Does unemployment aggravate suicide rates in South Africa? Some empirical evidence

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DOES UNEMPLOYMENT AGGRAVATE SUICIDE RATES IN SOUTH AFRICA? SOME EMPIRICAL EVIDENCE

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ABSTRACT: Our study investigates the cointegration relationship between suicides and unemployment in South Africa using annual data collected between 1996 and 2015 applied to the ARDL model. Furthermore, our empirical analysis is gender and age specific in the sense that the suicide data is disintegrated into different 'sex' and 'age' demographics. Our empirical results indicate that unemployment is insignificantly related with suicide rates with the exception for citizens above 75 years. On the other hand, other control variables such as per capita GDP, inflation and divorce appear to be more significantly related with suicides. Collectively, these findings have important implications for policymakers.

Keywords: Unemployment; Suicide; Cointegration; Causality; South Africa; Sub Saharan Africa (SSA).

JEL Classification Code: C22; C51; E24; E31; E71.

1 INTRODUCTION

The economics of suicide has been the subject of immense contention following the seminal contributions of Morselli (1882), Durkheims (1897), Ginsberg (1967) and Hamermesh and Soss (1974). A crude generalization in the literature is that suicide rates tend to rise mainly during periods of social change and in times of economic depression. Since the early 1990's most deaths by suicide have been primarily amongst the economically inactive individuals thus implying that the social costs of unemployment may be higher than previously thought and should therefore not be undermined or taken for granted by policymakers. In terms of business cycle trends, a number of academics have forewarned that the correlation between suicide rates and unemployment is more prominent during economic crisis; such as during the great depression of the 1930's (Platt (1984), Morrell et. al. (1993) and Granados and Roux (2009)), during the Soviet Union crisis of 1990 (Notzon et. al. (1998), Gavrilova et. al. (2000), Brainerd (2001) and Shkolnikov et. al. (2001)) and during the Asian crisis of 1998 (Kim et. al. (2004), Khang et. al. (2005) and Chang et al. (2009)). Consequentially, it is widely believed that the social costs associated with unemployment, such as lower income, lower levels of life satisfaction and higher levels of depression, which significantly contribute to suicide or serious intentions to commit suicide, are exacerbated during recessionary periods caused by economic crisis.

The advent of the 2009 global recession period has re-kindled the debate concerning the relationship between unemployment and suicides. Being rooted in the 2008 US banking crisis, the global recession period, which is dubbed as the worst and deepest recessionary period since the Great Depression, caused a global economic meltdown which eventually lowered global economic growth rates and increased unemployment rates worldwide more extensively so for Western and European economies. It is estimated that the economic downturn resulted in a subsequent loss of approximately 34 million jobs worldwide (Chang et. al. (2013) and Oyesanya et. al. (2015)) and an additional 10 000 estimated economic suicides occurring between 2008 and 2010 in Europe and North American countries alone (Reeves et. al., 2014). Currently, there exists a considerable amount of empirical research conducted on the

unemployment-suicide correlation in light of the most recent global recession period, with a majority of case studies being investigated for Western and Asian economies (Chen et. al. (2012), Defina and Hannon (2015), Norstrom and Gronqvist (2015), Oyesanya et. al. (2015) and Berg (2016)) and virtually no studies have been conducted for developing countries and in particularly Sub Saharan African (SSA) countries. This is indeed surprising as well as thought-provoking since SSA countries are historically characterized by high unemployment rates, high levels of poverty and low lifetime income levels, all which are contributory factors towards high suicide rates. Consequentially, this arouses a sense of urgency to know about the empirical relationship between unemployment and suicide rates in SSA countries.

In our study, we investigate the suicide-unemployment relationship for the South African economy which is currently deemed as the most developed economy in the SSA region, in terms of financial, economic and governance standards yet the country is characterized by what is popularly termed a jobless growth economy which has left youth unemployment as one of the highest worldwide (Phiri, 2014). In differing from previous South African studies which have focused exclusively on the socioeconomic effects of suicide (i.e. Burrows et. al. (2003) Burrows and LaFlamme (2005, 2006), Mars et. al. (2014), Stein et. al. (2008) and Botha (2012)), we investigate the relationship between suicide and unemployment using national level aggregated suicide data. Previous studies have focused on provincial or district level suicide data, thus limiting the interpretation of empirical results to specific geographical areas in South Africa. Touching on the cumbersome issue of data availability, Botha (2012) has previously mentioned that the availability of national suicide statistics has been particularly problematic for African economies hence hindering possible research endeavours on the subject matter for these countries. However, recent data released by the World Health Organization (WHO) has made it possible to gather suicide statistics on a national level for periods corresponding to the post-democratic era (i.e. 1996 to 2014). By taking a national outlook on the subject matter we offer an opportunity for public policymakers to gain some useful policy insights from a national viewpoint.

Methodologically, a number of recent studies have considered the use of cointegration frameworks to analyse the long-run steady state relationship between suicide and unemployment (Inagaki (2010), Jalles and Anderson (2014) and Chang and Chen (2017). The use of cointegration analysis in establishing an empirical relationship between suicide and unemployment is important since a number of studies have revealed unit root behaviour in time series data for unemployment (Romero-Avila and Usabiage (2007) and Phiri (2014)) and for suicide data (Alptekin et.al. (2010), Ceccherini-Nelli and Priebe (2011), Jalles and Anderson (2014), Lester et. al. (2015), and Chen et. al. (2016)). This would imply that cointegration techniques need to be applied in order to model meaningful long-run relationship using common stochastic trends found in the time series variables. Conversely, the absence of cointegration relations between the time series would imply that any estimated regression between suicide and unemployment can be regarded as being spurious in terms of violating certain/crucial statistical inferences (Inagaki, 2010). Again this would mean that the bulk majority of previous studies which have employed time series estimation techniques without considering the integration properties of individual time series are at a high risk of having obtained spurious results (i.e. Platt (1984), Crombie (1990), Pritchard (1990), Yang et. al. (1992), Platt et. al. (1992) and Morrell et. al. (1993) just to mention a few case studies).

In our study, we make use of the autoregressive distributive lag (ARDL) model of Pesaran et. al. (2001) in modelling the long-run and short-run relations between annual suicide and unemployment time series data collected between 1996 and 2015. Unlike other cointegration framework such as the Engle and Granger (1987) two-stage procedure or Johansen's (1991) multivariate framework, the ARDL model does not require the time series variables to be mutually integrated of order I(1) as a prerequisite for modelling cointegration effects. Furthermore, the ARDL model performs exceptionally well even when using small sample sizes. This later point is particularly important with regards to our empirical study considering that we use annual data collected between 1996 and 2015 which virtual leaves us with a small number of observations to work with. Moreover, the two-stage ARDL modelling procedure effectively corrects for any possible endogeneity in the explanatory variables (Chirwa and Odhiambo, 2017).

Against this background the rest of the study is formulated as follows. The next section of the paper present an overview of suicides in South Africa whereas the third section of the paper presents the review of the international literature. The empirical framework used in our analysis is outlined in the fourth section of paper whereas the empirical results of the paper are presented in the fifth section of the paper. The paper is concluded in the form of policy recommendations and avenues for future research in the sixth section of the manuscript.

2 AN OVERVIEW OF SUICIDE IN SOUTH AFRICA

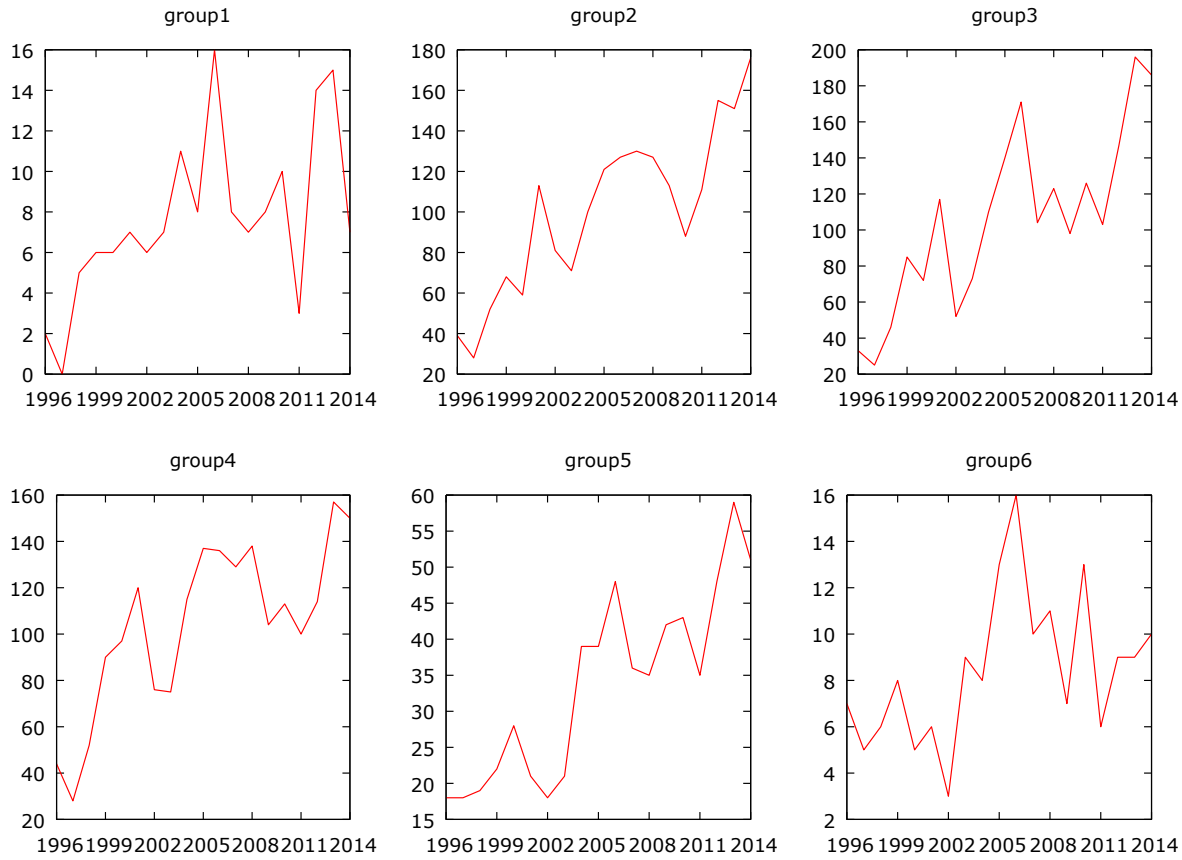
Historically, long-term data for complete suicide, attempted suicide and parasuicide in South Africa has been scarce. Reasons for this include statistical record keeping on injury and death during the apartheid years, especially for the black population; changes to the Birth and Death Registrations Act of 1992 which allow for the omission of the specific manner of death from death certificate records; and until recently, a lack of systematic national data collection (Favara, 2013). Currently, national epidemiological data on suicide mortality are not collected frequently/routinely following the Act No. 51 of 1992, government 'vital statistics' precluded entry of manner and mechanism of death of injury fatalities and, as of 1991, no distinction is made between different races (Burrows et al, 2003).

Fortunately, new statistical data on total number of suicides in South Africa has been recently published in the WHO mortality database. The current database consists of annual observations of suicides for sex and age demographics from 1996 to 2014. For the 'sex' demographics, the time series plot for the total number of suicides for males and females are presented in Figure 1 whereas the total number of suicides for the six age groups/demographic (5-14, 15-24, 25-34, 35-54, 55-74 and 75 and above) are plotted in Figure 2.

Figure 1: Suicides according to 'sex' demographics

With the exception of the year 1996, male suicides have historically been higher than females for all remaining annual observations. In terms of co-movement, male and female suicides moved together during the periods of 1997-1999 (rising), 1999-2000 (falling), 2000-2001 (rising), 2001-2002 (falling), 2002-2005 (rising), 2008-2009 (falling), 2009-2010 (rising), 2010-2011 (falling), 2011-2013 (rising) and 2013-2014 (falling). Between 2005 and 2008, total suicides between males and females moved in opposite directions. In particular, between 2005 and 2006 as well as between 2007 and 2008, male suicides were rising whilst figures for female suicides were falling. Conversely, between 2007 and 2008, female suicide numbers were rising whilst those for males were falling. Also note from Figure 1 that both males and females experienced historic low suicides in 1997 whilst mutually experiencing historic highs in 2013.

Figure 2: Suicides according to 'age' demographics



Notes: Age groups are as follows: group1 (5-14 years), group 2(15-24 years), group 3(25-34 years), group 4(35-55 years), group 5 (55-74 years) and group 6 (75 and above).

