Master

Mathematical Finance

Master's Final Work

Dissertation

Financial Crises meet society: Economic turmoil and societal stress through a local projection approach

Inês Isabel Faria Lopes Gouveia Rodrigues

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Supervision:

Bruno Miguel Pinto Damásio

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Abstract

This thesis studies the temporal profile of the impact of systemic banking crises on suicide rates using a panel from 53 countries between 1980 and 2016. A methodology developed by Oscar Jordà in 2005, the Local Projections, was used to measure this impact.
Focusing on a five-year horizon, it is clear that systemic banking crises' adverse effects persist throughout this time horizon on suicide rates.
With this study, a positive effect was identified between banking crises and suicide rates. Moreover, this study is consistent with previous studies since it was observed that this effect does not last for long.

Keywords:
Local projections
Banking crises
Suicide Rates
Mortality
GDP
Alcohol Consumption
Unemployment

Resumo

Esta dissertação estuda o perfil temporal do impacto das crises bancárias sistêmicas sobre as taxas de suicídio usando um painel de 53 países entre 1980 e 2016. Usamos a metodologia desenvolvida por Oscar Jordà em 2005, as Projeções Locais,para medir este impacto.
Com foco num horizonte de cinco anos, fica claro que os efeitos adversos das crises bancárias sistémicas persistem ao longo desse horizonte de tempo nas taxas de suicídio.
Com este estudo, foi identificado um efeito positivo entre crises bancárias e taxas de suicídio. Além disso, este estudo está de acordo com estudos anteriores, uma vez que foi observado que esse efeito é de curta duração.

Palavras-chave:
Projeções Locais
Crises Bancárias
Taxas de Suícidio
Mortalidade
PIB
Consumo de Álcool
Desemprego

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Acknowledgments

I want to dedicate this thesis to my parents, my brother, my boyfriend and the rest of my family and colleagues who have always supported me.

I thank my advisor for all the support and help over the past few years.

Sois as maiores dádivas de Deus e agradeço-Lhe reverentemente,
cada novo dia pelo milagre do vosso amor.

1 Introduction

Suicide is a health problem that globally affects all ages, genders, regions, professions, and religions.
Every year, 800.000 deaths occur by suicide, one of the leading causes of deaths estimated by the World Health Organization [43]. Each of these deaths has impacted families and society in general and, therefore, it is certainly worth knowing more about the subject and the possible causes associated with it.

Despite the most common factors that contribute to suicide are depression, traumatic experiences, alcohol consumption, drugs, and the presence of mental disorders [26], there is growing evidence that periods of economic recession and financial difficulties are also major factors contributing to suicide,[31]. These events end up destabilizing people who, until then, were considered mentally healthy and vital contributors to the well-being of society.
Some of these periods of economic recession are characterized by banking crises. Banking crises are associated with problems in the banking system, more significant market uncertainty with a climate of financial instability, severe financial intermediation disturbances, and economic performance. Uncertainty in the financial markets leads to significant economic and social changes, making it very difficult for some people to manage a future to safeguard their image as contributors to their community's development. Failure to comply with their financial and family responsibilities causes discomfort, leading to suicide being the final escape for these people.

The purpose of this thesis is to study whether banking crises impact suicide rates in 53 countries between 1980-2016. To measure this impact, we used a methodology developed by Oscar Jordà in 2005 [16], Local Projections, due to the advantages that this approach has as an alternative to the VAR methodology. Local Projections can be estimated more robust to specification errors, and they easily accommodate experimentation with highly non-linear and flexible specifications that can be impractical in a multivariate context.

This thesis is structured as follows: Section 2 introduces a review of the literature divided between the concepts of financial crisis, suicide and mortality rates, and the approach used, local projections.
In Section 3, we establish the empirical methodology; in this section, we start with the econometric background that led to the "creation" and local projections specification.
In Section 4, we start by presenting the data set and the control variables used to estimate our models. Section 5 displays the model specification.
Section 6 presents the results. Finally, section 7 concludes.

2 Literature Review

Every year, the World Health Organization [43] estimates that every 40 seconds, a person commits or attempts suicide. The World Health Organization considers self-directed violence, such as suicide, to be a severe public health problem.

This worldwide problem can be prevented with low-cost interventions to create a multisectoral strategy [30] [1]. Although, countries realize this type of violence and its impact as a global problem, there is no quality and availability in data on suicide; only 80 member countries of the World Health Organization recorded quality data useful for estimating suicide rates, [43].
Suicide is a phenomenon in all countries of the world and not only in developed countries or with high GDP. Over 79 % of global suicides occur in low and middle-income countries, [43], and is in fact, higher in vulnerable groups such as those who suffer discrimination and experience violence, abuse, loss, and even isolation, [5] [35].

Since suicide attempts are by far the most significant risk factor, it seems greater vigilance and monitoring of these attempts is necessary for an effective prevention strategy, [36].

Also, suicide impacts society having consequences in economy, in the population longevity and in politics. This impact is more drastic on people closest to the person who committed suicide, it does happen even when there is no relationship with the victim, or the victim is not known personally, [22]. With this, we know that the impact of suicide can be vast and, regardless of the circumstances in which it became known, it is essential to recognize that it has a major impact on society .

Lack of employment is more associated with increased suicide rates than being employed; a rapid and significant increase in unemployment causes a massive increase in suicide rates, [4] [41].
Chan et al. [6] investigated how changes in economic conditions associated with the crisis in South Korea influenced suicide rates. More specifically, they concluded that unemployment rates were positively associated with suicide rates among employees and unemployed.

Recent studies [30] [19] on the relationship between economic recessions and suicides have focused on the global financial crisis (2008), where there was a considerable increase in suicides. Norström and Grönqvist [30] studied how suicide rates responded to the sharp rise in unemployment spurred by the Great Recession. In particular, the consequences of unemployment and suicide when there is unemployment protection and the effect of the current crisis on suicide compared to previous economic crises. They concluded that the greater the protection against unemployment, the weaker the impact of increased unemployment on suicide.
Suicide rates and the proportion of suicides involving alcohol increased during the 2008–2009 recession. Kerr et al.[19] concluded that the population risk of suicide was more clearly associated with poverty rates and that poverty rates were also

associated with greater involvement with alcohol.
People who died by suicide during the 2008–2009 recession were more likely to have been blood alcohol above the legal limit at the time of death than those before the recession [17].

