

# SUICIDE AND THE SOUTH AFRICAN BUSINESS CYCLE: A TIME SERIES APPROACH, 2006–2015

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## ABSTRACT

Suicide is a major public health issue and imposes substantial economic cost on society every year. For example, the World Health Organisation has estimated that there are over one million completed suicides every year, of which about 75% occur in middle and low income countries. In South Africa, suicide is one of the leading causes of non-natural death, but remains under-researched from an economic point of view due to limited data availability.

Using monthly data for the period 2006-2015, this study explores whether there is a relationship between suicide and the South African business cycle. This is further broken down to examine how, if at all, this relationship with the business cycle differs across age-, gender-, and racial groups.

The primary source of data for suicide and demographic groups were obtained from Statistics South Africa's Mortality and Causes of Death Data from Death Notification released since 2006. The coincident indicator was used as a proxy for the business cycle as it represents the business cycle in real time.

Using an autoregressive distributed lagged model (ARDL), a long run relationship was established with suicide being a function of the coincident indicator, divorce and fertility rate. The findings of this paper show that the overall suicide rate moves with the South African business cycle (i.e. pro-cyclical relationship) in the long run. This relationship holds for males, the black population group and the 15-29 and 30-44 age categories. In addition, the divorce rate had a positive and significant relationship with the overall suicide rate, as well as suicide among the black population group and for the 30-44 age category, whereas fertility rates had no significant relationship with suicide.

Keywords: Suicide, business cycle, ARDL, South Africa

## DECLARATION

*Except where explicitly stated otherwise and acknowledged, this thesis is wholly my own work and has not been submitted to any other University, Technikon or College for degree purposes.*

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# CHAPTER 1. INTRODUCTION

## 1.1 Research context

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 on 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 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 have 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; Altinanahhtar and Halicioglu, 2009; Chang and Chen, 2017). These studies explored how business cycles<sup>1</sup> affect suicide in order 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).

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 (i.e. Viren, 1996; Lin, 2006; Koo and Cox, 2008; Altinanahhtar and Halicioglu, 2009). Suzuki (2008) extended Hamermesh and Soss' (1974)

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<sup>1</sup> The business cycle can be described as a period with fluctuations of economic activities (Luo *et al.*, 2011). The business cycle consists of four cycles that can range from one to twelve years (Luo *et al.*, 2011). The different cycles can be classified as trough, expansion, peak and contraction (Luo *et al.*, 2011). Once the peak (the highest point) is reached, it is followed by a contraction where the aggregate economic activity decreases, which can also be represented by the recession. Following the contraction, the economy will experience a trough (the lowest point) and then an expansion. The peak and the trough are said to be the turning points of the business cycle. There are many indicators to the business cycle such as the unemployment rate, Gross Domestic Product (GDP), inflation, Purchase Manager Index (PMI), inflation, property cycle and the coincident indicator.

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. Crombie (1990), Hintikka *et al.* (1999), Neumayer (2004), and Coope *et al.* (2014) 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 (gross domestic product) 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).

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. The control variables were the

divorce rate, urbanisation and liquidations. An Autoregressive Distributed Lagged model (ARDL) was used in order to determine how suicide moves with the Turkish business cycle (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 counter-cyclical relationship was found. The control 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 1928-2013. Chang and Chen's (2017) results suggested that suicide was counter-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 among 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 association suicide and the business cycle were 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 in the former, 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 Schlebusch (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 from Death Notification (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).

Botha (2012) was the first to explore 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 Henry and Short (1954), which predicted a counter-cyclical relationship between the business cycle and suicide. Phiri and Makuka (2017) examined the relationship between unemployment and suicide in South Africa for the period 1996-2015. Using annual data from the newly released WHO data; the unemployment rate, inflation rate and GDP were used as proxies for the business cycle. The controlled variables were the divorce and urbanisation rates (Phiri and Makuka, 2017). Using a cointegration technique, overall suicide and disaggregated suicide by gender and age groups were analysed in order to determine their separate influences on suicides in South Africa (Phiri and Makuka, 2017). The results showed that unemployment was only significantly related to suicide rates for the 75+ age group. In addition, other control variables such as GDP per capita, inflation and divorce had a mixed effect on suicide (Phiri and Makuka, 2017).

The main advantage of this study is its contribution to the existing South African research on the economics of suicide. In contrast to Phiri and Makuka's (2017) study, using monthly data this study will also examine suicide by race; an important variable in the South African context. By having better understanding of the relationship between suicide and the business cycle, it will provide policy measures to reduce the suicide rate in South Africa. After all, suicide is an avoidable cause of death.

## **1.2 Goals of the Research**

The goals of this study are:

- To examine how the aggregate suicide rate responds to changes in the South African business cycle.
- To examine how, if at all, the relationship between suicide and the South African business cycle differs across age-, gender-, and racial groups.