Suicide in the different age groups tend to have moved more-or-less together from 1996 to 2015. For instance, between 1996 and 2001, suicides were steadily rising. Suicides momentarily declined in all age groups between 2001 and 2002 whereas from 2003 suicides began to rise again, this time reaching record highs for '5-14', '75 and above' age groups between 2005 and 2006. Suicides in most age groups then temporarily dropped in the 2006 to 2007 period, and since the global financial crisis of 2007-2008, suicides have been more-or-less rising , this time reaching record highs for the '15-24', '25-34', '35-55' and '55-74' age groups. The only exception pertains to the youngest age group of '5-14' years which has shown a declining trend in suicides since 2013.

2.1 What else is known about suicide in South Africa?

In retrospective, suicides in South Africa vary across different races and genders and their causes can be further attributed to a number of factors. Moreover, there are various methods that have been identified for committing suicide. This sub-section uses a host of previous South African literature (Burrows et. al. (2003), Flisher et al. (2004), Burrows and Laflamme (2005), Joe et. al. (2008), Stark et al. (2010), Niehaus (2012), Botha (2012), Vawda (2014) and Naidoo and Schlebusch (2014)) to further probe into suicide tendencies in South Africa.

2.1.1 Racial and sex classifications

There exists an abundance of previous empirical evidence for South Africa depicting that there are more suicides amongst the white population in comparison to blacks from a racial perspective and there exist more male suicides in comparison to female suicides from a sex perspective (Burrows et. al. (2003), Flisher et al. (2004), Burrows and Laflamme (2005), Joe et. al. (2008), Stark et al. (2010), Niehaus (2012), Botha (2012), Favara (2013), Naidoo and Schlebusch (2014)). Even amongst the youth, South African males committed more suicides than their female counterparts. Despite South African females being less susceptible to commit suicides in comparison to South African males, Joe et al. (2008) report/argue that females are more prevalent to suicide behaviour even though this behaviour is usually non-fatal. In a more extended study, Joe et. al. (2008) further argue that coloureds are more likely to commit suicide compared to other racial groups. Nevertheless, in Durbin Muslim communities coloureds were least likely to commit suicide (Naidoo, 2014).

2.1.2 Causes of suicides in South Africa

In urban areas Burrows et. al. (2003) contend that suicides were mainly attributed to socioeconomic circumstances, economic need and matrimony problems. Joe et. al. (2008) further argue that poor male individuals in urban areas who fail to find unemployment to

provide a descent dwelling and basic family needs, were most like to commit suicides in urban areas, especially amongst men who are socially viewed as family breadwinners. From a more psychology perspective, Joe et. al. (2008) note that suicides can also be attributed to anxiety, moods, impulse control and substance abuse.

Females with low education or/and no formal education were the most vulnerable females to commit suicides in urban areas (Joe et. al., 2008). According to Meel (2003) impulse responses to alcohol and also depression caused by HIV due to isolation, discrimination, the inability to conduct daily duties as well as the awareness of extreme physical changes caused by the virus, are common cause of suicide in semi-urban areas. In rural areas, Niehaus (2012) discovered that female victims of abuse were most vulnerable towards suicide attempts whilst males who thought of themselves as failures in providing for their families were more prone to committing suicides in rural areas. Furthermore, females protesting against subordination as well as males who were unable to bear children or who were physically and/or emotionally abused by step-parents were also inclined towards suicidal behaviour in rural areas (Niehaus, 2012).

From a more aggregated socio-economic perspective, Vawda (2014) note that high rates of violence and trauma, unrealized personal outcome expectations following transformation and liberation from oppression, acculturation and socio-economic difficulties, including high unemployment in South Africa, also contribute to high suicide ideation. Finally, Mathews et al. (2008) unravel an interesting phenomenon dubbed as 'intimate-femicide suicide' whereby a female is killed by her lover (boyfriend or husband or same-sex partner) or former-lover or a rejected unrequited lover and shortly afterwards the 'killer' turns to kill themselves. This form of suicide was found to be most prevalent amongst white male individuals residing in urban areas.

2.1.3 Methods of suicide

A number of methods are reportedly used when individuals decide to commit suicide within South African communities. The most commonly methods have been conveniently summarized below.

- Hanging (Meel (2003), Burrows (2005), Burrows and LaFlamme (2005), Mathews et. al. (2008), Naidoo and Schlebusch (2014)).
- Shooting (Mathews et. al. (2008), Niehaus (2012), Naidoo and Schlebusch (2014)).
- Jumping from heights (Burrows (2005), Naidoo and Schlebusch (2014)).
- Drug overdose (Naidoo and Schlebusch (2014)).
- Burning (Burrows (2005), Niehaus (2012)).
- Ingestion of harmful substances such as paraffin, methylated spirits, shampoo, pesticides, detergents, battery acid, glass and medicine (Mhlongo and Peltzer (1999) and Favara (2013)).

3 REVIEW OF INTERNATIONAL EMPIRICAL STUDIES

From an international perspective, the literature on the suicide-unemployment relationship has gone through various stages of development which have been primarily facilitated by methodological advancement of analytical techniques. Having conducted a thorough or an extensive review of the international literature, we strongly believe that the previous literature can be conveniently classified into three strands of empirical literature. The first group of these studies are the research works which examine the aggregated suicides for entire populations (Boor (1980) for 9 highly advanced economies; Pritchard (1990) for 23 advanced countries; Yang et al. (1992) for the US and Japan; Weyerer and Wiedenmann (1995) for Germany, Gerdtham and Johannesson (2003) for Sweden; Fernquist (2007) for 8 European countries; Alptekin et al. (2010) for Turkey; Inagaki (2010) for Japan; Tsai and Cho (2011) for Taiwan; and Hunag and Ho (2011) for Japan and South Korea). Whereas a majority of these works (i.e. Yang et al. (1992); Weyerer and Wiedenmann (1995); Gerdtham and Johannesson (2003); Fernquist (2007); Alptekin et al. (2010); Inagaki (2010); Tsai and Cho (2011) and Hunag and Ho (2011)) advocate for a positive suicide-unemployment correlation, conversely

the studies of Boor (1980) and Pritchard (1990) establish inconclusive results in the sense of finding a combination of positive and negative relationship for different countries in their analysis.

The second strand of empirical studies are those which examine the suicide-unemployment relationship for males and females (gender-specific) in various populations. Belonging to this cluster of studies include the works of Stack and Haas (1984) for the US; Crombie (1990) for 16 developed countries; Platt et al. (1992) for Italy; Morrell et al, (1993) for Australia; Chuang and Huang (1997) for 23 Taiwanese regions; Hintikka et al. (1999) for Finland; Preti and Miotti (1999) for Italy; Neumayer (2004) for Germany; Lucey et al. (2005) for Ireland; Lin (2006) for 8 Asian countries; Noh (2009) for 24 OECD counties; Andres and Halicioglu (2010) for Denmark; Corcoran and Arensman (2010) for Ireland; Chang et al. (2010) for Taiwan; Kuroki (2010) for Japan; Wu and Cheng (2010) for the US; Ceccherini-Nelli and Priebe (2011) for France, Italy, the UK and the US; Milner et al. (2012) for 35 mixed countries and Jalles and Anderson (2014) for 10 Canadian provinces. These studies can be further sub-divided into three sub-categories. The first sub-group of these studies finds a positive suicide-unemployment correlation for both males and females (Stack and Haas (1984); Chuang and Huang (1997); Preti and Miotti (1999); Lin (2006); Noh (2009); Andres and Halicioglu (2010); Corcoran and Arensman (2010); Chang et al. (2010); Kuroki (2010); Wu and Cheng (2010); Ceccherini-Nelli and Priebe (2011). The second and yet smaller sub-group of studies establishes a positive suicide-unemployment relationship for males and no significant relationship for females (i.e. Platt et al. (1992); Morrell et al. (1993); Milner et al. (2012) and Jalles and Anderson (2014)). The third sub-group either finds a positive relationship for males and negative relationship for females (i.e. Crombie (1990) and Neumayer (2004)) or establishes no significant relationship for both males and females (i.e. Hintikka et al. (1999) and Lucey et al. (2005))

The last cluster of studies found in the literature are those which investigate the suicide-unemployment relationship within various age groups (i.e. Ruhm (2000) for the US; Andres (2005) for 15 European countries; Berk et al. (2006) for Australia; Maag (2008) for 28 OECD

countries; Kuroki (201) for Japan; and Walsh and Walsh (2011) for Ireland) and these studies tend to provide a wide range of conflicting empirical evidences. For instance Ruhm (2000) and Kuroki (2010) find a positive suicide-unemployment relationship across all examined age-groups. On the other hand, Andres (2005) find positive relationship only for males in '45-64' age group; Berk et al. (2006) find a positive relationship for all age groups except for males in '35-49' age group and '0-19' for females whereas the relationship turs insignificant. Moreover, Maag (2008) finds no significant relationship with the exception of females in the '15-24' age group where the relationship is significantly negative; whilst Walsh and Walsh (2011) establish a positive suicide-unemployment relationship for males in the '25-34' and '55-64' age groups and females in the '15-24' age group. Collectively, a comprehensive summary of these reviewed international studies is conveniently provided in Table 1 located at the Appendix of the manuscript.

4 EMPIRICAL FRAMEWORK

4.1 Model specification

Following the recent influential works of Huikari and Korhonen (2016) and Chang and Chen (2017), we specify our baseline empirical unemployment-suicide relationship as the following long run regression function:

$$SR = f(unemp, gdp.capita, inf, divorce, urban) \quad (1)$$

Where *SR* are the suicide rate which is further segregated into nine categories, namely; i) total number of suicides (i.e. *total*) ii) total number of male suicides (*male*) iii) total number of female suicides (i.e. *female*) iv) total suicides for age group 5-14 (i.e. *5-14*) v) total suicides for age group 15-24 years (i.e. *15-24*) vi) total suicides for age group 25-34 years (i.e. *25-34*) vii) total suicides for age group 35-54 years (i.e. *35-54*) viii) total suicides for age group 55-74 years (i.e. *55-74*) ix) total suicides for age group 75 years and above (i.e. *75+*).

The unemployment rate (i.e. *unemp*) represents the main explanatory variable in our study and, based on the findings of the general empirical literature, is hypothesized to have a positive effect on committed suicides as well as being more closely related to suicide than other economic variables (Chang et al., 2013). In particular, it is highly esteemed that the emotionally destructive consequences of unemployment, especially those associated with a loss of income, leads to higher suicide risk (Wu and Cheng, 2010). The other control variables used in regression (1) are the per capita GDP (i.e. *gdp.capita*), the inflation rate (i.e. *inf*), the number of divorces (i.e. *divorces*) and the rate of urbanization (i.e. *urban*).

The GDP per capita is a convenient measure of standard of living which is more of an accurate measure of economic welfare in comparison to GDP rates and hence lower GDP per capita rates are considered more of a contributing factor to suicide rates (Noh (2009), Chang et al. (2010), Chang et al. (2013)). Inflation is another economic variable which is included in our empirical regression. As argued by Botha, rising levels of inflation in South Africa are associated with economic upswings whereas falling inflation rates are associated with economic downswings. Therefore, in the spirit of Botha (2012), our study we include the inflation rates as a proxy for economic fluctuations.

Divorce is commonly viewed as an important factor of suicide (Chang et al. (2009), Chen et al. (2010), Botha (2012) and Chang and Chen (2017)). In particular, Chang and Chen (2017) argue that divorce exerts a positive effect on suicide via two effects, namely; i) the egotistic suicide effect which argues that divorces reduces social integration and connection with families and ii) the anomic suicide effect which contends that divorces increases stress associated with social regulation and the burden of care for families. Urbanization is the last control variable that is included in our empirical regression, and has been selected as a control variable since it is widely believed that the more urbanized an area is the more susceptible to increased committed suicides (Noh (2009) and Botha (2012)).