The suicide rate increases during crises, Huikari et al.[13] explain how different types of crises affect suicides in developed countries. They found that economic and financial crises since 1970 have led to excessive suicides in developed countries. Although, when compared in terms of effects on suicide mortality, the most recent global crisis of 2008-2009 is not particularly more severe than previous global financial crises. It is well documented that various types of crises as banking, monetary and inflation crises, and stock market crashes, have different effects on suicide.

Financial crises inflict significant human and economic difficulties, Aggarwal et al. [1] focused on the consequences of high stress in the capital market has on human behavior since these changes can manifest themselves in an increase in suicide rates. They found that suicides associated with adverse market sentiment delay the initial stressor by up to two years, thus opening a policy window for government/public health intervention to reduce these adverse outcomes.

The association between banking crises and suicide rates is studied in several papers. Bernal et al.[3], used suicide data between 2005 and 2010 in Spain and concluded that there has been an 8% increase in the suicide rate since the financial crisis and that people of working age may be at risk of suicide and therefore benefit from targeted interventions.

Karanikolos et al.[18], through the analysis of the effects of previous economic crises on health, realized that countries like Greece, Spain, and Portugal adopted strict fiscal austerity had increased suicides and outbreaks of infectious diseases in contrast to Iceland that rejected austerity. This study was critical since it concluded that despite recessions present significant health risks, each country's level of austerity seems to aggravate social crises and, in turn, suicide rates in Europe.
Economou et al.[9] also studied suicides and suicide attempts between 2009 and 2011 in Greece, where they concluded an increase in the prevalence of suicidal ideation and reported suicide attempts.

Chang et al.[7] aimed to study the impact of the 2008 economic crisis on international suicide rates by comparing the real number of suicides in 2009 with that which would be expected based on trends before the crisis. They concluded an increase in suicides mainly in Europeans and Americans in countries with high unemployment rates, and Reeves et al.[33] estimated an excess of 4750 suicides in the USA after the recession.
Houle and Light[12] studied the effect that foreclosure rates associated with a financial crisis had on suicide rates between 2005 and 2010; they concluded that the mortgage foreclosure crisis probably contributed to increased suicides and other factors associated with the recession.

Laeven and Valencia [20] [21] define a banking crisis as an event where serious financial difficulties and banking policy interventions occur due to significant losses in the banking system. These crises and their macroeconomic impacts have negative consequences for society's social well-being, defined by increases in mortality rates and suicide rates concerning their pre-crisis trajectories. [25]

As in [34], whenever banks close, merge, or are taken over by the public sector by multiple financial institutions, bank runs leads to a banking crisis.
Another type of event defined as a banking crisis is when a financial institution or group of institutions with great importance close or either merge or receive government assistance on a large-scale, which leads to a set of events that produce a similar result for others financial institutions. This way of defining the banking crisis originates from multiple sets of events, which does not become a systemic banking crisis. Reinhart and Rogoff,[34], also listed 100 systemic crisis since 1857, which were identified and separated into two Types. The Type I systemic banking crises are more severe, and Type II lead to less financial distress and, therefore, not so extreme.

Recently, several studies claim that financial crises have influenced in some way through rising unemployment, job insecurity, decreased earnings, personal debt, and sudden bankruptcy.
Therefore, economic crises have a major impact on society; in addition to the impact on suicide as we have seen, it also impacts the supply of credit. Sudheer and Amiyatosh [42] who realized that during the 1998 Russian crisis, companies that depended mainly on banks for capital experienced a decline in their capital expenditures and profitability consistent with an adverse shock in the supply of credit. These banks affected by the crisis decreased the number of their loans. It increased interest rates on loans in the period post-crisis.

Englund [10] analyzed the Swedish banking crisis in the early 1990s that resulted from a highly leveraged private sector that triggered a downward price spiral, resulting in bankruptcies and massive credit losses.
Major impacts were seen in the 2008 crisis, where the European economy experienced the worst economic crisis since the 1930s. As the ratio of public debt to national GDP increased across Europe, national credit ratings fell, and costs of loans to repay debt service, governments imposed harsh austerity programs aimed at reducing public spending and outstanding debt. [8]

Although there are several methodologies to calculate the impact of financial crises on suicide rates, we decided to use a modern econometric methodology, local projections, to analyze the effect that banking crises have on suicide.
Local projection methods are a promising recent development in the literature on impulse response analysis.
El-Shagi [37] studied an improvement of this method through the use of smoothed local projections that can deal with the adequate degree of smoothing and is usually more efficient than Local projections.

Han et al. [11] propose a new estimation method using the local projections; their paper investigates the estimation and inference of quantile impulse response functions where the primary application is for the Financial market data.
Lutz et al.[23] found that in small samples, the asymptotic Local Projections interval often is less accurate than the bias-adjusted bootstrap Vector Autoregressive (VAR) interval by comparing impulse response confidence intervals based on local projections and vector autoregressive models.

3 Empirical Methodology

Impulse Response functions provide the empirical results that underlie theoretical models. These functions are essential as they are fundamental to summarize structural shocks' dynamic effects on economic time series.
From the Wold decomposition of a VAR one can estimate an impulse response function, which consists of first estimating the model and then inverting its estimates to find the impulse responses. However, this is only justified if the proposed model matches the data generator process (DGP). Additionally, if it is not possible to invert its estimates, its Wold decomposition will not exist.
Instead, even when its Wold decomposition does not exist, impulse responses can be defined without knowing the DGP, [16] [32]. Method of Local projections is particularly useful; it does not demand specification and estimation of the unknown true multivariate dynamic system to compute impulse responses.

The procedure of estimating a model, such as a VAR, based on the sample, represents a global linear approximation to the true DGP, which is the optimal forecast when conceived for a one-period horizon. The error produced for one-period ahead forecasts it is relatively small even when the model is misspecified,[40].

Therefore, one can argue that using a collection of projections local to each forecast horizon will give us the best design and evaluation.

Traditionally, Vector Autoregressions (VAR) has been used to compute structural shocks and associated Impulse Response Functions. However, the rising popularity of the narrative identification approach popularized by using an alternative nonparametric Impulse Response estimation approach leads us to consider: the Local Projections. We denote Local Projections as the set of h regressions, specifically

Definition 3.1

$$\boldsymbol{y}_{t+s} = \alpha^s + B_1^{s+1}\boldsymbol{y}_{t-1} + B_2^{s+1}\boldsymbol{y}_{t-2} + ... + B_p^{s+1}\boldsymbol{y}_{t-p} + \boldsymbol{u}_{t+s}^s \quad s = 0, 1, 2, ..., h \qquad (1)$$

where $\boldsymbol{y}_{t+s}$ is projected onto the linear space generated by $(\boldsymbol{y}_{t-1}, \boldsymbol{y}_{t-2}, ..., \boldsymbol{y}_{t-p})'$, α^s is an $n \times 1$ vector of constants, the B_i^{s+1} are matrices of coefficients for each lag i and horizon $s+1$.

