1. ARE SUICIDE RATE FLUCTUATIONS TRANSITORY OR PERMANENT? PANEL KSS UNIT ROOT TEST WITH A FOURIER FUNCTION THROUGH THE SEQUENTIAL PANEL SELECTION METHOD

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Abstract

The purpose of this study is to examine whether suicide shocks are transitory or permanent in 23 OECD countries. The Panel KSS Unit Root Test with a Fourier Function through the Sequential Panel Selection Method (SPSM) that allow us to control for structural breaks and nonlinearity as well as cross-section dependency and heterogeneity is applied to test whether suicide rates across 23 OECD countries for the period from 1961 to 2006 are stationary. The SPSM classifies the whole panel into a group of stationary series and a group of non-stationary series that is very suitable to identify how many and which series in the panel are stationary processes. The empirical results from several conventional unit root tests indicate that the suicide rates for the OECD countries are non-stationary. Nevertheless, when the proposed panel unit root test is used to test for the unit root hypothesis of suicide rates, we find that the suicide rates are stationary in 7 out of the 23 OECD countries. Our results thereby point out the importance of the proper modelling of both structural breaks and nonlinearities to test for the unit root hypothesis of suicide rates. These findings also imply that suicide rates in these OECD countries are overall not transitory and the government should progressively intervene into unexpected shocks that would increase suicide rates for suicide prevention.

Keywords: suicide rates; sequential panel selection method; Panel KSS Unit Root Test; Fourier function; policy implications; OECD countries

JEL Classification: C22; C23

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1. Introduction

Whether suicide rates are characterized as stationary or non-stationary processes has several important economic and policy implications. First, if a series of suicide rates were characterized as an I(1) process, then the shocks affecting the series would have permanent effects, thus shifting suicide rates from one level to another. The random walk (non-stationary) property also implies that the volatility of suicide rates can grow without bound in the long run, which has consequences for social policy and regulation. In other words, if there were permanent effects from shocks to the suicide rates of a region, then the effects of a social policy should last longer. On the other hand, if shocks to the suicide rates are temporary, then suicide rates have short-lived effects. In this case, although the suicide rates temporarily deviate from the target, the government should not choose an unnecessary objective for its policy. Second, if suicide rates were stationary, then it is possible to forecast the series' future movements based on past behavior. Contrastingly, if the suicide rates were non-stationary, then one is unable to forecast suicide activities of the region. In fact, the stationarity of suicide rates might affect the prediction of suicide rates and its corresponding suicide prevention policy, which in turn affects the life expectancy and quality of life of society. Third, stationary properties of suicide rates series are of great importance for relative economic modeling. Nelson and Plosser (1982) pointed out that whether data are modeled as a stationary trend or as a different stationary process has important implications vis-à-vis modeling, testing, and forecasting. For instance, when testing for causality between suicide rates and other macroeconomics variables, a precondition is that both variables need to be integrals of order one (characterized by a random walk). For policy-makers and social professionals, Diebold and Kilian (2000) also propose that pre-testing for unit roots before applying forecasts yields superior forecasting performance, as opposed to the alternatives of always working with differential series or always working with level series. Therefore, it is important to check the stationarity of a series before proceeding to an analysis, because some useful properties in stationary series may exist only after taking differences (such as growth rate of suicide rates) into account (Lee *et al*., 2010).

