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Determinants of Suicides in Denmark: Evidence from Time Series Data

Abstract

This research examines empirically the determinants of suicides in Denmark over the period 1970-2006. To our knowledge, there exist no previous study that estimates a dynamic econometric model of suicides on the basis of time series data and cointegration framework at disaggregate level. Our results indicate that suicide is associated with a range of socio-economic factors but the strength of the association can differ by gender. In particular, we find that a rise in real per capita income and fertility rate decreases suicides for males and females. Divorce is positively associated with suicides and this effect seems to be stronger for men. A fall in unemployment rates seems to lower significantly suicides in males and females. Policy implications of suicides are discussed with some appropriate recommendations.

Keywords: Suicide, Denmark, Time Series, Cointegration

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1. Introduction

There are several reasons to be interested in the determinants of societal suicide rates. First, suicide is a major public health issue in many Western countries. According to the World Health Organization (WHO) [1], in 2004 suicide was responsible for 1.3% of the total burden of disease worldwide and for 2% of the burden in the European region. Second, in addition to its heavy economic costs[1], suicide has massive negative effects-psychological pain and suffering-on the suicide's family. Third, suicide rates can be considered as a more objective and reliable indicator of well-being or quality of life than self-reported health measures [2]. Moreover, suicide rates do not have the common problems associated with survey data on self-reported well-being (i.e., cognitive factors that affect subjective responses, such as the ordering of questions, the wording of the survey, etc.)[2]. Bertrand and Mullainathan make the point that in this context that respondents tend to overestimate their subjective well-being and that socio-economic status affects the way people respond to a survey. Self-reported measures are often challenged on the basis of reliability and validity. Finally, it has also been shown that there is a strong correlation between suicide and subjective well-being at the individual as well at the aggregate level [3], [2]. Recently, a study using American data concluded that the determinants of well-being are the determinants of suicide [4].

Generally, national wealth and quality of life have a positive correlation. That is, richer nations have better quality of life. Nevertheless, it is remarkable that wealthy countries also have higher suicide rates than poor countries. The explanation for this is likely to be a

[1] There have been European studies highlighting the enormous costs of completed suicides. For instance, in Ireland [5] the total cost has been shown to be 2.04 million euros and in Scotland 1.88 million euros [6]. These costs include not only direct costs (police and funeral costs) but also indirect costs such as loss of productivity and several intangibles-pain and grief experienced by relatives and the lost opportunity for successful suicides for future life experience.

[2] For a discussion on measurement error in self-reported well-being measures, see Ref. [7].

complex mixture of socio-economic factors. This article is a first attempt to understand the Danish suicide problem better. The suicide rate in Denmark was among the highest in Europe in 1980, and, even though suicide rates have declined for both men and women and for almost all age groups since then, Denmark still has higher suicide rates than other countries in Scandinavia [8].

Table 1 displays the average male and female suicide rates for the study period 1970-2006. Male suicide rates are higher than female rates. Specifically, average suicide rates for males are two times higher than for females. There has also been a decline in reported suicide rates over the study period. Reported suicide rates vary considerably across the Organization for Economic Cooperation and Development (OECD), as Table 2 shows. In 2004 the highest suicide rate was reported by Japan (24.97 per 100,000 people) followed by South Korea (23.77 per 100,000 people). Greece had the lowest suicide rate at 3.19 per 100,000 people. For male suicide rates, Japan ranked the highest among 23 OECD countries. For female suicide rates, South Korea was the highest in 2004. Across all countries, men are three times more likely to die due to suicide than women.

Table 1. Average suicide rates in Denmark: 1970-2006 per 100,000.

Years	Total suicide rate	Male suicide rate	Female suicide rate
1970-1979	24.08	30.16	18.10
1980-1989	28.40	36.51	20.52
1990-1999	18.91	25.96	12.04
2000-2006	12.82	18.96	6.81

Source: Denmark Statistical Bank [9]

Table 2. Suicide rates across OECD countries in 2004 per 100,000.