The impulse responses are easily produced by the local projections, these are simply a subset of the slope coefficients estimated by the projections.
According to definition (1), the impulse responses from the local projections in (1) are

$$\widehat{IR}(t, s, \mathbf{d}_i) = \hat{B}_1^s \mathbf{d}_i \quad s = 0, 1, 2, ..., h \qquad (2)$$

with the obvious normalization $B_1^0 = I$.

Although, fitting a linear vector autoregression to a set of variables is a common practice in macroeconomics, Local Projections are more robust when specifying the model incorrectly [16].

The LP approach does not force any dynamics underlying the system of variables as the VAR does.
This method estimates a set of individual models for different forecasting horizons in order to obtain the IRF. This contrasts with estimating conditional iterative predictions based on an optimized model to provide forecasts one step ahead as with VARs.

Local projections are a reasonable alternative for estimating IRF since, as univariate equation methods estimate them, they are easily calculated with the standard regression packages available.

In this thesis we use the following model, for s=0,1,2,...5,

$$y_{i,t+s} - y_{i,t-1} = \delta^{s+1} D_{i,t} + \gamma_0^{s+1} x_{i,t} + \gamma_1^{s+1} x_{i,t-1} + .. + \gamma_p^{s+1} x_{i,t-p} + \alpha_i^s + \beta_t^s + v_{i,t+s}^s. \quad (3)$$

where the dependent variable is the cumulative growth of the suicide rate, the dummy variable $D_{i,t}$ equals 1 if there is a banking crisis that starts in year t and zeroes otherwise, the vector $X = (x_{i,t}, x_{i,t-1}, ..., x_{i,t-p})$ contains control variables, which in our case include, female and male mortality, unemployment, alcohol consumption, and GDP. We control for country and year fixed effects denote by α_i^s and β_t^s. Since we want an appropriate number of crisis events, so that we can estimate the average partial effect of a banking crisis in the suicide rate, we are limited to a maximum number of 6 periods of our forecast horizon. Also the idiosyncratic error term is denoted by $v_{i,t+s}^s$.

The model was estimated using the Fixed Effects estimator and a robust autocovariance matrix.

4 Data

Since 1980 until 2016 and for 53 countries were identified 60 banking crises where 22 episodes started in the last decade of the data as we can see in the following table:

Table 1: Banking Crisis Dates by Countries

Countries	Dates	Countries	Dates
Argentina	1980,1989,1995,2001	Kazakhstan	1991,2008
Australia	-	Korea Republic	1997
Austria	-	Kuwait	1982
Azerbaijan	1991 ,1995	Kyrgyz Republic	1991,1995
Belarus	1991,1995	Latvia	1991,1995,2008
Belgium	2008	Mexico	1981,1994
Brazil	1990,1994	Moldova	1991,2014
Bulgaria	1996	Netherlands	2008
Canada	-	New Zealand	-
Chile	1981	Norway	1991
Colombia	1982,1998	Poland	1992
Costa Rica	1987,1994	Portugal	2008
Croatia	1998	Russian Federation	1991,1998,2008
Czech Republic	1996	Singapore	-
Denmark	2008	Slovenia	1992,2008
Estonia	1991,1992	Spain	2008
Finland	1991	Sweden	1991,2008
France	2008	Switzerland	2008
Georgia	1991	Trinidad and Tobago	-
Germany	2008	Turkmenistan	1991
Greece	2008	Ukraine	1991,1998,2008,2014
Guatemala	-	United Kingdom	2007
Hungary	1991,2008	United States	1988,2007
Ireland	2008	Uruguay	1981,2002
Israel	1983	Uzbekistan	1991
Italy	2008	Venezuela Republic	1994
Japan	1997		

During the period of our analysis, most countries have experienced at least one banking crisis. However, only 13 countries experienced two or more crises: Argentina (4), Ukraine (3) Brazil (2), Colombia (2), Costa Rica (2), Hungary (2), Latvia (2), Mexico (2), Russian Federation (2), Slovenia (2), Sweden (2), United States (2), Uruguay (2).

4.1 Systemic Banking Crises

Systemic banking crises are highly stressful events that lead to continued declines in economic and financial activity and welfare. It is well known that policymakers and academics try to construct models that predict crises and use them to design policies to resolve them. It should be mentioned that defining the concept of a systemic banking crisis is hard since there is no simple rule to quantitively classify an event as systemic banking crisis. Consequently, the use of an inappropriate crisis dating measure may create difficulties in developing the models. Nevertheless as mentioned in Table 1 using data from 1980 to 2016 we identified several banking crisis for the set of 53 countries.

Table 2: Descriptive Statistics of Suicide Rate by Banking Crises

	Suicide Rate				
	N	Mean	Std. Dev.	Minimum	Maximum
No Banking Crises	1835	12,76	8,04	0,71	39,8
Banking Crises	60	12,22	9,33	0,76	32,32

