An Analysis of Suicides in Japan, 1997–2007: Changes in Incidence, Persistence, and Age Profiles

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Abstract This study investigates the abrupt increase in the number of suicides in Japan in 1998 and the subsequent persistence of suicide thereafter; it does so by undertaking data decompositions in terms of demographic factors, reasons for suicide, employment status, and access to the means of committing suicide. The decomposition results regarding the growth in the Japanese suicide rate from 1997 to 1998 show that a large proportion of the abrupt increase in the number of suicides can be attributed to middle-aged men with financial problems, and that the self-employed subset of the population contributed significantly to growth in the suicide rate. Meanwhile, persistently high suicide rates since 1998 can be largely attributed to the younger generation (i.e., those aged 20–39). In accordance with the decomposition results, prefecture-level panel data regression

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established a correlation between suicide and economic hardship. In particular, the unemployment rate and the individual bankruptcy rate were found to be positively associated with the suicide rates of all males, males aged 20–39, and males aged 40–59, while individual bankruptcy was found to affect middle-aged males more than younger males.

Keywords   Suicide · Decomposition · Degree of contribution · Panel data regression

1 Introduction

Since the early 1990s, when the bubble in the domestic asset market burst, Japan has been suffering slow and even negative economic growth, accompanied by price deflation. Nonetheless, these events had no significant immediate impacts on the number of Japanese citizens committing suicide (see Fig. 1 for the age-adjusted suicide rates of Japan from 1982 to 2004).[1] While a slight increase in the male suicide rate was observed, the female suicide rate followed a decreasing trend until 1997. However, things changed dramatically in 1998, when a reported 34.73 % increase in the number of suicides—from 24,391 to 32,863—shocked the nation. Since then, in Japan—which has a total population of 127.5 million—more than 30,000 people have committed suicide in each of 12 consecutive years (i.e., 1998–2010). Despite the facts that some economic recovery occurred in 2003 and 2004 and that numerous preventive measures had been implemented by the government and suicide experts, the persistence of suicide remains a vexing problem for Japanese society.

A great deal of medical research has been conducted on the problem of suicide, and how severe depression or mental disorders are the major causes of suicide.[2] The Japan National Police Agency (NPA) reports that the most frequent reason for suicide in 2008 was health problems, and the main cause of breakdowns vis-à-vis various health problems was depression. In contrast, relatively little attention has been given to the underlying causes of depression itself—e.g., financial difficulties, problems in the workplace, and family problems—and their relationships to suicide. As a matter of fact, by examining individual-level data, the Suicide Investigation Team (2008) finds that people who killed themselves had typically suffered from multiple—i.e., four, on average—risk factors of suicide.[3] Therefore, an effective suicide prevention measure requires a more general understanding of suicide that transcends oversimplified medical perspectives.

On the other hand, it has been suggested that Japan has a "suicide tradition." Some argue that certain Japanese cultural elements—such as *samurai*, *kamikaze*, groupism, shame culture, and authoritarian familism—have contributed to Japan's remarkably high suicide rate, in relation to other industrialized countries. Such a claim is not necessarily

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[1] Japan National Police Agency (NPA), Annual Report on Suicide, (2009).

[2] See Mann et al. (2005) as an example.

[3] There are on average four factors involved out of the following 10 common suicide risk factors: business slump, changes in work environment, overwork, physical illness, deterioration in job place worker relationship, unemployment and failure in job seeking, over-indebtedness and multiple debt problem, problem in intra-household human relationship or relationship with his/her spouse, livelihood difficulties, and depression (mental illness).
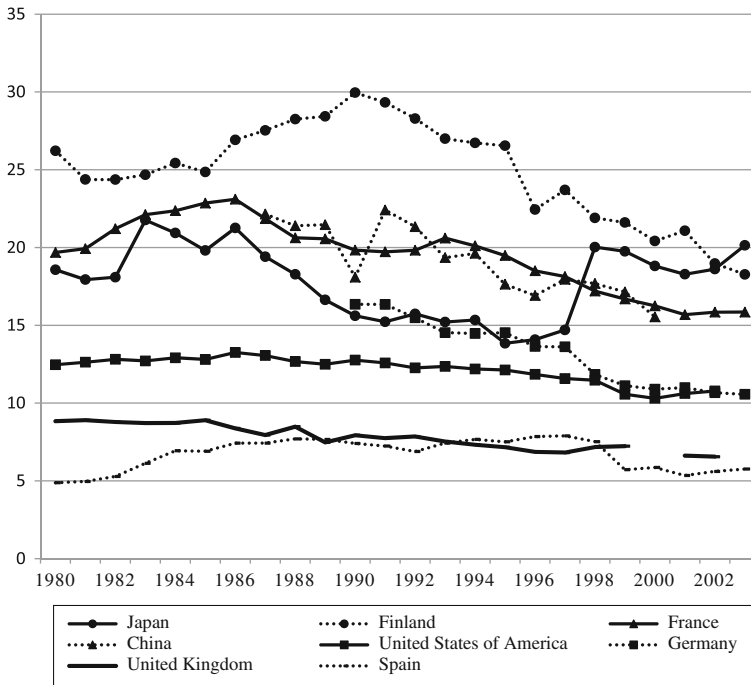
Fig. 1 Age-adjusted Suicide Rates, 1982–2004 (per 100,000 population). *Note* The age-adjusted suicide rate is a weighted average of the age-specific suicide rates per 100,000 persons, where the weights are the proportions of people in the corresponding age groups of the European Standard population. *Source* WHO Mortality Database, 2006; World Health

supported by empirical analysis. For example, in conducting cross-country panel regression analysis, Chen et al. (2009) empirically identify how suicide in Japan is different from suicide in other OECD countries. They show that the suicide rate in Japan is more markedly affected by economic variables such as female labor participation, per-capita gross domestic product, and unemployment rate than is the case in other OECD countries. Further, it has been found that life insurance contracts in Japan may have provided financial incentives to commit suicide, as life insurance policies there pay death benefits, even in cases of suicide (Chen et al. 2008).