### 1.3 Methods, Procedures and Techniques

The paradigm of this research is positivist. Four sources will be used to collect monthly time series data. To obtain suicide data, Statistics South Africa will be used for the Mortality and Causes of Death Data from Death Notification in South Africa for the period 2006-2015<sup>2</sup> (Statistics South Africa, 2017). There are many indicators that help economists to identify the various stage of the business cycle, including Gross Domestic Product (GDP), Gross National Product (GNP), industrial production, property cycles, unemployment and inflation. These economic indicators have been used as proxies for the business cycle in previous research (Yang, 1992; Viren 1996; De Vynck, 2003; Viren, 2005; Koo and Cox, 2008; Altinanahtar and Halicioglu, 2009; Chang and Chen, 2017). However, South Africa has few economic variables that are published on a monthly basis. In this study, the economic indicators (available in monthly frequency) chosen to represent the business cycle include the coincident indicator<sup>3</sup>, Purchasing Manager's Index<sup>4</sup> (PMI) and the ABSA house price index<sup>5</sup>, which will be obtained through the South African Reserve Bank, the Bureau of Economic Research and ABSA bank, respectively (SARB, 2017; BER, 2017; du Toit, 2017). Consistent with previous research (Viren, 2005; Altinanahtar and Halicioglu, 2009; Andrés and Halicioglu, 2011; Chang and Chen, 2017), cointegration analysis (i.e. Autoregressive Distributed Lag modelling) will be used to analyse how overall and disaggregated suicide (by age, gender and race) are linked to the business cycle.

### 1.4 Organisation of the study

The following chapter will present the theoretical framework of suicide from an economic view point. The discussion will begin with Durkheim's (1897) work on suicide followed by Hamermesh and Soss's (1974) study, which was the first study to have significantly contributed in the field of suicide from an economic perspective. Thereafter, two sets of theories relating to the business cycle will be elaborated on (i.e. pro-cyclical and counter-

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<sup>2</sup> Ethical approval for this study has been granted by the Rhodes University Department of Economics and Economic History's Ethics Committee. No other ethical considerations are expected other than the usual requirements of objectivity of analysis.

<sup>3</sup> 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).

<sup>4</sup> The purchasing manager's index reflects the business conditions in the manufacturing sector. For example, an index value of 50 means that there is no change in business conditions, an index value higher (lower) than 50 indicates that the business condition is expanding (declining) (BER, 2017).

<sup>5</sup> The ABSA house price index is also an indication of the business cycle. For example, an increase in the index is a reflection that the business cycle is in the upswing phase and vice versa (de Wynck, 2003).

cyclical) by Ginsberg (1966) and Henry and Short (1954) respectively. A discussion of international empirical studies will follow. This chapter will conclude suicide from a South African context where previous South African studies will be elaborated which will determine where this study can add value to the South Africa.

Chapter three describes the data and presents the methodology in order to achieve the set of objectives described above. Chapter four presents the results from the different models analysed and a discussion of the results. The concluding chapter will provide a summary, limitations and recommendations of this study.

## **CHAPTER 2. LITERATURE REVIEW**

### **2.1 Introduction**

Suicide is one of the leading causes of death in the world as well as in South Africa (Botha, 2012). This chapter reviews the theoretical and empirical literature on the relationship between suicide and the business cycle. Different methodologies have been used to analyse the relationship between suicide and the business cycle. Different relationships were found in different countries which helped policy makers in terms of policy design and implementation. Furthermore, limited research has been done in South Africa and little is known from an economic view point which will make this research interesting as well as add valuable insight to this research field.

The goal of this chapter is to review what has previously been done internationally and in South Africa in order to contribute to the South African context with the available data. This chapter is structured as follows: Section 2.2 will first elaborate on Durkheim's (1897) work, which substantially contributed to the field of suicide, followed by Hamermesh and Soss (1974) who significantly contributed to the field of suicide from an economic perspective. Thereafter, pro-cyclical and counter-cyclical theories will be discussed. Section 2.3 will elaborate on international empirical evidence. Section 2.4 discusses other factors that may affect suicide whereas Section 2.5 focuses on suicide from a South African perspective. Section 2.6 concludes the chapter.

### **2.2 Theoretical literature**

#### **2.2.1 An overview of the study of suicide**

For hundreds of years, suicide has been an interesting field of study for many professions. There has been research that associated suicide with religion, medicine, psychology and economics, for example. This was possible because suicide can be researched side by side with gender, age groups, nations, ethnicity and economics. In the book entitled *Le Suicide*, Durkheim (1897) was the first person known to have substantially contributed to theorizing about suicide. Durkheim (1897) debated emphasis on social norms, which was contrasted with moral and religious beliefs at the time, and was the first to argue that suicide was due to

social factors and individual traits. Durkheim (1897) found that suicide can be categorised into one of four categories based on the victim's relationship with society.

The first category, anomic suicide, is defined as the social instability of an individual that resulted from the breakdown of values and standards (Cameron, 2005). This category is divided into a domestic and economic anomie. The former is the result of individuals who may not be able to cope with the death of a family member and then commit suicide (Cameron, 2005). The latter was explained by individuals' confusion due to an economic recession or expansion. Durkheim (1897) asserted that suicide would both rise during recessions and expansions because of the lack of social integration and social regulation when compared to a normal economic condition. The second category, fatalistic suicide, is defined as a cause of severe regulation, which might result in committing suicide. For example, a prolonged prison sentence may cause someone to commit suicide (Cameron, 2005). The third category is described as egoistic suicide, where the lack of integration (i.e. feeling as if one does not belong to any social groups) might result in someone committing suicide (Cameron, 2005). The last category is altruistic suicide, where someone commits suicide to benefit others. For example, a mother might want to take her own life in order to save her child who needs an organ (Cameron, 2005).