4.2 ARDL modelling procedure

In our study, we use the ARDL bounds testing approach to cointegration as developed by Pesaran et al. (2001). The ARDL representation of the empirical model represented in equation (1) can be specified as follows:

$$\Delta InSR_t = \delta_0 + \sum_{i=1}^{p} \delta_{1i}\, \Delta InSR_{t-i} + \sum_{i=1}^{p} \delta_{2i}\, \Delta InUNEMP_{t-i} + \sum_{i=1}^{p} \delta_{3i}\, \Delta InGDP.CAPITA_{t-i} + \sum_{i=1}^{p} \delta_{4i}\, \Delta InINF_{t-i} + \sum_{i=1}^{p} \delta_{5i}\, \Delta InDIVORCE_{t-i} + \sum_{i=1}^{p} \delta_{6i}\, \Delta InURBAN_{t-i} + \phi_{1i} InSR_{t-i} + \phi_{2i} InUNEMP_{t-i} + \phi_{3i} InGDP.CAPITA_{t-i} + \phi_{4i} InINF_{t-i} + \phi_{5i} InDIVORCE_{t-i} + \phi_{6i} InURBAN_{t-i} + \xi_t \quad (2)$$

Where Δ is a first difference operator, δ_0 is the intercept term, the parameters $\delta_1, \ldots, \delta_6$ and $\phi_1, \ldots, \phi_6$ are the short-run and long-run elasticities, respectively, and ξ_t is a well-behaved error term. The choice of lag is paramount to obtaining appropriate ARDL estimates. As noted by Chirwa and Odhiambo (2017) the Schwarz-Bayesian Criteria (SBC) lag-length selection criterion is more superior compared to other information criterion such as the Akaike Information Criterion (AIC) when estimating a country-specific ARDL regression. Once the appropriate lag length is determined, then one can proceed to conduct the bounds test for cointegration effects. Pesaran et al. (2001) suggest testing the null hypothesis of no cointegration be imposing restrictions on all estimated long run coefficients of lagged level variables to zero i.e.

$$\delta_1 = \delta_2 = \delta_3 = \delta_4 = \delta_5 = \delta_6 = 0 \quad (3)$$

And this is examined against the alternative hypothesis of otherwise existence of cointegration effects i.e.

$$\delta_1 \neq \delta_2 \neq \delta_3 \neq \delta_4 \neq \delta_5 \neq \delta_6 \neq 0 \quad (4)$$

There aforementioned cointegration test is evaluated via a F-statistic. If the computed F-statistic is greater than the upper critical bound, then the no cointegration null hypothesis is rejected. Conversely, if the F-statistic is less than the lower critical bound level, then the null hypothesis of cointegration cannot be rejected. And finally, if the F-statistic falls between the upper and lower critical bound, then the cointegration tests are deemed as inconclusive. Once cointegration effects are validated, then the following unrestricted error correction model (UECM) representation of the ARDL regression (2) can be modelled as follows:

$$\Delta InSR_t = \delta_0 + \sum_{i=1}^{p} \delta_{1i}\, \Delta InSR_{t-i} + \sum_{i=1}^{p} \delta_{2i}\, \Delta InUNEMP_{t-i} + \sum_{i=1}^{p} \delta_{3i}\, \Delta InGDP.CAPITA_{t-i} + \sum_{i=1}^{p} \delta_{4i}\, \Delta InINF_{t-i} + \sum_{i=1}^{p} \delta_{5i}\, \Delta InDIVORCE_{t-i} + \sum_{i=1}^{p} \delta_{6i}\, \Delta InURBAN_{t-i} + \eta\, ect_{t-i} + \xi_t \quad (5)$$

Where ect_{t-1} is the error correction term which measures the speed of adjustment of towards steady-state equilibrium in the face of disequilibrium. Pragmatically, the error correction term should be significantly negative and must be bound between 0 and -1. As previously mentioned, one of the major advantages of the ARDL modelling system is that procedure allows for modelling of time series variables whose integration properties are either I(0) or I(1). Unfortunately, the modelling procedure cannot be applied to time series variables integrated of order I(2) or higher and hence it is imperative that the time series are tested for unit root properties before the variables can be estimated by the ARDL model.

5 EMPIRICAL ANALYSIS

5.1 Empirical data and unit root tests

The empirical data used in our empirical analysis has been collected from various sources. For instance, the suicide data is collected from the World Health Organization (WHO) mortality database statistics whereas the total number of divorces per year are collected from

the various issues of the Marriages and Divorces statistical releases from the Statistics South Africa (STATSSA) database. On the other hand, the rate of change on the total consumer prices index (CPI) are proxies for the inflation rate and are collected from the South African Reserve Bank (SARB) online database. Moreover, the urbanization rates (urban population as a percentage of the total population) are collected from the World Bank online database. All time series variables used are collected on an annual basis from 1996 to 2015 and has a sample size of 19 observation. However, as noted earlier on, the one major advantage of the ARDL modelling procedure is that it performs exceptional well even with small sample sizes. The basic descriptive statistics (i.e. mean and the standard deviation) and the unit root tests (i.e. ADF and DF-GLS tests) performed on the time series are reported below in Table 2.

Table 2: Data description and unit root tests

time series	Descriptive statistics		Unit root tests			
			ADF		DF-GLS	
	mean	sd	levels	1st difference	levels	1st difference
male	274.80	126.0	-3.95***	-4.02***	-1.34	-4.57***
female	79.00	29.80	-1.36	-4.60***	-1.12	-5.09***
5-14	7.68	4.15	-2.45*	-5.78***	-2.15	-5.78***
15-24	100.50	40.77	-2.67*	-4.28***	-0.90	-4.89***
25-34	105.6	49.19	-5.61***	-5.31***	-5.47***	-8.69***
35-54	103.90	36.01	-1.72	-3.99**	-1.50	-4.10**
55-74	33.68	12.94	-1.25	-4.30***	-1.18	-4.52***
75+	8.47	3.22	-1.84	-7.75***	-3.66***	-5.03***
unemp	23.92	1.76	-5.25***	-3.40**	-3.38**	-6.61***
gdp.capita	49677	4833	-2.03	-2.82	-0.51	-2.84*
inf	6.11	2.21	-2.21	-4.74**	-2.18	-3.83**
divorce	30094	4915	-3.57***	-4.87***	-0.77	-3.59*
urban	59.57	2.95	-0.40	-0.67	-1.48	-5.38***

Notes: '***', '**','*' represent the 1%, 5% and 10% significance levels, respectively. Optimal lag length for unit root tests is determined by the AIC.

A number of interesting stylized fact can be deduced from the statistics reported in Table 2. For instance, one can observe that the highest average suicides occur amongst males for 'sex' groups whilst for age groups the highest suicides occur in the '25 to 34 year' group. The lowest suicides occur in the most extreme age groups i.e. '5-14' years and '75 and above'. Nonetheless, our main interest from the findings presented in Table 2 concerns the unit root tests. When the ADF unit root tests are performed on the time series the results, the results obtained are unsatisfactory in the sense of have variables (i.e. 'gdp.capita' and 'urban') which fail to reject the unit root null in both their levels as well as in their first differences. However, when the DF-GLS test is employed we observe that all series manage to reject the unit root null in their first differences at significance levels of least 5 percent. We consider the DF-GLS unit root tests results to be more plausible since it is well known that DF-GLS tests has higher testing power compared to other 'first generation' unit root tests.

5.2 Empirical analysis and results

Having confirmed that none of the time series variables are integrated of order I(2) or higher, we proceed to conduct the bounds test for cointegration for the following seven suicide-unemployment regression functions:

- f(*SR*(*total*) | *unemp*, *gdp.capita*, *inf*, *urban*)
- f(*SR*(*male*) | *unemp*, *gdp.capita*, *inf*, *urban*)
- f(*SR*(*female*) | *unemp*, *gdp.capita*, *inf*, *urban*)
- f(*SR*(*5-14*) | *unemp*, *gdp.capita*, *inf*, *divorce*, *urban*)
- f(*SR*(*15-24*) | *unemp*, *gdp.capita*, *inf*, *divorce*, *urban*)
- f(*SR*(*25-34*) | *unemp*, *gdp.capita*, *inf*, *divorce*)
- f(*SR*(*35-54*) | *unemp*, *gdp.capita*, *inf*, *divorce*)
- f(*SR*(*55-74*) | *unemp*, *gdp.capita*, *inf*, *divorce*)
- f(*SR*(*75+*) | *unemp*, *gdp.capita*, *inf*, *divorce*, *urban*)

The F-statistics and their associated critical values are reported below in Table 2. The results reported in Table 3 can be summarized as follows. Firstly, we find only one regression function which completely rejects cointegration amongst the times series i.e. f(*SR*(*female*) | *unemp*, *gdp.capita*, *inf*, *urban*). Secondly, we obtain two regression which produce F-statistics which are indicative of cointegration effects at a 10 percent significance level i.e. f(*SR*(*total*) | *unemp*, *gdp.capita*, *inf*, *urban*) and f(*SR*(*male*) | *unemp*, *gdp.capita*, *inf*, *urban*). Lastly, the remaining six regressions produce F-statistics which lie above/exceed the upper bound of all critical levels i.e. f(*SR*(*5-14*) | *unemp*, *gdp.capita*, *inf*, *divorce*, *urban*), f(*SR*(*15-24*) | *unemp*, *gdp.capita*, *inf*, *divorce*, *urban*), f(*SR*(*25-34*) | *unemp*, *gdp.capita*, *inf*, *divorce*), f(*SR*(*35-54*) | *unemp*, *gdp.capita*, *inf*, *divorce*), f(*SR*(*55-74*) | *unemp*, *gdp.capita*, *inf*, *divorce*) and f(*SR*(*75+*) | *unemp*, *gdp.capita*, *inf*, *divorce*, *urban*).

Table 3: Bounds tests for cointegration

Dependent variable	F-statistic	95% lower bound	95% upper bound	90% lower bound	90% upper bound	Decision
SR(total)	4.01	*3.07*	*4.66*	*2.36*	*3.72*	*cointegration*
SR(male)	3.93	*3.07*	*4.66*	*2.36*	*3.72*	*cointegration*
SR(female)	2.08	*3.07*	*4.66*	*2.36*	*3.72*	*reject*
SR(5-14)	6.53	*3.05*	*4.69*	*2.37*	*3.70*	*cointegration*
SR(15-24)	5.47	*3.05*	*4.69*	*2.37*	*3.70*	*cointegration*
SR(25-34)	7.25	*3.07*	*4.66*	*2.36*	*3.72*	*cointegration*
SR(35-54)	8.16	*3.07*	*4.66*	*2.36*	*3.72*	*cointegration*
SR(55-74)	10.01	*3.07*	*4.66*	*2.36*	*3.72*	*cointegration*
SR(75+)	6.17	*3.07*	*4.66*	*2.36*	*3.72*	*cointegration*

Notes: '***', '**','*' represent the 1%, 5% and 10% significance levels, respectively.

The next step in our modelling process is to estimate the ARDL long cointegration regression for the significant cointegration relations and report the results of this empirical exercise in Table 4 below. As can be observed from these results, the coefficient on the unemployment variable is positive yet insignificant for seven specifications (i.e. f(*SR*(*total*) | *unemp*, *gdp.capita*, *inf*, *urban*), f(*SR*(*male*) | *unemp*, *gdp.capita*, *inf*, *urban*), f(*SR*(*5-14*) | *unemp*, *gdp.capita*, *inf*, *divorce*, *urban*), f(*SR*(*15-24*) | *unemp*, *gdp.capita*, *inf*, *divorce*, *urban*), f(*SR*(*25-34*) | *unemp*, *gdp.capita*, *inf*, *divorce*), f(*SR*(*35-54*) | *unemp*, *gdp.capita*, *inf*, *divorce*) and

f(*SR*(*55-74*) | *unemp*, *gdp.capita*, *inf*, *divorce*)). Conversely the unemployment coefficient becomes positive and significant at a 5 percent critical level for the f(*SR*(*75+*) | *unemp*, *gdp.capita*, *inf*, *divorce*, *urban*) specification.

The coefficient on the GDP per capita coefficient is positive and insignificant for two functions (i.e. f(*SR*(*total*) | *unemp*, *gdp.capita*, *inf*, *urban*) and f(*SR*(*male*) | *unemp*, *gdp.capita*, *inf*, *urban*)) whereas the coefficient turns positive and significant at a 10 percent significance level for the remaining estimated regressions (i.e. f(*SR*(*5-14*) | *unemp*, *gdp.capita*, *inf*, *divorce*, *urban*), f(*SR*(*15-24*) | *unemp*, *gdp.capita*, *inf*, *divorce*, *urban*), f(*SR*(*25-34*) | *unemp*, *gdp.capita*, *inf*, *divorce*), f(*SR*(*35-54*) | *unemp*, *gdp.capita*, *inf*, *divorce*) and f(*SR*(*55-74*) | *unemp*, *gdp.capita*, *inf*, *divorce*) and f(*SR*(*75+*) | *unemp*, *gdp.capita*, *inf*, *divorce*, *urban*)). On the other hand, the coefficient on the inflation variable is significant for all estimated regression functions at a critical level of 5 percent albeit being negative related in the f(*SR*(*total*) | *unemp*, *gdp.capita*, *inf*, *urban*) and f(*SR*(*75+*) | *unemp*, *gdp.capita*, *inf*, *divorce*, *urban*)) regressions whereas in the remaining regressions the effect is positive. Furthermore the coefficients on the divorce variable are positive and significant for all estimated regressions with the exception of the f(*SR*(*15-24*) | *unemp*, *gdp.capita*, *inf*, *divorce*, *urban*) regression function which produces a negative and insignificant estimate. Lastly, the coefficient on the urbanization variable produces a negative and insignificant for the f(*SR*(*total*) | *unemp*, *gdp.capita*, *inf*, *urban*) and f(*SR*(*male*) | *unemp*, *gdp.capita*, *inf*, *urban*) regressions, a negative and significant coefficient for the f(*SR*(*75+*) | *unemp*, *gdp.capita*, *inf*, *divorce*, *urban*) specification whilst a positive and significant coefficient is produced for the f(*SR*(*5-14*) | *unemp*, *gdp.capita*, *inf*, *divorce*, *urban*) regression.