Despite there being a long list of studies linking socioeconomic variables to suicide, little can be said on the disturbing upsurge of suicide in Japan in 1997 or on the persistently high number of suicides afterwards.[4] As a matter of fact, little is known of how Japanese suicides since 1998 can be characterized and to what extent Japanese suicides can be attributed to certain demographic and socioeconomic changes. Studying the suicide problem in Japan is particularly important from an economic perspective, because the Japanese economy has been suffering from a series of economic recessions. Especially in 1997, in the aftermath of the 1990 burst of the financial bubble, a number of financial institutions could not afford the massive bad loans, and they subsequently collapsed. As the

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[4] For a survey of the literature on suicide and socioeconomic variables, see Chen et al. (2012).

banks were calling back loans and becoming unwilling or unable to lend money, consequently, many of the companies facing credit constraints faced bankruptcy, which in turn led to high unemployment across Japan.

In this paper, we use the decomposition method and explore what contributed to the 1998 upsurge in the number of suicides in Japan, as well as the persistence in suicide there afterwards. Decomposition was applied to the 1997–1998 change and to the cumulative changes from 1998 to 2007; the results thereof revealed how each group (i.e., by gender and age profile) contributed to changes in the number of suicides in the 1997–2007 period. This set of results showed that while the abrupt increase in the number of suicides in 1998 can be mainly attributed to middle-aged males aged 40–59, it was the suicides of young people aged 20–39 that contributed to the persistently high number of suicides after 1998. This finding suggests that the age profile of suicide in Japan has been changing recently, in a transition from middle-aged to young suicides.

To shed more light on changes in the age profile of suicides in Japan during this period, we further decomposed suicide growth according to the reasons for committing suicide. While a large proportion of the 1997–1998 suicide upsurge can be attributed to the economic and financial problems of middle-aged males, it is not as important a factor in explaining persistently high suicide rates after 1998. In addition, decomposition by employment status showed that while self-employed persons contributed significantly to the 1997–1998 suicide upsurge, their contribution has been declining in recent years. Finally, supporting the assertion that there had been a change in the suicide age profile in Japan, the data also revealed a clear transition in the means of committing suicide. While hanging accounted for the most of the 1997–1998 suicide upsurge, gas poisoning—a means of suicide that has been widely discussed on the internet—has become prominent in more recent years.

To strengthen the link between economic hardship and suicide in Japan, prefecture-level panel regressions were used to examine the presumption that bankruptcies and unemployment following the 1997 credit crunch had played an influential role on both the abrupt increase in suicide in 1998 and the persistence of suicide afterwards. The regression results suggest that, first, the unemployment rate positively correlated with the suicide rate. Second, the personal bankruptcy rate was also a significant predictor of the total male suicide rate. Third, among middle-aged males, a higher personal bankruptcy rate was found more likely to increase the suicide rate.

The rest of this paper is organized as follows. Section 2 introduces the decomposition method we used to explore the abrupt increase in suicide from 1997 to 1998 and its cumulative changes between 1998 and 2007, by age, gender, employment status, reasons for committing suicide, and means of committing suicide. Section 3 provides details of our prefecture-level panel regression analysis, which was used to explore the role of bankruptcies and unemployment—following the 1997 credit crunch—on suicide in Japan in the 1997–2007 period. Finally, as concluding remarks in Sect. 4, we suggest some directions for future research and for developing measures that effectively prevent suicide.

2 Decomposition of Japanese Suicides

Using a decomposition method, we explored Japanese suicide data from 1997 to 2007. In Japan, the Ministry of Health, Labour, and Welfare (MHLW) and the NPA publish suicide

data independently.[5] While MHLW data are based on death certificates submitted to local offices, NPA data are constructed from jurisdictional police records. Although there are minor discrepancies between these two dataset series, the correlation coefficient between them is almost 1.[6] Neither of the two datasets provides individual suicide records; rather, released information includes suicide counts in terms of categories such as age, gender, and reasons for committing suicide.

For our purposes, from MHLW data, we obtained annual data on suicide numbers, classified by age, gender, and the means of committing suicide. At the same time, from the NPA data, we extracted data vis-à-vis annual suicides by employment status and reasons for committing suicide—two categories not available from the MHLW data.[7] Finally, population data made available in the Population Estimates by Japan's Ministry of Internal Affairs have been combined with MHLW suicide data, in order to control for effects arising from demographic changes.