After Durkheim's (1897) work, psychologists, psychiatrists and sociologists have written a substantial amount on this topic. However, it was only in 1974 that economists Hamermesh and Soss (1974) significantly contributed to the field of suicide from an economic point of view. They built the foundation of economic studies on suicide. Their model is given by:

$$Z(a, YP) = \int_a^\omega e^{-r(m-a)} U[C(m, YP) - K(m)] P(m) \omega m \quad (1)$$

where  $Z$  is the lifetime utility of the present value of somebody,  $a$  is the age,  $YP$  refers to permanent income or consumption,  $\omega$  is defined as the highest attainable age,  $r$  refers to the private discount rate,  $U[\cdot]$  and  $C[\cdot]$  are respectively the individual utility function and consumption function,  $K$  refers to the annual cost needed to keep oneself alive and  $P(m)$  is the probability that someone lives to a certain age  $m$ , given survival to age  $a$ . Hamermesh and Soss (1974) argued that when taking into account an individual's age, suicide will be committed if the "remaining discounted lifetime utility reaches zero or falls below a particular value of death" (Botha, 2012: 527). Hamermesh and Soss (1974) argued that suicide is positively related to age and inversely related to income. For example, as age

increases so does suicide and as income increases suicide should decrease. However, Hamermesh and Soss (1974) noted that unemployment would decrease the expected future income and would ultimately increase the probability of committing suicide. Researchers such as Viren (2005), Chuang and Huang (1997), Altinanahtar and Halicioglu (2009), and Chang and Chen (2017) have used the above-mentioned theory in their studies to verify if those relationships hold.

Suzuki (2008) expanded Hamermesh and Soss's (1974) theory 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. Furthermore, Hamermesh and Soss (1974) had placed substantial importance on an individual's age since the cost of living increases with age (i.e. health care costs). An individual's utility would decrease and reinforce the findings that suicide prevails among the elderly. Helliwell (2007) hypothesized that although suicide generally rises with age, suicide was also found to have been rising among youths since the 1950s. This increase was shown in the United States which was due to contagion and divorce (Helliwell, 2007). Cutler *et al.* (2001) argued that suicide among youths is more common when individuals have contact with family or friends that have attempted or committed suicide in the past. In addition, Cutler *et al.* (2001) also found that youths whose parents divorced were more prone to committing suicide.

Hamermesh and Soss's (1974) model focused only on completed suicides whereas Marcotte (2003) extended the model and focussed on suicidal attempts. In the United States alone, about 1.3 million individuals attempt suicide every year (Shepard *et al.*, 2015). There was an increase in attempted suicides from 17 to 25 in 1990 and 2015 for every completed suicide (Petronis *et al.*, 1990; CDC, 2015). Marcotte (2003) noted that individuals who attempted suicide may receive more attention from friends and family members, which would reduce the chances of further attempts. Marcotte's (2003) theory about suicidal behaviour predicts the following: First, there was a negative relationship between the likelihood of attempting suicide and income. For example, an individual is less likely to attempt suicide as real income rises (Marcotte, 2003). Secondly, it predicts that there was a positive relationship between attempted suicide and its utility function. The reasoning behind the second prediction can be viewed from two angles. First, suicide attempts could affect the utility function since a suicide attempt may have some positive effect on future consumption if others (i.e. family

members) are willing to help financially. Secondly, attempted suicide increases, which diminishes its utility function.

### **2.2.2 Pro-cyclical and counter-cyclical theories**

In relation to the association of suicide with the business cycle, three main theories have been developed throughout the years. Durkheim (1897) predicted a nonlinear relationship between suicide and the business cycle, whereas a pro-cyclical relationship was hypothesized by Ginsberg (1966) and a counter-cyclical relationship was argued by Henry and Short (1954).

Durkheim (1897) argued a nonlinear relationship where during economic upswings and downswings both social integration and regulation weaken, which increases suicide. Durkheim (1897) placed emphasis on the fact that social integration and social regulation are important factors that may determine suicide. Thus, Hintikka *et al.* (1999) explained that during an economic upswing, individuals' social interactions decline hence increasing the chances of someone committing suicide. Another perspective was argued by Posel and Casale (2011) and Daly and Wilson (2009), where suicide increased because the increase in income due to an economic upswing results in individuals being less content when comparing their peers' income to their own.

On the other hand, Ginsberg's (1966) theory stated a pro-cyclical relationship, which arises from the individual dissatisfaction "which is directly related to the discrepancy between the actual reward of an individual and his level of aspiration" (dos Santos *et al.*, 2016: 15). For example, during an economic upswing, the assumption is that an individual's consumption increases, leisure time declines and stress rises due to longer working hours. In addition, during upswings suicide may increase due to greater alcohol consumption (Coovadia *et al.*, 2009). On the other hand, Henry and Short (1954) argued suicide may be counter-cyclical, in that during upswings suicides decrease (i.e. as incomes rise individuals are doing better) and during recessions suicides increase (i.e. as incomes decrease individuals are worse off). This theory is based on the frustration-aggression theory, where during a recession individuals with high stature will be more likely to commit suicide because of the loss of stature.

