An Economic Interpretation of Suicide Cycles in Japan

Jahyeong Koo
and
W. Michael Cox

Research Department
Working Paper 0603

Federal Reserve Bank of Dallas

An Economic Interpretation of Suicide Cycles in Japan

Jahyeong Koo and W. Michael Cox*

September 15, 2006

Abstract: Suicide rates in Japan have increased dramatically in recent years, making. Japan's male rate the highest among developed economies. This study revises the standard economic model of suicide to accommodate Japan's experience, focusing on the change in human capital for the unemployed. We then use the new model and de-trended data to empirically investigate the relationship between the suicide cycle and the unemployment cycle. Unlike previous aggregate time series studies, we find that the relationship between the suicide rate and the unemployment rate is significantly and robustly positive for both males and females even after controlling for several social variables.

Keywords: suicide, cycles, unemployment, Japan
JEL classification: I12; J60; E30

---

* We thank Genevieve Solomon for excellent research assistant. We also thank two anonymous referees and seminar participants at the Federal Reserve Bank of Dallas for comments on an earlier draft that led to significant improvements in the paper. The views in this paper are those of the authors and not necessarily the views of the Federal Reserve Bank of Dallas or the Federal Reserve System.

Koo: Economist, Research Department, Federal Reserve Bank of Dallas, 2200 N. Pearl St. Dallas, TX 75201. Phone 1-214-922-5179, Fax 1-214-922-5194, E-mail address jahyeong.koo@dal.frb.org

Cox: Senior Vice President and Chief Economist, Research Department, Federal Reserve Bank of Dallas, 2200 N. Pearl St. Dallas, TX 75201. Phone 1-214-922-5150, Fax 1-214-922-5194, E-mail address wm.cox@dal.frb.org

An Economic Interpretation of Suicide Cycles in Japan

I. Introduction

Since the early 1990s, Japan has experienced a tremendous increase in its suicide rate, especially among middle-aged males. At the same time, most other industrialized countries have seen suicide rates fall or increase only mildly [Figure 1]. Although Japan has a culture that is more accepting of suicide than societies with Christian roots, the recent surge in the suicide rate has drawn the attention of policy makers and economists. The rate is unprecedented, and the suicide epidemic is probably related to the economic recession that the world's second biggest economy has suffered [Figure 2].

The male suicide rate in Japan in 2003 was 37.5 deaths per 100,000 persons—more than twice the U.S. rate of 17.8 deaths per 100,000 in 2002. Japan currently has the highest suicide rate among developed nations. The male rate is only lower than the suicide rates of the former Soviet Union and East European countries, which have endured a long and difficult economic transition, and Sri Lanka, which has suffered a long civil war. Japan's male suicide rate almost doubled from 1990 to 2003, a time when the country was in an economic recession. Japanese unemployment rates increased from 2.1 percent in 1990 to 5.3 percent in 2004. An unemployment rate of 5.3 percent may look quite healthy from European and U.S. perspectives, but it represents significant hardship in a country where the average unemployment rate for the last five decades has been 2.3 percent.

In standard economic models, suicide is considered a decision that a rational, optimizing agent makes when his expected remaining lifetime utility falls below a certain

threshold.[1] Suicide rates, therefore, should be higher when perceived lifetime incomes decrease. Models that follow the rational choice approach predict that the old age cohorts will have higher suicide rates, all other things being equal, as the costs of maintaining health increase with age.[2]

Empirical research, however, does not always support the theory. Most of the work on suicide uses the unemployment rate as a measure of economic hardship and lifetime earnings because measuring an agent's perceived lifetime income is not easy in practice. Empirical tests involving panel data show a strong correlation between unemployment and suicide (see Platt, 1984; Ruhm, 2000; Gerdtham and Johannesson, 2003), but studies with aggregated time-series data produce mixed results on at least two key points. First, the relationship between unemployment and suicide tends to be less sensitive in empirical models that incorporate more social variables, such as age, religion and divorce rates (Yang 1992, 1994). Second, aggregate time-series research often finds gender differences in responding to economic hardship. Vigderhous and Fishman (1978), Yang (1992), Brainerd (2001) and others report that female suicide does not respond at all (or at best shows little sensitivity) to unemployment compared with male suicide in the countries they examined.

A monotonically increasing relationship between age and suicide has been documented since Durkheim (1897) for many countries. However, the relationships have disappeared as youth suicide rates have surged and overall suicide rates have declined in

[1] Hamermesh and Soss (1974) formulate an economic model of suicide that treats individuals as rational, optimizing agents. Marcotte (2003) extended the Hamermesh and Soss framework to analyze nonfatal suicide attempts. Cutler, Glaeser and Norberg (2000) and Mathur and Freeman (2002) examine theories of youth suicide.

[2] In the Hamermesh and Soss (1974) setup, the age-specific rates depend upon the distribution of distastes for suicide and the distribution of permanent incomes.

developed countries, including the U.S. and U.K. In the U.S., the suicide rates of young adults (ages 20-24) are equal to those for prime-age adults (Cutler et. al. 2000). In former Soviet Union countries, the suicide rates of prime-age adults rose dramatically in the 1990s. This distribution of suicide rates by age follows an observed recent pattern of the labor markets in former Soviet countries (Brainard 2001).

Revising the Hamermesh and Soss (1984) setup and using filtered time series data, this article assesses how well an economic model can explain suicide cycles in Japan. An individual's economic and social conditions likely play an important role in suicidal behavior, although we acknowledge the influence of many non-economic and non-socioeconomic factors on the decision, such as physical and psychiatric illness.

In our revised model, we explain the cases where suicide is not a monotonically increasing function of age. In Japan, the suicide rate of middle-aged males has surged more than any other group. The model is also refined to incorporate the relationship between the suicide rate and the divorce rate, the most frequently examined social variable. We add the fertility rate, the female labor market participation rate, and alcohol consumption to control for the role of social variables in estimating the relationship between economic factors and suicide rate cycles in Japan.

II. Suicide in Japan: An overview

According to the standard model, suicide rates are positively correlated with income and age. In Japan, however, this simple framework has not served well to explain the rise in the country's suicide rates. Suicide trends by sex and age have not followed the standard theory's predictions.

In Japan, as in most other countries, the female suicide rate is lower than the male rate during the period we examine (1950 -2003). However, the male suicide rate shows a distinctive upward trend, whereas the female rate has been declining (Figure 2). The female suicide rate is not positively correlated with the unemployment rate. We suspect that improving social conditions for women have led to the downward sloping trend of the female suicide rate, thus any regression analysis which does not control for the trend of woman's status might end up with a negative or insignificant relationship between female suicide and unemployment[3]. Furthermore, running a regression that invloves non-stationary variables with trends can result in a complicated econometric problem of spurious regression.

