

# Suicide and the South African business cycle: A time series approach, 2006 – 2015

Amaury Pitot & Ferdi Botha<sup>1</sup>

PRELIMINARY WORKING DRAFT  
INCOMPLETE – DO NOT CITE OR QUOTE

## Abstract

Suicide is a major public health issue that brings about substantial economic costs every year. In South Africa, suicide is one of the leading causes of death, yet remains under-researched from an economic point of view, especially as broad macroeconomic conditions have been shown to be related to suicidal behaviour. Using monthly data from January 2006 to December 2015 together with cointegration and error-correction modelling, this paper examines how suicide rates change with changes in the South African business cycle. Apart from overall suicide rates, the paper also considers possible age, gender, and racial differences in suicide rates and how, if at all, they are related to the business cycle. Suicide and demographic data originate from Mortality and Causes of Death from Death Notification data released by Statistics South Africa since 2006. As indicators of the business cycle, the paper uses the South African Reserve Bank's coincident indicator, the Bureau of Economic Research's Purchasing Manager's Index, and ABSA's house price index.

*JEL Classification: Z13*

*Keywords: Suicide, ARDL, business cycle, South Africa*

## 1. Introduction

With a 60% increase in the global suicide rate over the last 45 years (Oyesanya et al., 2015), suicide has major public health and economic consequences for society (Luo et al., 2011). In the United States, for example, in 2015 alone the combined work loss and medical cost resulting from suicide amounted to 56.6 billion dollars (CDC, 2017). Globally, there are approximately one million suicides annually and about 75% of these suicides occur in low- and middle income countries (Nock et al., 2008; WHO, 2014). Previous studies have tried to explain suicidal behaviour in terms of social-, cultural-, psychological-, and medical- factors (Murphy and Robins, 1967; Heikkinen et al., 1995). For example, Murphy and Robins (1967) examined how depression and alcoholism affect suicide. Heikkinen et al. (1995) investigated

---

<sup>1</sup> Department of Economics and Economic History, Rhodes University, Grahamstown, South Africa.  
Email: [f.botha@ru.ac.za](mailto:f.botha@ru.ac.za)

how suicide rates change from a medical perspective (i.e. suicide relating to mental conditions) as well as from a social perspective (i.e. suicide depending on marital status and gender). A growing number of studies has also explored the relationship between suicide and economic variables, taking into account various demographic and socio-economic factors (Viren, 2005; Lin, 2006; Koo and Cox, 2008; Altinanahtar and Halicioglu, 2009; Chang and Chen, 2017). These studies explored how business cycles affect suicide to provide evidence that suicide can be influenced by economic indicators as well. The more knowledge gathered on suicide, the better the policy response would be as suicides are an avoidable cause of death (Luo et al., 2011; dos Santos et al., 2016).

## **2. Literature review**

### *2.1 Theoretical Framework*

Hamermesh and Soss (1974) developed the first economic theory on suicide. They argued that individuals would commit suicide if their expected lifetime utility reaches zero or falls below a certain threshold. The theory predicts a negative relationship between income and suicide and a positive relationship between age and suicide. Hamermesh and Soss' (1974) theory has been applied extensively (e.g.: Viren, 1996; Lin, 2006; Koo and Cox, 2008; Altinanahtar and Halicioglu, 2009). Suzuki (2008) extended Hamermesh and Soss' (1974) research in order to account for income uncertainty. Because of the permanent income hypothesis depicted in the Hamermesh and Soss (1974) model, Suzuki (2008) argued that a person's utility will depend on their future income earned and not the standard deviation of future income.

In relation to the business cycle, suicide has been found to follow a pro-cyclical and a counter-cyclical pattern. Ruhm (2000) and Oyesanya et al. (2015) argued that suicide may be pro-cyclical because during an economic upswing, the assumption is that an individual's consumption increases, leisure time declines and stress rises due to longer working hours, which was consistent with Ginsberg's (1966) theory. In addition, Chuang and Huang (1997) argued that during an economic upswing, social interaction among individuals decline, which increases the chances of someone committing suicide. Consistent with Henry and Short's (1954) theory, Yang (1992) stated that suicide may be counter-cyclical, in that during upswings suicides decrease (i.e. as income rise individuals are doing better) and during recessions suicides increase (i.e. as income decrease individuals are worse off). Therefore, knowledge of the relationship between suicide and the business cycle is important as there is

a need for an increase in suicide-prevention measures by policy makers and health workers to prevent suicides during the applicable stage of the business cycle (Luo et al., 2011; Thibodeau and Lachaud, 2016).

In line with Hamermesh and Soss' (1974) theory, Viren, (1996), Lin (2006), and Koo and Cox (2008) examined the relationship between the business cycle and suicide rates. Lin (2006) examined cases in Taiwan and other Asian countries while Viren (1996) and Koo and Cox (2008) looked at Finland and Japan. Viren (1996) used GDP growth, bankruptcies and unemployment as proxies for the business cycle, whereas Lin (2006) and Koo and Cox (2008) used the unemployment rate as a proxy for the business cycle. All three studies found a positive relationship between unemployment and suicide, implying that suicide is counter-cyclical. Viren (1996) showed that suicides were related to the change in the growth rate of GDP rather than the actual GDP itself. The results showed a counter-cyclical relationship between GDP growth and suicide. In addition, a positive relationship between bankruptcies and suicide were found (Viren, 1996).