To add to Henry and Short (1954), Ruhm (2000) also reasoned that suicides may increase during a recession (a counter-cyclical relationship). The reasons for this possibility were theorised to be due to an individual's financial and psychological stress. When a recession occurs, the expected future income of an individual declines and the likelihood of suicide

may increase. For unemployed individuals, a greater impact can be experienced. Suzuki (2008) reasoned that suicides may rise when future income is uncertain. Furthermore, Dixit and Pindyck (1994), and Yang and Lester (1995) also argued that suicide may increase during a recession because individuals may not think rationally and believe that their current situation will persist; thus, any future possible improvement is disregarded.

## **2.3 Empirical Evidence**

### **2.3.1 Counter-cyclical studies**

The majority of studies have found a counter-cyclical relationship between suicide and economic indicators (Viren, 2005; Lin, 2006; Koo and Cox, 2008; Altinanahtar and Halicioglu, 2009; Andrés and Halicioglu, 2010; Thibodeau and Lachaud, 2016; Chang and Chen, 2017).

Using a co-integration analysis and error correction modelling, Viren (2005) examined whether suicide can be related to economic determinants in Finland for the period 1878-1999. The employment share of primary production was used as a proxy for the business cycle (Viren, 2005). In Viren's (2005) study, the control variables were age, gender (female/male population) and population share of the cities (in total population). A counter-cyclical relationship was found. Consistent with Hamermesh and Soss's (1974) theory, suicide had a greater impact on elderly people. Male suicides were also found to be three to four times higher than that of female suicides (Viren, 2005). The results indicated that economic fluctuations only had a temporary effect on overall suicide rates (Viren, 2005).

Koo and Cox (2008) examined the relationship between suicide and the business cycle in Japan for the period 1950-2003. The unemployment rate was used as a proxy for the business cycle. Koo and Cox (2008) studied how the relationship between suicide and the business cycle differs across gender and age. The control variables were the divorce rate, fertility rate, female labour market participation (FLP) and alcohol consumption (Koo and Cox, 2008). Male suicides in Japan were the highest among developed countries (Koo and Cox, 2008). During the 1990s, Japan experienced suicide rates to be the highest among middle-aged men (Koo and Cox, 2008). This was contrary to Hamermesh and Soss's (1974) finding, which hypothesised that suicides were positively related to age. Koo and Cox (2008) suggested that the increase in suicides could be explained by the fact that Japan, the second largest economy

in the world at that time, slowed down. Using a time series analysis, a counter-cyclical relationship was found between suicide and unemployment. Koo and Cox (2008) forecasted that on average, one percentage point increase in the unemployment rate would increase suicides by 4,774 persons. Since unemployment has a negative impact on suicide, Koo and Cox (2008) argued that governments should place emphasis on policies that prevent the depreciation of human capital for the unemployed, which could help prevent the number of individuals committing suicide. For example, they suggested the implementation of a tax break on corporations which would assist them in hiring temporary workers (Koo and Cox, 2008).

Lin (2006) examined data for both Taiwan and other Asian countries for the period 1979-2002. Lin (2006) studied whether the relationship differs across age, education and gender. Using a fixed effect model, a counter-cyclical relationship was found between unemployment and suicide in Taiwan and other Asian countries. Consistent with Hamermesh and Soss's (1974) theory, Lin (2006) argued that unemployment decreases the individual's expected future income, which could result in a loss of health insurance and increase in psychological stress. These factors could cause a deterioration of health and hence increase suicide. Furthermore, male suicides were higher compared to the rates of their female counterparts. Contrary to the findings of Koo and Cox (2008), Lin (2006) found a positive relationship between age and suicide consistent with Hamermesh and Soss's (1974) theory. In addition, Lin's (2006) results showed a negative relationship between income and suicide. Using Hamermesh and Soss's (1974) theory, Lin (2006) explained that a higher income level implied a greater level of satisfaction and an increase in consumption, which reduces the probability of committing suicide. Therefore, authorities should concentrate their efforts on economic downturns by offering appropriate preventative measures that would encourage help seeking incentives (Lin, 2006).

Altinanahtar and Halicioglu (2009), and Chang and Chen (2017) used cointegration modelling, more precisely an Autoregressive Distributed Lagged model (ARDL), in Turkey and in the United States respectively. Both studies examined the determinants of suicide from an economic and socio-economic perspective for the period 1974-2007 and 1928-2013 respectively (Altinanahtar and Halicioglu, 2009; Chang and Chen, 2017). Altinanahtar and Halicioglu (2009) used per capita real income whereas Chang and Chen (2017) used the unemployment rate as a proxy for the business cycle. The control variables were the divorce

rate, urbanisation and liquidations in Altinanahtar and Halicioglu (2009) whereas Chang and Cheng (2017) controlled for the divorce and the fertility rates. The results in both studies showed that a long run relationship existed amongst the variables. Both studies depicted a counter-cyclical relationship between the economic determinants and suicide rate, which was consistent with Hamermesh and Soss's (1974) findings.

