Contributions

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Life Insurance and Suicide: Asymmetric Information Revisited

Abstract: This paper investigates the nexus between life insurance and suicide behavior by applying semiparametric instrumental variable regressions to OECD cross-country data from 1980 to 2002. The novelty of our analysis lies in the use of cross-country variations in the lengths of the suicide exemption period in policies and foreign market shares in life insurance industries as identifying instruments for life insurance demand. We find that, for the majority of observations, there exists a positive causality from life insurance demand to suicide. This result suggests the existence of adverse selection and moral hazards in life insurance markets in OECD countries.

Keywords: life insurance, suicide, asymmetric information

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A monk died after he accidentally ate poisonous Hiratake mushrooms. His lord felt sorry for the monk and paid for his funeral. Even after hearing about the incident, another monk at Todaiji Temple ate Hiratake mushrooms. People wondered why he risked his life. Then he said, “since I don’t have any money for my funeral after my death, in order to draw the lord’s sympathy and to finance my funeral, I ate Hiratake mushrooms. Yet, unfortunately, it did not work.”

Monks and Poisonous Hiratake Mushrooms, in *Kon Jyaku Monogatari* (A Japanese Book of Old Stories), circa 794–1185.

1 Introduction

Suicide is one of the most serious and vexing issues faced by all modern societies. According to the World Health Organization (WHO), an estimated

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804,000 worldwide suicide deaths occurred in 2012, and one suicide-related death is reported every 40 seconds (WHO 2014). Many medical professionals consider suicide to come as a result of depression or other psychiatric disorders (Mann et al. 2005). However, as early as in 1897, the sociologist Émile Durkheim, in his seminal book *Le Suicide*, developed the concept of social integration to explain suicide from a sociological perspective.¹ Moreover, in their economic theory on suicide, Hamermesh and Soss (1974) employed an expected lifetime utility maximization framework to explain suicide as a rational decision. Nonetheless, the existing literature has largely disregarded the role of economic or financial incentives in inducing suicide.

Suicides induced by economic incentives are not rare in real life.² Governmental policies can even encourage suicide through moral hazard. For example, some states in India have seen an increase in their suicide rate, presumably due to the governmental policy of compensating bereaved families for their loss of a breadwinner who has killed himself (*The Economist*, June 21, 2007). Life insurance contracts also provide incentives to commit suicide, as death benefits are paid in cases of suicide after expiry of the suicide exemption period.³ In fact, Toyokawa and Shirouzu (1998), Tsukitari (2001), and Amamiya (2002) stated that there was an increase in the number of suicides among life insurance policy holders immediately after expiry of the suicide exemption period. A figure from Tsukitari (2001) is reproduced as Figure 1. The figure shows a suicide index which was set to 100 for the average number of suicides

1 Sati is an old Hindu funeral practice in which the widow sacrifices her life by burning herself on her husband's funeral pyre; sati has been cited by Durkheim as an example of altruistic suicide in cases where there is high social integration. Contemporary sociologists have employed the same concept to explain the phenomena of Kamikaze pilots and suicide bombers. Chen, Choi, and Sawada (2010) also provide evidence that the co-guarantor borrowing system of Japan induces the suicide of borrowers in cases where the magnitude of the social stigma and the degree of altruism are high.

2 More extremely, there is some evidence showing that even the timings of deaths can be responsive to economic incentives. Kopczuk and Slemrod (2003) showed that when living longer or dying sooner could significantly affect the tax liability on an estate, the timings of deaths can be responsive to the tax consequences. Gans and Leigh (2006) also provide evidence suggesting that some deaths were shifted from the week preceding the abolition of the Australian federal inheritance taxes.

3 A suicide exemption period (suicide provision; suicide clause) states that if the insured dies as a result of suicide within the period specified in the suicide clause, no death benefit will be paid to any of the beneficiaries; after this period has lapsed, suicide is treated in the same way as any other type of death. The length of the exemption period differs according to the country, state, and/or policy. Some are regulated by law, while others are not. For details, refer to Section 3 and Table 1.

Figure 1: Jump in the suicide index after expiration of the suicide exemption period in Japan. Source: This figure is reproduced from Figure 5 in Tsukitani (2001, p. 275), which was drawn based on Japanese life insurance association data.

Note: The suicide index of the average number of suicides in the first 12 months is set to 100.

in the first 12 months after activation of a life insurance contract, and jumped to about 150 in the thirteenth month – the month immediately after the expiration of the suicide exemption period. Moreover, according to a media report, a major Japanese life insurance company saw 10% of its total insurance payments go to suicide-related deaths in 2005 (*Mainichi Shinbun*, October 4, 2005).⁴

In developing countries, microfinance (hereafter, MF) programs have been attracting wide attention, leading to the 2006 Nobel Peace Prize of Professor Muhammad Yunus and Grameen Bank of Bangladesh (Banerjee and Duflo, 2011). MF is defined as a variety of programs providing small-scale financial services to the poor lacking collateralizable assets, who are excluded from the formal banking sector. Theoretical developments in the 1990s revealed that the success of MF programs was driven by joint liability (group lending) loan arrangements in which adverse selection was prevented by peer selection,

⁴ Some of the payments actually went to consumer loan companies in order to clear the debts of suicide victims. Indeed, according to the Japanese Financial Services Agency, in the fiscal year 2004, 6,110 life insurance payments were made for suicides that resulted in a person's consumer loan debts being paid off by their life insurance company (Financial Services Agency, the Japanese Government, 2006). According to the Japan National Police Agency, the total number of suicides in 2004 was 35,325.

moral hazard was mitigated by peer monitoring, and strategic default was precluded by social sanction and ostracism (Armendáriz and Morduch 2010).

