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**Exploring Suicide in Japan:
In the Light of Mental Illness and Socioeconomic Factors**

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Abstract

This statistical study explores socioeconomic determinants of suicide with aggregate-level panel data over the period 1975-2005 in 47 prefectures in Japan. Introducing a new proxy for mental illness and employing male and female age-adjusted suicide death rates, this study attempts to avoid omitted variable bias. Controlling for period-specific, prefecture-specific characteristics, the findings of this study suggest that high unemployment rates, serious mental illness and insufficient livelihood protection are influential factors in high male suicide rates. The determinants of female suicide rates are somewhat different. High female suicide rates are attributable to low household income and insufficient livelihood protection. The statistical findings are robust to the addition of control variables and also to the exclusion of each prefecture. These large differences in the determinants of suicide between genders suggest that fine-tuned policy for suicide prevention needs to be sensitively drafted according to gender.

1. Introduction

Ninety people die as a result of suicide every day in Japan.¹ This is the largest figure among developed countries, and 32,845 human lives were lost due to suicide solely in the year 2009 (National Police Agency 2010a).² The suicide rate, which is the number of suicides per 100,000 persons, is a standard suicide statistic commonly used for international/regional comparison between areas with different sizes of population. The suicide rate in Japan is higher than any other developed countries, being twice as high as in Australia, Canada and the USA, and more than three times as high as in Italy and the UK. A sudden decline in suicides seems unlikely, considering that the ongoing economic depression in Japan is impoverishing households and worsening economic and social environments. Therefore, it is particularly pressing in Japan to reveal socioeconomic determinants of suicide in order to formulate effective socioeconomic policy for suicide prevention, but this subject has attracted little attention in the literature.

One straightforward way of assessing causes is to listen to people involved. Accordingly, we scrutinized the statistics of suicide notes (the details are discussed below) and rediscovered that mental illness is likely to be a significant factor in suicide.³ However, previous studies failed to include this

¹ The term “suicide” refers to completed suicide throughout this paper, unless noted otherwise. As in many suicide studies from socioeconomic viewpoints, this paper focuses on completed suicide rather than extending our attention to attempted suicide. Takahashi (2003) notes that attempted suicide is estimated to be ten times greater than completed suicide in Japan.

² The number of suicide deaths was six times higher than the number of deaths in traffic accidents (4,914) in the year 2009 (National Police Agency 2010a, b). Whilst the number of deaths in traffic accidents has been dropping for the last four decades, the number of suicide deaths has shown little sign of abating.

³ Interviewing survivors of suicide attempts (*i.e.*, living people who have experienced *incomplete* suicide) is unlikely to provide useful information to understand the reasons for *completed* suicide. Para-suicide and deliberate self-harm are motivated to a large extent by different reasons from those of completed suicide. The majority of deliberate self-harm is

important variable. The effect of mental illness on suicide has been neglected in past regression analyses due perhaps to lack of available data. Therefore, omitted variable bias is a serious concern in past statistical studies.

The purpose of this study is to explore socioeconomic determinants of suicide with panel data from 47 prefectures in Japan for the period 1975 to 2005 with five-year intervals. We quantify the degree of mental illness with the number of psychotic inpatients per 100,000 population in order to measure the impact of mental illness on the suicide rate. Introducing this new proxy, we avoid a serious concern over the source of omitted variable bias and attempt to clarify the true socioeconomic determinants of suicide by gender in Japan. This is the main contribution of the present study to the literature.

Exploring the socioeconomic determinants of suicide in Japan is substantial particularly in the following two aspects. First, a possible outlier country like Japan needs to be analyzed on its own. The extraordinarily high suicide rate in Japan, surpassing any other developed countries, may be caused by different factors from other countries. If this is the case, while cross-country statistical analyses provide useful information about an “average” country, applying the policy implications derived from cross-OECD-country evidence to Japan may not be appropriate for suicide-preventive policies in Japan. Nevertheless, little attention has been directed to explore the socioeconomic determinants of suicide in Japan, apart from cross-country data,⁴ whilst existing studies are based mostly on simple correlational

cessation-unintentioned or cessation-contraintentioned, the term “cessation” referring the final ending of consciousness (Platt 1984).

⁴ It is noteworthy that the number of suicides may be underreported in some countries and that this underreporting is likely to

methodologies.⁵ Second, understanding the factors contributing to the extraordinarily high suicide rate in Japan helps to fill in a blank piece of the suicide puzzle. In cross-country analysis by Chen *et al.* (2009) the Japan effect was confirmed with the interaction terms between the Japan dummy variable and explanatory variables. This implicates that unobserved characteristics in Japan expand the impact of socioeconomic factors on its suicide rate, yet the details of such upward effect on suicide still remains unexplained. It is a formidable task to solve the conundrum, but the determinants of suicide in Japan need to be clarified with rigorous investigations of data for policy formation on suicide prevention. This study attempts to be a step in that direction.

It should be stressed that suicide is determined not only by personal matters but also by macro socioeconomic factors. There is a remarkable difference in suicide rates between prefectures in Japan, as shown in Appendix 1. With respect to the male suicide rate, Akita prefecture records 39.7 while Kanagawa prefecture scores half of that figure (21.2). As for women, the female suicide rate in Shizuoka prefecture is less than two-thirds of the rate in Akita prefecture. This large regional difference in suicide rates is likely to reflect the fact that suicide is influenced, at least to some extent, by regional circumstances (Motohashi and Kaneko 2004; Motohashi 2003), and hence this regional difference itself is what researchers need to elucidate.

Due to the aggregation problem which inherently resides in aggregate-level data analysis,

depend on the degree to which society stigmatizes suicide. Hamermesh and Soss (1974) warn that differences in the degree of the underreporting of suicides between countries plague cross-country comparison of suicide rates.

