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A Demographic Evaluation of Increasing Rates of Suicide Mortality in Japan and South Korea

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A DEMOGRAPHIC EVALUATION OF INCREASING RATES OF SUICIDE MORTALITY IN JAPAN AND SOUTH KOREA

by

Sun Young Jeon

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ABSTRACT

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by

Sun Young Jeon, Master of Science

Utah State University 2012

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Suicide is one of the major health issues and causes of mortality in modern societies. A global morality rate of suicide is 16 persons per 100,000 according to the World Health Organization report. Fortunately, the rates in most OECD countries have shown a dramatic decrease over the last 20 years. There are, however, two important exceptions, Japan and South Korea. The suicide rates in these two countries have been on an increasing trend. Because the two neighboring countries share similar socio-demographic contexts, I investigated the effects of the three time-related demographic variables (age, period, and cohort) on suicide rates in Japan and South Korea. The Age-Period-Cohort Intrinsic Estimator model was operated using data of vital statistics and population census from the Statistics Bureau and the Ministry of Internal Affairs and Communications in Japan, and cause of death data and population census from Statistics Korea in South Korea. Even though the two countries are neighboring countries that have had some similar socio-demographic contexts, the factors contributing to increasing suicide rates vary in each country. The result showed age effects in Japan greatly contributed to suicide compared to period and cohort effects, and the age effects were highest during the fifties age bracket. On the other hand, South Korea turned out to have more compound reasons, showing pronounced age effects in the elderly population, increasing period effects, and the strong cohort effects of the current elderly and middle-aged populations. From this result, although Japan and South Korea are neighboring countries with shared histories, industrial structures, social systems, and some similar demographic characteristics, the cause of increasing suicide rates in the two countries clearly varies and the efforts for preventing suicide must also vary depending on the social contexts of each country.

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PUBLIC ABSTRACT

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According to a World Health Organization report, about one million people die by suicide each year. Fortunately, rates of suicide mortality have been decreasing among most of the OECD countries, but Japan and South Korea are the only two exceptions to this trend, which has shown increasing suicide rates over the last 25 years. A number of studies have focused on psychological motives and individual-level causes of suicide, such as depression, mental disorder, and disability. However, as Durkheim pointed out, suicide in a society does not have any obvious relationship to the prevalence of mental disorder. With his theory indicating that suicide is a social phenomenon that needs to be explained in a social context with social determinants, this study aimed to understand the effects of three types of time-related socio-demographic variables (age, period, and cohort) on suicide in Japan and South Korea.

This study focuses on (1) the relative contribution of age, period, and cohort effects on suicide in each country and (2) the comparison between the impact of the three effects on changes in suicide rates. I thought that it would be potentially significant concerning the increasing suicide rates in the two countries that Japan and South Korea are neighboring countries and share similar social contexts as well as demographic transitions. I operated the Age-Period-Cohort Intrinsic Estimator model to answer the questions using vital statistics and population census from the Statistics Bureau and the Ministry of Internal Affairs and Communications for Japan, and cause of death data and population census from Statistics Korea.

The results show that even though the two countries are neighbors that have had some similar socio-demographic contexts, the factors contributing to the increasing suicide rates vary in each country. Age effects are highest during the elderly period in South Korea, whereas age effects in Japan are highest during the fifties age bracket. Period effects in Japan increased sharply between 1995 and 2000, while period effects in South Korea mounted rapidly between 2000 and 2005. Cohort effects in Japan were highest among the 1905-1909 birth cohort and sustained a lower level since the 1925-1929 birth cohort, whereas the birth cohort born between 1915-1970 in South Korea showed high cohort effects.

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Sun Y. Jeon

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CHAPTER I

INTRODUCTION

Suicide is a significant health issue that has attracted the attention of social scientists for generations, beginning with Emile Durkheim's (1897/1951) comparison of suicide rates among Protestants and Catholics. Despite this attention, suicide remains an important social problem and cause of morbidity and mortality in modern societies. To illustrate, according to a recent WHO report (2002), about one million people die by suicide each year—and almost 10 to 20 times as many people attempt suicide. This means that, somewhere in the world, a person dies by suicide every 40 seconds and a suicide attempt occurs every 3 seconds.

Fortunately, rates of suicide mortality (hereafter simply referred to as suicide rates) have been decreasing among most OECD countries. Some countries such as Hungary, Finland, Denmark and Austria have shown dramatically decreasing suicide rates during the last 20 years. The suicide rate in Hungary was the highest among OECD countries in 1990 (35.3 persons per 100,000 person-years lived (PYL)), but since then it has steadily declined to 19.8 persons in 2009. The suicide rate in Finland, which was the second highest in 1990 (27.8 persons per 100,000 PYL), has also declined to 17.3 persons in 2009. Trends toward lower suicide rates have characterized most OECD countries, even though rates of suicide were once high in several of these nations (OECD Health Data 2011). Overall, the average suicide rate among OECD countries has decreased from 15.3 persons in 1985 to 11.3 in 2009.

However, South Korea and Japan are two important exceptions to the broader trend toward lower suicide rates in OECD countries (Figure 1.1). Contrary to most OECD nations, the suicide rate in Japan increased from 14.5 per 100,000 PYL in 1990 to 19.4 per 100,000 in 2009. Even though Japanese suicide rates slightly decreased immediately after the two peaks of suicide mortality in 1998 and 2003, they resumed increasing shortly thereafter. The suicide rate in Japan was fourteenth highest among OECD countries in 1990 but, as a result of this unfortunate trend, Japan now exhibits the second highest rate of suicide among OECD nations.

The increase in suicide mortality in South Korea has been even more dramatic in recent decades (Kwon, Chun, and Cho 2009). In 1990, the rate of suicide mortality in South Korea was just 7.9 per 100,000 PYL. By 2009, it had climbed to 28.4 per 100,000 PYL, an increase of about 360 percent. As Japan experienced, there were two large peaks of suicide mortality—one in 1998, and the other in 2003-2005. The suicide rate decreased immediately following these peaks, only to resume its upward march within a couple of years. The suicide rate in South Korea ranked as the twenty-fifth highest in 1990 among OECD countries, but by 2009 its rate of suicide mortality was higher than any other nations in the OECD.

There have been several studies to determine the causes of this dramatic increase in suicide rates in Japan and South Korea and most of these studies have focused on individual-level variables such as depression, mental disorder and disability (Chiu, Takahashi, and Suh 2004; Kawakami et al. 2005). These approaches are obviously persuasive in that suicide is, at least to some extent, driven by an individual's state of mind and psychological motives. However, if the suicide rates in one society are persistently higher than in another, it becomes difficult to explain such disparities with individual-level approaches (Lee and Kim 2010).

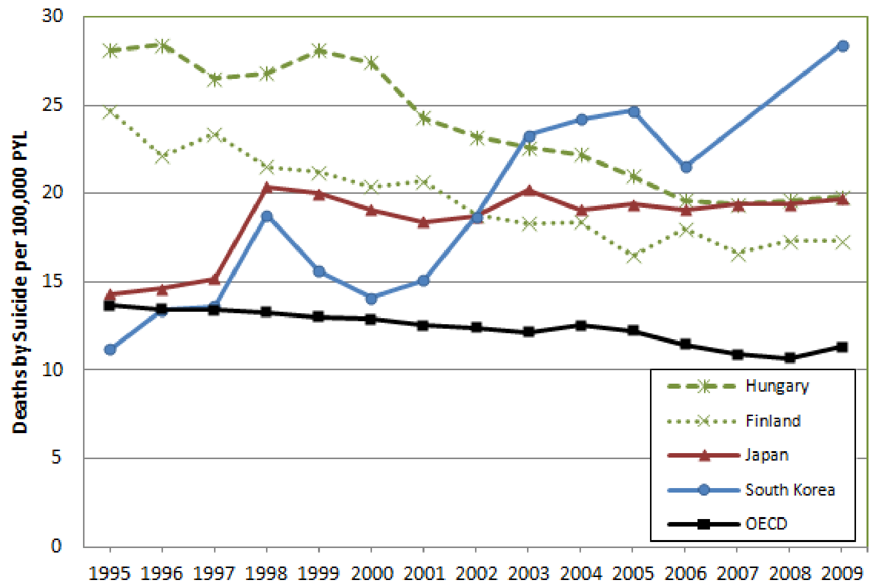


FIGURE 1.1 Deaths by Suicide per 100,000 PYL in Hungary, Finland, Japan and South Korea, 1995-2009, (OECD Health Data, 2011)

For example, if suicide is understood just as a result of depression, then scholars cannot explain higher suicide rates among males in South Korea. According to a report of the Health Insurance Review and Assessment Service in South Korea (2010), despite the fact that the prevalence of depression was higher among females than males from 2005 to 2009, suicide rates were nevertheless substantially higher among males. In addition, Lee and Kim (2010) pointed out researchers cannot explain the unusually high increase in suicide rates among older adults since the 1990s only as a result of depression. While the suicide rate among older adults has been increasing, the prevalence of depression in the same group has decreased from 3.4% to 2.5%.

These examples support Durkheim's claim (1897/1951) that suicide in a society does not have any obvious relationship to the prevalence of mental disorders. Rather than being the result of mental disorders or depression, suicide is a social phenomenon that needs to be explained with social determinants in a social context (Leo 2002). For instance, Figure 1 shows that suicide rates in Japan and South Korea peaked in 1998. Several socio-demographic studies have surmised that the sharp increase in suicides in 1998 in the two countries was triggered by an economic crisis that affected most Asian countries from 1997 to 1998 (Chang et al. 2009; Kim et al. 2011).

Likewise, various socio-demographic variables have been analyzed to gain a deeper understanding of suicide rates. Economic factors (Yang 1992), divorce rates (Kim et al. 2011), and marriage rates (Park and Lester 2006) have been important variables, and these studies have shed more light on the etiology of suicide by investigating correlations between those factors and suicide rates or by comparing trajectories of those factors to variations in suicide rates. The question then becomes, which demographic factors contributed to the unprecedented rise in suicide rates in Japan and South Korea?

Demographic Factors in Suicide Rates in Japan and South Korea

Japan and South Korea are two glaring exceptions to the world's broad trend toward lower suicide rates. It is potentially significant that Japan and Korea are neighboring countries and share similar social contexts, as well as demographic transitions which caused rapid population aging (Goodman and Peng 1996; Kim and Maeda 2001). Japan colonized Korea for 36 years in the early 20th century, and Japan has heavily influenced Korea in contemporary history (Kim et al. 2011). The two countries have similar industrial structures, education systems, and judicial and political institutions (Goodman and Peng 1996).

Both have experienced rapid socioeconomic development, industrialization, and urbanization (Kim and Maeda 2001), and the dramatic social changes have caused drastic demographic transitions in both countries, such as decreases in fertility and mortality in a short period. Both countries have also experienced the aging of their populations at a faster rate than in any Western countries (Kim and Maeda 2001). In addition, fertility rates have plummeted in a short time in both countries and have stayed significantly below the replacement rate. Furthermore, before the demographic transition started, the two countries experienced a baby boom with the end of World War 2 and the Korean War. There have been fluctuations in fertility rates in the two countries over the last century and these rapid variations in fertility rates, in turn, have caused rapid variations in birth cohort size.

Despite the fact that several studies have previously attempted to understand the effects of socio-demographic factors on suicide rates in Japan and South Korea, the majority of them have focused on each country in isolation (Kwon et al. 2009; Odagiri, Uchida, and Nakano 2011; Ooe, Ohno, and Nakamura 2009), and a comparative study between the two countries has not yet been carried out. This study aims to understand the effects of demographic factors on suicide rates in both Japan and South Korea and to compare the extent of the differences between the two countries with regards to the contribution that the demographic factors make to these suicide rates.

Age-Period-Cohort (APC) Analysis

Durkheim (1897/1951) was the first to demonstrate that suicide has a social component, and as a result, socio-demographic contextual variables can help us understand variations in suicide rates. A number of previous suicide studies in Japan and South Korea have focused on factors such as marriage rates, divorce rates, and economic factors and their relationship to suicide (Kim et al. 2011; Park and Lester 2006). However, relatively few studies have concentrated on the relative contributions of factors associated with demographic changes through different dimensions of time – namely age, period, and cohort effects.

By measuring these three effects and comparing them, one can determine not only whether an aging population (age), an economic crisis (period), or rapid variation in cohort size (cohort) has contributed to increasing suicide rates, but also the relative impact of each of these factors to increasing suicide rates in both countries. In addition, by comparing results in Japan and South Korea, one can better understand how age, period and cohort factors may have differed or worked in unison in each country's increasing vulnerability to suicide mortality.

My study investigates how age, period, and cohort factors affect suicide mortality in Japan and South Korea by (a) disentangling the three effects and (b) reviewing each effect's contribution to increasing suicide rates in Japan and South Korea. The research questions are:

1. What are the relative contributions of age, period, and cohort effects to changes in suicide rates in Japan and South Korea?

2. To what extent do Japan and South Korea differ with respect to the impact of age, period, and cohort on changes in suicide rates?

CHAPTER II

LITERATURE REVIEW

Durkheim's Social Determinants of Suicide

With the limitations of individual-level approaches in mind, Durkheim (1897/1951) insisted that suicide rates in a society should be considered as a new fact with its own social nature. He particularly emphasized social integration and regulation in predicting suicide rates in a society. Social integration refers to how much the members of a society are bound to social networks. Social regulation means how much the members of the society are controlled by social rules and norms (Park and Lester 2006). According to Durkheim, if the social integration and regulation in a society are unusually weak, individuals are likely to experience anomie, which fails to dissuade them from encourages destructive acts, including self-destructive acts such as suicide.

To examine associations between social integration, regulation and suicide, studies have attempted to measure social integration and regulation in various ways (Kim et al. 2011; Park and Lester 2006). The most widely used measures of social integration are divorce and marriage rates, since creating a family and being a member of a family tend to facilitate the integration of an individual into society. Those studies suppose that if the divorce rate is higher or the marriage rate is lower in one society than in others, it could cause a weakening of social integration and therefore, trigger higher suicide rates.