However, in March 2006 and October 2010, the Krishna District collector – i.e., the head of the district administration – of India's Andhra Pradesh state restricted the operations of MF institutions, believing that their single-minded focus on profitability led to usurious interest rates, over-indebtedness, abusive collection practices, and alleged borrower suicides. A rationale for this incident was given as follows: "... the incentives at the micro level were geared towards pushing clients to their desperate measures..... In many other cases, a government study found that MFI agents had urged non-performing clients to commit suicide; under the loan terms, borrower's debts were covered by insurance in case of death...." (Mader, p. 285). Focusing on a different aspect of MF programs, Chen, Choi, and Sawada (2010) also showed in their theoretical model that the joint-liability lending of MF institutions could induce the suicide of borrowers in cases in which the magnitude of the social stigma and the degree of altruism were high. This seems to be especially true in circumstances of adverse selection and moral hazard problems arising from information asymmetry.

These examples imply that some suicides are induced by adverse selection and/or moral hazard under imperfect informational conditions. In the presence of substantial adverse selection and moral hazard, life insurance participants will have a higher suicide rate than nonparticipants.

There has been a growing body of literature on asymmetric information in the life insurance market.⁵ Using Life Insurance Marketing Research Association (LIMRA) data, Beliveau (1984) found a positive relationship between the life insurance premium rate and the amount of coverage purchased, which he regarded as evidence for adverse selection. However, using three data sets including LIMRA data, Cawley and Philipson (1999) showed that the unit prices did not rise with the coverage, which is inconsistent with the theory of life insurance under asymmetric informational conditions. Polborn, Hoy, and Sadanand (2006) showed that while the regulation preventing insurers' access to individuals' genetic test results created adverse selection in the life insurance market, it also ameliorated the premium risks in a context in which relatively few people have genes related to high risks. Gatzert, Hoermann, and Schmeiser

⁵ A number of theoretical and empirical studies have examined asymmetric information in various insurance markets (Dionne and Doherty 1992; Chiappori and Salanié 2013). To name a few, Finkelstein and Porterba (2004) and McCarthy and Mitchell (2010) found asymmetric information in the annuity market, i.e., a positive correlation between the annuity demand and the longevity market. Chiappori (2000) and Chiappori and Salanié (2000) however found no evidence of it in the automobile insurance market.

(2009) pointed out the possibility of adverse behavior from an insured, that is, an insured with impaired health and reduced life expectancy who chooses the secondary market alternative and remains in the pool of insureds.⁶ They showed that after controlling for other risks, the people who died within a 12-year window were likely to have bought life insurance. This positive correlation between the insured's private information and the likelihood of a life insurance purchase suggests the existence of asymmetric information in the U.S. life insurance industry.

However, almost no economic research has directly explored this potential link between suicide and life insurance (Villeneuve 2000).⁷ One exception was the 2006 study by Tseng, which employed the mortality data submitted by large U.S. insurance companies to the Society of Actuaries. The results revealed that the suicide rate of the insured quadrupled following expiry of the suicide exemption period. However, Tseng (2006) presented contradictory data: the suicide rate of the general population was two to three times higher than that of the insured population.

In this paper, we investigate the causal relationship between the life insurance demand and the suicide rate, based on the asymmetric information theory. The primary difficulty in establishing causality between life insurance and suicide is the potential endogeneity associated with the use of the life insurance variable to explain the suicide rate. Controlling for observable socioeconomic factors, the demand for life insurance augments with the increase in unobservable factors such as the risk type, i.e., the tendency to commit suicide, the degree of risk aversion, and the degree of altruism. These unobservable factors may also affect suicide decisions, thereby causing an endogeneity problem. The novelty of our analysis lies in the use of cross-country variations for the lengths of the suicide exemption periods of life insurance policies and of the foreign market shares in the life insurance industries as instruments for identifying the life insurance demand. The cross-country variations in the suicide exemption periods generate a situation of quasi-natural experiments in which representative agents are faced with different incentive schemes for exogenous reasons (Chiappori 2000). Furthermore, the level of foreign market shares may reflect trade barriers in the market or the degree of competitiveness among domestic insurance companies. Hence, both the length of the exemption period and the

6 Their simulation analysis showed that the surrender rates of the insured decreased and the surrender profits for the insurers were significantly reduced when those adverse behaviors were incorporated into a model.

7 There have been many theoretical and empirical studies on asymmetric information in various insurance markets. The empirical literature on life insurance has also been growing.

foreign market share in the life insurance market are correlated with the life insurance demand. On the other hand, these two variables are not correlated directly with suicide: the lengths of the exemption periods are mostly constant, and suicide decisions would not be affected by the nationality of the policy writers.

Using data for OECD countries from 1980 to 2002, our first-stage IV regression employs the lengths of the exemption periods and the foreign market shares as instruments, and the results show a negative relationship between the length of the exemption period and the life insurance demand. Our second-stage, semiparametric regressions, reveal that there exists a positive causality from the life insurance demand to the suicide rate. The negative relationship in the first-stage regression suggests the existence of adverse selection, and the positive relationship in the second-stage regression is consistent with the existence of adverse selection and/or moral hazard. We believe that these findings contribute to the existing literature by confirming the existence of asymmetric information in the life insurance market, which is the largest private insurance market.

