ABSTRACT

Title of Dissertation: INEQUALITY OF SUICIDE IN SOUTH KOREA: UNEQUAL DISTRIBUTION OF COMPLETED SUICIDE AND SUICIDAL IDEATION

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Suicide in South Korea, considered a serious social issue, has been investigated by a number of scholars in multidisciplinary fields. However, suicide continues to be framed and focused only on limited aspects, such as having an individual-level focus on problems they face in only biomedical and psychiatric factors or only macro-level social contextual factors. Those one-sided approaches contain flaws from paying little attention, which results in an incomprehensive understanding of suicide occurring in society.

This dissertation has three primary aims to examine: (1) major influential factors of suicide rates in South Korea counties from 2005–2013, (2) gender, age group-specific influential factors of suicide rate of South Korea in 2005 and 2010, and (3) individual level inequality of suicidal ideation in South Korea from 2007–2017 controlling province level regional predictors.

County-level suicide rates were lower in the counties with higher population density and crude birth rate. In contrast, counties with higher crude divorce rates had

higher expected suicide rates. For age group- and gender-specific suicide rates, all age groups had higher suicide rates in 2010 than 2005 after holding all other variables constant. Especially for the elderly suicide rate, counties with a higher proportion of the elderly were associated with a lower suicide rate, indicating the social network effect. The risk of suicidal ideation was higher for females, older age groups, lower-income, unemployed, not currently married, negative health status (stressed, bad health, depression without care).

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by

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CHAPTER 1: INTRODUCTION

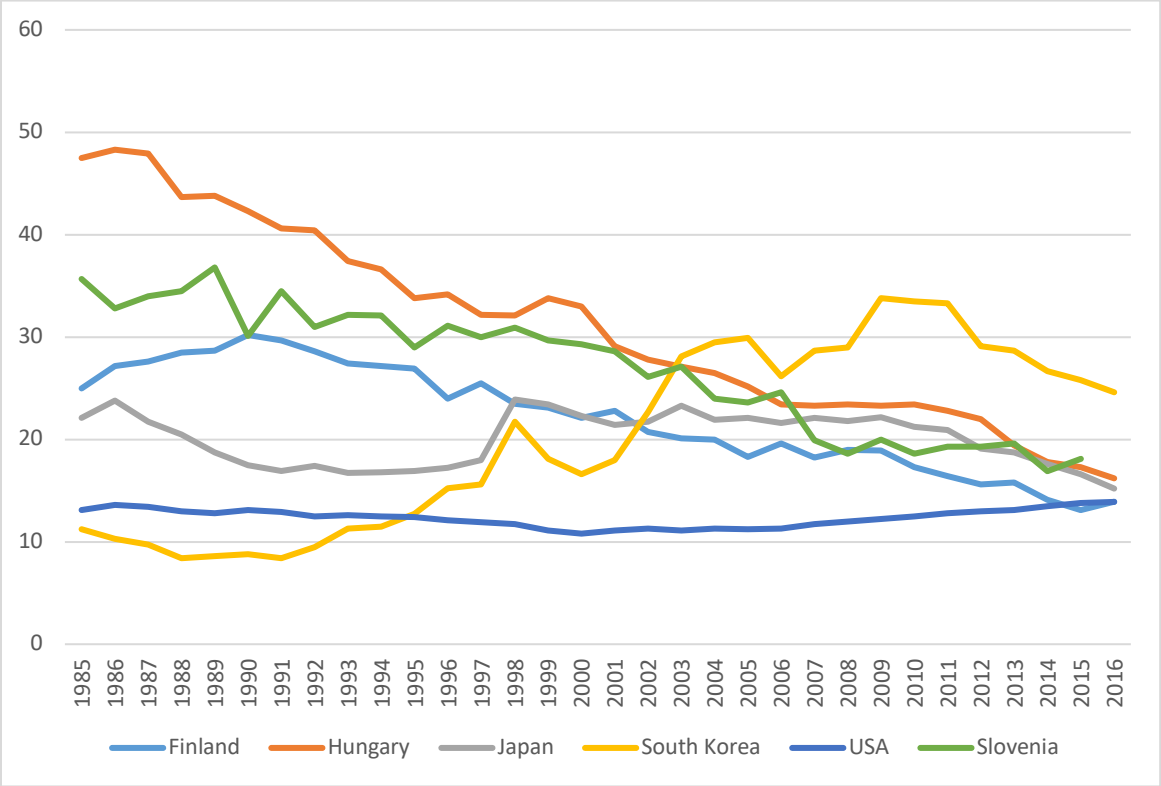
Suicide in South Korea

"Please forgive me. I want to quit my life. I don't have any reason to live, just don't want to be alive. I want to have eternal peace. Please forgive me."

The suicide note above was written by a 64-year-old man without a job and a cohabitant. In the classic novel, *Dante's Inferno*, suicide is a stigmatized way of death resisting human nature and virtue, even more disdained than murderers (Joiner 2007). In Eastern countries, including Asia and Middle Eastern countries, suicide is also considered a dishonorable death compared to deaths from natural causes (Headley 1983). Despite the pervasive and enduring taboo and stigma of suicide, suicides occur across the world every day. In fact, reports indicate that one person dies from suicide every 40 seconds in 2016 (WHO 2017). In general, 'death' is perceived as what human beings want to avoid from. However, sometimes it becomes the final stage of someone's life when he/she is in a desperate situation that disrupts their normal life (Park 2010). However, since suicide is deciding to kill oneself instead of opting to live, it can be considered a strong indicator of the 'abnormality' of lives in society (Kim 2010, Sainsbury 1955, Travis 1990). Even more, if the risks are distributed disproportionally by region, macro and micro differentials, it would indicate a specific kind of inequality in suicide.

Suicide is one of the top causes of death in South Korea. The suicide rates in South Korea from early 1990s have increased rapidly until early 2000s and are now ranked the highest in OECD countries. The overall suicide rate in OECD countries has been decreasing yearly (OECD 2016), but the rate in South Korea is still much higher

than in other countries. The Figure 1 presents recent trends of suicide rates in the last decade among selected OECD countries, having top level suicide rates. Suicide rate of South Korea exceeded the average by 5 persons over Japan and Hungary in suicide rates per 100,000 in 2005 (OECD, 2010). The elderly suicide rate especially exceeds by two or three times than Hungary and Japan (WHO 2017).



<Figure 1: Trend of top 5 suicide rates of OECD countries>

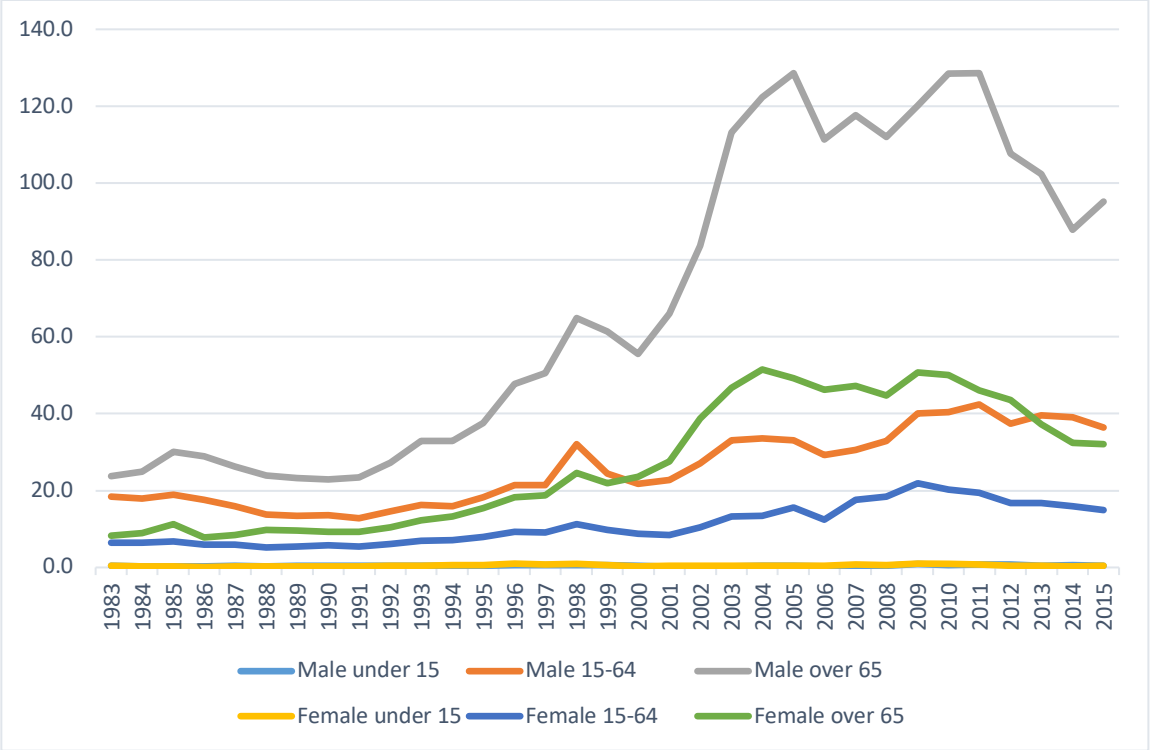
As the current suicide rate[1] of South Korea is a constant disaster, it can be even comparable to countries in a state of war. According to the mortality statistics by the

[1] 'Suicide rate' means 'number of committing suicides per 100,000' in this paper.

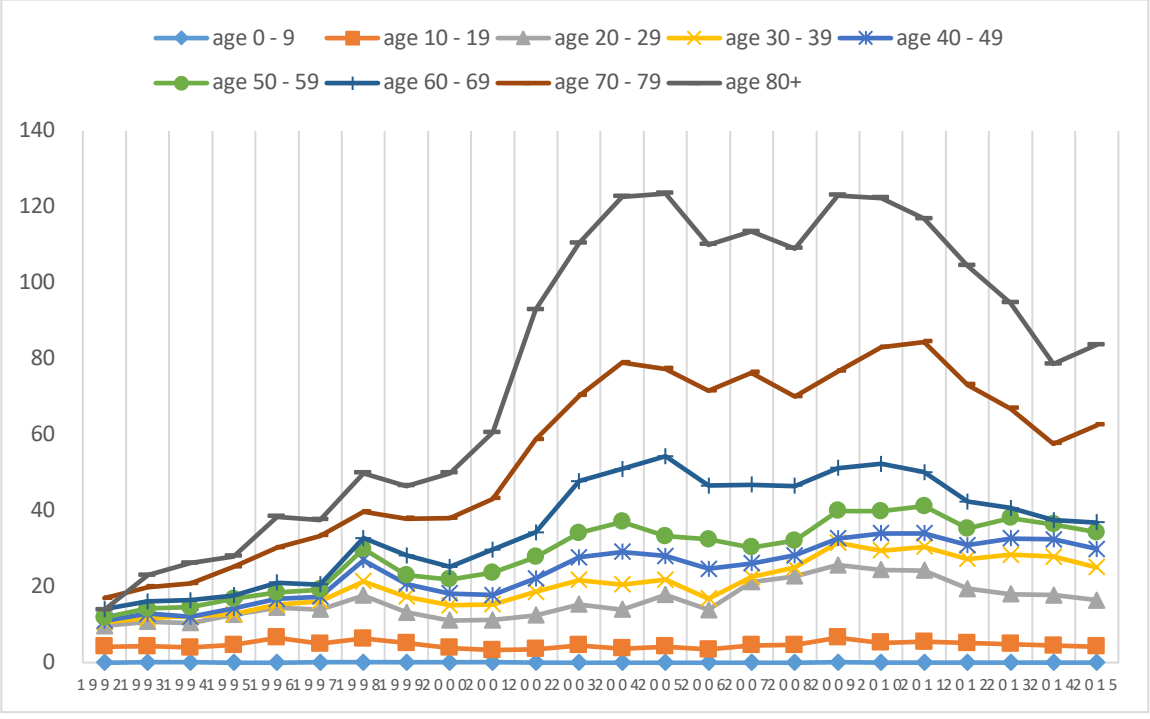
National Statistics Office, 15,558 persons committed[2] suicide in 2010 (NSO 2019a). This is higher than the number of American army forces who died during the Iraq War. It indicates that Koreans are killing themselves more frequently than local war situations. In 2010, the suicide rate was 31.2 per 100,000 and that of the elderly (over 60 years old) was 2.5 times higher than the younger age group (0~59 years old). Suicide rates among aged persons occurred more often than younger generations.

Based on Korean mortality statistics, suicide is one of the leading causes of death. Suicide was ranked 1st among causes of death for teenagers (10–19) and young adults (20–39). In all ages, suicide is the 4th most frequent reason for death following cancer, cerebrovascular disease, and cardiac disorders (NSO 2019a).

[2] Some scholars indicate suicidal deaths as 'die by suicide' instead of 'committing suicide' as it's potentially considering these deaths as criminal behaviors. However, I used 'committing suicide' as the decision of killing oneself is done by themselves voluntarily, and I believe the term 'committing' indicates a decision affected by social and individual factors.



< Figure 2: Trend of suicide rate by gender and age groups in South Korea>



<Figure 3: Trend of age group specific suicide rate in South Korea>

Figure 2 presents the diverged suicide rate, which is considered a severe issue in South Korea. In 1992, the difference in the suicide rate among age groups was not vast. The gap was relatively convergent. However, after the financial crisis in 1997, the suicide rate suddenly began to increase at a rapid speed. Economic uncertainty is a well-known fact for having an aggravating effect on suicidal risk because it is a good indicator of raised anomie and less social cohesion (Pierce, 1967). Before this crisis, lifetime employment was an expected, commonplace affair. In that year, however, a large amount of people received immediate dismissal from their workplaces.

However, severe economic insecurity collapses every part of society. Worsening economic insecurity was easily connected to family insecurity such as divorce and separation. It also started to execrate the risk of suicide rates (Eun 2005). In 1992, age group-specific suicide rates were almost similar except for juveniles (0~19 years old). Even though there was a rapid and steep increase of suicicde rate in 1998, the uprising trend occurred in all of the age groups and eventually began to decrease. Notably, after 2000, the elderly suicide rate increased sharply than younger age groups. The age-group specific suicide rate gaps among suicide rates became more divergent until 2005. After that, the highly increased elderly suicide rate was relented. However, the notable difference of suicide rates between elder and younger age groups are still larger than others.

In addition, according to the mortality data of South Korea, the highest county level suicide rate (administrative units, Si, Goon and Gu in Korea) was about 7.1 times higher than the lowest one in 2010. What is worse was that, the elderly suicide rate was a more severely distinguished from other age-groups' suicide rates. The highest elderly

suicide rate by administrative units was about 14.2 times higher than the lowest one (NSO 2016). It indicates huge gaps among counties that exist in South Korea. As some counties suffer from much a higher suicidal suicide rate, finding risk factors exacerbates inequalities in mortality, especially in suicide (Kang 2013, Wilkinson 1997).