⁵ Exceptions include Inagaki (2010) and Watanabe *et al.* (2006).

aggregate-level regional data is unlikely to be preferred to individual-level data particularly in the health literature.⁶ Opposing views are repeatedly advocated (Kunze and Anderson 2002; Robinson 1950), and the present author fully agrees with the importance of health research based on individual-level data. However, suicides' personal information such as income, medical records, employment records, educational qualifications, family backgrounds and drinking habits is strictly confidential and unpublicized in Japan. It is, to my knowledge, infeasible to adopt the Japanese individual-level data of mental health to regression analysis of suicide, but cross-prefecture analysis enables us to incorporate a proxy for the degree of mental health by prefecture. For this reason, the author believes that the use of aggregate-level regional data is justifiable here. The shortcoming of a potential aggregation problem in this study is compensated for by virtue of the introduction of a new measure of mental illness into regression analysis of the socioeconomic determinants of suicide.⁷

The remaining part of the paper is structured as follows. Section 2 presents a brief discussion on the mental illness-suicide nexus. Section 3 overviews the economic and sociological literature on suicide. Section 4 describes methodology and data. Section 5 summarizes the estimated results. Section 6 concludes

⁶ Concern about the use of aggregate-level data is popularly called the “ecological fallacy”, meaning “a logical fallacy inherent in making causal inferences from group data to individual behaviors” (Schwartz 1994, p.819). This concept causes researchers to exercise caution, but as Schwartz (1994) discussed, it has often been misused.

⁷ Susser (1994b) noted three legitimate reasons for the use of aggregate-level (that is, ecological) data in public health studies, as follows. “Ecological studies are obligate when they are the only choice available, either because of the question asked (as in testing differences between groups and discovering group effects), or because of a concern with dependent happenings (as in transactions involving more than one individual), or merely because of the lack of individual data” (p.830). The present study applies to the first and the last reasons. Also see another paper by Susser (1994a), which provides a thought-provoking discussion on the ecological fallacy.

the paper.

2. Mental illness and suicide

Some clues to the reasons and motives for suicide are available from the National Police Agency (2010a, 2009) in Japan. As for completed suicide with specifiable reasons, up to three reasons per suicide are specified and counted from evidence including suicide notes. Out of 32,845 suicide deaths in the year 2009, the number of suicides for which reasons were specifiable is 24,434. Out of the reason-specifiable cases, two thirds (15,867) are attributable to health problems. Mental illness shares 63% (10,022) of the health problems while physical illness shares a third.⁸ This suggests that 41% of completed suicides are attributable to mental illness. Therefore, a rough observation of these statistics implies mental illness is likely to be a significant factor in suicide in Japan.

However, mental illness has been ignored in the empirical literature on suicide. Previous empirical studies, regardless of the subject of research being Japan or other countries, failed to incorporate mental illness in statistical analysis due perhaps to lack of data. Accordingly, it is a serious concern that the previous statistical findings may be plagued by omitted variable bias.

This problem has been faced by several researchers. Insightful survey papers by Stack (2000a, b) suggest that empirical findings in many past studies of the positive association between divorce rate and suicide may be spurious. His argument is that while mentally unstable people are likely to develop conflicts

⁸ The rest includes physical disability and unspecified health problems.

in human relationships, which lead to divorce, they avoid real solutions and choose suicide. Given that mental illness is the “third” variable which causes both divorce and suicide, the observed statistical relationship between divorce and suicide in the previous literature is fallacious even with the individual-level data. This is exactly why our investigation introduces the measure of mental illness to our panel data analysis to search for the determinants of suicide. In a similar vein, where data of mental illness is missing, interpretation of the suicide-unemployment link is insurmountable. Papers by Platt (1984) and Platt *et al.* (1992) argue that where an individual’s psychiatric status and history is unavailable, it is indistinguishable whether the suicide-unemployment link is causal or mental health determines both suicide and unemployment. In other words, individuals suffering psychiatric disorders may be both more vulnerable to suicidal impulses and more likely to quit or to be dismissed from their jobs than those who do not suffer from psychiatric disorders. Therefore, psychological problems may be the root cause of both job loss and suicide. In the present study, the introduction of an aggregate-level measure of mental illness provides a practical approach to this conundrum.

Psychiatrists and epidemiologists, not surprisingly, emphasize the importance of the impact of psychological stress on health and of mental illness on suicide more than the roles of socioeconomic factors.⁹ A questionnaire investigation in Fukushima prefecture in Japan by Hiraiwa *et al.* (2000) reveals that suicide is determined by many sources of stress, but not solely by a single distinctive source. The authors asked the family members of people who had committed suicide to answer a questionnaire and

⁹ See a useful survey by Tanney (2000) for the association between mental ill health and suicidal behaviors.

collected information on the causes of stress that had afflicted the victims. They found that the results were very similar to those of counterparts in a control group. They also found that, prior to suicide, one-third of those who died were either outpatients or inpatients of psychiatric departments, which represents a clear difference from the control group. Based on this evidence, we focus on overall mental illness rather than on each specific mental disease.

3. Overview of the Economic and Sociological literature

Economic theory and empirics indicate that income and unemployment are influential factors in suicide. According to modern economic theory of suicide developed by Hamermesh and Soss (1974), an individual commits suicide when the total discounted lifetime utility remaining to him/her reaches zero. The higher their expected permanent income is, the higher the expected life-time utility. This predicts that income is inversely associated with suicide rate. Empirical evidence from panel data of developed and developing countries agrees with this theory (Neumayer 2003a, b). Similarly, the theoretical prediction is also supported by Chuang and Huang (1997) with cross-regional Taiwanese data and by Viren (2005) with longitudinal Finnish data.

Unemployment is well-documented to be closely connected with income. If this is the case, the relationship between unemployment and suicide rate is expected to be positive: high unemployment is associated with high suicide rates. A positive relationship between unemployment and suicide has been confirmed in many empirical investigations (Pritchard 1992 for Europe; Gerdtham and Johannesson 2003

for Sweden). A recent paper by Kuroki (2010) with the Japanese municipal level panel data found that serious male unemployment is associated with high male suicide rate.

Results from happiness research are useful in understanding suicide if unhappy people commit suicide as implicated by the suicide theory by Hamermesh and Soss (1974). Empirical evidence that high unemployment and/or low income are harmful to happiness is widely held (Clark and Oswald 1994 for UK; Di Tella *et al.* 2001 for Europe, 2003 for USA and Europe; Easterlin 1995 for USA and Europe, 2001 for USA; Winkelmann and Winkelmann 1998 for Germany).