If we focus on the cyclical components of the time series, even a casual look reveals a positive correlation between the unemployment rate and both the male and female suicide rates. During our sample period, Japan experienced three peaks of suicide rates which correspond to aggregate economic conditions. The first peak was during the mid-1950s, the second was after the second oil crisis and the third was the result of the economic recession of the 1990s. The cyclical components of the suicide rate in Japan were high when the unemployment rate cycles were high.

As the standard model predicts, female suicide rates in Japan increase with age. The patterns do not change when we compare the statistics of 1988, 1993, 1998, and 2003 (Figure 3). Male suicide rates show a significant hump shape for the middle-aged group between age 45 and 60 during the years 1998 and 2003. This pattern is not found in

[3] Durkheim (1897) described women's suicide in the 19th century as a byproduct of 'excessive regulation' that manifests itself in the form of women's their subordinate social status. In China today, the female suicide rate in the rural area is three times that in the cities. The relatively lower social status of women in rural area is considered to be a major cause of higher rural female suicide rates (Lee and Kleinman 2000).

other developed economies and is not clearly predicted by standard suicide models. We conjecture that changes in the labor market in Japan, including the devaluation of human capital to older unemployed workers and small business owners, is related to the high suicide rate of the middle age group.

III. An Economic model of suicide

To accommodate the patterns of Japanese suicide cycles and the distribution of suicide among age groups, we refine the standard suicide model first laid out by Hammermesh and Soss (1974) and assess how well our economic model explains the patterns of Japanese suicide cycles and the distribution of suicide among age groups.

Our revised model follows the framework of the standard model by assuming that individuals decide to commit suicide if the expected lifetime utility falls below a certain threshold. The utility function for an individual in the standard model is defined as,

$$U_m = U\,[C\,(m,\,Y) - K(m)] \tag{1}$$

where m is the individual's age, Y is income that could be devoted to consumption C, K is the cost of maintaining health in each year (presumably $K' > 0$). Then the discounted present value of an individual's lifetime utility at age α is:

$$Z(\alpha\,,\,Y) = \int_{\alpha}^{\omega} e^{-r(m-\alpha)}\, U_m\, P(m)\, dm \tag{2}$$

where r is the discount rate, ω is maximum life expectancy, $P(m)$ is the probability of living to age m at given age α. An individual chooses suicide when the discounted utility, $Z(\alpha\,,\,Y)$, falls below some critical threshold. Since Z is a decreasing function of α (due to the increasing cost of maintaining health with age) and an increasing function of Y, the model predicts that suicide propensity rises with age and falls with income.

By modeling the valuation of the discounted benefits and costs of living, this framework captures the essential element of an individual's decision to commit suicide. But with this formulation we cannot explain important aspects of the time series of Japanese suicide.

First, despite the prolonged recession, per capita real GDP continued to grow in Japan at an average rate of 1.1 percent a year during the 1990s, and labor's share of output peaked in the same period.[4] The observations are contradictory to the model, because while male suicide rose, average income continued to rise and the income distribution flattened during the 1990s.

Second, the simple model cannot account for the high suicide rate of middle-aged males shown in Figure 3B. Lacking any explicit treatment of the link between unemployment and lifetime income, the simple model fails to explain why the expected utility of middle-aged males drops so precipitously in the face of worsening economic conditions.

Third, some changes in social variables, such as the divorce rate, can be partly explained by rising unemployment. By including social variables, we can test whether their relationships to suicide are a simple reflection of the change of economic conditions. To accommodate these aspects of suicidal behavior in Japan, we revise the standard model. We also extend the setup to account for the indirect impact of unemployment on suicide through the divorce rate, which is the most frequently mentioned social variable in the literature.

[4] According to Miyanaga (2002), labor's share in Japan averaged 80.2 percent in 1990s—the highest among any 10-year window from 1955 to 2000. Labor's share during the whole sample period averages 76.8 percent.

In our revised model, relative income is measured as the distance to the social mean income at time *t*. So the suicide rate is not a monotonically decreasing function of the aggregate income level in time series analysis. It corresponds to the observation that suicide rates have not necessarily been lower after the decades of rapid economic growth. Relative income is an increasing function of human capital *h*, which is constant as long as an individual is employed. It depreciates if he is unemployed, reflecting the fact that the unemployed lose the opportunity to maintain human capital through on the job training. During periods of economic transition driven by technological shocks or regime shifts, the human capital of the unemployed depreciates faster. The diminished human capital drives down the expected relative lifetime utility of unemployed individuals faster than during a normal period.

The equation of discounted present value of an individual's relative lifetime utility at age α is;

$$RZ(\alpha\ ,\ RY(h)) = \int_{\alpha}^{\omega} e^{-r(m-\alpha)}\ RU\ [RC(m,\ RY(h)) - RK(m)]\ P(m)\ dm \qquad (3)$$

where *RY* is relative income which is an increasing function of human capital. *RU*, *RC* and *RK* are relative counterparts of *U*, *C*, and *K* in equation (1). Human capital declines when an individual is unemployed. So $h_m = h_{m-1}$ when employed and $h_m = \beta\ h_{m-1}$ when unemployed ($0 < \beta < 1$). ß is smaller when the economy is under rapid technological transformation or regime shift.

The revised model provides the same basic insights into the suicide behavior as the standard one. It assumes that individuals are more likely to commit suicide when expected relative lifetime utility falls below a certain level. The suicide rate is related to income and age. However, the revised model has a novel feature of clearly showing how

high unemployment rates lower the expected relative lifetime utility and increase suicide rates, as seem by

$$\frac{\Delta RZ}{\Delta Unemp} = \underset{+}{\frac{\Delta RZ}{\Delta U}} \underset{+}{\frac{\Delta U}{\Delta RC}} \underset{+}{\frac{\Delta RC}{\Delta RY}} \underset{+}{\frac{\Delta RY}{\Delta h}} \underset{-}{\frac{\Delta h}{\Delta Unemp}} < 0 . \qquad (4)$$

The unemployed come to have less human capital than individuals with jobs and consequently have less relative lifetime utility. Hence, the propensity to commit suicide will be positively related with the unemployment rate.

The model also can be used to show why the middle-aged group's suicide rate has been higher recently in Japan. During a period of economic transition, the technological shocks quicken the depreciation of human capital for unemployed middle-aged individuals, who tend to be slower than younger workers in adapting to new labor market conditions. In a society like Japan, where labor markets are not flexible, the depreciation of human capital is faster for those age groups that cannot easily find the same quality jobs once they are unemployed.[5] However, *ceteris paribus,* the suicide rate increases with age, just as it does in the standard model (2).