In this context, Kim et al. (2011) examined correlation coefficients between divorce rates and suicide rates in Japan and South Korea. According to the results, the coefficients varied significantly depending on gender and country. The correlations between suicide rates and high divorce rates for Korean men and women turned out to be very strong, while the correlation for Japanese men was relatively weak. Japanese women, on the other hand, showed a negative correlation between the suicide rates and high divorce rates. Park and Lester (2006) also focused on the correlation between suicide rates and marriage/divorce rates in South Korea. In spite of their efforts to develop useful statistical models, Park and Lester (2006) finally concluded that the marriage rate in predicting Korean suicide rates was ambiguous since the result of regression analysis between marriage rates and suicide rates were opposite to those found for simple correlations. They pointed out that the association between the traditional measures of social integration/regulation was only applied for elderly, not for younger people. With socio-cultural changes, the authors suggest that the risk factors for younger people could be different from those for elderly people.

Other than marriage and divorce rates, some studies measure social integration and regulation via economic indicators. Durkheim claimed that economic forces affect suicide rates indirectly by decreasing social integration and regulation (Yang 1992). With this perspective, many studies include factors such as the unemployment rate and economic growth rate to reflect economic conditions and compare the trajectories of those factors to trends in suicide rates. Chang et al. (2009) compared variations in unemployment rates, gross domestic product (GDP) per capita, and suicide rates in several East/Southeast Asian countries. The results showed that suicide rates in Japan and South Korea increased during economic crises, but a similar increase in suicide was not found during economic crises in Taiwan and Singapore. Thus, Chang et al. (2009) concluded that unemployment rates and economic crises are closely associated with suicide rates in certain East/Southeast Asian countries. However, given mixed evidence on this issue, it is premature to say that economic factors are causally related to suicide rates.

A Demographic Approach to Understanding Suicide:
Age, Period, and Cohort Effects

Due to the limitations of the aforementioned studies, investigators have attempted to identify other determinants of suicide rates. For example, age, period, and birth cohorts are three time-related factors have been useful in research on the determinants of other types of premature mortality in demography and epidemiology (Yang 2008). Studies of suicide have also examined the three effects.

Age Effects on Suicide

There is no doubt that age is a significant factor in mortality risk. Biological aging increases mortality risk, as described by Benjamin Gompertz and other prominent demographers and epidemiologists. This universal phenomenon makes similar trajectories of mortality with age across countries and time (Yang 2008). As the proportion of elderly people increases, both in developing and developed countries with prolonged life expectancy and lowered fertility rates, age effects have become a greater concern within the field of epidemiology (Shah 2007).

In reference to the correlation between age and suicide, Pampel (1996) stated that people's psychological and physiological experiences at different stages in the life cycle affect their decision to commit suicide. According to Durkheim (1897/1951), variations in age effects reflect the degree of social integration at different stages of the life cycle.

He wrote that suicide rarely occurs during childhood, increases steadily with age, and occurs most frequently during old age. In other words, elderly people have more determinants negatively affecting social integration (Girard 1993), such as retirement from a job and the loss of spouse and friends. Elias (1985) also pointed out that loneliness tends to increase with age. In summary, age effects are greatest among the elderly population.

Cattell (2000) pointed out that suicide rates in industrialized countries usually increase with age and are highest among elderly men. Since the elderly appear most vulnerable to suicide, “population aging” (which refers to increases in the elderly population, relative to the population as a whole) could be an important determinant of suicide rates in nations affected by this demographic phenomenon.

It is notable that Japan and South Korea have experienced particularly fast population aging compared to any other Western developed countries (Kim and Maeda 2001). Lee and Shinkai (2003) point out that Japan and South Korea have had the most rapidly aging populations among East and Southeast Asian countries. The portion of people aged over 65 comprised 10.3% of the total population of Japan in 1985, 14.5% in 1995, 19.6% in 2005 and 22.0% in 2010. By 2050, this proportion is expected to increase to 36.5%. The proportion was much lower in South Korea, only 4.3% in 1985, 5.9% in 1995, 8.6% in 2005 and 9.8% in 2010, but Chan (2006) expects that, by 2050, it will increase sharply by 30.5% with particularly tremendous momentum.

Is the rapid aging of the population responsible for the increase in suicide rates in Japan and South Korea? Using APC analysis, Lee and Kim (2010) showed that the age effects on suicide in South Korea from 1983 to 2003 were strongest among elderly people aged 80 and over. Age effects for both males and females were relatively weak among people in their forties, but they increased sharply thereafter. In South Korea where the elderly have unusually high rates of suicide, an increase in the elderly population could be largely responsible for the increase in the overall suicide rate.

Conversely, an APC analysis in Japan showed that age effects peak in the fifties, at least in the period the study examined, between 1985 and 2006 (Odagiri et al. 2011). Among Japanese males, the peak was prominent during their fifties, while among females, age effects kept increasing after their fifties. In Japan, therefore, it is hard to say that the increase in the elderly population is directly responsible for the increasing suicide rate.

There could be various explanations for differences in age effects between the two countries. As Lee and Kim (2010) pointed out, age effects in suicide could be interpreted as an index representing how well individuals adjust to social roles in a society. They assert that strong age effects on suicide mortality among South Korean elderly from 1983 to 2003 could be evidence of poor social conditions for elderly people in terms of role adjustments and socio-economic security. In that the speed of population aging has been faster in South Korea than in Japan (Kim and Maeda 2001), South Korean society has had comparatively less time to make the proper adjustments for their increase in the elderly population than Japan.

Japan, on the other hand, has had more time to make adjustments for the increasing number of elderly people. The particularly strong age effects on suicide among middle-aged Japanese could be explained as a reflection of work-related pressures, declining family incomes, and challenging, unstable work environments (Odagiri et al. 2011) for people in this age range. Also, contrary to the young adult population, older adults may have consumption and health care needs that exceed their income from labor (Bloom, Canning, and Fink 2008). This deficiency has to be supported by social institutions, including families and entitlement programs. Considering Japan is the only country in Asia that has experienced a decline in the working-age population (Mason, Lee, and Lee 2008), an increasing elderly population and the pressure of supporting them could be a burden to the working-age segment of the population and therefore, could contribute to high suicide rates among Japanese in their fifties.

Based on previous research, I hypothesized that: (1) age effects would remain highest among the elderly in South Korea. This is derived from the fact that South Korea has gone through a more rapid population aging process, as noted above, and has not had as much time, relatively speaking, as Japan to make proper adjustments for an increase in the number of its elderly citizens; (2) the age effects in Japan would be highest among people in their fifties. This hypothesis was based on the fact that there is a relatively small proportion of working-age people compared to the elderly population in Japan, and that this burden and other work-related pressures most acutely affects people during midlife.

Period Effects on Suicide

Period effects are distinct from age and cohort effects in that they influence the whole population simultaneously (Reither, Hauser, and Yang 2009). War, economic crisis, pandemics of infectious disease, as well as sweeping interventions in public health or medicine that affect the entire population are all examples of period effects (Yang 2008). In terms of suicide studies, during rapid social change or disruption, individuals are more likely to be isolated, and this condition makes people become more vulnerable to selfdestruction (Turner 2004).

Recent suicide studies that have examined period effects have primarily focused on economic crisis and growth, and their effects on suicide. Durkheim (1897/1951) wrote that suicide rates tend to increase during both economic booms and busts, with weakened social integration and regulation than usual. During such periods, a society experiences unstable norms, and these anomic conditions are reflected in higher suicide rates.

Since Durkheim, suicide studies have tried to verify the relationship between economic factors and suicide. In spite a number of previous studies that have tried to provide empirical verification of this relationship, there is no consensus incorporating all the results (Lee and Kim 2010). Ruhm (1996) insisted that 9 out of the 10 major causes of death in the United States (malignant neoplasm; major cardiovascular diseases; pneumonia and influenza; chronic liver diseases and cirrhosis of the liver; motor vehicle accidents; other accident and adverse effects; suicide, homicide, and legal intervention; infant mortality; neonatal mortality) showed negative associations with unemployment rate that were statistically significant. Suicide, on the other hand, was the only exception, showing a positive association. Yang (1992) pointed out that the overall suicide rate in the United States decreased with economic improvements from 1940 to 1984 but the female suicide rate showed an opposite result. Brenner (1979) pointed out economic crises have negative effects on mortality including suicide mortality by the loss of material resources, psychological distress from such loss, and actions to alleviate distress with alcohol or drugs. He verified his point by using data from the United States, England, and

Wales. Suicide rates in Helsinki, Finland were, on the other hand, stable during economic crises and even decreased among males (Ostamo and Lönnqvist 2001).

Since a severe economic crisis struck East and Southeast Asian countries in the late 1990s, a considerable amount of research has been devoted to the impact of the economic crisis on mortality rates, including suicide rates (Chang et al. 2009; Khang, Lynch, and Kaplan 2005; Kondo et al. 2008). Khang et al. (2005) insisted that suicide rates in South Korea increased during the economic crisis, whereas deaths by other causes such as cerebrovascular disease, cancer, and liver disease, decreased. The suicide rates among males aged 35–64 showed a particularly sharp increase during this period. Kondo et al. (2008) pointed out that the age-adjusted suicide rate in Japan also dramatically increased during the economic recession and has sustained a high level afterward. The greatest increase in Japan was also observed among males of working age. This might be because they are more likely to be exposed to high unemployment rates and reduced family income, which could promote psychological distress and increase the risk of suicide (Kondo et al. 2008; Odagiri et al. 2011).

According to previous research, suicide rates increased in both Japan and South Korea during the economic crisis of the late 1990. This study will, therefore, focus on a complete separation of period effects from two other effects (age and cohort) and compare their respective contributions to increasing suicide rates in Japan and South Korea. This study hypothesizes that: (1) period effects on suicide would be high in the late 1990s in both Japan and South Korea because of the effects of the economic recession of 1997–1998, and (2) South Korea would exhibit stronger period effects than Japan, due to the severity of the economic crisis in South Korea during this period of time. This hypothesis is based on the fact that South Korea was more affected than Japan by the economic recession, based on their respective GDP growth and unemployment rates (GDP growth in 1998 was -2.0% in Japan and -6.9% in South Korea. The unemployment rate in 1998 was 4.1% in Japan and 7.0% in South Korea [Chang et al. 2009]).

Cohort Effects on Suicide

A cohort is a group of individuals who experience the same event within the same time frame (Ryder 1965). The event is supposed as birth in most cohort studies and those studies hypothesize each birth cohort has unique characteristics that reflect historical experiences associated with age, which make the cohort distinctive from others. The cohort, therefore, reveals its own uniqueness that cannot be shown by an individual level of analysis.

One of the most salient characteristics of a birth cohort is its size in relation to other birth cohorts. The relative size of a birth cohort fundamentally affects members of that cohort across their lifetimes. That is, when cohorts of different sizes reach each major juncture in the life cycle, society has the problem of assimilating them. For example, when members of a large cohort jump into the job market upon the completion of their schooling, they experience a more crowded job market than the members of a relatively smaller birth cohort. Ryder (1965) insisted that these circumstances could cause persistent changes in the attitudes and behaviors of cohort members during their entire lifetimes.

Suicide studies regarding cohort size posit that the fluctuation of cohort size could be a significant factor in variations in suicide rates. Easterlin (1978) pointed out that a large cohort is likely to have a high suicide rate because of reduced standards of living and other factors. The members of a large cohort experience a shortage of schools and teachers during their school days, a competitive job market with rising unemployment rates, and relatively low income after graduation as well as limited public pensions during their retirement years. In other words, lower standards of living and associated stressors that accompany life in a highly competitive society with limited resources could account for increases in suicide.

Contrary to this view, Preston (1994) insisted that members of large birth cohorts tend to have lower suicide rates because the cohort holds relatively more political and social power, which translates into better life circumstances and enhanced psychological well-being. To examine these arguments, Pampel (1996) analyzed the relationship between cohort size and suicide in 18 high-income nations from 1953 to 1986. The result shows that individuals belonging to large cohorts tend to have higher suicide rates if they are either young or middle-aged, but they have lower suicide rates if they are elderly. He concluded the relationship of cohort size to suicide varies depending on four factors: age, gender, national context, and time period.

Among the three effects, cohort effects in Japan and South Korea have been studied least. In spite of the limited number of studies, cohort effects were most responsible for rising suicide in South Korea among the three effects in the period 1983 to 2003 (Lee and Kim 2010). The cohort effects in South Korea started to decrease after the 1948–1952 birth cohort but were still a significant factor for suicide rates. Lee and Kim (2010) pointed out that suicide rates in South Korea were forecasted to remain high until 2011, when the 1938–1947 birth cohort, which has the highest cohort effects on suicide, becomes the next elderly population. Considering the baby boom in South Korea that occurred from 1955 to 1964, variations in birth cohort size were not a significant factor for the cohort effects on suicide in South Korea.

Cohort effects on suicide in Japan turned out to have dramatic variations (Odagiri et al. 2011). The patterns were largely dependent on gender. While birth cohort effects decreased in South Korea, they increased in Japan. The cohort effects among males have been increasing since the 1920–1924 birth cohort, but the effects among females started to increase since the 1951–1955 birth cohort. Considering the baby boom in Japan that occurred from 1947 to 1949, variations in birth cohort size were not a significant factor for the cohort effects on suicide in Japan, as well.

In regard to birth cohort effects on suicide, this study hypothesized that: (1) birth cohort membership would have strong effects on suicide in both countries, but cohort effects would exhibit a decreasing trend in South Korea since the 1940-1949 birth cohorts, while in Japan birth cohorts effects would show an increasing trend since the 1920-24 birth cohort among males and the 1951-1955 birth cohort among females, and (2) variations in birth cohort size would not be a significant factor for the birth cohort effect on suicide in either country. In other words, the baby boomers (1947–1949 birth cohorts in Japan, 1955–1964 birth cohorts in South Korea) would not have any distinctive cohort effects on suicide compared to other cohort groups.

CHAPTER III

METHOD

Study Population

For an age-period cohort (APC) analysis of mortality, a researcher needs two types of data: (a) the number of people exposed to the risk and (b) the number of deaths from the risk. The population exposed to the risk in my research is the population for each country (divided by sex and age), which came from the population census in each country. Japan and South Korea both conduct a population census every five years and offer the data set through their respective organizations—the Ministry of Internal Affairs and Communications in Japan and Statistics Korea.

In this study, deaths are attributable only to suicide. Deaths by suicide in South Korea are offered by Statistics Korea. The numbers are based on death reports, which is an obligation of one of the deceased's family members. Once the death report is submitted to local organizations, the death is enrolled in the Web system. Statistics Korea, a central government organization for statistics, sums up the whole number of deaths annually, from January 1 to December 31.