Despite the important implications of stationarity, no consensus has been reached in the empirical literature on the issue of suicide rates series. It is believed that disadvantages exist in the econometric models of past studies (Chang and Chen, 2017; Chen *et al*., 2016; Lin and Chen, 2015). It has been reported that conventional unit root tests not only fail to consider information across regions, thereby leading to less efficient estimations, but also have lower power when compared with the near-unit-root but stationary alternatives. In order to increase the power of tests for a unit root, many researchers have employed panel data (Taylor and Sarno, 1998; Maddala and Wu, 1999; Levin *et al*. 2002; Im *et al*. 2003). However, panel tests are not informative in terms of the number of series that are stationary processes when the null hypothesis is rejected. The reason is simple: they are not joint tests of the null hypothesis. In this regards, Breuer *et al*. (2001) claimed that, by analogy to a simple regression, when an F-statistic rejects the null that a vector of coefficients is equal to zero, it is not necessarily true that each coefficient is nonzero. Likewise, when the unit-root null hypothesis is rejected, it may not be justified to assume that all series in the panel are stationary. In contrast to the panel-based unit root tests that are joint tests of a unit root for all members of a panel and that are incapable of determining the mix of I(0) and I(1) series in a panel setting, the Sequential Panel Selection Method (SPSM), proposed by Chortareas and Kapetanios (2009), classifies a whole panel into a group of stationary series and a group of non-stationary series. In doing so, it clearly identifies how many and which series in the panel are stationary processes.

In this paper, we test for the stationarity properties of the suicide rates collected from 23 OECD countries using the SPSM proposed by Chortareas and Kapetanios (2009). We believe that this is the first study in which SPSM tests have been used to test the stationarity hypothesis in suicide rates of 23 OECD countries. Application of nonlinear models in this study can be justified by an examination of the development of stable society across countries. This work considers the heterogeneity of economic development, socio-cultural factors, and other national circumstances. Hence, the development of stable society should vary for different income levels and different countries.

2. Data Description

The suicide rates of 23 OECD countries are retrieved from the OECD statistical database covering the period from 1961 to 2006. Table 1 presents the summary statistics of 23 OECD countries. In obvious, the maximum of the suicide rate is from Denmark with 33.90/100,000 population, and the minimum of the suicide rates among the 23 OECD countries belongs to Greece with only 2.80/100,000 population. In terms of the volatility of the suicide rates, Denmark behaves the most dramatic fluctuation due to the standard deviation 6.19/100,000 population. Besides, countries including Austria, Canada, Denmark, Finland, Ireland, Japan, Norway, Poland, Spain, Sweden and the United States have negatively skewed suicide rates. However, the rates of the rest countries show positive skewness. For the Kurtosis, the suicide rates of Australia, Greece, Iceland, Korea and the United Kingdom have leptokurtosis and fat-tails. The Jarque-Bera statistics says the suicide rates of France, Greece, Iceland, Korea, Spain and the United Kingdom are not subjected to normal distribution.

3. Methodology

Many macroeconomic variables and social indicators perform non-linearity and contain unit roots, which trouble researchers over a long period of time. Due to the low power of conventional unit root test including ADF test, PP test and KPSS test, these tests cannot detect the mean-reverting properties of the series employed. We focus on the existence of nonlinear behavior in suicide rates. Ucar and Omay (2009) proposed a nonlinear panel unit root test by combining the nonlinear framework in Kapetanios *et al.* (2003, KSS) with the panel unit root testing procedure of Im *et al.* (2003), which has been proved to be useful in testing the mean reversion of financial time series data. Therefore, the Sequential Panel Selection Method (SPSM) proposed by Chortareas and Kapetanios (2009), mixed with the Panel KSS unit root test with a Fourier function are used to test the stationarity of suicide rate in 23 OECD countries.

The nonlinear panel unit root test is similar to Kapetanios *et al.* (2003) test for an individual time-series variable in spirit. Following Ucar and Omay (2009) we begin with:

$$\Delta(suicide\ rate)_{i,t} = c_i + \alpha_i (suicide\ rate)^3_{i,t} + \sum_{j=1}^{k} \beta_{i,j} \Delta(suicide\ rate)_{i,t-j} + \varepsilon_{i,t} \qquad (1)$$

where: the null hypothesis is $H_0 : \alpha_i = 0$ for all *i* with linear non-stationarity and alternative hypothesis is $H_1 : \alpha_i \neq 0$ for some *i* with nonlinear stationarity. Perron (1989) argued that if there is a structural break, the power to reject a unit root decreases when the stationary alternative is true and the structural break is ignored. Meanwhile, ignoring structural changes present in the data generating process biases the analysis toward accepting the null hypothesis of a unit root. We then incorporate a Fourier function into equation (1):