We further extend the model by including the divorce rate. Following Becker (1974), we assume that marriage has mercenary value. A divorced individual has lower relative utility and is more likely to commit suicide than a married one. According to the literature, couples separate when the utility expected from remaining married falls below

[5] The Japanese practice of lifetime employment is typically portrayed as providing job security to workers. But because firms are not able to dismiss workers in response to a business downturn, companies are more likely to have serious cost overruns and eventually go bankrupt, in which case it is very difficult for workers to find another job at the same level. The paradoxical result is that workers may in fact wind up with *less* security, not more as a result of the lifetime employment practice. It is worth noting that the Japanese higher education system plays little role in retraining the jobless for alternative professions.

the utility expected from divorcing and possibly remarrying (Becker et. al. 1977). Weiss and Willis (1997) show empirically that the expectation of earnings capacity formed at the time of marriage does not influence divorce, but surprises concerning the partners' earning capacity are important in explaining divorce. We consider the reduction of human capital due to unemployment in Japan as a surprise in earning capacity that is likely to end in divorce.[6] Then the enriched model becomes:

$$RZ(\alpha\ ,\ Y(h)) = \int_{\alpha}^{\omega} e^{-r(m-\alpha)}\, RU\, [RC(m,\, RY(h)) - k(m) - Divorce(RY(h))]\, P(m)\, dm \qquad (5)$$

where *Divorce* is a dummy variable that is positive and constant when human capital *h* is below a certain level and zero otherwise. All other things are equal, divorced individuals have smaller relative utility and are more likely to commit suicide than married individuals. In the enriched model, unemployment influences relative utility through two channels. One channel is through low relative consumption *RC* and the other channel is through high probability of divorce.

$$\frac{\Delta RZ}{\Delta Unemp} = \overset{+}{\frac{\Delta RZ}{\Delta U}}\ \overset{+}{\frac{\Delta U}{\Delta RC}}\ \overset{+}{\frac{\Delta RC}{\Delta RY}}\ \overset{+}{\frac{\Delta RY}{\Delta h}}\ \overset{-}{\frac{\Delta h}{\Delta Unemp}} + \overset{+}{\frac{\Delta RZ}{\Delta U}}\ \overset{-}{\frac{\Delta U}{\Delta Divorce}}\ \overset{-}{\frac{\Delta Divorce}{\Delta RY}}\ \overset{+}{\frac{\Delta RY}{\Delta h}}\ \overset{-}{\frac{\Delta h}{\Delta Unemp}} < 0 \qquad (6)$$

If the divorce channel in the second part of equation (6) dominates the relative consumption channel in the first part, then the relationship between suicide and

[6] We assume that high unemployment rates are positively correlated with divorce rates. Weiss and Willis (1997) show that an unexpected increase in the husband's earning capacity reduces the divorce hazard, while an unexpected increase in the wife's earning capacity *raises* the divorce hazard so that two effects work in opposite directions. However, men traditionally have been the major bread earner in a typical Japanese family and thus we expect the former effect to dominate. We take evidence of the positive relationship between divorce and suicide rates from Durkheim (1897).

unemployment rates will be weaker in the regression analysis that includes divorce rates as an explanatory variable than in the simple regression with only unemployment rates[7].

IV. Empirical methodology and Data

A. Empirical methodology

One notable empirical contribution of the extended model is the redefining of variables in terms of distance from the social mean or trend. It is standard practice following Lucas (1977) to define the business cycle in terms of deviations from trend. This convention is preferred by modern macroeconomists and is the one most frequently employed in empirical macroeconomic studies. Recognizing the importance of de-trending as well as the lack of consensus about the optimal technique, we operationalize the cyclical components by employing three different filters.

First, we use a random-walk filter based on first differences of the relevant variables. Second, we use the well-known Hodrick-Prescott (1997) filter with a smoothing parameter of 100. Finally, we use a Band-pass filter to produce the components that correspond to cycles of duration 2-8 years.

Since the filtered series tend to be stationary (Baxter and King 1999), we avoid the complicated econometric problems that arise when variables with different levels of integration are included in the same equation. It is worth noting that the trends are defined operationally, i.e. the measurement procedure defines the concept (Prescott 2006). In our analysis, we do not rigorously investigate the factors that influence the diverging trends in Japan's male and female suicide rates.

[7] Using the data of twelve developed nations, Yang (1994) shows that the estimated coefficient on the unemployment rate is likely to be less significant when the divorce rate is added to the regression. The analysis however does not separate male and female suicides.

B. Econometric models

We concentrate on the de-trended suicide rates and unemployment rates to estimate their relationship as derived from the model (4). The regressions we estimate take the form:

$$Suicide_t = \alpha + \beta\ Unemployment_t + \varepsilon_t \quad (7)$$

$Suicide_t$ denotes de-trended suicides per 100,000 persons. For example, $Suicide_t = 2$ means 2 suicides per 100,000 persons above the trend. $Unemployment_t$ denotes the de-trended unemployment rate multiplied by 100. ε_t represents the myriad influences on suicide beyond the influence of economic hardship.

The unemployment-to-suicide channel shown in (6) is tested with the following regressions.

$$Suicide_t = \alpha + \beta\ Unemployment_t + \gamma\ Divorce_t + \varepsilon_t \quad (8)$$

$Divorce_t$ denotes de-trended divorces per 1,000 persons, so that $Divorce_t = 2$ means 2 divorces per 1,000 persons above the trend. By comparing the regression results of (7) and (8), we can determine whether the relationship between the divorce and suicide rates is the mere reflection of economic factors, or whether the divorce rate contains information about social anxiety not explained by the economic factors.

We extend our econometric model by adding three social variables that are frequently examined in the suicide literature—the fertility rate, the female labor market participation rate (FLP), and alcohol consumption.[8] Since the presence of children entails

[8] Catholicism strongly disapproves of suicide, viewing it as sin, and this factor is sometimes examined as a social variable. In Japan, Catholic believers represent only 0.34 percent of the total population and the ratio has not changed since 1990 (Catholic Bishop's Conference of Japan, 2005). In view of its size and stability, we exclude these influences from our analysis as we focus on the cyclical fluctuation in aggregate suicide.

family and social ties, it increases social integration and may reduce the likelihood of suicide. Fertility is, therefore, expected to be negatively related to suicide. Using panel data, Neumayer (2003) reports a significantly negative relationship between suicide rates and fertility rates in the U.S. states and Andrés (2006) reaches a similar conclusion for 15 European countries. However, to our knowledge no empirical research examines the relationship with time series data.

Increased FLP can be associated with higher male suicide rates. Perhaps men feel challenged in their role as head of the household and are less likely to be comforted by female partners who also work outside the home (Stack, 1998). This is problematic for men because they are more likely than women to rely solely on their spouses as their confidant (McGrath et al., 1990). On the other hand, the association of FLP and female suicide is not clear. Increased female participation in the labor force may strengthen social ties with other workers and may help to reduce the female suicide rate. But women are exposed to the stress of work life, and often face a double burden of outside employment and unpaid housework. The net effect of a change in female labor participation on male suicide depends on which of these two effects dominates. The empirical results are mixed for both cross-sectional and panel data (Chuang and Huang 1997, Neumayer 2003 and Andrés 2005). Heavy alcohol consumption is also reported to increase suicide rates in cross-sectional analysis (Markowitz et. al 2003, Andrés 2005 and Brainerd 2001).