Deaths by suicide in Japan are included in the Vital Statistics Survey, conducted by the Ministry of Health, Labor and Welfare. Based on Family Registry, municipal heads fill in "vital statistics survey forms", including information about births, deaths, stillborn infants, marriages, and divorces of family members, and then send these statistics to the prefectural government. The prefectural government inspects the forms submitted by the health centers and sends them to the Ministry of Health, Labor and Welfare. The results cover information from January 1 to December 31 of the survey year and are offered by the Statistics Bureau.

My investigation divided the period between 1985 and 2010 into five-year intervals to analyze the data by five-year age groups and five-year cohort groups. I excluded the age groups of 0–4 and 5–9 because suicide rates for these cohorts are mostly zero. To unify the classification of age categories of the data for the two countries across the entire period, I summed up the categories over the age of 80 into one category of 80 years and over.

Statistical Analysis

The APC model has been used to analyze cohort effects when a researcher is also interested in age and period effects (Yang, Fu, and Land 2004). The model is particularly useful in research concerning risk factors for mortality in demography and epidemiology (Hobcraft, Menken, and Preston 1982; Robertson, Gandini, and Boyle 1999) because it distinguishes three types of time-related effects.

Distinguishing the three effects is important (Ooe et al. 2009). If a researcher does not distinguish the cohort effects from the other two effects, the analysis will yield biased interpretations regarding age and period effects by assuming equal declines across birth cohorts (Reither et al. 2009). As a result, the variation in cohort effects could be regarded as the variation of age or period effects. Therefore, I separated the three effects and evaluated them independently by the APC model.

The APC model set by Mason et al. (1973) is written in log-linear regression form as follows:

$$\log (r_{ijk}) = \log(\frac{d_{ijk}}{n_{ijk}}) = \mu + \alpha_i + \beta_j + \gamma_{a-i+j}$$

r_{ijk} denotes the rate of deaths for the *i-th* age group, at the *j-th* time period and the *k-th* period group. d_{ijk} denotes the number of deaths in the *ijk-th* group. n_{ij} denotes the number of people exposed to the risk, which means the whole population in the *ij-th* group. μ denotes the intercept, meaning an adjusted mean of death rate. α_i denotes the age effect in the *i-th* row. β_j denotes the period effect in the *j-th* column. γ_k denotes the cohort effect in the *k-th* diagonal with $k = a–i+j$. (Yang et al. 2004).

In that this model measures the three effects, respectively, it is a useful method for researchers. However, this method has one chronic difficulty, despite its strong theoretical background and statistical relevance: This weakness is an "*identification problem"* (See details in Appendix A). Because age, period, and cohort variables are linearly dependent on each other (period = age + cohort), a matrix of one less than full rank yields multiple estimators of those three effects. It is difficult, therefore, to define the uniquely separated set of three effects among them (Yang and Land 2008; Yang et al. 2008).

Conventional APC models such as *Conventional Generalized Linear Models* (CGLIM) have tried to resolve this problem by finding a relevant constraint. Unfortunately, that technique has significant limitations; to establish the constraint a researcher needs to depend on additional, a priori information, but this information is generally difficult to acquire or verify. Otherwise, the researcher can test a wide range of models with different coefficient equality constraints for age, period, and cohort groups.

This method helps to establish the degree of sensitivity to various changes in coefficient constraints, but Hobcraft et al. (1982) point out that the method may still not be statistically dependable. The results from the method, consequently, are not stable and are difficult to interpret (Yang 2008; See details in Appendix B).

With this limitation, recent researchers of APC methodology have studied the estimable function, which is not dependent on the variation of constraints. The alternative method suggested by Fu (2000), called the *Intrinsic Estimator* (IE) model, has been adopted in recent studies. This model yields trustworthy estimates of mortality and morbidity by age, period, and cohort, which determine the unique coefficient. Through empirical analysis utilizing the IE model, Yang et al. (2004) concluded that it can be a useful alternative to conventional methods for APC. For any fixed number p of time period, the IE model is not only unbiased but has a smaller variance than that of any other conventional model. For any finite number p of time periods, the intrinsic estimator B has a reduced variance than that of any conventional general linear model estimator.

In this study, I estimated the APC-IE model of suicide rates in Japan and South Korea using the STATA module.

CHAPTER IV

RESULTS

Descriptive Analysis

Absolute Suicide Rate

Descriptive statistics are shown in Table 1.1, 1.2 and Figure 2.1, 2.2. They show absolute suicide rates in Japan and South Korea, i.e. the number of deaths by suicide per 100,000 PYL. The absolute suicide rate in Japan (Table 1.1) increased from 19.3 in 1985 to 23.1 in 2010. The rate has been flattening across all ages since 2000, meaning that differences between age groups have been narrowing (Figure 2.1). The suicide rate among the elderly decreased while the rates among younger people in their twenties, thirties and forties have increased. In 2010, the rate was highest among people in their fifties with 34.0 deaths per 100,000 PYL among age groups 50-54 and 55-59.

The absolute suicide rate in South Korea (Table 1.2) increased from 9.4 in 1985 to 32.4 in 2010. Compared to Japan, which has the highest suicide rate among middle aged people, absolute suicide rates in South Korea have had a tendency to increase with age (Figure 2.2). The absolute suicide rates in South Korea have been increasing across all ages since 1985, and have increased particularly drastically among the elderly. The eldest groups' (80 years old and over) suicide rate, which was 15.5 per 100,000 PYL in 1985, skyrocketed to 116.3 in 2010. This represents an increase of more than 700%. The rise turned out to be particularly drastic between 2000 and 2005 (53.0 in 2000, 125.31 in 2005).

TABLE 1.1 Absolute Suicide Rate, 1985-2010, Japan

	1985			1990			1995			2000			2005			2010		
	TOTAL	MALE	FEMALE	TOTAL	MALE	FEMALE	TOTAL	MALE	FEMALE	TOTAL	MALE	FEMALE	TOTAL	MALE	FEMALE	TOTAL	MALE	FEMALE
Total	19.3	25.8	13.0	16.3	20.3	12.4	17.1	23.1	11.2	23.8	34.9	13.3	23.9	35.7	12.7	23.1	33.7	13.0
0-4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5-9	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10-14	0.8	1.1	0.5	0.5	0.7	0.4	0.9	1.1	0.6	1.1	1.7	0.5	0.7	0.9	0.5	1.1	1.4	0.7
15-19	5.0	6.7	3.3	3.8	4.7	2.8	4.9	6.5	3.3	6.3	8.7	3.8	7.8	9.5	5.9	7.4	9.6	5.1
20-24	14.3	19.9	8.6	10.5	14.1	6.8	11.3	15.1	7.2	15.8	21.7	9.5	18.6	24.4	12.5	21.0	30.5	11.2
25-29	16.6	23.6	9.5	13.2	17.2	9.0	13.7	19.6	7.5	17.7	24.0	11.3	21.5	30.3	12.4	22.1	32.0	11.8
30-34	16.5	23.0	9.9	14.0	19.2	8.7	14.2	19.8	8.5	19.8	28.3	11.1	22.6	32.0	13.1	22.8	31.4	13.9
35-39	17.9	25.3	10.4	14.2	20.2	8.0	14.9	21.5	8.1	21.1	32.4	9.6	23.9	35.9	11.8	23.8	34.4	12.9
40-44	24.8	36.3	13.5	16.2	22.3	10.0	17.3	25.7	8.7	23.4	36.4	10.3	28.5	44.2	12.5	26.4	39.5	13.1
45-49	31.7	47.8	15.8	21.9	30.3	13.6	21.0	31.1	10.7	30.4	48.6	12.1	33.2	54.0	12.3	30.5	45.8	15.0
50-54	34.5	50.6	18.7	24.9	33.6	16.3	28.4	41.3	15.7	37.6	59.1	16.2	36.3	58.7	14.1	34.0	52.3	15.7
55-59	30.3	44.2	17.2	25.0	33.6	16.7	28.0	40.8	15.6	44.7	72.1	18.3	38.1	60.9	15.7	33.7	53.3	14.4
60-64	27.2	36.4	20.0	24.4	31.0	18.4	25.9	36.9	15.6	38.3	57.9	19.8	33.9	51.6	17.0	30.9	46.9	15.5
65-69	31.3	38.2	26.2	26.4	32.5	21.7	22.4	28.7	16.9	33.0	47.9	19.6	28.3	42.1	15.7	29.4	41.5	18.4
70-74	39.1	46.9	33.4	34.6	41.9	29.6	26.6	32.5	22.4	30.3	41.0	21.3	27.8	40.8	16.9	26.3	36.7	17.4
75-79	53.8	64.1	46.6	45.4	50.3	42.2	33.4	42.2	27.9	31.2	38.9	26.1	26.6	35.9	19.6	26.8	37.9	18.3
80+	70.0	86.1	60.9	62.3	77.0	54.4	47.4	63.2	39.4	43.7	62.6	34.6	32.3	51.1	23.4	27.6	43.5	19.6

TABLE 1.2 Absolute Suicide Rate, 1985-2010, South Korea

	1985			1990			1995			2000			2005			2010		
	TOTAL	MALE	FEMALE	TOTAL	MALE	FEMALE	TOTAL	MALE	FEMALE	TOTAL	MALE	FEMALE	TOTAL	MALE	FEMALE	TOTAL	MALE	FEMALE
Total	9.4	13.7	5.1	7.5	10.4	4.6	11.1	15.1	7.0	14.0	19.4	8.6	25.5	34.2	16.9	32.4	43.3	21.7
0-4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5-9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.2	0.3	0.1	0.0	0.1	0.0	0.0	0.0	0.0
10-14	0.7	0.9	0.6	1.1	1.4	0.7	1.5	1.5	1.6	0.8	0.9	0.6	1.2	1.1	1.2	1.9	1.6	2.2
15-19	8.1	10.7	5.2	6.2	8.5	3.9	7.7	9.4	6.0	6.5	7.2	5.8	7.7	7.9	7.5	8.5	9.0	7.9
20-24	15.6	21.5	9.4	10.4	13.2	7.3	12.3	14.9	9.5	11.2	13.3	8.9	16.6	15.5	17.8	18.8	20.2	17.1
25-29	13.9	20.5	7.3	10.3	13.5	7.1	14.7	18.5	10.8	12.2	16.3	8.1	20.5	22.3	18.6	31.5	33.8	29.1
30-34	11.1	16.3	5.6	9.5	12.9	6.1	12.9	18.0	7.6	14.7	19.9	9.3	22.8	28.9	16.7	31.3	37.0	25.5
35-39	12.1	17.3	6.6	10.0	14.1	5.7	13.4	19.3	7.3	17.7	25.1	10.1	24.0	31.0	16.9	31.8	39.4	24.1
40-44	14.2	21.8	6.4	8.6	11.7	5.3	13.3	18.8	7.5	19.0	27.6	10.2	27.3	38.5	15.8	33.5	45.4	21.6
45-49	15.9	25.6	6.3	11.4	17.8	4.9	15.6	23.3	7.5	18.6	28.5	8.3	31.4	47.5	15.1	38.9	57.3	20.4
50-54	14.2	23.1	6.0	10.6	17.0	4.4	18.4	28.6	8.3	19.5	31.4	7.5	33.4	51.6	15.2	40.1	59.6	20.7
55-59	14.7	24.6	6.8	11.2	17.5	5.7	15.7	25.8	6.4	26.1	41.9	11.1	35.1	54.9	15.7	42.4	65.8	19.7
60-64	14.5	25.7	5.8	11.1	18.8	5.4	16.5	25.2	9.3	25.7	40.0	13.0	50.4	79.7	23.9	46.4	72.8	21.6
65-69	20.8	35.5	9.9	14.4	22.1	9.0	18.7	30.7	10.6	24.5	37.7	14.4	62.4	101.6	30.3	63.0	97.9	33.3
70-74	17.6	24.1	13.5	13.3	22.3	7.5	24.0	35.8	16.6	33.1	49.4	23.2	69.1	112.4	39.0	74.7	121.3	39.6
75-79	15.4	25.1	10.5	13.3	18.8	10.4	27.4	40.5	20.3	44.5	75.2	27.7	84.2	142.3	52.6	87.3	138.8	56.0
80+	15.5	33.1	9.9	19.0	39.4	12.0	30.2	60.2	19.4	53.0	91.9	37.9	125.3	202.0	93.4	116.3	207.3	78.8