$$\Delta(suicide\ rate)_{i,t} = c_i + \alpha_i (suicide\ rate)^3_{i,t} + \sum_{j=1}^{k} \beta_{i,j} \Delta(suicide\ rate)_{i,t-j} + a_{i,1}\sin(\frac{2\pi kt}{T}) + b_{i,1}\sin(\frac{2\pi kt}{T}) + \varepsilon_{i,t} \quad (2)$$

where: $t = 1,2,...,T$. For selecting *k* representing the frequency selected for the approximation in equation (2), $[a_i, b_i]'$ measures the amplitude and displacement of the frequency component. If there is a structural break, there is at least one frequency component to be presented.[4] To implement the Chortareas and Kapetanios (2009) SPSM procedure, the following steps should be achieved:

Step 1, equation (2) is first estimated for the entire panel. If the unit-root null is not rejected, we accept that series in the panel are nonstationary and move to step 2.

Step 2, remove the series with the minimum KSS statistic since it is identified as being stationary.

Step 3, return to step 1 for the remaining series, or stop the procedure if all the series are removed from the panel. Final result is a separation of the whole panel into a set of mean-reverting series and a set of non-stationary series.

Table 1

Summary Statistics of 23 OECD Countries*

Countries	Mean	Max.	Min.	Std. Dev.	Skew.	Kurt.	J.-B.
Australia	13.67	19.20	8.30	2.26	0.30	3.74	1.74
Austria	23.44	28.60	14.70	3.54	-0.66	2.66	3.57
Belgium	19.34	24.60	15.00	2.60	0.31	2.03	2.54
Canada	13.07	16.00	9.40	1.69	-0.26	2.16	1.88
Denmark	22.26	33.90	11.30	6.19	-0.31	2.05	2.45
Finland	24.96	30.20	18.30	2.67	-0.42	2.92	1.39
France	19.19	24.20	16.50	2.17	0.80	2.33	5.82*
Greece	3.67	5.20	2.80	0.47	0.69	3.90	5.22*
Iceland	13.43	24.20	6.60	3.77	0.90	3.46	6.61*
Ireland	7.76	13.70	2.10	3.68	-0.20	1.63	3.89
Italy	7.04	8.80	5.60	0.82	0.15	2.01	2.07
Japan	21.09	25.70	16.70	2.23	-0.54	2.65	2.47
Korea	13.50	29.90	8.40	5.56	1.87	5.38	37.64***
Luxembourg	16.01	23.20	10.50	2.88	0.45	2.82	1.62

[4] *Enders and Lee (2012) indicate that the frequency k should be determined by the minimization of the sum of squared residuals. They also show that no more than one or two frequencies should be used for the loss of power related to a large number of frequencies by Monte Carlo experiments.*

Countries	Mean	Max.	Min.	Std. Dev.	Skew.	Kurt.	J.-B.
Netherlands	10.22	13.50	7.90	1.28	0.43	3.00	1.45
New Zealand	12.84	15.50	10.40	1.37	0.24	2.14	1.86
Norway	11.95	17.30	7.30	2.66	-0.01	2.10	1.56
Poland	13.78	16.20	10.30	1.57	-0.51	2.35	2.81
Spain	6.74	8.40	4.80	1.20	-0.16	1.48	4.62*
Sweden	17.82	23.10	12.00	3.32	-0.35	1.84	3.53
Switzerland	21.26	26.40	16.50	2.76	0.13	2.10	1.67
United Kingdom	8.60	12.50	6.60	1.51	0.99	3.43	7.80**
United States	12.87	14.30	10.80	0.99	-0.64	2.28	4.11

*The sample period is spaned from 1961 to 2006.The figures indicate suicides per 100,000 population. * , **, and *** indicate significance at the 0.1, 0.05, and 0.01 levels, respectively.