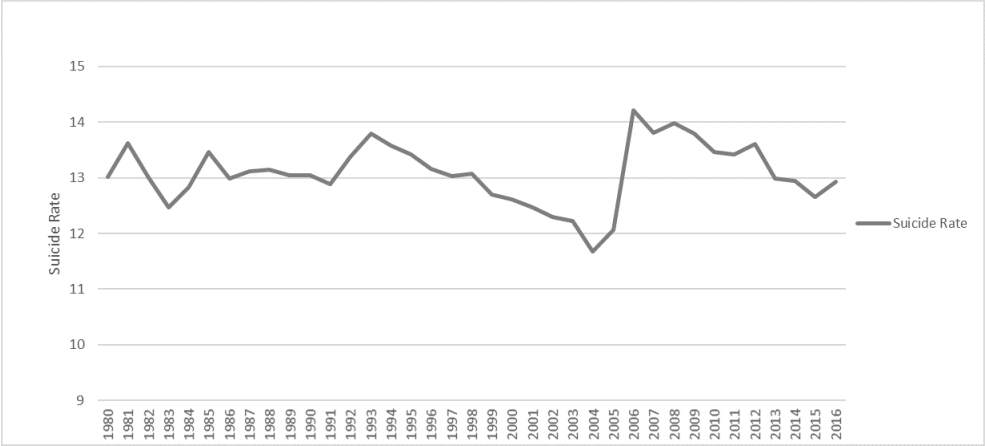
4.2 Suicide Rate

Suicide is the intentional act of killing itself, has as risk factors mental and/or psychological disorders such as depression, bipolar disorder, schizophrenia, or drug abuse, including alcoholism abuse. Other suicides result from impulsive acts due to stress, relationship problems or bullying and/or economic hardship as we are studying in our thesis.
Suicide is a serious public health problem and one of the leading causes of death worldwide. It is known that suicide is a complex and multifactorial phenomenon that involves socio-cultural, economic, psychological, biological, and environmental issues. The data obtained in the World Health Organization tells us that the suicide rate is higher in 2009, 2010 and 2011 in Republic of Korea with 43 suicides by 100000 inhabitants and lower in 1982 and 1983 in Kuwait with less than 0.5 suicides for 100000 inhabitants.
In Figure 1 we can easily see that 2006 was the year with the highest suicide rate for 53 countries with 14,20 suicides per 100.000 inhabitants and that 2004 was the year with the lowest rate with 11,60 suicides per 100.000 inhabitants.
Of the 53 countries, 16 had a banking crisis in 1991[1]. As we can see from figure 1, after that event there was an increase in the suicide rate over the next two years.
The last crisis recorded in our data occurred in 2014 which again after that period there was an increase in suicide rates in the following years.

On average, the country with the lowest suicide rate per 100.000 inhabitants (2,08 suicides) was Kuwait.

[1]12 of these 16 are post-communist transition countries, which in these cases, we are talking about a complete collapse of the centralized system of production that also dragged down the banks.

Figure 1: Worldwide average suicide rate by year



Notes: Suicides per 100,000 inhabitants

Hungary has the highest value of 29,09 suicides per 100.000 inhabitants.

Note that Guatemala, Turkmenistan, and Uzbekistan were the countries with suicide rates below ten suicides per 100.000 inhabitants and which have not registered banking crises in our data. In countries with more than twenty suicides per 100.000 inhabitants, all countries experienced at least one crisis between 1980 and 2016.

4.3 Control Variables

To identify the causal effect of the banking crisis on the suicide rate, we used several control variables: mortality, alcohol consumption, GDP, and unemployment. Due to the fact that we are trying to analyse the impact of systemic banking crises in suicide rates we used these variables to control for the existence of macroeconomic shocks as well as the effect that alcohol consumption has in suicide rates.

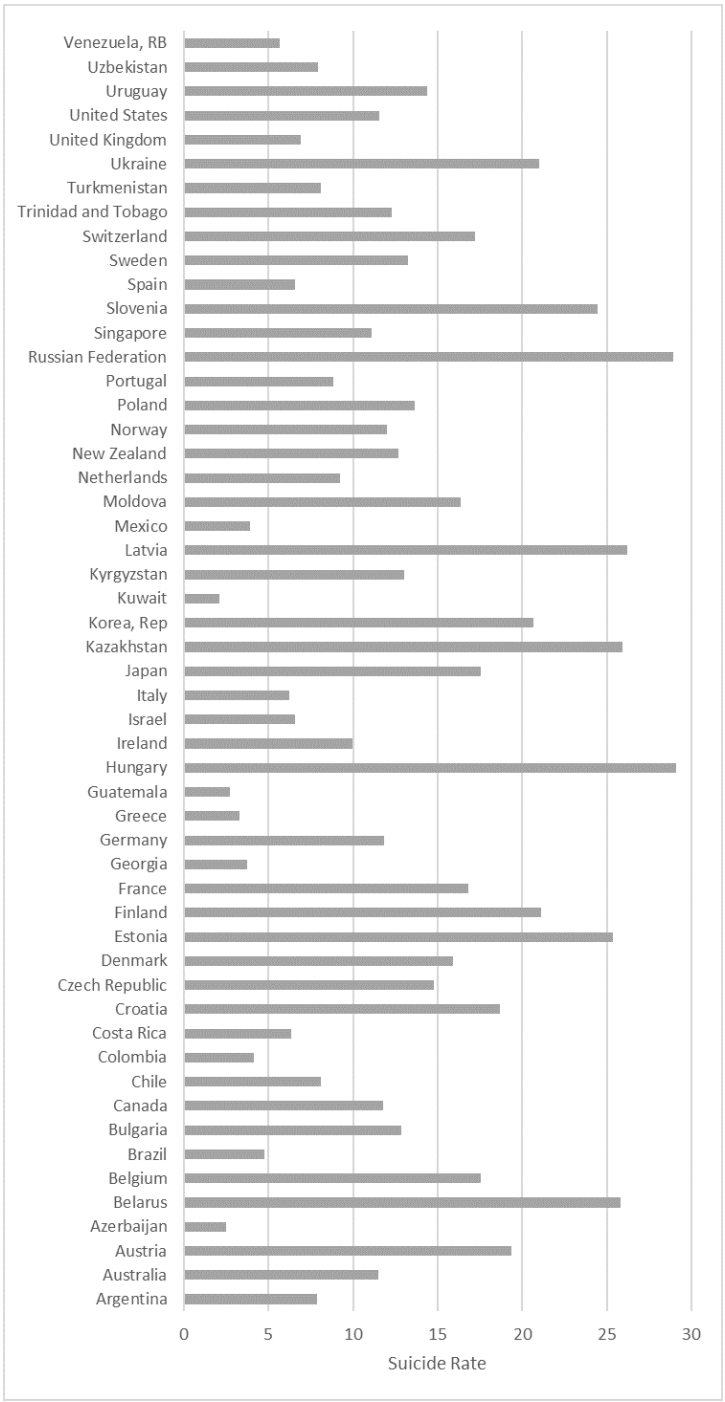
4.3.1 Mortality

The mortality rate or mortality coefficient is a demographic index that reflects the number of deaths recorded, on average per thousand inhabitants, in a given region over some time, usually a calendar year. The rate is commonly expressed in units of death per 1000 people per year.

According to the World Health Organization, between 1980 and 2016, the year with the highest rate of male and female mortality is that of 1980 for both, while the one with the lowest rate is that of 2016 for both too. The country with the highest male mortality rate is the Russian Federation and the lowest in Japan. The female mortality rate is highest in Guatemala and the lowest in Japan.