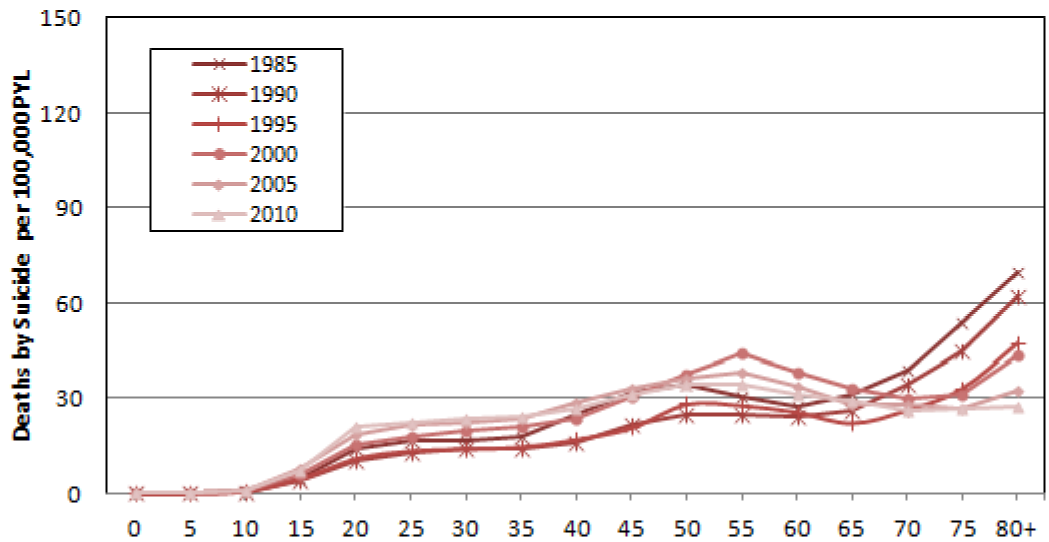


FIGURE 2.1 Absolute Suicide Rate, 1985-2010, Japan

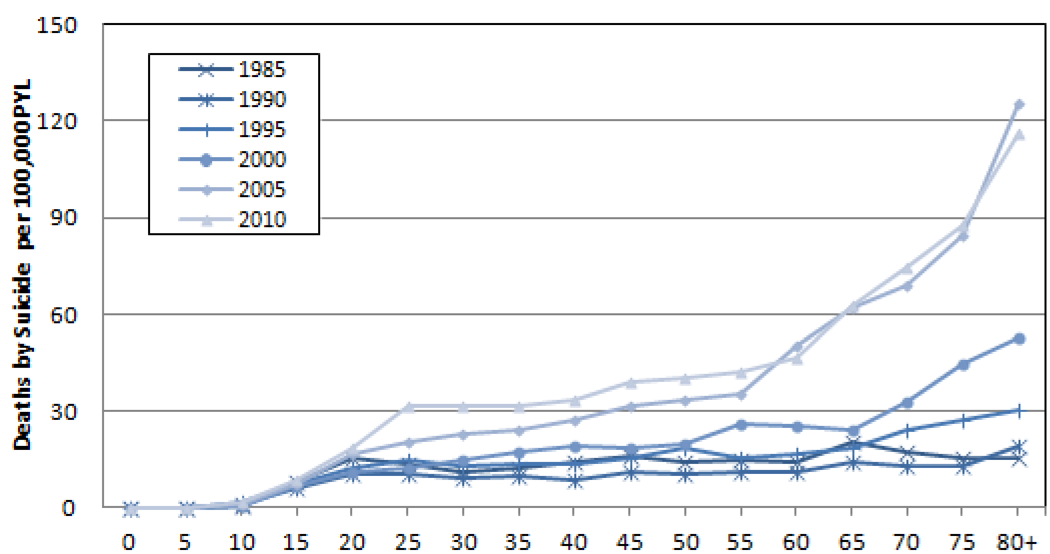


FIGURE 2.2 Absolute Suicide Rate, 1985-2010, South Korea

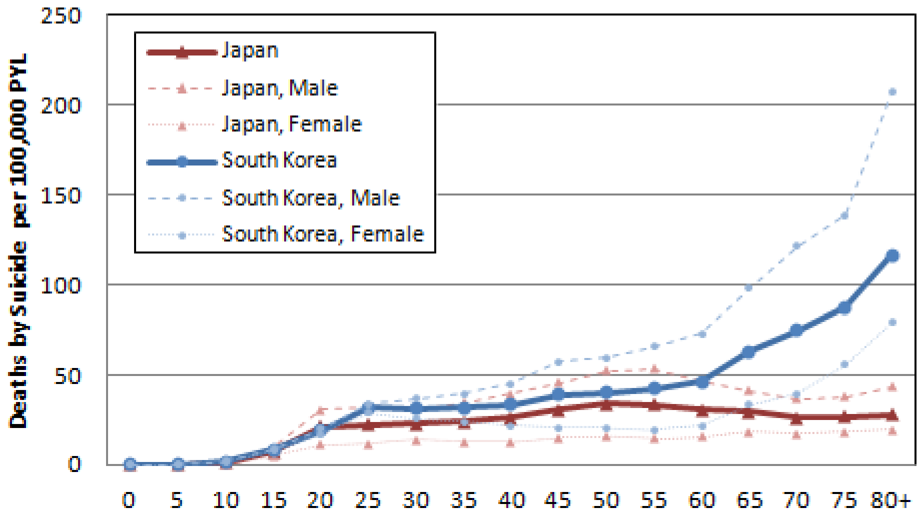


FIGURE 2.3 Gender Stratified Absolute Suicide Rate, 2010, Japan and South Korea

Absolute suicide rates were generally higher among males than females in both countries. In 2010 (Figure 2.3), the gender difference in Japan was largest among people in their fifties. The rate among males in this age group was more than three times higher than that among females of the same age (52.7 among males, 15.0 among females per 100,000 PYL). On the other hand, the gender differences in South Korea increased with age. The oldest group (80 years and older) in 2010 showed the largest difference between the sexes, with the suicide rate for males about three times greater than that of females (207.3 in males and 78.8 in females per 100,000 PYL). The only exception is among Korean females aged 10-14. In this group, the rate for females was slightly higher than that for males (1.6 in males and 2.24 in females per 100,000PYL).

Proportional Suicide Rate

Table 2.1 and Table 2.2 show proportional suicide rates in Japan and South Korea, i.e. the percentage of all deaths that are attributable to suicide. While the overall proportional suicide rate in South Korea increased from 1.6% in 1985 to 6.1% in 2010, the rate in Japan decreased from 3.1% from 1985 to 2.5% in 2010. In sum, in South Korea, both absolute and proportional suicide rates have increased over the last 25 years, whereas in Japan, the proportional suicide rate has decreased despite the rise in absolute suicide rates.

In both countries, the proportional rate was highest among younger people, particularly in their twenties. In 2010, 49.8% of all deaths among people aged 20-24 were by suicide in Japan (Table 2.1). That proportion has increased from 21.9% in 1995, to 33.0% in 2000 and 40.8% in 2005. In South Korea, 47.5% of total deaths among people aged 25-29 in 2010 were due to suicide (Table 2.2). That proportion has increased from 11.9% in 1995, to 15.0% in 2000 and 33.0% in 2005. Contrary to absolute suicide rates, the proportional rates among elderly in both countries were lower than those among the younger population.

In terms of gender differences (Figure 3.3), the proportional suicide rate in Japan was mostly higher among males than females. The only exception was the age group of 70-74, but the difference is negligible (1.6% in males and 1.8% in females). Conversely, the proportional suicide rate in South Korea is, higher among females for teenagers, people in their twenties, thirties and early forties. In summation, in South Korea, the total number of deaths by suicide is higher for males when compared with that of females but the proportion of suicides is lower for males when compared to females.

TABLE 2.1 Proportional Suicide Rate, 1985-2010, Japan

	1985			1990			1995			2000			2005			2010		
	TOTAL	MALE	FEMALE	TOTAL	MALE	FEMALE	TOTAL	MALE	FEMALE	TOTAL	MALE	FEMALE	TOTAL	MALE	FEMALE	TOTAL	MALE	FEMALE
Total	3.1	3.8	2.3	2.4	2.8	2.1	2.3	2.8	1.7	3.1	4.1	2.0	2.8	3.8	1.7	2.5	3.3	1.5
0-4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5-9	0.2	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.2	0.0	0.0	0.0	0.0
10-14	4.9	5.4	4.1	3.8	3.9	3.5	5.6	6.0	4.9	9.9	11.8	6.4	7.5	7.8	7.0	11.4	12.0	10.3
15-19	10.8	9.8	13.8	8.8	7.6	11.9	12.6	11.9	14.3	19.7	19.5	20.4	28.4	26.3	32.6	31.7	32.0	31.2
20-24	25.2	24.4	27.4	19.4	18.2	22.3	21.9	21.0	24.3	33.0	32.6	33.9	40.8	40.0	42.4	49.8	51.7	45.3
25-29	27.6	29.5	23.7	24.9	24.2	26.5	26.2	27.3	23.5	36.1	36.5	35.3	42.8	44.2	39.6	47.4	49.8	41.9
30-34	22.2	24.8	17.9	21.7	23.2	19.1	22.6	24.8	18.6	31.1	33.6	26.0	37.2	40.5	31.0	39.7	42.2	34.8
35-39	17.3	19.2	13.8	14.9	16.8	11.6	17.0	19.3	12.9	24.4	28.8	15.9	28.1	32.3	20.0	31.0	35.3	23.3
40-44	14.3	16.1	11.0	11.3	12.2	9.6	12.2	14.2	8.6	17.5	20.9	11.0	22.5	26.5	14.6	22.9	26.5	16.1
45-49	11.5	13.0	8.6	9.1	9.6	8.3	9.2	10.6	6.7	13.7	16.6	8.2	16.3	19.8	9.2	17.0	19.5	12.1
50-54	7.6	8.2	6.5	6.7	6.7	6.6	7.7	8.4	6.4	11.0	12.8	7.2	11.1	13.2	6.6	11.9	13.7	8.2
55-59	4.7	4.9	4.2	4.1	3.9	4.5	5.0	5.2	4.4	8.5	9.7	5.8	7.9	9.1	5.3	7.5	8.5	5.2
60-64	2.9	2.8	3.0	2.6	2.4	3.2	2.8	2.8	2.9	4.9	5.2	4.3	4.7	5.0	4.0	4.7	5.0	4.0
65-69	2.0	1.8	2.4	1.9	1.7	2.3	1.6	1.4	2.0	2.6	2.6	2.6	2.6	2.7	2.4	2.9	2.9	3.1
70-74	1.5	1.3	1.7	1.5	1.3	1.8	1.2	1.0	1.5	1.5	1.4	1.7	1.5	1.6	1.5	1.7	1.6	1.8
75-79	1.1	1.0	1.2	1.1	0.9	1.3	0.9	0.8	1.0	1.0	0.9	1.2	0.9	0.8	1.0	1.0	1.0	1.0
80+	0.6	0.6	0.6	0.6	0.6	0.6	0.5	0.5	0.5	0.5	0.6	0.5	0.4	0.5	0.3	0.3	0.4	0.3

TABLE 2.2 Proportional Suicide Rate, 1985-2010, South Korea

	1985			1990			1995			2000			2005			2010		
	TOTAL	MALE	FEMALE	TOTAL	MALE	FEMALE	TOTAL	MALE	FEMALE	TOTAL	MALE	FEMALE	TOTAL	MALE	FEMALE	TOTAL	MALE	FEMALE
Total	1.6	2.0	1.0	1.3	1.6	1.0	2.0	2.5	1.5	2.6	3.3	1.8	4.9	6.0	3.6	6.1	7.3	4.6
0-4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5-9	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.0	0.8	0.9	0.6	0.2	0.3	0.0	0.0	0.0	0.0
10-14	1.2	1.2	1.2	2.2	2.5	1.9	4.5	3.6	6.0	3.7	3.9	3.5	7.9	6.6	9.6	14.6	10.6	20.9
15-19	6.5	6.9	5.9	7.0	6.9	7.3	9.4	8.5	11.6	13.6	11.4	18.2	24.5	19.9	33.7	28.2	23.4	38.6
20-24	10.5	11.3	9.0	9.5	9.2	10.0	12.9	12.0	15.0	17.0	15.1	21.5	33.0	26.0	44.4	40.6	35.9	49.3
25-29	8.1	8.8	6.8	7.6	7.1	8.8	11.9	10.5	15.4	15.0	14.4	16.6	33.0	28.6	40.8	47.5	41.5	57.5
30-34	5.5	5.8	4.5	5.6	5.3	6.4	9.0	8.7	9.8	13.6	13.6	13.7	27.2	26.4	28.8	41.2	38.7	45.7
35-39	4.2	4.3	3.9	4.1	4.1	4.3	6.6	6.5	7.0	11.2	11.1	11.4	19.7	18.9	21.5	29.2	27.9	31.7
40-44	2.8	3.0	2.3	2.4	2.3	2.6	4.4	4.3	4.9	7.7	7.6	7.9	14.0	13.7	14.7	20.1	19.2	22.3
45-49	2.2	2.4	1.6	1.8	2.0	1.5	3.5	3.6	3.3	5.1	5.2	4.8	10.5	10.7	9.7	14.8	15.0	14.3
50-54	1.5	1.7	1.1	1.3	1.4	0.9	2.6	2.7	2.2	3.7	4.0	2.8	7.9	8.1	7.0	10.8	10.7	10.9
55-59	1.0	1.2	0.8	1.0	1.1	0.8	1.6	1.7	1.1	3.0	3.2	2.4	5.9	6.2	5.0	8.3	8.4	7.8
60-64	0.7	0.8	0.5	0.6	0.7	0.5	1.2	1.2	1.1	2.1	2.2	1.8	4.9	5.2	4.2	6.2	6.5	5.4
65-69	0.6	0.7	0.5	0.5	0.5	0.5	0.8	0.9	0.7	1.3	1.4	1.2	4.0	4.4	3.2	4.9	5.1	4.4
70-74	0.3	0.3	0.4	0.3	0.3	0.2	0.6	0.7	0.6	1.1	1.1	1.0	2.9	3.3	2.3	3.6	4.0	3.0
75-79	0.2	0.2	0.2	0.2	0.2	0.2	0.4	0.5	0.4	0.8	1.0	0.6	1.9	2.4	1.5	2.6	2.9	2.2
80+	0.1	0.1	0.1	0.1	0.2	0.1	0.2	0.4	0.2	0.4	0.6	0.3	1.2	1.6	0.9	1.3	1.9	1.0

