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February 2011

Online at http://mpra.ub.uni-muenchen.de/29075/
MPRA Paper No. 29075, posted 23. February 2011 / 06:19

A Study on the Socio-economic Determinants of Suicide: Evidence from 13 European OECD Countries*

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Abstract

This paper examines the factors affecting suicide in 13 European OECD countries from a socio-economic perspective. We use the autoregressive distributed lag approach to cointegration as the estimation methodology. Our results reveal that an increasing impact of divorce rates and a decreasing effect of per capita real GDP on suicide are confirmed in 9 countries. However, the evidence on the effects of fertility rates and per capita alcohol consumption are relatively less. For fertility rates, the results reveal that its increase leads to a decrease in suicide rates in four countries and a rise in suicide rates in one country. As for per capita alcohol consumption, the evidence supporting its significantly increasing effects on suicide rates is only confirmed in three countries. In addition, the tests of the cumulative sum and the cumulative sum of squares of the recursive residuals provide evidence indicating the stability of the estimated model.

Keywords: Suicide; European OECD Countries; Socio-economic Factors
JEL Classification: C22; I12; J17

1 Introduction

Suicide is the tragic end of a life. Since it has become a serious social problem in many countries, the examination of its causes and effects is a subject of study by many researchers. In spite of its importance, studies on suicide are still scarce from the economic perspective. As pointed out by Altinanahtar and Halicioglu (2009), previous studies on suicide have primarily been conducted from psychological and sociological viewpoints. Medical professionals consider

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suicide to be caused by depression and psychiatric disorders (e.g., Mann et al., 2005). Émile Durkheim, a famous sociologist, examines the determinants of suicide by focusing on the problems caused by social structure, instead of the personal factors of the individuals in his seminal work, "Le Suicide: Étude de Sociologie" (Durkheim, 1897). In contrast, Hamermesh and Soss (1974), who study suicide from an economic perspective, regard suicide as the behavior of a rational individual who maximizes their discounted expected utility.[1]

In an attempt to contribute to the suicide literature from the perspective of socio-economics, the purpose of this paper is to explore the similarities and differences of the determinants of suicide in European OECD countries. A time series analysis methodology, namely the autoregressive distributed lag (ARDL) approach to cointegration, will be applied. A literature review reveals several related studies. Using data from 17 European countries, Mäkinen (1997) illustrates that social factors, such as female labor participation and divorce rates, have significant impacts on suicide. Andrés (2005), using panel data from 15 European countries, shows that economic growth, fertility rates, and alcohol consumption appear to have significant impacts on male and female suicide rates.[2] Regarding time series analysis in a single country, Altinanahtar and Halicioglu (2009), using the ARDL approach, focus on the case of Turkey and find that urbanization is the most significant determinant of suicide. Andrés and Halicioglu (2010) demonstrate that a rise in per capita real income and fertility rates and a fall in unemployment rates decrease the suicide rates for males and females in Denmark, adopting a similar estimation approach. Andrés and Halicioglu (2011) also employ the ARDL approach to study the natural suicide rates in OECD countries and suggest that the suicide rates of a society could never be zero, even if both economic and social conditions were ideal from the point of view of suicide.[3]

Our paper differs from the previous studies in several aspects. Unlike previous empirical studies on the determinants of suicide that apply panel data and seek to determine the common factors of suicide (e.g., Neumayer, 2003; Chen, Choi, and Sawada, 2009), we will employ the time series analysis methodology on individual countries. This will enable us to clarify the effects, which may be overlooked in a panel analysis, leading to the identification of the country-specific determinants of suicide. Another advantage of a time series analysis for individual countries is that it can control racial, genetic, and climatic factors, to some extent. This paper complements the work of Altinanahtar and Halicioglu (2009) and Andrés and Halicioglu (2010, 2011) by providing evidence for an increased number of countries. Moreover, we conduct stability tests, CUSUM (cumulative sum) and CUSUMSQ (CUSUM of squares) of the recursive residuals not conducted in previous studies. The stability test is very important, since the cointegration relationship does not imply the stability of the estimated model. Hence, appropriate stability tests need to be conducted after the cointegration is established (e.g.,

[1] Chen, Choi, Mori, Sawada, and Sugano (2011) provide a detailed survey on economic theories and empirical studies on the socio-economic aspects of suicide.

[2] Leigh and Jencks (2007) is another study that uses panel data estimation to examine the factors affecting suicide rates in 12 developed countries. From their analysis, the evidence on the statistically significant relationship between income inequality and suicide rates cannot be confirmed.

[3] Yang and Lester (1991) originally proposed the concept of natural suicide rates.

Bahmani-Oskooee and Chomsisengphet, 2002).

Due to the availability of data, only 13 OECD countries are analyzed.[4] Using the ARDL approach, our estimation results illustrate that divorce rates reflecting the family factor, and per capita real GDP representing the economic factor, have significant impacts on suicide. The increasing effects of divorce rates and the reducing effect of per capita GDP on suicide is confirmed in most selected countries. Furthermore, our results present a diminishing effect of fertility rates on suicide only in some countries and an increasing impact of alcoholic consumption on suicide only in a few countries. Therefore, per capita real GDP and divorce rates are more common and robust determinant factors of suicide than fertility rates and alcoholic consumption. Additionally, the CUSUM and CUSUMSQ tests provide evidence supporting the stability of the estimated models.

The rest of this paper is structured as follows. Section 2 explains the estimation methodology. Section 3 provides the empirical analysis, including the data and estimation results. Section 4 is the conclusion.

