Economic crises and suicides between 1970 and 2011: time trend study in 21 developed countries

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ABSTRACT

Background Existing research on the relationship between economic recessions and suicides has almost completely concentrated on the most recent global financial crisis (2008). We provide the most comprehensive explanation to date of how different types of economic/financial crises since 1970 have affected suicides in developed countries.

Methods Negative binomial regressions were used to estimate what the suicide rates would have been during and 1 year after each crisis began in 21 Organisation for Economic Co-operation and Development countries from 1970 to 2011 if the suicide rates had followed the pre-crisis trends.

Results We found that every economic/financial crisis since 1970, except the European Exchange Rate Mechanism crisis in 1992, led to excess suicides in developed countries. Among males, the excess suicide rate (per 100 000 persons) varied from 1.1 (95% CI 0.7 to 1.5) to 9.5 (7.6 to 11.2) and, among females, from 0 to 2.4 (1.9 to 2.9). For both sexes, suicides increased mostly due to stock market crashes and banking crises. In terms of actual numbers, the post-1969 economic/financial crises caused >60 000 excess suicides in the 21 developed countries. The Asian financial crisis in 1997 was the most damaging crisis when assessed based on excess suicides.

Conclusions Evidence indicates that, when considered in terms of effects on suicide mortality, the most recent global financial crisis is not particularly severe compared with previous global economic/financial crises. The distinct types of crises (ie, banking, currency and inflation crises, and stock market crashes) have different effects on suicide.

INTRODUCTION

The global financial crisis of 2008 ('the Great Recession') was by many measures the worst crisis since the Great Depression of the 1930s. Evidence shows that the formerly declining suicide trend became markedly reversed in many Western countries after 2008. Barr *et al*[1] estimated that, in England, the economic recession in 2008–2010 caused approximately 1000 excess suicides. Chang *et al*[2] estimated that there were almost 5000 excess suicides across 54 countries in 2009 (calculated based on the trend for 2000–2007). Furthermore, suicide rates in European countries (especially in Greece) increased significantly after the global economic recession in 2008.[3–10]

In a series of papers by Ruhm,[11–13] Neumayer,[14] Tapia Granados,[15] and Tapia Granados and Ionides[16] show that economic recessions are associated with lower mortality. Also, Cutler *et al*[17] present that large recessions increase mortality. In recent studies,[18 19] there is evidence that total mortality has shifted from strong procyclical to unrelated to macroeconomic factors. The results related to suicide were mixed. Ruhm[11] presented that the occurrence of suicide increased when economic conditions decline. Neumayer[14] found that also suicides were lower in recessions. We should also emphasise that economic crises lead to a reduction of social networks, increase mental health problems, weaken self-esteem and reduce the possibilities to use one's skills. A well-established finding in the literature is that mental disorders play a significant role in almost all suicides.[20]

Unlike total mortality or other causes of death that are primarily proxies for physical health or non-disease sources of death, suicide mortality is generally reported to be countercyclical or neutral.[2 11 21–23] These results raise the possibility that worsening economic conditions have negative effects on some facets of mental health.[11] Gunnell and Chang[23] list stressors that are closely linked to economic recessions, such as increases in unemployment, difficulties in keeping up with mortgage repayments, and increased stress and workload of those who remain in work after staffing reductions. Increased stress could result in impaired mental health, lead to self-harm or increase alcohol abuse, all of which are major risk factors for suicide.

Previous studies on the relationship between economic recessions and suicides have almost completely concentrated on the most recent global financial crisis. There are a few notable exceptions. Luo *et al*[24] explored the association between suicide and business cycles with the US age-specific data from 1928 to 2007. They find that suicide rate generally rose during recessions, although different age groups responded differently. Blasco-Fontecilla *et al*[25] find that gross domestic product (GDP) adjusted for purchasing power parity per capita strongly correlates to suicide rates in their study with 10 WHO regions during the past 30 years.

We took a broader view by comparing the severities of different types of large economic/financial crises in developed countries since 1970. By exploring the effects of these crises in terms of excess suicides, we were able to compare how suicide rates responded to the major global level economic crises. In addition, we examined whether different types of economic or financial crises (stock market, currency, inflation or banking crises) have affected differently on the suicides.