## *2.2 Empirical Evidence*

Altinanahtar and Halicioglu (2009) used Turkish time series data to examine the causes of suicide from an economic and socio-economic perspective for the period 1974-2007. Per capita real income was used as a proxy for the business cycle. Overall suicide and disaggregated suicide by divorce rate, urbanisation and liquidations was used for cointegration testing in order to determine their separate influences on suicide rates in Turkey (Altinanahtar and Halicioglu, 2009). The results showed that a long run relationship existed amongst the variables. There was a counter-cyclical relationship between per capita real income and suicide rates, which were consistent with Hamermesh and Soss's (1974) finding where income and the business cycle were related to suicide. Viren (2005) used the same method and approach as Altinanahtar and Halicioglu (2009). In Viren's (2005) study, the employment share of primary production was used as a proxy for the business cycle and the aim was to provide evidence that overall suicide was related to economic determinants where a pro-cyclical relationship was found. The controlled variables were age, gender and population share of the cities (in total population). The results indicated that economic fluctuations only had a temporary effect on overall suicide rates (Viren, 2005). Consistent with the method applied by Viren (2005) and Altinanahtar and Halicioglu (2009), Chang and Chen (2017) examined the relationship between suicide and unemployment in the United

States for the period 1928 to 2013. Chang and Chen's (2017) results suggested that suicide was pro-cyclical after controlling for divorce and fertility rates. Compared to Viren's (2005) study, Chang and Chen (2017) found that unemployment had a symmetric long run effect on age-adjusted and four age-specific suicide rates (from ages 25-34 to 55-64). For individuals aged over 45, the effect of a downswing on suicide was greater than the effect of an upswing. Therefore, Chang and Chen (2017) suggested that intervention design should focus on downswing periods more than upswing periods, especially for individuals aged over 45, to reduce suicidal behaviour. In addition, Luo et al. (2011) examined the impact of the business cycle on suicide rates in the United States for the period 1928-2007, where the unemployment rate was also used as a proxy for the business cycle. Contrary to Chang and Chen's (2017) findings, Luo et al. (2011) used graphical analysis and found that suicide was counter-cyclical. Yang (1992) examined how overall and disaggregated suicides change with social and economic variables in the United States (female labour force participation rate, the divorce rate, membership in the Catholic Church, age, gender and racial groups were used as social and demographic variables). In this study the unemployment rate and the gross national product were used as a proxy for the business cycle. The results showed that overall suicide was counter-cyclical. However, this pattern was reversed for female suicides. The unemployment rate had a significant negative impact on white males only. In addition, the divorce rate had a consistent impact on suicide on all racial groups (Yang, 1992).

Gerdtham and Johannesson (2005) used many indicators as a proxy for the Swedish business cycle. Six different indicators were used as a proxy for the business cycle, namely the unemployment rate, the notification rate (ratio between notified workers and the labour force), the deviation from GDP trend, the change in GDP, industry capacity utilization and an industry confidence indicator as it was not clear how the business cycle was measured. Overall and disaggregated suicides by age and gender were tested and a counter-cyclical effect between suicide and the business cycle was found. Recent studies in Portugal and Canada examined the relationship between economic variables and suicide rates (dos Santos et al., 2016; Thibodeau and Lachaud, 2016). In Portugal real GDP was used as a proxy for the business cycle and a negative relationship between real GDP and suicide was found (dos Santos et al., 2016). Thibodeau and Lachaud (2016) examined the impact of economic fluctuations on suicide in Canada for the period 1926-2008; the unemployment rate and GDP were used as proxy for the business cycle. The results revealed that suicide was counter-cyclical.

Developed countries have an advantage over developing countries because detailed data exist, which enable authors to comprehensively analyse suicide dynamics. In South Africa, suicide is considered to be the top 20th cause of all deaths (Botha, 2012). In 2008, Burrows and Schlebush (2008) found there were about 7 000 suicides annually. Unfortunately, detailed data in South Africa only became available in 2006 with Statistics South Africa's Mortality and Causes of Death data (Statistics South Africa, 2006). Before 2006, the National Injury Mortality Surveillance System (NIMSS), which from 1999 to 2006 provided the only suicide data available in South Africa, was used by various researchers to examine suicidal behaviour. All the studies that used NIMSS primarily considered suicide as being a health problem and explained suicide through social and demographic variables such as race, gender and divorce (Burrows et al., 2003; Burrows and Laflamme, 2005; Burrows and Laflamme, 2008). Stark et al. (2010) examined overall and disaggregated suicide by age groups, gender, the month in which the suicide occurred, and racial group in Bloemfontein and the southern Free State province. Stark et al. (2010) found that more than half of people that committed suicide were unemployed. It is important to note that these studies were provincial and city-based analyses (Burrows et al., 2003; Burrows and Laflamme, 2005; Burrows and Laflamme, 2008; Stark et al., 2010).

In Botha's (2012) study explored the relationship between economic and socio-economic variables in South Africa from a national perspective. Inflation was used as a proxy for economic performance and the results showed that the probability of suicide increases as inflation decreases. Thus, Botha's (2012) findings were consistent with the model developed by Hamermesh and Soss (1974), which predicted a counter-cyclical relationship between the business cycle and suicide. To the best of the author's knowledge, no study has previously examined the relationship between the business cycle and suicide rates, taking into account age, gender, and racial differences in suicide prevalence in South Africa using a time series analysis.

Consistent with international studies such as Altinanathar and Halicioglu (2009); Andrés and Halicioglu (2010); Chang and Chen (2017); Phiri and Makuka (2018) examined the relationship between unemployment and suicide in South Africa for the period 1996 to 2015. Using annual data from the newly released WHO data, overall suicide and disaggregated suicide by divorce rate, urbanisation rate, gender and age groups was used for cointegration

testing in order to determine their separate influences on suicides in South Africa (Phiri and Makuka, 2018). The proxy for the business cycle was the unemployment rate, GDP per capita and inflation (Phiri and Makuka, 2018). The results showed that unemployment was only significantly related to suicide rates for the age group (i.e 75+). In addition, other controlled variables such as GDP per capita, inflation and divorce have a positive and significant effect on suicide (Phiri and Makuka, 2018).

### 3. Data and Methodology

#### 3.1 Model specification

Following the literature on suicide and consistent with Altinanahtar and Halicioglu (2009); Andrés and Halicioglu (2010); Chang and Chen (2017); Phiri and Makuka (2018) the long run relationship between suicide, coincident indicator, divorce and fertility in linear logarithmic form is established as follows:

$$S_t = a_0 + a_1 ci_t + a_2 dr_t + a_3 fr_t + \varepsilon_t \quad (1)$$

Where  $S_t$  is the suicide rate per 100 000 (suicide/population),  $ci_t$  the coincident indicator,  $dr_t$  the divorce rate and  $fr_t$  the fertility rate. The coincident indicator is an indication of the real time of the business cycle. For example, an increase in the coincident indicator is an indication of an upswing period and vice versa (Kim and Yoo, 1995; SARB, 2011). The connection that marriages bring to the family is psychological comfort and solidarity whereas divorce brings isolation and psychological break downs (Altinanahtar and Halicioglu, 2009). The divorce variable has been used extensively internationally and in South Africa (Altinanahtar and Halicioglu, 2009; Heikkinen et al., 1995; Yang 1992; Botha, 2012; Chang and Chen, 2017; Phiri and Makuka, 2018). Therefore, a positive relationship can be expected. Yang (1992); Chuang and Huang (1997); Koo and Cox (2008); Andrés and Halicioglu (2010); Chang and Chen (2017) debated that families with children promote social ties and increase social integration and thus reduce the probability of committing suicide. Therefore, the expectation is that as fertility increases (decreases) suicide should decrease (increase).