Research Objectives

Suicide studies found that people commit suicide due to hardships that are beyond their capacity to overcome (Canetto 1992, Douglas 2015, Gibbs 1982, Headley 1983, Kowalski, Faupel and Starr 1987). It is an individual's choice to decide to commit suicide. However, it is also strongly impacted by social and contextual factors that increase the chance of committing suicide (Wray, Colen and Pescosolido 2011, YIP 2008). It is apparent that sharply increasing suicide rate of South Korea represent the severe social problems in the country. Suicidal deaths have various negative impacts not only for the individual but also on society with bereavement impacts on their friends and family (Mishara 1995) and the community with imitative suicides (Stack 1987). Also, suicide can even be affected and exacerbated by disadvantageous social contextual factors and conditions that people in that society are confronted with (Bae and Park 2006, Lee and Lee 2009).

Regardless of the importance of suicide studies, a large proportion of studies regarding suicide focused only on limited perspectives, such as psychological, mental disorders, suicidal ideation and attempts weighing on individual factors more than societal ones (Eun 2005, Kang 2013). As a result, a large number of suicide studies continued to be framed, understood as a problem of the individual, largely not accounting

well-known social and contextual factors (Matt, Cynthia and Bernice 2011) and stated that it is hard to know the innate inequality of suicidal behaviors. Also, there are a number of academic studies that dealt with completed suicide regarding community factors and their impacts of differentiated suicide risk. However, they have several limitations such as using a limited number of predictors in the regression models due to lack of data (Ryu 2008), just applying simple correlations in the analysis (Eun 2005), or using a single cross-sectional study of non-age & gender differentials to suicide rates (Kang 2013). Furthermore, due to the lack of consensus on standard definitions of urban, metropolitan and rural areas, most studies have divided urbanity by administrative units of counties[3].

Those studies only focusing on one scope have limitations to investigate the current state of suicide in South Korea. In order to overcome the limitations of previous studies and extend knowledge about suicide in South Korea, I utilized the completed county level suicide rate, the minimum unit of official data in South Korea, and employ multiple regression models on the total suicide rate from a span of eleven years, 2005–2013. I also ran a separate model on gender and age group-specific suicide rates to test and find differentials of influential county-level factors. In addition, I also investigated inequality in risk of suicidal ideation with the most recent survey data of suicidal behavior in South Korea. In this dissertation project, I aim to extend the literature on

[3] If the counties have 'Si' and 'Gu' as ending letter of name, they have been considered as urban because that indicates city area. 'Goon' is considered as rural areas in the less developed areas.

differentials of risk in suicide due to various societal and individual factors that can be helpful to build possible policy interventions.

CHAPTER 2: COUNTY LEVEL VARIATIONS OF SUICIDE

Literature Review

Even though there are various debates and criticism (Joiner 2007, Matt et al. 2011, Park 2010, Värnik 2012), the most influential sociological study of suicide is *Durkheim's Suicide: A Study of Sociology* (Durkheim 1951). It's because his theory is considered to have taught the modern world how to think about suicide (Matt et al. 2011). Before Durkheim's study providing the general frame, specific knowledge, and forms of thoughts about suicide, some statisticians provided explanations about how the rising rates of suicide were due to unintended results of higher levels of education. Having a higher level of education helps people give up traditional ways of thinking and be open to committing suicide to solve their personal problems (Masaryk 1970). Also, a type of social learning theory by Tarde argued that humans imitate behaviors and actions of others living in their proximate geographic areas such as suicide due to a chain reaction, increasing suicidal behaviors, and the higher suicide rate in the given time and place (Abrutyn and Mueller 2014).

Compared to the explanations of suicide before Durkheim, Durkheim used an analytic view toward suicide that revealed how dramatic social change produced negative emotions and in turn influenced groups of people to be more vulnerable and show self-destructing behavior (Matt et al. 2011). Durkheim addressed that suicide should be considered as a 'social fact' and it should be a major part of research area in sociology, and investigated separate from individual acts that comprised the overall rate (Berk 2006). Although individuals decided to commit suicide by themselves, Durkheim treated suicide was a social phenomenon. Because suicide rate can increase when some society is

not well integrated to a proper degree. Moreover, suicide rate should be treated as a 'social fact' because it happens when society was not working well (Durkheim 1951).

The lack of social integration drives the risk of suicide because losing social regulation leads to the pervasive, anomic status present in modern society – framed as egoistic suicide (Durkheim 1951). With better integration of stable, long-lasting, cohesive social ties, people can feel more supported, particularly during the time of high suicide risks, and have less likelihood of committing suicide. In contrast, people who have experienced a life without support from social ties are more likely to have a higher risk of suicide when they face personal problems and crisis (Abrutyn and Mueller 2014). However, he also argued that "suicide rates vary inversely based on the degree of social group integration where the individual belongs," contributing to higher suicide risks of overly integrated groups since individuals value the needs of the group over their own needs to survive, choosing suicide instead of living, framed as altruism suicide (Durkheim 1951). Anomic and fatalistic suicides also result in increased risks impacted by social structures of under or overregulated systems (Pescosolido and Mendelsohn 1986).

Durkheim's point of view toward suicide became the baseline theory for investigating suicide in Sociology (Wu 2010). Many studies about suicide rates still utilize Durkheim's perspective about how social integration and related influential factors, testing how individuals and groups were affected by their surrounding environments such as the geography of communities and neighborhoods in ecological modeling of suicides (Maris 1969, Sainsbury 1955). The social integration idea was used but applied in different terms as social isolation (Trout 1980), and social support

(Berkman, Glass, Brissette et al. 2000). Followed by a community-based ecological study in the late 1950s, the status integration theory developed from Durkheim's social integration and regulation found solid empirical supports using quantitative data (Choi 2011, Joiner 2007, Matt et al. 2011). This status integration theory was majorly introduced by Gibbs and Martin (Gibbs and Martin 1964) that analyzes social roles and the increased risk of suicide. Specifically, social roles include age, sex, occupation, marital status and they applied the index of status integration (Gibbs and Martin 1958, Gibbs and Martin 1964, Gibbs 1982). Status integration theory contains more observable, testable concepts than Durkheim's concepts (social integration and regulation). Individuals who have high degrees of role conflict had higher suicide rates (Gibbs 1982).

There were not only sociological theories based on Durkheim, but also on Weber. They criticized that Durkheim's theory disregarded social, cultural meanings of suicide (Douglas 2015). Also, Douglas argued that suicide could have different meanings and definitions by medical examiners due to the increase of errors in validity and reliability of official suicidal records and inaccurate classifications of suicidal deaths (Park 2010). This approach led scholars to reject quantitative approaches of suicide issuing unreliable statistics and to weigh more in the importance of meanings of suicidal actions (Andriolo 1998, Douglas 2015, Marecek 1998). Other sociologists revisited Tarde's theory of an increased suicide rate after a celebrity commits suicide can play a big role (Abrutyn and Mueller 2014, Baller and Richardson 2002, Wasserman 1984). They found a significant increase in suicide rate after cases of celebrity suicide, such as singers, actors and politicians (Phillips 1974).

Many sociologists have tried to overrule Durkheim's study, but they were treated as adding little to Durkheim's theory (Evans and Farberow 2003). Even though Durkheim continued to influence theoretical frames of suicide studies after 2000, many concerns emerged regarding his theory resulting in the Durkheimian consensus that began to fray (Matt et al. 2011). But I believe we are not able deny that Durkheim is one of the most important scholars in the field of studying suicide. Although multiple number of research projects on suicide have utilized different analytic methods (qualitative or quantitative), suicide has been considered to be affected by gender, age group, population dynamics, family security, human capital and living condition, and etc.

Factors contributing to variations in suicide rates

Gender, Age and Suicide

Men continuously show a higher suicide rate than women in most countries; 41 out of 42 nations had a higher suicide rate of men than women in 1990, with the exception of Kuwait (Travis 1990). Recent studies state that men are 1.8 times more likely to commit suicide than women in the world (Värnik 2012). The ratio is even higher in the U.S. and Korea. The rate for American is 4 times higher than that of women (Curtin, Warner and Hedegaard 2016), and Korean men have a rate 2–4 times higher than that of women based on age group, showing even higher male suicide rates among the elderly (NSO 2016).

Notable number of scholars argued that males are more likely to have a high chance of committing suicide due to several reasons. In general, women tend to have better conditions to deal with the risk of suicide as they have a lower record of drug and

alcohol abuse (Canetto 1992). Also, women have higher coping skills based on higher involvement in religion (Stack 2000) and acceptance of changing roles in their life (Girard 1993). Women also have a more sensitive reaction to the psychological signs of suicide risks than men, such as depression (Sanborn 1990) and are more likely to seek professional help in suicidal prevention centers (Overholser, Evans and Spirito 1990).

Compared to men, women tend to have a more extensive social support system (Pescosolido and Wright 1990), lower access to lethal weapons (Khan and Reza 1998), and a higher level of traumatic experiences such as serious physical wounds and loss leading to a higher risk of committing suicide than men (Joiner 2007). In contrast, men are more likely to have a successful attempt of suicide, as a failed attempt may represent them as 'weak' (Stillion, McDowell and May 1984) and 'feminine' (Joiner 2007). Risk factors of suicide such as economic failure are more evident in males than in females (majorly due to family roles), which lead to a higher chance of feeling destructive failure (Girard 1993, Innamorati, Tamburello, Lester et al. 2009).

In some countries, the elderly are less likely to commit suicide than the younger population (Gunnell, Middleton, Whitley et al. 2003). Less developed countries tend to have a peak record of suicide in younger age groups (15–39 years) and a decline in suicide rates after that age (Girard 1993). However, as countries develop, there is a general pattern in many countries that the elderly tend to have a higher suicide rate than younger ages due to their lack of social-economic resources and disadvantageous health conditions in both the U.S and South Korea (Bae and Park 2006, Bengtson, Kim, Myers et al. 2000, Choi, Kim and Suh 2009, Gan, Yoo, Kang et al. 2009, Gunnell et al. 2003, Innamorati et al. 2009, Kim and Kwon 2013, Kim and Kim 2011, Lee 2006, Lee and Lee

2009, Ryu 2008, Yook, Choi, Kim et al. 2011). This pattern is tied to achievement orientation, increased age, and the trend that individuals are more likely to lose the resources they had (job, salary, social network, prestige) in younger ages, which increases suicidal risk as they get older (Stack 2000).

This pattern is more applicable to men than women. Suicide patterns in men tend to increase with age when compared to a peak of suicide in middle age women (Stillion and McDowell 2015). Once nations develop, economic development creates achievement opportunities mainly for men than for women. Women tend to define their identity on kinship more than the labor market, possibly caring for their children more than men (Stack 2000). Therefore, the suicide rate of women peaked at ages 45–55 when their children usually left home after getting married (Girard 1993). Once children leave home, women's stress can be decreased as they feel less pressure from their children's status (Girard 1993). However, when their children experience failures, such as divorce, crimes, and other accidents, women would have higher stress thus increasing the risk of suicide compared to men, which explains the higher risk at that age group. Recent studies show once women's roles are enforced by the labor force and other social roles besides kinship and nurturing roles, this trend could be altered based on their level of responsibility in society (Hedstrom, Liu and Nordvik 2008, Pampel and Williamson 2001).

Teenage and young adult suicide rates increased with lower religious attendance, which resulted in less support for the youth (Pampel and Williamson 2001), divorce, marital disruptions (Stack 1990), and negative relationships with parents (White, Murdock, Richardson et al. 1990). Teenagers were more likely to commit suicide when they were raised in dysfunctional families (Maris 1981). In South Korea, school bullies

and failure in university entrance exams (similar to the SAT in the U.S) were major factors of adolescent suicide (Kim and Kim 2008).

In the early 1990s, suicide among middle-aged Americans declined due to increased stability, acceptance, and comfort in their lives with higher social integration (McIntosh 1991). However, suicide among middle-aged Americans increased after 1999. The increased rate occurred particularly among unmarried, low educated populations (Phillips, Robin, Nugent et al. 2010). This pattern could be explained by a cohort effect. The middle-aged U.S. population born between 1945–1964 had high suicide rates in their younger ages, implying that there were less protected members from the baby boom.

The elderly tend to have higher stress factors including financial strain, physical illness, decreased daily functions, losing social network, and increased cost pressure of health care (Canetto 1992, Gan et al. 2009, Innamorati et al. 2009, Lee 2006, Yook et al. 2011). This pattern applied more to elderly males than women. In the sample of 11 nations, economic strain strongly explained higher suicide rates of the elderly, with a high level of spending on pensions and supportive policies (Altergott 1988). This rationale explains the increased suicide rate in South Korea as well. Even though South Korea has sharply increasing proportion of elderly people, current social welfare systems and policies to care elderly in Korea has not been considered well organized. According to the OECD statistics, South Korea has one of the lowest percentages of welfare expenditure compared to the GDP (OECD 2016). Due to the expanded life expectancy of South Korea's population, the elderly live longer without appropriate support from the government. The average life expectancy in 2012 was 80 (Finance 2013). However, the mandatory retirement age is 58~60, which means people should be expected to live

without work for about 20 years (JeoungHee 2011). Elderly males are especially considered as the most vulnerable age group to have a risk of suicide (Bae and Park 2006, Choi et al. 2009, Kim and Kwon 2013).

Population dynamics

As Durkheim's stated in his theory (Durkheim 1951), population dynamics decrease social integration and is considered a risk factor of suicide. Sainsbury (1955) argued that a higher mobility of residences (moving in and out in the area) tend to increase the anomic suicide rates of the area because of increased social isolation. In urban regions, there is a high magnitude of mobility associated with low bonds among residences (Walker 2008). Marris (1969) argued that urban settings have low social cohesion and social network opportunities than suburban areas that decrease the regulation of lesser social relationship contacts. In their perspective, relatively low population densities and less frequent moves are positively associated with higher suicide rates due to higher levels of isolation (Hirsch and Cukrowicz 2014). In contrast to those theories, researchers found that rural areas with a lower population density, growth level, and less active social networks tend to have higher suicide rates than urban areas (Hedstrom et al. 2008, Kang 2013, Ryu 2008). It's possibly because rural area doesn't have good resources for treating people at risk of suicide (Hirsch and Cukrowicz 2014) This is the effect of disadvantageous demographic characteristics (Oh, Cho and Kim 2005) and development levels (Kim and Kim 2011). In accordance with the literature, a recent study of Chinese suicide reported there were higher suicide rates in rural area

compared with urban area, showing 1.6 times higher suicide rates in rural than urban areas (Li 2020)

Family Security

From Durkheim's study of suicide, marital integration has been considered an important predictor of suicide (Durkheim 1951). As family is an important part of social integration for an individuals' life (Choe and Jang 2009), many studies found the lack of family security to be a cause for increased suicide rates. First of all, the crude divorce rate has been positively associated with suicide rates among all ages (Gan et al. 2009, Kang 2013, Kim and Kim 2011, Oh et al. 2005, Ryu 2008, Stack 1990, Yook et al. 2011). As bonds in family can be broken by divorce, there would also be an increase in the likelihood of having more suicidal ideations (Choi et al. 2009, Gan et al. 2009), suicidal attempts (Im and Kim 2011, Stone 1999) and attempts of suicide (Kang 2013, Kim and Kim 2011, Ryu 2008). Interestingly, Stack (1990) found that the association between divorce and suicide rates in Japan was not statistically significant. A majority of studies regarding suicide rate of South Korea reports statistically significant effects of divorce rates on suicide rate (Gan et al. 2009, Kang 2013, Kim and Kim 2011, Kim 2010, Ryu 2008). Especially in South Korea, as the divorce rate has been increasing, the positive association between divorce rate and suicide rate would be a serious social problem in the future (Park and Raymo 2013).