Country	Total suicide rate	Male suicide rate	Female suicide rate
Australia	10.50	16.71	4.36
Austria	17.35	27.03	8.20
Belgium	19.06	28.44	10.07
Canada	11.29	17.26	5.44
Denmark	11.65	17.03	6.38
Finland	20.33	31.71	9.44
France	17.81	26.65	9.45
Germany	13.01	19.68	6.63
Greece	3.19	5.20	1.22
Iceland	11.96	17.72	6.17
Ireland	10.51	16.71	4.38
Japan	23.97	35.64	12.84
Luxembourg	14.41	21.64	7.34
Netherlands	9.30	12.69	5.98
New Zealand	12.06	19.07	5.33
Norway	11.52	15.77	7.34
Portugal	11.47	17.87	5.48
South Korea	23.77	32.50	14.98
Spain	8.21	12.63	3.94
Sweden	12.83	18.69	7.08
Switzerland	17.36	23.68	11.31
UK	6.99	10.80	3.34
USA	11.02	17.65	4.60

Source: WHO Mortality Database [10]

This paper is novel in many ways. To the best of our knowledge, there is no empirical study which deals with the issue of suicide from a macro perspective in Denmark that has employed dynamic econometric models such as the *Autoregressive Distributed Lag* (ARDL) model[3]. Second, in addition to modeling the total number of suicides, we also estimate separate models for males and females, as the determinants of suicide might differ between sexes. Understanding gender differences might be important in informing appropriate health policies. This paper is organized as follows: in the following section, we present a brief summary of previous research. Next, we describe our empirical model and methodological approach. Subsequently, we present our empirical findings, followed by the conclusion.

[3] Most of the studies in Denmark have employed individual level data (see, for example, Ref. [11])

2. Literature review

As indicated elsewhere [12], two of the most frequently employed approaches to the study of suicide are the sociological approach [13] employed by Durkheim and the economic approach [14] of Hamermesh and Soss. According to the economic theory of suicide, an individual decides to commit suicide when the discounted expected lifetime utility remaining to him falls below some threshold level. This model predicts that suicide rates would increase with age and unemployment and decrease with income [14].

According to the economic model of suicide, the higher future expected income is, the higher is the expected utility; thus, living is relatively more attractive than committing suicide, and a higher income should lower suicide rates. However, Durkheim postulates that higher income levels increase independence (the opposite of social integration) and might lead to a higher suicide rate. Along this line Refs. [15, 16] state that economic development increases rates of suicide. Both the existing economic and sociological theories are inconsistent, and they do not permit a determination of whether income or economic growth may have a positive or negative effect on suicide. Durkheim suggests that changes in income are more likely to be relevant for suicide than the level of income. The empirical evidence for the effect of income on suicide is mixed, however. Though some empirical studies indicate that suicide rates have a positive association with income [17-19], there are many others suggesting the opposite effect [2, 20-26]. Others have reported an insignificant effect of income on suicide [27], [28]. The significant negative correlation effect seems to be stronger for men than for women [11].

Another economic variable that has received a lot of attention is the unemployment rate. Unemployment implies less economic opportunity, lowering an individual's expected income

and therefore increasing the likelihood of a person's committing suicide. The unemployment rate is often used as a proxy variable for economic hardships and lifetime earnings, because measuring an person's agent's lifetime income is not easy in practice [29]. But unemployment might be also associated with factors such as depressive episodes, anxiety, and loss of self-confidence that might lead directly to suicide. The empirical findings are fairly mixed. Much of the empirical literature reports a positive relationship, associating higher unemployment with higher suicide rates [21], [27], [23], [24], [30], [20], [29], [25]. Furthermore, the impact of unemployment might also differ across gender. In particular, male suicide rates are significantly affected by unemployment, but female suicide rates are not [23].