Research on overall mortality and economic conditions provides useful clues. Controversial, seminal works by Ruhm (2000, 2003) argue that recessions are beneficial to overall mortality.¹⁰ A re-examination of the Ruhm argument with German data by Neumayer (2004) found evidence supporting most of Ruhm's findings. However, it is worth stressing that Ruhm (2000, 2003) also found that suicide is the only exception, finding evidence that high unemployment rate is associated with high suicide rates, in other words, that recessions are harmful to suicide. In sharp contrast to Ruhm, Neumayer found that suicide goes in the same line with other cause-specific mortality: recessions lower suicide. Meanwhile, with respect to overall mortality and most of cause-specific mortality, Economou *et al.* (2008) presented statistical evidence contradictory to Ruhm's findings. However, as far as suicide is concerned, their evidence agrees with Rum's argument that recessions are bad for suicide. Noh (2009) found a positive link between unemployment and suicide rate, yet the opposite relationship was apparent in low-income countries. In sum,

¹⁰ See Miller *et al.* (2009) for different interpretations of the Ruhm findings.

available evidence mostly agrees that unemployment is harmful to suicide although debate over the association between other cause-specific mortality and unemployment has diverged rather than converged.

One source of confusion in the literature may be attributable to an inappropriate set of explanatory variables. Many previous studies employed both income (alternatively, per capita GDP in cross-country regressions) and the unemployment rate as explanatory variables in a single regression equation, and then typically concluded either of the two variables (*i.e.*, income or unemployment) is significantly correlated with the suicide rate, but the other not. Given that, unemployment is, as Okun's law indicates, highly correlated with income or per capita GDP, the effects of these variables on the suicide rate tend to compete with each other. Therefore, this statistical treatment may lead to false findings.¹¹ The inappropriate treatment of the explanatory variables and the mis-interpretation of the estimated results may be causes of counter-theoretical findings in the literature.

A sociological theory of suicide is instructive to deliberate the impact of socioeconomic factors on suicide. The classical theory of suicide by Durkheim (1897) stresses that suicide is influenced by the degree of social integration and regulation. Egoistic suicide arises when social integration weakens. Since social integration is an obstacle to restrain suicide, more individuals commit suicide in a society with less

¹¹ A relevant, illustrative example is a panel data study of European countries by Andres (2005), which found significant negative association between economic growth and suicide rate, but no statistical association between per capita GDP and suicide. Since the suicide rate was regressed on per capita GDP, economic growth, unemployment rate, fertility rate and some other controls in his analysis, multicollinearity is a serious concern there. Taking into consideration the fact that unemployment is negatively correlated with economic growth and that low per capita GDP is associated with high fertility rate, it is likely that the effects of per capita GDP and unemployment on suicide rate were captured unintentionally by the coefficients of fertility and economic growth, respectively.

social integration where individuals enjoy less social life. Anomic suicide arises when social regulations weaken. Where individuals' activities are not regulated, they pursue their desires and then face failures and frustration, which lead to suicide. Altruistic suicide arises when individuals are submissive to a value system in a society. Where an individual is regarded as merely a part of the whole, human life is slighted. We focus on the first two types of suicide since weakened social integration and regulation is a substantial symptom in modern societies (Putnum 2000). We dismiss the last type of suicide which applies to uncivilized societies and the military since the object of our investigation is modern Japan. Putting the Durkheim proposition into the context of our study, the proposition suggests that lack of social integration and regulation leads to an increase in the suicide rate.

4. Methodology and Data

4.1. Methodology

This study employs fixed effects estimation in order to control differences in regional characteristics such as culture, climate and traditional values, and in periodical characteristics such as changes in social acceptance to suicide and technological advances in hospital emergency wards. The fixed effects estimator is derived from the following two way fixed effects linear regression model:

$$S_{it} = \alpha + X_{it}\beta + \gamma_t + \delta_i + \varepsilon_{it}$$

S_{it} is age-adjusted suicide rate in the i th prefecture and in the t th period. α is an overall constant term. X_{it} is a matrix of explanatory variables, and β is the vector of estimated coefficients. The γ_t variables are period-specific effects, which are captured by period specific dummy variables. The δ_i variables represent time-invariant individual prefecture effects.

4.2. Dataset

The dataset consists of 47 prefectures in Japan for the concerned period 1975 to 2005 with five-year intervals.¹² The five-year intervals are established solely because most explanatory variables by prefecture are available every five years. The panel data is balanced. Appendix 2 provides data source and descriptive statistics of data. A correlation matrix is provided in Appendix 3.

4.3. Dependent Variables

Interpreting the actual number of suicides requires prudence since a change in the number of suicides might be misleading, because it results from a change in demographic transition. It is of importance to note that Japan has experienced population expansion in most of the period under investigation. Furthermore, differences in demographic composition need to be considered, since the tendency to commit suicide differs even among age cohorts. The age-adjusted suicide rate variable enables a strict comparison of suicide deaths in different demographic structures between different years and

¹² Japan is composed of 47 prefectures, and hence the present study excludes no prefecture from its main analysis.

regions. The suicide rate, that is suicide deaths per 100,000 persons, is a standard figure for comparing suicide statistics between different points of time or across regions. The age-adjusted suicide rate, which is the suicide rate adjusted by the year 1985 model population, is calculated as follows;

Age adjusted suicide rate

$$= \frac{\sum(\text{Age specific suicide rate} \times \text{Age specific population in standard population})}{\text{Total population of standard population}}$$

This study applies the age-adjusted suicide rate hereafter.

Male and female age-adjusted suicide death rates by prefecture are employed as two different dependent variables. Considering that the determinants of suicide may differ by gender, we investigate male and female suicide separately. Data are derived from the Ministry of Health, Labour and Welfare (2007), in which prefectural suicide rates are available every five years from 1960 to 2005. Our cutoff point is set in the year 1975 due to severe constraints of data availability of independent variables prior to that year.

4.4. Independent Variables

All independent variables are derived from the Ministry of Internal Affairs and Communications (2009), except for the variable of mental illness, which is collected from Ministry of Health, Labour and Welfare (2008).

Measuring the degree of mental illness is a complicated task. Ideally, individual data on suicide, mental illness and social status (*e.g.*, annual income, employment records, academic records, and family background) would help statistical analysis of suicide, but such data is unpublished and hence unavailable for the purpose of research in Japan. Meanwhile, the annual total number of psychotic inpatients by prefecture is available.¹³ We calculated the daily average number of psychotic inpatients in mental and general hospitals and employed the figure as a proxy variable for the degree of mental illness. For comparability among prefectures of different population size, we standardized this variable as per 100,000 population.¹⁴ On the assumption that serious mental illness is associated with increased suicide, the expected sign of the coefficient of the mental illness variable is positive.¹⁵

There may be some reservations about the use of the number of psychotic inpatients as a proxy for the degree of mental illness. The first concern is that the patients' financial constraints might prevent them from getting appropriate medical treatment in hospitals. If individuals suffering from mental illness

¹³ It would be more appropriate to use separate figures for female and male psychotic inpatients, but such data are not available. Since we calculate the degree of mental illness from the total number of psychotic inpatients by prefecture, our measure reflects the direct effect of mental illness on suicide rates as well as its indirect effect in which mental illness of one gender affects the suicide rate of the opposite gender by increasing partners' psychological burden.