### 3.2 Cointegration Methodology

This study will make use of an ARDL bound testing approach known as Auto-Regressive Distributed Lag which was developed by Pesaran et al. (2001). The empirical model is as follows:

$$\Delta \ln S_t = b_o + \sum_{i=0}^m b_{1i} \Delta \ln S_{t-i} + \sum_{i=0}^m b_{2i} \Delta \ln ci_{t-i} + \sum_{i=0}^m b_{3i} \Delta \ln dr_{t-i} + \sum_{i=0}^m b_{4i} \Delta fr_{t-i} + b_5 S_{t-1} + b_6 ci_{t-1} + b_7 dr_{t-1} + b_8 fr_{t-1} + v_t \quad (2)$$

Where  $\Delta$  is a first difference operator,  $b_o$  is the intercept and the variables  $b_{1i}$  to  $b_{4i}$  and  $b_5$  to  $b_8$  are the short and long run elasticities,  $v_t$  is the error term. The lag length was determined using Akaike Information Criterion (AIC) which is followed by bound testing for cointegration. The long run relationship can be tested using the modified F-statistic where the null hypothesis proposed by Pesaran et al. (2001) of no cointegration ( $\rho = b_5 = b_6 = b_7 = b_8 = 0$ ) against the alternative hypothesis ( $\rho \neq b_5 \neq b_6 \neq b_7 \neq b_8 \neq 0$ ). The testing procedure by Pesaran et al. (2001) used two critical bounds, the upper and the lower bound. Therefore if the modified F-statistic is greater than the upper bound, the null-hypothesis is rejected. However, if the F-statistic is lower than the lower critical bound then the null hypothesis cannot be rejected and if the F-statistic lies between the lower and upper bound the test is inconclusive.

When there is a long run relationship, the unrestricted error correction model (UECM) is determined which is shown as follows;

$$\Delta \ln S_t = c_o + \sum_{i=0}^m c_{1i} \Delta \ln S_{t-i} + \sum_{i=0}^m c_{2i} \Delta \ln ci_{t-i} + \sum_{i=0}^m c_{3i} \Delta \ln dr_{t-i} + \sum_{i=0}^m c_{4i} \Delta \ln fr_{t-i} + \lambda EC_{t-1} + u_t \quad (3)$$

Where  $\lambda EC_{t-1}$  is the error correction term which measures the speed of adjustment towards equilibrium, it has to be negative and statistically significant and must be between 0 and -1.

Equation 2 is examined by testing for serial correlation, heteroskedasticity and normality.

Using this approach to cointegration has several advantages and has become popular among researchers recently. For example, ARDL is known to be the most efficient in small sample and it does not require that all series are integrated of the same order. This allows researchers

to use I(0) and I(1) variables however, one cannot use I(2) series (Pesaran et al., 2001; Chang and Chen, 2017).

### 3.3 Data

This study uses three sources to collect monthly time series data. The suicide data was obtained from Statistics South Africa and will be used for the Mortality and Causes of Death data from death notification in South Africa for the period between 2006 and 2015<sup>2</sup> (Statistics South Africa, 2017). The data are obtained from the death notification forms which are first received by the Department of Home Affairs. Then Statistics South Africa processes all these forms<sup>3</sup>. The dataset includes information such as population groups, race, gender of the deceased, marital status, level of education, province of residence, date of death, underlying cause of death, date of birth and whether the deceased was pregnant 42 days prior to death (Statistics South Africa, 2017). The number of births and the mid-year population estimates were also obtained from Statistics South Africa (2017). The coincident indicator was obtained from the SARB (2017). A summary statistic of the overall sample is presented below.

*Table 1: Summary statistics*

Variable s	mean	median	Min	Max	SD
Suicide rate	0.0745	0.0712	0.1336	0.0323	0.0207
Male suicide rate	0.1202	0.1137	0.2096	0.0542	0.0360
Female suicide rate	0.0311	0.0292	0.0833	0.0077	0.0129
Black suicide rate	0.0610	0.0579	0.1227	0.0256	0.0203
White suicide rate	0.0711	0.0647	0.2174	0.0000	0.0441
Coloured suicide rate	0.1097	0.1043	0.2980	0.0206	0.0631
Coincident indicator	106.6992	106.8500	117.1000	94.0000	6.9863
Divorce rate	2.1695	2.1365	3.2930	1.0210	0.5110
Fertility rate	85.6222	85.9390	98.6340	64.5700	6.3212

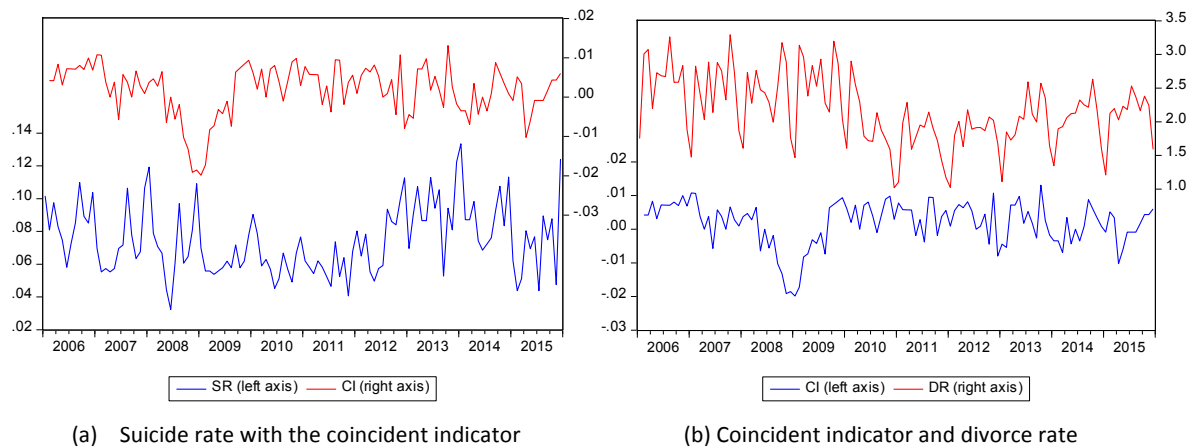
*Note: SD represents the standard deviation. Suicide rates are defined as the suicide/total population within specific race and gender groups per 100 000 people. Divorce rate is the number of divorce/1000 people and fertility rate is the number of births/1000 women aged between 15-44.*