4. Empirical Results and Policy Implications

4.1 Unit Root Tests

We firstly implement some univariate time series unit root tests including ADF, PP and KPSS test to examine the stationarity of suicide rates in 23 OECD countries. Table 2 reports the results of the three univariate unit root tests - the Augmented Dickey and Fuller (1981, ADF), the Phillips and Perron (1988, PP), and the Kwiatkowski *et al.* (1992, KPSS) tests. With considering the stationarity of suicide rates in levels, ADF and PP test support non-stationarity for all countries. The results of the KPSS test presenting the suicide rates are stationary for Canada, Finland, France, Iceland, Italy, Japan, Luxembourg, the Netherlands and Switzerland. What's more, the suicide rates for all nations in the first difference are stationary because all tests are in favor of the stationarity properties in the first difference of series. As we know, the univariate unit root always performs low efficient because they have low power when they are applied to a finite sample. Given that, panel unit root test could provide more faithful results.

Table 2

Unit Root Tests (ADF, PP and KPSS) for 23 OECD Countries*

Countries	Levels			First Difference		
	ADF	PP	KPSS	ADF	PP	KPSS
Australia	-0.102	-0.102	0.630**	-6.977***	-7.031***	0.231
Austria	1.297	1.858	0.532**	-7.204***	-7.193***	0.836
Belgium	-1.660	-1.737	0.352*	-6.859***	-6.858***	0.202
Canada	-1.633	-1.595	0.214	-5.414***	-7.092***	0.663
Denmark	0.383	0.214	0.473**	-6.318***	-6.345***	0.628
Finland	-0.964	-0.852	0.224	-4.887***	-8.316***	0.287
France	-1.099	-1.128	0.218	-4.969***	-5.188***	0.260
Greece	-2.287	-4.078	0.363*	-10.935***	-11.370***	0.118
Iceland	-5.021	-4.900	0.113	-9.109***	-21.798***	0.500
Ireland	-1.203	-1.023	0.772***	-9.316***	-9.788***	0.093

Countries	Levels			First Difference		
	ADF	PP	KPSS	ADF	PP	KPSS
Italy	-0.681	-0.922	0.222	-6.301***	-6.337***	0.361
Japan	-2.569	-2.717	0.165	-6.147***	-6.143***	0.132
Korea	0.354	0.354	0.459*	-5.171***	-5.166***	0.354
Luxembourg	-4.136	-4.085	0.235	-9.685***	-15.724***	0.500
Netherlands	-1.663	-1.657	0.223	-6.177***	-6.172***	0.261
New Zealand	-3.580	-3.483	0.559**	-11.154***	-13.660***	0.302
Norway	-2.085	-2.085	0.490**	-7.669***	-7.684***	0.452
Poland	-2.221	-2.277	0.798***	-5.376***	-7.527***	0.289
Spain	-0.878	-1.216	0.528**	-5.051***	-5.136***	0.169
Sweden	0.302	0.179	0.736***	-9.004***	-9.016***	0.417
Switzerland	0.026	-0.419	0.322	-9.557***	-9.485***	0.362
United Kingdom	-1.896	-1.245	0.719***	-7.629***	-7.514***	0.083
United States	-0.363	-0.363	0.710***	-6.681***	-6.705***	0.201

*[*]Testing statistics are reported. *, **, and *** denotes the significance levels at 10%, 5% and 1%, respectively.*

4.2 First-generation and Second-generation Panel Unit Root Tests

Tables 3 and 4 report the results for the first-generation and second-generation panel-based unit root tests for suicide rates. In Table 3, LLC test proposed by Levin *et al*. (2002) indicates non-stationary conclusions for suicide rates in all nations. In similar, results from IPS test (Im *et al*., 2003) and MW test (Maddala and Wu, 1999) also present non-stationarity conclusion for all series.