The remainder of this paper is organized as follows. Section 2 presents the empirical model, and Section 3 describes the data used in this study. Section 4 provides the results of the empirical analysis, and Section 5 offers some concluding remarks and implications for further studies.

2 Empirical model

At least two types of asymmetric information problems are involved in the nexus between life insurance and suicide: moral hazard and adverse selection. First, the adverse selection problem is defined as a situation in which life insurance contracts induce the participation of people with a higher probability of death than those with a lower probability of death. Second, the moral hazard problem is defined as a situation in which some of the insured who had no intention of committing suicide before purchasing the insurance commit suicide after subscribing to a life insurance policy, while they would not have chosen to do so had they not been insured.⁸ In either case, there exists a positive correlation between the life insurance purchase and the probability of committing suicide.

⁸ Suicides are considered as *ex post* – costlessly verifiable events –, excluding fake suicides by the insured or homicides staged as suicides by the beneficiaries.

To explore the existence of asymmetric information, we postulate a model of suicide as a function of the amount of life insurance purchased. If the suicide and life insurance purchase are positively correlated, the findings will be consistent with the hypothesis of life insurance-induced adverse selection and/or moral hazard. In order to analyze the model empirically, we employ the following semiparametric regression model of suicide as a nonparametric function of the life insurance demand D :

$$\log S_{it} = X_{it}\theta + f(\log D_{it}) + u_{it}, \quad [1]$$

where i and t represent the countries and years, respectively.⁹ The dependent variable $\log S_{it}$ is the natural log of the suicide rate; X_{it} is a set of attributes including socioeconomic variables such as the real GDP per capita, growth rate of the real GDP per capita, Gini coefficient, female labor participation rate, birth rate, divorce rate, and per capita alcohol consumption; and the life insurance demand D_{it} is captured by the life insurance density, defined as the per capita gross life insurance premium sold by both domestic and foreign-controlled companies. The final term, u_{it} , is an error term.

The econometric concern of eq. [1] is that the life insurance variable D_{it} is likely to be correlated with the error term u_{it} due to unobserved factors affecting both suicide and the demand for life insurance. Such factors may include the risk type, the degree of risk aversion, and the extent of altruism. This type of private information about the insured which is not revealed to insurers may lead to adverse selection: people with a higher (suicidal) risk are more likely to purchase life insurance than those with a lower risk.

Therefore, there can be a correlation between the error term and the insurance variable, such that $E(u|\log D, X) \neq 0$. This will generate a bias in the estimation of the nonparametric function $f(\cdot)$ in eq. [1]. In order to resolve this endogeneity problem, we impose two refinements on eq. [1]. First, we decompose the error term in eq. [1] as follows: $u_{it} = \alpha_i + \beta_t + \delta_i T + \varepsilon_{it}$. This decomposition controls for the omitted variable bias arising from unobserved country-specific

⁹ The nonparametric test for asymmetric information suggested by Chiappori and Salanié (2000) has been widely used. However, it restricts for the variables of the interests to be binary. In order to overcome the binary restriction and allow flexible relationship between variables, Su and Spindler (2013) developed a new nonparametric test for asymmetric information and demonstrated the workability of their test by applying it to the French automobile insurance data and the US long-term care insurance data. Naturally, their nonparametric test requires the number of observations per cell not to be too small and it is more appropriate to use for individual-level data rather than country-level data like ours.

and time-specific fixed effects through the addition of α_i and β_t respectively.¹⁰ Further, the decomposition controls for unobserved country-specific but time-varying effects by allowing for a country-specific coefficient δ_i in the linear time trend T :

$$\log S_{it} = X_{it}\theta + f(\log D_{it}) + \alpha_i + \beta_t + \delta_i T + \varepsilon_{it}. \quad [2]$$

Second, we introduce an IV regression equation for the life insurance density using the length of the exemption period and the foreign market shares as instruments, in order to mitigate the endogeneity bias arising from the simultaneity problem as in eq. [3].¹¹ For the relationship between the life insurance density and the length of the exemption period, we can hypothesize that a shorter exemption period may increase the life insurance demand by attracting riskier types, which is consistent with the existence of adverse selection in the life insurance market. For example, in the extreme case where life insurance policies deny death benefits in suicide cases – i.e., the length of the exemption period is infinite –, individuals who are seriously contemplating suicide in near future would not purchase such life insurance policies.

On the other hand, the foreign market share variable has been considered as one of the determinants for the life insurance demand in Li et al. (2007) and Ma and Pope (2008).¹² The foreign market share may reflect trade barriers in the market or the degree of competitiveness among domestic insurance companies. Regarding the former, a low level of foreign participation in a domestic market suggests strong regulations and/or low levels of insurance demands. On the other hand, in the latter case, a low level of foreign participation may be due to

10 This paper uses aggregate data, not individual-level data. In the panel econometrics context, estimates using aggregated data is equivalent to the group-mean estimation. The group-mean estimator is unbiased and consistent only if the aggregated individual-specific components are eliminated properly. Hence, incorporating country-fixed effects can mitigate country-specific omitted variable bias including aggregated individual-specific time-invariant heterogeneities. Also, the group-mean estimator is regarded as a better estimator than the OLS estimator in general because the former mitigate attenuation bias arising from measurement errors.