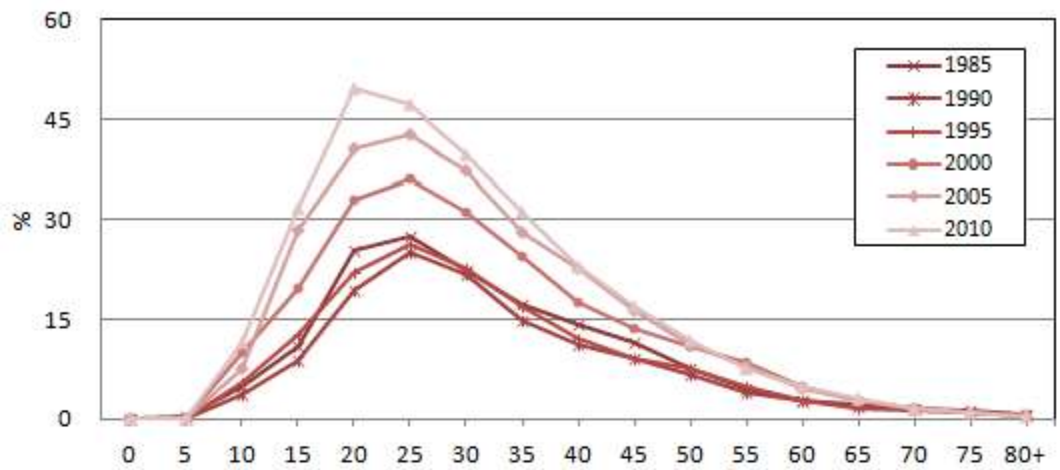


FIGURE 3.1 Proportional Suicide Rates, 1985-2010, Japan

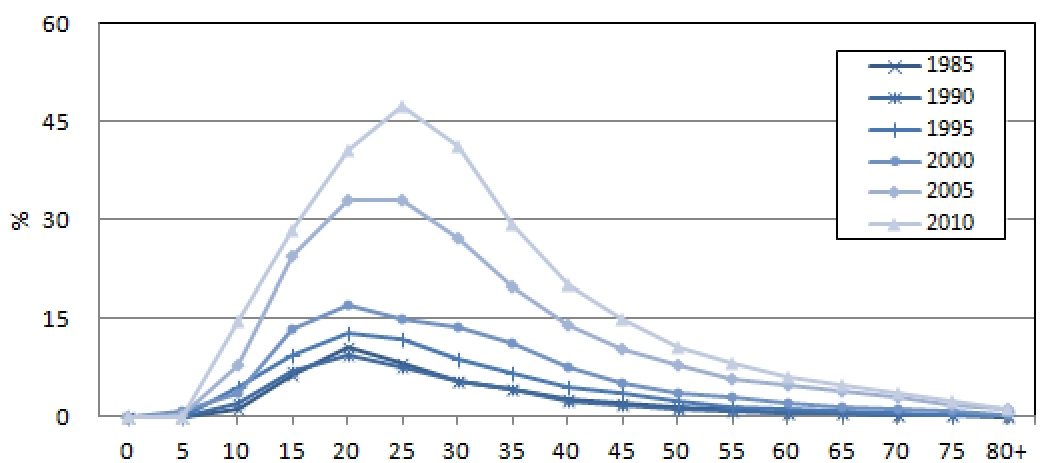


FIGURE 3.2 Proportional Suicide Rates, 1985-2010, South Korea

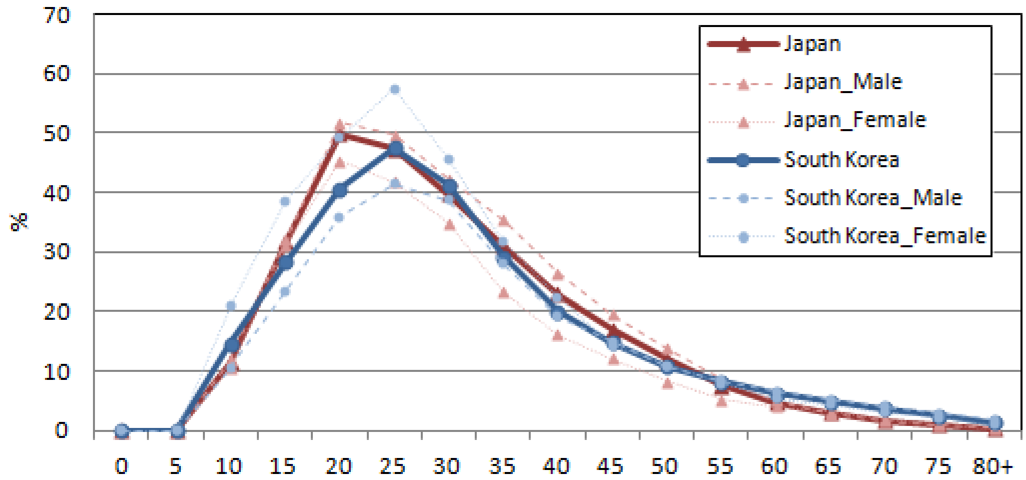


FIGURE 3.3 Gender Stratified Proportional Suicide Rates, 2010, Japan and South Korea

APC Analysis

Overall Mortality

Prior to investigating suicide through APC-IE analysis, I used the APC-IE method to analyze overall mortality rates in Japan and South Korea. Figure 4.1, 4.2 and 4.3 show the results: age and cohort effects show similar trends in the two countries. Period effects show a difference between the two countries having an increasing trend in Japan and a decreasing tend in South Korea.

In comparing the results of the two countries, the most similar trend was age effects on overall mortality rates, reflecting the increasing risk of death with age due to the general biological process of aging. Cohort effects also showed similar trends in the two countries. The cohort effects in Japan appear to decrease almost linearly; the more recent the birth cohort, the lower the cohort effect. This trend was similar in South Korea. Compared to Japan, South Korea showed slightly lower cohort effects among the oldest three birth cohorts (1905–1909, 1910–1914, and 1915–1919) and somewhat higher effects among people born between 1940 and 1974. Nevertheless, differences between the two countries were negligible.

In addition, when I compared the gender-stratified results, there were no noteworthy differences for the age and cohort effects. Period effects, however, showed somewhat differentiated trends in the two countries. Whereas period effects in South Korea have continually decreased since 1985, the effects in Japan have continually increased. The contribution of period effects to mortality rates was smaller than those of age and cohort effects. Gender-stratified results did not yield any significant findings in the period effects.

Suicide Mortality

Figure 5.1, 5.2, and 5.3 show the APC-IE results of suicide rates in both countries. Contrary to the overall mortality results, the suicide rate results showed distinctive differences between nations in the three effects. In Japan, age effects increased with age until the fifties age bracket and then decreased after the peak, following my hypothesis. Thus, age effects among elderly people above 60 years of age turned out to be lower than those among people in their fifties. This trend was similar among males and females, but cohort effects among males showed a wider variation.

Conversely, in South Korea, age effects were relatively lower among middle-aged people and were highest in elderly persons of age 80 and over. Age effects increased with age until the twenties age bracket, slightly dropped in the thirties, kept the lower level in middle age, and sharply increased with age after the sixties. This trend appeared among both males and females, but the age effects among elderly people were higher in females than in males.

Period effects increased in both countries since 1990. Period effects in Japan greatly increased between 1995 and 2000, which was a period of economic crisis. Conversely, in South Korea, period effects showed rapid growth between 2000 and 2005, several years after the economic crisis. The period effects in South Korea sharply increased until recently, whereas those in Japan have been moderate since 2000. The range of variation was wider in South Korea than in Japan. Japanese females are particularly less vulnerable to period effects and show the narrowest range in variation.

The cohort effects showed the most dramatic variations. The two countries show inverse trends in cohort effects. The birth cohorts born between 1915 and 1970 in South Korea have high cohort effects, but their counterparts in Japan have the lowest cohort effects. The birth cohort effects in South Korea began to decrease after the 1945–1949 birth cohort, slightly increasing after the 1995 birth cohort. The birth cohort effects in Japan were highest among the 1905–1909 birth cohort, the eldest population of my analysis, and sustained relatively lower levels since the 1925–1929 birth cohort.

TABLE 3.1 APC-IE Results: Overall Mortality, Japan

		Total		Male		Female	
		Effect	S.E.	Effect	S.E.	Effect	S.E.
Age	10-14	-2.258	0.111	-2.334	0.099	-2.134	0.177
	15-19	-1.371	0.066	-1.302	0.054	-1.547	0.121
	20-24	-1.171	0.059	-1.119	0.049	-1.301	0.106
	24-29	-1.230	0.058	-1.220	0.049	-1.268	0.101
	30-34	-1.113	0.052	-1.162	0.045	-1.044	0.088
	35-39	-0.875	0.045	-0.930	0.039	-0.800	0.075
	40-44	-0.528	0.038	-0.581	0.033	-0.458	0.064
	45-49	-0.149	0.032	-0.180	0.028	-0.115	0.054
	50-54	0.204	0.027	0.192	0.023	0.202	0.045
	55-59	0.503	0.022	0.526	0.019	0.430	0.038
	60-64	0.798	0.019	0.839	0.016	0.704	0.032
	65-69	1.108	0.018	1.155	0.016	1.035	0.030
	70-74	1.470	0.019	1.517	0.017	1.441	0.032
	75-79	1.872	0.022	1.919	0.019	1.900	0.036
	80+	2.739	0.025	2.680	0.022	2.958	0.042
Period	1985	-0.080	0.017	-0.096	0.015	-0.026	0.028
	1990	-0.078	0.013	-0.083	0.012	-0.063	0.021
	1995	-0.006	0.010	0.003	0.009	-0.021	0.016
	2000	0.000	0.010	0.016	0.009	-0.039	0.016
	2005	0.063	0.012	0.067	0.011	0.031	0.020
	2010	0.101	0.016	0.091	0.014	0.118	0.027
Cohort	1905-09	1.094	0.037	1.054	0.034	1.101	0.060
	1910-14	1.051	0.031	1.025	0.028	1.083	0.051
	1915-19	0.907	0.027	0.908	0.024	0.947	0.044
	1920-24	0.753	0.024	0.766	0.022	0.813	0.039
	1925-29	0.620	0.022	0.632	0.020	0.683	0.036
	1930-34	0.540	0.021	0.557	0.019	0.556	0.034
	1935-39	0.391	0.024	0.428	0.021	0.335	0.040
	1940-44	0.231	0.028	0.258	0.024	0.190	0.047
	1945-49	0.138	0.032	0.166	0.028	0.096	0.054
	1950-54	0.014	0.037	0.028	0.032	-0.009	0.061
	1955-59	-0.068	0.043	-0.052	0.037	-0.093	0.072
	1960-64	-0.204	0.050	-0.190	0.043	-0.233	0.085
	1965-69	-0.303	0.056	-0.287	0.048	-0.346	0.094
	1970-74	-0.351	0.059	-0.329	0.050	-0.420	0.101
	1975-79	-0.440	0.062	-0.443	0.053	-0.467	0.106
	1980-84	-0.523	0.074	-0.537	0.063	-0.541	0.129
	1985-89	-0.651	0.091	-0.680	0.077	-0.626	0.158
	1990-94	-0.864	0.119	-0.887	0.100	-0.827	0.210
	1995-99	-1.142	0.182	-1.231	0.158	-1.005	0.302
	2000-04	-1.196	0.385	-1.188	0.338	-1.237	0.622
Intercept		-5.923		-5.639		-6.312	
Deviance		4377.8		2133.6		4211.0	
DF		52		52		52	
Dispersion Coefficient		84.2		46.0		80.9	

TABLE 3.2 APC-IE Results: Overall Mortality, South Korea

		Total		Male		Female	
		Effect	S.E.	Effect	S.E.	Effect	S.E.
Age	10-14	-1.877	0.045	-2.016	0.048	-1.709	0.067
	15-19	-1.301	0.031	-1.330	0.031	-1.324	0.050
	20-24	-1.222	0.029	-1.289	0.029	-1.170	0.046
	24-29	-1.143	0.026	-1.159	0.026	-1.151	0.043
	30-34	-1.052	0.025	-1.069	0.025	-1.063	0.041
	35-39	-0.801	0.022	-0.800	0.022	-0.845	0.038
	40-44	-0.472	0.020	-0.448	0.019	-0.574	0.034
	45-49	-0.163	0.017	-0.122	0.017	-0.294	0.030
	50-54	0.099	0.016	0.152	0.015	-0.034	0.027
	55-59	0.350	0.014	0.420	0.014	0.217	0.024
	60-64	0.657	0.013	0.738	0.013	0.552	0.021
	65-69	0.998	0.013	1.070	0.013	0.967	0.019
	70-74	1.414	0.013	1.459	0.014	1.473	0.019
	75-79	1.863	0.014	1.868	0.015	2.012	0.020
	80+	2.650	0.015	2.526	0.016	2.943	0.022
Period	1985	0.253	0.010	0.258	0.010	0.257	0.016
	1990	0.146	0.009	0.149	0.009	0.150	0.013
	1995	0.049	0.008	0.055	0.009	0.047	0.012
	2000	-0.043	0.008	-0.048	0.009	-0.037	0.012
	2005	-0.164	0.009	-0.178	0.009	-0.154	0.013
	2010	-0.242	0.010	-0.236	0.010	-0.262	0.015
Cohort	1905-09	0.762	0.026	0.910	0.032	0.742	0.035
	1910-14	0.769	0.020	0.815	0.024	0.787	0.028
	1915-19	0.770	0.017	0.765	0.020	0.814	0.024
	1920-24	0.777	0.016	0.743	0.018	0.832	0.022
	1925-29	0.705	0.014	0.689	0.016	0.748	0.020
	1930-34	0.590	0.014	0.586	0.015	0.641	0.019
	1935-39	0.444	0.016	0.433	0.016	0.462	0.023
	1940-44	0.411	0.017	0.416	0.017	0.356	0.027
	1945-49	0.349	0.019	0.352	0.019	0.280	0.031
	1950-54	0.126	0.022	0.133	0.022	0.028	0.037
	1955-59	0.034	0.024	0.064	0.024	-0.106	0.040
	1960-64	-0.045	0.025	-0.012	0.025	-0.165	0.041
	1965-69	-0.146	0.027	-0.124	0.027	-0.223	0.044
	1970-74	-0.267	0.029	-0.272	0.029	-0.278	0.047
	1975-79	-0.411	0.032	-0.424	0.032	-0.398	0.050
	1980-84	-0.535	0.039	-0.562	0.040	-0.495	0.061
	1985-89	-0.714	0.048	-0.768	0.050	-0.622	0.074
	1990-94	-1.011	0.070	-1.055	0.071	-0.939	0.108
	1995-99	-1.215	0.093	-1.263	0.095	-1.141	0.145
	2000-04	-1.393	0.197	-1.428	0.208	-1.322	0.289
Intercept		-5.425		-5.101		-5.846	
Deviance		883.3		601.0		742.4	
DF		52		52		52	
Dispersion Coefficient		17.1		11.6		14.4	