The seminal work of Durkheim [13] indicates that suicide is influenced by other factors. These factors relate to the way in which individuals are integrated into a social group that is regulated by norms and conventions. The sociological perspective of suicide [13] predicts that lower levels of social integration and regulation are associated with higher societal suicide rates. From this perspective divorce and fertility rates can be viewed as indicators of social integration. Divorce can be a traumatic event for the individuals involved as well as for other affected parties, and it might lead individuals toward isolation and reduced poor psychological well-being. Thus, higher divorce rates might be expected to have a positive correlation with suicide rates. The empirical literature on suicide reports evidence that divorce is positively associated with suicide rates [20], [23], [24], [31], [15], [22]. Also, some papers show that the male suicide rate is more sensitive to divorce than the female suicide rate [29], [20], [32], [22]. Again, endogeneity concerns are relevant here, as divorce might be related to mental health problems. It should be also noted that this variable might capture the influence of diverse societal problems. Durkheimian arguments of social integration [13] suggest that increased fertility rates should be associated with lower levels of suicide, as the presence of

children promotes social and family ties. By increasing social integration, these factors lower the likelihood of a person's committing suicide. Empirical research has documented the existence of a protective effect of fertility against suicide [20], [22], [24]. However, some studies [33], [34] show that birth rate has either a positive impact or no impact on suicide rates. One possible explanation for the latter result is that childcare may put excessive strain on a parent or be too much of an economic burden, thus leading to suicidal behavior [33]. Lastly, the gender differences in suicide represent a double puzzle: while rates of suicide are far higher among males, females have higher rates of non-fatal attempts. This suggests that there may be different responses by males and females to the control variables used in the formal analysis. In light of the gender differential in suicidal behaviour [26], [25], [20], [32], we run separate models for males and females.

In sum, the formal literature provides ambiguous results on the ways socio-economic factors relate to male and female suicide rates. Of all the variables considered, the results corresponding to social factors such as divorce and fertility seem to be more robust than those related to economic factors such as unemployment and income. Suicide is a very complex event affected by many variables, many of which we are not able to observe in our sample. Nonetheless, the variables included here appear to be among the relatively important determinants.

3. Empirical model and econometric methodology

Following the empirical literature on suicide (for an extensive review of the literature, see Ref. [35]), we form the following long-run relationship between suicide, income, unemployment, divorce, and fertility in linear logarithmic form as:

$$s_{tj} = a_0 + a_1 y_t + a_2 u_t + a_3 d_t + a_4 f_t + \varepsilon_t , \quad (1)$$

where the subscript t indexes time period with t =1970,…,2006; j indexes each suicide with j= 0 (total), 1 (male), and 2 (female); y_t is per capita real income; u_t is the unemployment; d_t is the divorce rate; f_t is the fertility rate; and ε_t is the classical error term.

Recent advances in econometric literature dictate that the long-run relation in equation (1) should incorporate the short-run dynamic adjustment process. It is possible to achieve this aim by expressing equation (1) in an error-correction model [36], known as the Engle-Granger approach.

$$\Delta s_{t,j} = b_0 + \sum_{i=1}^{m1} b_{1i,j} \Delta s_{t-i,j} + \sum_{i=0}^{m2} b_{2i} \Delta y_{t-i} + \sum_{i=0}^{m3} b_{3i} \Delta u_{t-i} + \sum_{i=0}^{m4} b_{4i} \Delta d_{t-i} + \sum_{i=0}^{m5} b_{6i} \Delta f_{t-i} + \gamma \varepsilon_{t-1} + \mu_t , \quad (2)$$

where Δ represents change , γ is the speed of adjustment parameter, and ε_{t-1} is the lagged error term, which is estimated from the residuals of equation (1). The Engle-Granger method requires that all variables in equation (1) are integrated of order one, $I(1)$, and that the lagged error term is integrated order of zero, $I(0)$, in order to establish a cointegration relationship. If some variables in equation (1) are non-stationary, we may use a new cointegration method [37]. This procedure is known as ARDL approach to cointegration of Pesaran *et al*. that combines Engle-Granger two steps procedure into one by replacing ε_{t-1} in equation (2) with

its equivalent from equation (1). ε_{t-1} is substituted by linear combination of the lagged variables as in equation (3):

$$\Delta s_{t,j} = c_0 + \sum_{i=1}^{n1} c_{1i,j}\Delta s_{t-i,j} + \sum_{i=0}^{n2} c_{2i}\Delta y_{t-i} + \sum_{i=0}^{n3} c_{3i}\Delta u_{t-i} + \sum_{i=0}^{n4} c_{4i}\Delta d_{t-i} + \sum_{i=0}^{n5} c_{5i}\Delta f_{t-i} + c_6 s_{t-1,j} + c_7 y_{t-1} + c_8 u_{t-1} + c_9 d_{t-1} + c_{10} f_{t-1} + v_t \quad (3)$$

To obtain equation (3), one has to solve equation (1) for ε_t and lag the solution equation by one period. Then, this solution is substituted for ε_{t-1} in equation (2) to arrive at equation (3). Equation (3) is a representation of the ARDL approach to cointegration.