2 Estimation Methodology

In an attempt to explore the determinants of suicide, our study focuses on socio-economic factors, such as economic conditions and family factors. As an economic factor, per capita real GDP is taken into account. Previous studies have revealed that an increase in the level of per capita real GDP leads to a decrease in suicide rates (e.g., Altinanahtar and Halicioglu, 2009; Chen, Choi, and Sawada, 2009; Andrés and Halicioglu, 2010). Moreover, we focus on two variables reflecting family factors, namely divorce rates and fertility rates. An isolated situation, which means that family ties are sparse, may tend to cause suicide. The inclusion of divorce rates is motivated by Burr et al. (1994), Mäkinen (1997), and Chen, Choi, and Sawada (2010), who argue that a high level of divorce rates increases suicide rates. The consideration in fertility rates is based on Mäkinen (1997), Mathur and Freeman (2002), and Chen, Choi, and Sawada (2010). However, the fertility effect on suicide rates is empirically controversial. Hence, fertility rates can affect suicide negatively or positively. Finally, to control personal factors, we consider per capita alcoholic consumption, following Mathur and Freeman (2002) and Chen, Choi, and Sawada (2010). Compared to socio-economic factors, such as economic condition and family structure, addiction to alcohol is more a personal behavior. An excessive alcohol intake is related to mental illness, and as a result, suicide rates may increase. Given these discussions, our estimation equation is specified in a logarithm form as follows:

$$\ln s_t = \alpha_0 + \alpha_1 \ln d_t + \alpha_2 \ln y_t + \alpha_3 \ln f_t + \alpha_4 \ln a_t + \varepsilon_t \tag{1}$$

[4]The selected 13 European OECD countries include Austria, Belgium, Denmark, Finland, France, Hungary, Iceland, Luxemburg, Netherlands, Norway, Sweden, Switzerland, and the United Kingdom. For more detail on the data sources, refer to Subsection 3.1.

where s is the suicide rates per 100,000 people; d is the divorce rates measured as the share of the number of divorces to the total population; y stands for per capita GDP; f represents fertility rates calculated as the number of births per woman; a is the alcohol consumption per capita in liters; and ε is the error term. The expected signs of the estimated coefficients are as follows: α_1 and α_4 are expected to be positive; α_2 is expected to be negative; and α_3 can be positive or negative.

The cointegration method is applied in our analysis. Instead of the conventional methods of cointegration, such as the residual-based approach proposed by Engle and Granger (1987) and the maximum likelihood-based approach proposed by Johansen and Juselius (1990), we adopt the method proposed by Pesaran et al. (2001), known as the ARDL approach to cointegration. This approach has an advantage over other two, since it does not require that the variables in consideration be in the same integration order, I(1).

Equation (1) can be rewritten as an unrestricted error correction representation of the following ARDL model:

$$\begin{aligned}\Delta \ln s_t = \beta_0 &+ \sum_{i=1}^{n} \beta_{1i} \Delta \ln s_{t-i} + \sum_{i=1}^{n} \beta_{2i} \Delta \ln d_{t-i} + \sum_{i=1}^{n} \beta_{3i} \Delta \ln y_{t-i} \\ &+ \sum_{i=1}^{n} \beta_{4i} \Delta \ln f_{t-i} + \sum_{i=1}^{n} \beta_{5i} \Delta \ln a_{t-i} + \lambda_1 \ln s_{t-1} + \lambda_2 \ln d_{t-1} \\ &+ \lambda_3 \ln y_{t-1} + \lambda_4 \ln f_{t-1} + \lambda_5 \ln a_{t-1} + \nu_t \end{aligned} \tag{2}$$

where ν is the error term.

The steps for the ARDL estimation are as follows. First, we test whether there exists a long-run relationship between considering variables in the estimation equation, using the F test. More specifically, the null hypothesis of no cointegration or no long-run relationship, $H_0 : \lambda_1 = \lambda_2 = \lambda_3 = \lambda_4 = \lambda_5 = 0$, is tested against its alternative, $H_1 : \lambda_1 \neq 0$, $\lambda_2 \neq 0$, $\lambda_3 \neq 0$, $\lambda_4 \neq 0$, $\lambda_5 \neq 0$. The F statistics obtained from this test are compared to the critical values (CV) proposed by Pesaran et al. (2001), in which the bands covering all possible classifications of variables into I(0) or I(1), or fractional integration, are provided. The comparison between the computed F statistics and the critical values is as follows: if the computed F-statistic is higher than the appropriate upper bound of the critical value, the null hypothesis of no cointegration is rejected; if it is below the appropriate lower bound, the null hypothesis cannot be rejected; and if it lies between the lower and upper bounds, the result is inconclusive. Next, if the F-test confirms the existence of a long-run relationship among the variables, the lag orders of the variables are selected using the Schwarz Bayesian Criteria (SBC). The short-run and long-run models are then estimated following the selected ARDL models.[5] Additionally, the CUSUM and CUSUMSQ tests are conducted to investigate the stability of the estimated equation.

[5]Based on the Monte Carlo experiment, Pesaran and Shin (1998) suggest that the SBC-based ARDL model performs better than the AIC-based model.

3 Empirical Analysis

3.1 Data

Our study focuses on the cases of European OECD countries. The annual dataset used for the estimation is drawn from a variety of sources. To generate data on the suicide rates per 100,000 people (s), the total number of suicides and population data are collected. These data are obtained from the WHO Mortality Database (WHO, 2010). The data on divorce rates (d), the share of the number of divorces to the total population, is created based on information obtained from the United Nations Statistics Division (2010) database. Per capita real GDP (y) is extracted from the Penn World Table Version 6.3 (Heston et al., 2009). The data on fertility rates (f), measured as the number of births per woman, is obtained from the World Development Indicators (World Bank, 2010). Finally, the data on alcohol consumption per capita in liters (a) is drawn from the OECD (2010).