2.1 Increases in the Number of Suicides from 1997 to 1998

2.1.1 Decomposition of the 1997–1998 Suicide Growth Rate, by Gender, Age, and Population Structure

First, we conducted a decomposition of the 1997–1998 suicide growth rate data, by gender, age, and population structure. Note that the total number of suicides at time t (SCD_t) can be obtained by multiplying the suicide rate of group j at time t ($SR_{j,t}$) by the population of group j at time t ($POP_{j,t}$), and then summing them over J groups[8]:

$$SCD_t = \sum_{j=1}^{J} SR_{j,t} \cdot POP_{j,t}. \tag{1}$$

Taking the derivative of the logarithm of SCD_t with respect to t, one can decompose the total suicide growth rate in terms of changes in the population and changes in age group-specific suicides:

$$\frac{\Delta SCD_t}{SCD_t} \cong \sum_{j=1}^{J} \left(\frac{SR_{j,t}}{SCD_t} \cdot \Delta POP_{j,t} + \frac{POP_{j,t}}{SCD_t} \cdot \Delta SR_{j,t} \right) = \sum_{j=1}^{J} \left(cd\_POP_{j,t} + cd\_SR_{j,t} \right) \tag{2}$$

where $cd\_POP_{j,t}$ and $cd\_SR_{j,t}$ are respectively, the effect (degree of contribution) of changes in the number of population of group j at time t and the effect of changes in the number of suicides of group j at time t, on the total suicide growth rate. Equation (2) was

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[5] MHLW data are published in the Vital Statistics, while NPA data are published in the Annual Report on Suicide.

[6] In general, NPA data report slightly higher suicide numbers than MHLW data.

[7] There are limitations in examining NPA suicide data in terms of the reasons for committing suicide. First, since 2007, the NPA has been recording multiple reasons for each suicide, which makes it impossible to decompose into individual categories suicide data in terms of those reasons. Second, from 1999 to 2006, the reasons for committing suicide were not identified for those individuals who did not leave wills. As a result, the sample from each year is reduced to only one-third of the total suicides in this period, perhaps incurring sample-selection problems. Until and including 1998, the NPA suicide data covered almost all suicides in terms of reasons for committing suicide.

[8] For details on the decomposition formula, see Mori et al. (2012).

Table 1 Decomposition of the 1997–1998 suicide growth rate by gender, age, and population structure (Unit: %)

Age group	Sum of the degrees of contribution[a]	Degree of contribution			
		Male		Female	
		Suicide rate	Population	Suicide rate	Population
00–19	1.156	0.828	−0.034	0.375	−0.014
20–39	7.135	5.297	0.124	1.671	0.043
40–59	15.148	13.097	0.106	1.89	0.056
60–79	9.856	6.391	0.467	2.737	0.262
80 and above	1.538	0.756	0.136	0.417	0.229
Total	34.834	26.37	0.799	7.09	0.575

The suicide growth rate is 35.163 from 1997 to 1998 and the residual is 0.329

Population (columns 5–8) are summed up at each age group

The sample does not include suicides of unknown age

Source Vital Statistics, Japan Ministry of Health, Labour, and Welfare; Population Estimates, Japan Ministry of Internal Affairs

[a] The degrees of contribution of each gender's suicide rate and the

applied separately to male and female suicides, and the results thereof are presented in Table 1.[9]

The decomposition results in Table 1 suggest that, first, the 40–59 age group experienced the most dramatic increase in the number of suicides, followed by the 60–79 and 20–39 age groups. Second, 78 % of the suicide growth (i.e., 27.17 of 34.83 %) can be attributed to males; the males aged 40–59, in themselves contributed 37.9 % of the suicide growth rate (i.e., 13.2 of 34.83 %). Third, from the demographic perspective, the effect of the change in population on the number of suicides was of a substantially smaller magnitude, compared to the effect of age group-specific suicide changes. This is not surprising, since we were examining change within 1 year, during which there was little change in the population structure. However, for the age groups of 60–79 and 80 and above, the effects of population change on suicide growth were relatively higher than those of younger groups. Other things being equal, this implies that the aging population structure in Japan is expected to continuously fuel the suicide growth rate in the future. Finally, despite the decline in the population of young people aged up to 19 years—a decline that contributed negatively to suicide growth from 1997 to 1998—the combined effect (i.e., changes in population and suicide together) to the suicide growth rate was small, but positive.

2.1.2 Decomposition of the 1997–1998 Suicide Growth Rate, by Gender, Age, and Reasons for Committing Suicide

To gain more insight into the upsurge in the number of suicides, using the NPA dataset, we decomposed the suicide growth rate from 1997 to 1998 by gender, age, and reasons for

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[9] Note that there were some discrepancies between the actual suicide growth rate, 35.16 %, and the sum of the degrees of contribution, 34.834 %, due to the approximation of derivatives by first differences. We report this discrepancy as a residual, at the bottom of each table.

committing suicide. Note that the total number of suicides at time t (SCD_t) can be obtained by:

$$SCD_t = \sum_{j=1}^{J} SCD_{j,t} \tag{3}$$

where $SCD_{j,t}$ is the number of suicides in the jth cell of gender–age–reasons, $j = 1, \ldots, 56$, at time t.[10] Hence, the decomposition is performed via the following formula:

$$\frac{\Delta SCD_t}{SCD_t} = \sum_{j=1}^{J} \left(\frac{\Delta SCD_t}{SCD_t} \right) = \sum_{j=1}^{J} cd\_SCD_{j,t} \tag{4}$$

where $cd\_SCD_{j,t}$ is the effect (degree of contribution) of changes in the number of suicides of the jth group on the total suicide growth rate.