<sup>2</sup> A request was made to Statistics South Africa in order to get the “population group” included in the dataset. The request was granted and ethical approval was granted by the Department of Economics and Economic History’s Ethics committee. It is important to point out that the dataset does not publish personal information about the deceased and therefore it is anonymous. Therefore, the author will not be able to trace back the deceased to their name.

<sup>3</sup> Every year since 2006, Statistics South Africa releases the dataset which include all the deaths for that year that was registered at the Department of Home Affairs. Thus, the dataset might exclude some deaths which occurred but were not registered or deaths that had been registered but did not reach Statistics South Africa in time for the processing phases.

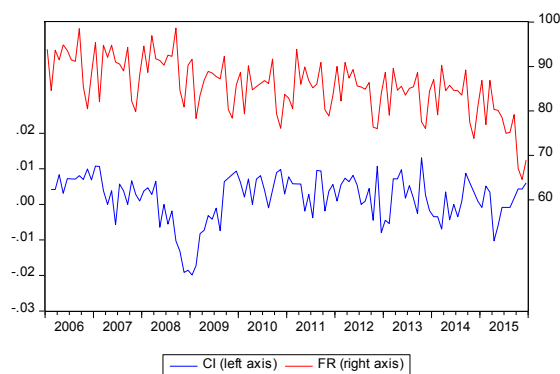
As shown in Table 1, suicides rates are small which is due to the under-reporting of suicide in South Africa. It is well reported in many South African studies such (Schlebusch, 2005; Botha, 2012; Naidoo and Schlebusch, 2014)<sup>4</sup>. Consistent with previous research such as Flisher et al. (2004); Botha (2012), male suicide rate is higher than the female suicide. Interestingly, suicide rate for the coloured population (proportional to their population) is higher as compared to other racial groups<sup>5</sup>, although, total suicide counts were higher among the black population.

Various time plots are shown in Figure 2 where suicide appears to follow a pro-cyclical relationship.

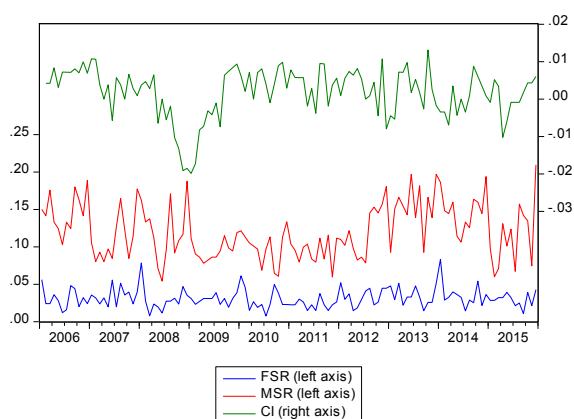


<sup>4</sup> Botha (2012) argued that suicide could be reported under undetermined intent which would explain why suicide is underreported. “Suicide can generally be understood as “death resulting from the use of force against oneself when a preponderance of the evidence indicates that the use of force was intentional,” while undetermined intent refers to a death resulting from “the use of force or power against oneself or another person for which the evidence indicating one manner of death is no more compelling than evidence indicating another”” (Karch et al., 2010: 4 in Botha, 2012: 533). In addition, the problem is that forensic pathologists are not required by law to state whether somebody committed suicide. Moreover, pathologists would have to provide more evidence if suicide was committed while with an undetermined intent, pathologists do not have to provide evidence (Liebenberg, 2012). Therefore, Botha (2012) stated that individuals who committed suicide in South Africa may be actual suicide which is reported under undetermined intent due to the lack of information. Middleton et al. (2003), Burrows and Laflamme (2007), Pritchard and Amanullah (2007) and Värnik et al. (2009) claimed that most deaths under undetermined intent are actually suicides. Going further, “in 2016, the National Statistics definition of suicide has been modified to include deaths from intentional self-harm in 10- to 14-year-old children in addition to deaths from intentional self-harm and events of undetermined intent in people aged 15 and over” (National statistics, 2016: 2).

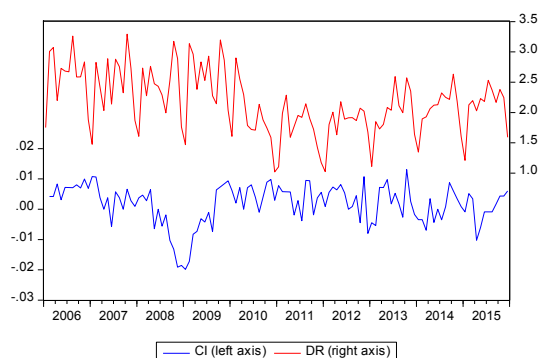
<sup>5</sup>The Asians/Indians racial groups were not included in this study due to the lack of suicide counts in each month.