Table 4: ARDL cointegration long-run regression estimates

	SR(total)	SR(male)	SR(5-14)	SR(15-24)	SR(25-34)	SR(35-54)	SR(55-74)	SR(75+)
ARDL	ARDL	ARDL	ARDL	ARDL	ARDL	ARDL	ARDL	ARDL
specification	(1,0,0,1,0)	(1,0,0,1,0)	(1,1,1,1,0,1)	(1,0,1,0,0,0)	(1,0,1,0,0)	(1,0,1,0, 1)	(1,0,1,0,0)	(1,1,0,1,1,0)
SR (-1)	0.60	0.63	-0.78	-0.52	-0.45	-0.45	-0.50	-0.50
	(0.01)**	(0.01)**	(0.04)**	(0.05)**	(0.08)*	(0.07)*	(0.04)**	(0.01)**
Unemp	1202.3	1262.5	7.02	5.62	3.12	1.89	0.55	9.14
	(0.40)	(0.30)	(0.18)	(0.26)	(0.28)	(0.54)	(0.80)	(0.03)**
unemp(-1)	N/A	N/A	4.17	N/A	N/A	N/A	N/A	5.93
			(0.42)					(0.01)**
gdp.capita	4585.8	4755.6	65.45	45.84	33.55	24.68	21.81	79.45
	(0.40)	(0.31)	(0.05)**	(0.12)	(0.02)**	(0.09)*	(0.03)**	(0.00)***
gdp.capita (-1)	N/A	N/A	-21.66	-47.09	-44.50	-38.09	-29.49	N/A
			(0.13)	(0.01)**	(0.00)***	(0.02)**	(0.01)**	
Inf	-4654.1	4127.4	-2.55	15.03	11.63	12.42	8.42	-15.73
	(0.05)*	(0.05)**	(0.74)	(0.02)**	(0.00)***	(0.00)***	(0.00)***	(0.00)***
inf(-1)	5814.6	5215.9	23.96	N/A	N/A	N/A	N/A	40.33
	(0.06)*	(0.05)**	(0.08)*					(0.00)***
divorce	N/A	N/A	-169.55	8.39	7.21	5.20	4.77	5.84
			(0.11)	(0.01)**	(0.00)***	(0.07)*	(0.00)***	(0.00)***
divorce(-1)	N/A	N/A	N/A	N/A	N/A	3.60	N/A	2.09
						(0.18)		(0.06)*
Urban	-14130	-14580	7.36	-36.77	N/A	N/A	N/A	-222.78
	(0.38)	(0.30)	(0.02)**	(0.52)				(0.00)***
urban(-1)	N/A	N/A	1.89	N/A	N/A	N/A	N/A	N/A
			(0.24)					
R^2	0.64	0.70	0.69	0.56	0.48	0.76	0.61	0.52

Notes: '***', '**','*' represent the 1%, 5% and 10% significance levels, respectively. p-values reported in parentheses ().

Table 5 reports the empirical results of the ARDL-ECM estimates. Of particular interest to us are the coefficients on the error correction terms which we note produce the correct negative coefficient and are all statistically significant at a significance level of at least 10 percent. In particular, we obtain error correction term estimates of -0.40 for the f(*SR*(*total*) | *unemp*, *gdp.capita*, *inf*, *urban*) model, -0.33 for the f(*SR*(*male*) | *unemp*, *gdp.capita*, *inf*, *urban*), -0.78 for f(*SR*(*5-14*) | *unemp*, *gdp.capita*, *inf*, *divorce*, *urban*) model, -0.48 for f(*SR*(*15-24*) | *unemp*, *gdp.capita*, *inf*, *divorce*, *urban*) model, -0.45 for the f(*SR*(*25-34*) | *unemp*, *gdp.capita*, *inf*, *divorce*) and f(*SR*(*35-54*) | *unemp*, *gdp.capita*, *inf*, *divorce*) models, -0.50 for the f(*SR*(*55-74*) | *unemp*, *gdp.capita*, *inf*, *divorce*) model and -0.49 for f(*SR*(*75+*) | *unemp*, *gdp.capita*, *inf*,

divorce, *urban*) model. Collectively, these results imply that between 33 and 78 percent of disequilibrium from the steady-state, as caused by shocks or disturbances to the cointegration system, are corrected in each period/periodically (i.e. annually). Moreover, these significant error correction estimates further imply that there exists long-run causality existing amongst the time series.

Table 5: ARDL-ECM estimates

	total	male	5-14	15-24	25-34	35-54	55-74	75+
Δunemp	1202.3	3.22	7.02	3.03	3.12	1.89	0.55	9.14
	(0.40)	(0.15)	(0.18)	(0.28)	(0.28)	(0.54)	(0.80)	(0.02)**
Δgdp.capita	4585.8	7.59	65.45	29.85	33.55	24.68	21.81	79.45
	(0.40)	(0.39)	(0.05)**	(0.03)**	(0.02)**	(0.09)*	(0.03)**	(0.00)***
Δinf	5814.6	-10.86	-2.55	11.53	11.63	12.42	8.42	-15.73
	(0.06)*	(0.02)**	(0.74)	(0.00)***	(0.00)***	(0.00)***	(0.00)***	(0.00)***
Δurban	-14130	-45.76	7.36	N/A	N/A	N/A	N/A	-266.78
	(0.38)	(0.13)	(0.02)**					(0.00)***
Δdivorce	N/A	N/A	-169.55	7.15	7.21	5.20	4.77	5.84
			(0.11)	(0.00)***	(0.00)***	(0.07)*	(0.00)***	(0.00)***
ecm(-1)	-0.40	-0.33	-0.78	-0.48	-0.45	-0.45	-0.50	-0.49
	(0.08)*	(0.03)**	(0.00)***	(0.00)***	(0.00)***	(0.00)***	(0.00)***	(0.00)***
R^2	0.64	0.70	0.69	0.56	0.48	0.76	0.61	0.52

Notes: '***', '**','*' represent the 1%, 5% and 10% significance levels, respectively. P-values reported in parentheses (). The symbol 'Δ' denotes a first difference operator

As a final step in our empirical modelling procedure, we perform diagnostic tests on the residuals obtained from our regression estimates. In particular, we conduct the Breusch-Godfrey (B-G) tests for serial correlation, Jarque-Bera (J-B) tests for normality, the autoregressive conditional heteroscedasticity (ARCH) Lagrange multiplier (LM) tests for hetereoskedasticity as well as Ramsey's RESET test for functional form. The results from the diagnostic tests are reported in Table 6, and as can be observed, all estimated models passed all diagnostic tests. Further supplementing these results are the Cumulative Sum of Recursive Residuals (CUSUM) and Cumulative Sum of Squares of Recursive Residuals (CUSUMSQ) which indicate that the estimate regressions are stable at a 5 percent critical value. The CUSUM

and CUSUMSQ plots for each of the estimated regressions is presented in appendix A as Figures 1 to 8.

Table 6: Diagnostic tests on regression residuals

	total	female	5-14	15-24	25-34	35-54	55-74	75+
B-G	0.16	0.15	0.17	0.13	0.18	0.69	0.32	0.60
J-B	0.98	0.49	0.46	0.86	0.87	0.81	0.95	0.70
ARCH	0.13	0.46	0.41	0.89	0.81	0.21	0.94	0.32
RESET	0.79	0.94	0.92	0.83	0.83	0.73	0.46	0.55

6 CONCLUSSIONS

We investigate the relationship between unemployment and suicide for the South African economy using newly released suicide data collected from the WHO database between 1996 and 2015. Our empirical suicide data is provided in terms of sex demographics (i.e. male and female) as well as in six age demographic groups (i.e. 5-14, 15-24, 25-34, 35-55, 55-74 and 75 and above). Other important control variables such as per capita gdp, inflation, divorce and urbanization are included in the estimation regressions. Our empirical approach is the ARDL model of Pesaran et al. (2001) which caters for cointegration between a mixture of stationary and difference stationary variables and further performs well in small sample sizes. Surprisingly, our empirical results indicate that suicide is only significantly related with unemployment for citizens above the age of 75 years with all other sex and age demographic groups bearing an insignificant relationship with unemployment. Similarly, the effects of urbanization on suicides is only influential for the 5-14 year and 75 and above age groups, being positive in the former age group and negative in the later. Collectively, these results imply that both unemployment and level of urbanization are not important factors that influence suicides rates in South Africa except at the extreme lower or upper age groups.

On the other hand, other control variables used in our empirical study such as per capita gdp, inflation and divorce appear to exert a more positive and significant impact on suicide

levels regardless of sex or age whereas the effects. These particular findings highlight importance which monetary and macroeconomic policies play on socioeconomic aspects of the country. For instance, our results could be interpreted to imply that the inflation targeting regime policy currently utilized by the South African Reserve Bank (SARB) may indirectly play a significant role in controlling levels of suicide by ensuring lower domestic rates of inflation. Furthermore, other long-term macroeconomic policies such as the New Growth Path (NGP) and National Development Programme (NDP) which aim to lower poverty levels and improve economic welfare may lead to higher suicide rates if proper suicide prevention plans are not integrated into such national policies. Finally, socioeconomic policies which are specifically aimed at lowering current high rates of divorce need to implemented as part of policy objective in an effort to lower suicide incidences.

REFERENCES

Alptekin D., Alptekin V. ad Utsal D. (2010), "A VAR analysis of the unemployment-suicide relationship in the case of Turkey within the context of anomie theory", *The Journal of Academic Studies*, 12(44), 63-83.

Andres A. (2005), "Income inequality, unemployment, and suicide: A panel data analysis of 15 European countries", *Applied Economics*, 37(4), 439-451.

Andres A. and Halicioglu F. (2010), "Determinants of suicide in Denmark: Evidence from time series data", Health Policy, 98(2-3), 263-269.

Berk M., Dodd S. and Henry M. (2006), "The effect of macroeconomic variables on suicide", Psychological Medicine, 36(2), 181-189.

Berg J. (2016), "Which suicides increase during the economic crisis? A commentary and a proposal", *Journal of Public Health and Epidemiology*, 8(5), 82-86.

Blakely T., Collings S. and Atkinson J. (2003), "Unemployment and suicide. Evidence for a causal association?", *Journal of Epidemiology and Community Health*, 57(8), 594-600.

Botha F. (2012), "The economics of suicide in South Africa", *South African Journal of Economics*, 80(4), 526-552.

Boor M. (1980), "Relationship between unemployment rates and suicide rates in eight countries, 1962-1976", *Psychological Reports*, 47(3), 1095-1101.

Brainerd E. (2001), "Economic reform and mortality in the former Soviet Union: A study of the suicide epidemic in the 1990s", *European Economic Review*, 45(4-6), 1007-1019.

Breetzke K. (1988), Suicide in Cape Town: Is the challenge being met effectively?", *South African Medical Journal*, 73, 19-23.

Burrows S., Vaez M., Butchart A. and Laflamme L. (2003), "The share of suicide in injury deaths in the South African context: Sociodemographic distribution", *Public Health*, 117(1), 3-10.

Burrows S. (2005), "*Suicide mortality in the South African context. Exploring the role of social status and environmental circumstances*", Stockholm: Karolinska Institutet.

Burrows S. and Laflamme L. (2005), "Living circumstances of suicides mortality in a South African city: An ecological study of differences across race groups and sexes", *Suicide and Life-threatening Behaviour*, 35(5), 592-603.

Burrows S. and Laflamme L. (2006), "Suicide mortality in South African: A city-level comparison across socio-demographic groups", *Social Psychiatry and Epidemiology*, 35(5), 592-603.

Caner M. and Hansen B. (2001), “Threshold autoregression with a unit root”, *Econometrica*, 69, 1555-1596.

Ceccherini-Nelli A. and Priebe S. (2011), “Economic factors and suicide rates: Assocaitions over time in four countries”, *Social Psychiatry and Psychiatric Epidemiology*, 46(10), 975-982.

Chang S., Gunnell D., Sterne J., Lu T. and Cheng A. (2009), “Was the economic crisis 1997-1998 responsible for rising suicide rates in East/Southeast Asia? A time-trend analysis for Japan, Hong Kong, South Korea, Taiwan, Singapore and Thailand”, *Social Science and Medicine*, 68, 1322-1331.

Chang S., Sterne J., Huang W., Chuang H. and Gunnell D. (2010), “Association of secular trends in unemployment with suicide in Taiwan, 1959-2007: A time-series analysis”, *Public Health*, 124, 49-54.

Chang S., Stuckler D., Yip P. and Gunnell D. (2013), “Impact of the 2008 global economic crisis on suicide: Time trend study in 54 countries”, *British Medical Journal*, 347(f5239), 1-15.

Chang T. And Chen W. (2017), “Revisiting the relationship between suicide and unemployment: Evidence from linear and nonlinear cointegration”, *Economic Systems*, 41(2), 266-278.