As for child mortality, Turkmenistan is the country with the highest mortality rate in the list of countries analyzed, and New Zealand is the country with the lowest

Figure 2: Suicide Rate by Countries for 1980-2016



Notes: Suicides per 100,000 inhabitants

child mortality rate. The year 1980 is the one with the highest death toll among children under one year, while 2015 are the one with the lowest number of deaths.

Since there is a high correlation between mortality rates and suicide rates, it is reasonable to use them as control variables in order to avoid spurious results.

4.3.2 Alcohol Consumption

Usually, a diagnosis of addiction/dependence is given if three or more of the following factors are present at some point during the previous year[14]:

- a strong desire or sense of compulsion to take the substance;
- difficulties in controlling substance use behavior in terms of onset, end, or levels of use;
- a physiological state of abstinence when substance use is terminated or reduced;
- evidence of tolerance so that increased doses of the psychoactive substance are required to obtain effects initially produced by lower doses;
- progressive neglect of alternative pleasures or interests due to the use of psychoactive substances;
- increased amount of time required to obtain or take the substance or recover from its effects;
- persistence of substance usage despite clear evidence of overtly harmful consequences such as liver damage from excessive drinking.

Alcohol continues to play an essential role in the development and the social bond of many. Moderate alcohol consumption or social drinking for many is enjoyable and used to reduce stress and anxiety. However, it is known that this consumption, especially in excess, is linked to several negative outcomes: being a risk factor for disease and health impacts, crime, road incidents, and, for some, alcohol dependence.

When consumed in high doses, alcohol has a more significant impact on human beings and society, leading to an increase in impulsivity and aggression, factors that give an additional risk to suicide [39].
Alcohol dependence deaths can occur directly or indirectly, and indirect deaths are of interest to us in this work. Indirect deaths from alcohol-related disorders can occur through suicide. While the precise attribution of suicide deaths is challenging, alcohol use disorders are a known and established risk factor.

Alcohol consumption is well known risk factor for various health conditions and possible mortality. It seems evident that one should control for alcohol in order to study the partial effect of the banking crises in the suicide rates.

4.3.3 GDP

Andrés [2] estimated that the effect of GDP per capita is positive and statistically significant on suicide rates, where a higher GDP per capita is associated with higher death rates by suicide for both sexes. However, Sher [39] says that there was a negative correlation trend among men and that men in countries with lower GDP commit suicide more frequently when compared to those who live in a country with

a higher GDP.

Iemmi et al. [15] findings show a consistent trend indicating that poverty, particularly in the form of the worse economic situation and decreased wealth, which is associated with suicidal ideas and behaviors. Gross domestic product per capita (GDP) is a metric calculated by dividing GDP by a country's population, showing the amount of economic output attributed to each citizen.
Worldwide, per capita GDP is a universal measure used by economists alongside GDP to analyze a country's prosperity and economic growth since its components are regularly tracked on a global scale, facilitating calculation.

This quantity is one of the primary measures of a country's economic productivity and shows the market value of services and goods it produces. This way, governments can use GDP per capita to understand how the economy is growing and is being influenced by the country's domestic population .

4.3.4 Unemployment

Unemployment is an essential economic indicator because it signals workers' inability to readily obtain paid work to contribute to the economy's productive production. More unemployed workers mean that less total economic output will occur, meaning that the economy with high unemployment has lower output without a proportional decline in the need for basic consumption.
High and persistent unemployment can signal serious problems in an economy and even lead to social and political unrest. [29] Unemployment directly affects individuals' health, and studies have proposed an association between unemployment and suicide.[28] Noh et al. shows that the implied effect of unemployment on suicide rates is positive for countries with higher income.
In fact, for countries with lower-income levels, there is a negative impact of unemployment on suicides [28]. Neumayer [27] estimates the impact of unemployment on male and female suicide rates, where it concluded that the effect of unemployment on total suicide rate is weakest in the age group 45–65 and strongest in the 20–44, and 65 years or older.

Since suicide deaths associated with unemployment were nine times higher than the number of events attributed to the most recent economic crisis [29], it is obvious that we should use unemployment as a control of the study of the possible effect of banking crises in suicide.

5 Model Specification

The first model a first set of explanatory variables as we can see in the following equation:

$$\begin{aligned} suic_{i,t+s} - suic_{i,t-1} &= \delta_0^{s+1} bankc_{i,t} + \gamma_{1,0}^{s+1} unemployment_{i,t} + \gamma_{2,0}^{s+1} femalemortality_{i,t} \\ &+ \gamma_{2,1}^{s+1} femalemortality_{i,t-1} + \gamma_{2,2}^{s+1} femalemortality_{i,t-2} \\ &+ \gamma_{3,1}^{s+1} infantmortality_{i,t-1} + \gamma_{3,2}^{s+1} infantmortality_{i,t-2} \\ &+ \alpha_i^s + \beta_t^s + v_{i,t+s}^s,\ s = 0, 1, 2, ..., 5. \end{aligned} \tag{4}$$

This set of control variables were used in order to obtain the partial effect of the banking crises in suicide rates. We control for the contemporaneous and lagged effects of up to 2 periods of the mortality rate for the female population and only the lagged effects of the infant mortality. Finally we also include unemployment as a way of discriminating the real effect of the banking crises in suicide rates. This way we obtain the partial effect of the banking crises in suicide rates after removing the effects of GDP , female mortality and unemployment. This variables shown to be statiscally significant using low levels of significance.

In order to improve the previous model we specified a second model which uses another set of variables such as male mortality, unemployment without any lags and GDP, female mortality, and alcohol consumption (this one do not have the contemporaneous effect) lagged up to two periods as we can see in the following equation, s=0,1,...,5:

$$\begin{aligned} suic_{i,t+s} - suic_{i,t-1} &= \delta_0^{s+1} bankc_{i,t} + \gamma_{1,0}^{s+1} unemployment_{i,t} + \gamma_{2,1}^{s+1} lgdp_{i,t-1} \\ &+ \gamma_{2,2}^{s+1} lgdp_{i,t-2} + \gamma_{3,1}^{s+1} alco_{i,t-1} + \gamma_{3,2}^{s+1} alco_{i,t-2} \\ &+ \gamma_{4,0}^{s+1} femalemortality_{i,t} + \gamma_{4,1}^{s+1} femalemortality_{i,t-1} \\ &+ \gamma_{4,2}^{s+1} femalemortality_{i,t-2} + \gamma_{5,1}^{s+1} infantmortality_{i,t-1} \\ &+ \gamma_{5,2}^{s+1} infantmortality_{i,t-2} + \alpha_i^s + \beta_t^s + v_{i,t+s}^s \end{aligned} \tag{5}$$