Human Capital

Generally, one's education level plays an important role in a person's entire life. It is a generally accepted notion that more educated people have a lower chance of suffering from chronic, mental and general types of diseases (Wilkinson 1997). A higher education level can be a predictor of lower mortality in the region. Some scholars argue that education is the optimal measure because it is determined by the early decisions made in someone's life (Park and Raymo 2013). Furthermore, education is also a very important factor in determining their future income, information gathering, social networking, and health behavior (Hummer, Rogers and Eberstein 1982). Therefore, higher levels of education can be associated with a lower suicide rate by having access to an enhanced quality of life of better goods and services. In contrast, lower education can cause lower occupational status, which is usually associated with higher suicide rates (Choi 2011, Oh et al. 2005).

Living Condition

Mortality in most developed countries is affected, especially more by relative than absolute living standards, such as income equality and economic insecurity (Wilkinson 1997). If the welfare policy system lacks of sufficient level of support for the vulnerable groups (in terms of education, race, health and etc), informal kinship support is important to further protect them from dangerous events in life. Generally, disadvantageous living conditions with more pollution and less social infrastructure are more likely to be associated with higher suicide (Choi 2011, Innamorati et al. 2009, Kang 2013, Walker 2008). Ill-prepared social infrastructure and support systems cannot be a buffer of risk

factors of suicides as it leads to a lower level of suicide in the region (Gage 1971, Gunnell et al. 2003). Other factors include residential classification such as urban and rural areas. In the early stages of urbanization, this region had a very high suicide rate mainly due to social disruptions (Stack 1990). But well managed and installed social infrastructure with supportive environments has been reported as a factor of reducing the regional suicide rate. Region-specific characteristics regarding medical infrastructure can be applied in sociological studies about suicide (Kowalski et al. 1987).

Data and Methods

Data: Inequality of Total Suicide Rates in 2005–2013 and age group- and gender-specific suicide rates in 2005 and 2010

To conduct an empirical examination of county-level suicide rates in South Korea, I used mortality statistics released by National Statistics Office of South Korea and created two datasets to examine 1) determinants of county-level suicide rate in 2005–2013 and 2) determinants of gender, age group-specific county-level suicide rate in 2005 and 2010. Controlling that affects time periods will contribute to finding time-invariant county-level indicators affecting suicide rates (Judith and Melinda 2011). I pooled (extended) the records of suicide to keep a larger number of cases and compare the effects of indicators on county-level suicide rates[4]. The Korea Social Science Data

[4] As I pooled two time periods, it may have violated the assumption of regression that observations should be independent. Therefore, I used Stata's vce option with county codes to cluster the variable to relax the possible problems caused by repeated observations (counties). It can produce correct standard errors when pooling two time periods.

Archive (KOSSDA) was released in 2013, covering regional statistics from 2005 to 2013 (KOSSDA 2013), and their unit of analysis included 246 counties in South Korea[5]. Although the size of basic units of analysis (areas) is much smaller than counties of the U.S., it helps us to collect aggregated death record data from individuals. While it is almost impossible to find information on deaths by suicide, the suicide rate of each region can be predicted using county-level records and statistics.

Dependent Variable

I calculated the county-level suicide rate by the number of suicides over the county population and multiplied it to present the rate per 100,000. Total suicide rates, as well as age and gender-specific suicide rates by county, could be calculated by using the mortality statistics data containing causes of death produced by the National Statistics Office (NSO 2016). This population data is collected and calculated from the 'number of registered population' data collected by the Ministry of Public Administration and Security, which lists the population of each area by age (NSO 2016). The specific suicide rate was calculated as below:

County-level suicide rate[6]: $\frac{Number\ of\ committed\ suicides\ in\ the\ county}{Number\ of\ people\ in\ the\ county} * 100{,}000$

[5] However, due to lack of detailed data for some counties, BookJeju and Namjeju Island in the South area of South Korea was excluded from analysis. Also, due to the changed boundary of range of the counties, several counties united due to the consistency of analysis (Dongnam-gu and Subook-gu into Chenan-city, Echang-gu and Sungsan-gu into Changwon-city).

[6] County level age group specific suicide rate = $\frac{\#\ of\ committed\ suicides\ in\ that\ age\ group\ in\ the\ county}{\#\ of\ people\ in\ that\ age\ group\ in\ the\ county} * 100{,}000$

I also invested more into age-specific suicide rates by dividing age groups by their life course: 1) 20~39 years old (young adults), 2) 40~59 years old (middle ages), 3) 60 years old and older (elderly) (Choi 2011). Males were found to have a higher risk of dying in both middle and old ages because of their heavy burdens and responsibilities as the breadwinner, or the main supporter of their family, and the loss of that authority after retirement. This was especially matter for male population in South Korea (Bae and Park 2006, Bengtson et al. 2000, Gan et al. 2009, Innamorati et al. 2009, Lee 2006, Lee and Lee 2009).

Independent Variable

In order to predict population dynamics to analyze social isolation and population mobility (Maris 1969, Sainsbury 1955), I utilized the population density and population change rate. Most quantitative studies about suicide in Korea simply sorted counties by their administrative names to prevent county division disputes. I set the standard of population density into quartiles to reduce the effect of the vast differences of the population in counties. Population growth rate is another measure of population dynamics. It is calculated as the value of the ratio between population mobility out of the population in the previous period as,

Population growth rate: $\frac{population\ in\ current\ year - population\ in\ the\ past\ year}{Population\ in\ the\ past\ year} * 100$

Therefore, it implies the ratio of mobility into the area, which may imply the relative level of anonymity and density of the social network. Also, as older adults are more likely to commit suicide than young adults (Bae and Park 2006, Gage 1971,

Lee 2006, Lee and Lee 2009, Ryu 2008), aging levels (population over 65/population under 14)*100) and proportion of the elderly in each county can be used as measures of aging level for county-level suicide rate in 2007–2013. For the age group-gender specific rates, I calculated the proportion of 60 years and older population in each county for more consistency of age group categorization (elderly as 60+).

For predicting family security, I considered three major components of demographic variables of crude rates: crude birth, marriage and divorce rate. Out of the three components, the crude divorce rate has been considered the most influential factor of the suicide rate at the community level (Bengtson et al. 2000, Choi et al. 2009, Gunnell et al. 2003, Kang 2013, Kim-Yu-Jin 2011, Mishara 1995, Ryu 2008, Stack 1990). In addition to divorce levels, marriage and birth could be considered as an impactful factor to predict the level of suicide rates, by increasing cohesion with partners and motivation in life (Gunnell et al. 2003). Numbers of crude measures implies the occurrence of the event per 1,000 persons. Also, as a proxy indicator of human capital, the education level was utilized as an independent variable of this research by the proportion of people who have a college or higher degrees.

As the indicators of living conditions in the county, I collected social infrastructure information (average percentage of paved road, water supply and disposal systems), the percentage of the independent budget of the county out of the total amount (fiscal independency ratio), and the number of beds per 1,000 persons as the indicator of medical facilities. Normally, low levels of social infrastructure and medical facilities increases the likelihood of death compared to urban areas that have relatively better living conditions (Chuang and Huang 1997, Gan et al. 2009, Kim and

Kim 2011, Kowalski et al. 1987, Pampel and Williamson 2001, Park 2010, Ryu 2008).

Hypotheses

My hypotheses are designed to test models derived from previous researches about the influential factors of South Korea's suicide rate. The first hypothesis is about the time trend. The age-standardized suicide rate of South Korea started from 10.7 per 100,000 in 1993 and remained in a general increasing trend until 1997, 14.5 suicidal deaths per 100,000. The trend had a downfall in 1999, 2000, but started to increase again from 2002, reaching as high as 25.1 suicidal deaths in 2005. The suicide rate fluctuated after then, but compared to 2005, 2009–2013 had higher suicide rates. In terms of trend, I would expect higher suicide rates compared to 2005 in the years 2009–2013.

Hypothesis 1. Suicide rates[7] will be higher in 2009–2013 than 2005.

The second hypothesis tests the effect of active population dynamics on the suicide rate.

Hypothesis 2. Suicide rates will be higher in counties with less active population dynamics.

- *Hypothesis 2(a). Suicide rates will be higher in counties in lower quartiles of population density.*

[7] Every 'suicide rates' in this study mean the county level suicide rate per 100,000.

- *Hypothesis 2(b). Suicide rates will be higher in counties that have lower population growth rates.*

Although many types of research argued that higher population density and more frequent migration could be associated with higher suicide rates due to higher social isolation and lower social integration (Maris 1969, Stone 1999, Walker 2008), I expected to see the reverse relationship with those previous studies.

The third hypothesis is consistent with the results of researchers about South Korea's suicide rates. As older adults were more likely to be in a disadvantageous socio-economic and health status than younger age groups, older persons will be more likely to be associated with higher suicide rates (Kim and Kwon 2013, Kim and Kim 2011, Lee 2006). This hypothesis can be tested with the aging level and proportion of the elderly.

Hypothesis 3. Suicide rates will be higher in counties that have more aged persons.

- *Hypothesis 3(a). Suicide rates will be higher in counties with higher aging level*[8].

- *Hypothesis 3(b). Suicide rates will be higher in counties with a higher proportion of the elderly*[9].

My fourth hypothesis is based on a number of previous research using family security as a predictor of suicide rate because it either influences social integration to increase or decrease suicide rates (Gunnell et al. 2003, Kang 2013, Ryu 2008). Higher

[8] For total suicide rates of 2005–2013
[9] For age-group, gender specific rates in 2005 and 2010

family security levels would be measured as having a lower divorce rate, high fertility, and marriage rates in the counties.

Hypothesis 4. Suicide rates will be higher in counties that have lower family security level

- *Hypothesis 4(a). Suicide rates will be higher in counties that have higher divorce rates.*
- *Hypothesis 4(b). Suicide rates will be higher in counties that have lower birth rates.*
- *Hypothesis 4(c). Suicide rates will be higher in countries that have lower marriage rates.*

Hypothesis 5 is derived from the importance of education levels in predicting the suicide rate of counties. As higher levels of education can mean better living conditions and other advantageous lifestyles (Innamorati et al. 2009, Oh et al. 2005), the higher the level of college or higher degrees, the lower the suicide rates were.

Hypothesis 5. Suicide rates will be lower in counties with higher proportion of college or higher degree holders.

Hypothesis 6 tests the relationship between the wide range of measures of living conditions and suicide rates. Living conditions would be related to social infrastructure, economic conditions, and medical institutions (Choi 2011, Eun 2005, Song, Jin-Dal-lae, Song et al. 2013, Yook et al. 2011).

Hypothesis 6. Suicide rates will be lower in counties that have better living condition levels.

- *Hypothesis 6(a). Suicide rates will be higher in counties that have lower levels of social infrastructure.*
- *Hypothesis 6(b). Suicide rates will be higher in counties that have lower levels of economic conditions.*
- *Hypothesis 6(b). Suicide rates will be higher in counties that have lower levels of medical institutions.*

Analytic Method

Limitations of linear and Poisson regression

There are four major types of the analysis for suicide rate determination based on the previous studies. Firstly, OLS (ordinary least square) multiple regression analysis for suicide study has been utilized widely, but many scholars found the analytic methodology has various downsides, especially when the dependent variable is rarely occurring social events including the suicides, birth defects (Moksony and Hegedűs 2015). Especially when the suicide rate is transformed to log-scale due to highly skewed distribution, there are high chances of losing cases due to undefined values. Therefore, linear regression would be very inefficient when the data has a count dependent variable (Liu and Cela 2008), and the method is rarely used to analyze suicide rates in recent suicide studies.

Secondly, Poisson regression is widely utilized in studies of suicide, considering suicide rates as count data (Harris, Yang and Hardin 2012). This analysis is very useful, especially adjusted counts in specific periods of time, such as the counted number of suicidal deaths in each county in a year, and when the distribution of counted suicides follow Poisson distribution with rarely happening social events such as suicide (Ismail and Zamani 2013). It would satisfy the important assumption of the Poisson distribution,

as one type of extreme case of the binomially distributed variable (Moksony and Hegedűs 2015). We can find the mean of binomially distributed variable as,

$\bar{x} = np$,

Also, the variance is

$s^2 = np(1-p)$.

When we have rarely occurring cases such as suicides in the county, the relative occurrence of the event p gets lesser and lesser with the number of cases as n. Then the value in the bracket in the righthand side gets closer to 1, it satisfies the important assumption of Poisson regression that the mean is the same with the variance.

However, as the Poisson regression assumes the dependent variable is not over-dispersed (the expected mean is equal to the expected variance), it is not always appropriate based on the distribution of count data (Lawless 1987). In other words, the Poisson regression is not appropriate when the data has the variance larger than the mean in many cases (Moksony and Hegedűs 2015). In this case, we need to consider some other alternatives to ameliorate the distribution in the expected outcome data, such as suicide.

<Table 1: Overdispersion test results>

Suicide	**Mean**	**Variance**	**Overdispersion**	**# of zeros**	**NB vs ZINB**
County Level Total Suicides in 2005-2013					
Total	28.2	69.5	Yes	2	NB
County Level Age-Group and Gender Specific Suicide Rates					
Total	29.3	68.9	Yes	1	NB
Male	44.5	349.3	Yes	1	NB
Female	21.4	103.5	Yes	3	NB
Young male	30.9	340.4	Yes	23	ZINB
Young female	20.5	236.9	Yes	63	ZINB
Middle age male	54.6	601.8	Yes	4	ZINB
Middle age female	19.6	220.7	Yes	54	ZINB
Elderly male	113.3	2486.2	Yes	5	ZINB
Elderly female	43.4	584.2	Yes	17	ZINB

The summary statistics and over-dispersion test indicate that variances of all dependent variables in the study exceed the mean of county-level suicide rate per 100,000, and there's an over-dispersion problem[10].

Alternatives when the count data has an over-dispersion problem

There are two major alternatives to Poisson regression if the data does not meet the assumption. The first alternative is negative binomial regression. This method can be applied when the data is over-dispersed if the conditional variance exceeds the conditional mean. Negative binomial regression relives the restriction of over-dispersion with narrower confidence intervals, with the mixture of two different distributions as 1) the dependent variable Y scatters around the mean ($\tilde{\lambda}$) as follows the Poisson distribution, 2) the mean, itself a random variable, follows Gamma-distribution scatters around the central value (Hilbe 2011). This method can be altered when there is over-dispersion issue in the data with the equation as

$$E(Y) = \lambda \; and \; var(Y) = \; \lambda \; (1 + \alpha\lambda) = \; \lambda + \alpha\lambda^2,$$

as the over-dispersion parameter α indicates the level of over-dispersion. When the dependent variable does not have over-dispersion, α equals to 0 and $var(Y)$ equals to $E(Y)$, simply satisfying the assumption of Poisson distribution.