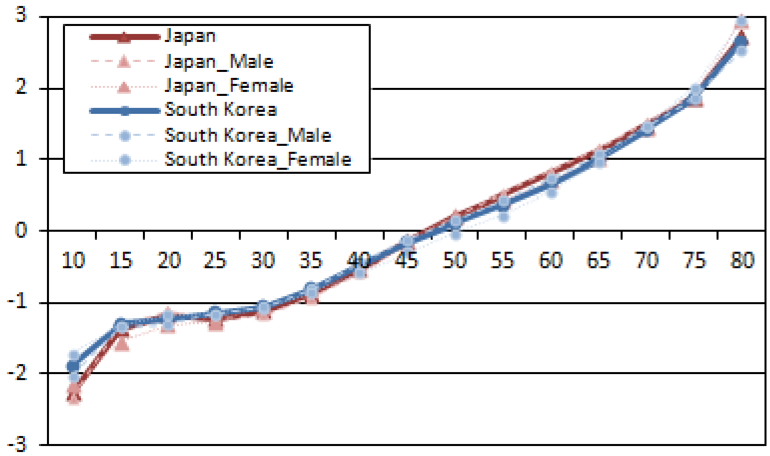


FIGURE 4.1 APC-IE Result: Overall Mortality, Age Effects

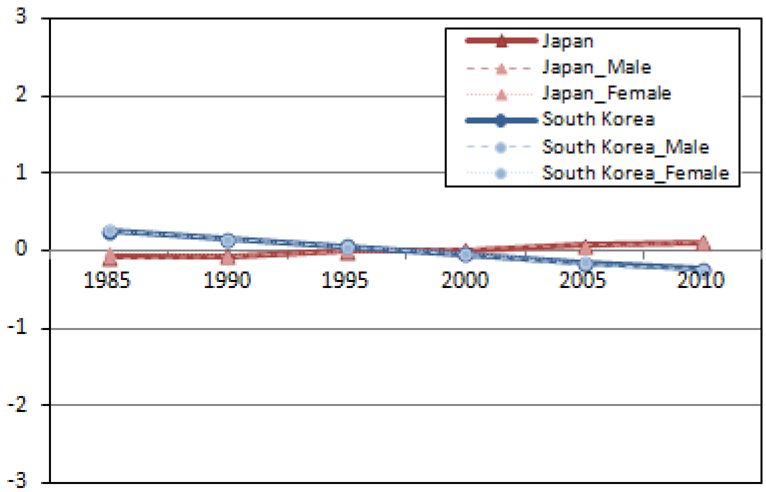


FIGURE 4.2 APC-IE Result: Overall Mortality, Period Effects

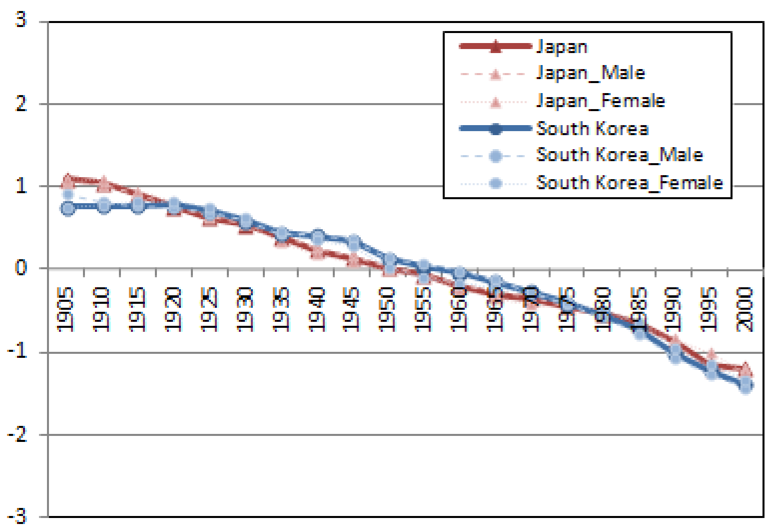


FIGURE 4.3 APC-IE Result: Overall Mortality, Cohort Effects

TABLE 4.1 APC-IE Results: Suicide Mortality, Japan

		Total		Male		Female	
		Effect	S.E.	Effect	S.E.	Effect	S.E.
Age	10-14	-3.011	0.192	-2.996	0.201	-3.026	0.178
	15-19	-1.081	0.074	-1.111	0.079	-1.008	0.067
	20-24	-0.108	0.053	-0.101	0.056	-0.099	0.050
	24-29	0.079	0.050	0.089	0.052	0.069	0.047
	30-34	0.161	0.047	0.147	0.049	0.189	0.045
	35-39	0.217	0.045	0.234	0.046	0.149	0.044
	40-44	0.354	0.042	0.376	0.043	0.246	0.042
	45-49	0.538	0.039	0.576	0.040	0.366	0.040
	50-54	0.665	0.036	0.689	0.037	0.525	0.036
	55-59	0.651	0.035	0.690	0.035	0.470	0.035
	60-64	0.489	0.036	0.485	0.038	0.446	0.033
	65-69	0.324	0.038	0.272	0.042	0.408	0.033
	70-74	0.251	0.041	0.187	0.046	0.401	0.034
	75-79	0.208	0.044	0.132	0.052	0.426	0.035
	80+	0.263	0.042	0.333	0.050	0.439	0.033
Period	1985	-0.108	0.025	-0.114	0.026	-0.063	0.023
	1990	-0.252	0.025	-0.347	0.027	-0.067	0.022
	1995	-0.184	0.024	-0.211	0.025	-0.120	0.022
	2000	0.172	0.021	0.213	0.022	0.084	0.021
	2005	0.196	0.021	0.253	0.022	0.068	0.021
	2010	0.177	0.022	0.206	0.023	0.098	0.021
Cohort	1905-09	1.058	0.097	0.897	0.122	1.168	0.072
	1910-14	0.981	0.072	0.917	0.088	0.998	0.054
	1915-19	0.682	0.061	0.623	0.075	0.743	0.046
	1920-24	0.348	0.055	0.326	0.066	0.442	0.043
	1925-29	0.033	0.050	0.033	0.059	0.141	0.040
	1930-34	-0.118	0.045	-0.085	0.050	-0.072	0.038
	1935-39	-0.105	0.045	-0.033	0.048	-0.142	0.040
	1940-44	-0.134	0.045	-0.061	0.048	-0.184	0.042
	1945-49	-0.138	0.046	-0.066	0.048	-0.206	0.043
	1950-54	-0.272	0.047	-0.201	0.048	-0.382	0.045
	1955-59	-0.322	0.050	-0.238	0.051	-0.496	0.049
	1960-64	-0.315	0.053	-0.243	0.055	-0.471	0.053
	1965-69	-0.290	0.055	-0.247	0.057	-0.387	0.053
	1970-74	-0.301	0.057	-0.267	0.059	-0.394	0.055
	1975-79	-0.301	0.059	-0.315	0.062	-0.293	0.055
	1980-84	-0.250	0.066	-0.280	0.069	-0.232	0.061
	1985-89	-0.194	0.075	-0.230	0.078	-0.160	0.071
	1990-94	-0.068	0.092	-0.078	0.095	-0.062	0.087
	1995-99	-0.159	0.161	-0.227	0.171	-0.053	0.145
	2000-04	-0.137	0.496	-0.225	0.523	0.041	0.448
Intercept		-8.478		-8.173		-8.947	
Deviance		768.7		572.3		207.2	
DF		52		52		52	
Dispersion Coefficient		14.8		11.0		4.0	

TABLE 4.2 APC-IE Results: Suicide Mortality, South Korea

		Total		Male		Female	
		Effect	S.E.	Effect	S.E.	Effect	S.E.
Age	10-14	-2.044	0.189	-2.212	0.218	-1.860	0.176
	15-19	-0.315	0.081	-0.411	0.092	-0.237	0.079
	20-24	0.089	0.065	-0.048	0.075	0.224	0.063
	24-29	0.091	0.059	-0.022	0.067	0.210	0.057
	30-34	-0.019	0.056	-0.108	0.062	0.059	0.057
	35-39	-0.049	0.053	-0.131	0.057	0.024	0.056
	40-44	-0.088	0.052	-0.132	0.055	-0.092	0.059
	45-49	-0.035	0.052	-0.019	0.053	-0.185	0.062
	50-54	-0.032	0.055	0.007	0.056	-0.202	0.066
	55-59	0.006	0.059	0.073	0.060	-0.185	0.071
	60-64	0.083	0.061	0.163	0.064	-0.056	0.070
	65-69	0.246	0.063	0.333	0.068	0.176	0.068
	70-74	0.430	0.067	0.528	0.075	0.425	0.068
	75-79	0.658	0.074	0.789	0.086	0.673	0.071
	80+	0.979	0.078	1.190	0.093	1.028	0.070
Period	1985	-0.394	0.044	-0.338	0.046	-0.497	0.049
	1990	-0.654	0.045	-0.652	0.048	-0.641	0.050
	1995	-0.276	0.038	-0.281	0.040	-0.258	0.041
	2000	-0.039	0.034	-0.025	0.035	-0.072	0.037
	2005	0.560	0.028	0.534	0.031	0.600	0.030
	2010	0.803	0.029	0.763	0.033	0.868	0.030
Cohort	1905-09	-0.531	0.432	-0.374	0.527	-0.488	0.378
	1910-14	-0.139	0.262	-0.076	0.313	-0.110	0.233
	1915-19	0.033	0.181	0.013	0.220	0.118	0.159
	1920-24	0.326	0.131	0.341	0.153	0.345	0.120
	1925-29	0.502	0.098	0.482	0.117	0.548	0.089
	1930-34	0.366	0.084	0.429	0.100	0.310	0.078
	1935-39	0.396	0.081	0.438	0.093	0.301	0.079
	1940-44	0.483	0.076	0.559	0.085	0.247	0.079
	1945-49	0.503	0.073	0.569	0.081	0.290	0.079
	1950-54	0.296	0.073	0.361	0.079	0.081	0.081
	1955-59	0.267	0.067	0.342	0.073	0.067	0.075
	1960-64	0.259	0.061	0.337	0.067	0.095	0.066
	1965-69	0.219	0.058	0.292	0.064	0.087	0.061
	1970-74	0.093	0.058	0.125	0.065	0.056	0.059
	1975-79	-0.052	0.060	-0.038	0.068	-0.049	0.059
	1980-84	-0.165	0.067	-0.226	0.077	-0.047	0.063
	1985-89	-0.300	0.074	-0.462	0.088	-0.056	0.067
	1990-94	-0.728	0.102	-0.843	0.119	-0.540	0.094
	1995-99	-1.036	0.151	-1.182	0.176	-0.808	0.139
	2000-04	-0.791	0.395	-1.084	0.506	-0.448	0.332
Intercept		-8.828		-8.489		-9.267	
Deviance		432.0		330.5		159.8	
DF		52		52		52	
Dispersion Coefficient		8.3		6.4		3.1	

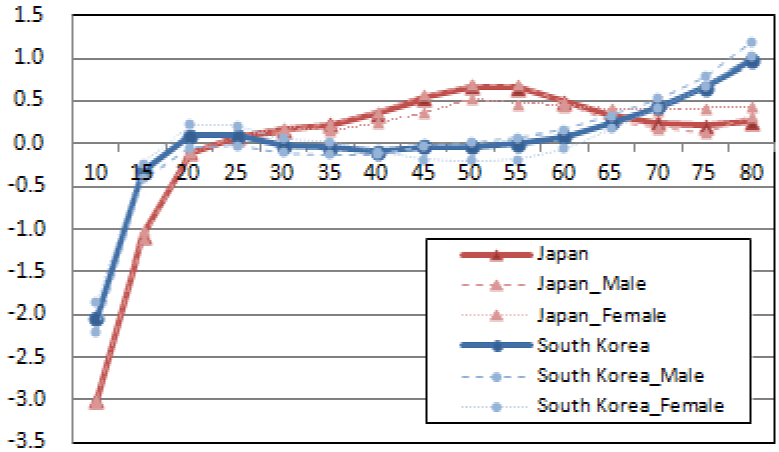


FIGURE 5.1 APC-IE Result: Suicide Mortality, Age Effects

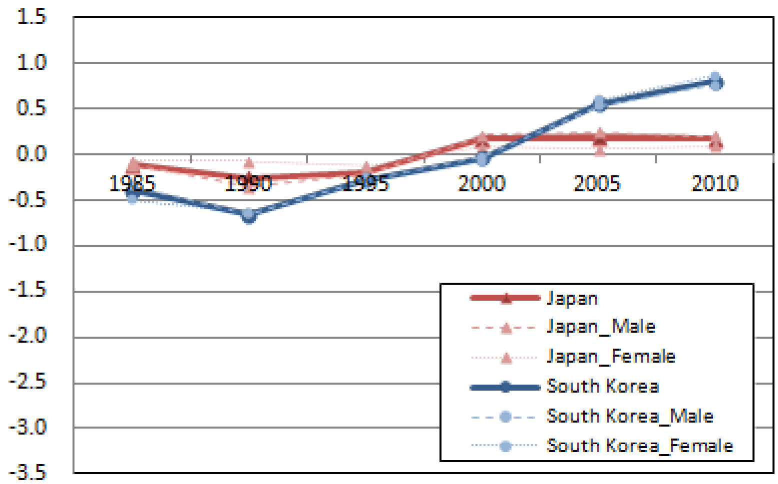


FIGURE 5.2 APC-IE Result: Suicide Mortality, Period Effects

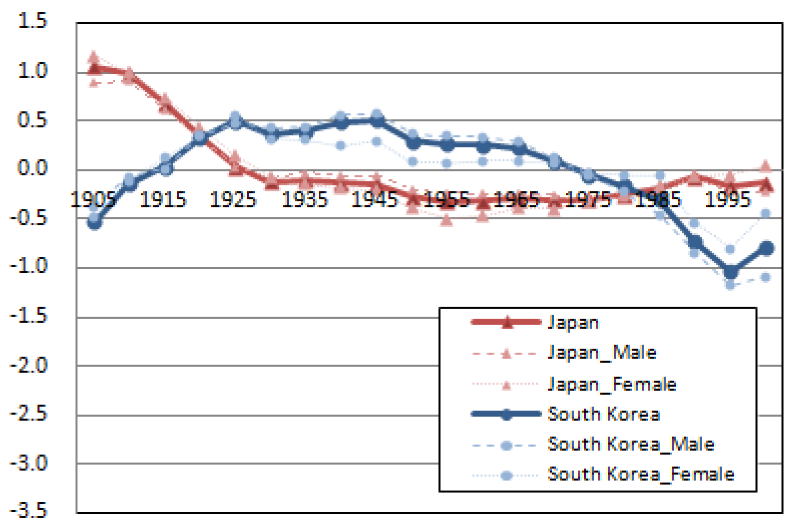


FIGURE 5.3 APC-IE Result: Suicide Mortality, Cohort Effects

CHAPTER V

DISCUSSION

Main Findings

Japan and South Korea are neighboring countries that have experienced similar demographic circumstances (i.e., rapid demographic transitions and fast population aging) and historical events (i.e., economic crisis in the late 1990s). However, the details of how those factors affected suicide are complex. Even though Japan and South Korea share several characteristics, these characteristics do not affect each society in the same way. For example, although both nations underwent an economic crisis in the late 1990s, the impacts of the crisis are not identical. Unemployment rates were higher in South Korea than Japan and GDP growth slowed down more in South Korea than Japan (Chang et al. 2009). Similarly, both have experienced rapid population aging, but the decline in the working-age population has occurred only in Japan. Those issues may have caused some differentiation of age, period, and cohort effects in the suicide rates of the two nations.