Table 3

First Generation Panel Unit Root Test (without Trend)*

Levin, Lin and Chu (2002)	t_{ρ}^{*}	$\hat{\rho}$	t_{ρ}^{*B}	t_{ρ}^{*C}	
	3.780 (1.00)	-0.047*** (0.00)	5.523 (1.00)	6.497 (1.00)	
Im, Pesaran and Shin (2003)	t_bar_{NT}	$W_{t,bar}$	$Z_{t,bar}$	$t\_bar_{NT}^{DF}$	$Z_{t,bar}^{DF}$
	1.286	1.293 (0.92)	1.284 (0.90)	-1.450	0.401 (0.656)
Maddala and Wu (1999)	P_{MW}	Z_{MW}			
	44.561 (0.533)	-0.150 (0.560)			

Testing statistics are reported. p values are displayed in parentheses. * represents significance at 1% level.*

Table 4 shows that four second-generation panel-based unit root tests yield different results. Based on Table 4, BN test (Bai and Ng, 2004), MP test (Moon and Perron, 2004) and Pesaran (2003) test cannot reject the null hypothesis of unit root, which indicates non-stationary conclusions for suicide rates in 23 OECD countries. But the results from Choi (2002) are different from other second-generation panel unit root test. Chang (2005) points out both the first and second-generation panel-based unit root tests are joint tests of a unit root for all members of a panel, and hence, are incapable of determining the mix of I(0) and

I(1) series in a panel setting. To identify how many areas, and which areas in the panel support the non-stationary process, we proceed to the SPSM procedure combined with the Panel KSS unit root test.

Table 4

Second Generation Panel Unit Root Test*

Bai and Ng (2004)	$Z_{\hat{e}}^{c}$	$P_{\hat{e}}^{c}$		
	-1.049 (0.853)	35.943 (0.857)		
Moon and Perron (2004)	t_a^*	t_b^*	t_a^{*B}	t_b^{*B}
	-0.039 (0.485)	-0.997 (0.159)	-0.038 (0.485)	-1.001 (0.158)
Choi (2002)	P_m	Z	L^*	
	4.168*** (0.000)	-1.565* (0.059)	-2.066** (0.019)	
Pesaran (2003)	$CIPS$	$CIPS^*$		
	-1.497 (0.100)	-1.497 (0.100)		

Testing statistics are reported. p values are displayed in parentheses. *, **, and * represents significance at 1%, 5%, and 10 level, respectively.*

4.3 Panel KSS Test with and without a Fourier Function

For the comparative purpose, we firstly implement panel KSS test without a Fourier function beforehand. Table 5 reports the results from the Panel KSS test without a Fourier function on suicide rates. Table 5 reports a sequence of the Panel KSS statistics with their bootstrap p-values on a reducing panel, the individual minimum KSS statistic, and the stationary series identified by this procedure for each value.[5] In obvious, the empirical results cannot reject the null hypothesis of unit root in suicide rates for suicide rates in 23 OECD countries. Next, we implement panel KSS unit root test with a Fourier function through the sequential panel selection. Table 6 reports the results of panel KSS test with a Fourier function on suicide rates. Firstly, the panel KSS unit root test is firstly to deal with the whole panel with the UO statistic -3.0248 significant at 1% level. After implementing the SPSM procedure, we find Greece is stationary with the minimum KSS value of -6.0739 among the panel. Greece is then removed from the panel and the Panel KSS unit root test is implemented again to the remaining countries. After that, we find that the Panel KSS unit root test still cannot be rejected the unit root null with a value of -2.8862 with a very small p-value 0.00, and Luxembourg is found to be stationary with the minimum KSS value of -5.9847 in the panel this time. Luximbourg is then removed from the panel and the Panel KSS unit root test is implemented again for the remaining set of series. The procedure is continued until the Panel KSS unit root test fails to reject the null hypothesis of unit root at the 10% significance level, and finally we find that this procedure stops at the eighth sequence with country Ireland. Thus, the SPSM procedure using the Panel KSS unit root test with a Fourier function provides strong evidence favoring the mean-reverting in suicide rates for Greece, Luxembourg, Iceland, New Zealand, the United Kingdom, Canada and Switzerland, i.e., the suicide rates in these nations are stationary. The empirical results from Table 5 and 6 shed