The bounds-testing procedure is based on the F- or Wald-statistics, and this is the first stage of the ARDL cointegration method. Accordingly, a joint significance test that implies no cointegration hypothesis, (H_0: $c_6 = ... = c_{10} = 0$), against the alternative hypothesis, (H_1: at least one c_6 *to* $c_{10} \neq 0$), should be performed for equation (3). The F-test used for this procedure has a non-standard distribution. Thus, Pesaran *et al*. compute two sets of critical values for a given significance level with and without a time trend. One set assumes that all variables are *I*(0), and the other set assumes that they are all *I*(1). If the computed F-statistic exceeds the upper critical bounds value, then the H_0 is rejected. If the F-statistic falls into the bounds, then the test becomes inconclusive. Lastly, if the F-statistic is below the lower critical bounds value, it implies no cointegration. Given the size of the sample used in this study (37 observations), the critical values for the bounds F-test reported by Ref. [38] are more appropriate than that of Pesaran *et al*.

Once a long-run relationship has been established, equation (3) is estimated using an appropriate lag-selection criterion. At the second stage of the ARDL cointegration procedure, it is also possible to obtain the ARDL representation of the error-correction model. To estimate the speed with which the dependent variable adjusts to independent variables within the bounds-testing approach, following Pesaran *et al*., the lagged-level variables in equation (3) are replaced by EC_{t-1} as in equation (4):

$$\Delta s_{t.j} = \alpha_0 + \sum_{i=1}^{k1} \alpha_{1i,j} \Delta s_{t-i,j} + \sum_{i=0}^{k2} \alpha_{2i} \Delta y_{t-i} + \sum_{i=0}^{k3} \alpha_{3i} \Delta u_{t-i} + \sum_{i=0}^{k4} \alpha_{4i} \Delta d_{t-i} + \sum_{i=0}^{k5} \alpha_{5i} \Delta f_{t-i} + \lambda EC_{t-1} + \mu_t . \quad (4)$$

A negative and statistically significant estimation of λ not only represents the speed of adjustment but also provides an alternative means of supporting cointegration between the variables. Annual data over the period 1970-2006 were used to estimate equation (3) by the ARDL cointegration procedure of Pesaran *et al*. All data have been collected on-line from Statistics Denmark [9].

The time-series properties of the variables included in equation (1) are checked through Augmented Dickey-Fuller (ADF) [39] to make sure that the variables in consideration are not integrated at an order higher than one, *I(1)*. The critical values of Refs [37, 38] are not applicable in the presence of *I(2)* variables. The results of the ADF tests are reported in Table 3. The variables of per capita real income (y_t) and fertility rate (f_t) are stationary in their levels, whereas other variables contain a unit root in their levels which warrant our applying the bounds-testing procedure. Visual inspection of the variables in logarithms indicated to us that there are not any structural breaks in the time-series.

Table 3. Tests for integration[a].

ADF test statistic				
Variable	Levels	*k* lag	1st Differences	*k* lag
$s_{t,0}$	-2.2498	1	-3.5906*	1
$s_{t,1}$	-2.3817	1	-4.6671*	1
$s_{t,2}$	-2.0785	1	-4.0421*	1
y_t	3.6275*	3	-4.6035*	4
u_t	-1.3618	2	-2.9852*	3
d_t	-2.4867	1	-3.3425*	1
f_t	-5.0959*	4	-2.5101	1

[a] Sample levels 1976-2006 and differences 1977-2006. Rejection of unit root hypothesis, according to McKinnon's [40] critical value at 5% is indicated with an asterisk. ADF tests include an intercept and a 1 to 5 lagged difference variable and *k* stands for the lag level that maximizes the AIC (Akaike Information Criteria). The critical values are -3.5615 and -2.9627 at levels and differences, respectively.