¹⁴ It might be useful to adjust this figure by age cohort, but this is impracticable. Data on the number of psychotic patients by age group is not available. Equally important, there is no established evidence that the number of psychotic inpatients is an increasing or decreasing function of age. For the above reasons, we do not consider this issue.

¹⁵ The author is aware that, prior to our method for measuring mental illness, a similar attempt was made in a study by Economou *et al.* (2008), but with different definition, context and interpretation. It is important to remember that our analysis employs a variable of *psychotic* inpatients, which is different from the total number of inpatients of *physical* and psychotic symptoms as employed by Economou *et al.*

are more likely to be unemployed and hence face more serious budget constraints than individuals without mental illness, the potential patients' accessibility to medical treatment may be restricted for financial reasons. This concern may apply to the variable of outpatients, but not necessarily to inpatients as in our analysis. The severe degree of mental illness reflected in psychotic inpatients forces to reallocate their budget to medical treatment under the national health insurance system in Japan.¹⁶ Second, the number of mental patients may reflect the degree of social acceptance of mental illness, since people may hesitate to admit such an illness and treat their own or their family member's psychotic symptoms in a society with a strong bias against mental illness. This also may apply to outpatients, but is unlikely to apply to inpatients.

Unemployment rate by gender is used as a measure of economic conditions. The unemployment variable is a regular regressor of economic conditions in many empirical suicide studies. Meanwhile, this study leaves out average personal income, which is another common variable for economic conditions, for the following two reasons. First, average income is subject to be positively correlated with unemployment rate (the latter is our independent variable), since the unemployed receive no income. Average income in a prefecture can have an indirect impact on the number of suicides in the prefecture through taxation, since low average income leads to low prefectural budgets being allocated to preventive policy for suicide.

However, this study also employs explanatory variables of welfare expenditure and livelihood protection

¹⁶ Nationwide comprehensive health insurance, which is a system of compulsory insurance, was introduced in the year 1961 in Japan. Under the current national health insurance, patients pay 30% of medical expenses (20% for age over 70 and under six). Therefore, it seems unconvincing to believe that access to medical services is denied for financial reasons under the national health insurance system in Japan, when serious symptoms of mental illness require hospitalization.

allowance. Therefore, this channel through which average personal income affects the suicide rate is captured by the direct effects of policy. Second and most crucial, comparable prefectural data of prefectural income (per capita) or gross prefectural product (per capita) is, to our knowledge, not available for longitudinal analysis. The Cabinet Office compiles and publicizes prefectural data for the economy in Japan. The present series of data are calculated on the basis of the 93SNA (1993 System of National Account). This method was applied for the 1996 data and since, but not retrospectively. Since prefectural data for the economy are calculated with different calculation methods between prior and posterior to 1996, the two different time series are incomparable. We choose to leave the variable of average income, instead of attempting arbitrary transformation of the data or of *ad hoc* joint of the two different series, both of which would cause serious measurement errors.

Education may be a significant determinant of suicide. We employ the ratio of senior high school graduates going to further education as a measure of educational level. Admittedly, this education variable reflects flow rather than stock of education. It is clear that ratio of going to further education in a certain year is not necessarily a good sample of educational level of the entire population. However, no superior alternative is available.

To test the Durkheim (1897) supposition of social integrity, this study employs birth rate, densely inhabited districts, divorce rate, one person households, and female labor force participation. As the first two variables are expected to have a negative association with the suicide rate, the second two variables are expected to be positively correlated with the suicide rate. Female labor force participation is another

important measure of social integrity. Female participation in the labor force creates role conflicts and hence decreases social integration, whereas it strengthens social bonds in the workplace and increases social integration. Since these two opposite effects offset each other, the net impact of female labor participation on suicide depends on the relative importance of these two effects (Yang 1992). The expected sign of the estimated coefficients of female labor participation is *a priori* unknown.

Social policy by central and local governments may be effective in suicide prevention. As policy variables, we employ livelihood protection allowance, and welfare expenditure. A variable for livelihood protection allowance is persons assisted by livelihood protection per 1,000 persons. Welfare expenditure is welfare expenditure per capita by prefecture and municipality. In the case that these policies are effective in reducing the suicide rate, their estimated coefficients are expected to have negative signs. Inclusion of these controls is empirical regularities in the suicide empirics, and hence this study follows them.

5. Estimation Results

Table 1 summarizes the estimated results on male suicide rates. The coefficient of unemployment rate has a positive sign and is statistically significant at the 1% significance level, suggesting that unemployment is a risk factor for male suicide. The coefficient of mental illness has an expected positive sign and is highly significant, suggesting that serious mental illness is associated with high male suicide rate. The coefficient of livelihood protection is negative and statistically significant at the 1% significance level, indicating that supporting poor households with livelihood protection leads to lower male suicide rate.

Meanwhile, we found no statistical evidence that other variables are strongly associated with male suicide in Japan. These results are robust to addition of control variables. When one of the measures related to criminal offence, larceny, and welfare commissioners is added, our main results remain almost identical.

We paid careful attention to Hyogo prefecture, which experienced a major earthquake in January 1995. More than 6,400 people died, over 300,000 people were evacuated, and 100,000 houses were completely destroyed in the earthquake. While inhabitants experienced acute mental stress and trauma which was caused by tremendous loss in this unanticipated natural disaster, some suicides in the prefecture after the earthquake might have been driven by such sudden loss. Therefore, it is possible that the suicide rates in Hyogo prefecture after the earthquake are exceptional because they may not have been determined by standard socioeconomic factors and the mental illness variable, and not captured by region-specific, period-specific effects. However, our preferred regression remains almost identical when Hyogo prefecture is excluded from our sample.