[5] *The 5000 replications of bootstrap simulations are employed to accurate the asymptotic p-values.*

light on the importance of considering the non-linearity and structural breaks when testing the stationarity of suicide rate in 23 OECD countries. In obvious, all of the series have structural breaks and trend all exhibit nonlinearity. The time-varying intercepts plotted by red line are also shown in Figure 1. Besides, the Fourier function seems reasonable to deal with the structural breaks.

Table 5

Results of Panel KSS Test without a Fourier Function on Suicide Rates*

Sequence	UO statistic	Min. KSS statistic	Series
1	-1.5325(0.26)	-4.8214	Iceland
2	-1.3830(0.39)	-4.1398	Luxembourg
3	-1.2517(0.61)	-3.9267	Ireland
4	-1.1180(0.68)	-2.7614	Poland
5	-1.03150(0.80)	-2.6419	Japan
6	-0.9420(0.88)	-2.6024	United Kingdom
7	-0.8443(0.90)	-2.3316	New Zealand
8	-0.7514(0.99)	-2.2418	Greece
9	-0.6520(0.95)	-2.0498	Norway
10	-0.5522(1.00)	-1.6513	Canada
11	-0.4676(1.00)	-1.6471	Belgium
12	-0.3693(0.98)	-1.6387	Netherlands
13	-0.2540(0.99)	-1.19	Spain
14	-0.1603(1.00)	-1.0979	France
15	-0.0562(1.00)	-0.9738	Finland
16	0.0585(0.99)	-0.6761	Italy
17	0.1635(0.99)	-0.5313	Australia
18	0.2793(1.00)	-0.3719	United States
19	0.4095(1.00)	0.0147	Switzerland
20	0.5082(1.00)	0.1829	Korea
21	0.6166(1.00)	0.3046	Denmark
22	0.7726(0.98)	0.3345	Sweden
23	1.2107(0.99)	1.2107	Austria

**Entry in parenthesis stands for the bootstrap p-value. The significance level is 10%. The maximum lag is set to be 8. The bootstrap replications are 5,000.*

Table 6

Results of Panel KSS Test with a Fourier Function on Suicide Rates*

Sequence	UO statistic	Min. KSS	Fourier(K)	Series
1	-3.0248(0.00)	-6.0739	1	Greece
2	-2.8862(0.00)	-5.9847	1	Luxembourg
3	-2.7386(0.00)	-5.8402	1	Iceland
4	-2.5835(0.00)	-5.7754	1	New Zealand
5	-2.4155(0.01)	-4.1174	1	United Kingdom
6	-2.3210(0.02)	-4.0775	4	Canada

Sequence	UO statistic	Min. KSS	Fourier(K)	Series
7	-2.2177(0.05)	-3.7933	1	Switzerland
8	-2.1192(0.11)	-3.6006	2	Ireland
9	-2.0204(0.27)	-3.3583	2	Poland
10	-1.9248(0.36)	-3.1771	1	Norway
11	-1.8285(0.40)	-3.0449	1	Denmark
12	-1.7272(0.49)	-2.9282	2	Japan
13	-1.6180(0.60)	-2.8906	1	Spain
14	-1.4907(0.63)	-2.5105	1	Italy
15	-1.3774(0.75)	-2.4285	1	Belgium
16	-1.2460(0.80)	-2.1899	1	France
17	-1.1112(0.86)	-2.1464	1	Finland
18	-0.9386(0.92)	-2.0127	1	Netherlands
19	-0.7238(0.99)	-1.9553	1	United States
20	-0.4159(0.99)	-1.3052	1	Korea
21	-0.1195(0.99)	-0.9033	1	Sweden
22	0.2724(1.00)	-0.6474	1	Austria
23	1.1922(1.00)	1.1922	1	Australia