Another alternative is the zero-inflated regression model when there is an excessive number of zeros (Ismail and Zamani 2013, Ridout, Hinde and Demétrio 2001). The counted number of zeroes does not mean 'nothing' but means there was no counted

[10] The overdispersion is tested if $var(Y) = \; \lambda + \; \alpha\lambda^2$ indicates that the variance is equal to the mean with the dispersion parameter, and all the tests rejected the null hypothesis in $p<0.001$ level. It implies that the distribution of dependent variable is over-dispersed.

deaths by suicide in the specific year and county. But when we analyze a relatively small area with low population density, there are high chances of having no suicidal deaths due to scarcity of people. In this case, we could consider the zeros are not the "true zeros" but "excess zeros" generated by specific settings of data (Minami, Lennert-Cody, Gao et al. 2007).

For the total suicide rate and gender-specific suicide rates, only 1 out of 452 counties has zero as the counted suicide rate per 100,000. However, when the scope is narrower, there were a higher chance of having more number of zeros, especially for women, age-group specific suicide rates. Therefore, negative binomial regression is utilized for total suicide rates as well as Male-Female suicide rates analysis. For age group-, gender-specific suicide rates, the zero-inflated regression model is applied to deal with the excessive number of zeros to check if the number of zeroes would impact the model choice, between negative binomial regression and zero-inflated regression model.

Analysis results

The term 'significant' and 'significantly' indicates only statistical significance, not theoretical importance or the magnitude of the association between independent and dependent variables.

County-Level Suicide Rates 1: the total suicide rate in 2005–2013

<Table 2: Descriptive Statistics[11]: County level suicide rates in 2005-2013>

Variables	2005	2006	2007	2008	2009	2010	2011	2012	2013
Suicide Rate	27.17 (8.12)	24.1 (7.81)	26.35 (7.61)	27.24 (7.79)	31.88 (9.00)	31.36 (7.85)	31.65 (8.37)	27.49 (7.86)	26.77 (6.9)
Population Growth	-0.09 (2.95)	0.23 (3.12)	0.45 (2.67)	0.29 (2.81)	0.31 (2.24)	1.24 (2.16)	0.39 (1.82)	0.02 (1.84)	0.37 (1.92)
Population Quartile	2.5 (1.11)	2.48 (1.12)	2.48 (1.12)	2.49 (1.12)	2.48 (1.12)	2.5 (1.11)	2.52 (1.13)	2.52 (1.13)	2.52 (1.12)
Crude Birth Rate	8.23 (1.98)	8.39 (2.07)	9.29 (2.21)	8.67 (2.09)	8.29 (1.98)	8.7 (2.18)	8.63 (2.15)	8.77 (2.17)	7.84 (1.99)
Crude Marriage Rate	5.78 (1.12)	6.14 (1.17)	6.34 (1.25)	6.00 (1.22)	5.64 (1.13)	5.94 (1.19)	5.87 (1.27)	5.75 (1.28)	5.68 (1.25)
Crude Divorce Rate	2.45 (0.53)	2.4 (0.48)	2.38 (0.45)	2.21 (0.42)	2.37 (0.44)	2.25 (0.4)	2.22 (0.4)	2.2 (0.39)	2.22 (0.39)
Aging Level	82.13 (58.8)	89.15 (63.55)	96.69 (67.91)	104.1 (73.24)	111.45 (78.46)	119.28 (83.17)	125.78 (86.61)	134.66 (91.91)	143.85 (97.58)
Water Disposal System	67.61 (30.78)	69.94 (29.15)	72.24 (27.65)	74.12 (26.71)	75.55 (25.73)	77.48 (24.11)	79.69 (21.75)	80.74 (20.93)	81.65 (20.12)
Observations	246	246	246	246	246	246	246	246	246

Descriptive statistics are shown in Table 2. The unit of analysis is 246 counties in South Korea per year, so the total sample size is 2,214. In 2009, the mean suicide rate reached its peak of 31.88 during the 2005–2013 period. After 2009, the suicide rate declined to 26.77 in 2003, which is comparable with the suicide rate of 2005. It could be explained with the effects of suicidal prevention policies introduced in 2007 with high

[11] Weighted by population size of counties, and standard deviations in the parentheses

governmental spending on suicidal prevention centers and campaigns (Lee and Kang 2014). Population growth representing the population change rate of counties remained similar between 0.2–0.5% for each year. However, there was an extraordinary increase of 1.24% in 2010, implying more active moves in counties during that year. The crude birth rate remained similar to around 8–9 per county but declined in 2013 as 7.84 is considered a low birth rate in South Korea. The crude marriage rate also remained about similar, between 5–6, similar to the crude divorce rate as 2.2–2.4 during 2005–2013. The aging level representing the proportion of the elderly compared with younger ages increased gradually during this period. It started from 82.13, which means 82.13 elderly individuals for one hundred 0–14 years old individuals in the county on average, measuring the proportion of elderly compared with the younger generation. However, it increased to over 100 in 2008 and reached 143.85 in 2013, representing the rapid rise of the older population in South Korea. Also, the installation of the water disposal system in counties reached 81.65% in 2013, compared with 67.61% in 2005, implying an approved social infrastructure and hygiene system in South Korea.

<Table 3: Negative Binomial Regression Estimation of County Level total Suicide Rates>

Predictors	**Population Dynamics**	**Family Security**	**Full Model**
Years (ref=2005)			
2006	0.89***	0.89***	0.90***
	(0.02)	(0.02)	(0.02)
2007	0.97	0.99	1.00
	(0.02)	(0.02)	(0.02)
2008	1.00	1.05**	1.06**
	(0.02)	(0.02)	(0.02)
2009	1.17***	1.19***	1.20***
	(0.02)	(0.02)	(0.02)

2010	1.16***	1.21***	1.22***
	(0.02)	(0.03)	(0.03)
2011	1.17***	1.22***	1.23***
	(0.02)	(0.02)	(0.03)
2012	1.01	1.07**	1.08**
	(0.02)	(0.02)	(0.03)
2013	0.99	1.02	1.04
	(0.02)	(0.02)	(0.03)
Population Growth	1.00	1.00	1.00
	(0.00)	(0.00)	(0.00)
Population Density (ref=1st quartile)			
2nd quartile	0.94*	0.91***	0.92**
	(0.03)	(0.02)	(0.03)
3rd quartile	0.79***	0.77***	0.81***
	(0.02)	(0.02)	(0.03)
4th quartile	0.74***	0.71***	0.75***
	(0.02)	(0.02)	(0.03)
Crude Birth Rate		0.99*	0.99
		(0.01)	(0.01)
Crude Marriage Rate		1.01	1.00
		(0.01)	(0.01)
Crude Divorce Rate		1.20***	1.20***
		(0.02)	(0.02)
Aging Index			1.00
			(0.00)
% Water disposal			1.00
			(0.00)
Constant	31.22***	22.62***	22.67***
	(0.75)	(1.27)	(2.64)
Observations	2,214	2,214	2,214

Robust Standard Errors in parentheses
*** p<0.001, ** p<0.01, * p<0.05, + p<0.10

Table 3 shows the estimation results of negative binomial regression on the total suicide rate between 2005–2013 in South Korea in the incidence rate ratio. Model 1 only includes time and population dynamics, showing increasing trends of suicide rate by years, and lower population density areas. Holding all other variables constant, the suicide rate in 2006 is expected to decrease by a factor of 0.89 compared with 2005.

However, in 2009, 2010, and 2011, the suicide rates are expected to increase by a factor of 1.17, 1.16, and 1.17 respectively, compared to 2005, holding all other variables constant. Except for 2012 and 2013, suicide rates in 2009–2011 were significantly higher, as expected in hypothesis 1. Additionally, in terms of population dynamics, more populated counties are expected to have lower suicide rate, by a factor of 0.94, 0.79 and 0.74 respectively in 2nd, 3rd, and 4th quartiles in population density, holding all other variables constant, as expected in hypothesis 1(a). But population growth was not significantly associated with the incident rate ratio of suicide rate.

In model 2, family security variables are added: the crude rates related to birth, marriage, and divorce. There are the numbers of family events per 1,000 individuals in that county, indicating the frequency of the events of the people living in that county. There was a weak relationship between crude birth rate and the total suicide rate in 2005–2013 so that the incident rate ratio of county-level suicide is expected to decrease by a factor of 0.99, holding all other variables constant, as expected in hypothesis 4(b). Crude marriage rate was not significantly associated, but each additional number of crude divorce rates in the county, the incident rate ratio of suicide rate was expected to increase by a factor of 1.2, holding all other variables constant, supporting the hypothesis 3(a) and other previous studies (Stack 1990, Stack 2000).

Model 3 is the full model, with aging level and water disposal system installation rate as the proxy measure of development level of the county, even if the county is a rural area with more aged people (there is high likelihood of rural area with lower development level). After holding all other variables constant, the aging index and the proportion of

area with water disposal system were not significantly associated with the incident rate ratio of suicide in the counties.

In summary, suicide rates from 2005–2013 were significantly associated with population density and the crude divorce rate. There was a consistent pattern that more populated city areas were more likely to have better social environments and social network opportunities to cope with the risks of suicide as well as higher family stability and social support to prevent the higher risk of suicide. However, due to the limitation of data for a long period of years (2005–2013), many covariates could not be added as they were not released to the public. The Korean government established an institute of health big data, and user-requested detailed data became available only of Korean citizens using Korean IP (Internet Protocol). So, the more detailed data not open to the public were not available while I was physically in the U.S.

In the next study, I added more covariates as well as age group- to gender-specific suicide rates from 2005 to 2010 based on the publicly released data by the National Statistics Office online.

County-Level Suicide Rates 2: age-, gender-specific suicide rate

< Table 4: Descriptive: Age-group and gender specific suicides in 2005 & 2010 [12]>

	2005 Mean (S.D.)	**2010 Mean (S.D.)**	**Max/Min 2005**	**Max/Min 2010**
Population density[13]	4327.92 (6576.00)	4385.04(6616.37)	1421	1461.62
Proportion of elderly (60+)	17.61 (8.16)	20.22 (8.70)	8.98	9.18
Percentage growth rate	1.77 (1.73)	1.55 (1.96)	-0.94	-4.24
Crude Birth Rate	8.23 (1.99)	8.73 (2.21)	3.50	3.75
Crude Marriage Rate	5.79 (1.12)	5.95 (1.20)	2.41	2.71
Crude Divorce Rate	2.45 (0.54)	2.25 (0.40)	4.41	3.18
Proportion of college degree or higher degree holders	16.00 (10.17)	17.94 (10.13)	16.03	12.89
Average percent of social infrastructure[14]	75.62 (20.22)	81.82 (16.02)	3.06	2.46
Proportion of independent budget	32.43 (18.84)	29.79 (17.68)	13.42	9.64
Number of hospital beds per 1,000	8.27 (5.16)	11.27 (17.68)	182	397
Suicide rate per 100,000[15]	27.20 (8.19)	31.30 (7.91)	5.92	4.59
Male's Suicide rate per 100,000 (total)	40.00 (17.42)	49.02 (18.86)	20.73	10.02
Male's Suicide rate per 100,000 (20-39)	27.18 (17.67)	34.58 (18.51)	24.94	23.07
Male's Suicide rate per 100,000 (40-59)	51.82 (24.91)	57.40 (23.87)	13.22	13.35
Male's Suicide rate per 100,000 (60+)	111.50 (51.15)	115.13 (48.58)	23.34	21.33
Female's Suicide rate per 100,000 (total)	18.58 (9.07)	24.23 (10.45)	12.77	8.19
Female's Suicide rate per 100,000 (20-39)	16.99 (11.60)	23.98 (17.76)	15.91	30.16
Female's Suicide rate per 100,000 (40-59)	17.11 (14.48)	22.08 (14.84)	35.27	47.76
Female's Suicide rate per 100,000 (60+)	41.83 (24.95)	44.88 (23.32)	50.72	51.17

[12] Calculated by nation level. In my analysis, those statistics will be divided by county level as community level data. Provided by Korea Social Science Data Archive KOSSDA. 2013. *Regional Statistics of South Korea 2005-2010*. Seoul: Korea Social Science Data Archive.

[13] (person/Km square)

[14] Average of percentages of paced road, water supply and disposal systems by county

[15] Mean of suicide rate per 100,000 of counties.

The unit of analysis is also 246 counties in South Korea per year, and the total size of sample is 492. Overall, the suicide rate in South Korea increased from 2005 to 2010 in every age groups as stated in Table 4. Especially for males, the elderly population had about 2-3 times higher suicide rates in both 2005 and 2010. Although the absolute rate has increased, the variation of suicide rates decreased except for young adults (20–39 years old), with decreased standard deviations and the ratio between the maximum and minimum suicide rates of countries. Compared to males, female suicide rates were lower in South Korea. It may imply a higher risk of suicidal deaths among males in South Korea than females. As an indicator of mobility, the percentage of population change reduced in 2010. However, the higher standard deviation can imply active population changes/flows within counties in South Korea. Also, reflecting the rapid increasing trend of aging, the proportion of elderly in counties increased in 2010.

Although there was a small decrease in the average crude divorce rate in 2010, there was an increase in crude birth and marriage rates, implying better family security measure results in 2010 than in 2005. As time goes by, the general education level (16% -> 17.94%), average percent of social infrastructure (75.62% -> 81.82), number of hospital beds per 1,000 persons (8.27 ->11.27) have increased. In contrast, there was a decrease in fiscal independency ratios (32.43% -> 29.79%), implying less independence and capacity of welfare policies in the people of that county. Also, as seen in Figures 3-5, the distribution of suicide rates diverged in 2010 compared to rates in 2005. In general, there was a lesser number of darker shaded areas in the map of 2005, indicating a lower suicide rate. By 2010, all maps for male and female suicide rates showed an increase in numbers for countries with dark shades. Eastern and southern areas were especially more

likely to have a higher suicide rate than western and middle areas. This indicates uneven/unequal development among more populated areas (Seoul metropolitan city and other specialized cities) and less developed, populated counties by out-migration to better living standards in more developed counties.

< Table 5: Negative Binomial Regression Estimation of total suicide rates in 2005 & 2010 >

Predictors	**Model 1 Population Dynamics**	**Model 2 Aging Level**	**Model 3 Family Security**	**Model 4 Human Capital**	**Model 5 Full Model**
Year (ref=2005)					
Year	1.16***	1.17***	1.22***	1.23***	1.26***
	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)
Population Density (ref=1st quartile)					
2nd quartile	0.95	0.94	0.91+	0.92+	0.92+
	(0.04)	(0.05)	(0.04)	(0.04)	(0.05)
3rd quartile	0.81***	0.78***	0.77***	0.80***	0.83**
	(0.03)	(0.05)	(0.05)	(0.05)	(0.05)
4th quartile	0.76***	0.73***	0.69***	0.75***	0.79***
	(0.03)	(0.05)	(0.04)	(0.05)	(0.05)
Population Growth	1.00	0.99	0.99	1.00	1.00
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Proportion of Elderly		1.00	1.00	1.00	0.99*
		(0.00)	(0.00)	(0.00)	(0.00)
Crude Birth Rate			0.97**	0.97**	0.97**
			(0.01)	(0.01)	(0.01)
Crude Marriage Rate			1.04*	1.04*	1.04*
			(0.02)	(0.02)	(0.02)
Crude Divorce Rate			1.22***	1.14***	1.16***
			(0.03)	(0.04)	(0.04)
% of College Graduated				0.99***	0.99**
				(0.00)	(0.00)
Budget Independence					1.00
					(0.00)

Social Infrastructure					1.00*
					(0.00)
Number of Hospital Beds per 1,000					1.00
					(0.00)
Constant	30.88***	32.66***	20.00***	27.86***	33.59***
	(1.02)	(2.83)	(2.95)	(4.80)	(6.98)
Observations	492	492	492	492	492

Robust Standard Errors in parentheses
*** p<0.001, ** p<0.01, * p<0.05, + p<0.10

The table 5 presents estimated results of incident rate ratio of suicide rates by negative binomial regression in 2005 and 2010. After checking the standard negative binomial regression and zero-inflated model, the test statistic indicated that the negative binomial regression fits better.