11 There is a broad corpus of literature identifying the determinants of life insurance density, such as Beck and Webb (2003) and Li et al. (2007). Those determinants include socioeconomic characteristics and insurance market characteristics such as income, life expectancy, number of dependents, level of education, social security expenditure, financial development, foreign market share, and so on. In eq. [3] for the insurance density, we include the lagged insurance density variable as well as socioeconomic factors. Moreover, following the previous literature, the foreign market share variable is included as instrument variable for the life insurance demand. Lastly, the country-specific effects are taken into account with the random effects.

12 The foreign market share variable has been used only recently due to the lack of data availability.

severe domestic competition and could hence be associated with high levels of insurance demands. Therefore, the direction of the overall effect is an empirical question.¹³ If the latter channel is important, a low foreign market share (due to domestic competition) will coincide with a low price level, theoretically leading to more density D_t . Indeed, the foreign market share has a negative coefficient in the density regression.

In terms of econometric framework, we apply the augmented regression technique of Holly and Sargan (1982) to the IV regression equation for the life insurance density:

$$\log D_{it} = Z_{it}\gamma + \eta_{it} \quad [3]$$

where Z is the set of determinants of the life insurance density. This includes the length of the life insurance exemption period variable and the foreign market shares in the life insurance industries as identifying instruments, as well as a lagged log for the life insurance density and the socioeconomic variables X from eq. [1]. Based on the previous discussion, if the estimated coefficients for the length of the exemption period variable show negative signs in eq. [2], we can interpret them as being consistent with the presence of adverse selection in the life insurance market.

Following Holly and Sargan (1982), Blundell, Duncan, and Pendakur (1998), and Gong, van Soest, and Zhang (2005), we assume that $E(\eta|Z, X) = 0$ and $E(\varepsilon|\log D, Z, X, M) = \rho\eta$, where M includes the country-specific and time-specific fixed effects and the country-specific linear time trend. The first conditional mean assumption implies that the length of the exemption period and the foreign market share in the life insurance industry are uncorrelated with the error term η in eq. [3]; the error term η includes unobserved factors such as the risk type, the degree of risk aversion, and the extent of altruism. The second conditional mean assumption provides the structure of the way in which ε and η are related.

One may have doubts about the validity of the first conditional mean assumption with respect to the length of the suicide exemption period variable. This is because the life insurance industry would presumably adopt a long exclusion period in any country in which the suicide rate is high. Nonetheless, after examining the data, we can dismiss this concern. First, within the sample period, despite the variations in the suicide rates, the length of the exemption period is the same within each OECD country, being determined either by insurance laws or industrial norms. The only exception is the United States,

¹³ Indeed, the existing empirical results are mixed. While Li et al. (2007) found a significant positive relationship, Ma and Pope (2008) suggested that the relationship was non-linear.

where the length of the suicide exemption period differs across the states (see Table 1 for details). Hence, the length of the exemption period can be considered to be exogenous.¹⁴ Second, even in Belgium, Finland, Greece, and Japan, where the lengths of the exemption periods were modified, the changes were made with significant lags and can therefore be considered as predetermined.^{15,16} As to the validity of the first conditional mean assumption with respect to the foreign market share variable, since both foreign and domestic life insurance companies operating in the same market have the same length of exemption period, suicide decisions should not be affected by the nationality of the insurer. Hence, both the length of the exemption period and the foreign market share in the life insurance market are correlated with the life insurance demand, but not directly with the suicide rate.¹⁷

Finally, the semiparametric regression model in eq. [2] can be rewritten as follows:

$$\log S_{it} = X_{it}\theta + f(\log D_{it}) + \alpha_i + \beta_t + \delta_i T + \rho\eta_{it} + v_{it}, \quad [4]$$

where v_{it} is a mean-zero error term, i.e., $E(v | \log D, Z, X, M) = 0$, with a variance of σ_v^2 .¹⁸ We estimate eq. [4] by a two-step procedure using the fitted value of η from the residual of eq. [3]. As to the nonparametric estimation technique, we

14 A simple correlation check of the suicide rates and lengths of exemption periods in these countries shows negative (correlation coefficient = -0.0645) but insignificant results (p -value = 0.4176).

15 In Belgium, the suicide rate started to increase from 1991. However, going against the adverse selection theory, the length of the exemption period decreased from infinity (no payments to suicides) to one year in 1993. In Finland, the suicide rate increased between 1981 and 1990, but there was no change in the length of the exemption period. When the suicide rate started to decrease from 1990, the length of the exemption period decreased from three years to one year in 1994, with a four-year lag. In Greece, the suicide rate has been rather stable (around 3 to 3.5 per 100,000 people) in our sample period, and the decrease in the length of the suicide exemption period from infinity to two years in 1997 did not seem to be driven by changes in the suicide rate. In Japan, there was no change in the length of the exemption period between 1986 and 1995, when the suicide rate saw a significant decrease. Meanwhile, there was a steep increase in the suicide rate (the number of suicides increased from 24,391 in 1997 to 32,863 in 1998) in 1997 and 1998, but the extension of the length of the suicide exemption period was not implemented until 2000.

16 Including these four countries, where the length of the exemption period did change, a correlation check of the suicide rates and the lengths of the exemption periods showed either insignificant results, or marginally significant but negative results.

17 The relevance tests for the potential weak instrument problem supported the validity of our instruments (Staiger and Stock 1997; Stock and Yogo 2002).