The decomposition results are shown in Table 2.[11] First, notice that suicides associated with economic and financial problems contributed the most (i.e., 39.2 %) to male suicide growth (10.39 % of 26.5 %), but it contributed little (i.e., 7.28 %) to female suicide growth (0.58 of 7.97 %). Second, especially, the percentage of males in the 40–59 age group who committed suicide for economic and financial reasons increased dramatically; they alone accounted for 18.83 % of the 1997–1998 suicide growth rate (6.49 of 34.47 %). This finding is consistent with the presumption that bankruptcies and unemployment, followed by the unprecedented 1997 credit crunch, had played an influential role in this upsurge in suicide. Third, the male group aged 60 and above with health problems was the second-largest contributor to suicide growth (4.05 of 34.47 %), followed by the male group aged 40–59 with health problems (3.37 of 34.47 %).

2.1.3 Decomposition of the 1997–1998 Suicide Growth Rate, by Employment Status and Reasons for Committing Suicide[12]

Using the NPA data, we also decomposed the suicide growth rate from 1997 to 1998, by employment status and reasons for committing suicide. Equation (3) is used to carry out this decomposition, except that $SCD_{j,t}$ denotes the number of suicides in the jth cell of employment status and reasons for committing suicide, for $j = 1, \ldots, 42$.[13]

Table 3 presents the decomposition results. First, we found that suicides prompted by economic and financial problems contributed second-most to the 1997–1998 suicide growth rate (10.97 of 34.4 %), following suicides for health reasons (13.63 of 34.4 %). Second, those who were unemployed, employed, and self-employed accounted for 89.11 % of the suicide increase in 1998 (30.66 % of 34.40 %). Third, except for the housewife or househusband, student, and unemployed categories, suicides for financial problems contributed most to the 1997–1998 suicide upsurge; furthermore, it was most significant for those who were self-employed. Since there are relatively fewer self-employed workers in Japan compared to those who are employed, this high degree of

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[10] $J = 2$ (genders) $\times$ 4 (age groups) $\times$ 7 (reasons for committing suicide) = 56.

[11] Tables 1 and 2 use different age-group categorizations, due to categorization differences between the MHLW and NPA datasets. The data in Table 2 exclude suicides of unknown age or for unidentified reasons.

[12] The term "employment status" used throughout the paper is somewhat of a misnomer; we followed the categorizations offered by each of the data sources

[13] $J = 6$ (employment status) $\times$ 7 (reasons for committing suicide) = 42.

Table 2 Decomposition of the 1997–1998 suicide growth rate, by gender, age, and reasons for committing suicide (Unit: %)

Gender	Age group	Sum of the degrees of contribution[a]	Economic and financial problems	Family	Health	Relationship	School	Work	Others
Male	00–19	0.58	0.031	0.048	0.215	0.044	0.092	0	0.149
	20–39	5.436	1.721	0.452	1.221	0.29	0.114	0.926	0.711
	40–59	12.879	6.49	0.918	3.368	0.11	0	1.44	0.553
	60 and above	7.61	2.147	0.676	4.048	0.018	0	0.202	0.518
	Subtotal	26.504	10.389	2.094	8.852	0.461	0.206	2.569	1.932
Female	00–19	0.364	−0.004	0.066	0.026	0.048	0.101	0.009	0.119
	20–39	1.822	0.004	0.338	0.953	0.228	0.026	0.162	0.11
	40–59	1.914	0.369	0.479	0.869	−0.031	0	0.088	0.141
	60 and above	3.868	0.211	0.571	2.951	0.018	0	0.009	0.11
	Subtotal	7.97	0.58	1.453	4.799	0.263	0.127	0.268	0.479
Total		34.474	10.969	3.548	13.652	0.725	0.334	2.837	2.411

The sample does not include suicides of unknown age or for unspecified reasons. 3. *Source* Annual Report on Suicide, Japan National Police Agency

[a] It sums the degrees of contribution of each gender's reasons for committing suicide at each age group

contribution by self-employed suicides for financial problems underscores the significance of the impact of the credit crunch event during this period on this subset of the data sample. This finding indicates that bankruptcies triggered by the 1997 financial crisis would be a significant factor to growth in the suicide rate.

2.1.4 Decomposition of the 1997–1998 Suicide Growth Rate, by Gender and Means of Suicide

The number of suicides, $SCD_{j,t}$, can be obtained by summing the various numbers of suicides categorized by the means of committing suicide; therefore, Eq. (3) also applies here, with j indicating each means of committing suicide. In the original MHLW data, there are 25 categories of suicide means, by gender.[14] For simplicity, we reduced these to seven categories.[15] The decomposition results are presented in Table 4.

Table 4 indicates that most of the increased number of suicides from 1997 to 1998 had been committed by individuals who hanged themselves. Note that these events took place before knowledge of relatively new suicide means—e.g., carbon monoxide poisoning and the use of homemade hydrogen sulfide gas—became widespread and readily available through internet chat rooms and bulletin boards.

2.2 The Persistence of Suicide since 1998

Following the same set-up and using the same decomposition method as that used in the previous subsection, we looked into the long-term effects of gender, age, population structure, the reasons for committing suicide, employment status, and the means of suicide on cumulative suicide growth since 1998. By comparing the decomposition results here with those from the 1997 to 1998 decomposition, we can shed some light on the changing factors that affect the suicide rate in Japan and the persistence of the suicide problem in Japan.

2.2.1 Decomposition of the Cumulative Suicide Growth Rate from 1998 to 2007, by Gender, Age, and Population Structure

To examine the long-term effects of gender, age, and population structure on the cumulative suicide growth rate in Japan, we first applied the same decomposition technique to each year's data. After obtaining the annual degrees of contribution of changes in population and age group-specific suicide on the annual suicide growth rate, we aggregated them over the years to compute the cumulative degree of contribution of a particular component $x_{j,t}$ from t_1 to t_2, i.e., $\sum_{t=t_2}^{t_2-1} cd\_x_{j,t}$.