Equation (3) is estimated in two stages. In the first stage of the ARDL procedure, the long-run relationship of equation (1) was established in two steps. First, the order of lags on the first-differenced variables for equation (3) was obtained from unrestricted Vector Auto Regression (VAR) by means of Akaike Information criteria (AIC) and the Schwarz Bayesian Criterion (SBC). The results suggest the optimal lag length as 2, but this stage of the results is not presented here to conserve space. Second, a bound F-test was applied to equation (3) in order to establish a long-run relationship between the variables. The results of the bounds F-testing are displayed in Table 4. The results show that total suicides, male suicides, and female suicides all enter the regression equations as dependent variables in the long-run.

Table 4. The results of F-test for cointegration.

	Critical value bounds of the *F*-statistic					
	90% level		95% level		99% level	
	I(0)	*I(1)*	*I(0)*	*I(1)*	*I(0)*	*I(1)*
	2.69	3.89	3.27	4.63	4.59	6.36
Calculated F-statistic						
$F_C(s_0 \mid y,u,d,f)$	14.86					
$F_C(s_1 \mid y,u,d,f)$	14.92					
$F_C(s_2 \mid y,u,d,f)$	6.51					

The critical value bounds are from Narayan [38]

The ARDL cointegration procedure was implemented to estimate the parameters of equation (3) with maximum order-of-lag set to 2, which is selected on the basis of SBC and $\overline{R}^2$ selection criteria. This stage involves estimating the long-run and short-run coefficients of equations (1) and (2).

4. Results

The summary ARDL results with some diagnostic tests for total suicides, male suicides, and female suicides are presented in Tables 5-7 respectively. The overall empirical results appear to be rather satisfactory, considering the small sample size. First, income enters negatively in the regressions for overall, male, and female suicides. The long-run elasticity of suicide with respect to income is highest in the case of female suicides. This is -3.22, suggesting that each 1% increase in per capita real income will decrease the number of female suicides by 3.22 %. The long-run income elasticities for total and male suicides are -2.22 and -1.73, respectively. This finding implies that females are more vulnerable to income loss than males. Second, unemployment rates are positively and significantly related to overall, male, and female suicide rates. The long-run elasticity of suicide with respect to unemployment seems to be almost the same in all the categories, indicating that a 1% rise in unemployment rates will trigger an increase in all suicides by about 0.1%. Therefore, it is crystal clear that the impact of male and female unemployment on suicides is identical. Gender seems to have no special effect on a suicide decision, when an individual becomes unemployed. Third, divorce rates are positively correlated with suicide rates but are statistically insignificant. Finally, we find a negative association between fertility rates and suicide rates. In the case of female suicides, a 1% increase in the fertility rate seems to reduce the suicide rates by 0.92 %, but this impact is

almost halved in the case of male suicides, suggesting that females are naturally more protective of their families.

The long-run elasticity of suicide with respect to the fertility rate variable implies that a 1% increase in fertility will decrease total suicides by 0.70% and female suicides by 0.92% but male suicides by only 0.57%. In regards to the relative magnitude of the explanatory variables in this study, the fertility rate seems to be the second most important factor in explaining the suicide rates, followed by divorce and unemployment rates.

All the error correction terms in the estimated models are statistically significant and with the expected signs. They also represent a strong level of dynamic equilibrium between the short-run and long-run, since their values are greater than 0.5.

Table 5. ARDL cointegration results.

Panel A.
Estimated long-run coefficients using the ARDL approach for *aggregate suicide* model: ARDL (1,0,2,0,2) selected based on the Schwarz Bayesian Criterion, 1970-2006.

Dependent variable $s_{t,0}$

Regressor	Coefficient	Standard error	T-ratio
y_t	-2.2215*	0.1407	15.7441
u_t	0.1051*	0.0409	2.5707
d_t	0.3447	0.4309	0.7999
f_t	-0.7003**	0.3352	2.0891

Panel B.
Error correction representation results.