18 v_{it} is the error term after controlling for the unobserved factors affecting the insurance premium and suicide, as well as the fixed effects and time effects. $\varepsilon_{it} = \rho\eta_{it} + v_{it}$ where $u_{it} = \alpha_i + \beta_t + \delta_i T + \varepsilon_{it}$ in eq. [1].

Table 1: Length of exemption periods in OECD countries.

	1980–1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	Law
Australia	1	1	1	1	1	1	1	1	1	1	1	1	1	0
Austria	3	3	3	3	3	3	3	3	3	3	3	3	3	1
Belgium	∞	∞	∞	1	1	1	1	1	1	1	1	1	1	1
Canada	2	2	2	2	2	2	2	2	2	2	2	2	2	1
Czech Republic	2	2	2	2	2	2	2	2	2	2	2	2	2	0
Denmark	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Finland	3	3	3	3	1	1	1	1	1	1	1	1	1	1
France	2	2	2	2	2	2	2	2	2	2	2	2	2	1
Germany	3	3	3	3	3	3	3	3	3	3	3	3	3	1
Greece	∞	∞	∞	∞	∞	∞	∞	2	2	2	2	2	2	1
Hungary	2	2	2	2	2	2	2	2	2	2	2	2	2	1
Iceland	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Ireland	1	1	1	1	1	1	1	1	1	1	1	1	1	NA
Italy	2	2	2	2	2	2	2	2	2	2	2	2	2	0
Japan	1	1	1	1	1	1	1	1	1	1	2	2	2	1
Korea	2	2	2	2	2	2	2	2	2	2	2	2	2	1
Luxembourg	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Mexico	2	2	2	2	2	2	2	2	2	2	2	2	2	1
Netherlands							NA							1
New Zealand	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Norway	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Poland	2	2	2	2	2	2	2	2	2	2	2	2	2	1
Portugal	2	2	2	2	2	2	2	2	2	2	2	2	2	0
Slovak Republic	2	2	2	2	2	2	2	2	2	2	2	2	2	0
Spain	1	1	1	1	1	1	1	1	1	1	1	1	1	0

(continued)

Table 1: (Continued)

	1980–1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	Law
Sweden	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Switzerland	3	3	3	3	3	3	3	3	3	3	3	3	3	1
Turkey	3	3	3	3	3	3	3	3	3	3	3	3	3	1
United Kingdom	1–2	1–2	1–2	1–2	1–2	1–2	1–2	1–2	1–2	1–2	1–2	1–2	1–2	0
United States						Different by states								0

Data sources: The authors' survey of life insurance associations in each OECD country. Australia: Accident Research Center: Monash University; Austria: UNIQA Versicherungen AG; Belgium: Vanbreda Insurance Policy; Canada: Judgments of the Supreme Court of Canada; Czech Republic: Insurance Contact Act: Act No. 37/2004; Denmark: The Danish Insurance Association; Finland: Veritas Life Insurance Company Ltd; France: Insurance code (www.legifrance.gouv.fr); Germany: AXA Konzern AG; Greece: Association of Insurance Companies; Hungary: Hungarian Financial Supervisory Authority; Iceland: Act on Insurance Contracts, No 30/2004; Ireland: Eagle Star; Italy: Assicurazioni Generali; Japan: Life Insurance Association of Japan; Korea: Korea Life Insurance Association, Luxembourg: Association des Compagnies d'Assurances; Mexico: Asociacion Mexicana de Instituciones de Seguros; Netherlands: Dutch Association of Insurers; New Zealand: Insurance Council of New Zealand Inc.; Norway: Norwegian Financial Services Association; Poland: Polish Chamber of Insurance; Portugal: Portuguese Insurers Association; Slovak: Republic Slovenská asociácia poisťovní; Spain: Association of Spanish Insurers; Sweden: Svenska Försäkringsföreningen; Switzerland: Swiss Insurance Association; Turkey: Association of the Insurance and Reinsurance Companies of Turkey; United Kingdom: Association of British Insurers; and United States: different across states.

Notes: 1. In the United States, most states (33) have a two-year suicide exemption period: Alabama, Alaska, Arizona, Arkansas, California, Delaware, Georgia, Hawaii, Idaho, Illinois, Kentucky, Louisiana, Maine, Maryland, Minnesota, Montana, Nebraska, Nevada, New Hampshire, New Mexico, New York, North Carolina, Oklahoma, South Carolina, South Dakota, Tennessee, Texas, Utah, Virginia, Washington, West Virginia, Wisconsin, and Wyoming. Two states – Colorado and North Dakota – specify a one-year provision. In the following 14 states and the District of Columbia, the length of the suicide exemption period exclusion is not addressed: Connecticut, Florida, Indiana, Iowa, Kansas, Massachusetts, Michigan, Mississippi, New Jersey, Ohio, Oregon, Pennsylvania, Rhode Island, and Vermont. Finally, Missouri has a law that invalidates the suicide clause. 2. With the exception of the United States, among the OECD countries, there are laws governing the length of the suicide exemption period (in 20 countries; law = 1). The length of the suicide exemption period in the other nine countries is determined by industrial norms (law = 0).

use Lokshin's (2006) algorithm, which is based on the differencing method for the estimation of the partial linear models introduced by Yatchew (1997).¹⁹ In sum, if the estimated nonparametric part in eq. [4] shows that $f'(\cdot) > 0$, we can interpret the derivative as being consistent with the presence of adverse selection and/or moral hazard in the life insurance market.

3 Data

Our data set includes all OECD countries for the period 1980–2002. The raw number of suicides and the population were obtained from the WHO Mortality Database. An age-standardized suicide rate per 100,000 inhabitants was calculated by using the world standard population figures published by the WHO.²⁰ By using this adjustment, the differences in the age structure across countries and time could be controlled for. In other words, this eliminated the need to include the ratio of specific age groups in the analysis (Neumayer 2003).

The life insurance density, defined as the per capita gross life insurance premium sold by both domestic and foreign-controlled companies, was obtained from the Swiss Re Sigma Database. The foreign market share in the life insurance industries, defined as the ratio of the gross premium of foreign-controlled undertakings and branches and agencies of foreign undertakings to the total gross premiums, was obtained from the OECD (2008) Insurance Statistical Yearbook.

A considerable amount of time and effort was devoted to the collection of information for the key identifying instrument, the length of the suicide exemption period, through our own survey of life insurance associations and/or companies in each OECD country. We also asked if there were related laws, regulations, and/or industrial norms governing the exemption period. Some

19 First, the parametric part is estimated by using first-order differencing based on the sorted life insurance density data, so that $D_1 \leq D_2 \leq \dots \leq D_n$, where n is the number of observations. The nonparametric part differenced as $(f(\log D_j) - f(\log D_{j-1}))$ goes to zero, as f has bounded the first-order derivative. We then use the least squares as in full parametric specifications (Yatchew 1997; Lokshin 2006). Second, we estimate the non-parametric part, $f(\cdot)$. Subtracting the estimated parametric part from the dependent variable, we estimate the non-parametric part $f(\log D)$ and the first-order derivative $f'(\log D)$ using the locally weighted regression of Fan (1992). We use the PLREG program for STATA developed by Lokshin (2006).

20 Unadjusted suicide rates assign equal weight to each suicide, while adjusted suicide rates assign different weights according to the suicide rates for different age groups, based on a world-standardized age profile. This reduces the influence of country-specific age structures on the total population (aggregated) suicide rate.

countries had regulations. Others did not, so that the insurance companies were free to choose, but they tended to follow the industrial norms on the specific length.²¹ These data were gathered for the first time for this study. The dummy variables representing the length of the suicide exemption period were constructed as follows: the one-year exemption dummy variable took one if the exemption period was one year, and 0 otherwise; the two-year exemption dummy variable took one if the exemption period was two years, and 0 otherwise; the three-year exemption dummy variable took one if the exemption period was three years, and 0 otherwise; and the infinite exemption period dummy variable took one if there was no payment for suicide-related deaths, and 0 otherwise. The number of observations for the zero-year exemption period was taken as the default variable for the exemption period dummy variables.²² The United States, the Netherlands, and the United Kingdom were excluded because the length of the exemption period differed across states in the United States, and precise information on the length of the suicide exemption period was not available for the Netherlands and the United Kingdom.

With regard to the socioeconomic variables, the economic variable – the real GDP per capita – was obtained from the Penn World Table 6.2 and the growth rate was calculated based on the real GDP per capita. The unemployment rate was obtained from OECD health data. As a proxy for income inequality, Gini coefficients based on different definitions were acquired from the United Nations University's World Income Inequality Database (WIID), and the average of the available Gini coefficients for each country in each year was used as a single index. The birth rate, measured by the ratio of live births to the total population, was taken from the WHO Mortality Database. The divorce rate, measured by the ratio of the number of divorces to the total population, was obtained from the United Nations Common Database.

The female labor force participation rate, measured as a percentage of the female population aged 15–64, was acquired from the World Development Indicators of the World Bank. Finally, with respect to alcohol consumption, the sales data of pure alcohol, per individual over 15 years of age, measured

21 While insurance companies in each country tend to base the length of the exemption period on the industry norm, there are some exceptions. For instance, in Australia, if the insurance applicant has a past history of mental illness or attempted suicide, then an insurer may include a suicide exclusion provision in the policy.

22 The number of observations for the one-year, two-year, three-year and infinite exemption period dummies are 63, 87, 24, and 5, respectively (a total of 179), for the FE-IV estimation in Table 3. The number of observations for the zero-year exemption period is 20. Note that the latter applies whenever life insurance benefits are paid for any kind of death, including suicide.

Table 2: Variables and data sources.

Variable	Definition	Source(s)
Suicide rate	Rate per 100,000 people	WHO Mortality Database (last updated: Nov 17, 2006)
Birth rate	Live birth to total population	
Population	–	
Life insurance density	Life insurance premium/population	Swiss Re Sigma database
Foreign market share	Foreign-controlled undertakings and branches, and agencies of foreign undertakings/total domestic business on a gross premiums basis	OECD Insurance Statistical Yearbook
Per capita GDP	Real GDP	Penn World Table 6.2, 2006
Per capita GDP growth rate	Real GDP growth rate	
Unemployment rate	% of total labor force	OECD Health Data 2005
Alcohol consumption	Liters per person aged 15 and above	Additional source for alcohol consumption (only for Japanese data): National Tax Agency, Japan
Divorce rate	% of total population	United Nations Common Database, 2007
Gini coefficient	Average of Gini indices from different definitions	World Income Inequality Database, V 2.0b, May 2007
Female labor force participation	% of female population aged 15–64	World Development Indicators, 2006

in liters, were taken from OECD health data. Table 2 lists the definitions of the socioeconomic variables and their sources.

4 Results of the empirical analysis

As discussed in Section 2, since we imposed two refinements in order to deal with the endogeneity problem, we conducted the estimations in the following order: first, eq. [1] was estimated without considering the omitted variables and the simultaneity problems (the baseline specification); second, only the simultaneity problem in eq. [1] was addressed by using the IV technique through eq. [3] (the IV specification); third, only the omitted variable problem in eq. [1] was addressed by including the time- and country-specific fixed effects as well as the country-specific time trend (the FE specification); finally, we estimated eq. [4], in which

both the omitted variable problem and the simultaneity problem were accounted for (the FE-IV specification). For the following discussion, the nonparametric estimation results are presented in Figure 2(A)–2(D), and the estimation results of the parametric part are provided in Table 3. Since the main focus is on the relationship between the suicide rate and the life insurance density, we commence our discussion with the nonparametric estimation results.

Figure 2: Nonparametric plots of relationship between suicide rate and life insurance density.

Figure 2(A) and 2(B) present the nonparametric estimation results of the baseline and IV specifications, respectively. These two figures show a slightly U-shaped relationship between the suicide rate and the life insurance density and are quite similar. This either implies that there is no endogeneity problem or that the IV method alone fails to appropriately address the endogeneity problem. Indeed, the estimate for the coefficient of η in Table 3 is not significant. However, this may be an artifact from not addressing the omitted variable bias, although the positive part of the U-shaped relationship is consistent with the existence of adverse selection and/or moral hazard in the life insurance markets.

Figure 2(C) and 2(D) present the nonparametric estimation results of the FE and FE-IV specifications, respectively. Taking into account the fixed effects, the results in

Table 3: Summary results of the parametric part.

Model specification	Baseline	IV	FE	FE-IV
Controlled for fixed effects	No	No	Yes	Yes
Instrumental variable estimation	No	Yes	No	Yes
Variables	Estimate	Estimate	Estimate	Estimate
Per capita GDP	−0.1301*** (0.0552)	−0.2853*** (0.0657)	−0.4600*** (0.0993)	−0.6364*** (0.1183)
Per capita GDP growth rate	−0.8214 (0.9446)	0.7240 (1.0836)	−0.1560 (0.2405)	0.1380 (0.2774)
Unemployment rate	−1.1835* (0.6828)	0.0895 (0.7669)	−0.0211 (0.4279)	−0.3068 (0.5457)
Female labor force participation	0.0524*** (0.0103)	0.0074 (0.0135)	−0.0128 (0.0152)	−0.0194 (0.0180)
Birth rate	0.3899*** (0.1456)	0.4708*** (0.1701)	0.0430 (0.0757)	−0.1115 (0.1756)
Divorce rate	0.0852** (0.0339)	0.3541*** (0.0570)	0.0615** (0.0305)	0.0305 (0.0404)
Alcohol consumption	0.0475*** (0.0101)	0.0378*** (0.0111)	−0.0012 (0.0147)	−0.0209 (0.0179)
Gini coefficient	−0.0389*** (0.0057)	−0.0298*** (0.0083)	0.0049** (0.0020)	0.0040 (0.0026)
$\hat{\eta}$	− (0.0057)	0.2466 (0.1915)	− (0.0020)	0.1367** (0.0543)
Number of observations	308	196	308	196
R^2	0.4421	0.6237	0.9861	0.9914
Significance test statistics for the nonparametric part	1.284	1.785	4.880	7.088
[<i>p</i> -value]	[0.100]	[0.037]	[0.000]	[0.000]

Notes: 1. The estimation was done by using the nonparametric part for the life insurance density country-fixed effects, time-fixed effects, and country-specific linear time trends, which are not shown in Table. 2. Robust standard errors provided in parentheses. 3. *Significant at 10%; **Significant at 5%; ***Significant at 1%.

these two figures are significantly different from the previous ones. Figure 2(C) and 2(D) present a positive relationship between the suicide rate and the life insurance density, except at their right-end tails, where the life insurance density is high.²³ This positive relationship is consistent with the existence of adverse selection and/or

²³ A significance test for the life insurance density variable entering the specification non-linearly indicates that the log of the life insurance density is highly significant, with a *p*-value of 0.0000.

moral hazard in the life insurance markets. The steeper slope in Figure 2(C) suggests a more substantial asymmetric information problem. However, the estimate for the coefficient of η in the FE-IV specification (the fourth column in Table 3) is significantly positive. This positive correlation implies that the FE specification overestimates the nonparametric part without taking into account the simultaneity pertaining to life insurance density and suicide. Since the results presented in Figure 2(D) and in the fourth column of Table 3 take into account both refinements, we hold them to be the most accurate.

In addition, a negative relationship between the suicide rate and the life insurance density is shown in the right-end tail of Figure 2(D). This may be considered to be inconsistent with the asymmetric information theory when the life insurance density is sufficiently high. One plausible interpretation may be the existence of some other relevant, unobservable variables which the estimation equations failed to account for. One such example may be wealth. On average, wealthier individuals are likely to purchase more life insurance (life insurance is a normal good). Nevertheless, the proportion of the loss coverage in the event of death is likely to decrease with an increase in wealth.²⁴ This implies that death benefits are less valuable in the case of wealthier people. Hence, the financial incentives for suicide from insurance payments are weaker or minimal, leading to a negative relationship as shown in the figure. This result is in line with that of Spindler's study (2013), which demonstrated the presence of asymmetric information for low and medium insured sums in the German disability insurance system – i.e., a positive correlation between the risk and coverage –, but not for high insured sums.