Table 5 indicates that the cumulative suicide growth rate was negative, i.e., -1.92 %, which suggests that despite a marginal decrease, the overall number of suicides from 1998 to 2007 resided at the new plateau established by the suicide upsurge in 1998. This showed that the large number of suicides persisted during that period.

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[14] According to the 10th Revision of the International Statistical Classification of Diseases and Related Health Problems (ICD-10) from Japan's Vital Statistics, these 25 categories correspond to Categories X60–X84.

[15] We follow the same categorization as that in Table 22 of the Vital Statistics Special Report (2004): Hanging, X70; gas poisoning, X67; drugs, X60–X66, X68, and X69; drowning, X71; jumping (others), X80; jumping (towards a moving object such as a train), X81; and others, X72–X79 and X82–X84.

Table 3 Decomposition of the 1997–1998 suicide growth rate, by employment status and reasons for committing suicide (Unit: %)

Employment Status	Sum of the degrees of contribution[a]	Economic and financial problems	Family	Health	Relationship	School	Work	Others
Employed	9.392	2.976	1.116	2.262	0.423	0.004	2.099	0.512
Housewife or househusband	2.174	0.181	0.586	1.31	0.022	0	0.022	0.053
Management	0.825	0.428	−0.026	0.159	0.013	0	0.256	−0.004
Self-employed	5.697	3.625	0.472	1.199	0.018	0	0.154	0.229
Student	0.75	0.018	0.031	0.229	0.031	0.273	0.013	0.154
Unemployed	15.566	3.739	1.429	8.471	0.212	0.053	0.3	1.363
Total	34.403	10.967	3.607	13.63	0.719	0.331	2.844	2.306

The sample is limited to suicides with wills and does not include suicides of unknown employment status age or for unspecified reasons

Source Annual Report on Suicide, Japan National Police Agency

[a] It sums the degrees of contribution of the reasons for committing suicide at each employment status

Table 4 Decomposition of the 1997–1998 suicide growth rate, by gender and means of suicide (Unit: %)

Means	Sum of the degree of contribution[a]	Degree of contribution	
		Male	Female
Drowning	0.396	0.26	0.136
Drug overdose	−0.272	−0.136	−0.136
Gas poisoning	1.434	1.349	0.085
Hanging	30.702	24.083	6.619
Jumping towards a moving object such as a train	0.145	0.094	0.051
Jumping (others)	2.145	1.328	0.817
Others	0.613	0.468	0.145
Total	35.163	27.446	7.717

[a] The degrees of contribution of each gender's suicide rate (columns 3–4) are summed up for each means of suicide

Source Vital Statistics, Japan Ministry of Health, Labour, and Welfare

Table 5 Decomposition of the 1998–2007 cumulative suicide growth rate, by gender, age, and population structure (Unit: %)

Age group	Sum of the degrees of contribution[a]	Degree of contribution			
		Male		Female	
		Suicide rate	Population	Suicide rate	Population
00–19	−0.659	−0.336	−0.255	0.064	−0.132
20–39	2.606	2.117	−0.301	1.048	−0.257
40–59	−4.393	−2.530	−0.897	−0.745	−0.220
60–79	0.796	−2.261	3.914	−2.474	1.616
80 and above	0.167	−1.064	1.658	−2.159	1.731
Total	−1.483	−4.074	4.119	−4.266	2.738

The cumulative suicide growth rate is –1.918 and the residual is –0.435

The sample does not include suicides of unknown age

Source Vital Statistics, Japan Ministry of Health, Labour, and Welfare; Population Estimates, Japan Ministry of Internal Affairs

[a] The degrees of contribution of each gender's suicide rate and the population (columns 5-8) are summed up at each age group

The decomposition results indicated that the persistently large number of suicides was promoted by suicide increases among those of the younger generation (age 20–39) and the older generation (age 60 and above); nonetheless, there were qualitative differences in their contributions. First, unlike the 1997–1998 suicide upsurge—which was mainly attributed to the increase of suicide among middle and older generations (those aged 40–59 and 60–79)—it was the increase in suicide among the relatively younger generation (20–39 years) that led to persistence in the high number of suicides. Since the population of this age group has been decreasing, the contribution of the demographic component of this age group, POP_{20-39}, to the cumulative overall suicide growth rate has been negative (−0.301

and −0.257 for males and females, respectively). Therefore, holding the population of this age group constant, the increase in the suicide rate within this group would have been 3.17 % instead of 2.61 or 21.45 % higher. This finding is consistent with the suicide-age migration claim that, after the 1997–1998 suicide upsurge, the incidence of suicide shifted from the middle-aged group to the young group, i.e., to people in their 20 and 30 s. This is very different from the public perception that middle-aged males contribute most to Japan's high suicide rate. Our results here revealed that, in terms of the age profile, suicides by younger people explain the persistence of the high suicide rate after 1998. Second, population aging has also been a serious problem that has led to persistence in the number of suicides. Holding the age group-specific suicide rates constant, the population-aging effect in the groups of males and females aged 60–79 and 80 years and above would result in a cumulative suicide growth rate of 8.92 %.

2.2.2 Decomposition of the Cumulative Suicide Growth Rate from 1999 to 2006, by Gender, Age, and Reasons for Committing Suicide[16]

To gain greater insight into the persistence of suicide in Japan, we conducted a decomposition of the cumulative suicide growth rate, by gender, age, and reasons for committing suicide. The same decomposition method as that used in Sect. 2.1.2 was applied to the NPA data for the period from 1999 to 2006; cumulative degrees of contribution were calculated and are reported in Table 6.