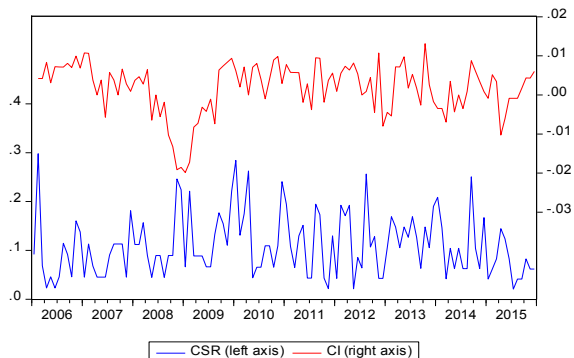
(c) Coincident indicator and fertility rate



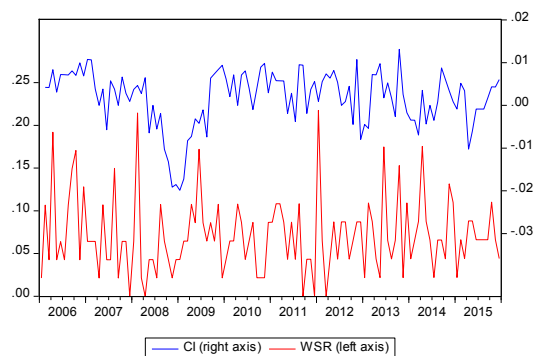
(d) Male, female and the coincident indicator



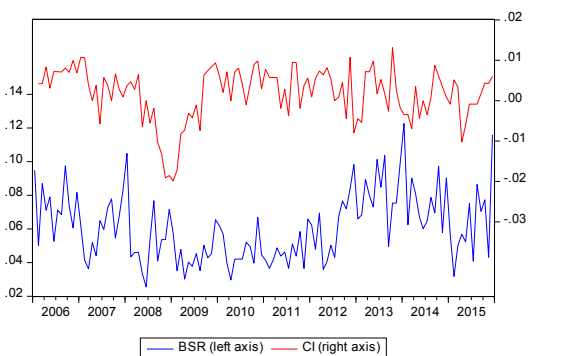
(e) Coincident indicator and the divorce rate



(f) Coloured suicide rate and the coincident indicator



(g) Coincident indicator and white suicide rate



(h) Black suicide rate and the coincident indicator

**Figure 1: Graphical representation of the variables used in this study**

#### 4. Empirical results

As mentioned above, the ARDL model does not require that all series are integrated of the same order which allow the researcher to use  $I(0)$  and  $I(1)$  series in the long run relationship. Therefore, unit root testing was done on all variables to check whether or not they were integrated higher than the order one. Table 2 represents the unit root tests (Augmented Dickey Fuller) ADF which suggests that all series were either integrated of order zero or one. Since there is no series higher than  $I(1)$ , the cointegration testing was established for various suicide rates, taking into account socio-economic variables such as the divorce (dr) and

fertility rate (fr). Six models were examined which included the overall male, female, black, white and coloured suicide rates. Table 3 represents the various model test results.

Table 2: Unit root tests (ADF)

Variable	Level Constant	1st difference Constant	Order
Suicide rate	-6.6076* (0)	-9.8954* (2)	I(0)
Male suicide rate	-6.8216* (0)	-10.4141* (2)	I(0)
Female suicide rate	-9.7734* (0)	-8.4800* (5)	I(0)
Black suicide rate	-3.8378* (1)	-18.6129* (0)	I(0)
White suicide rate	-11.9415* (0)	-9.9073* (4)	I(0)
Coloured suicide rate	-8.9702* (0)	10.0046* (2)	I(0)
Coincident indicator	-1.3486 (2)	-3.5754* (1)	I(1)
Divorce rate	-1.2222 (12)	-5.1925* (11)	I(1)
Fertility rate	0.9482 (12)	-2.896966** (11)	I(1)

Note: ‘\*\*\*’, ‘\*\*’ represent the 1%, 5% and 10% significance levels, respectively. In brackets are the optimal lag structure of the ADF test

Table 3: ARDL cointegration test

	ARDL	Bound test F-statistic
$S_t   CI_t, DR_t, FR_t$	(1,0,5,3)	8.9044*
$MSR_t   CI_t, DR_t, FR_t$	(1,0,0,3)	10.4337*
$FSR_t   CI_t, DR_t, FR_t$	(1,0,0,5)	19.03*
$BSR_t   CI_t, DR_t, FR_t,$	(2,0,3,3)	4.8554*
$WSR_t   CI_t, DR_t, FR_t,$	(1,0,0,0)	28.7731*
$CSR_t   CI_t, DR_t, FR_t,$	(1,0,5,5)	13.393*

Note: ‘\*\*\*’ represent the 1% significance level.

Table 4: Diagnosis check

	LM test	pvalue	HET	p value	JB	p value
$S_t   CI_t, DR_t, FR_t$	0.061957	0.9400	13.76364	0.3161	2.6975	0.2596
$MSR_t   CI_t, DR_t, FR_t$	0.596345	0.8404	7.698237	0.36	5.7631	0.056
$FSR_t   CI_t, DR_t, FR_t$	1.069736	0.3945	5.339233	0.8038	5.77	0.0559
$BSR_t   CI_t, DR_t, FR_t,$	0.178154	0.9492	2.206442	0.9976	8.4275	0.0148
$WSR_t   CI_t, DR_t, FR_t,$	0.776223	0.6732	1.194569	0.879	2.2945	0.3175
$CSR_t   CI_t, DR_t, FR_t,$	0.645665	0.6312	9.446985	0.8014	3.5392	0.1704

Note: LM test, HET and JB represent the test of residual correlation, heteroskedasticity and normality.