To ensure that the sample size is sufficient for the cointegration analysis, we drop countries with continuous sample periods of less than 25 years, given the number of variables in the estimation model. As a result, 13 European OECD countries are selected for our study: Austria (1960-2007), Belgium (1960-1991), Denmark (1960-2006), Finland (1960-1990), France (1970-2006), Hungary (1970-2007), Iceland (1961-2007), Luxembourg (1977-2003), Netherlands (1963-2007), Norway (1960-1997), Sweden (1960-2007), Switzerland (1960-1994), and the United Kingdom (1970-1999). The sample sizes are different, as they are dependent on the availability of data for the variables in consideration.

3.2 Estimation Results

Although the ARDL approach does not require that the variables in consideration be I(0) or I(1), the critical values of the F statistics provided in Pesaran et al. (2001) are based on whether the variables are I(0) or I(1). Hence, when conducting an F-test to investigate the existence of the cointegration relationship among the variables, these critical values may not be applicable if any of the variables has an integration order of two, I(2), or higher. For this reason, the unit root test is still necessary to confirm the integration order of the variables. Table 1 illustrates the results of the unit root test based on the augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) tests. From the table, it is evident that no variable is I(2). Although, in Hungary, the result illustrating that lny is I(1) is somewhat weak, based on the ADF and PP tests, when employing the Kwiatkowski-Phillips-Schmidt-Shin (KPSS) unit root test, the hypothesis that the first difference of lny is stationary can not be rejected, even at the 10% significance level for the model with the intercept. Therefore, it is reasonable to judge lny as I(1) in Hungary.

[Table 1 here]

Due to the fact that no variable is I(2) from the unit root tests, the F test suggested by Pesaran et al. (2001) is applicable for investigating the cointegration relationship among the variables. The F test results with maximum lags of one and two are reported in Table 2.[6] From Table 2, we find that the computed F statistics are above the criteria bounds suggested by Pesaran et al. (2001) in nine countries, at least in either case of the maximum lag order, suggesting evidence supporting the existence of the cointegration or long-run relationship among variables in these countries. In the other four countries, the results are mixed. In Denmark and Sweden, the computed F statistics lie between the criteria bounds, while in Austria and Belgium, they are below the criteria bounds. When facing this situation, the significance of the error correction (EC) term in the next step should be relied upon for examining the existence of the cointegration relationships (e.g., Kremers et al., 1992; Bahmani-Oskooee and Nasir, 2004). If the EC term is negative and smaller than unity in absolute value, we judge that there exists a cointegration or long-run relationship among the variables in consideration. In the cases of Austria, Belgium, and Demark, this condition is satisfied.

[Table 2 here]

As the next step, Equation (2) is estimated using the ARDL approach. We set the maximum lag order to two for our estimation.[7] Under this maximum lag setting, the ARDL model for each country is selected using the SBC. Table 3 presents the long-run estimation results. The estimated coefficients of the EC terms are also reported in Table 3. The third column of the table illustrates the selected ARDL model for each country.

[Table 3 here]

As can be seen in the table, except for the cases of Finland, Luxembourg, the Netherlands, and Sweden, the coefficients of the EC terms are significantly negative and smaller than unity in absolute values, implying the evidence supporting the existence of a cointegration relationship among variables in most countries. However, this does not assure that all variables are in the cointegration vector space. We need to verify the significance of the estimated coefficients of the variables in consideration in the long-run estimation results. Except for Finland, Iceland, Luxembourg, and Sweden, Table 3 illustrates that the estimated coefficients of the divorce rates, lnd, are statistically significant and have positive signs, as expected. These results imply that an increase in divorce rates leads to an increase in suicide rates in most countries in our study. For per capita real GDP, lny, except for Finland, France, Iceland, and Luxembourg, it is evident that an increase in per capita real GDP contributes to a reduction in suicide rates. The reduction effect of per capita real GDP on suicide for the case of Denmark is consistent with that of Andrés and Halicioglu (2010), who apply a similar approach, but use a different model specification. For fertility rates, lnf, whose effect on suicide can be negative or positive, our estimation confirms statistically significant results in five out of 13 countries.

[6]The maximum lag order is set to one and two to ensure a sufficient degree of freedom for the time series analysis, since the sample periods of the selected countries are quite small.

[7]We do not consider a lag order higher than this, since our sample sizes for estimation are quite small, given the number of variables.

More specifically, in the significance cases, an increase in fertility rates leads to a decrease in suicide in Austria, Denmark, Norway, and Switzerland, while it leads to an augmentation in suicide in the case of Finland. For per capital alcohol consumption, lna, the evidence showing its significant impact on suicide is fewer than other variables in consideration. We can confirm its positive effect, as expected, but only in three out of the 13 selected counties. The countries in which the estimated coefficient of per capita alcohol consumption is statistically significant include Austria, Belgium, and Switzerland. Finally, our results illustrate that the estimated coefficient of the constant term in each country is significantly positive in all countries, except France and Iceland, whose estimated coefficients are not significant. This finding supports the concept of natural suicide rates in most countries, which suggests that the suicide rates of a society could never be zero, even if both economic and social conditions were ideal from the point of view of suicide. These results are also consistent with that of Andrés and Halicioglu (2011), who conduct their study on the case of OECD countries.