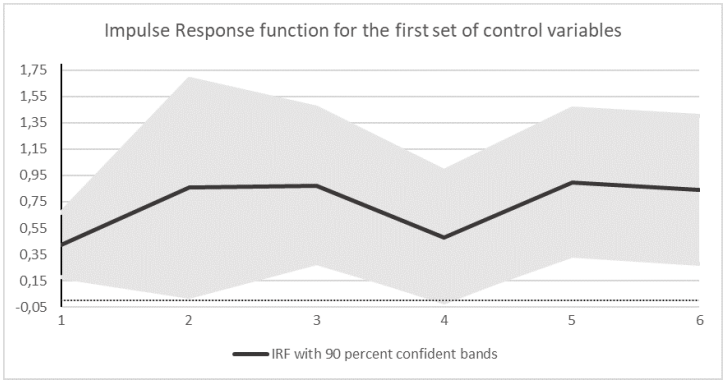
Contrary to model (4) , model (5) controls for the effects of the GDP lagged up to two periods to mitigate possible problems of serial correlation in the error terms. Additionally we included alcohol consumption in order to control for the past effect of alcohol consumption, which we know has some correlation to suicide rates. The contemporaneous effect of female mortality also showed to be statistically significant using low levels of significance. With this model we are able to control for both the effects of female and infant mortality in order to distinguish the effect of systemic banking crises in suicide rates.

In both models (4) and (5), we control for country and year fixed effects denote by α_i^s and β_t^s. Since we want an appropriate number of crisis events, so that we can estimate the average partial effect of a banking crisis in the suicide rate, we are limited to a maximum number of 6 periods of our forecast horizon. Also the idiosyncratic error term is denoted by $v_{i,t+s}^s$.

6 Results

In Table 4 we present the impulse response functions for model (4).
As we can observe, in figure 3, there was a positive effect in the first two periods which then started to decrease for the next two periods and increases for the final two periods, s=5 and s=6. Remarkably, the three first impulse response functions were statistically significant for at least a level of significance of 10% and much more precise than the subsequent IRFs. This is somewhat expected since there is already been evidence of a positive impact of the banking crisis in suicide rates which does not last for too many years.
In table 3 we can observe the various regressions estimated for the 6 periods. Note that in this model banking crisis is not statiscally significant in the fourth regression. For the other control variables there is at least one regression in which each control variable is statistically significant at a level of 1%. Keeping other factors fixed we estimate that, on average, banking crisis has a positive effect in suicide rates. This impact has a peak in the second year and decreases thereafter for the next two periods. In the fifth horizon it has once again an increase and reaches a new maximum decreasing thereafter.
As for the other control variables, we can discern that Female mortality have a contemporaneous positive effect in the suicide rates in opposition to the female mortality lagged 1 period. We can also distinguish a positive impact of the lagged infant mortality. Using this observed sample, unemployment has a negative impact in suicide rates which, curiously, is only statiscally significant for the last 3 periods.

Figure 3: Impulse response function of Suicide Rates with the first set of control variables



Notes: The confidence bands are based on autocorrelation robust-clustered standard errors. The IRF is represented in table 4.

The impulse response function for model (5) are presented in table 6.
For this model, as we also saw in model (4), there is an increasing positive effect in the first two periods reaching a maximum of 0,91, then decreases from the second period to period 4. After that the positive effect restarts to increase reaching a new peak of 0,95 which then decreases in period 6. A similar phenomenon occured for the first set of variables but now the positive effect is stronger.

Table 3: Estimation of model with the first set of control variables

	(1)	(2)	(3)	(4)	(5)	(6)
Banking crises	0,422***	0,858*	0,874**	0,479	0,899***	0,841**
	(0,149)	(0,502)	(0,36)	(0,308)	(0,338)	(0,341)
Female mortality	0,175***	0,069**	0,047	0,041	0,055	0,054
	(0,022)	(0,035)	(0,038)	(0,036)	(0,039)	(0,049)
Unemployment	-0,006	-0,033	-0,081	-0,164***	-0,223***	-0,287***
	(0,022)	(0,036)	(0,051)	(0,055)	(0,06)	(0,056)
Female mortality lag 1	-0,192***	-0,196***	-0,205***	-0,204***	-0,224***	-0,229***
	(0,034)	(0,039)	(0,049)	(0,047)	(0,055)	(0,05)
Female mortality lag 2	-0,011	0,026	0,024	0,005	0,005	0,012
	(0,016)	(0,028)	(0,037)	(0,034)	(0,039)	(0,037)
Infant mortality lag 1	0,052*	0,088*	0,083	0,103	0,116	0,141*
	(0,031)	0,048	(0,072)	(0,064)	(0,081)	(0,072)
Infant mortality lag 2	-0,017	-0,009	0,029	0,028	0,021	0,003
	(0,028)	(0,034)	(0,061)	(0,054)	(0,065)	(0,06)
Observations	718	670	622	575	530	487

Notes: Robust-clustered standard errors are in parenthesis; *** ,**, and * denote significance levels of 1, 5, and 10 percent respectively.

Table 4: Impulse response function of suicide rate with the first set of control variables

Event	$s = 1$	$s = 2$	$s = 3$	$s = 4$	$s = 5$	$s = 6$
Banking Crisis	0,422***	0,8582*	0,8743**	0,4791	0,8992***	0,8412**
	(0,1495)	(0,5023)	(0,3596)	(0,3083)	(0,3384)	(0,3414)
Number of events	56	56	54	54	54	54
Observations	718	670	622	575	530	487

Notes: Robust-clustered standard errors are in parenthesis; *** ,**, and * denote significance levels of 1, 5, and 10 percent respectively.

Again, the three first impulse response functions are statistically significant for at least a level of 5 percent. But now in comparison with model (4) the IRFs are now more statistically significant in the sixth period than in the fifth period, as we can see in Table 6.