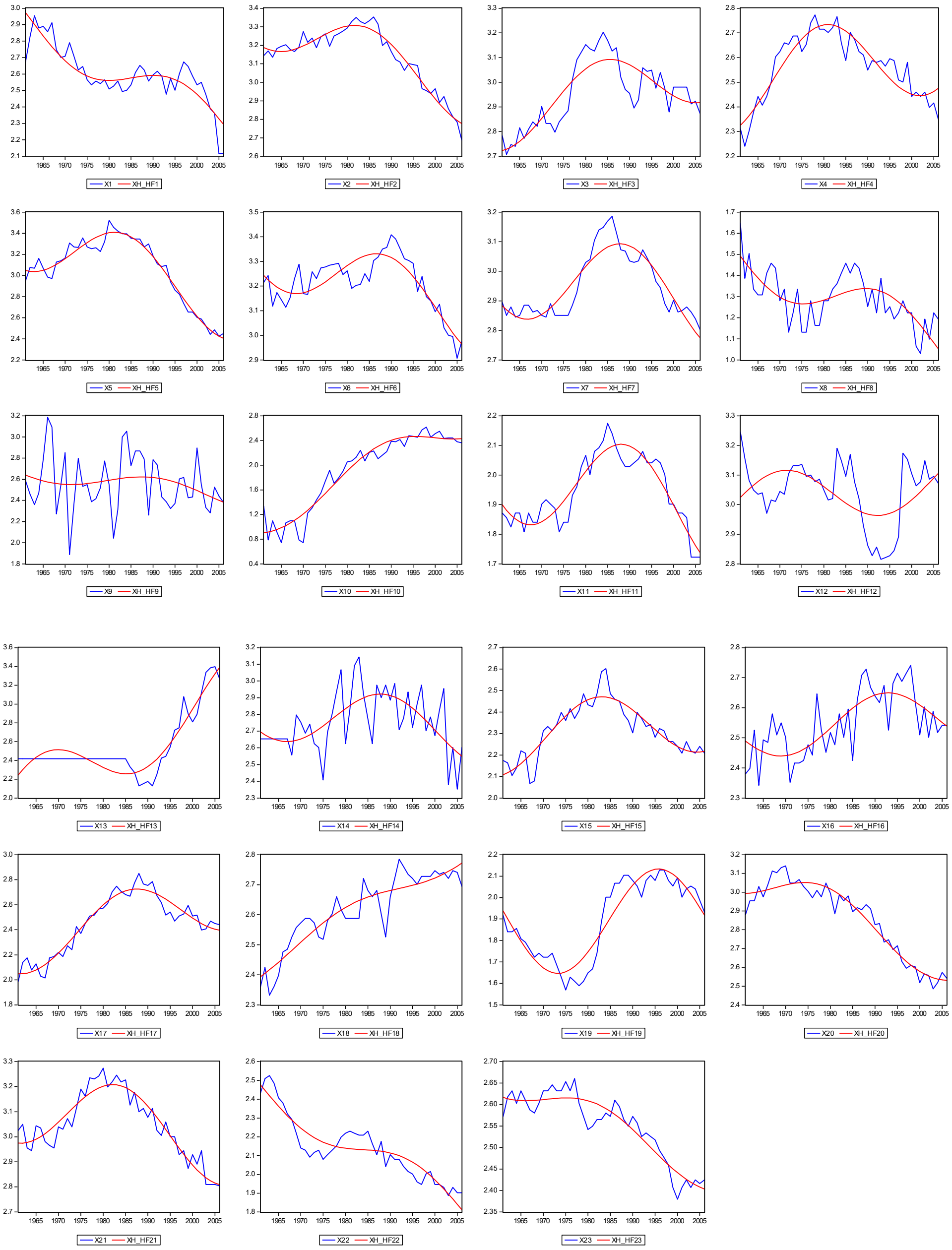
**Entry in parenthesis stands for the asymptotic p-value. The significance level is 10%. The maximum lag is set to be 8. The asymptotic p-values are computed by means of Bootstrap simulations using 5,000 replications. Fourier (K) is chosen by minimum sum square of residual for Fourier function.*