The extended econometric model including sociological variables is

$$Suicide_t = \alpha + \beta\ Unemployment_t + \gamma\ Divorce_t + \delta\ SV_t + \varepsilon_t \qquad (9)$$

The majority of Japanese claim to be a believer of Shinto or Buddhism or both. However, as Shinto and Buddhism do not have distinctive teachings on suicide and there are no reliable statistics available, we do not examine the influence of religion in our analysis.

SV_t denotes a vector of de-trended sociological variables, the elements of which are fertility rates, FLP and alcohol consumption. We measure the fertility rate with average births from a mother in her reproduction years (ages 15 − 49). FLP is measured by (female labor force / female population 15 years old and over) x 100. Alcohol consumption is measured by the net alcohol consumption per adult (age 15 and over). A comparison of the estimated results of (7), (8) and (9) help us see how well the enriched explains the suicide cycles in Japan.

C. Data

For this study, we use annual data from 1950 to 2003. Table 1 presents the descriptive statistics of the variables in levels. To control for the influence of the changing distribution of age groups on suicide rates, the age-adjusted suicide rates based on the population of 1986 are used. Japan's Ministry of Health, Labor and Welfare is the primary source for statistics on suicide, unemployment and divorce. For unemployment rates from 1950 to 1952, we use the estimates of the Statistical Information Institute for Consulting and Analysis (www.sinfonica.or.jp). Fertility rates and FLP come from the Statistics Bureau of Japan. Alcohol consumption for 1961-2001 comes from World Health Organization alcohol database (www.who.int). For 1950-1960 and 2002-2003, we calculated alcohol consumption based on data from National Tax Agency of Japan.

Figure 4 shows the time series of three social variables. The fertility rate is highest in 1950 at 3.65 children per woman and it has declined since reaching its lowest point of 1.29 in 2003. The fertility rate tends to decline partly because the opportunity cost of raising children becomes higher with increased female education. The sharp

decline in Japan's fertility in the 1950s reflects the bust following the post Second World War baby boom.

In the US, FLP rates have increased with little variation around the trend, rising from 32.5 percent in 1950 to 59.6 percent in 2003. By contrast, Japan's FLP rates first declined from 56.7 percent in 1955 to 45.8 percent in 1976, then increased to 50.7 percent in 1991 declining to 48.3 percent in 2003. The massive migration of farming families to the cities and rapid economic growth after the Second World War resulted in an increase of full-time housewives, and consequently lowered FLP in the first part of our sample. The recession after 1991 lowered the rate, although it is generally considered to be countercyclical.

Japan's alcohol consumption per capita increased from 1.4 liters in 1950 to 6.9 liters in 1990, the peak of the bubble economy. Since then, it has fluctuated around the 1990 level. Alcohol seems to be a normal good—with demand increasing with income before 1990 in Japan. During the 1990s, the fluctuation of alcohol consumption does not show a noticeable correlation with the rising suicide rate.

Table 2 presents the correlations of the de-trended variables using the random walk filter. We have to sacrifice the beginning and ending three periods when applying the band pass filter owing to construction of the weighted moving average. The data are relatively poorly estimated with the HP filter during the beginning and ending periods. To have the same period for all of the filters, we report the results using the de-trended data for the period 1953-2000 after eliminating the beginning and ending three years. The correlation coefficients of the de-trended variables are not significantly influenced by the de-trending method used.

The de-trended female suicide rate is positively correlated with the de-trended unemployment rate (0.38) and divorce rate (0.17), even though the correlation coefficients are smaller than those of the male suicide rate with the unemployment rate (0.62) and divorce rate (0.52). The divorce rate is positively correlated with the unemployment rate as our model predicts (0.46). Alcohol consumption does not have a positive relationship with either male (-0.03) or female suicide rates (-0.02). The fertility rate has a negative relationship with the male (-0.10) and female (-0.30) suicide rates as sociology theories predict. FLP is slightly countercyclical (-0.06) and has a positive relationship with the male (0.25) and female suicide rate (0.24).

V. Empirical Results

OLS estimates of equation (7) with the male suicide rate (the first four rows of TABLE 3) indicate that the effect of the unemployment rate on the suicide rate is more pronounced when we focus on the cyclical components of the two variables. Equations with de-trended variables have larger coefficients for unemployment than equations with level variables. The coefficient with the random-walk filter indicates that a 1 percentage point increase in Japan's unemployment rate will result in 57.6 more male suicides per million people in Japan—an overall increase of 3,592. The estimate using the HP filter is the largest. A 1 percentage point increase in the unemployment rate corresponds to 71.4 more male suicides per million people, an increase of 4,452.

Introducing de-trended variables causes sweeping changes in the estimates of the female suicide rate. When the variables are not de-trended, the coefficient of unemployment rate is negative and insignificant. With de-trended variables (the first four

rows TABLE 4), the coefficients of the unemployment rate are all positive and significant at the 1 percent level. The female suicide rate in Japan, however, still responds less than the male suicide rate to the unemployment rate.[9] Based on estimates with the random-walk filter, a 1 percentage point increase in the unemployment rate will result in 14 more female suicides per million people, a total of 902 for the nation.

Taking the average of the three estimates, forecasted total suicides will increase by 4,774 with a 1 percentage point increase in the unemployment rate over the trend. The country now has a population of 128 million.

Divorce rates are an important social variable that has more explanatory power than unemployment rates in some research (Yang 1994). Our model assumes that marriage has mercenary value and divorce leads to a lower relative income that might precipitate suicidal behavior. Divorce in our model occurs when couples encounter unexpected negative income shocks. If divorce were mainly driven by economic factors and the reduction of utility from divorce were to dominate the reduction from low income in deciding suicide, the inclusion of divorce should weaken the effect of unemployment in estimates of (8) compared with (7). Instead, the addition of a filtered divorce rate does not significantly alter the coefficient of *Unemployment.* The coefficient of *Unemployment* for the male suicide rate declined about 20 percent compared with the simple regression, but the estimates are still significant at the 1 percent level.

For the female suicide rate, the inclusion of *Divorce* does not alter the coefficient of *Unemployment.* However, the impacts of *Divorce* on *Suicide* show distinctive gender differences. The *Divorce* coefficient is positive and significant for *Male Suicide*, but it is

[9] Brainerd (2001) posits that women are more protected from macroeconomic instability in the societies where women's non-market work is valued more highly than men's.

mixed and insignificant for *Female suicide* in the equations using the three different de-trending methods. R^2 increases about 26 percent for the three filtered variables for the male suicide rate, but R^2 does not change very much for the female suicide rate. These findings parallel results for the former Soviet Union countries (Brainerd 2001) and for the U.S. (Cutler et al, 2000). They also suggest that the mercenary value of marriage is larger for males than females and factors other than economic hardship also matter[10].