First, in the comparison of the decomposition results in Tables 2 and 6, we found that health problems and economic and financial problems were still the main reasons for committing suicide. Together, these two reasons account for 69.1 % of the suicide growth (8.97 of 12.98 %). Second, in comparison to the decomposition results in Tables 5 and 6, we confirmed that the persistence of high suicide rates was due to a change in the age profile of suicides from the middle-aged (40–59 years) to the young generation (20–39 years), and to suicide among the non-weary members of the older generation (age 60 and above). These two facts hold, regardless of the use of different datasets. Moreover, while males aged 60 and over killed themselves mainly because of financial and health problems and males aged 40–59 did so because of family problems, young people aged 20–39 committed suicide for a variety of reasons, including family and work-related problems.

On the other hand, the decomposition results in Table 6 (and in Table 7, below) should not be taken without a proverbial grain of salt, because the samples are limited to suicides who had executed wills. Within that group, the number of suicides had grown by 12.98 % from 1999 to 2006. Since the suicide numbers had been almost constant or slightly declining within this period, the results may be subject to sample-selection bias.

2.2.3 Decomposition of the Cumulative Suicide Growth Rate from 1999 to 2006, by Employment Status and Reasons for Committing Suicide

We also decomposed the cumulative suicide growth rate from 1999 to 2006, by employment status and reasons for committing suicide; we did so, using the NPA data. The results thereof are shown in Table 7. First, we found that suicides due to financial problems

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[16] In Sect. 2.2.1, we used MHLW data from 1998 to 2007, while Sects. 2.2.2 and 2.2.3 use NPA data from 1999 to 2006. As mentioned, only the NPA data contains information on the number of suicides by reason and by employment status; due to changes in the NPA's categorization system in 2007, we were limited to the use of data from 1999 to 2006

Table 6 Decomposition of the 1999–2006 cumulative suicide growth rate, by gender, age, and reasons for committing suicide (Unit: %)

Gender	Age group	Sum of the degrees of contribution	Economic and financial problems	Family	Health	Relationship	School	Work	Others
Male	00–19	−0.065	−0.012	0.078	−0.014	−0.083	−0.072	0.01	0.028
	20–39	4.324	0.955	0.602	1.529	0.121	0.189	0.594	0.333
	40–59	0.543	0.01	0.861	−0.29	0.122	0.001	0.228	−0.389
	60 and above	3.898	1.365	0.638	1.611	0.059	0.001	0.063	0.162
	Subtotal	8.701	2.318	2.179	2.837	0.218	0.119	0.896	0.134
Female	00–19	−0.035	−0.014	−0.068	0.105	−0.082	0.035	0	−0.011
	20–39	2.055	0.05	0.281	1.582	−0.035	0.031	0.176	−0.031
	40–59	0.81	0.472	−0.174	0.525	−0.032	0	0.096	−0.077
	60 and above	1.446	0.506	0.206	0.592	0.02	−0.001	0.034	0.089
	Subtotal	4.275	1.014	0.245	2.804	−0.13	0.065	0.307	−0.029
Total		12.976	3.331	2.425	5.64	0.089	0.184	1.202	0.105

Same as in Table 2

Table 7 Decomposition of the 1999–2006 cumulative suicide growth rate, by employment status and reasons for committing suicide (Unit: %)

Employment Status	Sum of the degrees of contribution	Economic and financial problems	Family	Health	Relationship	School	Work	Others
Employed	4.993	2.145	1.175	0.889	0.172	−0.01	0.787	−0.165
Housewife or househusband	1.341	0.367	0.048	0.962	−0.051	0	−0.02	0.037
Management	−0.422	−0.379	0.048	−0.292	0.038	0	0.214	−0.051
Self-employed	−1.544	−1.822	0.148	0.19	−0.015	0	−0.023	−0.022
Student	0.578	0.074	0.047	0.294	−0.094	0.204	0.008	0.045
Unemployed	7.769	2.869	0.882	3.535	0.032	−0.009	0.251	0.21
Total	12.716	3.253	2.348	5.578	0.081	0.185	1.216	0.054

Same as in Table 3

contributed second-most to suicide growth (3.25 % of the 12.72 % increase), trailing suicides committed for health reasons (5.58 % of the 12.72 % increase). Second, the unemployed accounted for most of the suicide growth, followed by the employed, and housewives or househusbands. Interestingly, while financial problems constituted the number one reason for suicide among the employed, health-related problems were the main cause of suicide among the unemployed.[17] Third, suicide among the self-employed showed negative growth between 1999 and 2006—a completely different picture from its significantly positive contribution to suicide growth from 1997 to 1998 (Table 3). However, there may be sample selection bias arising from the omission of individuals who had committed suicide without leaving wills. Therefore, using the same NPA data, we decomposed all suicides solely by employment status, regardless of will availability. Table 8 confirms the negative suicide growth among the self-employed, which contributed to decreases in the overall suicide numbers. This result indicated that while the self-employed had been seriously affected by the 1997 credit crunch, it was suicide among the employed that accounted for the persistently high level of suicide after 1998. Finally, a comparison of the results in Tables 3 and 7 also suggests that while financial problems were the main contributor to an increase in suicide among the self-employed from 1997 to 1998, they actually led to a *decrease* in suicide among the self-employed from 1999 to 2006. On the other hand, for those employed and unemployed, suicide due to financial problems always plays a significant role in the increases in suicide from 1999 to 2006.

