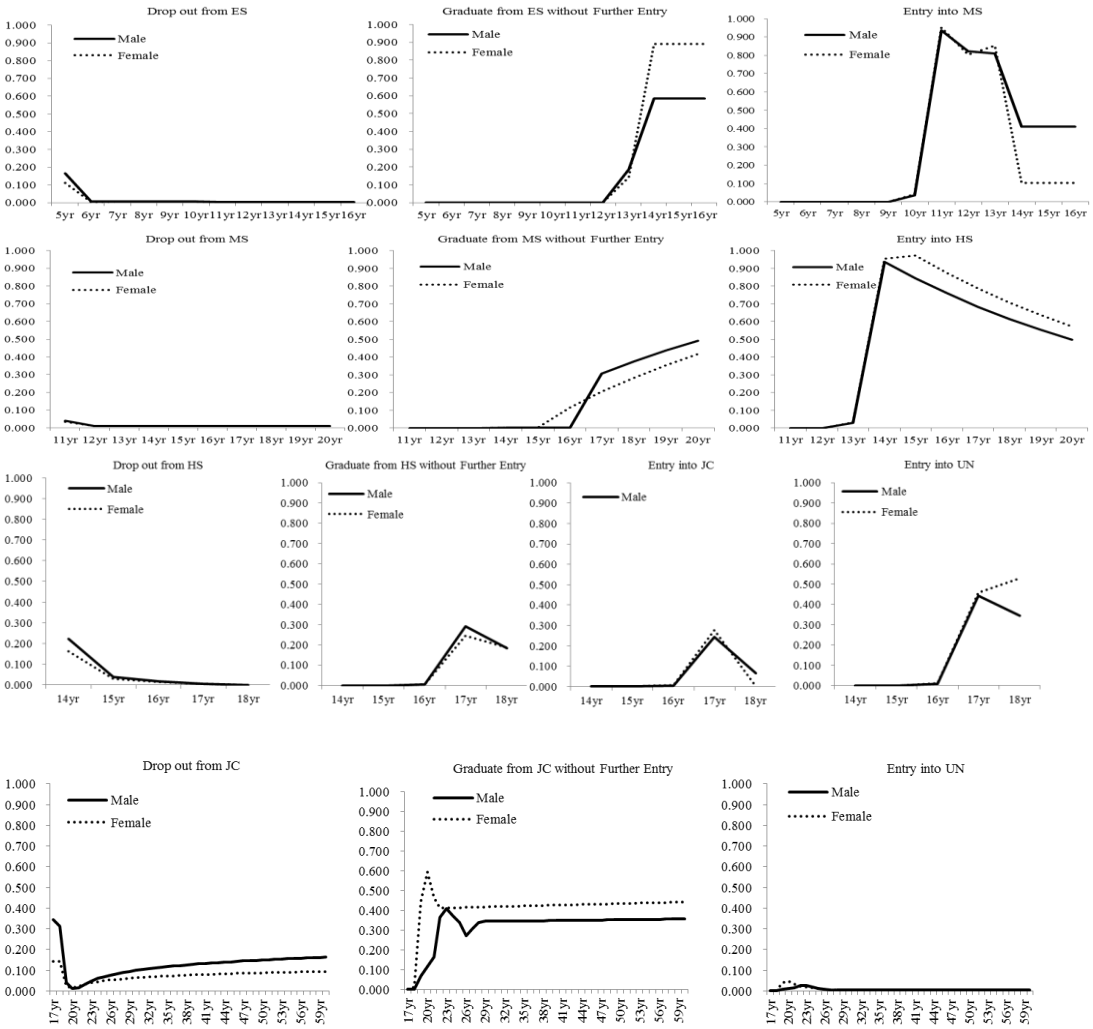
[6] Ministry of Security and Public Administration. *2010 residential registration population.*

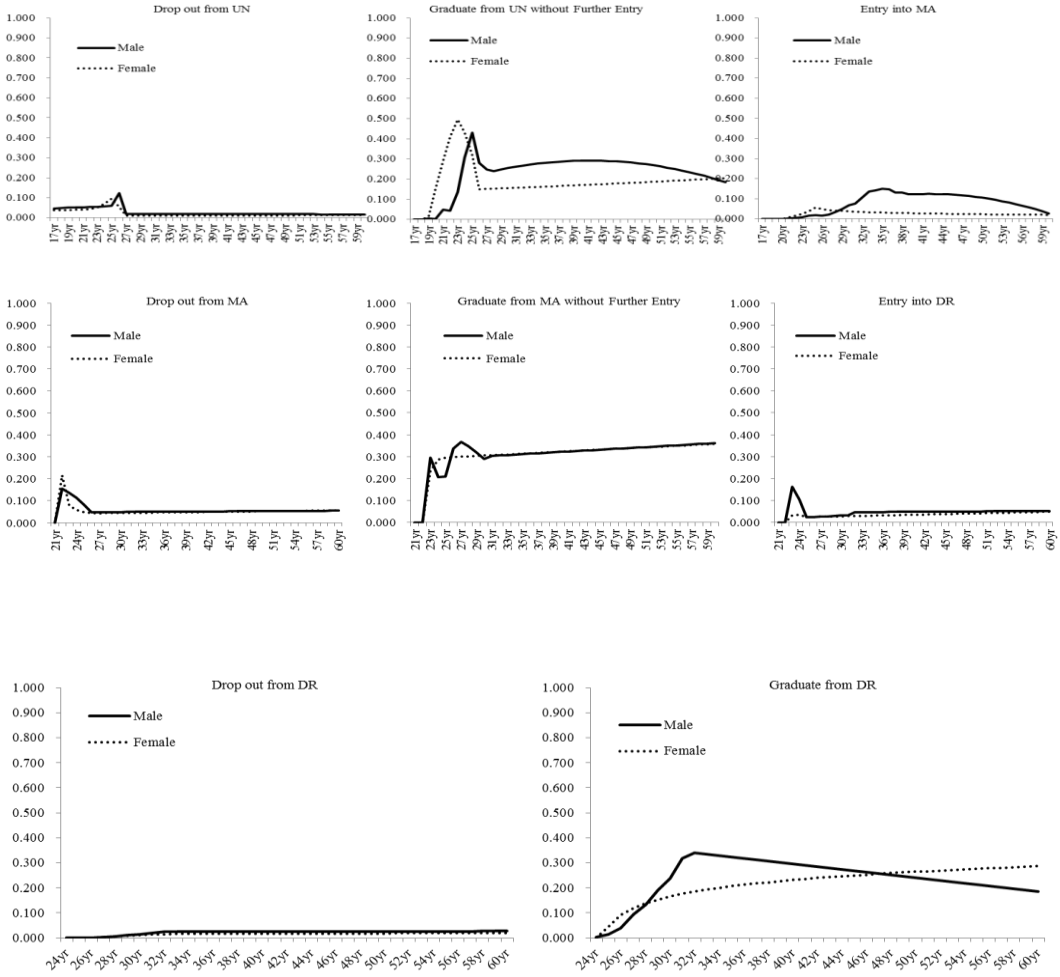
[7] Ministry of Education. *2010 education administrative statistics*.

[8] Ministry of Education. *2011 education administrative statistics.*

Appendix.

Figure. Transition Probabilities among States of Education (as of 2010)





Note : Elementary school (ES), Middle school (MS), High school (HS), Junior college (JC), University (UN), Graduate school for Master's course (MA), and Graduate school for Doctor's course (DR).

Received: August 31, 2014