Compared to the similar trajectories of age effects on overall mortality in Japan and South Korea, age effects on suicide are dissimilar in the two countries. In South Korea, the age effects are highest during the elderly period, whereas age effects in Japan are highest during the fifties age bracket. According to Pampel (1996), variation in suicide rates could reflect an age group's relative social well-being and economic status. Following this argument, the highest age effects on suicide rates among Korean elderly people could be explained by the lack of social well-being and poor economic status. Conversely, although Japan has gone through a fast population aging period, the age effects among the Japanese elderly population are relatively low; however, the effects are high among middle-aged Japanese people, particularly those in their fifties. This could be explained by Japan's relatively well-established social system for elderly persons but low well-being for middle-aged people. Considering the age effects in middle-aged Japanese females, the figure is much higher for their male counterparts. In turn, middle-aged Japanese males appear to be the most vulnerable to suicide in Japan. As the working-age population decreased and the elderly population that the working-age population had to support increased, social well-being and economic status of middle-aged Japanese males declined, contributing to high suicide rates.

In regard to period effects, one notable detail is that before the economic crisis in 1997–1998, period effects on suicide in both countries had already seen an increasing trend since 1990. Therefore, the economic crisis does not appear to be the factor that initiated the increase in suicide rates in the two countries. However, it could have been one critical factor that accelerated the rise in suicide in Japan; period effects in Japan significantly increased from 1995 to 2000. Period effects in South Korea, on the other hand, increased more sharply during 2000–2005 than during the economic crisis in the late 1990s.

It is unclear that the increase in suicide mortality during 2000-2005 reflects the delayed impacts of the economic crisis, but it is obvious that the period effects on suicide in South Korea have continued to increase until recently, while the period effects in Japan have been moderate since 2000. Considering relatively weak and decreasing period effects on overall mortality in South Korea, the increasing trend in period effects for suicide mortality is notable. Furthermore, although period effects make a small contribution to overall mortality, its effects on suicide are noticeably higher in South Korea than age and cohort effects. No one has determined a specific reason for why the period effects in South Korea have been increasing. Future studies on suicide in South Korea need to have a strong focus on specific factors attributed to period effects.

Cohort effects show opposite trends in the two countries. Baby boomers in Japan (people born in 1947–1949) do not show high cohort effects compared to the other birth cohorts. Rather, the 1945–1949 birth cohorts have relatively modest cohort effects on suicide. Baby boomers in South Korea (born in 1955–1963) also do not show notable cohort effects on suicide. The cohort effects in South Korea started to decrease after the 1945–1949 birth cohorts. In summation, cohort size is not a decisive factor for determining cohort effects in the two countries.

Even after the cohort effects started to decrease in South Korea after 1945-1949, the birth cohort groups that had the strongest cohort effects were still alive and had just begun to comprise part of the elderly population. The overall contribution of cohort effects, therefore, should remain high for at least a couple of decades in South Korea. Conversely, the contribution of cohort effects in Japan should remain low in the near future because the cohort effects have been low since the 1925–1929 birth cohort (people 80–84 years of age in 2010).

Will the Suicide Rates in Japan and South Korea Keep Increasing?

The suicide rate in South Korea is expected to continue to increase for several decades. The period effects have been increasing since 1990 and show the highest levels in 2010, the most recent time period of my analysis. Furthermore, as the birth cohorts with the strongest cohort effects become elderly (this group has the strongest age effects as well), it is unlikely that the suicide rate in South Korea will decrease in the near future.

Conversely, the suicide rates in Japan are expected to become somewhat more moderate in the coming years. Period effects in Japan are decreasing, and the cohort effects have remained at a low level since the 1925–1929 birth cohort. The only decisive factor appears to be age effects among Japanese persons in middle age, particularly people in their fifties. Studies to determine the specific factors behind strong age effects for Japanese individuals in their fifties should aid in the prevention of suicide in Japan.

CHAPTER VI

CONCLUSION

Suicide rates in Japan and South Korea have gradually increased in recent years and this appears to be contrary to patterns that are been observed elsewhere in the world, where there is a broad decreasing trend. This study aimed to (a) identify the age, period, and cohort effects on suicide in Japan and South Korea and (b) compare the extent to which each effect contributed to the increasing suicide rates that are being observed in both countries. Using previous research into this area, which did not separate the three effects (Kwon et al. 2009), this study examined the three effects on suicide respectively using the APC-IE method. Furthermore compared to previous APC works which focused on each individual country (Lee and Kim, 2010; Odagiri et al. 2011; Ooe et al. 2009), this study attempted to compare differences in the suicide events in Japan and South Korea in terms of the three effects.

In answer to my primary research questions, age effects in Japan greatly contributed to suicide. Period effects have been moderate since 2000 and cohort effects sustained relatively lower levels since the 1945-1949 birth cohort that correspond with current middle-aged people. Reasons for suicide in South Korea were more complex than in Japan. Pronounced age effects among the elderly population, increasing period effects, and strong cohort effects of the elderly and middle-aged populations all contributed to high suicide rates in South Korea. Based on the results, I anticipate the suicide rate in Japan to be level off in the near future, whereas the suicide rate in South Korea will more likely remain at a high level for at least a couple of decades.

In creating intervention plans to prevent suicide, Japan and South Korea need different approaches. To be effective in Japan, (a) suicide studies need to determine the specific factors making suicide so prevalent among people in their fifties, and (b) interventions need to focus primarily on this highly vulnerable age group. Conversely, in South Korea, (a) suicide studies must determine why age effects are disproportionately strong among the elderly population, (b) suicide studies must determine the major factors that have recently caused period effects to increase and (c) interventions need to focus primarily on the elderly population and on birth cohort groups born between 1925 and 1969.

Although Japan and South Korea are neighboring countries with shared histories, industrial structures, social systems, and some demographic characteristics, the causes of increasing suicide rates in the two countries clearly varies. This means the efforts for pre venting suicide must also vary, depending on social contexts of each country.

REFERENCES

Bloom, D. E., D. Canning, and G. Fink. 2010. "Implication of Population Ageing for Economic Growth." *Oxford Review of Economic Policy* 26 (4):583-612.

Brenner, M. H. 1979. "Mortality and the National Economy." *The Lancet* 314(8142):568-573.

Cattell, H. 2000. "Suicide in the Elderly." *Advances in Psychiatric Treatment* 6:102-108.

Chan, A. 2006. "Aging in Southeast and East Asia: Issues and Policy Directions." *Journal of Cross-cultural Gerontology* 20:269-284.

Chang, S., D. Gunnell, J. A. C. Sterne, T. Lu, and T. A. Cheng. 2009. "Was the Economic Crisis 1997-1998 Responsible for Rising Suicide Rates in East/Southeast Asia? A Time-trend Analysis for Japan, Hong Kong, South Korea, Taiwan, Singapore and Thailand." *Social Science & Medicine* 68:1322-1331.

Chiu, H. F. K., Y. Takahashi, and G. H. Suh. 2004. "Elderly Suicide Prevention in East Asia." *International Journal of Geriatric Psychiatry* 18:973-976.

Durkheim, E. 1951. *Suicide: A Study in Sociology*. Trans. J. A. Spaulding and G. Simpson. Glencoe, IL.: Free Press. (Orig. pub. 1897)

Easterlin, R. A. 1978. "What Will 1984 Be Like? Socioeconomic Implications of Recent Twists in Age Structure." *Demography* 15 (4):397-432.

Elias, N. 1985. *The Loneliness of the Dying*. Trans. E. Jephcott. Oxford UK: Basil Blackwell.

Fu, W. J. 2000. "Ridge Estimator in Singulah Oesiun with Application to Age-Period-Cohort Analysis of Disease Rates." *Communications in Statistics- Theory and Method* 29(2):263-278.

Girard, C. 1993. "Age, Gender, and Suicide: A Cross-National Analysis" *American Sociological Review* 58(4):553-574.

Goodman, R. and Peng, I. 1996. "*The East Asian Welfare States: Peripatetic Learning, Adaptive Change, and Nation-building.*" Pp. 192-224 in *Welfare States in Transition,* edited by G. Esping-Andersen. London: Sage.

Health Insurance Review and Assessment Service in South Korea . 2010. "The Depression Prevalence is higher among females than males (in Korean)." Retreived, April 6, 2010 (http://www.hira.or.kr/dummy.do?pgmid=HIRAA020041000000&cmsurl=/cms/notice/2/1199281_13390.html).

Hobcraft, J., J. Menken, and S. Preston. 1982. "Age, Period and Cohort Effects in Demography: A Review." *Population Index* 48(1):4-43.

Kawakami, N., T. Takeshima, Y. Ono, H. Uda, Y. Hata, Y. Nakane, H. Nakane, N. Iwata, T. Furukawa, and T. Kikkawa. 2005. "Twelve-Month Prevalence, Severity, and Treatment of Common Mental Disorders in Communities in Japan: Preliminary Finding From the World Mental Health Japan Survey 2002-2003." Psychiatry and Clinical Neurosicences 59(4):441-452.

Khang, Y. H., J. W. Lynch, and G. A. Kaplan. 2005. "Impact of Economic Crisis on Cause-Specific Mortality in South Korea." *International Journal of Epidemiology* 34:1291-1301.

Kim, I. K., and D. Maeda. 2001. "A Comparative Study on Sociodemographic Changes and Long-term Health Care Needs of the Elderly in Japan and South Korea." *Journal of Cross-Cultural Gerontology* 16:237-255.

Kim, S. Y., M. H. Kim, I. Kawachi, and Y. T. Cho. 2011. "Comparative Epidemiology of Suicide in South Korea and Japan: Effects of Age, Gender and Suicide Methods." *Crisis: The Journal of Crisis Intervention and Suicide Prevention* 32(1):5-14.

Kondo, N., S. V. Subramanian, I. Kawachi, and Z. Yamagata. 2008. "Economic Recession and Health Inequalities in Japan: Analysis with a National Sample 1986-2001." *Journal of Epidemiology & Community Health* 62(10): 869-875.

Kupper, L. L., M. J. Joseph, A. Karamous, and B. G. Greenberg. 1985. "Statistical Age-Period-Cohort Analysis: A Review and Critique." *Journal of Chronic Diseases* 38(10):811-830.

Kwon , J., H. Chun, and S. Cho. 2009. "A Closer Look at the Increase in Suicide Rates in South Korea from 1986-2005" *BMC Public Health* 9(72).

Lee, J. Y., S. H. Kim. 2010. "Suicide in Korea (in Korean)." *Korean Sociological Association* 44:63-94.

Lee, Y., and S. Shinkai. 2003. "A Comparison of Correlates of Self-Rates Health and Functional Disability of Older Persons in the Far East: Japan and Korea." *Archives of Gerontology and Geriatrics* 37:63-76.

Leo, D. D. 2002. "Struggling Against Suicide: The Need for an Integrative Approach." *Crisis: The Journal of Crisis Intervention and Suicide Prevention* 23 (1):23-31.

Mason, K. O., W. M. Mason, H. H. Winsborough, and W. K. Poole. 1973. "Some Methodological Issues in Cohort Analysis of Archival Data." *American Sociological Review* 38(2): 242-258.

Mason, A., R. Lee, S. H. Lee. 2008. “The Demographic Transition and Economic Growth in the Pacific Rim.” *East Asian Seminar on Economics*. Retrieved August 16, 2008. (http://hdl.handle.net/10125/3002)

Odagiri, Y., H. Uchida, and M. Nakano. 2011. “Gender Differences in Age, Period, and Birth-Cohort Effects on the Suicide Mortality Rate in Japan, 1985-2006.” *Asia-Pacific Journal of Public Health* 23(4):581-587.

Ooe, Y., Y. Ohno, and T. Nakamura. 2009. “Age-Period-Cohort Analysis of Suicides among Japanese 1950-2003: A Bayesian Cohort Model Analysis.” *The Journal of the Japan Hospital Association* 28: 71-8.

Organisastion for Economic Co-operation and Development (OECD). 2011. “OECD Health Data 2011.” Retrieved June 30, 2011 (http://www.oecd.org/document/30/0,3746,en_2649_37407_12968734_1_1_1_37407,00Html) .

Ostamo, A., J. Lönnqvist. 2001. “Attempted Suicide Rates and Trends during a Period of Severe Economic Recession in Helsinki, 1989-1997*.” Social Psychiatry and Psychiatric Epidemiology* 36(7):354-360.

Pampel, F. C., 1996. “Cohort Size and Age-Specific Suicide Rates: A Contingent Relationship.” *Demography*, 33(3):341-355.

Park, B. C. B., and D. Lester. 2006. “Social Integration and Suicide in South Korea*.” Crisis: The Journal of Crisis Intervention and Suicide Prevention* 27(1):48-50.

Preston, S. H. 1984. “Children and the Elderly: Divergent Paths for America’s Dependents.” *Demography* 21(4):435-457.

Reither, E. N., R. M. Hauser, and Y. Yang. 2009. “Do Birth Cohorts Matter? Age-Period-Cohort Analyses of the Obesity Epidemic in the United States.” *Social Science & Medicine* 69:10:1439-1448.

Robertson, G., S. Gandini, and P. Boyle. 1999. “Age-Period-Cohort Models: A Comparative Study of Available Methodologies.” *Journal of Clinical Epidemiology* 52(6):569-583.

Ruhm, C. J. 1996. “Are Recessions Good for Your Health?” *The Quarterly Journal of Economics* 115(2):617-650.

Ryder, N. B. 1965. “The Cohort as a Concept in the Study of Social Change.” *American Sociological Review* 30(6):843-861.

Shah, A. 2007. “The Relationship Between Suicide Rates and Age: An Analysis of Multinational Data From the World Health Organization.” *International Psychogeriatrics* 19(6):1141-1152.

Turner, B. 2004. *The New Medical Sociology: Social Forms of Health and Illness*. Trans. J. C. Alexander. W. W. Norton & Company, New York London.

World Health Organization. 2002. "Mental Health: Introduction." Retrieved March, 2002 (http://www.who.int/mental_health/media/en/382.pdf).