Including social variables does not alter the size and significance of the coefficients of the unemployment and divorce rates for both male and female suicide. The increases in R^2 are moderate − on average 0.053 for males and 0.076 for females. Fertility is negatively correlated with the suicide rate for both males and females. The coefficient is significant at the 1 percent level for two out of three de-trending methods regarding the female suicide rate, but it is significant at the 10 percent level for only one de-trending method regarding the male rate. The hypothesis that the presence of children, with promotion of family and social ties, reduces the suicide rate is weakly supported, and the relationship is more distinct for females than males.

FLP has a positive coefficient for both the male and female suicide rates. The relationship of *FLP* with suicide also shows a gender differential. The coefficient is significant for all de-trending methods regarding males, but only one for females. The findings also support the hypothesis that loss of social support due to female participation in the labor market leads to an increase in male suicide. For females, the double burden of outside work and housework may be bigger than the benefit of having social ties in work, but the relation is not robustly significant. Our results coincide with Stack (1987)—at the

[10] The utility loss of the mercenary value of marriage via divorce is equivalent in sociological terms to individual trauma and the lack of social control.

aggregate level, the overall *FLP* affects the male but not the female suicide rate in the U.S. It is worth noting that even though the coefficient is significant, the impact of *FLP* on the male suicide rate is smaller than the unemployment effect. A one standard deviation increase in the Band-Pass filtered *Unemployment* variable will be associated with an increase of 7,131 male suicides, whereas a one standard deviation increase in *FLP* will be associated with an increase of only 678 male suicides.

The coefficients on *Alcohol* are positive but insignificant for males, and mixed and insignificant for females. However, our results should not be interpreted as saying that there is no relationship between alcohol abuse and suicidal behavior at the micro level. The relationship between alcohol consumption and suicide may not be linear. A recent study by Akechi et al. (2006) using Japanese cohort data shows that the relationship is U-shaped. Those who do not drink at all commit suicide more than those who drink occasionally. These results indicate that our time-series data, which aggregate the cross-sectional distribution of individual alcohol consumption, may not have enough information to determine the relationship between alcohol abuse and the suicidal behavior of individuals.

In sum, our initial estimates of the coefficients of the unemployment rate and divorce rate do not change significantly after controlling for social variables. We may conclude from these results that the reduction of relative consumption is the major channel by which relative utility falls and consequently leads individuals to commit suicide.[11] The divorce cycle is partly correlated to a society's unemployment cycle, even

[11] We explored the effect of using real per capita GDP in the place of the unemployment rate. The coefficients are robustly significant in all equations estimated, but less significant than those of the unemployment rate. A simple comparison of correlation coefficients also shows that real per capita GDP is less correlated with suicide than is unemployment.

though non-economic factors influence divorce rates. Our previous results derived from a simple regression approach (7), thus seem to be reasonable estimates of the relationship between the unemployment and suicide rates in Japan.

VI. Concluding Remarks

In this paper, we tried to extend the research on the economics of suicide in two ways. First, we revised the standard economic model to analyze the cyclical relationship between the suicide rate and the unemployment rate. Our model suggests that the recent surge of middle-aged male suicides in Japan is related to the inflexible labor market that leads the human capital of the unemployed to depreciate rapidly during periods of technological shocks and regime shifts. The revised model clearly links the unemployment and suicide rates and focuses on relative utility rather than the absolute level. The relative terms conceptually correspond to cyclical components of the variables. Second, we used three different filters to de-trend Japanese time series. By filtering out long-term trends from the variables, we are able to illustrate the cyclical relationship between suicide and unemployment more clearly.[12] Unlike previous research, which often failed to trace the response of the female suicide rate to economic hardship, our study indicates that the female suicide rate is also significantly influenced by the unemployment rate in Japan, even though women are more protected than men from macroeconomic fluctuations. The results are robust when we include the divorce rate and three other social variables in the equation. The impacts of social variables show gender differentials. *Fertility* is more clearly related to female suicide, whereas the negative

[12] When variables are stationary (as with some U.S. data), the filtered time series approach does not generally improve estimation.

impact of *FLP* is more distinctive with male suicide. With our aggregate time series data, we could not find any significant relationship between alcohol consumption and the suicide rate in Japan.

We conjecture that 4,774 more Japanese will commit fatal suicide anually3 if de-trended unemployment rises 1 percentage point. Such an acute response of people to unemployment may be one reason why the Japanese government has been reluctant to adopt drastic reform measures that could lead to a temporary surge of unemployment rates during the sustained economic recession that began more than a decade ago.

The theories and empirical results in this paper suggest that government policy to prevent the depreciation of human capital of the unemployed would help to remedy the hazard of suicide. Retraining programs for jobless salarymen, tax breaks to encourage the establishment of temporary agencies, and tax breaks to encourage corporations to hire temporary workers are policies worth considering in this context.

References

Akechi, T., M. Iwasaki, Y. Uchitomi and S. Tsugane. "Alcohol Consumption and Suicide among Middle-aged Men in Japan." *British Journal of Psychiatry*, 188, 2006, 231-236.

Andrés, A. R. "Income Inequality, Unemployment, and Suicide: A Panel Data Analysis of 15 European Countries." *Applied Economics*, 37, 2005, 439-451.

Baxter, M., R. G. King. 1999, "Measuring Business Cycles: Approximate Band-Pass Filters for Economic Time Series." *Review of Economics and Statistics*, 81, 1999, 575-593.

Becker, G. *Human Capital: A Theoretical and Empirical Analysis with Special Reference to Education*. New York: National Bureau of Economic Research, 1964.

Becker, G. "A Theory of Marriage." in *Economics of the Family*, edited by T. W. Schultz. Chicago: University of Chicago Press, 1974.

Becker, G. "An Economic Analysis of Marital Instability." *Journal of Political Economy*, 85, 1977, 1141-1188.

Brainerd, E. "Economic Reform and Mortality in the Former Soviet Union: A Study of the Suicide Epidemic in the 1990s." *European Economic Review* 45, 2001, 1007-1019.

Catholic Bishops' Conference of Japan, *Statistics of the Catholic Church in Japan 2005*, Japan, 2006.

Chatterji, P., D. Dave, R. Kaestner, and S. Markowitz. "Alcohol Abuse and Suicide Attempts among Youth." *Economics and Human Biology*, 2, 2004, 159-180.

Chuang, H. and W. Huang. "Economic and Social Correlates of Regional Suicide Rates: A Pooled Cross-Section and Time-Series Analysis." *Journal of Socio-Economics*, 26, 277-289.

Durkheim, L. J. *Le Suicide*. 1897 [translated by Spaulding, J. A., Simpson G. 1951 Suicide. Free Press, New York]

Cutler, D. M., E. L. Glaeser, K. E. Norberg. "Explaining the Rise in Youth Suicide." NBER Working Paper 7713, 2000.