To investigate the stability of the estimated models, we also conduct CUSUM and CUSUMSQ stability tests for each country in which the existence of a cointegration relationship is confirmed from the results of the EC term's estimated coefficients. Results of the CUSUM and CUSUMSQ tests are illustrated in Figure 1. The stability test results are also summarized in the last two columns of Table 3. As can be seen from the figure, our results support the stability of the estimated models since the plots of CUSUM and CUSUMSQ are within the critical bounds in all selected countries.

[Figure 1 here]

4 Conclusion

This paper examines the factors affecting suicide in 13 European OECD countries from a socio-economic perspective. The autoregressive distributed lag to cointegration is adopted as the estimation methodology. Furthermore, the stability tests, CUSUM (cumulative sum) and CUSUMSQ (CUSUM of squares), are applied to investigate the stability of the estimated models.

Our estimation results provide strong evidence that divorce rates and per capita real GDP have significantly increasing and reducing impacts on suicide, respectively, since their effects are confirmed in nine out of 13 selected countries. For fertility rates, the results show that its increase leads to a decrease in suicide rates in four countries and a rise in suicide rates in one country. As for per capita alcohol consumption, we obtain evidence supporting its significantly increasing effects only in three countries. Additionally, the CUSUM and CUSUMSQ tests provide us with evidence supporting the stability of the estimated models.

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Table 1: Results of unit root test

		ADF-test				PP-test			
		Level		First Difference		Level		First Difference	
	Sample	Intercept	Intercept and Trend	Intercept	Intercept and Trend	Intercept	Intercept and Trend	Intercept	Intercept and Trend
Austria	1960-2007								
ln$s$		0.5568	-0.4688	-7.7690***	-8.8540***	0.8331	-0.1472	-7.7204***	-8.9803***
ln$d$		-1.0233	-1.4861	-5.5605***	-5.5818***	-1.1811	-1.5604	-5.5744***	-8.3216***
ln$y$		-3.1069**	-1.6813	-6.2491***	-7.1293***	-3.1540**	-1.6815	-6.4463***	-7.1317***
ln$f$		-1.7682	-0.1928	-2.9151*	-5.7675***	-1.5432	-0.6152	-5.3207***	-5.7711***
ln$a$		-3.7971***	-3.2725*	-6.7149***	-7.8584***	-3.7140***	-3.9058**	-6.8133***	-7.8085***
Belgium	1960-1991								
ln$s$		-1.1185	-0.4563	-2.4776	-4.8523***	-1.2356	-1.0305	-4.9232***	-4.9637***
ln$d$		-0.6751	-0.9967	-4.7344***	-4.7468***	-0.6601	-1.4621	-4.7691***	-4.7695***
ln$y$		-3.4094**	-1.2869	-3.9417***	-4.9715***	-3.4094**	-1.2869	-3.8786***	-4.9715***
ln$f$		-0.9872	-0.5478	-4.3424***	-4.5216***	-0.9667	-1.0781	-4.3636***	-4.5216***
ln$a$		-1.9721	-0.0508	-1.2722	-3.5999**	-1.9317	0.3988	-5.7884***	-7.1217***
Denmark	1960-2006								
ln$s$		0.0817	-0.7936	-6.9028***	-7.9838***	0.0068	-0.7936	-6.9003***	-7.9838***
ln$d$		-1.7881	-1.0963	-5.3047***	-5.5115**	-1.7909	-1.3548	-5.3884***	-5.5189***
ln$y$		-2.6609*	-3.3860*	-6.3131***	-6.6698***	-2.7020*	-3.4253*	-6.3127***	-6.6860***
ln$f$		-1.9476	-1.0801	-4.1436***	-4.5874***	-1.8824	-0.8629	-4.1651***	-4.5967***
ln$a$		-3.4303**	-1.3152	-5.1633***	-6.0655***	-3.3295**	-1.3234	-5.3476***	-6.0549***
Finland	1960-1990								
ln$s$		-0.6231	-2.8174	-6.8710***	-6.8457***	-0.6231	-2.7632	-6.8710***	-6.8457***
ln$d$		-1.3496	-1.3309	-4.1522***	-4.1477**	-1.3207	-1.4992	-4.1971***	-4.1396**
ln$y$		-1.6643	-1.7961	-4.1423***	-4.2267**	-3.0734**	-1.7837	-3.8986***	-4.2766**
ln$f$		-2.2835	-1.0783	-2.9812**	-3.6820**	-2.1801	-0.5878	-3.0003**	-3.4288*
ln$a$		-1.8738	-0.9719	-4.6730***	-4.9424***	-1.7758	-1.1217	-4.7599***	-4.9542***