Table 5: ARDL results

$S_t \mid CI_t, DR_t, FR_t,$			$MSR_t \mid CI_t, DR_t, FR_t,$			$FSR_t \mid CI_t, DR_t, FR_t,$		
Var	Coeff	T-stat	Var	Coeff	T-stat	Var	Coeff	T-stat
C	-5.8011	-2.9458*	C	-5.3944	-2.5531	C	-6.0588	-1.8691
LNMSR(-1)	-0.6169	-7.2005*	SRt-1	-0.5918	-6.6530*	LNFSR(-1)	-0.9115	-9.6743
CIt	1.1145	1.5701**	LNCI	0.9537	2.1174**	LNCI	0.7745	1.0999
DRt-1	0.2489	0.1638	LNDI	0.1064	0.8186	LNDI	0.2100	1.0255
LNFER(-1)	0.0857	0.1143	LNFER(-1)	-0.0414	-0.0711	LNFER(-1)	-0.0039	-0.0039
D(LNDI)	0.0168	-1.0179	D(LNFER)	0.0827	0.1898	D(LNFER)	0.8325	1.2109
D(LNDI(-1))	-0.1615	-2.4368**	D(LNFER(-1))	-0.6382	-1.0399	D(LNFER(-1))	-0.0165	-0.0145
D(LNDI(-2))	-0.3600	0.0977	D(LNFER(-2))	-1.4318	-3.3002*	D(LNFER(-2))	-2.3491	-2.2751**
D(LNDI(-3))	0.0123	-2.3041				D(LNFER(-3))	-2.2759	-2.5495**
D(LNDI(-4))	-0.2468	0.0239				D(LNFER(-4))	-1.7897	-2.5686**
D(LNFER)	0.0095	-0.8630						
D(LNFER(-1))	-0.5259	-3.3239*						
D(LNFER(-2))	-1.7557							
Symmetric long-run coefficients								
Var	Coeff	T-stat	Var	Coeff	T-stat	Var	Coeff	T-stat
C	-12.4057	-2.0528**	C	-9.2289	-1.4723*	C	-7.6890	-1.0566
CIt	1.8832	2.7054*	CIt	1.5458	2.1852**	CIt	0.8497	1.0997
DRt	0.4206	1.6285	DRt	0.1724	0.8196	DRt	0.2304	1.0206
FRT	0.1448	0.1636	FRT	-0.0671	-0.0711	FRT	-0.0043	-0.0039
Error correction coefficients								
Var	Coeff	T-stat	Var	Coeff	T-stat	Var	Coeff	T-stat
ECT	-0.5918	-6.8021*	ECT	-0.6169	-7.3541*	ECT	-0.9115	-9.9386*

Note: “\*” and “\*\*” represent the 1% significance level.

Table 6: ARDL results.

BSRt  Cit, DRt, GFRt			WSRt  Cit, DRt, GFRt			CSRt  Cit, DRt, GFRt		
Var	Coeff	T-stat	Var	Coeff	T-stat	Var	Coeff	T-stat
C	-7.0233	-3.0862**	C	-0.2515	-0.2515	C	0.7290	0.1607
LNBSR(-1)	-0.4784	-4.8270*	LNWSR(-1)	-11.7234	-11.7234*	LNCBSR(-1)	-0.7445	8.0620*
LNCI	1.4480	2.9392*	LNCI	-0.1213	-0.1213	LNCI	-0.7252	-0.6919
LNDI(-1)	0.2805	1.7260	LNDI	1.6941	1.69409	LNDI(-1)	-0.2713	-0.6799
LNFER(-1)	0.1713	0.2993	LNFER	-0.5295	-0.5295	LNFER(-1)	1.0659	0.7172
D(LNBSR(-1))	-0.2870	-3.1442*				D(LNDI)	0.1433	0.3711
D(LNDI)	-0.1414	-0.8997				D(LNDI(-1))	-0.2017	-0.4192
D(LNDI(-1))	-0.2114	-1.5542				D(LNDI(-2))	0.1914	0.4612
D(LNDI(-2))	-0.2261	-1.7687				D(LNDI(-3))	-0.0285	-0.0922
								-
D(LNFER)	0.4575	1.0790				D(LNDI(-4))	-0.8673	2.8994*
D(LNFER(-1))	-0.2388	-0.3646				D(LNFER)	0.1528	0.1537
D(LNFER(-2))	-1.2394	-2.3103**				D(LNFER(-1))	-1.8659	-1.0483
						D(LNFER(-2))	-2.5932	-1.3853
						D(LNFER(-3))	-0.0162	-0.0091
								-
								2.3752*
						D(LNFER(-4))	-3.0975	*
Symmetric long-run coefficients								
Var	Coeff	T-stat	Var	Coeff	T-stat	Var	Coeff	T-stat
	-							
	19.032							
C	0	-2.3519**	C	-0.1462	-0.2522*	C	-0.3037	0.1609
Cit	3.0269	3.2860*	Cit	-0.1013	-0.1212**	Cit	-0.9741	-0.6981
DRt	0.5864	1.7728	DRt	0.3671	1.6913	DRt	-0.3644	-0.6834
FRt	0.3582	0.2977	FRt	-0.3773	-0.5257	FRt	1.4318	0.7104
Error correction coefficients								
Var	Coeff	T-stat	Var	Coeff	T-stat	Var	Coeff	T-stat
	-							
ECT	0.4784	-5.0202*	ECT	-1.1131	-12.2229*	ECT	-0.7445	8.3453*

Note: “\*\*\*” and “\*\*” represent significance at the 1 and 5%

## 5. Conclusion

To be completed.

## References

- ALTINANAHTAR, A. and HALICIOGLU, F. (2009). A dynamic econometric model of suicides in Turkey. *Journal of Socio-Economics*, 38: 903-907.
- BOTHA, F. (2012). The economics of suicide in South Africa. *South African Journal of Economics*, 80(4): 526-552.
- BUREAU FOR ECONOMIC RESEARCH (BER). 2017. Purchasing Managers' Index™ (PMI™), A monthly index of business conditions in the manufacturing sector. Bureau of Economic Research. [Online]. Available: <https://www.ber.ac.za/Archive/?doctypeid=1066>. [Assessed 24 May 2017].
- BURROWS, S. and LAFLAMME, L. (2005). Living circumstances of suicide 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. (2008). Pattern analysis of suicide mortality surveillance data in urban South Africa. *Suicide and Life-Threatening Behaviour*, 38(2): 209-220.
- BURROWS, S. and SCHLEBUSCH, L. (2008). Priorities and prevention possibilities for reducing suicidal behaviour. In S. Suffla, A. van Niekerk and N. Duncan (eds), *Crime, Violence and Injury Prevention in South Africa: Developments and Challenges*. Cape Town: MRC-UNISA, 186-215.
- BURROWS, S., VAEZ, M., BUTCHART, A. and LAFLAMME, L. (2003). The share of suicide in injury deaths in the South African context: socio-demographic distribution. *Public Health*, 117: 3-10.
- CENTERS FOR DISEASE CONTROL AND PREVENTION (CDC). (2017). Suicide: Consequences. Centers for disease control and prevention. [Online]. Available: <https://www.cdc.gov/violenceprevention/suicide/consequences.html>. [Assessed 5 May 2017].
- CHANG, T. and CHEN, W. (2017). Revisiting the relationship between suicide and unemployment: Evidence from linear and nonlinear cointegration. *Economic Systems*.
- 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(3): 277-289.
- DE WYNCK, D. (2003). A medium-term forecast and interpretation of the crucial property variables. *Rode & Associates CC*, 14(1): 13-19.
- DOS SANTOS, J.P., TAVARES, M. and BARROS, P.P. (2016). More than just numbers: Suicide rates and the economic cycle in Portugal (1910–2013). *SSM-Population Health*, 2: 14-23.
- DU TOIT, J. (2017). ABSA House Price Index. HPI data [Property Analyst]. Johannesburg: ABSA.