Table 1. Male suicide rate and socioeconomic factors

	Two-way fixed effects Preferred model	Two-way fixed effects	Two-way fixed effects	Two-way fixed effects	Two-way fixed effects Without Hyogo prefecture
<i>Unemployment rate (male)</i>	1.97** (4.47)	1.98** (4.50)	1.98** (4.49)	1.97** (4.46)	1.97** (4.43)
<i>Mental illness</i>	0.021* (2.48)	0.019* (2.26)	0.020* (2.34)	0.020* (2.41)	0.021* (2.43)
<i>Further education</i>	-0.020 (-0.28)	-0.0068 (-0.094)	-0.012 (-0.17)	-0.018 (-0.24)	-0.012 (-0.16)
<i>Birth rate</i>	-0.13 (-0.38)	-0.12 (-0.35)	-0.12 (-0.36)	-0.13 (-0.37)	-0.12 (-0.36)
<i>Female labor force participation</i>	-0.19 (-1.57)	-0.16 (-1.28)	-0.17 (-1.43)	-0.19 (-1.58)	-0.17 (-1.37)
<i>Densely inhabited districts</i>	-0.019 (-0.20)	-0.030 (-0.30)	-0.025 (-0.26)	-0.018 (-0.18)	-0.017 (-0.17)
<i>Divorce rate</i>	3.23 (1.51)	3.72 (1.70)	3.55 (1.62)	3.27 (1.51)	3.26 (1.50)
<i>One person households</i>	0.078 (0.32)	0.11 (0.45)	0.10 (0.41)	0.082 (0.33)	0.062 (0.25)
<i>Livelihood protection</i>	-0.22** (-2.85)	-0.23** (-2.91)	-0.23** (-2.90)	-0.22** (-2.75)	-0.21** (-2.66)
<i>Welfare expenditure</i>	0.0084 (0.41)	0.0021 (0.098)	0.0050 (0.24)	0.0081 (0.40)	0.018 (0.70)
<i>Criminal offences</i>		-0.098 (-1.12)			
<i>Larceny offences</i>			-0.069 (-0.70)		
<i>Welfare Commissioners</i>				0.0033 (0.12)	
<i>Constant</i>	20.34* (2.03)	19.57 (1.95)	19.94* (1.98)	19.51 (1.61)	18.30 (1.74)
<i>Prefecture-specific effects included?</i>	Yes	Yes	Yes	Yes	Yes
<i>Period-specific effects included?</i>	Yes	Yes	Yes	Yes	Yes
<i>Adjusted R²</i>	0.84	0.84	0.84	0.84	0.84
<i>F-statistic (prob.)</i>	F[62, 266] = 28.43 (0.00)	F[63, 265] = 28.03 (0.00)	F[63, 265] = 27.94 (0.00)	F[63, 265] = 27.88 (0.00)	F[61, 260] = 28.09 (0.00)
<i>Hausman test (p-value)</i>	45.90 (0.00)	49.70 (0.00)	48.40 (0.00)	42.43 (0.00)	43.62 (0.00)
<i>No. of prefectures</i>	47	47	47	47	46
<i>No. of observations</i>	329	329	329	329	322

Note: The dependent variable is the age-adjusted male suicide rate. Figures in parentheses are *t*-statistics. ** and * indicate significance at the 1% and 5% significance levels, respectively. The Hausman test estimates a fixed effects model vs. a random effects model.

Table 2. Female suicide rate and socioeconomic factors

	Two-way fixed effects Preferred model	Two-way fixed effects	Two-way fixed effects	Two-way fixed effects	Two-way fixed effects Without Hyogo prefecture
<i>Unemployment rate (female)</i>	-0.51 (-1.47)	-0.45 (-1.30)	-0.45 (-1.28)	-0.54 (-1.53)	-0.49 (-1.39)
<i>Mental illness</i>	0.0016 (0.35)	0.00039 (0.08)	0.00049 (1.03)	0.0026 (0.54)	0.0015 (0.32)
<i>Further education</i>	-0.0011 (-0.03)	0.010 (0.26)	0.0096 (0.24)	-0.013 (-0.32)	-0.00073 (-0.018)
<i>Birth rate</i>	0.52** (2.71)	0.54** (2.79)	0.54** (2.79)	0.50** (2.59)	0.52** (2.65)
<i>Female labor force participation</i>	0.22** (3.27)	0.25** (3.57)	0.24** (3.53)	0.23** (3.32)	0.24** (3.39)
<i>Densely inhabited districts</i>	0.11 (1.90)	0.095 (1.71)	0.096 (1.72)	0.10 (1.81)	0.10 (1.79)
<i>Divorce rate</i>	-0.54 (-0.44)	-0.18 (-0.14)	-0.15 (-0.12)	-0.73 (-0.58)	-0.54 (-0.43)
<i>One person households</i>	0.058 (0.42)	0.084 (0.61)	0.088 (0.64)	0.036 (0.26)	0.043 (0.31)
<i>Livelihood protection</i>	-0.086* (-1.99)	-0.091* (-2.12)	-0.094* (-2.17)	-0.096* (-2.19)	-0.079 (-1.81)
<i>Welfare expenditure</i>	-0.0015 (-0.13)	-0.0074 (-0.61)	-0.0068 (-0.56)	0.000016 (0.001)	0.0018 (0.12)
<i>Criminal offences</i>		-0.084 (-1.70)			
<i>Larceny offences</i>			-0.097 (-1.73)		
<i>Welfare Commissioners</i>				-0.018 (-1.17)	
<i>Constant</i>	-8.17 (-1.44)	-8.84 (-1.57)	-8.74 (-1.55)	-3.75 (-0.55)	-8.70 (-1.48)
<i>Prefecture-specific effects included?</i>	Yes	Yes	Yes	Yes	Yes
<i>Period-specific effects included?</i>	Yes	Yes	Yes	Yes	Yes
<i>Adjusted R²</i>	0.72	0.72	0.72	0.72	0.71
<i>F-statistic (prob.)</i>	F[62, 266] = 14.46 (0.00)	F[63, 265] = 14.38 (0.00)	F[63, 265] = 14.38 (0.00)	F[63, 265] = 14.27 (0.00)	F[61, 260] = 14.14 (0.00)
<i>Hausman test (p-value)</i>	40.03 (0.00)	45.58 (0.00)	46.05 (0.00)	37.79 (0.00)	37.08 (0.00)
<i>No. of prefectures</i>	47	47	47	47	46
<i>No. of observations</i>	329	329	329	329	322

Note: The dependent variable is the age-adjusted female suicide rate. Figures in parentheses are *t*-statistics. ** and * indicate significance at the 1% and 5% significance levels, respectively. The Hausman test estimates a fixed effects model vs. a random effects model.