Chen J., Choi Y., Mori K., Sawada Y. and Sugano S. (2012), “Recession, unemployment and suicide in Japan”, *Japan Labour Review*, 9(2), 75-92.

Chen Y., Yip P., Lee C., Fan H. and Fu K. (2010), “Economic fluctuations and suicide: A comparison of Taiwan and Hong Kong”, *Social Sciences and Medicine*, 71, 2083-2090.

Chen W., Chang T. and Lin Y. (2016), "Investigating the persistence of suicide in the United States: Evidence from the quantile unit root test", *Social Indicators Research*, (forthcoming).

Chirwa T. and Odhiambo N. (2017), "Sources of economic growth in Zambia: An empirical investigation", *Global Business Review*, 18(2), 275-290.

Chuang H. and Huang W. (1997), "Economic and social correlates of regional suicide rates: A pooled cross section and time series analysis", *Journal of Socio-Economics*, 26, 277-289.

Corcoran P. and Arensman E. (2001), "Suicide and unemployment status during Ireland's Celtic Tiger economy", *The European Journal of Public Health*, 21(2), 209-214.

Crombie I. (1990), "Can changes in the unemployment rates explain the recent changes in suicide rates in developed countries?", *International Journal of Epidemiology*, 19, 412-416.

DeFina R. and Hannon L. (2015), "The changing relationship between unemployment and suicide", *Suicide and Life-Threatening Behavior*, 45(2), 217-229.

dos Santos J., Tavares M. and Barros P. (2016), "More than just numbers: Suicide rates and the eoncomic cycle in Portugal (1910-2013)", *SSM-Population Health*, 2, 14-23.

Durkheim E. (1951), "*Suicide*", New York: Free Press.

Edwards S., Cheetham R., Naidoo L. and Griffiths J. (1981), "Parasuicide in the Durban Indian community", *South African Medical Journal*, 60(6), 241-243.

Enders W. and Siklos P. (2001), "Cointegration and threshold adjustment", *Journal of Business and Economic Statistics*, 19(2), 166-176.

Favara D. (2013), “The burden of deliberate self-harm on the critical care unit of a peri-urban referral hospital in the Eastern Cape: A five-year review of 419 patients”, *South African Medical Journal*, 103(1), 40-43.

Fernquist R. (2007), “How do Durkheimian variables impact variation in national suicide rates when proxies for depression and alcoholism are controlled?”, *Archives of Suicide Research*, 11(4), 361-374.

Flisher A., Liang H., Laubscher R. and Lombard C. (2004), “Suicide trends in South Africa, 1968-90”, *Scandinavian Journal of Public Health*, 32(6), 411-418.

Gavrilova N., Semyonova V., Evdokushkina G. and Gavrilova L. (2000), “The response of violent mortality to economic crisis in Russia”, *Population Res Policy Rev*, 19, 397-419.

Gerdtham U. and Johannesson M. (2003), “A note on the effect of unemployment on mortatility”, *Journal of Health Economics*, 22, 505-518.

Ginsberg R. (1967), “*Anomie and aspirations: A reinterpretation of Durkheim’s theory*” New York: Arno Press.

Granados T. and Roux D. (2009), “Life and death during the Great Depression”, *Proceedings of the National Academy of Sciences of the United States of America*, 106(41), 17290-17295.

Hamermesh D. and Soss N. (1974), “An economic theory of suicide”, *Journal of Political Economy*, 82(1), 83-98.

Henry A. and Short J. (1954), “*Homicide and suicide: Some economic, sociological and psychological aspects of aggression*”, The Free Press of Glencoe, Collier-McMillan Ltd.: London.

Hintikka J., Saarinen P. and Viinamaki H. (1999), "Suicide mortality in Finland during an economic cycle", *Scandinavian Journal of Public Health*, 27, 85-88.

Huang C. and Ho Y. (2016), "Does high unemployment rate cause high suicide rate? Evidence from Japan and South Korea", *Journal of Reviews on Global Economics*, 5, 165-170.

Huikari S. and Korhonen M. (2016), "The impact of unemployment on well-being: Evidence from the regional level suicide data in Finland", *Social Indicators Research*, 128(3), 1085-1101.

Inagaki K. (2010), "Income inequality and the suicide rate in Japan: Evidence from cointegration and LA-VAR", *Journal of Applied Economics*, 13, 113-133.

Jalles J. and Anderson M. (2014), "Suicide and unemployment: A panel analysis of Canadian provinces", *Archives of Suicide Research*, 18(1), 14-27.

Joe S., Stein D., Seedat S., Herman A. and Williams D. (2008), "Non-fatal suicide behaviour amoung South Africans: Results from the South African stress ad health study", *Social Psychiatry and Psychiatric Epidemiology*, 43, 454-461.

Khang Y., Lynch J and Kaplan G. (2005), "Impact of economic crisis on cause specific mortality in South Korea", *International Journal of Epidemiology*, 34, 1291-1301.

Khasakhala L., Sorsdahl K., Harder V., Williams D., Stein D. and Ndetei D. (2011), "Lifetime disorders and suicide behaviours in South Africa", *African Journal of Psychiatry*, 14(2), 134-139.

Kim H., Song Y., Yi J., Chung W. and Nam C. (2004), "Changes in mortality after the recent economic crisis in South Korea", *Annals of Epidemiology*, 14, 442-446.

Kim C. and Cho Y. (2017), “Does unstable employment have an association with suicide rates among the young?”, *International Journal of Environmental Research and Public Health*, 14(470), 1-14.

Kuroki M. (2001), “Suicide and unemployment in Japan: Evidence from municipal level suicide rates and age-specific suicide rates”, *Journal of Socio-economics*, 39(6), 683-691.

Lester B., Lyke J. and Olsen R. (2015), “Is the suicide rate a random walk?”, *Psychological Reports*, 116(3), 983-985.

Lin S. (2006), “Unemployment and suicide: Panel data analysis”, *The Social Science Journal*, 43(2), 727-732.

Lucey S., Corcoran P., Keeley H., Brophy J., Arensman E. and Perry I. (2005), “Socioeconomic change and suicide: A time-series study from the Republic of Ireland”, *Crisis*, 26, 90-94.

Mars B., Burrows S., Hjelmeland H. and Gunnell D. (2014), “Suicide behaviour across the African continent: A review of the literature”, *BMC Public Health*, 14(606), 1-14.

Maag T. (2008), “Economic correlates of suicide rates in OECD countries”, KOF Swiss Economic Institute, Working Paper No. 08-207.

Mathews, Abrahams, Jewkes, Martin, Lombard and and Vetten (2008)

Meel B. (2003), “A study on the incidence of suicide by hanging in the sub-region of Transkei, South Africa”, *Journal of Clinical Forensic Medicine*, 10(3), 153-157.

Mhlongo T. and Peltzer K. (1999), “Parasuicide among youth in a general hospital in South Africa”, *Curationis*, 22(2),72-76.

Milner A., McClure R. and De Leo D., "Socio-economic determinants of suicide: An ecological analyisis of 35 countries", *Social Psychiatry and Psychiatric Epidemiology*, 47(1), 19-27.

Minnaar G., Schlebusch L. and Levin A. (1980), "A current study of parasuicide in Durban", *South African Medical Journal*, 57(6), 204-207.

Morrell S., Taylor R., Quine S. and Kerr C. (1993), "Suicide and unemployment in Australia 1907-1990", *Social Science and Medicine*, 36(4), 749-756.

Morselli H. (1882), "*Suicide: An essay on comparative moral statistics*", New York: D. Appleton and Company.

Naidoo S. and Schlebusch L. (2014), "Sociodemographic characteristics of persons committing suicide in Durban, South Africa: 2006-2007", *African Journal of Primary Heath Care and Family Medicine*, 6(1), 1-7.

Neumayer E. (2004), "Recessions lower (some) mortality rates: Evidence from Germany", *Social Science and Medicine*, 58(6), 1037-1047.

Niehaus I. (2012), "Gendered endings: Narratives of male and female suicides in the South African Lowveld", *Culture, Medicine and Psychiatry*, 36(2), 327-347.

Noh Y. (2009), "Does unemployment increase suicide rates? The OECD panel evidence", *Journal of Economic Psychology*, 30, 575-582.

Norstrom T. and Gronqvist H. (2015), "The great recession, unemployment and suicide", *Journal of Epidemiology Community Health*, 0, 1-7.

Notzon F., Komarov Y., Ermakov S., Sempos C., Marks J. and Sempos E. (1998), "Causes of declining life expectancy in Russia", *JAMA*, 279(10), 793-800.

Naidoo P. and Pillay B. (1993), "Parasuicide in a general hospital in South Africa", *Psychological Reports*, 72(3), 979-982.

Oyesanya M., Lopez-Moringo J. and Dutta R. (2015), "Systematic review of suicide in economic recession", *World Journal of Psychiatry*, 5(2), 243-254.

Peltzer K., Cherian V. and Cherian L. (1998), "Attitudes towards suicide among South African secondary school pupils", *Psychological Reports*, 72, 1259-1265.

Pesaran H., Shin Y. and Smith R. (2001), "Bounds testing approaches to the analysis of levels relationships", *Journal of Applied Econometrics*, 16(3), 289-326.

Phiri A. (2014), "Nonlinear cointegration between unemployment and economic growth in South Africa", *Managing Global Transitions*, 12(4), 303-324.

Platt S. (1984), "Unemployment and suicidal behaviour: A review of the literature", *Social Science and Medicine*, 19(2), 93-115.

Platt S., Micciolo R. and Tansella M. (1992), "Suicide and unemployment in Italy: Description, analysis and interpretation of recent trends", *Social Science and Medicine*, 34(11), 1191-2101.

Preti A. and Miotto P. (1999), "Suicide and unemployment in Italy, 1982-1994", *Journal of Epidemiology and Community Health*, 53(11), 694-701.

Pritchard C. (1990), "Suicide, unemployment and gender variations in the Western world 1964-1986. Are women in Anglo-phone countries protected from suicide?", *Social Psychiatry and Psychiatric Epidemiology*, 25, 73-80.

Reeves A., McKee M. and Stuckler D. (2014), "Economic suicides in the Great Recession in Europe and North America", *The British Journal of Psychiatry*, 205, 246-247.

Romero-Avila D. and Usabiage C. (2007), "Unit root test, persistence and the unemployment rates in the US states", *Southern Economic Review*, 73, 689-716.

Solano P., Pizzorno E., Gallina A., Mattei C., Gabrielli F. and Kayman J. (2011), "Employment status, inflation and suicidal behaviour: An analysis of a stratified sample in Italy", *International Journal of Social Psychiatry*, 58(5), 477-484.

Shkolnikov V., McKee M. and Leon D. (2001), "Changes in life expectancy in Russia in the mid-1990s", *Lancet*, 357, 917-921.

Stack S. and Haas A. (1984), "The effect of unemployment duration on national suicide rates: A time series analysis, 1948-1982", *Sociological Focus*, 17(1), 17-29.

Stark K., Joubert G., Struwig M., Pretorius M., Van der Merwe N., Botha H., Kotze J and Krynauw D. (2010), "Suicide cases investigated at the state mortuary in Bloemfontein, 2003-2007", *South African Family Practice*, 52(4), 332-335.

Tsai J. and Cho W. (2011), "The secular trend of suicide rate and the socio-economic, media and climate factors in Taiwan, 1926-2009: A population based study", *Journal of Affective Disorders*, 129(1-3), 270-274.

Walsh B. and Walsh D. (2011), "Suicide in Ireland: The influence of alcohol and unemployment", *The Economic and Social Review*, 42(1), 27-47.

Weyerer and Wiedenmann A. (1995), "Economic factors and rates of suicide in Germany between 1881 and 1989", *Psychological Reports*, 76(3), 1331-1341.

Wu W. and Cheng H. (2010), "Symmetric mortality and asymmetric suicide cycles", *Social Science and Medicine*, 70, 1974-1981.