Dependent variable $\Delta s_{t,0}$

Regressor	Coefficient	Standard error	T-ratio
Δy_t	-1.4483*	0.3118	4.6449
Δu_t	0.0560	0.0518	1.0809
Δd_t	0.2253	0.2877	0.7833
Δf_t	-0.0846	0.3567	0.2373
EC_{t-1}	-0.6536*	0.1450	4.5066

Diagnostic tests

$\bar{R}^2$	0.45	F-statistic	5.16*	$\chi^2_{SC}(1)$	5.82	$\chi^2_{FF}(1)$	0.17
RSS	0.06	DW-statistic	2.18	$\chi^2_{N}(2)$	2.99	$\chi^2_{H}(1)$	0.81

*, **, and, *** indicate, 1%, 5%, and 10% significance levels respectively. RSS stands for residual sum of squares. T-ratios are in absolute values. χ^2_{SC}, χ^2_{FF}, χ^2_{N}, and χ^2_{H} are Lagrange multiplier statistics for tests of residual correlation, functional form mis-specification, non-normal errors and heteroskedasticity respectively. These statistics are distributed as Chi-squared variates with degrees of freedom in parentheses. The critical values for $\chi^2(1) = 3.84$ and $\chi^2(2) = 5.99$ are at 5% significance level.

Table 6. ARDL cointegration results.

Panel A.
Estimated long-run coefficients using the ARDL approach for *male suicide* model: ARDL (1,0,2,1,2) selected based on the R-Bar Squared Criterion, 1970-2006.

Dependent variable $s_{t,1}$

Regressor	Coefficient	Standard error	T-ratio
y_t	-1.7295*	0.1446	11.9539
u_t	0.0970**	0.0426	2.2746
d_t	0.3282	0.4866	0.6745
f_t	-0.5794	0.3527	1.6425

Panel B.
Error correction representation results

Dependent variable $\Delta s_{t,1}$

Regressor	Coefficient	Standard error	T-ratio
Δy_t	-1.2706*	0.2649	4.7948
Δu_t	0.0695	0.0612	1.1371
Δd_t	0.5815	0.3592	1.6187
Δf_t	-0.2139	0.3991	0.5360
EC_{t-1}	-0.7346*	0.1576	4.6598

Diagnostic tests

$\overline{R}^2$	0.48	F-statistic	5.96*	$\chi^2_{SC}(1)$	6.4871	$\chi^2_{FF}(1)$	0.0077
RSS	0.07	DW-statistic	2.60	$\chi^2_{N}(2)$	1.9560	$\chi^2_{H}(1)$	1.2618

*, **, and *** indicate, 1%, 5% and 10% significance levels respectively. RSS stands for residual sum of squares. T-ratios are in absolute values. χ^2_{SC}, χ^2_{FF}, χ^2_{N}, and χ^2_{H} are Lagrange multiplier statistics for tests of residual correlation, functional form mis-specification, non-normal errors and heteroskedasticity respectively. These statistics are distributed as Chi-squared variates with degrees of freedom in parentheses. The critical values for $\chi^2(1) = 3.84$ and $\chi^2(2) = 5.99$ are at 5% significance level.

Table 7. ARDL cointegration results.

Panel A.
Estimated long-run coefficients using the ARDL approach for *female suicide* model: ARDL (1,2,1,2,2) selected based on the R-Bar Squared Criterion, 1970-2006.

Dependent variable $s_{t,2}$

Regressor	Coefficient	Standard error	T-ratio
y_t	-3.2146*	0.1785	18.0085
u_t	0.0958***	0.0543	1.7628
d_t	0.1636	0.6366	0.2570
f_t	-0.9219**	2.5769	2.0300

Panel B.
Error correction representation results.

Dependent variable $\Delta s_{t,2}$

Regressor	Coefficient	Standard error	T-ratio
Δy_t	-4.5916*	1.2742	3.6036
Δu_t	-0.2036	0.1221	1.6665
Δd_t	0.2473	0.5354	0.4619
Δf_t	1.0567***	0.5973	1.7690
EC_{t-1}	-0.7509*	0.1510	4.9721

Diagnostic tests							
$\overline{R}^2$	0.40	F-statistic	4.38**	$\chi^2_{SC}(1)$	8.7367	$\chi^2_{FF}(1)$	0.0090
RSS	0.12	DW-statistic	2.67	$\chi^2_{N}(2)$	3.2717	$\chi^2_{H}(1)$	5.9284

*, **, and *** indicate, 1%, 5% and 10% significance levels respectively. RSS stands for residual sum of squares. T-ratios are in absolute values. χ^2_{SC}, χ^2_{FF}, χ^2_{N}, and χ^2_{H} are Lagrange multiplier statistics for tests of residual correlation, functional form mis-specification, non-normal errors and heteroskedasticity respectively. These statistics are distributed as chi-squared variates with degrees of freedom in parentheses. The critical values for $\chi^2(1) = 3.84$ and $\chi^2(2) = 5.99$ are at 5% significance level.