The number of observations available for estimation, for models 4 and 5, is 718 in the first period (s = 1), 670 for the second period (s = 2), decreasing and reach-

Table 5: Estimation of model with the second set of control variables

	(1)	(2)	(3)	(4)	(5)	(6)
Banking Crises	0,428***	0,905*	0,831**	0,465	0,946**	0,863***
	(0,153)	(0,505)	(0,371)	(0,302)	(0,381)	(0,305)
Female mortality	0,176***	0,068**	0,047	0,044	0,057	0,055
	(0,023)	(0,033)	(0,037)	(0,037)	(0,04)	(0,049)
Unemployment	-0,008	-0,04	-0,1**	-0,177***	-0,221***	-0,287***
	(0,021)	(0,032)	(0,047)	(0,055)	(0,053)	(0,059)
Female mortality lag 1	-0,192***	-0,201***	-0,206***	-0,204***	-0,231***	-0,234***
	(0,035)	(0,038)	(0,05)	(0,05)	(-0,231)	(0,051)
Female mortality lag 2	-0,011	0,031	0,035	0,013	0,015	0,023
	(0,017)	(0,027)	(0,036)	(0,035)	(0,039)	(0,04)
Infant mortality lag 1	0,051*	0,094*	0,084	0,104	0,128*	0,149**
	(0,03)	(0,049)	(0,07)	(0,064)	(0,077)	(0,069)
Infant mortality lag 2	-0,016	-0,018	0,011	0,02	0,014	-0,002
	(0,03)	(0,034)	(0,056)	(0,055)	(0,066)	(0,069)
GDP lag 1	0,065	0,196***	0,357***	0,453***	0,418***	0,472***
	(0,05)	(0,06)	(0,114)	(0,132)	(0,11)	(0,182)
GDP lag 2	0,099	0,209***	0,309***	0,373***	0,496**	0,487
	(0,062)	(0,076)	(0,11)	(0,134)	(0,496)	(0,327)
Alcohol lag 1	0,021	0,147	-0,084	-0,061	0,229	0,143
	(0,064)	(0,136)	(0,074)	(0,134)	(0,286)	(0,21)
Alcohol lag 2	0,004	-0,198*	0,003	0,044	-0,262	-0,279
	(0,067)	(0,113)	(0,114)	(0,164)	(0,353)	(0,238)
Observations	718	670	622	575	530	487

Notes: Robust-clustered standard errors are in parenthesis; *** ,**, and * denote significance levels of 1, 5, and 10 percent respectively.

ing 487 in the last period (s = 6). Moreover, the number of events included in both models was 56 banking crises in the first two periods and 54 in the last four periods.

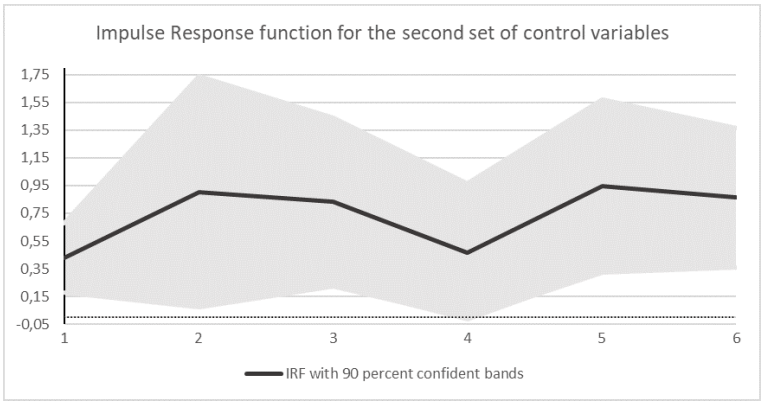
Although in figures 3 and 4, there are no visual differences if we compare tables 4 and 6, the results show us that both models have five out of six IRFs which are statistically significant (at least at 10%). It is also clear that most of all impulse response functions (excepting the ones that refer to the third and fourth period) in model 5 are higher than the ones in model 4.

Table 6: Impulse response function of suicide rate with the second set of control variables

Event	$s = 1$	$s = 2$	$s = 3$	$s = 4$	$s = 5$	$s = 6$
Banking Crisis	0,4281***	0,9048*	0,8309**	0,4652	0,9461**	0,8632***
	(0,1528)	(0,5046)	(0,3709)	(0,3018)	(0,3807)	(0,3051)
Number of events	56	56	54	54	54	54
Observations	718	670	622	575	530	487

Notes: Robust-clustered standard errors are in parenthesis; *** ,**, and * denote significance levels of 1, 5, and 10 percent respectively.

Figure 4: Impulse response function of Suicide Rates with the second set of control variables



Notes: The confidence bands are based on autocorrelation robust-clustered standard errors. The IRF is represented in table 6.

On the other hand, the latter's impulse response functions are more precise than the former (except for the fourth and sixth period), which can be due to higher collinearity between the lagged variables.

Table 5 presents the various estimated regressions for the 6 periods. In this second model, the banking crisis is statistically significant, except in the fourth regression. Keeping other factors fixed, we estimate that, on average, the banking crisis has a much stronger positive effect on the suicide rates than in the first model.

Indeed, this impact reached a maximum in the second year and fifth year, which were stronger than the previous model. As for the other control variables, we can discern that Female mortality has a contemporaneous positive effect on suicide rates. On the other hand, the lagged variable has the opposite effect. Both the first and second lag of GDP also positively affect the suicide rates, but the second lag has less precise estimates. As in model 4, unemployment has a negative effect but now with significant estimates from period three onward. Results showed that for infant mortality, this effect is not clear across regressions. Surprisingly, alcohol consumption lagged one period has predominantly a positive effect while having both positive

and negative effects when lagging two periods.

Our results show us that systemic banking crises have a positive impact on suicide rates. This positive effect was also reported in several studies,[3] [9] [7][12] but using different methodologies. Bernal et al.[3] use a segmented regression with a quasi Poisson model adjusted seasonally to study the effects of the 2008 financial crisis in suicide rates for Spain. Economou et al.[9] also observed, for Greece, a strong association between socioeconomic variables through the use of logistic regression using a set of variables as predictors such as unemployment.
Houle and Light[12] also reported a positive association between suicide rates and foreclosure from 2005-2010, using hybrid random- and fixed-effects models. Finally, Chang et al.[7] investigated the relationship between the economic crisis and suicide rates in South Korea.
Different studies show the same positive association between some crisis events and suicide rates, but not to our knowledge to the same extent as our study. We used a novel approach called local projections and used panel data for several countries for a more extended period to study this positive effect of banking crises on suicide rates.

7 Conclusion

We can conclude that systemic banking crises have an impact on suicide rates. We studied this effect for the period of 1980 to 2016 using panel data for 53 countries. We identified a positive effect between banking crises and suicide rates, using a recent econometric approach, namely local projections, using a five-year horizon.