Table 2 presents the estimated results of the female suicide rate. The coefficient of female labor force participation has a positive sign and is statistically highly significant. This can be interpreted in the following two ways. One is that psychological stress at the workplace and role conflicts leads to an increase in the female suicide rate. Our evidence accords with a nation-wide survey by the Ministry of Health, Labour and Welfare (2009), which reveals that working Japanese women are more likely to suffer from stress than those outside the labor force (56.6% and 49.2%, respectively). Since job stress and job insecurity in low-class occupations are greater among women than men in Japan (Kawakami *et al.* 2004), working Japanese women are exposed to a higher level of stress than working men. In contrast, women outside the labor force and female home-makers are protected from the stresses of the workplace (Kawachi and Kondo 2007). Another possible interpretation of the positive effect of female labor force participation is that a high level of female labor force participation can reflect poverty. According to classical empirical works by Douglas (1934) and Arisawa (1956), family members in poor households are more likely to participate in the labor force.¹⁷ Assuming that this prediction is true, in a society where the traditional male role is income-earning, women in poor households are more likely to participate in the labor force than those in rich families. Although the traditional gender roles tend to become outdated among young cohort in recent years in Japan (Ohara 2001), the Douglas-Arisawa proposition seems to apply to Japan for the period under investigation in this study. Therefore, our finding on the positive effect of female labor force participation indicates that low household-income and its related factors are associated with high female

¹⁷ See Ohtake (2005) for further discussion.

suicide rates.

The coefficient of birth rate has a positive sign and is statistically significant. The same argument as stated above also explains the estimated positive effect of birth rate on female suicide rates. Poor households tend to have more children than rich ones, since the opportunity cost of bearing children is lower in low-income households than in high-income households. The coefficient of livelihood protection is negative and statistically significant, indicating that financial support to poor households by government is effective in lowering female as well as male suicide rates. Unemployment, mental illness and the other socioeconomic factors are found statistically insignificant in regressions of female suicide rates. The statistical results are robust to addition of control variables. When Hyogo prefecture was excluded from our sample, our preferred model remains unchanged.

Tables 3 and 4 summarize the results of further robustness tests of our preferred models of male and female suicide rates, respectively. When each prefecture was excluded once from the sample, our preferred model of male suicide maintains its robustness. In the robustness test, our preferred model of female suicide is less robust to the male counterpart, but it is still substantially robust where the 10%, instead of the 5%, significance level is applied.

Table 3. Robustness tests of our preferred model of male suicide

	<i>Prefecture excluded</i>	<i>Do the three variables remain significant at the 5 % level and hold the same sign? If no, insignificant variables out of the three variables are listed. However, if the variable is significant at the 10% level, (10) is also shown.</i>	<i>Do the other variables remain insignificant at the 5 % level? If no, significant variables are listed with the sign of their coefficients.</i>	<i>Adjusted-R²</i>
1	Hokkaido	Yes	Yes	0.84
2	Aomori	Yes	Yes	0.84
3	Iwate	Yes	Yes	0.83
4	Miyagi	Yes	Yes	0.84
5	Akita	Yes	Divorce rate (+)	0.83
6	Yamagata	Yes	Yes	0.84
7	Fukushima	Yes	Yes	0.84
8	Ibaraki	Yes	Yes	0.84
9	Tochigi	Yes	Yes	0.84
10	Gunma	Yes	Yes	0.84
11	Saitama	Yes	Yes	0.84
12	Chiba	Yes	Yes	0.84
13	Tokyo	Yes	Yes	0.84
14	Kanagawa	Yes	Yes	0.84
15	Niigata	Yes	Yes	0.84
16	Toyama	Yes	Yes	0.84
17	Ishikawa	Yes	Yes	0.84
18	Fukui	Yes	Yes	0.84
19	Yamanashi	Yes	Yes	0.84
20	Nagano	Yes	Yes	0.84
21	Gifu	Yes	Yes	0.84
22	Shizuoka	Yes	Yes	0.84
23	Aichi	Yes	Yes	0.84
24	Mie	Yes	Yes	0.84
25	Shiga	Yes	Yes	0.84
26	Kyoto	Yes	Yes	0.84
27	Osaka	Yes	Yes	0.84
28	Hyogo	Yes	Yes	0.84
29	Nara	Yes	Yes	0.84
30	Wakayama	Yes	Yes	0.84
31	Tottori	Yes	Yes	0.85
32	Shimane	Yes	Yes	0.84
33	Okayama	Yes	Yes	0.84
34	Hiroshima	Yes	Yes	0.84
35	Yamaguchi	Yes	Yes	0.84
36	Tokushima	Yes	Female LF participation (-)	0.85
37	Kagawa	Yes	Yes	0.84
38	Ehime	Yes	Yes	0.84
39	Kochi	Mental illness	Yes	0.84
40	Fukuoka	Yes	Yes	0.84
41	Saga	Yes	Yes	0.84
42	Nagasaki	Yes	Yes	0.84
43	Kumamoto	Yes	Yes	0.84
44	Ooita	Yes	Yes	0.84
45	Miyazaki	Yes	Yes	0.84
46	Kagoshima	Yes	Yes	0.84
47	Okinawa	Mental illness	Female LF participation (-)	0.84

Note: The dependent variable is the age-adjusted male suicide rate.