Gerdtham, U., M. Johannesson. "A Note on the Effect of Unemployment on Mortality." *Journal of Health Economics*, 22, 2003, 505-518.

Hamermesh, D. S., N. M. Soss. "An Economic Theory of Suicide." *Journal of Political Economy*, 82, 1974, 83-98.

Hodrick, R. J., E. C. Prescott. "Post-war U.S. business cycles: an empirical investigation." *Journal of Money, Credit and Banking*, 29, 1997, 1-16.

Huang, W. "Region, Culture, Economic and Sociological Correlates of Suicide Rates: A Cross-National Analysis." *Applied Economics Letters*, 3, 1996, 779-782.

Lee, S. and A. Kleinman. "Suicide as Resistance in Chinese Society." In: EJ Perry and M. Selden. Eds. *Chinese Society: Change, Conflict and Resistance*. London Routledge, 2000, 221-240.

Lucas, R. E. "Understanding Business Cycles." *Carnegie-Rochester Conference Series on Public Policy*, 5, 1977, 7-29.

Marcotte, D. E. "The Economics of Suicide, Revisited." *Southern Economic Journal*, 69, 628-643.

Markowitz, S., P. Chatterji, and R. Kaestner. "Estimating the Impact of Alcohol Policies on Youth Suicides." *Journal of Mental Health Policy and Economics*, 6, 2003, 37-43.

Mathur, V. K., Freeman, and D. G. Freeman. "A Theoretical Model of Adolescent Suicide and Some Evidence from US data." *Health Economics,* 11, 695-708.

McGrath, E., G. P. Keita, B. Strictland, and N. F. Russo. *Women and Depression*, Washington: American Psychological Association, 1990.

Miyanaga, W. "Labor's Share and the Adjustment of Wages and Employment." Research Report no. 27 Development Bank of Japan, 2002.

Neumayer, E. "Socioeconomc Factors and Suicide Rates at large-unit Aggregate Levels: A Comment." *Urban Studies*, 40, 2769-2776.

Newey, W. K., and K. D. West. "A simple, positive semi-definite, heteroskedasticity and autocorrelation consistent covariance matrix." *Econometrica*, 55, 1987, 703-705.

Platt, S. "Unemployment and Suicidal Behavior: A review of the literature." *Social Science and Medicine*, 19, 1984, 93-115.

Prescott, E. "Nobel Lecture: The Transformation of Macroeconomic Policy and Research." *Journal of Political Economy,* 114, 2006, 203-235.

Ruhm, C. J. "Are Recessions Good for Your Health?" *Quarterly Journal of Economics*, 115, 2000, 617-650.

Stack, S. "The Effect of Female Participation in the Labor Force on Suicide: A Time Series Analysis." *Sociological Forum*, 2, 1997, 257-277.

_____. "The Relationship of Female Labor Force Participation to Suicide: A Comparative Analysis." *Archives of Suicide Research*, 4, 1998, 249-261.

Vigderhous, G., G. Fishman. "The Impact of Unemployment and Familial Integration on Changing Suicide Rates in the U.S.A., 1920-1969." *Social Psychiatry*, 13, 1978, 239-248.

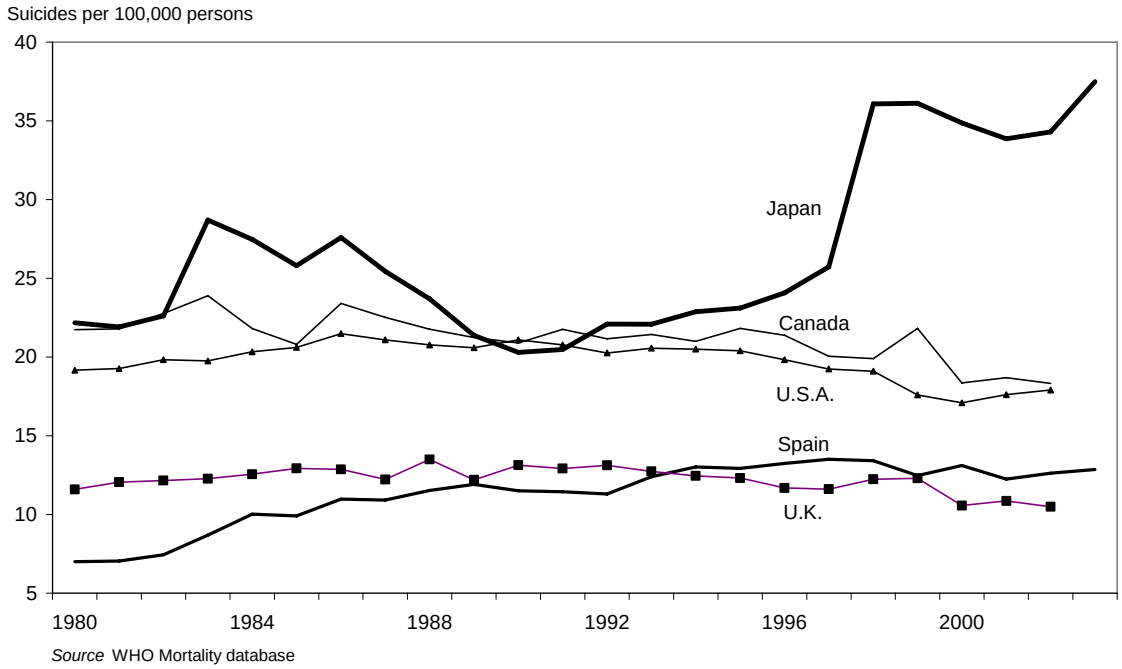
Weiss, Y., R. Willis. "Match Quality, New Information , and Marital Dissolution." *Journal of Labor Economics*, 15, 1997, s293-s329.