5. Discussion

This paper has investigated the determinants of suicides over the period 1970-2006 in Denmark from a macro perspective, using the bounds approach to cointegration developed by Pesaran *et al*. A number of findings have been presented here. Income does significantly affect suicide rates. In particular, higher income is associated with higher suicide rates. The direction of this effect is consistent with other studies [21, 22]. According to the economic theory [14], higher income is expected to lower the suicide rate as the higher the future expected income, the higher the expected utility, thus making living more attractive relative to

committing suicide. This effect seems to be gender specific. The existing empirical evidence using individual-level data for Denmark suggests that men are more vulnerable than women to economic conditions [11], but this study reveals contradictory results. Our finding that unemployment increases suicide rates is in accordance with several empirical studies using aggregate data [20, 24], among others. Nevertheless, this factor results in almost the same level of impact in both the male and female sectors of the society, although unemployment might be related to a number of life-style factors of known impact on suicide. The positive effect of divorce is in accordance with the sociological perspective on suicide [13], which argues that divorce lowers social integration and entails a rupture of family ties. From this perspective a society characterized by a high divorce rate is expected to have a higher suicide rate. In addition, the effect of divorce on suicide depends on sex; the impact of this factor is twice as great in males as in females. A similar finding was obtained in the Barstad study of Norway [41], using a time-series approach. In comparison to income as a cause of suicide, the magnitude of divorce is considerably greater than unemployment but substantially lower than income. Finally, following Durkheimian arguments of social integration, fertility rates increase family integration and promote socials ties and are thus expected to lower societal suicide rates, although this effect seems to be greater for women than for men. This result is also consistent with past empirical studies [22, 23]. One can argue that the presence of a young child may increase parents' feelings of self-worth, possibly due to their experience of being needed, and the presence of a dependent child may also increase the sense of obligation. Women are the natural caregivers and the backbone for the raising of families. They should thus feel emotionally and physically closer to their families than men. This may explain our finding that parents—especially mothers—are less likely to die by suicide.

Denmark's social economic environment is similar to that of other Scandinavian countries and is also similar to many Western European countries. However, one should be cautious about generalizing the results of this study to other countries with different socio-economic environments. This paper also sheds light on the time-series properties of the variables included in empirical analysis of suicide. Close attention needs to be paid to previous results based on the stationarity assumption of the time-series used in suicide regressions. More importantly, individuals might respond to changes in socio-economic factors with some delay, thus a dynamic approach to modelling suicide seems to be more appropriate. National or international studies of suicide might be plagued of endogeneity problems. Therefore, it is clear that extreme care should be given to the interpretation of the final conclusions. The ARDL approach employed in this paper might overcome the problem of endogenous regressors in suicide equations.

Recommendations for suicide prevention are generally a combination of strategies targeting high-risk groups and strategies targeting a whole population. The findings of this study reveal that labour market conditions are related to suicidal behavior. Perhaps the most immediate application of these findings would be in government, social agency, and employer responses to the current economic recession, which is likely to produce increased numbers of suicides. This might also generate considerable pressure on suicide prevention policies. If suicide increases during recessions, policy makers might want to re-allocate resources from a focus on one cause of death to another. In bad economic times characterized by high unemployment rates, specialist advice on dealing with financial problems is also needed to restrain people's impulse towards suicide. Training for GPs and other medical service providers including specialists could also be provided by local government agencies. Government policies should also promote family cohesion to reduce the negative impact of divorce rates and provide

further economic incentives to raise birth rates, as these policies will reduce the suicide rate. The planning suicide of prevention policies should consider both macro-economic conditions and the individual conditions.

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