3 Regression Analysis

The decomposition results show that males aged 40–59 who suffered from financial problems contributed the most to the upsurge of suicides in 1998. In addition, the self-employed had been seriously affected by the 1997 credit crunch. On the other hand, the persistently high suicide rate after 1998 has been attributed to young males aged 20–39; in terms of employment status, the suicides of the employed account most for the persistently high level of suicide after 1998. In periods following 1998, a considerable proportion of suicides among the employed were due to financial problems. These results point to a link in Japan between economic hardship and suicide. In this section, we use prefecture-level panel regressions to examine this link and, in particular, the presumption that bankruptcies and unemployment following the 1997 credit crunch played an influential role in both the 1998 suicide upsurge and the persistence of suicide afterwards. The focus will be on male suicides: middle-aged males aged 40–59, and young males aged 20–39.

3.1 Regression Model and Data

For our purpose, we adopted the following regression model for suicide:

$$Suicide\ Rate_{i,t} = \beta_1 Unemp_{i,t} + \beta_2 Fbankrupt_{i,t} + \beta_3 Ibankrupt_{i,t} + \alpha_i + \alpha_t + \varepsilon_{i,t} \quad (5)$$

with i and t being the indexing prefectures and years, respectively. The dependent variable, *Suicide Rate*, is the suicide rate of all males, middle-aged males aged 40–59, or young

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[17] One possible interpretation is that the unemployed include not only individuals who lost their jobs, but also individuals who were retired due to old age or for other reasons. Also, unemployed people may have already suffered from depressive illness at the same time they lost their jobs; hence, in this group, health becomes a dominant reason for suicide.

Table 8 Decomposition of the 1999–2006 cumulative suicide growth rate, by employment status (Unit: %)

Suicide growth rate	Degree of contribution					
	Employed	Housewife or husband	Self-employed	Student	Supervisory	Unemployed
−1.177	1.074	−0.04	−2.224	0.192	−0.299	0.119

The cumulative suicide growth rate is decomposed by employment status

The sample does not include suicides of unknown employment status

Source Annual Report on Suicide, Japan National Police Agency

males aged 20–39. The independent variables included economic variables such as unemployment rate (*Unemp*), firm bankruptcy rate (*Fbankrupt*), and individual bankruptcy rate (*Ibankrupt*). Previous literature suggests that unemployment and bankruptcies diminish the present value of expected lifetime utility and result in a greater number of suicides.[18] We included prefecture fixed effects, α_i, and year effects, α_t.

The dataset covered 47 Japanese prefectures for the period of 1997–2005. Table 9 lists the definitions and sources of the variables; summary descriptive statistics are shown in Table 10. The number of suicides and population figures by age and gender were obtained from the MHLW Vital Statistics. Suicide rates (per 100,000 members of the population) for specific gender–age groups were calculated via the ratio of the number of suicides to the population of a specific gender–age group. Unemployment rates were taken from the Annual Report on the Labour Force Survey, from the Ministry of Internal Affairs and Communications. The number of firm bankruptcies was obtained from Japan's Enterprise Bankruptcy Survey Annual Report, from the Organization for Small and Medium Enterprises and Regional Innovation. We calculated the firm-bankruptcy rate as the number of firm bankruptcies per 1,000 firms. The number of individual bankruptcies was obtained from the Annual Report of Judicial Statistics, from the Supreme Court of Japan. We calculated the individual-bankruptcy rate as the number of individual bankruptcies per 100 people.

3.2 Estimation Results

Table 11 reports the results from the multiple regression analysis on the effects of unemployment and bankruptcies on male suicide rates. Both the ordinary least squares (OLS) regressions and panel (FE) regressions with prefecture and year fixed effects were conducted. For all males, both the OLS regression and the fixed effect regression suggested that the individual bankruptcy rate was positively associated with the suicide rate. The unemployment rate was positively associated with the suicide rate only in the fixed effect regression, and the firm bankruptcy rate was negatively associated with the suicide ate in the OLS regression. The mixed statistical significance and unexpected signs of the coefficient might have resulted from pooling the data of all ages. The results of the separate OLS regressions are similar to the one of the pooled sample. However, the fixed effect regression results showed that unemployment rate is positively associated with the suicide rates of both groups. This result is consistent with Hamermesh and Soss (1974) hypothesis vis-à-vis the positive impact of unemployment on suicide rate. Moreover, this finding is in

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[18] See, for example, Hamermesh and Soss (1974). For a recent survey of the literature of unemployment and suicide, we refer the readers to Chen et al. (2012).

Table 9 Variable definitions and data sources

Variable	Variable definition	Source
Suicide rate	Rate per 100,000 persons	Demographic statistics; ministry of health, labor, and welfare
Age group-specific male suicide rate	Aged 00–19, 20–39, 40–59, 60–79, and 80 and above	
Total population	Per 1,000	
Unemployment rate	Percentage of total labor force	Labor force survey, ministry of internal affairs and communication
Firm bankruptcy rate	N of firm bankruptcies per 1,000 persons	Enterprise bankruptcy survey annual report, organization for small and medium enterprises and regional innovation
Individual bankruptcy rate	N of personal bankruptcies per person × 100	Annual report of judicial statistics, supreme court