Andrés and Halicioglu (2010) also used an ARDL approach to examine the determinants of suicide in Denmark for the period 1970-2006. Real income per capita and unemployment were used as a proxy for the business cycle and the control variables were the divorce and fertility rates. Andrés and Halicioglu (2010) found a counter-cyclical relationship between real income per capita and overall, male and female suicide. Although this study has shown that females are more vulnerable to income loss than males, existing research in Denmark showed that men were more vulnerable to economic conditions as compared to women (Qin *et al.*, 2003). However, there was no clear explanation as to why this was the case in this study. In addition, there was a counter-cyclical relationship between the unemployment rate and suicide rate for all the categories implying that the impact on female and male unemployment with regards to suicide was identical (Andrés and Halicioglu, 2010).

Chang and Chen (2017) found that the unemployment rate 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. In addition, the results showed that a negative change in unemployment has a greater impact on specific age groups (i.e. 45-54; 55-64 and 65-74), where suicides escalate steadily during recessions and decrease faster during economic expansions. According to Chang and Chan (2017), during a recession, depression, anxiety and frustration may arise from unemployment and as a result suicides may increase. Chang and Chen (2017) argued that only a small number of individuals who suffer from serious psychological pain would actually commit suicide, which would increase during a recession but at a constant pace. In addition, most individuals have positive expectations about the future and most individuals would find employment again when the economy recovers, hence the propensity of committing suicide would be low. As a result, the expectation is that suicide would fall faster during an economic expansion.

Thibodeau and Lachaud (2016) examined the impact of economic fluctuations on suicide in Canada for the period 1926-2008, using the unemployment rate and GDP as a proxy for the

business cycle. The control variables were the divorce rate and the fertility rate consistent with the study conducted by Chang and Chen (2017). Using a time series approach, the results revealed that suicide was counter-cyclical and that unemployment played a significant role in a specific age group (i.e. 45-64 years old) predominantly among males. This can be explained by the fact that middle-aged men are the breadwinners in the household. They are the ones paying for the insurance, mortgage and children's education. Therefore, Thibodeau and Lachaud (2016) hypothesized that they were the most vulnerable to economic fluctuations. Moreover, the results showed that the unemployment rate had a significant negative relationship between unemployment and the 15-24 age category between 1951-1973.

### 2.3.2 Pro-cyclical studies

Some studies have reported a pro-cyclical relationship between suicide and economic variables (Crombie, 1990; Hintikka *et al.*, 1999; Neumayer, 2004; Coope *et al.*, 2014).

Hintikka *et al.* (1999) examined this relationship in Finland for the period 1985-1995. The unemployment rate and GDP were used as a proxy for the business cycle. The control variables were the divorce rate and alcohol consumption. Using a regression analysis, both male and female suicides were positively associated with an increase in GDP, indicating that suicide increases during upswings and decreases during downswings. Interestingly, this study was not in line with previous studies that found a counter-cyclical relationship between the unemployment and suicide rates. One possible explanation lies in the fact that "being unemployed no longer had the usual social stigma that increases the risk of suicide" (Hintikka *et al.*, 1999: 87).

Coope *et al.* (2014) explored the relationship between suicide and the business cycle in England and Wales for the period 2000-2011. The study's aim was to identify which demographic group (i.e. gender and age groups) was affected the most before, during and after the financial crisis. The control variables were marital status, age, occupation class and the deprivation decile<sup>6</sup> to identify the differences before, during and after the 2008 economic crisis. Many indicators for the business cycle were used, namely the unemployment rate, house repossessions, insolvencies, bankruptcy orders and redundancy rate (Coope *et al.*,

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<sup>6</sup> The deprivation decile index supplied with the mortality data is defined as "as '1' being most-deprived, '5' intermediate deprived and '10' being least-deprived. The English indices of deprivation identify the most deprived areas across the country and combine a number of indicators, chosen to cover a range of economic, social and housing issues, into one score for each small area in England" (Coope *et al.*, 2014: 78).

2014). Using a time series analysis, there was no association found between female suicide and economic indicators. Coope *et al.* (2014) showed that during the downturn, suicide rates among the 16-34 year olds halted before and during the 2008 financial crisis. For men between 25-34 years of age “this halt in decreasing suicide rates may be partly explained by pre-recession increases in indicators of financial strain such as house repossession and insolvencies, whilst in the 16-24 year olds just entering the labour market rising rates of unemployment from 2004 may have contributed” (Coope *et al.*, 2014: 84). Between the end of 2008 and beginning of 2010, for men between 35-44 years of age, the trend was reversed from downward to upward. This corresponded to various economic indicators such as the rise in the unemployment rate, economic hardships (i.e. house repossession and household debt) and the rise of individual insolvencies. Coope *et al.* (2014) suggested that interventions should focus on individuals who have difficulties in meeting debt obligations, which could be more effective than interventions that look only at the unemployed.