GERDTHAM, U. and JOHANNESSON, M. (2005). Business cycles and mortality: results from Swedish microdata. *Social Science & Medicine*, 60(1): 205-218.

GINSBERG, R.B. (1966). *Anomic and aspiration: an interpretation of Durkheim's theory*, New York.

HAMERMESH, D. S. and SOSS, N. M. (1974). An economic theory of suicide. *Journal of Political Economy*, 82(1): 83-98.

HEIKKINEN, M.E., ISOMETSA, E.T., MARTTUNEN, M.J., ARO, H.M. and LONNQVIST, J.K. (1995). Social factors in suicide. *The British Journal of Psychiatry: The Journal of Mental Science*, 167(6): 747-753.

HENRY, A.F. and SHORT, J.F. (1954). *Suicide and homicide: Some economic, sociological and psychological aspects of aggression*. Free Press New York.

KIM, M. and YOO, J. (1995). New index of coincident indicators: A multivariate Markov switching factor model approach. *Journal of Monetary Economics*, 36(3): 607-630.

KOO, J. and COX, W. M. (2008). An economic interpretation of suicide cycles in Japan. *Contemporary Economic Policy*, 26(1): 162-174.

LIN, S-J. (2006). Unemployment and suicide: Panel data analysis. *Social Science Journal*, 43: 727-732.

LUO, F., FLORENCE, C. S., QUISPE-AGNOLI, M., OUYANG, L. and CROSBY, A. E. (2011). Impact of business cycles on US suicide rates, 1928–2007. *American Journal of Public Health*, 101(6): 1139-1146.

MURPHY, G.E. and ROBINS, E. (1967). Social factors in suicide. *Jama*, 199(5): 303-308.

NOCK, M. K., BORGES, G., BROMET, E. J., CHA, C. B., KESSLER, R. C. and LEE, S. (2008). Suicide and suicidal behavior. *Epidemiologic Reviews*, 30: 133-154.

OYESANYA, M., LOPEZ-MORINIGO, J. and DUTTA, R. (2015). Systematic review of suicide in economic recession. *World Journal of Psychiatry*, 22(5): 243-254.

RUHM, C. J. (2000). Are recessions good for your health? *Quarterly Journal of Economics*, 115(2): 617-650.

SOUTH AFRICAN RESERVE BANK (SARB). (2011). Composite business cycle indicators for South Africa. South African Reserve Bank. [Online]. Available: [https://www.resbank.co.za/Research/Statistics/Documents/Press%20release\\_Apr2011.pdf](https://www.resbank.co.za/Research/Statistics/Documents/Press%20release_Apr2011.pdf). [Assessed 12 May 2017].

SOUTH AFRICAN RESERVE BANK (SARB). (2017). Release of Selected Monthly Data Economic indicators (seasonally adjusted). South African Reserve Bank. [Online]. Available: <https://www.resbank.co.za/webindicators/MonthlyIndicators.aspx?DataType=MRDEI>. [Assessed 13 March 2017].

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.

STATISTICS SOUTH AFRICA. (2006). Mortality and causes of death in South Africa, 2006: Findings from death, 2006: Findings from death notification. Statistical Release P0309.3. Pretoria: Statistics South Africa.

STATISTICS SOUTH AFRICA. (2017). Nesstar. Statistics South Africa. [Online]. Available: <http://interactive.statssa.gov.za:8282/webview/>. [Assessed 13 March 2017].

SUZUKI, T. (2008). Economic modelling of suicide under income uncertainty: For better understanding of middle-aged suicide. *Australian Economic Papers*, 47(3): 296-310.

THIBODEAU, L. and LACHAUD, J. (2016). Impact of economic fluctuations on suicide mortality in Canada (1926–2008): Testing the Durkheim, Ginsberg, and Henry and Short theories. *Death Studies*, 40(5): 305-315.

VIREN, M. (1996). Suicide and business cycles: Finnish evidence. *Applied Economics Letters*, 3: 737-738.

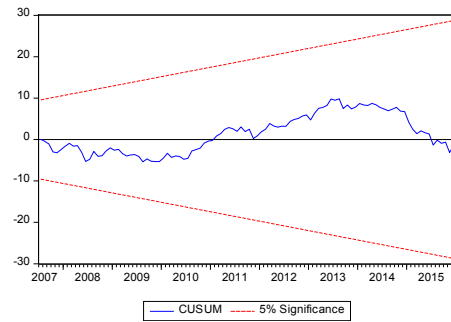
VIREN, M. (2005). Suicide and business cycles: New empirical evidence. *Applied Economics Letters*, 12: 887-891.

WORLD HEALTH ORGANIZATION (WHO). (2014). Preventing Suicide: a Global Imperative. World Health Organization: Geneva, Switzerland.

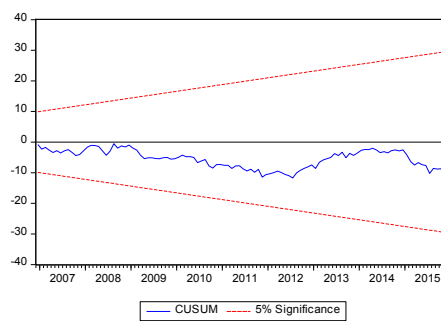
YANG, B. (1992). The economy and suicide. *American Journal of Economics and Sociology*, (51)1: 87-99.