Table 1 (Continued): Results of unit root test

	Sample	ADF-test				PP-test			
		Level		First Difference		Level		First Difference	
		Intercept	Intercept and Trend	Intercept	Intercept and Trend	Intercept	Intercept and Trend	Intercept	Intercept and Trend
France	1970-2006								
ln$s$		-1.6313	-0.6704	-4.0843***	-4.8255***	-1.6308	-0.9075	-4.2281***	-4.9003***
ln$d$		-3.6909***	-2.4733	-5.9139***	-6.6643***	-4.2314***	-2.5318	-5.9871***	-6.6440***
ln$y$		-2.9107*	-3.1880	-4.3974***	-4.7123***	-2.9107*	-3.1442	-4.3694***	-4.6658***
ln$f$		-3.7954***	-2.8321	-3.1400**	-4.0330**	-2.8609*	-1.4606	-3.2232**	-3.9305**
ln$a$		0.2956	-3.9411**	-5.8403***	-5.8117***	0.5497	-3.9287**	-7.45100***	-7.3972***
Hungary	1970-2007								
ln$s$		0.8635	-1.8813	-6.2308***	-8.2329***	0.7722	-2.1274	-6.2407***	-8.4163***
ln$d$		-2.7539*	-2.8115	-7.1946***	-7.1261***	-2.6851*	-2.6913	-7.4802***	-7.4519***
ln$y$		-0.6972	-2.0335	-1.9882	-1.9767	-0.8946	-1.7922	-2.8605*	-2.7953
ln$f$		-0.3164	-3.2803*	-4.4675***	-4.4651***	-0.4542	-2.4053	-4.4675***	-4.4651***
ln$a$		-2.0278	-2.1719	-5.2689***	-5.4225***	-2.0749	-2.1640	-5.2725***	-5.3944***
Iceland	1961-2007								
ln$s$		-5.4585***	-5.5846***	-8.9075***	-8.8196***	-4.8868***	-4.9203***	-18.6566***	-18.8628***
ln$d$		-3.7004***	-0.7786	-11.7846***	-7.7624***	-2.2102	-1.2889	-11.3279***	-16.3495***
ln$y$		-1.6271	-2.5676	-4.5993***	-4.7153***	-2.0345	-2.3179	-4.3288***	-4.4152***
ln$f$		-2.1999	-1.1954	-5.2905***	-5.7169***	-2.1873	-1.2401	-5.2521***	-6.2771***
ln$a$		-1.3283	-3.0930	-6.9560***	-6.8589***	-1.3050	-3.0930	-7.4123***	-7.2737***
Luxembourg	1977-2003								
ln$s$		-4.4263***	-4.7023***	-5.5989***	-5.4772***	-4.1524***	-4.8159***	-10.1890***	-13.2500***
ln$d$		-2.3446	-3.3699*	-3.0353**	-3.0356	-2.5817	-3.6272**	-8.9158***	-8.8732***
ln$y$		-0.3733	-3.2557*	-3.2433**	-3.1408	-0.1186	-2.0227	-3.2867**	-3.1869
ln$f$		-1.3463	-1.5993	-6.0804***	-5.9748***	-1.3448	-1.7026	-5.9805***	-5.8854***
ln$a$		-2.1768	-3.4174*	-7.0650***	-6.9325***	-2.0514	-3.5350*	-7.2418***	-7.1325***

Table 1 (Continued): Results of unit root test

		ADF-test				PP-test			
		Level		First Difference		Level		First Difference	
	Sample	Intercept	Intercept and Trend	Intercept	Intercept and Trend	Intercept	Intercept and Trend	Intercept	Intercept and Trend
Netherlands	1963-2007								
ln$s$		-2.3662	-1.1125	-5.4397***	-6.1055***	-2.3831	-0.4985	-5.3111***	-9.8644***
ln$d$		-2.7839*	-1.4242	-3.7861***	-4.6459***	-3.0164**	-1.0448	-3.6958***	-4.6213***
ln$y$		-0.8056	-2.4721	-4.3204***	-4.2176***	-1.8494	-2.8548	-4.3683***	-4.2176***
ln$f$		-3.0577**	-1.9673	-2.9736**	-3.9573**	-2.8161*	-1.3034	-2.9736**	-3.8993**
ln$a$		-2.1337	-2.0105	-2.7935*	-2.8851	-3.6633***	-2.6998	-6.1460***	-7.5835***
Norway	1960-1997								
ln$s$		-1.8131	-0.7037	-6.6213***	-7.1696***	-1.8342	-0.4874	-6.5989***	-7.1696***
ln$d$		-1.3858	0.5914	-3.7712***	-4.0312**	-1.3298	-0.2266	-3.8261***	-3.9800**
ln$y$		-1.0116	-1.9946	-4.2983***	-4.1869**	-0.9497	-1.9707	-4.1197***	-3.9146**
ln$f$		-1.9320	-1.7063	-3.1119**	-3.4408*	-1.3169	-0.7740	-3.1779**	-3.4299*
ln$a$		-2.0530	-1.5671	-2.4043	-2.3705	-2.0311	-1.6169	-5.9370***	-6.0255***
Sweden	1960-2007								
ln$s$		-0.0593	-3.2169*	-8.4364***	-9.1208***	-0.0593	-2.627924	-8.4681***	-9.1591***
ln$d$		-1.9682	-1.4090	-5.7983***	-6.0023***	-1.9764	-1.4964	-5.7832***	-5.9684***
ln$y$		-0.7530	-2.6193	-4.0067***	-3.9470**	-1.4315	-2.7396	-3.9078***	-3.8494**
ln$f$		-2.4964	-2.5318	-3.1818**	-3.2528*	-1.8327	-1.7913	-3.2775**	-3.3203*
ln$a$		-2.3310	-2.5106	-5.2976***	-5.3262***	-2.7283*	-2.5007	-5.3617***	-5.3922***
Switzerland	1960-1994								
ln$s$		-1.2334	-1.2936	-7.0119***	-7.0431***	-1.1569	-1.2255	-6.9770***	-7.0369***
ln$d$		-0.5790	-1.6816	-3.7729***	-3.7033**	-0.3053	-1.6907	-3.7310***	-3.6566**
ln$y$		-2.6990*	-2.0037	-3.9557***	-4.1793**	-2.5448	-1.8493	-3.8696***	-3.9916**
ln$f$		-1.4447	-1.2182	-4.2078***	-4.2618**	-0.9108	-1.4062	-4.1710***	-4.2514**
ln$a$		-0.9026	-2.1309	-4.1371***	-4.6802***	-1.5636	-2.1597	-4.0701***	-4.8829***