Crombie (1990) analysed the relationship between unemployment rate and suicide in sixteen countries for the period 1973-1983. Crombie (1990) found that only Germany followed a pro-cyclical relationship between suicide and the unemployment rate. However, no further explanations were given to clarify as to why this was the case. Consistent with Crombie’s (1990) findings, Neumayer (2004) examined the relationship between economic variables (i.e. unemployment and economic growth) and mortality in Germany for the period 1980-2000. Using a static and a dynamic econometric model, Neumayer (2004) found that mortality decreases in recessions, when using the unemployment rate as a proxy for the business cycle. This was the case with suicide for males and females as well as aggregated suicide. Thus, suicide was pro-cyclical in Germany. However, when real GDP was taken as a proxy for the business cycle, suicide did not follow a pro-cyclical between Germany’s business cycle and suicide. There were no clear explanations as to why this may be the case.

### **2.3.3 Mixed results studies**

Two studies worth mentioning which found mixed results were Yang (1992) and Saurina *et al.* (2013).

Yang (1992) examined how overall and disaggregated suicides by female labour force participation rate, the divorce rate, membership in the Catholic Church, age, gender and racial groups change with social and economic variables in the United States for the period 1940-1984. In this study, the unemployment rate and the gross national product were used as

proxies for the business cycle. Using a multiple regression analysis, aggregated suicides followed a counter-cyclical relationship. However, this pattern was reversed for female suicides. The unemployment rate had a significant negative impact on the suicide rate for white males. In addition, the divorce rate had a consistent impact on suicide in all racial groups and had a greater impact compared to unemployment on the overall suicide rate (Yang, 1992). Contrary to Koo and Cox's (2008) findings, Yang (1992) found that the prevalence of suicide was higher among females. In addition, Yang (1992) found that females' mental health may be more affected by the experience of divorce as compared to males. For example, one plausible explanation was that after divorce females were worse off financially when compared to males. Thus, the probability of committing suicide may increase (Yang, 1992).

Saurina *et al.* (2013), and Fountoulakis *et al.* (2015) analysed the relationship between the unemployment rate and completed suicide using a hierarchical mixed models and descriptive statistics for England and Greece, respectively. Fountoulakis *et al.* (2015) extended this relationship to attempted suicide for the period 2000-2012. Interestingly, the results show a negative correlation between attempted suicide and the unemployment rate, whereas a positive correlation was found between completed suicide and the unemployment rate. However, no explanation was given as to why a negative correlation was present. In the study by Saurina *et al.* (2013) aggregated and disaggregated suicide by gender and regions were analysed for the period 2008-2013. There was no significant relationship with the overall suicide rate. However, a pro-cyclical relationship in East England, East Midlands and London and a counter-cyclical relationship in South West, North West and North East was found for men. There was no clear explanation for these findings but it was argued that the relationship might have been spurious because of the absence of control variables (Saurina *et al.*, 2013).

## **2.4 Suicide and other factors**

In addition to the business cycle, it is important to note that suicide rates may also be affected by many other variables such as social ties/fertility, female labour force participation rate, migration/urbanisation, divorce, alcoholism, education, and depression, for example.

Yang (1992), Chuang and Huang (1997), Koo and Cox (2008), Andrés and Halicioglu (2010), and Chang and Chen (2017) argued that families with children promote social ties

and increase social integration which thus reduces the probability of committing suicide. However, this seemed to have a greater impact on women than on men. Therefore, the expectation is that as fertility increases (decreases) suicide should decrease (increase). Classen and Dunn (2011), Schaede (2013), and Chang and Chen (2017) also reported that fertility rates increases stress levels among individuals because of the burden of care for families which may increase suicides. Chuang and Huang (1997) reported no relationship between suicide and the fertility rate in Taiwan when other social variables were taken into account. In the United States, Lester and Yang (1992) found a positive relationship between suicide and the fertility rate. In Koo and Cox (2008), the results showed that fertility was more related to female suicides. However, in the case of Chang and Chen (2017) the fertility rate had no significant impact on overall suicide rate in the long run whereas Andrés and Halicioglu (2010) found that as the fertility rate increases suicides decrease which is in line with the above-mentioned theory.

Chuang and Huang (1997) stated that the increase in female labour force participation might impact suicides. For example, with the increase in women participating in the labour force, a decrease in social integration might be experienced. Thus, the increase in female labour participation rates might lead to higher suicides because of the conflicts that arise between genders (Chuang and Huang, 1997). Consistent with Chang and Huang's (1996) argument, Koo and Cox's (2008) results showed that in Japan the negative impact in female labour force is more distinctive in male suicides. Huang (1996) added that the influence between suicide and female participation in the labour force is not clear because females' participation rates can also strengthen their social bond and integration (Huang, 1996). This can be explained by the fact that women have the chance to develop themselves and bring something "new" to the family. Thus, the relationship between suicide and female labour participation will vary (Huang, 1996).

Migration and urbanisation were also hypothesised to be a possible cause of suicide (Chuang and Huang, 1997). Chuang and Huang (1997) claimed that migration could result in social disruption and reduce social integration because the individuals were leaving behind friends and family. Such scenarios could lead to individuals committing suicide. In Altinanahtar and Halicioglu's (2009) study discussed above, the results showed that the urbanisation factor had a greater impact on real income. In the last decade, more people have fled villages across Turkey to settle around big cities in the hopes of finding a better job and more money. Thus, shanty towns were created to accommodate for the influx of people (Altinanahtar and

Halicioglu, 2009). The move was seen as a hope to get a better education, health and safety. However, the quality of life and job opportunities were far less than expected. As a result, the probability of committing suicide in the cities was greater than in rural areas.