## Appendix

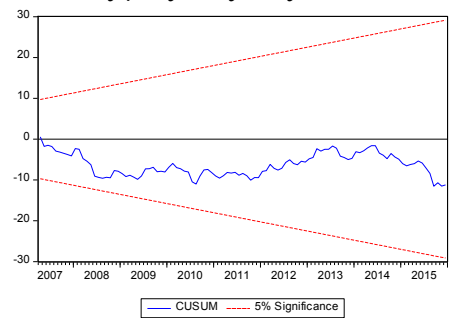
$$S_t \mid CI_t, DR_t, FR_t,$$



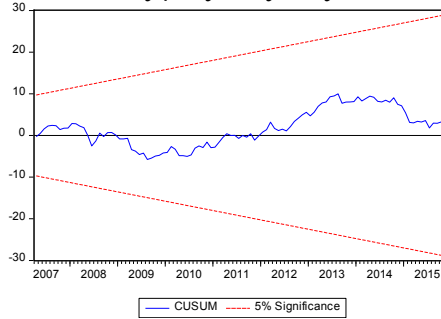
$$MSR_t \mid CI_t, DR_t, FR_t,$$



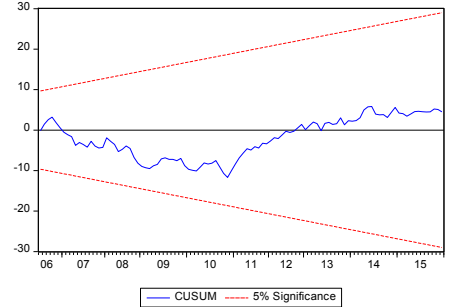
$$FSR_t \mid CI_t, DR_t, FR_t,$$



$$BSR_t \mid CI_t, DR_t, FR_t,$$



$$WSR_t \mid CI_t, DR_t, FR_t,$$



$$CSR_t \mid CI_t, DR_t, FR_t,$$

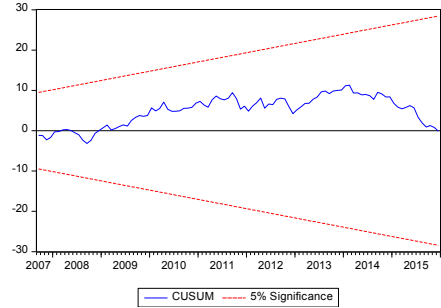
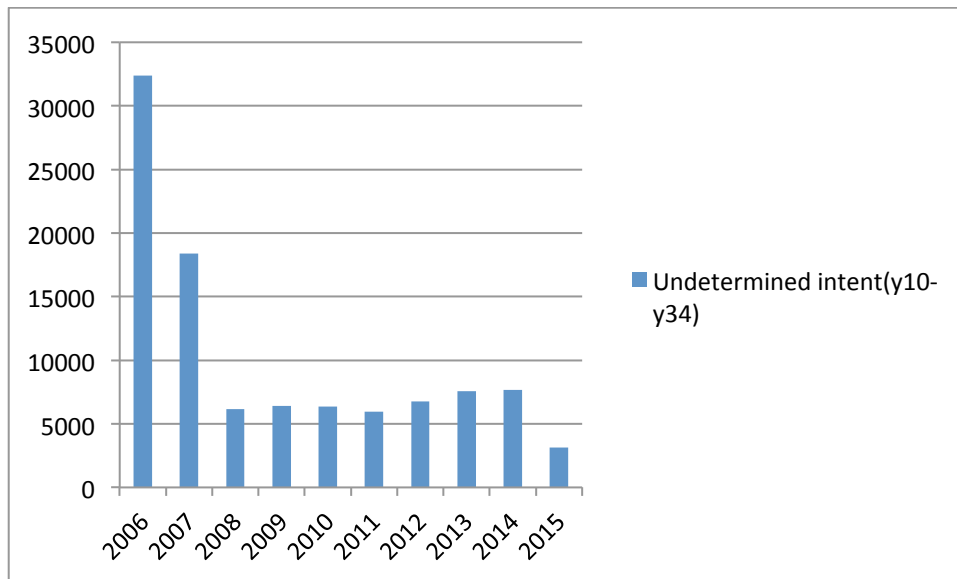
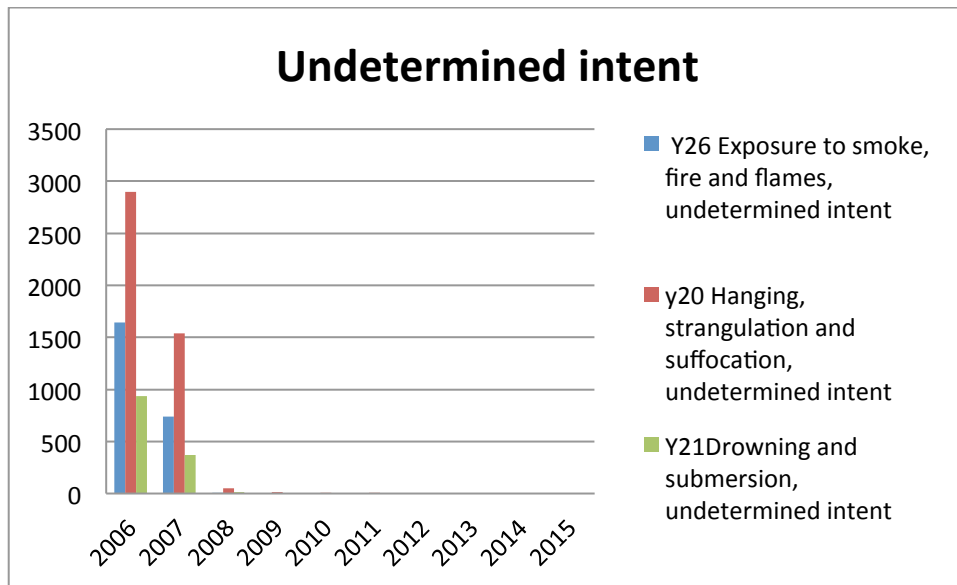


Figure 2: CUNSUM test diagrams



*Figure 3: Undetermined intent (y10-y34)*



*Figure 4: Undetermined intent (Y20 – Y21 - Y26)*