Table 1 (Continued): Results of unit root test

		ADF-test				PP-test			
		Level		First Difference		Level		First Difference	
	Sample	Intercept	Intercept and Trend	Intercept	Intercept and Trend	Intercept	Intercept and Trend	Intercept	Intercept and Trend
United Kingdom	1970-1999								
ln$s$		-1.5436	-1.7882	-7.5478***	-7.5857***	-1.5235	-1.7088	-7.2884***	-7.5423***
ln$d$		-6.7354***	-5.7861***	-4.9124***	-5.7549***	-6.3585***	-5.8238***	-5.0652***	-5.9327***
ln$y$		-0.0540	-2.9879	-3.8076***	-3.7432**	-0.1092	-2.2306	-3.6486**	-3.5634*
ln$f$		-5.1692***	-5.2927***	-2.8233*	-3.0627	-3.6433**	-2.9965	-2.8233*	-3.1657
ln$a$		-3.4489**	-3.4891*	-4.4852***	-4.5248***	-3.8520***	-4.4391***	-4.4562***	-4.5013***

Notes:

1. Null hypothesis: non-stationary

2. The asterisks ***, **, and * indicate the rejection of null hypothesis at 1%, 5%, and 10% of significant levels, respectively.

Table 2: F-statistics of bound tests

Country	Sample	Maximum Lag = 1	Maximum Lag = 2
Austria	1960-2007	2.1450	2.0247
Belgium	1960-1991	0.9432	1.603
Denmark	1960-2006	3.3625^a	2.5832^a
Finland	1960-1990	1.2523	5.9162***
France	1970-2006	3.5511*	6.0560***
Hungary	1970-2007	4.8279***	3.1518^a
Iceland	1961-2007	6.9665***	2.0853
Luxembourg	1977-2003	3.9009**	2.7891^a
Netherlands	1963-2007	4.8990***	2.4815^a
Norway	1960-1997	3.6048*	2.0739
Sweden	1960-2007	2.5085^a	2.3949^a
Switzerland	1960-1994	5.1517***	3.6612*
United Kingdom	1970-1999	2.2169	3.5197*

Notes:
1. The asterisks ***, **, and * are 1%, 5%, and 10% of significance levels, respectively.
2. 10% CV [2.262, 3.367], 5% CV [2.649, 3.805], 1%CV [3.516, 4.781].
3. "^{a}" indicates the value lies between CV bands.

Table 3: Estimation results using ARDL approach

Dependent variable: ln$s$

Country	Sample	SBC-Based ARDL	Constant	ln$d$	ln$y$	ln$f$	ln$a$	EC_{t-1}	CUSUM	CUSUMSQ
Austria	1960-2007	ARDL(1,0,0,1,0)	21.3633***	0.9193***	-1.7908***	-1.1902***	0.6943***	-0.4355***	S	S
			(2.8956)	(0.3152)	(0.2466)	(0.2343)	(0.1949)	(0.1257)		
Belgium	1960-1991	ARDL(1,1,0,0,0)	14.9915***	1.0338***	-1.5661***	0.9120	2.0028***	-0.3894***	S	S
			(4.5828)	(0.3059)	(0.4896)	(0.7975)	(0.6309)	(0.1133)		
Denmark	1960-2006	ARDL(1,0,0,0,0)	20.9309***	1.0084*	-1.2582***	-1.8146***	-1.2091	-0.2638***	S	S
			(2.5953)	(0.5502)	(0.2695)	(0.4573)	(0.8183)	(0.0664)		
Finland	1960-1990	ARDL(0,0,0,0,1)	1.9061**	0.2087	0.1106	0.3815**	0.1807	-	-	-
			(0.8990)	(0.1219)	(0.0949)	(0.1829)	(0.1648)	-		
France	1970-2006	ARDL(1,0,0,0,1)	-1.6297	0.9769***	0.1251	0.2330	1.7348	-0.2088**	S	S
			(13.5115)	(0.2941)	(0.9943)	(0.4972)	(1.2997)	(0.0869)		
Hungary	1970-2007	ARDL(2,1,0,0,0)	14.9706***	1.9900**	-1.0726***	0.2225	0.4881	-0.2339**	S	S
			(4.3300)	(0.8189)	(0.3263)	(0.3015)	(0.5897)	(0.0844)		
Iceland	1961-2007	ARDL(2,0,0,0,0)	-1.5852	-0.3647	0.4591	-0.4607	-0.5565	-1.1299***	S	S
			(4.4906)	(0.2878)	(0.4673)	(0.5761)	(0.4665)	(0.2003)		
Luxembourg	1977-2003	ARDL(0,0,1,1,0)	9.5444**	0.2409	-0.4215	1.2328	-0.9266	-	-	-
			(4.2594)	(0.4267)	(0.3273)	(0.9252)	(0.9195)	-		
Netherlands	1963-2007	ARDL(1,0,0,0,0)	6.9445***	0.4628**	-0.3860***	0.0058	0.0066	-0.5685	S	S
			(1.4945)	(0.1844)	(0.1258)	(0.3840)	(0.2013)	(0.1543)		
Norway	1960-1997	ARDL(1,0,1,2,0)	8.7004***	0.5827***	-0.5144**	-0.4942**	0.3115	-0.6571***	S	S
			(2.2686)	(0.1840)	(0.2030)	(0.1943)	(0.2006)	(0.1235)		
Sweden	1960-2007	ARDL(2,0,1,0,0)	11.4988**	-0.2130	-1.0323**	-0.0199	0.5834	-0.1239	S	S
			(4.3614)	(0.5405)	(0.3987)	(0.6529)	(0.6903)	(0.0922)		
Switzerland	1960-1994	ARDL(1,2,0,0,0)	9.8275***	0.3962*	-0.7594***	-0.5763***	0.8067**	-0.7169***	S	S
			(2.4061)	(0.2071)	(0.2394)	(0.2025)	(0.3120)	(0.1428)		
United Kingdom	1970-1999	ARDL(1,0,0,0,0)	6.6625***	0.5126**	-0.6203*	0.2607	0.9219	-0.5122**	S	S
			(1.4509)	(0.1835)	(0.1733)	(0.3681)	(0.5603)	(0.1887)		