The divorce rate can also affect suicidal behaviour (Yang, 1992; Cutler *et al.*, 2001; Chang and Chen, 2017; Thibodeau and Lachaud, 2016). Divorce reduces social integration because it deviates from the social norm. The disruption that arises from being divorced might affect the family negatively and reduce the social ties between them. Moreover, divorce can be classified as a trauma that can result in someone committing suicide (Barstad, 2008). Therefore, the expectation is that countries with high divorce rates should have high suicide rates as well. Interestingly, Cutler *et al.* (2001) found that the chance of committing suicide is greater in households with divorced parents. In the United States, Cutler *et al.* (2001) reported that suicides were increasing among the youth and might be explained through divorce rates. Stack and Scourfield (2015) also showed that the timing of divorce affected whether individuals committed suicide. For example, the probability of committing suicide after one year of the divorce is greater than after five years. Altinanahtar and Halicioglu's (2009) results showed that the divorce rate had almost no impact on suicides in Turkey. This can be explained by the fact that the divorce rate was lower in developed countries because marriages are highly valued by the Turkish people (Altinanahtar and Halicioglu, 2009).

The empirical results in Chang and Chen (2017) showed that the divorce rate had mixed results for different age categories. For example, for the 45-54, 55-64 and 65-74 age groups a positive shock to the divorce rate in the short run resulted in an increase in suicide, which was consistent to Durkheim's (1897) egotistic effect (Chang and Chen 2017). However, for the 45-54, 55-64 and 65-74 age groups, a negative shock to the divorce rate resulted in an increase in suicide rates. This was consistent with Durkheim's (1897) work, specifically the anomic suicide effect. Chang and Chen (2017) noted that it remains unclear as to why the above effects were different for the various age groups; perhaps it was because the different age groups belonged to different generations. In Hintikka's *et al.* (1999) study the divorce rate had no relationship with suicide rates, which does not support Durkheim's (1987) (integration/regulation) theory. Hintikka *et al.* (1999) explained that this relationship was non-existent because divorce has become more socially acceptable than it was before. In South Africa, Botha's (2012) findings showed that the probability of suicide was lower for single men and women as compared to a divorced individual. Moreover, compared to a single individual, married individuals have a higher chance of committing suicide contrary to

existing research by Stack and Wasserman (1993) and Kposowa (2000). These two studies reported that suicide was lower for married individuals as compared to others. For example, Burrows and Laflamme (2005), in line with Botha's (2012) findings, reported that in the Tshwane municipality, suicides were greater in areas with higher counts of married individuals.

Excessive alcohol intake increases the probability of committing suicide due to the lack of integration among individuals (Neumayer, 2003; Neumayer, 2003a; Ramsted, 2001; Brainerd, 2001; Memtsov, 2003; Andrés, 2005). Hintikka *et al.* (1999) explained that alcohol abuse is generally higher among men and the rise in alcohol consumption increases the risk of suicide. This phenomenon has been shown in the South African context. For example, in the Western Cape Allan *et al.* (2001) found that alcohol consumption was positively related to suicide. In Russia, Pridemore (2006) reported that the relationship between alcohol consumption and suicide was among the highest as compared to other nations. Memtsov (2003) concluded that in Russia, alcohol consumption did indeed play a role in suicide, especially in males.

Research consistently reports significant gender differences in suicidal behaviour. Möller-Leimkühler (2003) argued the suicides were generally higher among males. Traditionally, men were persuaded to express feelings of masculinity (i.e. strength, courage) as compared to feelings of anxiety and fear, for example. As a result, men would not express these feelings and consequently, avoid treatments due to possible damage to their self-esteem. In addition, with the increase of women in the workplace, traditional gender roles have changed significantly. Women are becoming more independent and competitive from a job perspective, which might be seen as a threat to men's jobs. Therefore, due to anxiety and low self-esteem in the workplace men have higher chances of committing suicide because of the change in gender roles (Möller-Leimkühler, 2003). Botha (2012) reported that the above-mentioned factors were consistent in the South African context as the current labour legislation promotes the hiring of woman.

The relationship between suicide and education is unclear as has been documented by Shah and Bhandarkar (2009). Shah and Bhandarkar (2009) argued that education is positively related to income, which implies that for every additional year of education the higher the expected income. The level of education can also be an indication of a person's status in society. Thus, individuals with low income may experience financial stress due to the lack of

education, which increases the risk of suicide. On the other hand, additional years of education would result in a higher ranking position, which would increase the stress experienced by the individual due to added responsibilities (Botha, 2012). In South Africa, the probability of committing suicide is higher among individuals with no education relative to those with primary education (Botha, 2012). However, the findings also showed that the probability of committing suicide was greater among individuals with secondary and post-secondary education as compared to individuals only having obtained a primary education. Lin's (2006) results showed that individuals who have a tertiary education were more prone to committing suicide, which was also consistent with Botha's (2012) findings. Therefore, Lin (2006) consistent with Shah and Bhandarkar's (2009) study hypothesized that stress (due to more responsibilities gained via higher educational attainment) increases the probability of committing suicide.