As stated above, eq. [3] – a first-stage estimation regressing the log life insurance density on the exemption period dummies and the foreign market share – was used in the IV and FE-IV specifications in order to address the simultaneity problem.²⁵ In fact, since a short exemption period may induce the

²⁴ Enz (2000) provides evidence suggesting that life insurance is a normal good for higher levels of income.

²⁵ For a robustness check, we carried out several regressions with various combinations of the instrumental variables: a regression with only the four exemption period dummy variables (one-year, two-year, three-year, and infinite year), a regression with only the foreign market share variable, a regression with both the exemption period dummy variables and the foreign market share, and lastly, a regression with the interaction of the exemption dummies and the foreign market share. We found that all the regression results were quite robust to the variations of the instrumental variables. First, our IVs kept the same signs and were significant in the first-stage regression. Second, the coefficients of the residual estimates from the first-stage estimation were positive and significant as per the results of this paper. Third, the non-linearity between the log of the suicide rates and the log of the life insurance density held. To save space, we report the estimation results for the regression with both the four exemption dummies and the foreign market share. Our detailed results are available upon request.

self-selection of riskier types with regard to life insurance contracts, the estimation result of eq. [3] can provide information on the existence of adverse selection. Table 4 shows the result of the first-stage estimation. We found that both the three-year and infinite exemption period dummies were significantly negative with regard to the level of life insurance density. This suggests that a longer exemption period or no life insurance payment in cases of suicide is associated with a decrease in the purchase of life insurance policies. In other words, a longer exemption period may deter riskier types from purchasing life insurance policies. As to the foreign market share, the results show a significantly negative trend, implying that a low level of foreign participation is associated with high levels of life insurance demands, possibly due to severe competition among domestic companies.

Table 4: Life insurance density equation regression results (first-stage instrumental variable regression).

	Coefficient	Std. Err.
One-year exemption dummy	0.0251	(0.0255)
Two-year exemption dummy	−0.0180	(0.0168)
Three-year exemption dummy	−0.0480*	(0.0234)
Infinite exemption dummy	−0.0932*	(0.0454)
Foreign market shares	−0.0014**	(0.0006)
Lag life insurance density	0.9607***	(0.0159)
Per capita GDP	−0.0191	(0.0194)
Per capita GDP growth rate	1.1573	(0.7056)
Unemployment rate	−0.3586**	(0.1807)
Female labor force participation	0.0049	(0.0038)
Birth rate	−0.1401***	(0.0444)
Divorce rate	−0.0120	(0.0217)
Alcohol consumption	0.0038	(0.0031)
Gini coefficient	0.0019	(0.0026)
Constant	0.3123	(0.2268)
Overall R^2	0.9864	
Wald statistics for zero coefficients	171,301.36	
[p-value]	0.0000	
Number of observations	207	
Number of countries	25	

Notes: 1. The estimation was done by using random effects; the robust standard errors are in parentheses. 2. *Significant at 10%; **Significant at 5%; ***Significant at 1%.

With respect to the parametric part shown in Table 3, a consistent finding is that the real GDP per capita is significantly negative. The female labor force participation rate is significant in the baseline specification; in addition, the birth,

divorce, and alcohol consumption rates are significant in the baseline and IV specifications. However, all these variables except for the real GDP per capita become insignificant in the FE-IV specification. The coefficient of the Gini index in the baseline and IV specifications suggests a significantly negative relationship between the suicide rate and inequality. This puzzling finding may result from the omitted variables bias. Indeed, the coefficient becomes significantly positive after controlling for the fixed effects; nevertheless, it becomes insignificant in the FE-IV specification.

5 Concluding remarks

In this paper, we investigated the nexus between life insurance and suicide, using OECD cross-country data from 1980 to 2002. By using semiparametric IV regressions with fixed effects, this study found a negative relationship between the life insurance demand and the length of the suicide exemption period, together with a positive relationship between the suicide rate and the life insurance demand for a majority of observations. These two relationships suggest the presence of adverse selection and moral hazard in life insurance markets. There are exceptions in cases of high levels of life insurance density, which may be explained by the wealth effect.

This result challenges the current conception in the literature that life insurance markets are immune to the problems associated with asymmetric information. The novelty of our analysis lies in the use of data on cross-country variations, with the length of the suicide exemption periods and the foreign market share in the life insurance industries as the main identifying instrumental variables for the life insurance density. Nevertheless, the aggregate nature of the data used in this study does not allow for clean differentiation between adverse selection and moral hazard. In further studies, the issues of adverse selection and moral hazard should be investigated using individual-level data.

Through this study, we would like to emphasize the importance of studying suicides by employing a somewhat rational approach. If we recognize that some suicides may be rational, studies can be conducted to ascertain the different incentives behind suicide. This way, we believe that suicide-related research can gather sufficient resources, as is warranted by the seriousness of the current situation, and effective measures can thereby be developed and implemented for suicide prevention. Nevertheless, there is an important caveat to this study, particularly when deriving policy implications: not all suicides are driven by financial incentives. To stop making suicide-related death payments may

eliminate the adverse selection and moral hazard problems, as discussed in this paper, but it also questions the very basic function of life insurance – that is to say, to protect beneficiaries against the sudden economic loss associated with the death of their loved ones. These issues should be investigated carefully in future studies.

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