In model 1, only with population dynamics model as population density and population growth, the suicide rate of 2010 was expected to have significantly increased the incident rate ratio compared with 2005 by a factor of 1.16, holding all other variables constant. It is consistent with the expectation of hypothesis 1, showing higher suicide rate in 2010 than in 2005. Also, in counties with 3rd and 4th quartiles of population density, the incident rate ratio of suicide rates was expected to decrease by a factor of 0.81, 0.76 respectively, compared with the 1st quartile of population density. It's also consistent with the expectation of hypothesis 2(a). However, there was no significant association related to population growth. In model 2, the aging level was added but there was no significant association as well.

In model 3, county-level family security measures were added, and the measures were significantly associated with an incident rate ratio of county-level suicide rates. After holding all other variables constant, each additional crude birth rate was associated

with the decrease in the incident rate ratio of county-level suicide, by a factor of 0.97. Also, with each additional crude marriage rate and crude divorce rate, the incident rate ratio of county-level suicide was expected to increase by a factor of 1.04 and 1.22 respectively, holding all other variables constant. The hypothesis 4(a) was supported by the estimation result, but 3(c) was not supported. In model 4, human capital measure was added, and holding all other variables constant, the incident rate ratio of suicide rate was expected to decrease significantly by a factor of 0.99, as expected in hypothesis 5.

In model 5, the full model with social infrastructure measures indicated interesting findings. Most predictors remain the same in terms of the direction of relationship and significance, but the proportion of the elderly became significantly associated with the suicide rate. In other words, the incident rate ratio of suicide rate was expected to decrease with each percent of the proportion of elderly in the county by a factor of 0.99. It is not consistent with hypothesis 3(a), and conventional findings that the suicide rate of rural areas with a higher proportion of elderly is high, due to high level of elderly suicide. However, it indicates that after controlling population dynamics, family security, human capital, social infrastructure level of the counties, the proportion of elderly can be associated with a decreased level of suicide rate for all ages and gender.

In summary, many predictors showed consistent relationships with the total suicide rates (population density, crude birth and divorce rate, education level and social infrastructure) compared to previous studies. However, some predictors such as aging levels measured by the proportion of elderly crude marriage rate contradicted other studies. Regarding gender differences, I divided the group into male and female and ran multiple regression models on suicide rates of males and females separately.

< Table 6: Negative Binomial Regression Estimation of total suicide rates in 2005 & 2010>

Predictors	**Model 1 Male**	**Model 2 Female**	**Model 3 Male**	**Model 4 Female**
Year (ref=2005)				
Year	1.27***	1.34***	1.33***	1.44***
	(0.03)	(0.05)	(0.05)	(0.06)
Population Density (ref=1st quartile)				
2nd quartile	0.86**	0.95	0.87*	1.06
	(0.04)	(0.06)	(0.05)	(0.08)
3rd quartile	0.60***	0.72***	0.70***	0.99
	(0.03)	(0.05)	(0.06)	(0.10)
4th quartile	0.57***	0.68***	0.69***	0.95
	(0.03)	(0.04)	(0.06)	(0.11)
Population Growth	0.98**	0.98*	0.99	0.99
	(0.01)	(0.01)	(0.01)	(0.01)
Proportion of Elderly			1.00	1.00
			(0.00)	(0.00)
Crude Birth Rate			0.95**	0.95**
			(0.02)	(0.02)
Crude Marriage Rate			1.06*	1.05+
			(0.02)	(0.03)
Crude Divorce Rate			1.17***	1.16**
			(0.05)	(0.06)
% of College Graduated			0.99***	1.00
			(0.00)	(0.00)
Budget Independence			1.00	1.00
			(0.00)	(0.00)
Social Infrastructure			1.00	0.99*
			(0.00)	(0.00)
Number of Hospital Beds per 1,000			1.00	0.99+
			(0.00)	(0.00)
Constant	52.32***	22.08***	47.48***	23.81***
	(1.93)	(1.25)	(12.71)	(8.15)
Observations	492	492	492	492

Robust Standard Errors in parentheses
*** p<0.001, ** p<0.01, * p<0.05, + p<0.10

Table-6 presents negative binomial regression results of incident rate ratios of county-level male and female suicide rates in 2005 and 2010. I also checked the test statistic to check the standard negative binomial regression versus zero-inflated regression to see which model fits better. For the total suicide rates of male and female, the negative binomial regression model fitted better than the zero-inflated regression.

Model 1 and Model 2 indicates the total suicide rates of male and female only with population dynamics variables. Consistent with the previous model with the total suicide rate of all age groups and gender, the incident rate ratio of male suicide rate in 2010 was expected to increase by a factor of 1.27, supporting hypothesis 1. For males, the 2nd, 3rd, and 4th population density quartile counties were expected to have decreased incident rate ratio of male suicide rate by a factor of 0.86, 0.6 and 0.57, respectively, holding all other variables constant. Also, for each additional population growth percent, the incident rate ratio of the male suicide rate was expected to decrease by a factor of 0.98, holding all other variables constant. The incident rate ratio of the female suicide rate in 2010 was expected to increase by a factor of 1.34, supporting hypothesis 1. For females, only 3rd and 4th population density quartile counties were expected to have decreased the incident rate ratio of the female suicide rate by a factor of 0.72 and 0.68, respectively, holding all other variables constant. Also, for each additional population growth percent, the incident rate ratio of the female suicide rate was expected to decrease by a factor of 0.98, holding all other variables constant.

Model 3 and Model 4 indicates the full model for male and female suicide rates in the counties. After adding the aging level, family security, human capital and social infrastructure, population growth was no more significant. After holding all other

variables constant, the incident rate ratio of the male suicide rate was expected to decrease by a factor of 0.95 with each additional crude birth rate. In addition, after holding all other variables constant, the incident rate ratio of the male suicide rate was expected to increase by a factor of 1.06 and 1.17 respectively with each additional crude marriage rate and crude divorce rate. Interestingly, if the counties have higher human capital, in terms of the proportion of college degree holders, the incident rate ratio of male suicide was expected to decrease by a factor of 0.99, with each additional percent of college degree holders. But the social infrastructure measures were not significantly associated with the incident rate ratio of the male suicide rate. In contrast, after adding the other variables in the full model, population dynamics measures were no more significantly associated with the incident rate ratio of the female suicide rate. Family security measures remained very similar to male (factors as 0.95 of each additional crude birth rate, 1.05 of crude marriage rate, and 1.16 of crude divorce rate), the better social infrastructure was associated with a decreased incident rate ratio of female suicide rate. After holding all variables constant, the incident rate of the female suicide rate was expected to decrease significantly with each additional percent of social infrastructure, by a factor of 0.99. The number of beds was also marginally ($p<0.10$) associated with the expected decrease in the incident rate ratio of the female suicide rate by a factor of 0.99, after holding all other variables constant.

For males, population dynamics and the human capital model showed consistent results with previous studies and hypotheses of this article. Interestingly, those models were not significant for female suicide rates. Instead, the living condition model was significantly associated with females, with the exception of a lower suicide rate in

counties with better living conditions. For both male and female, family security was a meaningful measure for suicide rates. But the crude marriage rate was positively associated with suicide rates of male and female, same as in my previous analysis on the total suicide rate.

< Table 7: Zero-inflated Regression Estimation of age-group, gender specific suicide rates in 2005 & 2010>

Predictors	Young Male	Young Female	Middle Male	Middle Female	Old Male	Old Female
Year (ref=2005)						
Year	1.40***	1.41***	1.17***	1.24***	1.20***	1.22***
	(0.08)	(0.08)	(0.06)	(0.08)	(0.06)	(0.07)
Population Density (ref=1st quartile)						
2nd quartile	0.91	0.76**	0.80***	0.92	0.95	1.06
	(0.06)	(0.07)	(0.05)	(0.08)	(0.06)	(0.08)
3rd quartile	0.86	0.91	0.65***	0.92	0.78**	0.90
	(0.09)	(0.11)	(0.06)	(0.11)	(0.07)	(0.10)
4th quartile	0.75*	0.79+	0.63***	0.83	0.72**	0.89
	(0.08)	(0.11)	(0.06)	(0.11)	(0.07)	(0.11)
Population Growth	0.98+	0.99	1.00	1.00	1.01	1.02
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Proportion of Elderly	1.00	1.01*	0.99*	1.01	0.99**	0.99*
	(0.00)	(0.01)	(0.00)	(0.01)	(0.00)	(0.01)
Crude Birth Rate	0.96*	0.94***	0.96**	0.95*	0.99	0.99
	(0.02)	(0.02)	(0.01)	(0.02)	(0.02)	(0.02)
Crude Marriage Rate	1.08*	1.11**	1.06*	1.09*	0.97	0.94+
	(0.03)	(0.04)	(0.03)	(0.04)	(0.03)	(0.03)
Crude Divorce Rate	1.07	1.11	1.12*	0.97	1.24***	1.23**
	(0.06)	(0.07)	(0.06)	(0.07)	(0.07)	(0.08)
% of College Graduated	0.99	1.00	0.99***	0.99+	0.99	1.00
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Budget Independence	1.00*	1.00	1.00	1.00	1.00	1.00
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Social Infrastructure	1.00	1.00	1.00	1.00+	1.00*	0.99**
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)

Number of Hospital Beds per 1,000	1.00	0.99+	1.01**	0.99	0.99+	0.98***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Constant	34.52***	15.51***	64.61***	32.33***	184.11***	121.12***
	(12.12)	(6.14)	(19.68)	(13.70)	(59.66)	(47.84)
Inflated						
Year (ref=2005)						
Year	0.91	0.71	0	0.45	0.36	0.09*
Population Density (ref=1st quartile)						
2nd quartile	0.51	0.6	1489.05	0.44+	349.88+	0.36
3rd quartile	0.24	0.08*	0	0.26	0	0.54
4th quartile	0	0	0	0.03*	0	0.19
Population Growth	1.19	1.28*	4430.37	0.93	1.03	1.30+
Proportion of Elderly	1.03	1.02	0.6	1.04	0.83	1
Crude Birth Rate	0.79	0.99	1.67	0.89	0.36+	0.47*
Crude Marriage Rate	1.1	0.9	0	1.29	150.03	1.55
Crude Divorce Rate	0.59	2.19	79220051.48	1.03	0.03	1.38
% of College Graduated	1.12	0.96	196.54	1.03	0.75	0.97
Budget Independence	0.91+	0.92*	0.13	0.98	0.70+	0.97
Social Infrastructure	1.01	0.99	1.06	1.01	1.04	1.01
Number of Hospital Beds per 1,000	0.79***	0.96	0	0.94*	0.38+	0.97
Alpha	0.13	0.14	0.11	0.17	0.14	0.19
Observations	492	492	492	492	492	492

Results indicates Incident Rate Ratio of zero-inflated regression estimation. The inflated part only contains exponentiated values calculated from coefficients as Stata only calculates e-transformation for first part of equation, not inflated part

Robust Standard Errors in parentheses
*** p<0.001, ** p<0.01, * p<0.05, + p<0.10

Results for age group- and gender-specific suicide rates in South Korea from 2005 and 2010 are displayed in Table-7. Each age group indicates 1) Young: 20–29, 2) Middle: 40–59, and 3) Old: 60 and over. After testing the model fit, I found that the zero-inflated

regression model fits better than the negative binomial regression. Therefore, I included the results of zero-inflated regression and interpreted only significant inflated variables that how the variables are associated with the chance of the counties to have excessive certain 'zero' as their age group-gender specific suicide rates.

For the young male group, counties were expected to have a higher suicide rate by a factor of 1.40 in 2010 compared with 2005. Only 4th quartile counties, the most populous counties, were expected to have a decreased incident rate of young male suicide rates compared with 1st quartile population density counties. Each additional crude birth rate as associated with decreased (IRR=0.96, $p<0.05$) male suicide rate, was compared with an increased male suicide rate with each additional crude marriage rate (IRR=1.08, $p<0.05$).

For the young female group, counties were expected to have a higher incident rate ratio of suicide rate by a factor of 1.41 compared with 2005, holding all other variables constant. The more populated counties were expected to have decreased incident ratio rate of female suicide rate in the 2nd quartile (IRR=0.76, $p<0.01$) and 4th quartile (IRR=0.79, $p<0.10$). Interestingly, each additional percent of the elderly of the county was associated with the expected increase in the young female suicide rate (IRR=1.01, $p<0.05$), holding all other variables constant. Similar to the young male suicide rate, each additional crude birth rate was associated with decreased (IRR=0.94, $p<0.001$) young female suicide rate, compared with increased young female suicide rate with each additional crude marriage rate (IRR=1.11, $p<0.05$), holding all other variables constant. In addition, only the number of hospital beds was marginally associated with the expected decrease in the young female suicide rate (IRR=0.99, $p<0.10$).

For middle-age male suicide rates, after holding all other variables constant, counties were expected to have increased middle-age male suicides rates in 2010 compared with 2005 (IRR=1.17, $p<0.001$), each additional crude marriage rate (IRR=1.06, $p<0.05$), crude divorce rate (IRR=1.12, $p<0.05$), and the number of hospital beds (IRR=1.01, $p<0.01$). In contrast, counties were expected to have decreased middle-age suicide rates when there were more populous areas as population density quartiles of 2nd (IRR=0.80, $p<0.001$), 3rd (IRR=0.65, $p<0.001$), and 4th (IRR=0.63, $p<0.001$), each additional proportion of elderly (IRR=0.99, $p<0.05$), crude birth rate (IRR=0.96, $p<0.01$), college educated (IRR=0.99, $p<0.001$).

For middle-age females, after holding all other variables constant, counties were expected to have an increased middle-age female suicides rates in 2010 compared with 2005 (IRR=1.24, $p<0.001$), each additional crude marriage rate (IRR=1.09, $p<0.05$). In contrast, counties were expected to have decreases in middle-age female suicide with each additional crude birth rate (IRR=0.95, $p<0.05$), college educated (IRR=0.99, $p<0.10$).

For elderly male suicide rates, after holding all other variables constant, counties were expected to have increased elderly male suicides rates in 2010 compared with 2005 (IRR=1.20, $p<0.001$), each additional crude divorce rate (IRR=1.24, $p<0.001$). In contrast, counties were expected to have decreased elderly age suicide rates when there were more populous areas as population density quartiles of 3rd (IRR=0.78, $p<0.01$), 4th (IRR=0.72, $p<0.01$), each additional proportion of elderly (IRR=0.99, $p<0.05$), number of hospital beds (IRR=0.99, $p<0.10$). No single variable was significantly associated with the odds of having certain zeros as young male suicide rates of the counties.

Lastly, for elderly female suicide rates, holding all other variables constant, counties were expected to have increased elderly female suicides rates in 2010 compared with 2005 (IRR=1.24, $p<0.001$), each additional crude divorce rate (IRR=1.23, $p<0.05$). In contrast, counties were expected to have decreases elderly female suicide with each additional percentage of the elderly population (IRR=0.99, $p<0.05$), crude marriage rate (IRR=0.99, $p<0.10$), each additional percentage of social infrastructure (IRR=0.99, $p<0.01$) and the number of hospital beds (IRR= 0.98, $p<0.01$). No single variable was significantly associated with the odds of having certain zeros as young male suicide rates of the counties.

Each age-group, gender-specific models had alpha values bigger than 0, which indicates that there were over-dispersion issues and Poisson regression would not be appropriate. In the inflated results indicating the likelihood of having certain zeros as the county level age-group, gender-specific rates, most of the variables were not significant. For the younger male group, the counties with more budget independent rate and number of hospital beds are less likely to have zeros as male suicide rates. Compared with the young male group, the young female group presented a different pattern. The higher population density (only between 1st vs 3rd quartile), more hospital beds, the counties are less likely to have a certain zero as young female suicide rates. In contrast, the higher the growth rate the counties had, they are more likely to have certain zeros of the young female suicide rate. For the middle-age male group, no single variable was significantly associated with the odds of having certain zeros as young male suicide rates of the counties. For the middle-age female group, the higher the population density and more hospital beds, the less likely the counties were to have certain zero as middle age female

suicide rates. Elderly male group model only had a marginal significance that the higher population density (only 1st vs 2nd quartile) was associated with a higher likelihood of having zeros as the elderly male suicide rates. In contrast to more hospital beds, the counties were less likely to have certain zero as elderly male suicide rates. For elderly females, compared with 2005, counties were less likely to have certain zeros as the elderly female suicide rate ($p<0.05$), and when they have higher crude birth rates ($p<0.05$). In contrast, if the county has higher population growth rates ($p<0.10$), the counties are more likely to have zeros as certain elderly female suicide rates. Controlling all other variables, suicide rates in 2010 were higher than those in 2005. For young adults (20–39 years old), the population dynamics model has a limited relationship with suicide rates. For young adult males, only the 4th quartile in population density was significantly associated with suicide rates. Similarly, only the 2nd quartile in population density was significantly related to suicide rates of young adult females. The population growth rate was not a meaningful predictor of suicide rates of young adults. However, the population dynamics model is still relevant to suicide rates of middle-age (40–59 years old) and elderly (60 years old or older) males, showing negative relationships with population density and suicide rates. It may imply that social isolation by frequent migration would not be applied to trends of suicide in South Korea. But population density and population growth rate were not relevant to suicide rates of middle age and elderly females. Therefore, Hypothesis 1 is hardly supported in age group- and gender-specific suicide rates.

In summary, most models were marginally associated with suicide rates among young adult males. But the aging and family security models were statistically

significantly associated with suicide rates of young adult females. For middle-age and elderly males, the population density was significantly related to suicide rates but population growth was not a relevant measure for them. Interestingly, a higher elder population in counties were significantly associated with lower suicide rates of the elderly, implying the positive effects of social network and reduction of social isolation. Still, crude divorce and marriage rates showed consistent relationships with previous studies and crude marriage rates were positively associated with suicide rates, indicating that more frequent marriages are related to higher suicide rates of counties.

CHAPTER 3: INDIVIDUAL LEVEL VARIATIONS OF SUICIDAL IDEATION

Literature review

Another major approach of suicidal study is psychiatric studies, emphasizing the psychological matters that increase suicidal risks. Those studies generally measure the level of suicidal ideation or having thoughts of suicide, affected by individual and social factors (Choi et al. 2009, Ha, Kim, Jeong et al. 2013, Kim-Yu-Jin 2011, Stepakoff 1998). Many scholars realize that the social and psychopathological studies of suicide do not conflict with each other. They are rather complementary in many aspects (Evans and Farberow, 2003). Although he doesn't agree that mental disorders are definite causes for suicide, even Durkheim himself doesn't deny the impact of mental disorders in the suicidal ideation of suicidal people (Durkheim 1951). A basic notion of suicide is that people tend to easily commit suicide under risk factors of suicidal ideations that are considered as being socially and psychologically disordered. According to Durkheim's point of view, which stresses the social dimensions of life, the risk of suicide also increased under certain bad conditions of live we can suffer from: when social solidarity, cohesion or collective consciousness was not working accordingly (Wu, 2010). Therefore, one commits suicide when either the individual or the society is in extremely marginalized, vulnerable situation.

The central idea in suicidal ideation theories is that when an individual has mental health disorders, they are also affected by social structural and environmental factors (Beck, Steer, Beck et al. 1993a). Therefore, they are more likely to have suicidal ideation, leading to a higher chance of committing suicide (Gan et al. 2009, Kim-Yu-Jin 2011). Long before the release of Durkheim's study, suicide was considered to be a result of

emotional problems such as melancholy (Wu, 2010). Studies found that suicide is caused by depression and other mental illnesses (Beck, Steer, Beck et al. 1993b, Gupta and Gupta 1998, Hovey and King 1996). This is because suicidal ideation levels increase in the cases of people with major depressive and psychological disorders. The epidemiological correlation of suicide and mental illnesses is well tested by numerous scholars (Wu, 2010); this debate is one about how mental illness and problems should be considered a distal influential factors, an immediate cause, or even an outcome of some other health problems (Batchelor and Napier, 1953).

Suicide has been explained as a continuum of the behavioral process, initiated with pressures increasing the likelihood of suicidal ideation, leads suicidal attempts to result in completed and incomplete suicides (Beck et al. 1993a). Pokorny and colleagues (Pokorny, Beck, Resnik et al. 1974) introduced the suicidal model, which shows the process of gradually increasing seriousness in suicidal behavior. It generally begins with a weariness of life, death wishes, suicidal ideation, suicidal attempt, and then to completed suicide (Beck et al, 1979). Their model claimed that frequent suicidal thoughts could be an effective predictor of suicide. Indeed, research has found evidence to support the model. Fawcett and colleagues (1993) reported that 60% of patients who killed themselves expressed suicidal ideation prior to committing suicide. Given that the suicidal ideation is known to be a powerful predictor for attempted and completed suicide, an increasing number of researchers have investigated suicidal ideation and its major risk factors (Eom, 2007). Recently, research has detected several social, psychological factors and health-related stressors associated with suicidal ideation: Physical illness, poor self-perception of health, less social support, stressful life events,

financial strain, and depression are important factors of attempted suicide and suicidal ideation (Ahn and Chun, 2009).

Gender and age

Aging is a very important factor affecting individuals in South Korea. The elderly population of over 65 years makes up 11% of the total population. If this rapid aging tendency is maintained, South Korea will be called an 'aged country' in the near future (Kim and Kim, 2012), and reach the highest proportion of elderly people in 2045, according to the population projection by National Statistics Office of South Korea (NSO 2019b). Therefore, aging will be a severe social phenomenon in the foreseeable future (Bae and Park, 2006). Compared to the rapid incline of aging population, the current social welfare systems for the elderly in Korea do not reflect those statistics. Due to the overall expanded life expectancy, the elderly usually live longer than before. Also, social expenditures related to the elderly such as the demand for health insurance system and long-term care have largely increased. However, combined with changing family systems from an extended to a nuclear family, care for the elderly from families has been decreasing drastically (Choe and Jang, 2009).

As the legally defined retirement age in South Korea is 60, people cannot survive with their own earnings as their main resource. In addition, without sufficient support from the government such as the 'Basic Livelihood Security Program' or 'National Basic Livelihood Security Program,' older people would need to rely on their adult children or relatives. In accordance with relatively weak safety-nets from government and hardship after retirement, the economic status of the elderly has a negative impact on their quality of life. Also according to OECD statistics (OECD, 2008), South Korea has the highest

poverty rate, which indicates the percentage of people earning below the median household income. This poverty rate is about two times as high as the rate of the U.S.A. Also, it is about 4 times higher than the average rate of OECD countries. It is also about three times as high as the poverty rate of all populations and other age groups (18~64). It means that the elderly are relative, absolutely facing economic hardship in South Korea (Jones and Urasawa 2014).

Furthermore, the elderly lose social support due to retirement, death of their spouse, or negative health conditions. Therefore, they face the problems that they didn't have in their earlier lives (Lee, 2006). If their society doesn't prepare a social supporting system, these hardships will become more serious as they experience a higher amount of isolation compared to younger ages (Atchely, 1994). Moreover, suicide attempts and suicide behaviors in the elderly can be a serious choice to end their life. In contrast, suicidal attempts at a younger age can be a form of expression. Many suicidal attempts of the elderly are relatively fatal or put them in a critical condition. Therefore, prevention of suicide among the elderly is very important because their attempt at suicide can easily result in death (Bae and Park, 2006), and can be considered as a risk factor to suicidal ideation as a whole.

Human Capital

Having a better human capital, in general, plays an important role in a person's whole life. In general, higher income and job status have negative relations with suicidal ideation (McMillan, Enns, Asmundson et al. 2010). In other words, higher social resources with better income and job level could be a buffer from the stresses and other

negative events in life. Especially, unemployed individuals were reported to have more negative health conditions, including anxiety, depression and suicidal ideation in South Korea (Kim and Choi 2012). Studies found that the uncertainty and hopelessness without appropriate support lead hardships of well-being lead to a higher chance of having suicidal ideation (Beak 2013, Lee and Ha 2011). However, if the job demands too much, in terms of time and energy, some occupations would have a higher risk of having suicidal ideation than other workers. Yoon and his colleagues (2016) found that high emotional demand and low job control were associated with a high risk of suicidal ideation among service and sales workers, from a survey of 1,995 participants in the survey. The authors pointed out that emotional demands and stress influenced by a low level of job control lead to a higher risk of suicidal ideation (Yoon, Jeung and Chang 2016).

In many studies, residential classification such as urban and rural areas can be considered influential variables. There are various debates about the significance of urbanism or the level of development. In the early stages of urbanization, that region would have a very high suicide rate influenced by social disruptions (Stack, 2000). But better social infrastructure such as better environments has been reported as the factor of reducing the regional suicide rate. Region-specific characteristics can be applied in sociological studies about suicide (Kowalski et al, 1987). In cities, the robust infrastructures that are provided allow for people to live in better conditions.

Family Structure

Social isolation increases the risk of losing life satisfaction, which also means an increased risk of suicidal ideation (Kim and Yoo, 2009; Jung, 2010; Lee et al, 2011). Low levels of social activities and social relationships would increase the tendency of psychological depression and stress, resulting in more severe psychological disorders, such as suicidal ideation (Jo and Kim, 2008). In contrast to being socially isolated, participating in more frequent meetings such as an association, religious services, leisure groups, and volunteer work were positively related to higher life satisfaction and lowered risk of suicidal ideation (Park and Chung, 2006). Also, having more participating groups brings social support, reduces the level of negative effects from decreased family functions and provides an alternative source of emotional support (Lee et al, 2011).

Living alone is also perceived to be a risk factor for suicide. Those who are living alone can be considered to be part of a high-risk group of suicide. It is because they cannot be supported by other family and household members in unexpected situations (Jung, 2010). According to the 'Statistics of Elderly', produced by National Statistics Office (2011), 34.2% of older adults live alone. Older adults living alone are more likely to have underlying medical issues, low social-economic status, and depression. Those are strong risk factors of suicidal attempts and completed suicides, especially for disadvantaged, solitary elders (Jo and Kim; Kim and Yoo, 2009).

Health Status

Bad health status leads to various life restrictions and even worse life conditions (Chochinov, Wilson, Enns et al. 1998). Especially when individuals have disease and

illness, they would have a higher chance of suicidal ideation than others without bad health conditions (Marusic and Goodwin 2006). If they have some serious diseases impact on health, such as Darier's, Parkinson's and Alzheimer's disease, their suicidal ideation level was much higher than others without the bad health conditions (Denicoff, Lehman, Rubinow et al. 1990, Kummer, Cardoso and Teixeira 2009). Also at risk are those who have other bad health conditions such as cancer (Recklitis, Lockwood, Rothwell et al. 2006), physical illness (Goodwin, Kroenke, Hoven et al. 2003), and other general bad health indicators (Russell, Turner and Joiner 2009).

Depression is a well-known singular factor associated with a higher level of suicidal tendencies in all age groups, from young generations in college (Garlow, Rosenberg, Moore et al. 2008), to the elderly (Szanto, Mulsant, Houck et al. 2007). Depression leads to high level of stress, hopelessness and anxiety which often accompanies risky self-harm behaviors after having a high chance of suicidal ideation (McKelvey, Pfaff and Acres 2001). Also, individual and social factors impact the increased risk of depression, such as economic hardships, bad health conditions, and stress (Kim and Choi 2012, Lee, Pak and Kim 2017, Shin, Lee, Seol et al. 2017)

Studies found that patients with depression symptoms would suffer from a high level of suicidal ideation and attractions to engage in self-harm behaviors (Bartels, Coakley, Oxman et al. 2002). Even for professionals with high income and job security, higher demands and stress lead to symptoms of depression and often lead to higher levels of risks of suicidal ideation. In a special report of Shanafelt and his colleagues (2011) regarding the suicidal ideation of American surgeons, even though the rate of having suicidal ideation was rare (6.3%), they had a higher chance of suicidal ideation than the

general population if they didn't seek professional help due to time restrictions and concerns that it might impact their medical licenses (Shanafelt, Balch, Dyrbye et al. 2011). This type of stigma of mental illness is very prevalent in South Korea (Park and Jeon 2016), and often leads patients to hesitate to have services from mental health professionals. However, individuals without mental professional care services are more likely to think about committing suicide and suffer from a higher risk of committing suicide (Moon, Lee, Park et al. 2008), which leads to serious concerns regarding life-threatening self-harm behaviors who are without appropriate care of depression.

Data and Methods

Data: Korean National Health and Nutrition Examination Survey

For this study, I utilized the Korea National Health and Nutrition Examination Survey (KNHANE hereafter) conducted by the Korea Centers for Disease Control and Prevention every year by the Ministry of Health and Welfare. This data was designed to build statistical materials about health conditions, behaviors, and consciousness about health, type of food consumption in the national, regional level. This dataset was collected through the stratified multistage probability sampling design as a repeated cross-sectional study. Survey response rates were 88.5–95.3%. I chose this data (KNHANES) as it is useful to explore the social contexts of respondents who have had suicidal ideation. The data contains questionnaires about the subjective quality of life and stressors of their life. I pooled all the waves from 2007–2017 that have the same survey questions format. Only 46,786 cases over 20 years old are included in the analysis to 1)

have consistent age range with the age group-, gender-specific suicide rate analysis, 2) utilize occupational and educational information as predictors, 3) particularly rare cases in teenage suicide rates. Therefore, only adults are included in the suicidal ideation analysis part of this paper.

In accordance with the theoretical background, the dependent variable is 'Suicidal Ideation', thoughts about committing suicide in the last year. The aim of this study was to explore the impact of major determinants of suicidal ideation. Therefore, I selected suicidal ideation, measured dichotomous variables for logistic regression analysis to check association among related variables affecting suicidal ideation.

To test the models of previous studies, I divided models by inputting specific variables. The first model was the baseline model, only including age, period and gender. The second model included human capital, educational degree, individual income measured by quartile, living environment (rural vs urban area). In the third model, I added health status to test the effect of physical and mental health conditions, while controlling other factors. In the fourth model, I also added living arrangements and marital status, to measure social support. I plan to use those hypotheses to see the relationship between social isolation and suicidal ideation.

Dependent variable

The dependent variable is a dichotomous variable, whether the respondent thought about committing suicide last year. Having no suicidal ideation is coded as 0, and 1 is coded as had suicidal ideation. Therefore, the dependent variable indicates the likelihood of having suicidal thoughts in the last year.

Independent variable

Basic demographic variables including age group in 10 years interval (from 20 years old) and gender were included for the baseline model with years as time trend and 17 regions including special cities and provinces. The time (year) includes 2007–2017, but excluding 2014, 2016 and 2018 only asked suicidal ideation questions to the young population under 20. The 17 regions include Seoul, Pusan, Daegu, Incheon, Ghwangju, Daejeon, Ulsan, Sejong, Kyounggi, Gangwon, Chungbuk, Chungnam, Chheonbuk, Cheonnam, Kyoungbuk, Kyungnam and Jeju. As for human capital measures, individual annual income quartile, occupation, whether living in the rural or urban area was included. Due to the high correlation between income and education degree category, and with a better model fit, personal income was included in the models. Occupation category is classified as 'official standard occupation classification' guide, as 1) Manager, Professionals, 2) Unemployed, 3) White Collar, 4) Sales, Service, 5) Farmer, Fisher, 6) Blue Collar workers. Unemployed refers to students, job seekers, housewives and all other people who are not actively involved in paid work. Living in urban and rural areas is an indicator of their living condition, due to the highly unbalanced development of South Korea. The rural area indicates the official regional categories as 'Eup', 'Meon' and 'Ri' referring to regions with a small number of populations. Those regions with more than 20,000 individuals are transitioned to 'Gu,' the higher official unit of regions, as the unit of analysis in the county-level suicide analysis. So the 'Eup', 'Meon' and 'Ri' areas are very less populated, people are not living in the city area with around or under 20,000 individuals mostly underdeveloped and do not have the sufficient level of social

and cultural infrastructure. For family structure measure, living arrangements (living alone or not living alone), marital status (currently married, never married, divorced, widowed, separated) were included. Cohabitation is too rare in South Korea and there are no population-level cohabitation statistics.

Personal health status measures were also included as stress level (rarely stressed, frequently stressed), self-rated health (bad, normal, and good) and depression status. The depression status is measured in a detailed category based on their diagnosis experience as 1) Never diagnosed and experienced depression, 2) Diagnosed as depression in the past, but no more suffer from depression, 3) Diagnosed as depression and still suffering from depression, but having medical professionals' care 4) Diagnosed as depression and still suffering from depression, and do not have any medical professionals' care. This detailed differentiation could lead to better understand whether depression without care would be different from other depression categories. The region-level statistics were also merged from publicly released data from the National Statistics Office website. The regional statistics were selected corresponding to the previous parts of this dissertation, county-level suicide rates. The regional statistics includes the crude rates (divorce, marriage, and birth), the proportion of elderly over 65, the unemployment rate in actively working age, non-regular job rate based on the employed individuals, age-standardized total suicide rate, budget independence, number of hospital beds, social infrastructure (calculated average percentage of area installed paved road, water disposal, and supply system), and the population in millions.

Hypotheses

H1: If R has more human capital, he (she) is less likely to think about committing suicide.

H2: If R has a negative health condition, he (she) will be more likely to think about committing suicide.

H3: If R lives alone, he (she) will be more likely to think about committing suicide.

H4: If R has disrupted marital status other than married, he (she) will be more likely to think about committing suicide.

H5: If R gets older, he (she) will be more likely to think about committing suicide.

H6: If R is male, he will be more likely to think about committing suicide.

H7: As surveyed year increases, he (she) will be more likely to think about committing suicide.

H8: If R is suffering from depression and without care, he(she) will be more likely to think about coming suicide compared with other counterparts.

Analytic Method

As the dependent variable is a dichotomous variable with only two categories: have had suicidal ideation or not, therefore, I utilized logistic regression with nested models as a baseline (only years, regions, gender and age groups), human capital (occupation, income, and living area), family structure (living arrangement, marital status), and health status (self-rated health, stress level and depression status). As the final model, I included all the variables including regional statistics.

Analysis results

< Table 8: Descriptive Statistics[16]: Suicidal Ideation in 2007-2017 >

Predictors	Mean[17]	S.D[18]
Suicidal Ideation		
No	0.89	
Yes	0.11	
Gender		
Male	0.51	
Female	0.49	
Age group		
20-29	0.18	
30-39	0.21	
40-49	0.22	
50-59	0.18	
60-69	0.11	
Over 70	0.09	
Income Quartile		
1st Quartile	0.25	
2nd Quartile	0.25	
3rd Quartile	0.25	
4th Quartile	0.25	
Occupation Category		
Manager, Professional	0.15	
Unemployed	0.37	
White Collar	0.10	
Sales, Service	0.14	
Famer, Fisher	0.05	
Blue Collar	0.20	
Rural Area		
Living in rural area	0.18	
Living in urban area	0.82	
Living alone		
Living alone	0.08	
Not living alone	0.92	
Marital Status		
Currently Married	0.69	
Never Married	0.21	
Divorced	0.03	
Widowed	0.07	
Separated	0.01	
Stress level		

[16] All the descriptive results are weighted as directed by Korean National Health and Nutrition Survey
[17] Proportion of each category for categorical variables (1=100%, 0=0%)
[18] Only for continuous independent variables

Rarely Stressed	0.72	
Stressed Frequently	0.28	
Subjective Health		
Bad	0.18	
Normal	0.47	
Good	0.35	
Depression care		
Never experienced	0.96	
No more depression	0.02	
Depression with care	0.01	
Depression without care	0.01	
Year		
2007	0.10	
2008	0.11	
2009	0.11	
2010	0.11	
2011	0.11	
2012	0.11	
2013	0.11	
2015	0.11	
2017	0.12	
Regional Statistics		
Crude divorce rate	2.23	0.23
Crude marriage rate	6.17	0.70
Crude birth rate	9.00	1.14
Proportion of elderly	11.51	3.09
Unemployment rate	3.43	0.88
Non-regular job rate	33.72	3.95
Suicide rate	27.97	5.13
Budget independence	60.86	22.23
Number of hospital beds	11.20	3.64
Social infrastructure	92.95	8.73
Population in millions	6.27	4.44
Region		
Seoul-si	0.21	
Pusan-si	0.07	
Daegu-si	0.05	
Incheon-si	0.06	
Ghwangju-si	0.03	
Daejeon-si	0.03	
Ulsan-si	0.02	
Sejong-si	0.00	
Kyounggi-do	0.24	
Gangwon-do	0.03	
Chungbuk-do	0.03	
Chungnam-do	0.04	
Cheonbuk-do	0.03	
Cheonnam-do	0.03	
Kyungbuk-do	0.06	
Kyungnam-do	0.06	
Jeju-do	0.02	
Observations	49,711	

Descriptive statistics of weighted mean and standard deviations (for continuous independent variables only), and proportions of each category (for categorical variables) are presented in Table 8. Overall, 11% of the analytic sample thought about committing suicide in the last year. In the occupation category, other than common job categories such as white collar, blue collar (manual workers) and professionals, farmers and fishers are included to check individuals living in mostly rural and sea areas and those who work in relatively small businesses or own businesses who are in a relatively marginalized area. 82% of the sample lived in urban areas, representing a high concentration of population in city areas in South Korea. Only 8% of the analytic sample live alone without any family members. Regarding marital status, a very small proportion of people were divorced (3%), widowed (7%) and separated (1%) categories, compared with currently married (69%) and never married (21%). 28% of the sample replied that they were stressed frequently, and only 18% of the sample rated their health was bad, compared with 47%, and 35% of the sample rated their health as normal and good health respectively.

The depression status revealed that only 4% of the sample had a doctor's diagnosis of depression. 96% of the sample answered that they never experienced and were not diagnosed as depression in their life. 2% was diagnosed with depression, but they do not have depression symptoms any longer, compared with 1% of the sample that was undergoing care for the depression and 1% of the sample that had not had any depression care. In this pooled model, the weighted mean and standard deviations of regional statistics were also included. The regions include the special cities of South Korea (indicated as -si, means city in Korean) and provinces (indicated as -do, means

province in Korean) as mostly divided as north and south provinces (buk means north, and nam means south in Korean). Seoul had the largest proportion out of 17 regions, as 21% of the total analytic sample. It's reasonable that the population of South Korea is around 25% of the total population in South Korea.

Crude rates of divorce, marriage, and birth (2.23, 6.17 and 9.00) were included for the consistency of family security models in the earlier part of the dissertation. There were 11.51% of elderly who were over 65, and the employment status was relatively stable in the mean (3.43% of unemployment) though 33.72% of the employed had non-regular jobs on average. The mean suicide rate of regions was 27.97 per 100,000, as well as 60.86% of the budget independence rate of the regions. The mean number of hospital beds was 11.2, and regions had 92.95% of the area covered with paved road, installed water supply and disposal system. The mean population of the regions was 6.27 million.

< Table 9: Logistic Regression Estimation of suicidal ideation in 2007-2017>

Predictors	Model 1 Baseline	Model 2 Human Capital	Model 3 Family Structure	Model 4 Health Status	Model 5 Region Data
Gender (ref=Female)					
Male	0.50***	0.52***	0.52***	0.61***	0.61***
	(0.02)	(0.02)	(0.02)	(0.03)	(0.03)
Age group (ref=20-29)					
30-39	0.84*	0.85*	1.13	1.16	1.16
	(0.06)	(0.06)	(0.10)	(0.11)	(0.11)
40-49	0.94	0.94	1.30**	1.40***	1.40***
	(0.06)	(0.06)	(0.13)	(0.13)	(0.13)
50-59	1.18*	1.16*	1.56***	1.65***	1.65***
	(0.08)	(0.08)	(0.16)	(0.16)	(0.16)
60-69	1.50***	1.42***	1.91***	1.95***	1.95***
	(0.10)	(0.10)	(0.20)	(0.20)	(0.20)
Over 70	2.25***	2.07***	2.61***	2.70***	2.70***
	(0.14)	(0.14)	(0.27)	(0.29)	(0.28)
Income Quartile (ref=1st quartile)					
2nd Quartile		0.73***	0.78***	0.84***	0.84***

		(0.03)	(0.04)	(0.04)	(0.04)
3rd Quartile		0.58***	0.63***	0.71***	0.71***
		(0.03)	(0.03)	(0.04)	(0.04)
4th Quartile		0.48***	0.52***	0.61***	0.60***
		(0.03)	(0.03)	(0.04)	(0.04)
Occupation Category (ref=unemployed)					
Manager, Professional		0.69***	0.67***	0.61***	0.61***
		(0.05)	(0.05)	(0.05)	(0.05)
White Collar		0.73***	0.71***	0.62***	0.62***
		(0.06)	(0.06)	(0.06)	(0.06)
Sales, Service		0.86**	0.84**	0.81***	0.81***
		(0.05)	(0.05)	(0.05)	(0.05)
Famer, Fisher		0.91	0.94	0.99	0.99
		(0.07)	(0.08)	(0.08)	(0.08)
Blue Collar		0.91+	0.89*	0.94	0.94
		(0.05)	(0.05)	(0.05)	(0.05)
Rural Area (ref=urban area)					
Living in rural area		1.00	1.01	1.03	1.03
		(0.06)	(0.06)	(0.06)	(0.06)
Living alone (ref=Not living alone)					
Living alone			1.06	1.06	1.06
			(0.07)	(0.08)	(0.08)
Marital Status (ref=currently married)					
Never Married			1.66***	1.67***	1.67***
			(0.14)	(0.14)	(0.14)
Divorced			2.25***	1.92***	1.92***
			(0.19)	(0.18)	(0.18)
Widowed			1.30***	1.30***	1.30***
			(0.09)	(0.09)	(0.09)
Separated			1.43*	1.40*	1.39*
			(0.23)	(0.23)	(0.23)
Stress level (ref=rarely stressed)					
Stressed Frequently				4.77***	4.77***
				(0.19)	(0.19)
Subjective Health (ref=bad health)					
Normal				0.53***	0.53***
				(0.02)	(0.02)
Good				0.44***	0.44***
				(0.02)	(0.02)
Depression care (ref=never experienced and diagnosed depression)					
No more depression				2.24***	2.24***
				(0.25)	(0.25)
Depression with care				3.91***	3.90***
				(0.46)	(0.46)
Depression without care				6.98***	6.93***
				(1.09)	(1.08)
Year (ref=2007)					
2008	1.18+	1.19*	1.18*	1.16+	1.23

	(0.10)	(0.10)	(0.10)	(0.10)	(0.18)
2009	1.11	1.11	1.10	1.02	1.03
	(0.10)	(0.09)	(0.09)	(0.08)	(0.24)
2010	1.00	0.99	0.98	0.96	1.18
	(0.09)	(0.09)	(0.08)	(0.08)	(0.25)
2011	0.90	0.89	0.89	0.86+	1.04
	(0.08)	(0.08)	(0.08)	(0.07)	(0.27)
2012	0.86+	0.85+	0.83*	0.81*	1.08
	(0.08)	(0.07)	(0.07)	(0.07)	(0.33)
2013	0.26***	0.26***	0.25***	0.22***	0.23**
	(0.03)	(0.03)	(0.03)	(0.02)	(0.10)
2015	0.29***	0.29***	0.28***	0.22***	0.30*
	(0.03)	(0.03)	(0.03)	(0.02)	(0.17)
2017	0.26***	0.27***	0.25***	0.20***	0.21+
	(0.03)	(0.03)	(0.03)	(0.02)	(0.18)
Regional Statistics					
Crude divorce rate					1.68
					(0.60)
Crude marriage rate					1.36
					(0.30)
Crude birth rate					0.74+
					(0.13)
Proportion of elderly					1.04
					(0.15)
Unemployment rate					0.92
					(0.08)
Non-regular job rate					1.01
					(0.01)
Suicide rate					1.00
					(0.02)
Budget independence					1.01
					(0.01)
Number of hospital beds					0.97
					(0.02)
Social infrastructure					0.97
					(0.02)
Population in millions					0.99
					(0.16)
Region (ref=Seoul)					
Pusan-si	1.12	1.01	1.01	1.07	1.47
	(0.10)	(0.08)	(0.08)	(0.10)	(1.87)
Daegu-si	0.98	0.92	0.93	1.00	1.85
	(0.09)	(0.08)	(0.08)	(0.09)	(2.67)
Incheon-si	1.11	1.04	1.05	1.03	1.14
	(0.13)	(0.11)	(0.11)	(0.11)	(1.52)
Ghwangju-si	0.93	0.94	0.96	1.00	2.56
	(0.10)	(0.10)	(0.10)	(0.10)	(4.21)
Daejeon-si	1.08	1.10	1.10	1.04	2.12
	(0.11)	(0.11)	(0.11)	(0.11)	(3.36)
Ulsan-si	1.10	1.08	1.10	1.21	1.98
	(0.17)	(0.17)	(0.17)	(0.19)	(3.37)
Sejong-si	0.69+	0.79	0.86	0.91	3.82
	(0.15)	(0.22)	(0.24)	(0.21)	(7.47)
Kyounggi-do	1.14*	1.10	1.12+	1.11+	1.51
	(0.07)	(0.07)	(0.07)	(0.07)	(0.75)
Gangwon-do	1.04	0.96	0.97	1.00	0.78

	(0.17)	(0.15)	(0.16)	(0.16)	(1.29)
Chungbuk-do	1.22+	1.09	1.11	1.05	1.15
	(0.13)	(0.12)	(0.13)	(0.12)	(1.69)
Chungnam-do	1.11	1.04	1.08	0.99	0.70
	(0.10)	(0.10)	(0.10)	(0.10)	(0.95)
Cheonbuk-do	1.05	0.95	0.98	0.97	1.23
	(0.11)	(0.10)	(0.10)	(0.10)	(1.86)
Cheonnam-do	1.11	1.01	1.03	1.00	0.84
	(0.12)	(0.11)	(0.12)	(0.12)	(1.32)
Kyungbuk-do	1.15+	1.07	1.11	1.10	1.18
	(0.10)	(0.10)	(0.10)	(0.10)	(1.58)
Kyungnam-do	1.11	1.04	1.05	1.08	1.67
	(0.09)	(0.09)	(0.09)	(0.10)	(1.99)
Jeju-do	1.02	1.04	1.05	0.95	1.26
	(0.14)	(0.14)	(0.14)	(0.15)	(2.06)
Constant	0.19***	0.33***	0.21***	0.15***	0.51
	(0.02)	(0.03)	(0.03)	(0.02)	(2.14)
Observations	49,711	49,711	49,711	49,711	49,711

Estimation results of logistic regression models are presented in Table 9. Model 1 indicates the baseline model, only including time (years), region (not regional controls but distinguishing regions), and simple demographic information such as gender and age groups. In the baseline model, males were less likely to have suicidal thoughts than females (OR=0.50, $p<0.001$), holding all other variables constant. Compared with the 20s, 30s were less likely to have suicidal ideation (OR=0.84, $p<0.05$), but older groups had a higher chance of thought about committing suicides. The oldest group had the most increased odds ratio of having suicidal ideation in the last year compared with the 20s (OR=2.25, $p<0.001$). In summary, the baseline model indicated female and older (except 30s) groups that are more likely to have suicidal ideation than their counterparts (male, 20s), as expected and tested in the conventional studies of suicidal ideation.

In model 2, human capital measures are included. If he (she) was in the higher income quartile, they were less likely to have suicidal ideation. Compared with the 1st quartile, the higher quartile income groups were expected to have decreased odds ratio of

suicidal ideation by a factor of 0.73 (2nd quartile, $p<0.001$), 0.58 (3rd quartile, $p<0.001$) and 0.48 (4th quartile, $p<0.001$). Compared with unemployed individuals, managers and professionals (OR=0.69, $p<0.001$), white collar (OR=0.73, $p<0.001$), sale and service (OR=0.86, $p<0.05$) were less likely to have suicidal ideation. Farmer and fishers were also less likely to have suicidal ideation in the last year, but that was marginal (OR=0.91, $p<0.10$). Living in rural or urban areas was not associated with the odds ratio of suicidal ideation, holding all other variables constant. In summary, the higher human capital was associated with a lower chance of suicidal ideation in general, but the blue collar worker didn't have a significant difference with unemployed, indicating their marginalized working and living conditions.

In model 3, family structure measures were included. After adding the family security measure, except the 30s, all the older age groups were more likely to have suicidal ideation significantly than the 20s. The oldest group, the 70s, had the highest factor of increase in the odds ratio of having suicidal ideation, as 2.61 ($p<0.001$). After holding all other variables constant, compared with currently married individuals, all other marital status individuals had a higher chance of having suicidal ideation in the last year, especially divorced (OR=2.25, $p<0.001$). Living alone was not significantly associated with suicidal ideation. In summary, married individuals would have the least chance of having thoughts about suicide.

In model 4, the health indicators were included. The frequently stressed (OR=4.77, $p<0.001$) were highly likely to have a higher chance of having suicidal thoughts last year, compared with rarely stressed ones. Better health individuals had a lower chance of having suicidal thoughts compared with individuals who rated their

health as bad (normal: OR=0.53, p<0.001, good: OR=0.44, p<0.001). Compared with people who never experienced depression, all the individuals who had diagnosed depression but do not suffer from depression anymore (OR=2.24, p<0.001), or those who are suffering from depression but are in care (OR=3.91, p<0.001) and without care (OR=6.98, p<0.001) had a higher chance of having suicidal ideation. Especially, those who are having depression but were without care had the highest odds ratio of having suicidal thoughts, which could be a red alert for their safety and a higher chance of committing suicides than other categories of depression, holding all other variables constant. In model 5, I included regional statistics to check if the macro factors impact the chance of suicidal ideation of individuals, but only region-level crude marriage rate was marginally associated with decreases chance of having suicidal ideation (OR=0.74, p<0.10). All other variables remained about the same, in terms of the direction of the relationship (whether OR> 1 or OR<1) and significance.

In summary, except the 30s age group, all other age groups were more likely to have a higher chance of suicidal thoughts than the 20s. Those who had higher income were less likely to have a lower chance of thinking about committing suicide. Compared with unemployed, manager, professional, white-collar, sales and service employees were less likely to think about suicide. But there were no significant differences with farmers, fishers, and blue-collar workers. Compared with currently married, all other marital status individuals had a higher chance of thinking about suicide. The more stressed individuals who rated their health condition as worse were more likely to have suicidal thoughts. In terms of depression status, all other depression status compared with never experienced depression had a higher chance of suicidal ideation. Among individuals who currently

suffer from depression, not having mental care was associated with high odds ratio of thinking about suicide last year.

CHAPTER 4: DISCUSSION, LIMITATIONS

Discussion

Recently, suicide has been one of the top leading causes of death in middle and old ages, especially for elderly males in South Korea (Kim-Yu-Jin 2011, Kim and Kim 2011, Lee 2006, NSO 2016). However, most studies concentrated on limited aspects of suicidal deaths with limited time scopes, non-representative small sample data, regardless of age-group and gender, resulting in limited understanding of suicides in South Korea. In contrast, my dissertation project, I attempted to find influential social factors to county-level suicide rates of South Korean counties in investigated county-level total suicide rates in 2005–2013, and county level age-gender specific suicide rates in 2005 and 2010, and risks of suicidal ideations in South Korea to provide more comprehensive understanding of suicide with macro-micro perspectives in the risk of suicides in South Korea.

As various studies investigated and tested, less/weaker social integration with higher social isolation was associated with higher suicide rates (Durkheim 2006 [1897], Kwon, Um and Kim-Yu-Jin 2012, Maris 1969, Park 2010, Sainsbury 1955, Walker 2009) in most of age groups and gender. However, the less populous counties were expected to show higher suicide rate in the contrary to the previous theories that rural area with higher social integration would have lower suicide rate in most age groups and gender (Hirsch and Cukrowicz 2014). It is possibly due to higher risk of usage of pesticides and other lethal products to commit suicide (e.g., sharp farming tools), and relatively disadvantaged situations in medical services people can have to prevent suicidal risks (Li 2020)

Higher social isolation with less secure families (higher crude divorce rate, lower crude birth rate) predicted higher suicide rates, which were consistent with previous studies (Bengtson et al. 2000, Judith and Melinda 2011, Kang 2013, Mishara 1995, Ryu 2008, Stack 1990). Especially, Korean crude divorce rate has reached high as 2.2 in 2019 (NSO 2020) and it's lower than rates of many western countries, such as US, reported 2.9 divorces per 1,000 people in 2018 (CDC 2019). However, divorce in South Korea is higher than other Asian countries such as China, Singapore and other European countries such as Spain, and the rate has been increased (Park and Raymo 2013). As the divorce trend shows general increase in recent days, the higher chance of suicide rate can be expected based on the analysis results of this dissertation, and theories indicating trends of positive associations between crude divorce rates and suicide rates (Eun 2005, Ryu 2008)

However, the crude marriage rate was positively associated with a higher suicide rate, which was not expected in the research question and hypothesis. Also, living in less developed areas with less human capital and living standards was generally associated with higher suicide rates, especially for the elderly. It would imply that less developed areas with more disadvantageous living conditions would be harmful to residents associated wit (Bruce, Bloome, Sosnaud et al. 2012, Chuang and Huang 1997, Kim and Kwon 2013, Kim and Kim 2011, Lee and Ha 2011, Pritchard 1967).

Relatively, the elderly suicide rates were a more severe issue in South Korea. The rate has skyrocketed from 2000 to 2010. Although the uprising trend was stalled after 2005, it started to rise again from 2009. In contrast to some western countries (Gunnell et al. 2003), suicide rates of the elderly in South Korea remain the highest. Because South

Korea's social welfare policy systems and policies for the elderly are not well managed and organized, the elderly easily lose their sources of support, such as devaluated assets and requiring informal kin support for their adult children and relatives (Lee 2006). One another possible reason of high elderly suicide rate would be the war situation experience of elderly. In 1950s, Korea had civil war between South and North Korea, and most of the population in Korea experienced war situation, forced migration due to battles all around the country. Aged individuals in their 60s or older directly and indirectly experienced the war situations, possibly leading them into the risks of PTSD or other trauma, leading to higher risk of suicides (Koven 2017). This is a more serious problem as elderly population has been increased so quickly, compared with other countries. According to the recent study of aging in South Korea (Kim and Kim 2020), South Korea had shorter period of time to join aged society (over 14% of elderly population of 65 years old or older) than Japan, taking only 14 years for the transition from aging society to aged society. They projected South Korea will transition to super-aged society (over 21% of elderly population), and this will be further problem combined with lowest-low fertility rate in South Korea, facing relatively shorter resources to support elderly generations based on taxes, financial aids from younger generations.

In contrast to other age groups, the high population of elderly people in that county was negatively associated with the suicide rate of the elderly in both genders. It may imply that larger homogeneous age groups, after controlling other social factors, can prevent higher suicide rates in older adults compared to other counties with a small elderly population, which can imply higher social isolation levels. Therefore, increasing the social support system for networking activities for the elderly could be a possible

policy implication to ameliorate the disadvantageous social demographic characteristics of the elderly in South Korea.

Even after controlling the regional level covariates, there are still variations of county-level suicide rates. It indicates the other unexplained factors impacting suicide rates, such as economic condition in general, social and cultural trends and social policies. It is found that banning purchase, selling fatal pesticides contributed to decreased suicide rates after 2011. The South Korean government decided to ban one of the most-used pesticides, Gramoxone (Paraquat), and scholars found that contributed to decreasing suicide rates, especially among the elderly in rural areas who used to have easier access to the pesticide (Myung, Lee, Won et al. 2015). As other alternative pesticides has a lower chance of successful death than Gramoxone (Kyu-Yoon, Eun-Young and Sae-Yong 2002), it could be reasonable to ban the utilization of that type of pesticides as it attracts people who are in danger of suicidal ideation and suicidal death. Cha and her colleagues (2016) analyzed the impact of paraquat regulation on suicide rate changes, and they found 37% of decrease in suicidal deaths by pesticides after cancellation of paraquat (Gramoxone) re-registration in 2011 (Cha, Chang, Gunnell et al. 2016), indicating very significant impact of banning a specific poisonous pesticide in South Korea. The banning of pesticide was reported as a success story to prevent risks of suicide (Organization 2016)

Regarding suicidal ideation, I found that females and older generations were suffering from more risks of suicidal ideation. It is a well-known dilemma and paradox: females tend to have a higher chance of having suicidal ideation but have a lower rate of completed suicide in reality. A well-known scholar in suicide studies in the U.S., Thomas

Joiner, pointed out that males are more likely to use brutal ways of self-harm behaviors such as gunshot, jumping, cutting neck, and stabbing compared with relatively mild methods of women (Joiner 2007). It is consistent with findings in South Korea, that Korean males use pesticides, jumping, and other brutal ways that successfully lead to death in a short time (Im, Choi, Hong et al. 2011), compared with women who do use hanging, cutting wrists and others (Ahn, Park, Ha et al. 2012). Having a better job would be associated with a lower chance of suicidal ideation risks, but the manual workers including fishers, famers, and other blue-collar workers did not have a better condition in the risk of suicidal ideation than unemployed individuals. Currently, married people had the lowest chance of suicidal ideation, compared with others. In terms of health condition, better health individuals had a lower chance of suicidal ideation, but the people who are stressed frequently, and suffer from depression but without care had a very high chance of having suicidal ideation. As the risk of stress and depression can be increased with marginalized economic conditions, worse health status, and other social factors (Garlow et al. 2008, Goodwin et al. 2003, Gupta and Gupta 1998, Lee et al. 2017, Shin et al. 2017), these mental health indicators would need to be considered as red alerts to prevent the risk of suicidal deaths(Yook et al. 2011).

Along with a sharp increase in total suicide rates in South Korea within the last decade (OECD 2016), many researchers tried to examine influential factors of suicide rates. However, due to the lack of qualified dataset of individuals who committed suicides, most of the studies concentrated on solely on psychological factors of risk behaviors such as suicidal ideation and attempts (Choi et al. 2009, Gan et al. 2009, Innamorati et al. 2009, Lee and Lee 2009, Walker 2009) or used a limited number of

variables. Compared with previous studies, I tried to use macro factors with differentiated age group-, gender-specific suicide rate with more diverse categories of indicators, even for suicidal ideation study. By incorporating community-level statistics as indicators, I expected to contribute knowledge of trends and differentials of age groups and gender-specific suicide rates in South Korea.

Limitations

Although this study could contribute to the understanding of the recent trend of differentials in South Korea's completed suicide rate, there are several important limitations. Most of all, as Durkheim was criticized by other prominent scholars toward his study of suicide by regional statistics, this study also has a high risk of ecological fallacy. Assuming the homogeneity of individuals living in the area, counties must be used as the basic unit of analysis because the county level is the smallest unit of analysis provided by the Korean government and institutions. However, as counties are still too large and spacious units to assume the same characteristic of individuals, it is challenging for one to overcome the possibility of ecological fallacy. To improve the quality of project, I checked the availability of more detailed information on county-level statistics. As South Korea has a strong government-provided general health insurance system, the Korean government has rich information of patients who are covered by health insurance, providing well-qualified big data provided on request. However, when I tried to acquire the data to extend my study, the international IP (Internet Protocol) user did not have access to the data (even though I am a Korean citizen), which lead me to the restrictions of the data availability. Therefore, for further research projects regarding suicide rates

and suicidal ideation risks, more qualified data source should be granted with the chance of access to Korean big data resources.

In addition, there are several limitations of using official statistics of South Korea, regarding suicide and suicidal ideation. As mentioned in the previous chapters, suicide is not considered an honorable way of death, and is sometimes mislabeled, leading to underrepresented reporting results of suicidal deaths in death statistics and suicidal ideations. Park (2010) used police report data instead of national death statistics so that he could have more accurate data of suicidal deaths and he found a larger number of cases were recorded when he used the police data. Therefore, it would be greater to have the more accurate sources, though these types of data are very restricted to use.

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