METHODS

Data

We used data on economic/financial crises and suicides from 21 Organisation for Economic Co-operation and Development (OECD) countries for the period 1970–2011. The included countries were Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Japan, the Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, the UK, and the USA. The suicide data were collected from the WHO Mortality Database.[26] The database includes the number of sex-specific suicide deaths by country, as coded according to the International Classification of Diseases (7th, 8th, 9th and 10th revisions). Mid-year sex-specific population counts were obtained from the same database. We used these population counts to compute the actual, expected and excess suicide rates.

The data on unemployment and growth rates of the real GDP per capita were collected from the Conference Board Total Economy Database[27] and the online database of the OECD, OECD.Stat.[28]

Measures of economic/financial crises

We concentrated on the most severe global economic/financial crises since 1970. The included crises were the oil-shock recession of 1974, inflation-defeating recession of 1982, Black Monday crash of 1987, Nordic banking crisis of 1991, European Exchange Rate Mechanism (ERM) crisis of 1992, Asian financial crisis of 1997, Dot-com bubble (IT bubble) of 2001, global financial crisis of 2008 ('the Great Recession') and Eurozone debt crisis of 2010. An important feature of these crises is that they were unexpected. Detailed histories of these economic/financial crises can be found, for example, in Kindleberger and Aliber[29] (see online supplementary data for a concise description of each crisis).

The distinct categories of economic/financial crisis used in our analysis were banking, currency and inflation crises, and stock market crashes. We use the definitions of Reinhart and Rogoff[30] for each type of crisis (see online supplementary data for the specific definitions).

There are some notable differences between how these distinct types of crises are related to suicides. Shiller[31] explored people's perception of the costs of inflation and found that the major concern of high inflation is the concern of a reduction of individual's standard of living. The most damaging currency crisis occurs when there is initially a fixed exchange rate and individuals and financial agents have made their economic decisions under the assumption that this fixed exchange rate will maintain in the future. For example, during the South Asian currency crisis in 1997, several exchange rates depreciated >50% within a few months after the speculative attack took place. When stock markets crash, a large number of individuals suffer major losses in their wealth and savings. For example, the stock market crash during the Great Depression led to impulsive suicides by bankers because of acute financial losses. Also, the wealth losses after the 2008 stock market crash increased significantly depression as presented in McInerney *et al*.[32] Compared with the other types of crisis, the banking crises are distinctive in a way that they affect the whole economic system and, hence, have impacts on all individuals. Furthermore, the banking crises have serious effects on the trust and confidence, which are the most important bases of the entire financial system.

Statistical analyses

We used negative binomial regressions to assess excess suicides during and 1 year after each economic/financial crisis erupted. The same approach is used, for example, in Barr *et al*,[1] Cha *et al*,[33] Chang *et al*,[2] Laanani *et al*[34] and Reeves *et al*.[35]

First, we estimated the 10-year linear suicide trends before each economic/financial crisis in each of the 21 OECD countries using dummy variables for crisis years and for the 1 year after the crises erupted. From these models, we obtained the estimated rate ratios for actual and expected suicides, along with their CIs. The statistical significance of the rate ratios was set at a p value <0.05. Based on the rate ratio estimations, we calculated the expected numbers of suicides, that is, what the suicide numbers would have been if the pre-crises trends had continued. The estimates of the numbers of excess suicides were then obtained by quantifying the deviation between the actual and expected numbers of suicides (given the pre-crisis trends) (see online supplementary data for further methodological details). All the analyses were conducted with Stata V.14 (StataCorp).

The relationship between economic/financial crisis and suicide should be considered with care because an economic/financial crisis can impact on suicide, for example, via an increase in unemployment.[34] It is important to note that economic/financial crises typically involve periods when unemployment increases and output declines. This implies that during an economic crisis all 'excess' suicides are probably not directly the result of the crisis itself. An economic/financial crisis could affect suicide due to concomitant features of the crisis, for example, by increasing unemployment or decreasing income. Also, Laanani *et al*[34] argue that the high correlation between the impact of unemployment and the impact of the other features of the economic crisis (or 'crisis effect') makes it difficult to study them independently. For this reason, we estimated excess suicides after including variables for unemployment and GDP as controls (the results without these covariates are presented in online supplementary table S1-S3). In this way, we were able to assess whether there were excess suicides attributable to a 'crisis effect' beyond the unemployment and income effects. The resulting model, which was estimated for each country and separately for male and female population, was as follows:

$$ln\left(\lambda_t\right) = ln\left(E\left(sui_t\right)\right) = ln\left(pop_t\right) + \alpha + \beta t + \delta ue_t + \mu ln\left(y_t\right) + \gamma \mathbf{I}_{\{t=crisis\ year\}} \quad (1)$$

where t is the year, sui_t is the number of suicides that occurred, pop_t is the population size, ue_t is unemployment rate and $ln\left(y_t\right)$ natural logarithm of GDP per capita. The α, β,δ and μ values are coefficients estimated from the data. The term involving the natural logarithm of the population size, ln(*pop*), is called the offset variable, and it was included in the model to adjust for annual changes in population figures. The dummy variable for economic/financial crisis for a particular year (or the year after the crisis erupted) is denoted as $\mathbf{I}_{\{t=crisis\ year\}}$.

The rate ratios between the actual and expected number of suicides, $\frac{sui_t}{\lambda_{crisis\ year}}$, were obtained from the exponential of γ. These rate ratios were then used to calculate the expected number of suicides, $\lambda_{crisis\ year}$, that is, what the number of suicides would have been if the preceding 10-year trend had continued. The number of excess suicides was obtained based on the positive deviation between the actual and expected number of suicides. All the estimated rate ratios which were used in calculations associated to global crises are presented in the third column of online supplementary table S4.

Table 1 Male and female excess suicide rates associated with major economic crises* (during and/or 1 year after) in 21 Organisation for Economic Co-operation and Development countries

Crisis	Male excess suicide rate ‡, n (95% CI)	%§	Female excess suicide rate, n (95% CI)	%
Oil-shock recession, 1974	1.4 (0.8 to 2.0)	17.8	0.8 (0.4 to 1.2)	16.0
Inflation-defeating recession, 1982	4.1 (3.2 to 4.9)	21.4	1.0 (0.6 to 1.4)	12.5
Without Japan	1.5 (0.5 to 2.4)	17.3	0.6 (0.2 to 0.9)	26.2
Black Monday crash, 1987	3.4 (0.5 to 5.9)	15.1	–	
Nordic banking crisis, 1991	3.3 (0.3 to 5.8)	24.1	–	
European Exchange Rate Mechanism crisis, 1992	–		–	
Asian financial crisis, 1997	9.5 (7.6 to 11.2)	35.0	2.4 (1.9 to 2.9)	23.1
Without Japan	–		1.4 (0.8 to 2.0)	31.3
Dot-com bubble, 2001	3.0 (1.2 to 4.7)	20.5	0.4 (0.2 to 0.5)	8.2
Global financial crisis, 2008	2.7 (1.0 to 4.0)	26.5	–	
Eurozone debt crisis, 2010	1.1 (0.7 to 1.5)	5.9	0.9 (0.5 to 1.3)	17.9

*Additional covariates in estimated regression models were unemployment and natural logarithm of gross domestic product per capita.
†Per 100 000 persons.
‡Excess rates are calculated as the difference between the actual suicide rate and the rate that would have been expected on the basis of the preceding 10-year trend.
§% denotes increase in suicide rate compared with the suicide rate that would have been expected based on the preceding trend.

RESULTS

Online supplementary figure S1 displays the population-weighted suicide rates (in all of our sample countries combined) for both genders and the world aggregate crisis index[30] from 1960 to 2012. The effects of economic/financial crises in terms of excess suicides are presented in table 1. By measuring the severity of crises in terms of excess suicide rates, it is clear that the Asian financial crisis (1997) was the most severe crisis (the lower limits of 95% CIs exceed the upper limits of 95% CIs of excess suicide numbers in any other crisis). The excess suicide rate (per 100 000 persons) was 9.5 (95% CI 7.6 to 11.2) for males and 2.4 (1.9 to 2.9) for females. This implies a 35% increase in male suicide rates and a 23.1% increase in female suicide rates during and/or 1 year after the crisis compared with the suicide rate that would have been expected based on the preceding trend. Almost all of these excess suicides occurred in Japan. When we excluded Japan, the excess suicide rate was not statistically significant (at the 5% significance level) for males and it was 1.4 (0.8 to 2.0) for females. Thus, male excess suicides increased by 0.0% but for females they increased by 31.3% with respect to the expected rate. The Asian financial crisis seems to have had a huge effect in terms of increasing women's suicides in developed countries irrespective of whether Japan was included.

High excess suicide rates also occurred after the inflation-defeating recession (1982). The excess suicide rate for males was around 4.1 (95% CI 3.2 to 4.9) and for females around 1.0 (0.6 to 1.4), implying a 21.4% increase in male suicides and a 12.5% increase in female suicides (compared with the expected rates). However, like for the Asian financial crisis, the excess suicide rates dropped markedly when we disregarded Japan, being 1.5 (0.5 to 2.4) for males and 0.6 (0.2 to 0.9) for females. Nevertheless, the percentage increase in suicide rates (compared with the expected rates) stayed high for males, at 17.3%, and it even increased to 26.2% for females. This indicates that the effect of the crisis among females in Japan was relatively small compared with the other countries affected by the crisis.

The stock market crash in October 1987 (which started on so-called Black Monday) and the Nordic banking crisis in 1991 were two other major crises that led to high male excess suicide rates. In these crises, however, there were not huge numbers of excess suicides in Japan. The excess rate for males was 3.4 (95% CI 0.5 to 5.9) after the stock market crash and 3.3 (0.3 to 5.8) after the Nordic banking crisis. Interestingly, for females, the excess suicide rates were not statistically significant after either crisis. For males, the stock market crash caused a 15.1% increase and the Nordic banking crisis caused a 24.1% increase in the suicide rate (compared with the expected rate). The ERM crisis in 1992 was the only crisis that was not statistically significantly (at the 5% significance level) associated with excess suicides for either males or females.

It is noteworthy that the economic crises in the 2000s led to somewhat lower excess suicide rates compared with the earlier major economic crises since 1970. For example, the global financial crisis of 2008 led to an excess suicide rate of 2.7 (95% CI 1.0 to 4.0) for males and a non-significant rate for females. This implies a percentage increase in the suicide rate (compared with the expected rate) of 26.5% for males, which is the second highest percentage increase among the crises analysed. The bursting of the Dot-com bubble in the early 2000s resulted in a male excess suicide rate of 3.0 (1.2 to 4.7) and a female excess suicide rate of 0.4 (0.2 to 0.5). Expressed in the terms of an increase in suicides compared with what would have been anticipated based on preceding trends, the increase was 20.5% for males and 8.2% for females. Furthermore, the results for the Eurozone debt crisis were among the least severe, with an excess suicide rate of 1.1 (0.7 to 1.5) for males and 0.9 (0.5 to 1.3) for females, corresponding to percentage increases of 5.9% and 17.9% in the expected suicide rates for males and females, respectively.

For robustness, we conducted separate regressions using different covariates, using 15-year trend, and only for those of working age (25–64 years). The estimates of suicide rate ratios are presented in online supplementary table S4-S9. In addition, we have replicated table 1 on the basis of the preceding 8-year and 15-year trend, and the results are presented in online supplementary table S10. We find that our 10-year time trend estimates for the whole population are relatively robust since the rate ratio estimates do not substantially change across regressions. Further, we conduct placebo tests to validate our model approach. The estimations were done for the periods 1955–1965 and 1962–1973. The placebo regression results are presented in online supplementary table S11-S12. The estimated numbers of excess suicides suggest that predicted suicide numbers do not substantially deviate from actual suicide numbers that occurred (ie, there are no excess suicides) in 'fake' crash years of 1965 and 1973.

Table 2 Number of male and female excess suicides associated with major economic crises* (during and/or 1 year after) in 21 Organisation for Economic Co-operation and Development countries

Crisis	Male excess suicides†, n (95% CI)	Female excess suicides, n (95% CI)
Oil-shock recession, 1974	807 (470 to 1118)	503 (256 to 732)
Inflation-defeating recession, 1982	3438 (2703 to 4128)	1024 (610 to 1409)
Without Japan	388 (125 to 622)	229 (91 to 348)
Black Monday crash, 1987	470 (67 to 811)	–
Nordic banking crisis, 1991	59 (6 to 103)	–
European Exchange Rate Mechanism crisis, 1992	–	–
Asian financial crisis, 1997	5800 (4647 to 6877)	3301 (2554 to 4008)
Without Japan	–	133 (77 to 182)
Dot-com bubble, 2001	4585 (1782 to 7076)	795 (431 to 1116)
Global financial crisis, 2008	1121 (404 to 1688)	–
Eurozone debt crisis, 2010	2584 (1674 to 3475)	874 (477 to 1193)

*Additional covariates in estimated regression models were unemployment and natural logarithm of gross domestic product per capita.
†Numbers of excess suicides were calculated as the difference between the actual number of suicides and the number that would have been expected on the basis of the preceding 10-year trend.

The gender-specific numbers of excess suicides associated with major economic crises are presented in table 2. The Asian financial crisis (1997) seems to have caused the most excess suicides for both males and females. Our results show that there were >9000 total excess suicides (compared with the expected number if the pre-crisis trends had continued). Japan accounted for almost all these suicides. However, when we disregarded Japan, the crises in the 2000s, namely the Dot-com bubble (2001), the global financial crisis (2008) and Eurozone debt crisis (2010), caused the largest numbers of excess suicides. The total numbers of excess suicides in these crises were 5380 (95% CI 2213 to 8192), 1121 (404 to 1688) and 3458 (2151 to 4668), respectively. The inflation-defeating recession (1982) also led to a high number of excess suicides, causing almost 4500 excess suicides when Japan was included in the analysis. The number without Japan was only about 600. One possible explanation for excess suicides in Japan was a drop in the NIKKEI index after several years of increase in the early 1980s.

The results regarding the severity of the crises (in terms of absolute numbers rather than excess suicide rates) differ somewhat to what is presented in table 1. While table 1 shows that excess suicide rates were not particularly high for the crises in the 2000s, the numbers of excess suicides indicate that these most recent crises led to relatively high numbers of excess suicides. The reason is that these crises led to excess suicides in countries where the population is large, such as the USA. Thus, when comparing the severity of each crisis, it is crucial to also consider this scale effect.

There is a notable gender difference in the relationship between economic/financial crises and suicides. On average, men account for the majority of excess suicides after major global economic/financial crises. The number of male excess suicides ranged from 59 to 5800 (95% CI 6 to 7076), whereas the equivalent numbers for females were from 133 to 3301 (77 to 4008). However, when comparing excess suicides in relative terms (ie, relative to their trend-based values, in terms of percentage increases), we did not find any systematic gender difference in excess suicides.

Table 3 shows the effects of distinct types of crises in terms of excess suicide rates and numbers across the 21 countries. Banking crises and stock market crashes seem to be the most fatal types when the severity of each crisis is measured as the number of excess suicides. Although the estimated suicide rates in each crisis fall in 95% CIs of all other crises, the lower limits of excess numbers for banking and stock market crises exceed the upper limits of excess numbers of currency and inflation crisis. Only when comparing the excess numbers due to stock market and inflation crises among females there is overlapping in the excess suicide numbers. After the banking crises, the average excess suicide rate was 1.6 (95% CI 0.6 to 2.5) for males and 0.9 (0.4 to 1.3) for females. Since 1970, banking crises have solely accounted for >13 000 excess suicides. The majority of these, 8889 (3564 to 13 854), were among males.

The effects of stock market crashes in terms of excess suicide rates were estimated to be 2.2 (95% CI 0.8 to 3.4) for males and 1.1 (0.5 to 1.6) for females. The number of excess suicides due to stock market crashes was 12 459 (4625 to 19 560) for males and 2968 (1260 to 4497) for females. Hence, during stock market crashes, there were also more excess suicides for males.

After currency crises, the excess suicide rates were 1.2 (95% CI 0.3 to 2.0) for males and 0.6 (0.3 to 0.8) for females. The numbers of excess suicides were 1726 (504 to 2867) and 974

Table 3 Male and female excess suicide rates and numbers associated with different economic crises* (during and/or 1 year after) in 21 Organisation for Economic Co-operation and Development countries

Crisis	Male excess suicide rate†‡, n (95% CI)	%§	Female excess suicide rate, n (95% CI)	%	Male excess suicides¶, n (95% CI)	Female excess suicides, n (95% CI)
Currency	1.2 (0.3 to 2.0)	8.5	0.6 (0.3 to 0.8)	13.5	1726 (504 to 2867)	974 (522 to 1386)
Inflation	–	–	1.4 (0.2 to 2.1)	67.4	–	22 (4 to 33)
Stock market crash	2.2 (0.8 to 3.4)	13.7	1.1 (0.5 to 1.6)	17.8	12 459 (4625 to 19 560)	2968 (1260 to 4497)
Banking crisis	1.6 (0.6 to 2.5)	8.7	0.9 (0.4 to 1.3)	13.4	8889 (3564 to 13 854)	4135 (1981 to 6077)
Stock and/or Banking	2.8 (1.6 to 4.0)	15.5	1.3 (0.7 to 1.9)	17.4	40 711 (22 280 to 57 604)	15 048 (7883 to 21 511)
Without Japan	1.9 (0.8 to 2.8)	11.3	0.9 (0.4 to 1.3)	15.7	20 808 (8565 to 31 990)	5991 (2550 to 9036)
Stock and/or banking and/or currency	2.6 (1.4 to 3.8)	15.1	1.2 (0.6 to 1.7)	17.1	43 932 (23 404 to 62 737)	16 492 (8580 to 23 628)
Without Japan	1.8 (0.7 to 2.7)	11.3	0.8 (0.4 to 1.2)	15.6	24 029 (9689 to 37 123)	7434 (3247 to 11 153)

*Additional covariates in estimated regression models were unemployment and natural logarithm of gross domestic product per capita.
†Per 100 000 persons.
‡Excess rates are calculated as the difference between the actual suicide rate and the rate that would have been expected on the basis of the preceding 10-year trend.
§% denotes increase in suicide rate compared with the suicide rate that would have been expected based on the preceding trend.
¶Numbers of excess suicides were calculated as the difference between the actual number of suicides and the number that would have been expected on the basis of the preceding 10-year trend.

(522 to 1386), respectively. Inflation crises led to an excess suicide rate of 1.4 (0.2 to 2.1) for females and a non-significant rate for males. The numbers of excess suicides related to inflation crises were much milder than for other types of crises, being only 22 (4 to 33) for females.

There is a close temporal link between different types of economic crises. To examine the effects on countries facing either a stock market crash, a banking crisis or both at the same time, we combined the results for either stock market crashes or banking crises or instances of both (table 3, fifth row from the top). According to the results, there were almost 56 000 more suicides than would have been expected based on the trends that preceded these crises. Approximately 73% of these excess suicides occurred among males. When we also added the results of currency crises (table 3, second row from the bottom), the estimated number of excess suicides increases to >60 000. The country-specific results are presented in online supplementary table S13-S14.

DISCUSSION

We showed that there was a significant increase in suicides during and/or 1 year after every major economic/financial crisis in 21 developed countries since 1970. Uniquely, we revealed that 'the Great Recession' was not particularly disastrous relative to previous crises in terms of global excess suicide figures. We showed that the Asian financial crisis (1997) was the most severe economic/financial crisis compared with any earlier crises since 1970 when severity is measured according to excess suicide rates. It caused nearly 35% more male suicides and >23% more female suicides compared with expected values based on the preceding trends. Also, we found that the effects (in terms of excess suicides) of distinct types of crises have different magnitudes. Banking crises and stock market crashes cause more excess suicides than currency and inflation crises.

The strengths of this study include that we went beyond the effect of the most recent crises, namely the global financial crisis (2008) and Eurozone debt crisis (2010), and compared the effects of all the major economic/financial crises since 1970. Importantly, our results are comparable to those of Chang *et al*[2] and Barr *et al*[1] as we used the same model specification. We also included other economic covariates and used a longer time period in our analysis to alleviate issue with confounding and time biases reported in previous research.[36] Especially, we showed that the effects of economic crises (in terms of excess suicides) remained at a high level even if we took the population-level unemployment and income variables into account.