Table 4. Robustness tests of our preferred model of female suicide

	<i>Prefecture excluded</i>	<i>Do the three variables remain significant at the 5 % level and hold the same sign? If no, insignificant variables out of the three variables are listed. However, if the variable is significant at the 10% level, (10) is also shown.</i>	<i>Do the other variables remain insignificant at the 5 % level? If no, significant variables are listed with the sign of their coefficients.</i>	<i>Adjusted-R²</i>
1	Hokkaido	Livelihood protection (10)	DIDP (+)	0.72
2	Aomori	Livelihood protection	UNEMF(-), DIDP(+)	0.73
3	Iwate	Yes	Yes	0.70
4	Miyagi	Yes	Yes	0.72
5	Akita	Yes	Yes	0.71
6	Yamagata	Livelihood protection (10)	Yes	0.72
7	Fukushima	Livelihood protection (10)	Yes	0.72
8	Ibaraki	Livelihood protection (10)	Yes	0.72
9	Tochigi	Yes	Yes	0.72
10	Gunma	Yes	Yes	0.71
11	Saitama	Livelihood protection (10)	Yes	0.72
12	Chiba	Yes	Yes	0.72
13	Tokyo	Yes	DIDP(+)	0.72
14	Kanagawa	Yes	Yes	0.71
15	Niigata	Yes	Yes	0.71
16	Toyama	Livelihood protection (10)	DIDP (+)	0.72
17	Ishikawa	Yes	Yes	0.72
18	Fukui	Yes	Yes	0.72
19	Yamanashi	Livelihood protection (10)	DIDP (+)	0.73
20	Nagano	Yes	Yes	0.72
21	Gifu	Livelihood protection (10)	Yes	0.71
22	Shizuoka	Yes	Yes	0.71
23	Aichi	Livelihood protection (10)	DIDP (+)	0.72
24	Mie	Yes	Yes	0.71
25	Shiga	Livelihood protection (10)	DIDP (+)	0.72
26	Kyoto	Yes	Yes	0.71
27	Osaka	Yes	Yes	0.72
28	Hyogo	Livelihood protection (10)	Yes	0.71
29	Nara	Livelihood protection (10)	DIDP (+)	0.72
30	Wakayama	Yes	Yes	0.72
31	Tottori	Yes	DIDP(+)	0.72
32	Shimane	Yes	Yes	0.72
33	Okayama	Yes	Yes	0.72
34	Hiroshima	Livelihood protection (10)	DIDP (+)	0.72
35	Yamaguchi	Livelihood protection (10)	Yes	0.72
36	Tokushima	Yes	DIDP(+)	0.72
37	Kagawa	Livelihood protection (10)	Yes	0.72
38	Ehime	Livelihood protection (10)	Yes	0.72
39	Kochi	Livelihood protection (10)	Yes	0.73
40	Fukuoka	Yes	Yes	0.72
41	Saga	Livelihood protection (10)	DIDP (+)	0.72
42	Nagasaki	Livelihood protection (10)	Yes	0.72
43	Kumamoto	Yes	Yes	0.72
44	Ooita	Yes	Yes	0.72
45	Miyazaki	Livelihood protection (10)	Yes	0.72
46	Kagoshima	Yes	Yes	0.72
47	Okinawa	Livelihood protection	Yes	0.72

Note: The dependent variable is the age-adjusted female suicide rate.

6. Conclusions

Although exploring suicide is a multi-disciplinary subject and mental illness is a well-documented risk factor in suicide, past statistical studies failed to consider mental illness in the search for socioeconomic factors of suicide. As a result, omitted variable bias is a serious concern in the literature. Unlike past studies, we attempted to bypass this problem in order to detect the true determinants of suicide in Japan. Introducing a new measure of mental illness to the regression procedure, this study investigated socioeconomic determinants of suicide in Japan, the country with the highest suicide rate among developed countries, with panel data of 47 prefectures for the period 1975 to 2005. With respect to men, after controlling prefecture-specific and time-specific effects, high unemployment rate, serious mental illness and insufficient livelihood protection are found to be the principal determinants of male suicide in Japan. The determinants of female suicide are less clear than those of their male counterparts. Our evidence suggests that more female participation in the labor force, high birth rate, and insufficient livelihood protection are associated with high female suicide. Low household income is likely to represent the high female labor force participation and high birth rate, and hence needs to be the object of further discussions. Our statistical evidence is robust to the addition of control variables and to the exclusion of each prefecture.

These large differences in the determinants of suicide between genders suggest that fine-tuned policy for suicide prevention needs to be sensitively drafted according to gender. It is worth emphasizing that insufficient livelihood protection is the only common determinant of male and female suicides, indicating that financial support by government to poor households is an effective measure to prevent

suicide. A wide-ranging livelihood protection by government will cover more than poor individuals' everyday expenses.

The author wishes to point out that evidence from this study of aggregate-level data might possess limited utility and terminable usability for policy recommendations. If individual-level data on suicides' detailed personal backgrounds becomes available for the purpose of research in Japan in the future, our empirical design and findings need to be reexamined taking such data into account. Until then, the evidence from the present study stays on the active list, drawing social scientists' attention to the concern of omitted variable bias in the suicide empirics where mental illness has been ignored all this while.

Appendix 1. Mental illness and suicide rate by prefecture, 1975-2005

<i>Prefecture</i>	<i>Mental illness</i>		<i>Male suicide rate</i>		<i>Female suicide rate</i>	
	<i>Average</i>	<i>Rank</i>	<i>Average</i>	<i>Rank</i>	<i>Average</i>	<i>Rank</i>
Hokkaido	358.4	14	28.8	11	12.1	20
Aomori	294.1	24	33.1	5	12.2	17
Iwate	316.7	19	35.8	2	15.7	2
Miyagi	204.6	38	24.5	32	11.9	24
Akita	350.5	15	39.7	1	15.9	1
Yamagata	237.7	35	28.5	13	12.5	15
Fukushima	364.3	13	26.8	23	12.1	20
Ibaraki	273.3	28	24.7	30	11.8	25
Tochigi	273.4	27	27.0	21	13.0	9
Gunma	263.1	30	26.8	24	13.9	4
Saitama	171.2	45	22.4	40	12.2	19
Chiba	205.1	37	22.3	42	10.8	36
Tokyo	203.2	40	22.0	43	11.4	29
Kanagawa	153.2	47	21.2	47	10.3	43
Niigata	287.3	25	32.3	7	14.8	3
Toyama	320.9	17	28.1	15	13.4	7
Ishikawa	320.3	18	24.1	35	10.1	44
Fukui	247.0	33	23.9	37	10.4	42
Yamanashi	297.2	23	27.1	20	11.6	27
Nagano	246.1	34	25.6	27	12.5	14
Gifu	192.6	41	24.7	31	13.9	4
Shizuoka	185.2	44	23.1	38	9.8	45
Aichi	188.8	42	21.8	44	12.1	20
Mie	276.9	26	21.7	45	10.9	35
Shiga	164.3	46	22.3	41	11.3	30
Kyoto	258.1	31	24.4	34	12.2	18
Osaka	221.7	36	25.4	28	12.4	16
Hyogo	204.4	39	25.8	25	12.7	11
Nara	188.6	43	21.6	46	11.0	34
Wakayama	252.6	32	28.2	14	13.5	6
Tottori	298.4	22	27.6	17	10.6	40
Shimane	307.4	21	34.3	4	13.1	8
Okayama	267.1	29	22.8	39	9.7	46
Hiroshima	309.7	20	25.2	29	11.3	31
Yamaguchi	393.0	10	27.8	16	12.7	13
Tokushima	494.4	3	23.9	36	11.1	32
Kagawa	368.6	11	24.5	33	11.7	26
Ehime	326.6	16	27.1	19	11.5	28
Kochi	466.0	6	31.5	9	11.9	23
Fukuoka	422.7	8	28.7	12	10.8	37
Saga	454.7	7	26.8	22	10.4	41
Nagasaki	514.9	2	29.8	10	11.1	33
Kumamoto	469.9	5	25.7	26	10.8	38
Ooita	417.7	9	27.5	18	10.7	39
Miyazaki	481.9	4	35.7	3	12.7	12
Kagoshima	535.3	1	32.3	6	12.8	10
Okinawa	365.2	12	32.1	8	9.1	47