Note that we are not excluding the possibility of having a third factor, possibly currency crises that explains part of the banking crises' impact on suicide rates. We decided not to include this other factor to avoid multicollinearity issues. To minimize this possible bias, we used a set of control variables such as the GDP, unemployment, mortality rates, and alcohol consumption.
The findings are consistent with previous results in which there is a positive but not permanent effect of the banking crisis in suicide rates. After the beginning of a crisis event, a positive effect is seen in the first two years and seems to have an oscillating pattern after that with a frequency of two years.
We did not study the effects of the banking crisis for periods more extended than six years so that the used observations were sufficiently large.

Our analysis involves data for several countries, so it seems that we should consider, as future research, the effects that each country has on each other.

It would also be interesting, as future research, to investigate the effects of the 2008 banking crisis and the recent pandemic crisis in suicide rates. More specifically, study if there is a significant difference before and after the crisis of 2008 using the study of structural breaks.

Future work is also studying the increasingly more famous machine learning models such as Artificial Neural Networks and comparing them with local projections methodology.

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A Appendix

Table 7: Descriptive Statistics for the Suicide Rate by Country

Countries	N	Mean	Std. Dev.	Minimum	Maximum
Argentina	36	7,86	1,22	6,15	10,69
Australia	36	11,52	1,01	8,47	13,51
Austria	45	19,37	5,17	0,99	31,3
Azerbaijan	22	2,52	1,68	0,76	5,77
Belarus	29	25,82	4,9	16,79	31,84
Belgium	33	17,55	1,35	14,92	20,16
Brazil	34	4,76	0,91	3,63	6,45
Bulgaria	35	12,86	1,45	9,22	15,54
Canada	34	11,79	1,19	10,1	14,31
Chile	46	8,12	2,95	5,13	14,53
Colombia	23	4,15	1,08	2,75	6,04
Costa Rica	35	6,37	0,85	4,87	8,4
Croatia	32	18,71	1,99	14,63	22,14
Czech Republic	31	14,78	1,55	12,26	18,34
Denmark	36	15,91	6,01	8,97	28,32
Estonia	33	25,34	5,92	16,96	37,74
Finland	36	21,1	3,66	13,43	27,48
France	35	16,79	1,55	14,09	19,47
Georgia	30	3,76	1,34	1,57	7,06
Germany	26	11,84	1,2	9,21	13,69
Greece	36	3,27	0,62	2,29	4,99
Guatemala	33	2,72	0,89	0,71	4,8
Hungary	37	29,09	6,4	20,16	39,8
Ireland	35	9,98	1,67	6,99	13,17
Israel	36	6,58	0,79	5,37	8,29
Italy	36	6,22	0,58	4,93	7,17

Countries	N	Mean	Std. Dev.	Minimum	Maximum
Japan	36	17,58	2,84	13,14	22,4
Kazakhstan	33	25,92	4,31	18,45	32,15
Korea, Rep	31	20,67	12,91	7,24	43,29
Kuwait	30	2,08	5,23	0,12	29,74
Kyrgyzstan	33	13,01	2,62	8,2	17,47
Latvia	35	26,2	5,02	20,03	37,87
Mexico	36	3,94	1,47	1,55	9,37
Moldova	24	16,39	3,59	1,8	20,86
Netherlands	37	9,24	1,13	7,79	12,74
New Zealand	33	12,68	1,21	10	15,03
Norway	36	12,03	1,41	9,99	15,64
Poland	32	13,65	1,7	7,09	16,43
Portugal	34	8,84	4,9	3,7	32,61
Russian Federation	34	28,95	6,09	13,21	39
Singapore	35	11,08	2,14	8,07	15,97
Slovenia	32	24,44	3,19	17,27	30,46
Spain	36	6,57	1,17	4,07	8,7
Sweden	36	13,25	2	10,37	17,25
Switzerland	36	17,24	3,1	13,09	22,79
Trinidad and Tobago	31	12,28	3,57	2,66	21,63
Turkmenistan	30	8,13	3,6	1,94	14,02
Ukraine	33	21,02	4,13	8,68	26,43
United Kingdom	36	6,92	0,56	6,01	7,93
United States	35	11,56	1,36	9,53	14,62
Uruguay	33	14,4	4,66	7,96	22,5
Uzbekistan	30	7,91	1,72	5,07	11,1
Venezuela, RB	23	5,67	0,59	4,12	6,61

Table 8: Descriptive Statistics for the Suicide Rate by Year

Year	N	Mean	Std. Dev.	Minimum	Maximum
1980	39	13,01	9,07	0,92	39,03
1981	44	13,62	9,42	0,71	39,34
1982	41	13	8,88	0,12	37,3
1983	36	12,46	8,64	0,42	39,8
1984	43	12,83	8,83	0,69	39,58
1985	50	13,46	8,05	1,08	38,08
1986	52	12,99	7,75	0,76	38,79
1987	52	13,11	7,77	1,04	38,58
1988	51	13,15	7,47	2,7	35,17
1989	50	13,04	7,41	2,4	35,27
1990	51	13,05	7,5	2,02	33,46
1991	52	12,88	7,67	2,08	32,32
1992	52	13,37	8,62	2,37	37,87
1993	51	13,79	9,12	1,15	39
1994	53	13,58	9,24	0,78	38,4
1995	52	13,42	9	0,76	36,72
1996	52	12,83	8,51	1,11	34,65
1997	53	13,02	8,48	1,6	33,13
1998	52	13,07	8,47	0,84	35,32
1999	52	12,7	8,18	0,78	35,24
2000	51	12,61	8,04	0,84	35,49
2001	50	12,47	7,57	1,15	34,11
2002	52	12,3	7,13	1,56	31,46
2003	49	12,43	6,9	1,51	30,53
2004	52	11,56	6,93	1,38	31,08
2005	48	11,47	7,47	1,38	32,61
2006	48	14,41	8,04	1,32	35,04
2007	52	14,18	8,96	0,99	38,88
2008	49	15,04	8,28	0,98	37,69
2009	51	14,43	8,71	1,23	43,29
2010	51	13,94	8,27	0,84	43,18
2011	50	13,48	8,01	0,95	42,92
2012	48	13,22	7,23	1,3	36,94
2013	49	13,02	7,04	0,82	35,71
2014	48	12,96	6,52	1,32	32,11
2015	39	13,01	6,51	2,37	32,43
2016	6	17,77	4,4	12,74	24,13