## **2.5 Suicide in a South African context**

Developed countries have an advantage over developing countries because detailed data exists, which enable authors to comprehensively analyse suicide dynamics. Unfortunately, it was only in 2006 that more detailed data became available in South Africa (Statistics South Africa, 2006). During the apartheid period, record keeping was not reported accurately for all racial groups and thus was considered unreliable. In addition, in 1992 the Births and Registration Act (Act 51 of 1992) was changed and prohibited the record keeping of the nature of all deaths. Therefore, it was impossible to analyse the determinants of suicides at a national level at that time (Botha, 2012). It was only in 1999 that the National Injury Mortality Surveillance System (NIMSS) was created with the aim of facilitating and collecting death injuries data, which included complete suicides as well. The NIMSS did not cover all municipalities at the time although the number of municipalities increased every year. Research that represents South Africa as a whole was not yet possible. For example, in the province of KwaZulu-Natal, no data were collected as part of NIMSS in 2008 because of the non-participation of medico-legal laboratories (CVILP, 2010).

All the studies prior to 2012 used the NIMSS (Burrows, 2005; Burrows and Laflamme, 2006; Stark *et al.*, 2010) and the South Central Statistical (CSS) databases in order to investigate suicide rates by race, gender and age groups (Flisher *et al.*, 2004; Burrows, 2005; Burrows and Laflamme, 2006; Stark *et al.*, 2010) and by cities (Burrows, 2005; Burrows and

Laflamme, 2006). Flisher *et al.* (2004) revealed that suicide was high among the youths and also among white males and the elderly. Flisher *et al.* (2004) noted that the increase in suicide rates among the white elderly may be because of the growth of the population at that time (i.e. the white population over the age of 65 increased by 88% for the period 1968-1990), which caused a decrease in resources per elderly person. Since suicides were rising among the youths in line with Europe and the United States, preventive measures were needed for the target groups (Flisher *et al.*, 2004).

To add to Flisher *et al.* (2004), Burrows (2005) found that that the odds of suicide were also significantly higher during middle adulthood, particularly among white individuals. Similar to Burrows's (2005) findings, Burrows and Laflamme (2006) exhibited that suicide prevalence was higher among whites in almost all cities. Furthermore, the results showed that cities played a significant role in determining suicide across races and gender. Stark *et al.* (2010) examined overall and disaggregated suicide by age groups, gender, the month in which the suicide occurred, and racial groups in Bloemfontein and the southern Free State province for the period 2003-2007. Stark *et al.* (2010) found that over 56% of the individuals who committed suicide were unemployed. The majority of suicides were also committed by males. Interestingly, the majority of white males and black females committed suicide in January while female suicides have a higher percentage in January and July. However, black male suicides were generally equally distributed throughout the year. It is important to note that these studies were provincial and city-based analyses because of the poor data availability at that time (Burrows, 2005; Burrows and Laflamme, 2006; Stark *et al.*, 2010).

It was only in 2006 that Statistics South Africa started the release of the datasets entitled Mortality and Causes of Death Data from Death Notification, which enabled suicide analysis in South Africa at a national level which Botha's (2012) study made use of. And it was only in 2017 that the WHO dataset released yearly data corresponding to post-democratic era (1996-2015) which was used by Phiri and Makuka (2017). Both studies were the first and, to date, only studies that explored the relationship between economic and socio-economic variables in South Africa from a national perspective (Botha, 2012; Phiri and Makuka, 2017).

Botha's (2012) study aimed to analyse the mortality trends by geographic locations in South Africa. The only two variables that could be used as a proxy for economic performance were the inflation rate and new car sales, as they were the only data available by province (Botha, 2012). The chosen variable as a proxy for economic performance was the inflation rate

(Botha, 2012), based on the argument that the inflation rate was more likely to affect individuals directly as compared to new car sales. Using a probit model, Botha (2012) estimated the likelihood of an individual committing suicide versus an individual dying from another cause, which is consistent with previous studies such as Stack and Wasserman (1993), and Masocco *et al.* (2010). Botha's (2012) control variables were age, gender, education, marital status, the month the suicide was committed and the province of residence of the individuals. The results showed that the probability of suicide increases as inflation decreases, but this was not statistically significant. Thus, although not significant, 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. Thus, an improvement of the South African economy was associated with a decrease in the likelihood of committing suicide for both men and women (Botha, 2012). The counter-cyclical relationship can be explained by the increase in psychological and financial stress during a downturn period (Ruhm, 2000). In addition, with retrenchment and job cuts, more individuals become unemployed and therefore, financial and psychological stress may rise and increase the probability of committing suicide. Moreover, downswing periods may also lead to future income uncertainty, which may increase suicide (Suzuki, 2008).

Botha (2012) confirmed that the probability of suicide was higher among men as compared to women, which was consistent with previous studies (Chuang and Huang, 2007; Meel, 2003; Burrows, 2005). Botha's (2012) findings also showed that the probability of committing suicide for younger individuals (i.e. 15-24 years old) was greater than for all other groups. Existing research also confirm the same pattern (Cutler *et al.*, 2001; Flisher *et al.*, 2004; Burrows and Laflamme, 2008). There are various explanations as to why the youth have a higher chance of committing suicide. For example, youths are more emotional compared to adults, and can fall into depression more easily which may result in suicide. