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Course: DSC 503 – Statistical Methods
Assignment: Week 8 – Final Paper

Suicide Mortality Rates in Japan vs. South Korea: Are There National Economic Signs?

Introduction

Suicide mortality rates in the United States have become a growing concern for the public health community in recent years, as they increased 46% between 2000 and 2019 (World Bank, 2021). A husband-wife team of Princeton economists, Drs. Anne Case and Angus Deaton, famously chronicled the rise of "deaths of despair" in their New York Times bestselling book *Deaths of Despair and the Future of Capitalism* (2020), arguing that wage stagnation and declining labor force participation were primary factors behind the rise in mortality rates from suicide, drug overdoses, and alcohol-related liver disease among non-college-educated white people in the US (Karma, 2020).

Globally, the situation looks quite different. Since the year 2000, global suicide mortality rates have actually *decreased* by almost 30%. Twenty countries have cut their suicide rates in half (or very nearly in half) since that time. However, four countries doubled their suicide mortality rates (or very close to it) over the same period (World Bank Group, 2021).

As developed, high-income countries (World Bank Group, *High Income*, 2021) in the same region that have both sustained a long-lasting period of economic prosperity through the 20th and into the 21st century, it is somewhat surprising that since the year 2000, Japan's suicide mortality rate has decreased 36% while South Korea's has nearly doubled, making its rate the highest among OECD countries and the fourth highest overall (World Bank Group, *World Development Indicators*, 2021). Although it is a deeply personal and undoubtedly complex decision, can nationwide economic indicators predict the direction of suicide mortality rates each year?

Country	Suicide mortality rate 2000	Suicide mortality rate 2010	Suicide mortality rate 2019
Japan	23.9	24.1	15.3
Republic of Korea (South Korea)	14.5	34	28.6

Source: World Bank Group, World Development Indicators (2021)

Literature Review

Many studies exist that have investigated the causes of suicide, and in support of Case and Deaton's thesis, there is strong evidence to suggest that unemployment is linked to suicide. The CDC lists among its risk factors for suicide "financial problems' as well as "job problems and loss" (CDC, 2021). In "Unemployment and suicide. Evidence for a causal association?" (2003), Blakely, Collins, and Atkinson examined data from New Zealand and found that "being unemployed was associated with a twofold to threefold increased relative risk of death by suicide, compared with being employed." In *Suicide in Asia* (2008), Yip asserts that "Japan and South Korea share very similar suicide patterns and have had high suicide rates since the Asian financial turmoil in 1997" (p. 134), suggesting a possible association with negative economic factors. The large 2010 study "Socio-economic determinants of suicide: An ecological analysis of 35 countries" by Milner, McClure, and De Leo found that "variables related to the [labor] market and the economy were better explanatory factors of suicide rates than population-level indicators of interpersonal relationships." They found that the following factors best correlated with suicide mortality rates:

1. Income
2. Unemployment
3. Healthcare spending
4. Education

Hypotheses and Data

This study will attempt to find possible correlations between the suicide mortality rate and eight economic factors as measured by the World Bank Databank and OECD Data. For the purposes of simplifying each factor's column heading in R, each has been given an alias:

Factor	Alias	Source
Suicide mortality rate (dependent variable)	factor_a	World Bank
Adjusted net national income (annual % growth)	factor_b	World Bank
Adjusted net national income per capita (annual % growth)	factor_c	World Bank
Unemployment, total (% of total labor force) (modeled ILO estimate)	factor_d	World Bank
Current health expenditure (% of GDP)	factor_e	World Bank
Out-of-pocket expenditure (% of current health expenditure)	factor_f	World Bank
Domestic general government health expenditure (% of GDP)	factor_g	World Bank
Household debt total, % of net disposable income	factor_h	OECD Data
Social spending (% of GDP)	factor_i	OECD Data

These data were chosen to reflect each of the first three factors identified by Milner, McClure, and De Leo. They span the years 2000-2018. Educational factors were excluded due to missing data in the World Bank DataBank. The hypotheses are:

- H_0 = None of the eight factors will have any significant effect on the suicide mortality rate in Japan or South Korea
- H_a = At least one factor will have a significant effect on the suicide mortality rate in Japan or South Korea

It is also hypothesized that among these factors, the strongest predictive indicator will be unemployment (factor D).

Methodology and Results

Multiple linear regression, followed by relative importance of regressors, were run on these statistics in RStudio to indicate which of the eight factors, if any, were important in determining the suicide mortality rate.

Japan

```
Call:
lm(formula = factor_a_jpn ~ factor_b_jpn + factor_c_jpn + factor_d_jpn +
    factor_e_jpn + factor_f_jpn + factor_g_jpn + factor_h_jpn +
    factor_i_jpn, data = data_clean)

Residuals:
    Min      1Q  Median      3Q     Max
-0.9611 -0.2627 -0.1076  0.3746  1.2021

Coefficients:
             Estimate Std. Error t value Pr(>|t|)
(Intercept)   62.9183    26.1190   2.409  0.03932 *
factor_b_jpn  -1.1791     4.3307  -0.272  0.79157
factor_c_jpn   1.0777     4.3371   0.248  0.80934
factor_d_jpn   1.7930     0.3975   4.511  0.00147 **
factor_e_jpn -16.3100    21.0502  -0.775  0.45832
factor_f_jpn   1.3096     1.6713   0.784  0.45339
factor_g_jpn  16.2907    23.1768   0.703  0.49990
factor_h_jpn  -0.4441     0.1132  -3.924  0.00349 **
factor_i_jpn   0.4150     0.8157   0.509  0.62318
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 0.8183 on 9 degrees of freedom
  (1 observation deleted due to missingness)
Multiple R-squared:  0.9475,    Adjusted R-squared:  0.9008
F-statistic:  20.3 on 8 and 9 DF,  p-value: 6.82e-05
```

Figure 1: Multilinear regression run on Japan statistics

```
> calc.relimp(fit_jpn, type = c("lmg"), rela = TRUE)
Response variable: factor_a_jpn
Total response variance: 6.752712
Analysis based on 18 observations

8 Regressors:
factor_b_jpn factor_c_jpn factor_d_jpn factor_e_jpn factor_f_jpn factor_g_jpn facto
r_h_jpn factor_i_jpn
Proportion of variance explained by model: 94.75%
Metrics are normalized to sum to 100% (rela=TRUE).

Relative importance metrics:

                     lmg
factor_b_jpn 0.03254965
factor_c_jpn 0.03597129
factor_d_jpn 0.24074619
factor_e_jpn 0.14954988
factor_f_jpn 0.15115582
factor_g_jpn 0.15420145
factor_h_jpn 0.12707019
factor_i_jpn 0.10875553
```

Figure 2: Relative importance run on Japan statistics

As demonstrated by the multiple linear regression function, two factors had p values well under .05, which were unemployment (factor D, .001) and household debt (factor H, .003). This means there is sufficient statistical evidence to reject the null hypothesis. In other words, unemployment and household debt had a significant effect on the suicide mortality rate in Japan between 2000-2018.

The relative importance function found that the most influential factors on the suicide mortality rate in Japan were unemployment (factor D, 24%), followed by domestic general government health expenditure (factor G, 15.4%), out-of-pocket health expenditure (factor F, 15.1%), current overall health expenditure (factor E, 15%), household debt (factor H, 12.7%), and social spending (factor I, 10.9%). However, current health expenditure and domestic general government health expenditure are called into question due to their high standard errors. Both income factors appeared to be negligible at around 3% each. This appears to be in line with what was found in “Socio-economic determinants of suicide: An ecological analysis of 35 countries” as well as the alternative hypothesis.

South Korea

```
> fit_skr <- lm(factor_a_skr ~ factor_b_skr + factor_c_skr + factor_d_skr + factor_
e_skr + factor_f_skr + factor_g_skr + factor_h_skr + factor_i_skr, data=data_clean)
> summary(fit_skr)

Call:
lm(formula = factor_a_skr ~ factor_b_skr + factor_c_skr + factor_d_skr +
    factor_e_skr + factor_f_skr + factor_g_skr + factor_h_skr +
    factor_i_skr, data = data_clean)

Residuals:
       9       10       11       12       13       14       15       16
-0.03035  0.04558 -0.03184  0.03238  0.06281  0.07590 -0.34198 -0.04921
      17       18       19
 0.71897 -0.55344  0.07118

Coefficients:
             Estimate Std. Error t value Pr(>|t|)
(Intercept)  129.6006    26.9267   4.813   0.0406 *
factor_b_skr   6.6655     5.2664   1.266   0.3331
factor_c_skr  -6.7432     5.1519  -1.309   0.3208
factor_d_skr  -3.3016     2.0916  -1.578   0.2552
factor_e_skr -20.2165    15.8392  -1.276   0.3300
factor_f_skr  -1.9513     0.5969  -3.269   0.0822 .
factor_g_skr  37.5788    14.6041   2.573   0.1236
factor_h_skr  -0.1695     0.1863  -0.910   0.4590
factor_i_skr  -0.9293     2.9923  -0.311   0.7855
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 0.6937 on 2 degrees of freedom
  (8 observations deleted due to missingness)
Multiple R-squared:  0.9891,    Adjusted R-squared:  0.9457
F-statistic: 22.78 on 8 and 2 DF,  p-value: 0.04273
```

Figure 3: Multilinear regression run on South Korea statistics

```
> calc.relimp(fit_skr, type = c("lmg"), rela = TRUE)
Response variable: factor_a_skr
Total response variance: 8.864545
Analysis based on 11 observations

8 Regressors:
factor_b_skr factor_c_skr factor_d_skr factor_e_skr factor_f_skr factor_g_skr facto
r_h_skr factor_i_skr
Proportion of variance explained by model: 98.91%
Metrics are normalized to sum to 100% (rela=TRUE).

Relative importance metrics:

                    lmg
factor_b_skr 0.02773411
factor_c_skr 0.02798696
factor_d_skr 0.02790272
factor_e_skr 0.19041902
factor_f_skr 0.14026256
factor_g_skr 0.19207074
factor_h_skr 0.18922279
factor_i_skr 0.20440111
```

Figure 4: Relative importance run on South Korea statistics

The data from South Korea tell a different story. None of the factors have a p value small enough to be considered significant, so the null hypothesis cannot be rejected. Four factors had similar levels of relative importance: social spending (factor I, 20.4%), domestic general government health expenditure (factor G, 19.2%), current health expenditure (factor E, 19%), and household debt (factor H, 18.9%). Out-of-pocket health expenditure (factor F, 14%) was also significant. Interestingly, unemployment and income seemed to be negligible at under 3% each. This is similar to the results for Japan in terms of income, but in direct contrast in terms of unemployment.

Discussion

Among others, one major limitation of the study is the lack of knowledge regarding how suicide deaths are recorded and how reliable the numbers are. Another is not accounting for time lag between variables (such as last year's social spending was associated with a drop in next year's suicide rate). Both could be accounted for in future studies that examined death records in each country as well as a time series analysis of the significant factors to give more insight into how they are potentially influencing future suicide rates.

Conclusion

According to the national economic data, it seems that the suicide mortality rate for Japan is in line with what was determined in many previous studies, but South Korea's is not. It is interesting to note that not only was South Korea an outlier in terms of its suicide rate increasing since 2000, but none of the economic factors were significant, either, despite having been identified as such in many other studies covering other countries. In these ways, South Korea indeed appears to be an outlier with regard to suicide rates. It is likely that other factors, perhaps even cultural factors, are driving the suicide rate in South Korea. Numerous social factors are named as possibly contributing to South Korea's high suicide rate in Singh's 2017 article *The "Scourge of South Korea": Stress and Suicide in Korean Society*: untreated mental illness, a fear of economic issues stemming back to the 1997 economic crash, a culture that encourages long work and study hours, and a lack of pension benefits for some seniors are all identified as possible reasons for the high suicide rate. Interestingly, this seems to be in line with social spending – defined by OECD Data as "cash benefits, direct in-kind provision of goods and services, and tax breaks with social purposes. Benefits may be targeted at low-income households, the elderly, disabled, sick, unemployed, or young persons…[involving] either redistribution of resources across households or compulsory participation" (OECD Data, *Social spending (indicator)*, 2021) – as the factor of greatest importance among the eight studied. Hopefully with some cultural shifts and increased social spending, South Korean can begin to rein in their tragically astronomical suicide rate.

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