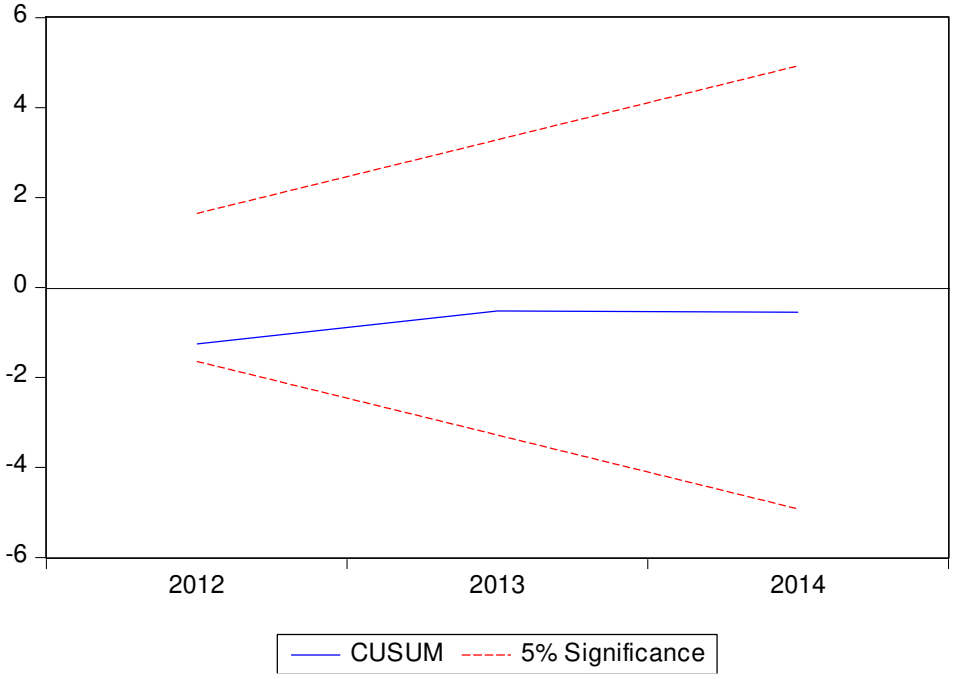
Van Niekerk L, Scribante L. and Raubenheimer P. (2012), "Suicidal ideation and attempt among South African medical students", *South African Medical Journal*, 102(6), 372-373.

Vawda N. (2014), "The prevalence of suicidal behaviour and associated risk factors in grade 8 learners in Durban", *South African Family Practice*, 56(1), 37-42.

Ying Y. and Chang K. (2009), "A study of suicide and socioeconomic factors", *Suicide and Life-Threatening Behaviour*, 39(2), 214-226.

APPENDIX

Figure 1: CUSUM and CUSUMSQ plots for f(*SR*(*total*) | *unemp*, *gdp.capita*, *inf*, *urban*)



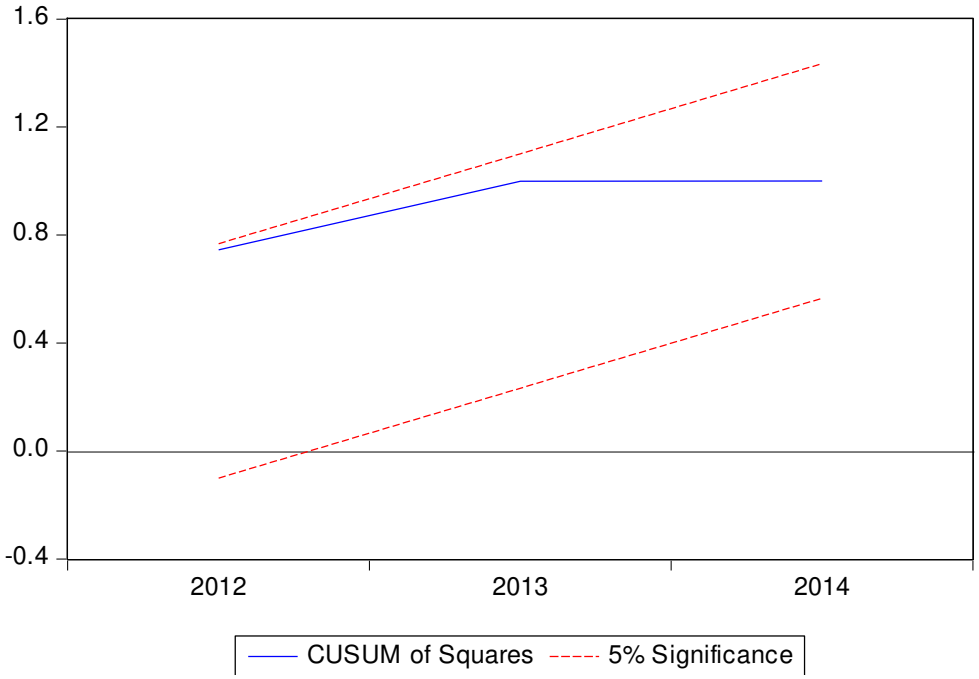
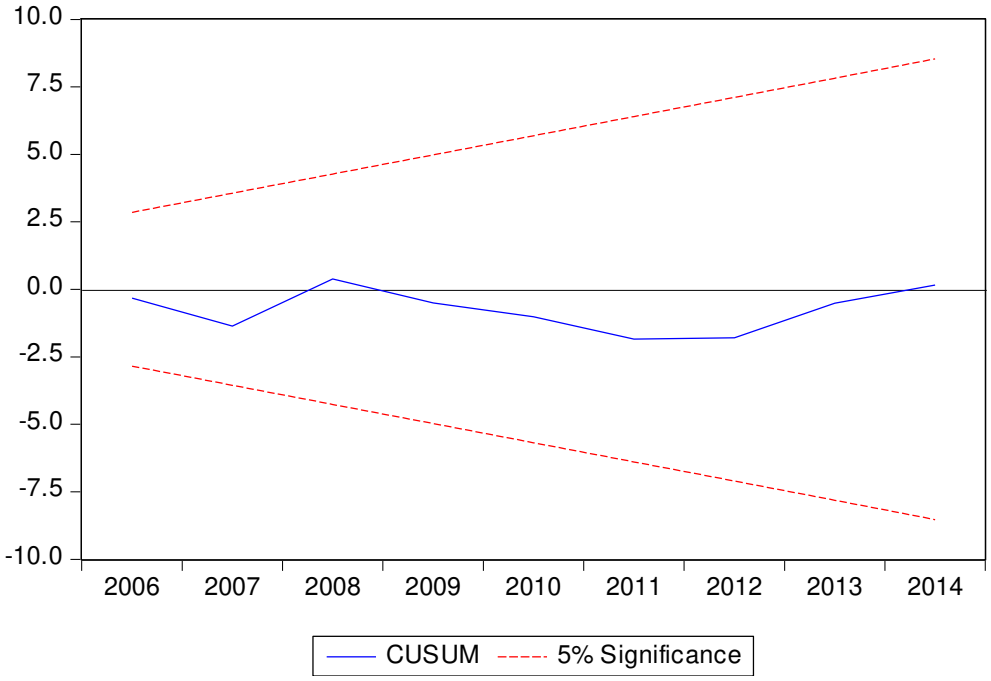


Figure 2: CUSUM and CUSUMSQ plots for f(*SR*(*male*) | *unemp*, *gdp.capita*, *inf*, *urban*)



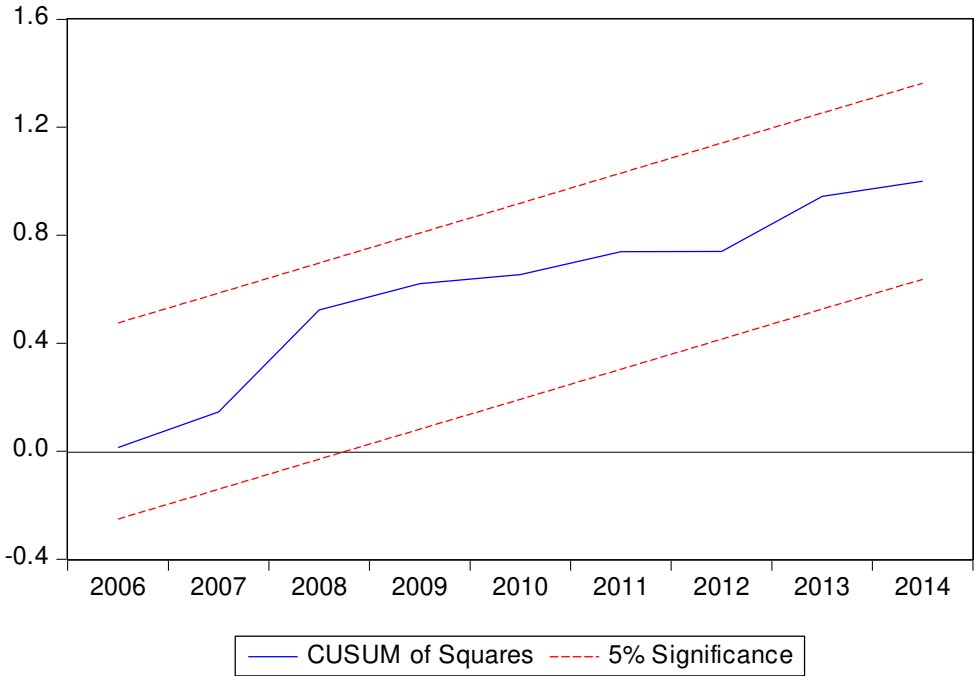
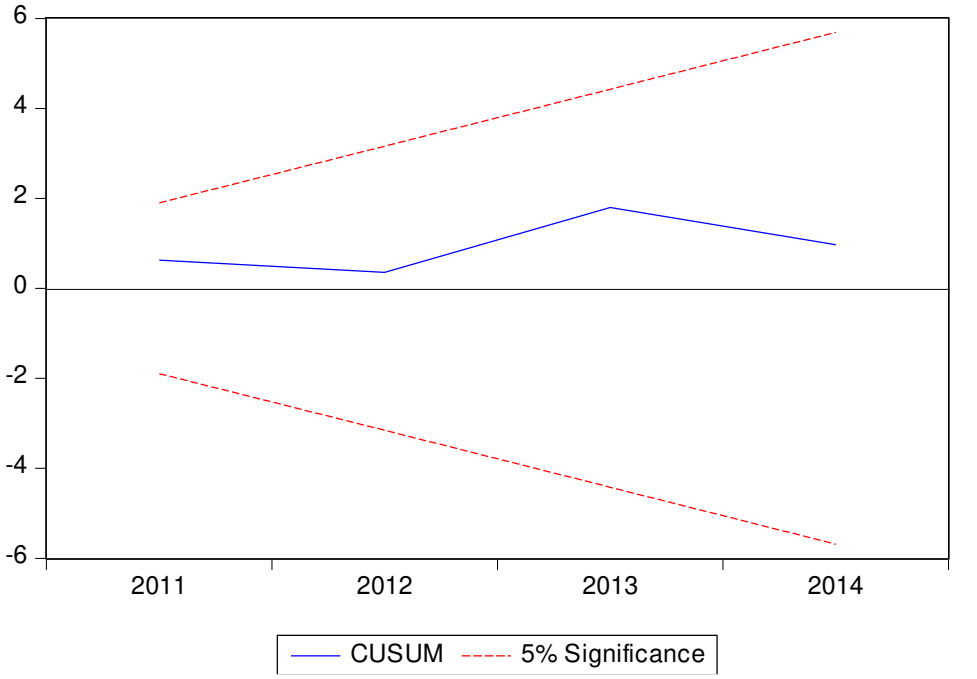


Figure 3: CUSUM and CUSUMSQ plots for f(*SR*(*5-14*) | *unemp*, *gdp.capita*, *inf*, *divorce*, *urban*)



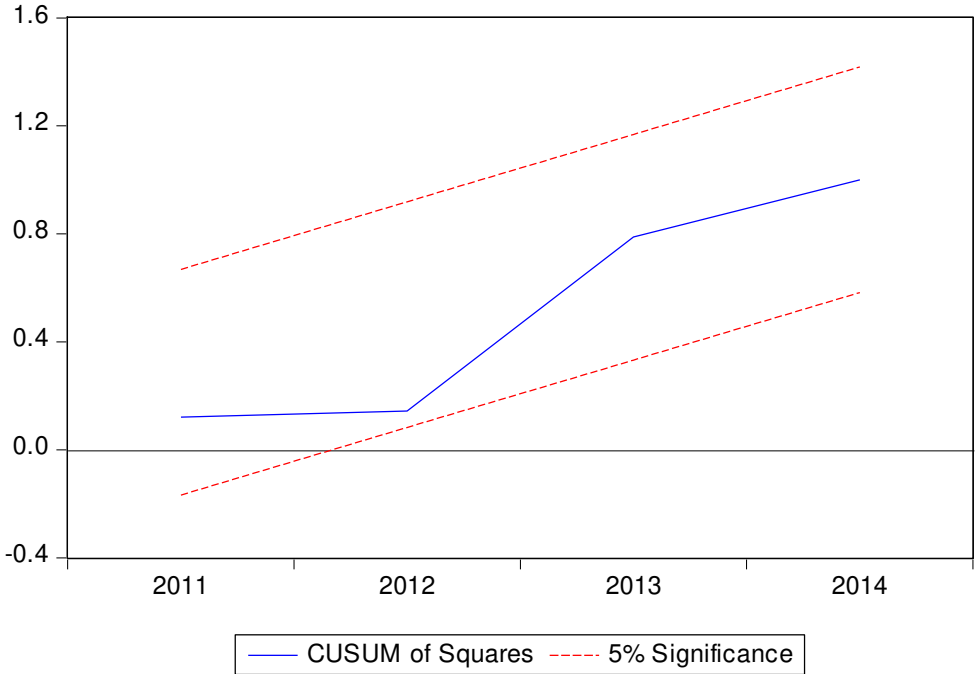
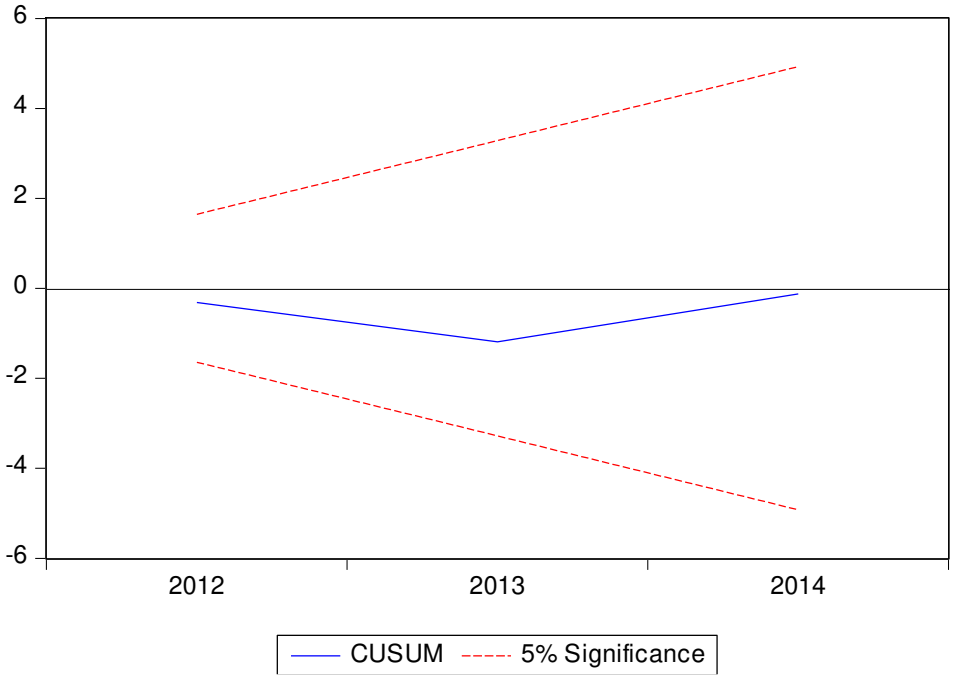