4.4 Policy Implications

Our empirical results have important policy implications for suicide prevention. First, the effect of the unexpected shocks on suicide rate is transitory for those countries with stationary suicide rate. It follows that any shock leads suicide rate to deviate from its long run equilibrium rate (defined as the natural suicide rate, see Viren, 1999) will eventually revert back to its long-run equilibrium without any further intervention. Second, for those countries with nonstationary suicide rate, the effect of the unexpected shocks on suicide rate is permanent. In this case, any unexpected shock will have permanent effect on suicide rate. Suicide rate deviating from its long run equilibrium will not return to its long-run equilibrium unless an effective intervention is taken to drive the suicide rate back to its long-run equilibrium. Third, the policymakers in the countries with nonstationary suicide rate need to be more concerned about those shocks that could affect suicide rates than those in the countries with stationary suicide rate.

Figure 1

Time Plots of Suicide Rates across 23 OECD Countries*



*Note: *The time-varying intercepts are plotted by red line.*

The most frequently mentioned shocks in the literature include the change of several influential determinants of suicide such as economic condition factors (including income status, income inequality, and unemployment), social status factors (including marital status, family status, and female labor participation), cultural factors (religion and education), and health behavior factors (including drug and alcohol usage) (See Milner *et al*., 2013; Chen *et al*., 2012; Chen *et al*. 2009). Thus, the surveillance system established for the suicide prevention should monitor the dynamic change of some socioeconomic indicators such as economic indicators (economic growth, unemployment, and GINI index), social indicators (marital, divorce, birth rates, and female labor participation rate), and prevalence of drug usage.

5 . Conclusion

This study implements panel KSS unit root test with considering both nonlinearity and structural breaks to investigate the stationarity of suicide rate in 23 OECD countries. The univariate unit root tests are employed beforehand, but find less persuasive empirical results due to the well-known low power. Then, the first-generation and second-generation panel unit root tests are used to further survey the stationarity of suicide rate. The first-generation test including LLC test (Levin, Lin and Chu, 2002), IPS test (Im, Pesaran and Shin, 2003) and MW test (Maddala and Wu, 1999) shows the suicide rates contains unit root. The second-generation unit root test such as BN test (Bai and Ng, 2004), MP test (Moon and Perron, 2004) and Pesaran (2003) test also present nonstationary conclusion, but the test proposed by Choi (2002) indicates the suicide rates are stationary. Next, panel KSS unit root test with considering both nonlinearity and structural breaks are again to revisit the stationarity of the suicide rates with a benchmark of without Fourier function. When considering the Fourier function, the suicide rates of Greece, Luxembourg, Iceland, New Zealand, the United Kingdom, Canada and Switzerland behave stationary. But the test without Fourier function presents nonstationary results for all suicide rates, which reveals necessity of employing nonlinearity and structural breaks.

The findings generated from this study have important policy implications for health authorities who intend to intervene into unexpected suicide shocks. The suicide rates in Greece, Luxembourg, Iceland, New Zealand, the United Kingdom, Canada and Switzerland have mean-reverting properties, so that there is no need to perform some progressive intervention schemes to moderate suicide fluctuations in the long-run. Nevertheless, for the rest of the OECD nations included in this study, the unexpected shocks would permanently make impacts on suicide rates in the long-run. Thus, the governments in these countries should establish a thorough surveillance system monitoring dynamic change of important socioeconomic indicators in order to effectively moderate the possible increase of suicide rates due to some unexpected shocks beforehand.

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