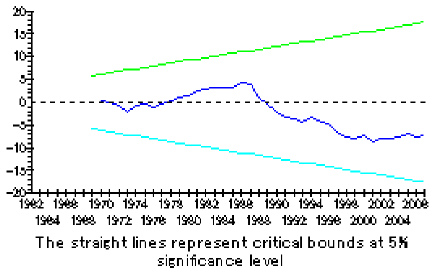
Notes:

1. The asterisks ***, **, and * are respectively the 1%, 5%, and 10% of the significance level, respectively.
2. The numbers in parentheses are standard errors.
3. "S" stands for stable.
4. ARDL(p,q,r,s) represents the ARDL model in which the variables take the lag length p, q, r, and s, respectively.

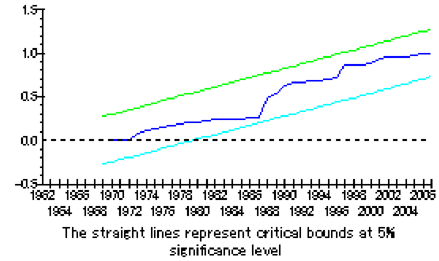
Figure 1: Plots of CUSUM and CUSUMSQ

Austria

Plot of CUSUM

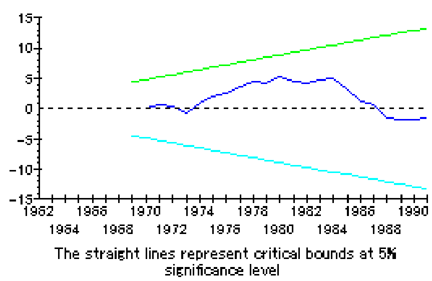


Plot of CUSUMSQ

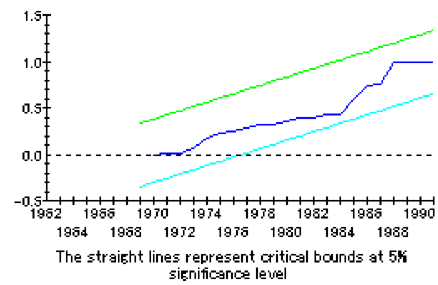


Belgium

Plot of CUSUM

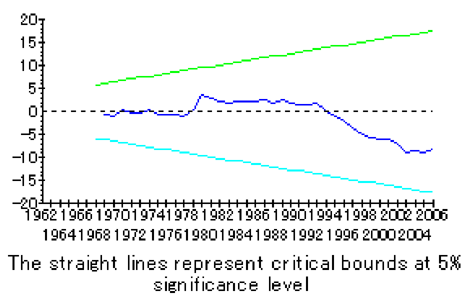


Plot of CUSUMSQ

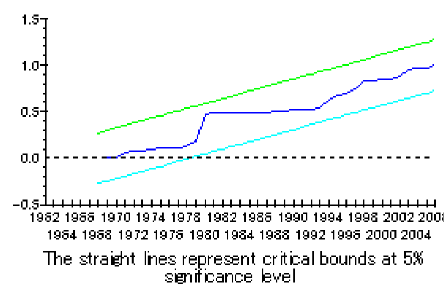


Denmark

Plot of CUSUM

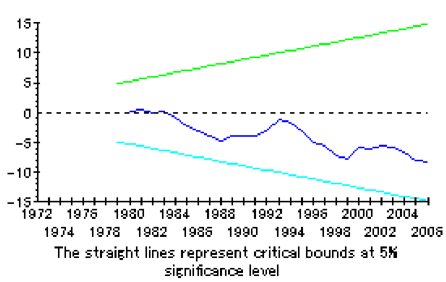


Plot of CUSUMSQ



France

Plot of CUSUM



Plot of CUSUMSQ

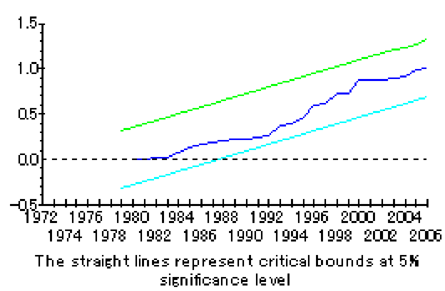
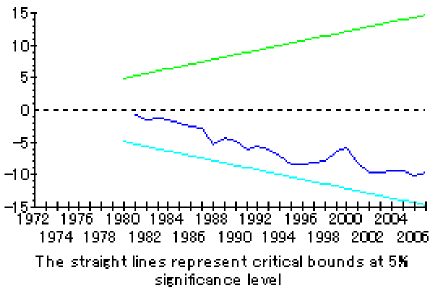