Figure 4: CUSUM and CUSUMSQ plots for f(*SR*(15-24) | *unemp*, *gdp.capita*, *inf*, *divorce*, *urban*)



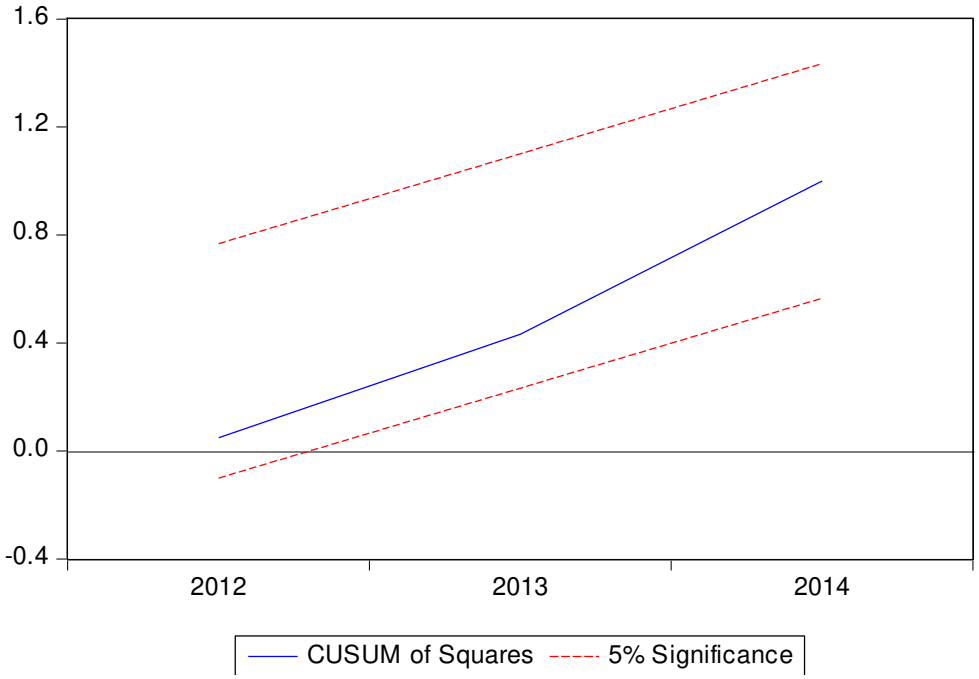
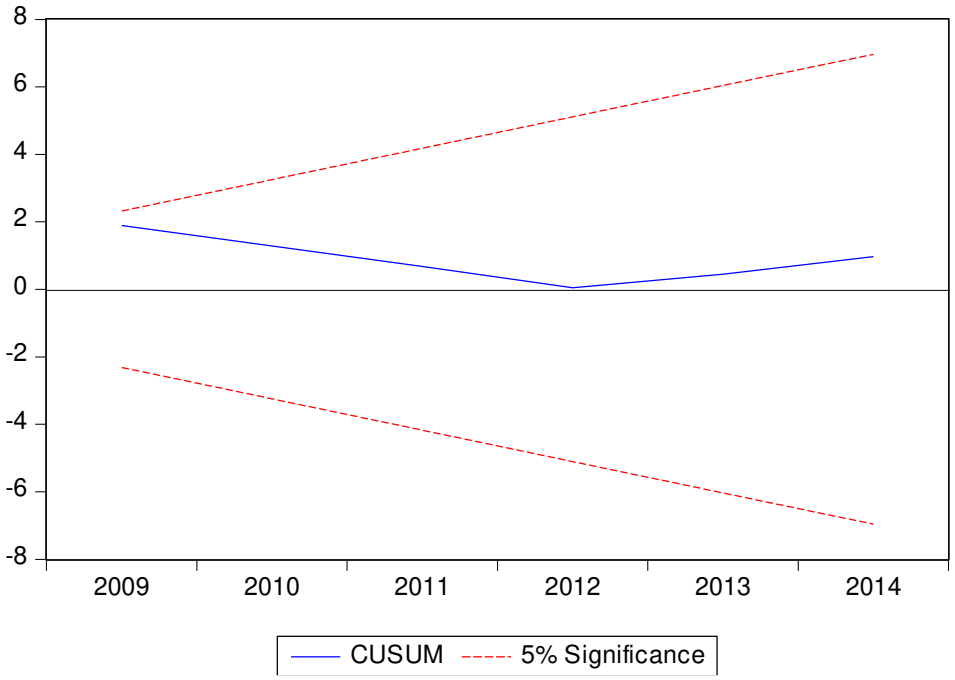


Figure 5: CUSUM and CUSUMSQ plots for f(*SR*(*25-34*) | *unemp*, *gdp.capita*, *inf*, *divorce*)



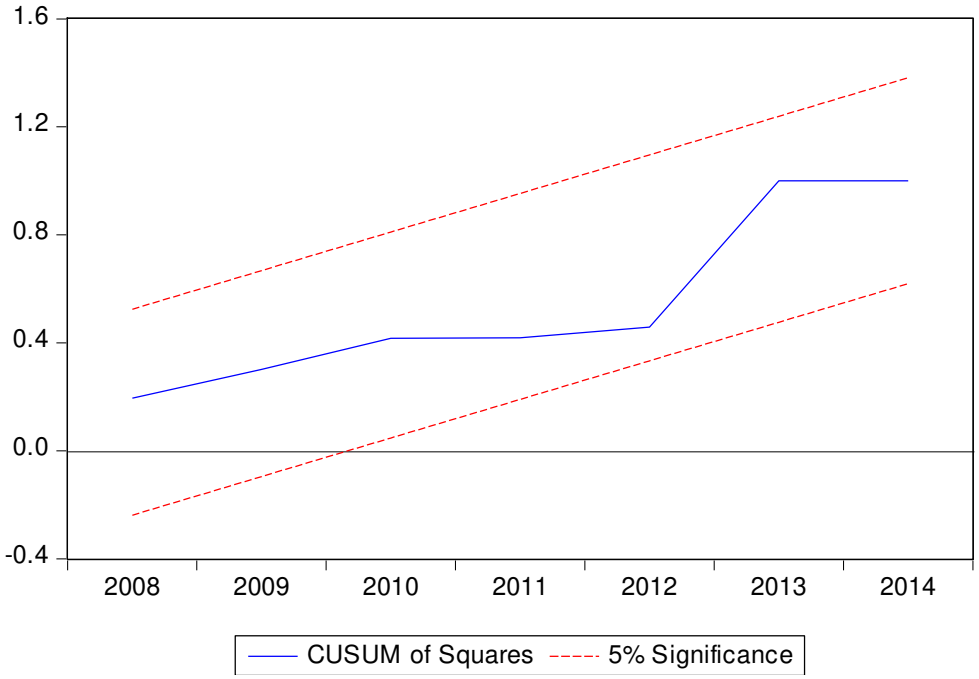
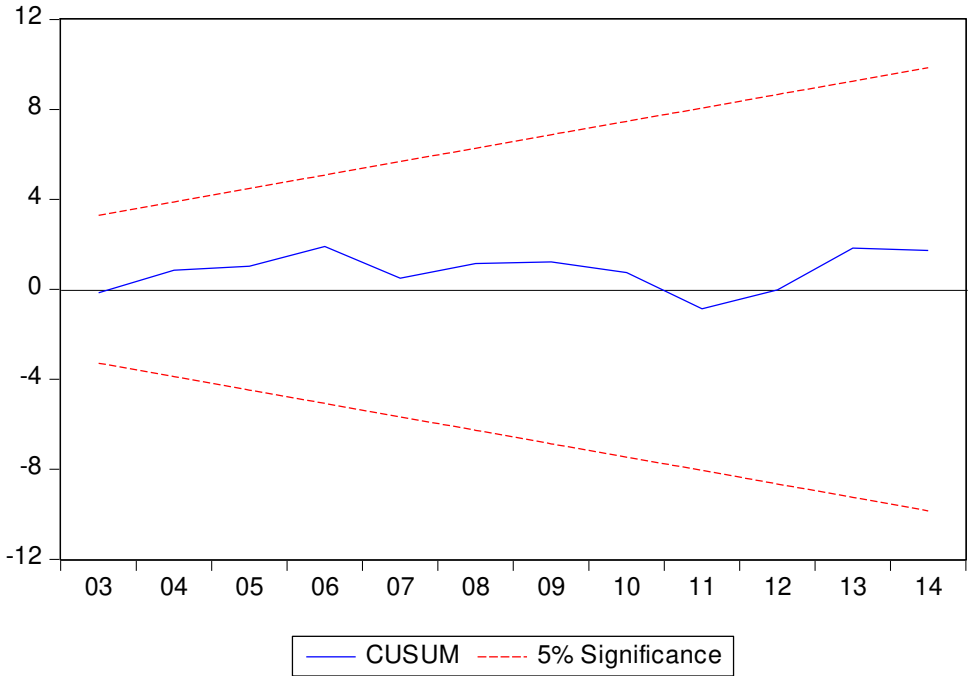


Figure 6: CUSUM and CUSUMSQ plots for f(*SR*(*35-54*) | *unemp*, *gdp.capita*, *inf*, *divorce*)