Note: Suicide rates are age-adjusted.

Appendix 2. Data source and descriptive statistics of variables

<i>Variable</i>	<i>Definition</i>	<i>Source</i>	<i>Mean</i>	<i>SD</i>	<i>Min.</i>	<i>Max.</i>
Age-adjusted male suicide rate (SUIM)	Age-adjusted suicide death rate by prefecture, male (per 100,000 population)	Ministry of Health labour and welfare (2007)	26.96	6.59	14.6	52.2
Age-adjusted female suicide rate (SUIF)	Age-adjusted suicide death rate by prefecture, female (per 100,000 population)	As above	11.92	2.81	6.3	22.4
Mental illness (PSYINP)	Daily average of psychotic inpatients in mental and general hospital (per 100,000 persons)	Author's calculation (Leap years are taken into consideration.)	306.69	103.55	143.83	587.59
Psychotic inpatient (PSYIN)	Total number of psychotic inpatients in mental and general hospitals (thousand persons)	Ministry of Health labour and welfare (2008)	2532	1871	595	9385
Male unemployment rate (UNEMM)	Unemployment rate [male]	Ministry of Internal Affairs and Communications (2009)	4.13	1.84	1.4	13.7
Female unemployment rate (UNEMF)	Unemployment rate [female]	As above	2.96	1.41	0.8	9.3
Birth rate (BIRTH)	Crude birth rate (per 1,000 persons)	As above	11.30	2.86	6.72	21.46
Criminal offence (CRIMI)	Recognitions of criminal offences (per 1,000 population)	As above	12.13	4.33	5.42	30.63
Densely inhabited districts pop. (DIDP)	Ratio of DIDPs (Densely Inhabited Districts) population	As above	47.75	18.61	21.8	98.0
Divorce rate (DIVOR)	Rate of divorces (per 1,000 persons)	As above	1.43	0.44	0.63	2.72
Female labor force participation (FELFP)	Labor force participation rate (female) (%)	As above	49.10	4.09	35.7	59.50
Further education (FUREDU)	Ratio of senior high graduates going to further education (%)	As above	36.19	9.14	18.1	61.20
Larceny offence (LARCE)	Recognitions of larceny offences (per 1,000 population)	As above	10.29	3.75	4.61	27.24
Livelihood protection recipient (LIVEPR)	Persons assisted by livelihood protection per 1,000 persons (monthly average)	As above	9.91	6.28	1.83	39.50
One person household (ONEPH)	Ratio of one person households (%)	As above	18.78	6.68	6.77	42.53
Welfare expenditure (WELEX)	Welfare expenditure per capita (prefecture and municipality) (thousand yen)	As above	80.38	41.80	16.4	186.20
Welfare commissioner (WELCOM)	Welfare commissioners (per 100,000 persons) This variable represents the number of volunteer workers for welfare.	As above	185.66	46.30	65.6	305.90

Male population (POPM)	Total population [male] (thousand persons)	As above	1273	1199	277	6265
Female population (POPF)	Total population [female] (thousand persons)	As above	1322	1188	304	6312

Note: The data are prefectural figures. The dataset is balanced panel data, and the number of observations is 329 for all the variables.

Appendix 3. Correlation matrix (n = 329)

	SUIM	SUIF	UNEM M	UNEM F	JOBVA	PSYINP	BIRTH	ONEPH	DIDP	DIVOR	FELFP	CRIMI	LARCE	FURED U	LIVEP R	WELE X	WELC OM
SUIM	1.000																
SUIF	0.140	1.000															
UNEMM	0.503	-0.438	1.000														
UNEMF	0.426	-0.508	0.957	1.000													
JOBVA	-0.382	-0.040	-0.367	-0.360	1.000												
PSYINP	0.326	-0.066	0.290	0.149	-0.271	1.000											
BIRTH	-0.254	0.571	-0.457	-0.493	-0.174	-0.111	1.000										
ONEPH	0.287	-0.564	0.683	0.759	-0.121	0.113	-0.726	1.000									
DIDP	-0.210	-0.206	0.233	0.396	-0.040	-0.391	-0.097	0.457	1.000								
DIVOR	0.460	-0.500	0.840	0.894	-0.332	0.134	-0.563	0.823	0.394	1.000							
FELFP	0.075	0.080	-0.305	-0.352	0.279	0.092	-0.105	-0.154	-0.531	-0.278	1.000						
CRIMI	0.032	-0.331	0.463	0.561	-0.101	-0.262	-0.323	0.599	0.625	0.653	-0.339	1.000					
LARCE	-0.037	-0.338	0.397	0.505	-0.103	-0.244	-0.285	0.542	0.613	0.606	-0.344	0.979	1.000				
FURED U	0.063	-0.410	0.370	0.408	0.023	-0.211	-0.467	0.607	0.292	0.518	-0.150	0.522	0.458	1.000			
LIVEP R	0.190	0.141	0.347	0.257	-0.505	0.439	0.280	0.022	0.141	0.177	-0.375	0.103	0.084	-0.185	1.000		
WELEX	0.461	-0.550	0.734	0.746	-0.146	0.266	-0.800	0.850	0.119	0.776	-0.037	0.377	0.315	0.574	0.009	1.000	
WELCOM	0.455	-0.068	0.162	0.041	-0.119	0.391	-0.394	0.133	-0.641	0.088	0.364	-0.304	-0.334	0.138	-0.079	0.459	1.000

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