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

_____. "The Social Impact of Unemployment." *Applied Economics Letters*, 1, 1994, 223-226.

FIGURE 1

Male Suicide Rates in Five Industrialized Countries



Source WHO Mortality database

FIGURE 2

Suicide rates, Unemployment rates and Divorce rates in Japan

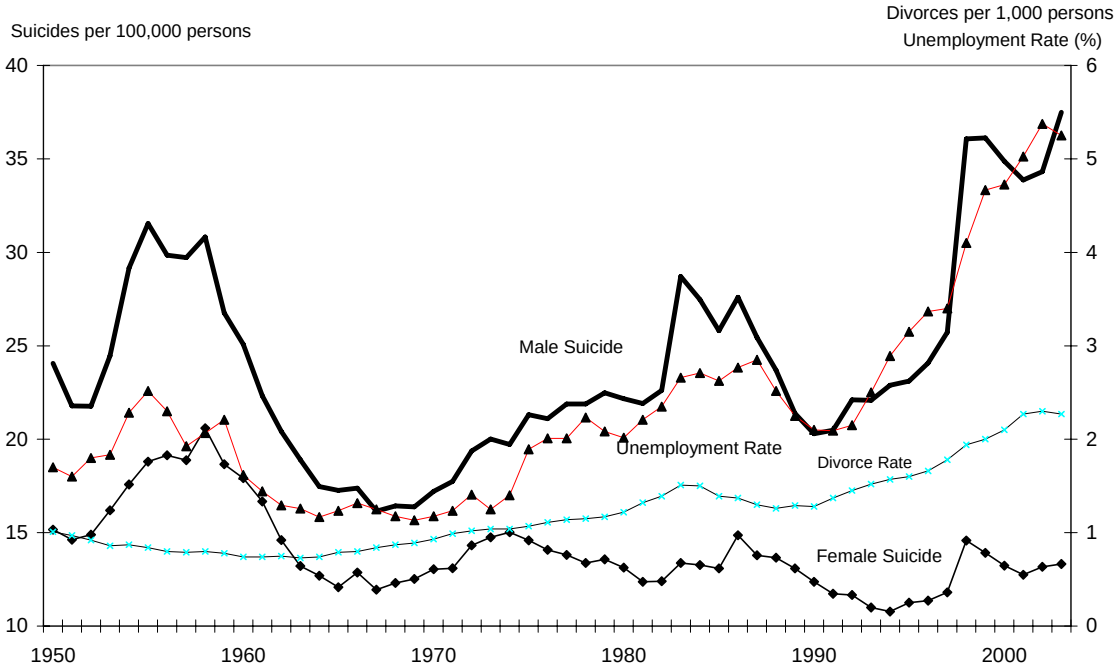


FIGURE 3A
Female Suicide by Age

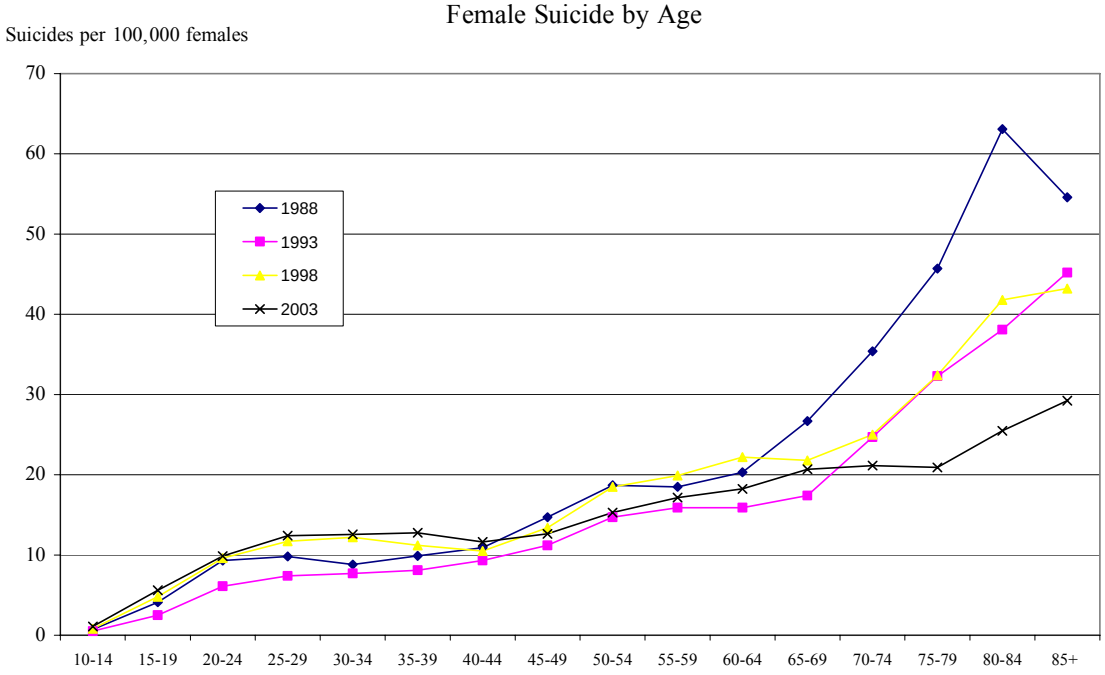


FIGURE 3B
Male Suicide by Age

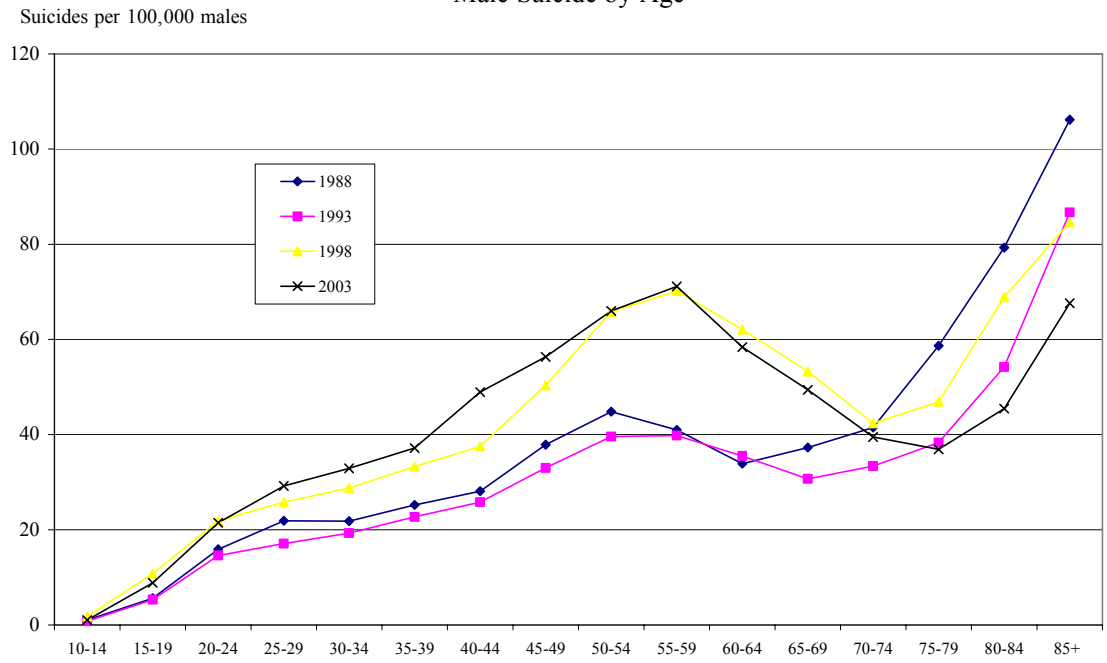


TABLE 1

Descriptive Statistics

Variable	Male Suicide	Female Suicide	Unemploy-ment Rate	Divorce Rate	Fertility Rate	FLP**	Alcohol Consumption
Unit	suicide/ 100,000	suicide/ 100,000	percent	divorce/ 1,000	birth/ 1000*	percent	liter
Mean	24.09	14.02	2.33	1.22	1.90	50.24	5.21
Std. Dev.	5.56	2.25	1.08	0.43	0.47	2.72	1.86
Maximum	37.49	20.59	5.38	2.30	3.65	56.70	8.08
Minimum	16.14	10.78	1.13	0.73	1.29	45.70	1.40

* 1000 women with age between 15-49.