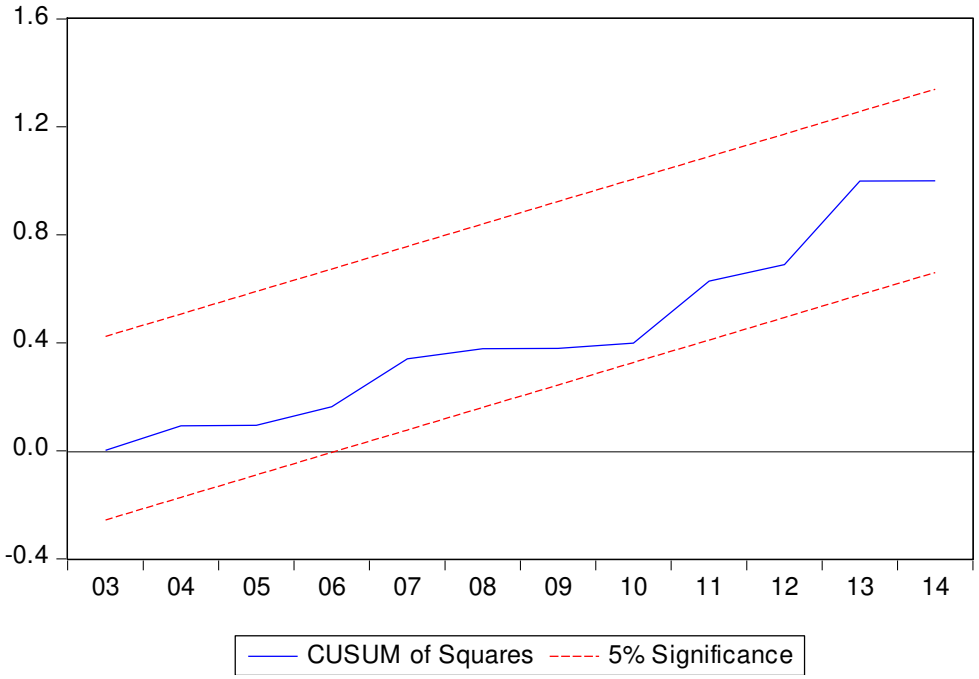
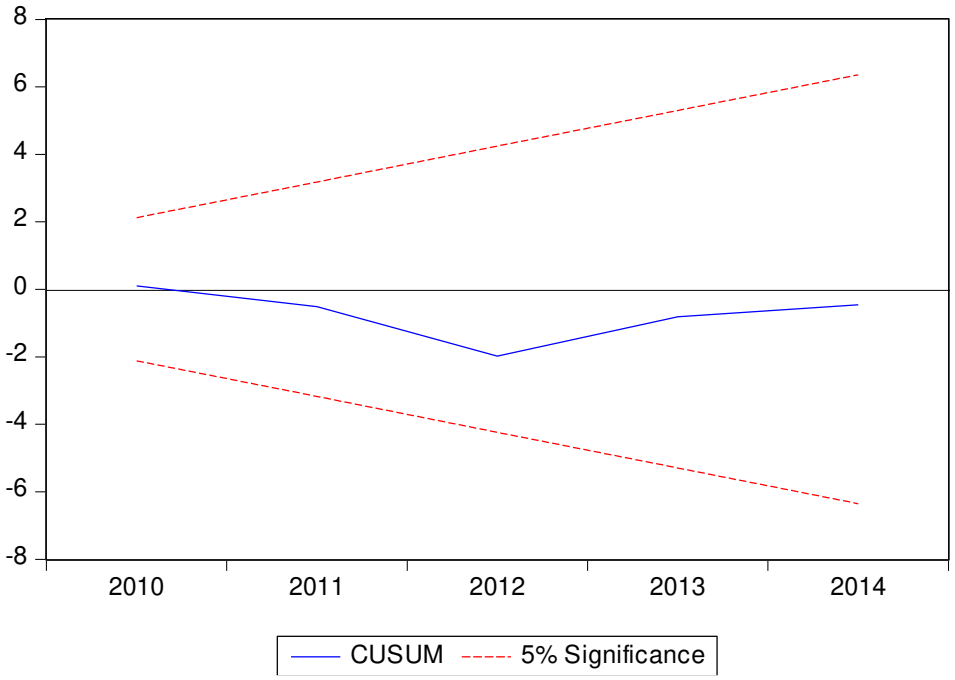


Figure 7: CUSUM and CUSUMSQ plots for f(*SR*(*55-74*) | *unemp*, *gdp.capita*, *inf*, *divorce*)



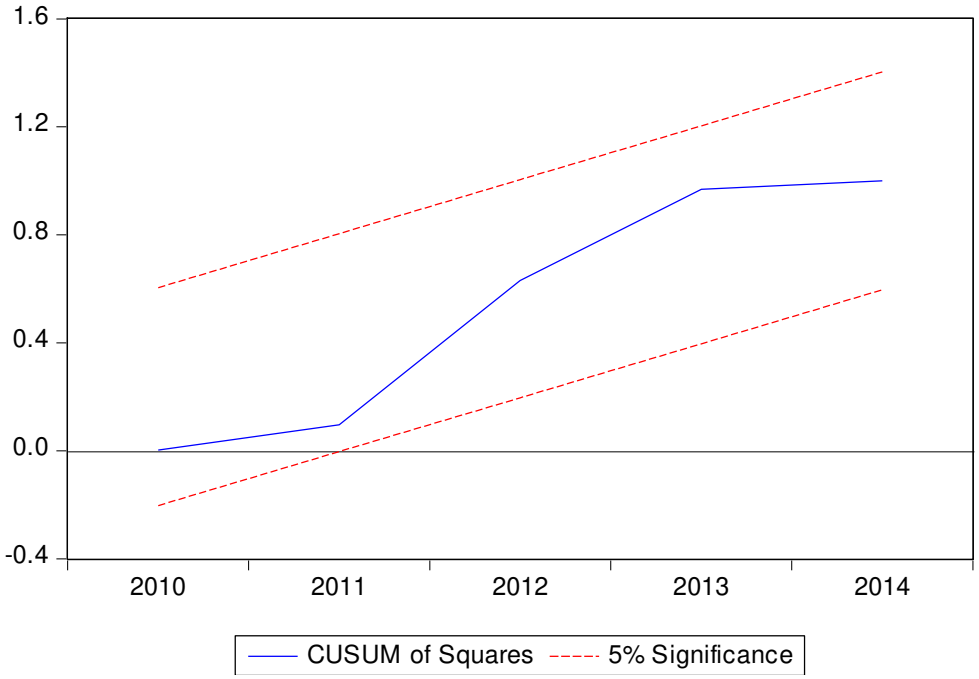


Figure 8: CUSUM and CUSUMSQ plots for f(*SR*(*75+*) | *unemp*, *gdp.capita*, *inf*, *divorce*, *urban*)

Table 1: Review of international literature

Author	Country/ Countries	Period	Method	Control variables	Results
Boor (1980)	9 highly advanced countries	1962-1976	Correlation analysis	N/A	Positive relationship between Canada, France, Germany, Japan and Sweden. Negative relationship between Italy, England and Wales.
Stack and Haas (1984)	US	1948-1982	Cochrane-Orcutt technique	Divorce and female labour force participation	Unemployment positively affect both male and female suicides
Pritchard (1990)	23 advanced countries	1964-1986	Correlation analysis	N/A	No suicide-unemployment relationship between 1964 and 1986 and a significant positive relationship between 1974 and 1986.
Crombie (1990)	16 developed countries	1973-1983	Correlation analysis	N/A	15 positive relationships and 1 negative suicide-unemployment relationship for males and 4 positive and 11 negative relationships for females.
Yang et. al. (1992)	US and Japan	1952-1984	OLS	GDP, divorce, female labour	Positive suicide-

				participation rate.	unemployment relationship for US and insignificant suicide-unemployment relationship for Japan.
Platt et.al. (1992)	Italy	1977-1987	Correlation analysis	N/A	Insignificant suicide-unemployment relationship for women and positive and significant relationship for males.
Morrell et. al. (1993)	Australia	1907-1990	Correlation analysis	N/A	Insignificant suicide-unemployment relationship for women and positive and significant relationship for males.
Weyerer and Wiedenmann (1995)	Germany	1881-1989	Correlation analysis	Economic growth, per capita GDP and frequency of bankruptcy.	Suicides are positively related with unemployment levels but not rates.
Chuang and Huang (1997)	23 Taiwanese regions	1983-1993	OLS and GLS estimates.	Divorce, fertility, female labour force participation, migration, per capita GDP.	Unemployment is weakly correlated with suicides for males but strongly so for females.
Hintikka et. al. (1999),	Finland	1985-1995	Correlation analysis	Per capita GDP, alcohol consumption and divorce.	Unemployment is insignificantly related with both male and

					female suicides.
Preti and Miotto (1999)	Italy	1982-1994	Correlation analysis	N/A	Positive and significant suicide-unemployment relationship for both sexes and is relationship is stronger in people seeking first job.
Ruhm (2000)	US states	1972-1991	Panel fixed effects	Personal income	Positive suicide-unemployment relationship across all age groups.
Gerdtham and Johannesson (2003)	Sweden	1980-1986	Probit model estimates	Initial health status, annual income, immigration, education, marital status and number of children.	Unemployment and suicides are positive and significantly correlated.
Neumayer (2004)	Germany	1980-2000	GMM estimates	N/A	Negative relationship between unemployment and suicides for both males and females.
Andres (2005)	15 European countries	1970-1998	Panel regression analysis	Per capita GDP, economic growth, alcohol consumption, divorce, Gini index.	Unemployment is insignificantly related all suicide rates with the exception of males in the 45-64 age group.

Lucey et. al. (2005)	Ireland	1968-2000	Correlation analysis	GDP, unemployment, female labour participation rate, alcohol, marriage rate, births outside marriage and crime rate.	Unemployment is insignificantly related with both male and female suicides.
Berk et al. (2006)	Australia	1968-2002	Correlation analysis	Housing loan interest rates, inflation, GDP, days lost to industrial disputes and Consumer Sentimental Index.	Significant positive relationship for both sexes in all age groups except for '35-49' for males and '0-19' for females.
Lin (2006)	8 Asian countries	1979-2002	Panel fixed effects	Per capita GDP, population, female and health expenditure per capita.	Positive suicide-unemployment relationship for both sexes.
Fernquist (2007)	8 European countries	1973-1997	MGLS	Life satisfaction, cirrhosis death rate, per capita GDP, education, religion, divorce-marriage rates and political integration.	Positive and significant suicide-unemployment relationship in all countries.
Maag (2008)	28 OECD countries	1980-2002	POLS	Per capita GDP, income inequality and inflation, female labour participation rate, birth rate, marriage rate,	Insignificant suicide-unemployment relationship in both sexes across all age groups except for females

				divorce rate and alcohol consumption.	aged 15-24 in which relationship is significantly negative.
Noh (2009)	24 OECD countries	1980-2002	POLS	Per capita GDP, fertility rate, female labour participation rate, aged population, dependency ratio, alcohol consumption, CO2 emissions, public expenditures on unemployed and old aged and urbanization.	Positive and significant suicide-unemployment relationship for both sexes when regressions are run without interaction term whereas with an interaction term negative and significant relationship for males and insignificant relationship for females.
Andres and Halicioglu (2010)	Denmark	1970-2006	ARDL	Divorce, per capita GDP and fertility rate.	Positive suicide-unemployment relation for both sexes.
Corcoran and Arensman (2010)	Ireland	1996-2006	Correlation analysis	N/A	Economic boom has strengthened the positive suicide-unemployment relationship for both sexes.
Chang et.al. (2010)	Taiwan	1959-2007	Correlation analysis	N/A	Weak suicide-unemployment relationship for women and positive and significant

					relationship for males.
Alptekin et.al. (2010)	Turkey	1974-2007	Cointegration and causality analysis	N/A	Positive suicide-unemployment relations with causality running from unemployment to suicides
Kuroki (2010)	Japan	1983-2007	POLS	Per capita GDP	Positive suicide-unemployment relationship for both sexes in all observed age-groups
Inagaki (2010)	Japan	1951-2007	DOLS, FMOLS and LA-VAR model	Gini coefficient	A positive suicide-unemployment relationship with causality from unemployment to suicide rates.
Wu and Cheng (2010)	US	1951-2005	Symmetric and asymmetric regression estimates	Public health, immigration, alcohol consumption, cigarettes consumption, divorce.	Only negative unemployment rates are correlated with both male and female suicides whereas there is no correlation between positive unemployment and suicides.
Tsai and Cho (2011)	Taiwan	1976-2009	Correlation analysis	GNP, spouseless population, aged population,	Positive and significant suicide-unemployment relationship

				female labour participation rate, media and climate.	
Ceccherini-Nelli and Priebe (2011)	France, Italy, UK and US	1901-2006	Cointegration analysis	Inflation and economic growth	Positive suicide-unemployment relationship for both sexes across all countries.
Walsh and Walsh (2011)	Ireland	1968-2009	OLS	Alcohol consumption	Suicides are only significantly and positively correlated with unemployment for males in '25-34' and '55-64' age group and '15-24' year females.
Milner et al. (2012)	35 countries	1980-2006	Panel fixed effects	Rural population, employment, female participation rate, migrant as percentage of population, fertility rate and health expenditure per capita.	Positive and significant suicide-unemployment relationship for males and insignificant for females.
Jalles and Anderson (2014)	10 Canadian provinces	2002-2008	Panel cointegration and causality analysis	N/A	Positive suicide-unemployment relationship for males, negative suicide-unemployment relationship for females.

Huang and Ho (2016)	Japan and South Korea	1985-2012	Asymmetric causality analysis	N/A	No causality for Japan, negative unemployment shocks granger cause negative suicide rates.
Kim and Cho (2017)	20 OECD countries	1994-2010	Panel regression analysis	Economic growth, per capita GDP, divorce, fertility, employment protection legislation.	Protection legislation for regular employment as opposed to unemployment exerts a significant effect on suicide rates.
Chang and Chen (2017)	US	1928-2013	ARDL and nonlinear ARDL	Divorce, and fertility rate.	Positive suicide-unemployment relationship for all age groups between '25 and 64' years old otherwise insignificant.

Notes: MGLS – Modified generalized least squares (MGLS); ARDL – autoregressive distributive lag; NARDL - nonlinear autoregressive distributive lag; LA-VAR – lag augmented vector autoregressive; DOLS – dynamic ordinary least squares; FMOLS – Fully modified ordinary least squares.