The strength of our analysis is the use of the negative binomial regression, which can handle overdispersed data common in rare discrete events, such as suicide frequencies relative to the population.[37] While the variant of negative binomial model that is used in this study has been found to be very useful in applied work,[38] there remain a few methodological issues to consider. The use of small sample sizes may cause bias in the dispersion parameter estimates of negative binomial models, which has been shown, for example, by Lord.[39] Another methodological issue is that the results may be sensitive to the assumed form of the time trend. However, as Laanani *et al*[34] point out, the use of a linear time trend is probably the safer choice compared with a non-linear trend when sample periods are relatively short and have few data points. The possibility of non-linear data generating process remains an important further research topic.

There are several limitations in our study. One important limitation is how to distinguish the possible effect of job losses from the crisis effect. Economic/financial crises often led to increased unemployment and decreased material well-being. The negative well-being effects of unemployment are well documented in many previous studies.[40–42] While we added unemployment as a control variable, we could not fully distinguish the crisis effect from the job-loss effect.

Another limitation is the number of covariates that we took into account. There are probably many factors beyond unemployment and GDP that would affect an individual's decision to commit suicide. For example, an individual's religion, number of children, education and pre-crisis wealth could help them to cope with economic downturns. For example, unemployed individuals who do well financially are not necessarily affected by an economic/financial crisis. On the other hand, divorces, alcohol consumption and debt can influence the likelihood of suicidal behaviour. However, controlling for these covariates would not be methodologically possible due to the limitations associated with estimated parameters in relatively short (eg, 10-year) estimation windows.

The nature of the ecological data limits the interpretation of our results at the individual level. The use of aggregate data makes it impossible to explore whether people who are affected significantly due to economic hardship have some confounding factors, including mental health problems, that might lead them to commit suicide. In using an ecological design, we are also not able to prove direct causality between economic crises and excess suicides. We argue, however, that an ecological design is the most appropriate way to proceed when analysing excess suicides due to global economic crises. Importantly, our study was not designed to assess whether certain groups of people (eg, the unemployed) are more likely to die by suicide than other people (the employed), but rather to assess the impact of different economic/financial crises on national suicide numbers, which justifies the use of an ecological design. Also, due to the long timespan (1970–2011) and the large set of analysed countries (21 OECD members), there are no appropriate individual-level longitudinal data easily available.

While our results indicate that economic crises have an increasing effect on suicides, an important question is whether the effects of economic crises and unemployment on suicides are separable. Since most times the increase in unemployment occurs simultaneously with economic crisis, it is natural to presume that there might be a close interaction between them. Epidemiologists present two basic theories that might explain the increase in association between unemployment and suicide during economic crisis. The causal theory predicts that job loss increases depressions especially during bad economic times precipitating suicide. The selection theory predicts that individuals who are more probable to commit suicide are also more probable to lose their job during crises.[43 44] An important future research area is to identify the pure economic crisis effect from the joint effect with unemployment. For policymakers, it is important to differentiate the reasons in order to target right factors with prevention policies.

In conclusion, this study shows that >60 000 suicides are attributable to the economic/financial crises since 1970. Two main findings emerged from the data. First, our findings indicate that the impact of the most recent global financial crisis (2008) on suicides was not particularly stronger than that of previous major economic/financial crises. Second, stock market crashes and banking crises are the most severe economic crises in terms of excess suicides calculated based on population-level data.

What is already known on this subject

- Most published studies on the relation between economic downturns and increase in number of suicides have almost completely concentrated on the most recent global financial crises.
- It is unknown whether similar rises have occurred in countries affected by previous crises and which sex groups are most affected by different financial/economic crises.

What is study adds

- This study shows that economic/financial crises have led to a significant increase in suicides across developed countries.
- The major economic/financial crises since 1970 caused >60 000 excess suicides across 21 developed countries.
- The impact of the most recent global financial crisis on suicides seems not to have been particularly severe compared with the impacts of previous major economic/financial crises.
- Stock market crashes and banking crises are the most severe economic crises when assessed based on excess suicides associated with economic/financial crises according to population-level data.

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