** FLP is the female labor force participation rate.

FIGURE 4

Male Suicide and Social Variables in Japan

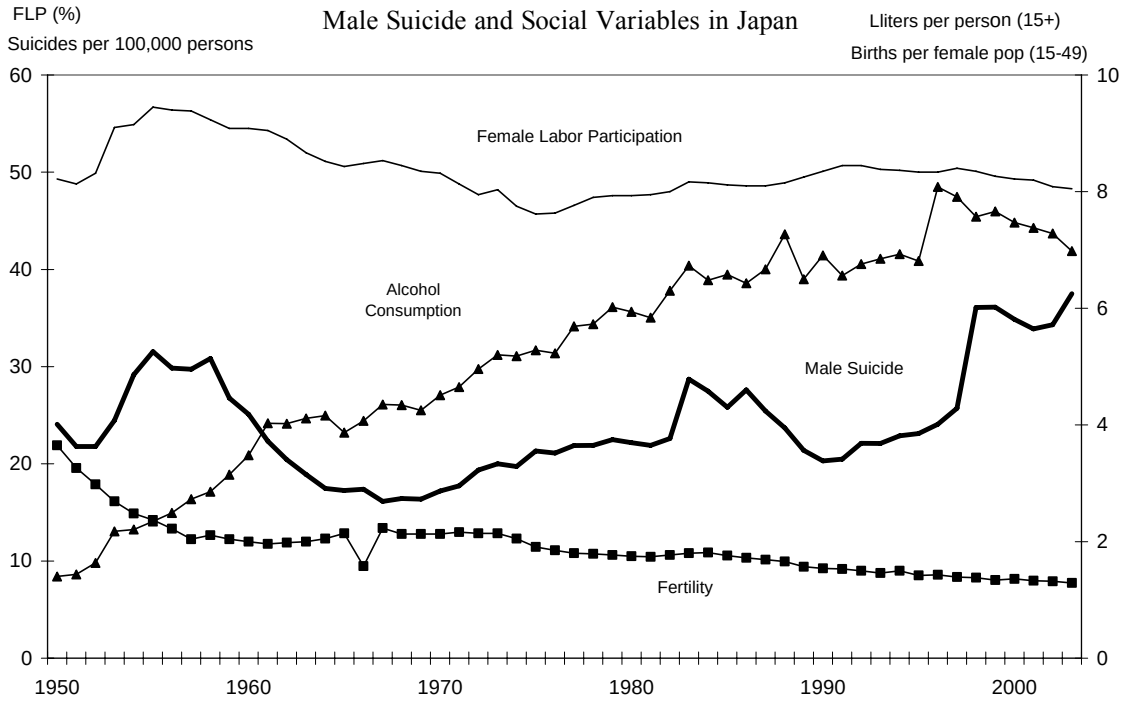


TABLE 2

Correlation Coefficients of De-trended Variables*

De-trended Variable	*Male Suicide*	*Female Suicide*	*Unemploy-ment*	*Divorce*	*Fertility*	*FLP*
Female Suicide	0.76					
Unemployment	0.62	0.38				
Divorce	0.52	0.17	0.46			
Fertility	-0.10	-0.30	-0.05	0.23		
FLP	0.25	0.24	-0.06	-0.12	-0.22	
Alcohol	-0.03	-0.02	-0.11	-0.24	0.00	0.20

*Random Walk filtered series (1953-2000)

TABLE 3

Estimates of Male Suicide in Japan

	De-trending Method	*Unemploy-ment*	*Divorce*	*Fertility*	*FLP*	*Alcohol*	R^2
Eq. (7)	Level	2.19***					
		(3.48)					0.13
	Random Walk	5.76***					
		(4.26)					0.38
	Hodrick-Prescott	7.14***					
		(7.84)					0.55
	Band-Pass	5.31***					
		(4.22)					0.32
Eq. (8)	Random Walk	4.51***	12.64*				
		(3.50)	(1.81)				0.46
	Hodrick-Prescott	6.04***	12.70***				
		(7.00)	(3.58)				0.62
	Band-Pass	4.11***	22.71***				
		(3.71)	(4.52)				0.50
Eq. (9)	Random Walk	4.34***	15.99*	-1.53*	0.67***	0.40	
		(4.00)	(2.93)	(1.83)	(4.29)	(0.61)	0.56
	Hodrick-Prescott	5.94***	11.96***	-0.69	0.45**	0.19	
		(7.84)	(3.07)	(0.35)	(2.02)	(0.27)	0.65
	Band-Pass	4.43***	21.98***	-0.89	0.47*	0.05	
		(4.44)	(4.53)	(1.03)	(1.79)	(0.09)	0.53

Newey-West heteroskedasticity-autocorrelation consistent *t* statistics in parenthesis. A *** indicates significance at the 1% level. A ** indicates significance at the 5% level. A * indicates significance at the 10% level.

TABLE 4

Estimates of Female Suicide in Japan

	De-trending Method	*Unemploy-ment*	*Divorce*	*Fertility*	*FLP*	*Alcohol*	R^2
Eq. (7)	Level	-1.85***					
		(4.45)					0.12
	Random Walk	1.40***					
		(3.00)					0.14
	Hodrick-Prescott	2.06***					
		(4.26)					0.23
	Band-Pass	1.08***					
		(3.14)					0.10
Eq. (8)	Random Walk	1.41***	-0.06				
		(2.84)	(0.02)				0.14
	Hodrick-Prescott	2.20***	-1.62				
		(4.31)	(0.85)				0.23
	Band-Pass	0.95***	2.34				
		(2.92)	(1.08)				0.11
Eq. (9)	Random Walk	1.21***	1.84	-1.66***	0.20*	-0.01	
		(2.81)	(0.81)	(4.68)	(2.14)	(0.02)	0.27
	Hodrick-Prescott	2.13***	-1.74	-0.57	0.18	0.01	
		(4.33)	(0.86)	(0.50)	(0.98)	(0.02)	0.26
	Band-Pass	0.97***	2.59	-1.28***	0.12	-0.10	
		(2.77)	(1.30)	(3.13)	(1.29)	(0.41)	0.18

Newey-West heteroskedasticity-autocorrelation consistent *t* statistics in parenthesis. A *** indicates significance at the 1% level. A ** indicates significance at the 5% level. A * indicates significance at the 10% level.