Table 10 Summary descriptive statistics of key variables

Variable	Number of observations	Mean	Standard deviation	Minimum	Maximum
Suicide rate of all males	423	0.416	0.092	0.173	0.760
Suicide rate of males aged 20–39	423	0.290	0.075	0.123	0.583
Suicide rate of males aged 40–59	423	0.572	0.143	0.167	1.117
Unemployment rate	423	4.262	1.155	1.700	8.400
Firm-bankruptcy rate	423	0.122	0.120	0.041	2.400
Individual-bankruptcy rate	423	0.131	0.060	0.031	0.323

line with the decomposition analysis, which showed that unemployed individuals experienced a high suicide growth rate and that financial problems not only constituted one of the major reasons for suicide, but that it has also been a main contributor to the high suicide growth rate since 1998. On the other hand, the individual-bankruptcy rate was positively associated with the suicide rate of Males aged 40–59 while it becomes insignificant in Males aged 20–39. This is consistent with our decomposition result of Table 2 that, for males aged 40–59, economic and financial problem explain half of the suicide rate jump. In 1998, the number of suicides by self-employed people increased by 43.9 % (Chen et al. 2010). The credit crunch in 1997 would have been identified as the reason underlying this dramatic increase (Cabinet Office 2007; Watanabe et al. 2006). The firm-bankruptcy rate was not significant in both groups. There is a possible interpretation regarding the reason why the firm-bankruptcy rate shows little effect on suicide: self-employed persons can close their businesses before assuming a large debt load, because of limited liability; in contrast, in Japan, individual loans function as *de facto* unlimited liability contracts (Chen et al. 2010). As a matter of fact, we do have the decomposition result from Table 8 that suicides by self-employed persons contributed to a reduction in suicides in the periods after 1998. However, our estimation results should be interpreted with caution; although we have separate regressions for different age groups, economic variables are aggregated variables that are applied to all groups, not just those that are age group-specific.

Table 11 The regression results

Dependent variables	Total male suicide rate		Males aged 20–39 suicide rate		Males aged 40–59 suicide rate	
	Ordinary least squares regression	Fixed effect regression	Ordinary least squares regression	Fixed effect regression	Ordinary least squares regression	Fixed effect regression
Unemployment rate	−0.002	0.030***	0.003	0.027***	0.007	0.040***
	[0.003]	[0.006]	[0.004]	[0.008]	[0.006]	[0.012]
Firm-bankruptcy rate	−0.097***	−0.008	−0.097*	0	−0.146***	−0.01
	[0.036]	[0.016]	[0.056]	[0.024]	[0.047]	[0.032]
Individual-bankruptcy rate	0.729***	0.228**	0.448***	0.113	1.183***	0.395*
	[0.068]	[0.104]	[0.071]	[0.155]	[0.106]	[0.212]
Constant	0.341***	0.211***	0.300***	0.130***	0.407***	0.270***
	[0.015]	[0.017]	[0.015]	[0.026]	[0.023]	[0.035]
Year effect	No	Yes	No	Yes	No	Yes
Prefecture fixed effect	No	Yes	No	Yes	No	Yes
Observations	422	422	422	422	422	422
Number of prefectures		47		47		47

Robust standard errors are in brackets

*** Significance at 1 %; ** Significance at 5 %; * Significance at 10 %

In conclusion, the regression results support the hypothesis that the economic recession following the 1997 credit crunch played an influential role on the abrupt increase in and persistence of suicide since 1998. Especially, unemployment and individual bankruptcies had strong impacts on the suicide rate.

4 Concluding Remarks

The number of suicides in present-day Japan is at an all-time high. The dauntingly high level of suicide began in 1998 with an abrupt 35.16 % increase in the suicide rate. We used a generalized decomposition formula, and the results thereof showed that the suicide upsurge in 1998 was primarily caused by suicide among middle-aged males aged 40–59 who had suffered from financial problems. Moreover, a disproportionate increase in suicide among self-employed male workers was also uncovered. These results are consistent with the suggestion that the upsurge in the number of suicides in 1998 was largely due to the severe credit crunch in late 1997.

However, a new problem has arisen, given that the number of suicides each year after 1998 has shown no sign of dropping, despite there being some economic recovery in 2003 and 2004. The decomposition of cumulative changes from 1998 to 2007 pointed to an aspect of age-profile migration in suicides—namely, the growth in suicides among the younger generation (i.e., those aged 20–39). Naturally, one wonders about the reasons underlying the growing number of suicides among members of the younger Japanese generation. Our decomposition analysis shows that four different reasons strongly contributed to suicide among that subset of the population: health, finances, family, and work-related problems. Our data do not allow for further exploration; from both academic and policy-making perspectives, future research is needed to identify the factors that drive suicide among young Japanese people today.

One hypothesis attributes the rise in suicide among young people in Japan to structural changes in the Japanese labor market. Since the late 1990s, the number of unskilled, non-regular workers in the Japanese labor market has been increasing at an alarming rate (Asano et al. 2011). Compared to regular workers, most of these workers are relatively young; also, their jobs are typically low-paying, and the employees are not provided with enough job security or appropriate benefits. This institutional structure may have played a role in increasing suicide risk among the younger generation in recent years. This hypothesis should be carefully investigated in future research.

Our results also indicate that the aging of the population is another phenomenon that has caused a rise in the overall number of suicides. As shown in psychiatric studies, depressive illness is more prevalent among older suicide victims.[19] This indicates another policy direction in combating suicide: one that involves the detection and treatment of depressive illness among older people, especially as their conditions are less likely to be correctly diagnosed and treated.

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[19] See, for example, Conwell and Brent (1995).

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