Yang, B. 1992. "The Economy and Suicide: A Time-Series Study of the U.S.A." *American Journal of Economics and Sociology* 51(1):87-99.

Yang, Y. 2004. "APC Anlysis of Table of Rates: 1.1. Stata module." (http://www.unc.edu/~yangy819/apc/sectionE.html).

Yang, Y. 2008. "Trends in U.S. Adults Chronic Disease Mortality, 1960-1999: Age, Period, and Cohort Variations." *Demography* 45(2):387-416.

Yang, Y., and K. C. Land. 2008. "Age-Period-Cohort Analysis of Repeated Cross-Section Surveys: Fixed or Random Effects?" *Sociological Methods & Research* 36(3):297-326.

Yang, Y., S. Schulhofer-Wohl, W. J. Fu, and K. C. Land. 2008. "The Intrinsic Estimator for Age-Period-Cohort Analysis: What It Is and How to Use It." *American Journal of Sociology* 113(6):1697-1736.

Yang, Y., W. J. Fu, and K. C. Land. 2004. "A Methodological Comparison of Age-Period-Cohort Models: The Intrinsic Estimator and Conventional Generalized Linear Models." *Sociological Methodology* 34(1):75-110.

APPENDIXES

APPENDIX A

The Identification Problem of Conventional APC Model

The APC model for demography was set by Mason et al. (1973). The model for mortality rates can be written in linear regression as follows:

$$M_{ij} = \frac{D_{ij}}{P_{ij}} = \mu + \alpha_i + \beta_j + \gamma_{a-i+j} + \epsilon_{ij} \qquad (1)$$

M_{ij} denotes the rate of deaths for the *i-th* age group at the *j-th* time period. D_{ij} denotes the number of deaths in the *ij-th* group. P_{ij} denotes the whole population in *ij-th* group, which means the number of people exposed to the risk. μ denotes the intercept, meaning the adjusted mean of death rate. α_i denotes the age effect in the *i-th* row. β_j denotes the period effect in the *j-th* column. γ_{a-i+j} denotes the cohort effect in the *k-th* diagonal. means the random errors expected to E (ε_{ij})=0 (Yang et al. 2004).

For example, let us suppose that a=3, p=4 (Kupper et al. 1985).

TABLE1. A Representation of Equation (1) for the example of a=3, p=4

		Period group (j)			
		j = 1	j = 2	j = 3	j = 4
age group (i)	i = 1	$Y_{11} = \mu + \alpha_1 + \beta_1 + \gamma_3$	$Y_{12} = \mu + \alpha_1 + \beta_2 + \gamma_4$	$Y_{13} = \mu + \alpha_1 + \beta_3 + \gamma_5$	$Y_{12} = \mu + \alpha_1 + \beta_4 + \gamma_6$
	i = 2	$Y_{21} = \mu + \alpha_2 + \beta_1 + \gamma_2$	$Y_{22} = \mu + \alpha_2 + \beta_2 + \gamma_3$	$Y_{23} = \mu + \alpha_2 + \beta_3 + \gamma_4$	$Y_{24} = \mu + \alpha_2 + \beta_4 + \gamma_5$
	i = 3	$Y_{21} = \mu + \alpha_3 + \beta_1 + \gamma_1$	$Y_{22} = \mu + \alpha_3 + \beta_2 + \gamma_2$	$Y_{23} = \mu + \alpha_3 + \beta_3 + \gamma_3$	$Y_{24} = \mu + \alpha_3 + \beta_4 + \gamma_4$

In Table 1, cells in the same row share the same age effect: α_i Cells in the same column share the same period effect: $\beta_{j.}$ Cells in the same diagonal share the same cohort effect: γ_{a-i+j}

After re-parameterization for ANOVA-type models, the equation (1) can be written in the following form;

$$Y_{ij} = \mu^* + \alpha_i{}^* + \beta_j{}^* + \gamma_{a-i+j}{}^* + \epsilon_{ij}$$

The re-parameterization here means to define $\mu^* = (\mu + \overline{\alpha} + \overline{\beta} + \overline{\gamma})$, $\alpha_i{}^* = (\alpha_i - \overline{\alpha})$, $\beta_j{}^* = (\beta_j - \overline{\beta})$ and $\gamma_{a-i+j}{}^* = (\gamma_{a-i+j} - \overline{\gamma})$, where $\overline{\alpha}, \overline{\beta}$ and $\overline{\gamma}$ are defined as parametric means such as;

$$\overline{\alpha} = \frac{1}{a}\sum_{i=1}^{a} \alpha_i\,,\quad \overline{\beta} = \frac{1}{p}\sum_{j=1}^{p} \beta_j\,,\quad \overline{\gamma} = \frac{1}{(a+p-1)}\sum_{k=1}^{a+p-1} \gamma_k \qquad (2)$$

Then, we can write Table A into the re-parameterized form;

TABLE2. The Re-parameterized form of Table A

		Period group (j)			
		j = 1	j = 2	j = 3	j = 4
age group (i)	i = 1	$Y_{11} = \mu^* + \alpha_1{}^* + \beta_1{}^* + \gamma_3{}^*$	$Y_{12} = \mu^* + \alpha_1{}^* + \beta_2{}^* + \gamma_4{}^*$	$Y_{13} = \mu^* + \alpha_1{}^* + \beta_3{}^* + \gamma_5{}^*$	$Y_{14} = \mu^* + \alpha_1{}^* + \beta_4{}^* + \gamma_6{}^*$
	i = 2	$Y_{21} = \mu^* + \alpha_2{}^* + \beta_1{}^* + \gamma_2{}^*$	$Y_{22} = \mu^* + \alpha_2{}^* + \beta_2{}^* + \gamma_3{}^*$	$Y_{23} = \mu^* + \alpha_2{}^* + \beta_3{}^* + \gamma_4{}^*$	$Y_{24} = \mu^* + \alpha_2{}^* + \beta_4{}^* + \gamma_5{}^*$
	i = 3	$Y_{31} = \mu^* + \alpha_3{}^* + \beta_1{}^* + \gamma_1{}^*$	$Y_{32} = \mu^* + \alpha_3{}^* + \beta_2{}^* + \gamma_2{}^*$	$Y_{33} = \mu^* + \alpha_3{}^* + \beta_3{}^* + \gamma_3{}^*$	$Y_{34} = \mu^* + \alpha_3{}^* + \beta_4{}^* + \gamma_4{}^*$

Everything in Table 2 is equivalent to Table 1 except with an asterisk. However, we can write Y_{14}, Y_{24}, Y_{31}, Y_{32}, Y_{33} and Y_{34} in other forms without the final clauses of each effect, $\alpha_3{}^*$, $\beta_4{}^*$ and $\gamma_6{}^*$ using (2) and the followings;

$$\sum_{i=1}^{a-1} \alpha_i^* = (\alpha_1 - \overline{\alpha}) + (\alpha_2 - \overline{\alpha}) + \cdots + (\alpha_{a-1} - \overline{\alpha})$$

$$= \sum_{i=1}^{a-1} \alpha_i - (a-1)\,\overline{\alpha} = a\overline{\alpha} - \alpha_a - a\overline{\alpha} + \overline{\alpha} = -\alpha_a^*$$

(Applied for β and γ as well)

Then, the final expression of Y can be written as Table 3.

TABLE3. The Final Form of Equation (1)

		Period group (j)			
		j = 1	j = 2	j = 3	j = 4
age group (i)	i = 1	$Y_{11} = \mu^* + \alpha_1^* + \beta_1^* + \gamma_3^*$	$Y_{12} = \mu^* + \alpha_1^* + \beta_2^* + \gamma_4^*$	$Y_{13} = \mu^* + \alpha_1^* + \beta_3^* + \gamma_5^*$	$Y_{14} = \mu^* + \alpha_1^* - \beta_1^* - \beta_2^* - \beta_3^* - \gamma_1^* - \gamma_2^* - \gamma_3^* - \gamma_4^* - \gamma_5^*$
	i = 2	$Y_{21} = \mu^* + \alpha_2^* + \beta_1^* + \gamma_2^*$	$Y_{22} = \mu^* + \alpha_2^* + \beta_2^* + \gamma_3^*$	$Y_{23} = \mu^* + \alpha_2^* + \beta_3^* + \gamma_4^*$	$Y_{24} = \mu^* + \alpha_2^* - \beta_1^* - \beta_2^* - \beta_3^* + \gamma_5^*$
	i = 3	$Y_{31} = \mu^* - \alpha_1^* - \alpha_2^* + \beta_1^* + \gamma_1^*$	$Y_{32} = \mu^* - \alpha_1^* - \alpha_2^* + \beta_2^* + \gamma_2^*$	$Y_{33} = \mu^* - \alpha_1^* - \alpha_2^* + \beta_3^* + \gamma_3^*$	$Y_{34} = \mu^* - \alpha_1^* - \alpha_2^* - \beta_1^* - \beta_2^* - \beta_3^* + \gamma_4^*$

Then, we can put it in a matrix form as follows;

$$\varepsilon(Y) = X^* \xi \qquad (3)$$

Where,

$$Y^T = \left| Y_{11}, Y_{12}, Y_{13}, Y_{14}, Y_{21}, Y_{22}, Y_{23}, Y_{24}, Y_{31}, Y_{32}, Y_{33}, Y_{34} \right|$$

$$\xi^{*T} = \left| \mu^*, \alpha_1^*, \alpha_2^*, \beta_1^*, \beta_2^*, \beta_3^*, \gamma_1^*, \gamma_2^*, \gamma_3^*, \gamma_4^*, \gamma_5^* \right|$$

$$X^* = \begin{vmatrix} 1 & 1 & 0 & 1 & 0 & 0 & 0 & 0 & 1 & 0 & 0 \\ 1 & 1 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 1 & 0 \\ 1 & 1 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 1 \\ 1 & 1 & 0 & -1 & -1 & -1 & -1 & -1 & -1 & -1 & -1 \\ 1 & 0 & 1 & 1 & 0 & 0 & 0 & 1 & 0 & 0 & 0 \\ 1 & 0 & 1 & 0 & 1 & 0 & 0 & 0 & 1 & 0 & 0 \\ 1 & 0 & 1 & 0 & 0 & 1 & 0 & 0 & 0 & 1 & 0 \\ 1 & 0 & 1 & -1 & -1 & -1 & 0 & 0 & 0 & 0 & 1 \\ 1 & -1 & -1 & 1 & 0 & 0 & 1 & 0 & 0 & 0 & 0 \\ 1 & -1 & -1 & 0 & 1 & 0 & 0 & 1 & 0 & 0 & 0 \\ 1 & -1 & -1 & 0 & 0 & 1 & 0 & 0 & 1 & 0 & 0 \\ 1 & -1 & -1 & -1 & -1 & -1 & 0 & 0 & 0 & 1 & 0 \end{vmatrix}$$

(※ A^T means the transposition of a matrix A)

Hypothesizing ξ^* is the ordinary least square, the solution of (3) follows;

$$X^{*T}Y = X^{*T}X^* \xi^*$$

However, an inverse matrix of $(X^{*T}X^*)$-1 does not exist because X*is a singular matrix having one less than a full rank. This is ultimately derived from a linear relationship between age, period and cohort (Period=Age + Cohort). A unique ξ^*, therefore, cannot be defined without an additional constraint.

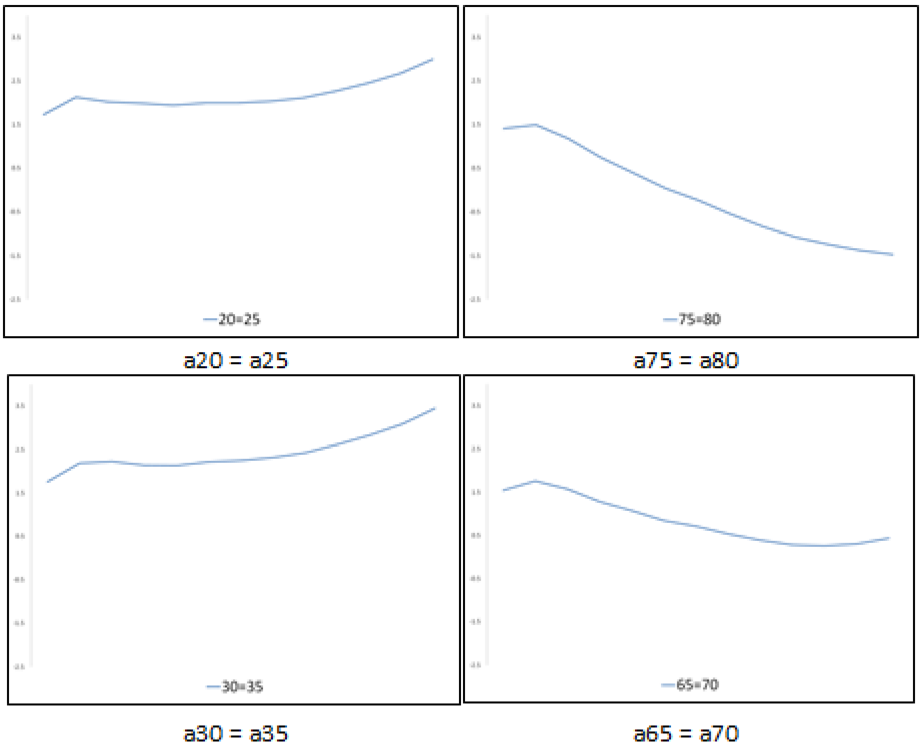
APPENDIX B

The Unstableness of CGLIM Model

In Yang et al. (2004), their CGLIM results show largely different trajectories of each effect following the different constraints. Among the various constraints, they picked up the one appropriate constraint and compared the result to the result by IE.

CGLIM is a great method if a researcher can find out the appropriate constraint. However, as mentioned above, picking up the appropriate constraint is not a straightforward work. Following are the age effects calculated by the CGLIM model with different age constraints using suicide data of South Korea.

FIGURE1. Variations of Age Effects with Different Constraints in CGLIM model



As shown in Figure 1, the age effects largely changes following the constraint. The constraint simultaneously affects the period effects and cohort effects as well. To get an appropriate constraint, the researcher needs to compare all of the variation of three effects following every possible constraint. In my case, I have 15 age variables, 6 period variables and 20 cohort variables. Thus, I need to examine 820 possible combinations to find an appropriate constraint. Even after examining 820 possibilities, an appropriate constraint cannot be guaranteed due to the unstableness of the results.