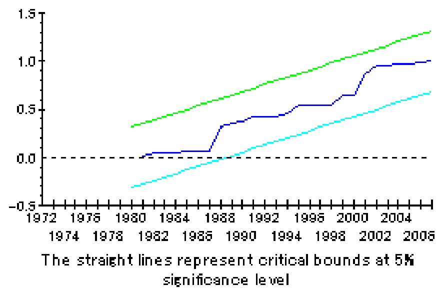
Figure 1 (Continued): Plots of CUSUM and CUSUMSQ

Hungary

Plot of CUSUM

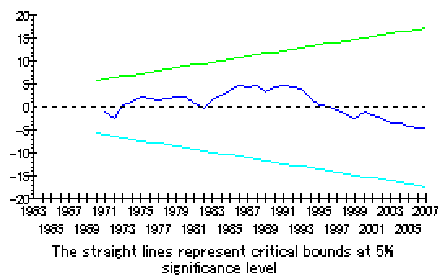


Plot of CUSUMSQ

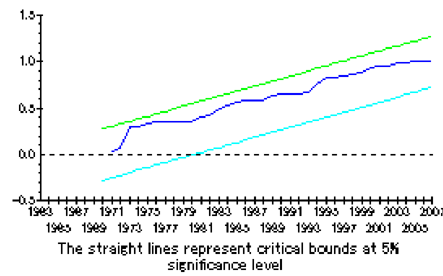


Iceland

Plot of CUSUM

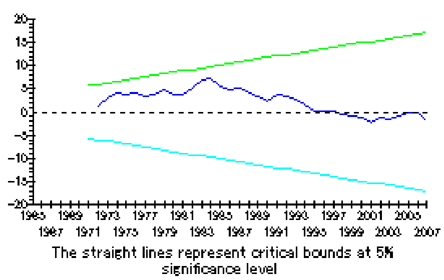


Plot of CUSUMSQ

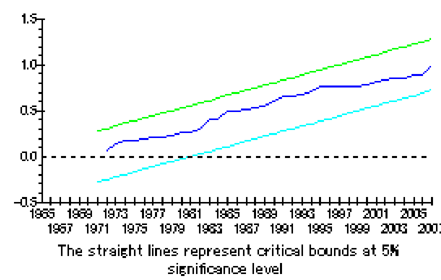


Netherlands

Plot of CUSUM

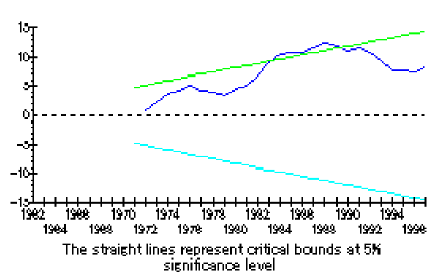


Plot of CUSUMSQ



Norway

Plot of CUSUM



Plot of CUSUMSQ

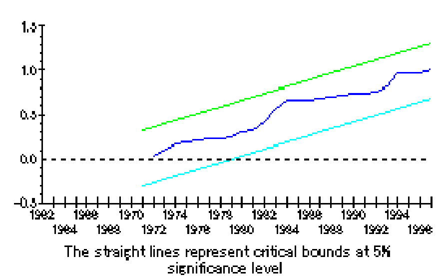
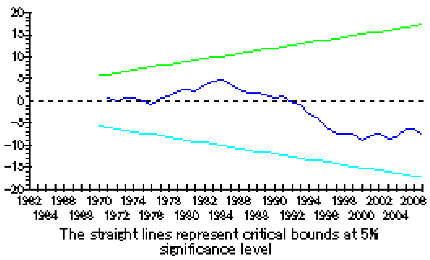


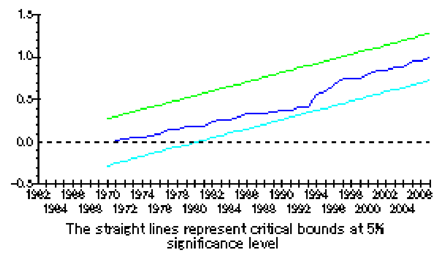
Figure 1 (Continued): Plots of CUSUM and CUSUMSQ

Sweden

Plot of CUSUM

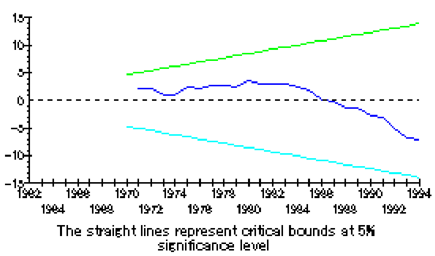


Plot of CUSUMSQ

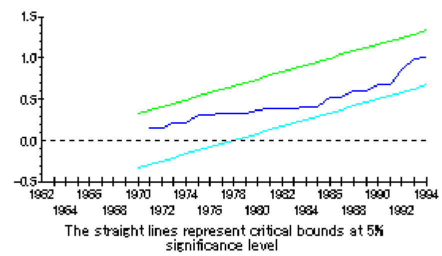


Switzerland

Plot of CUSUM

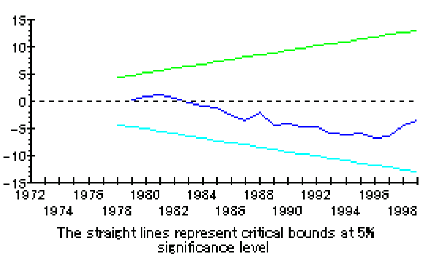


Plot of CUSUMSQ



United Kingdom

Plot of CUSUM



Plot of CUSUMSQ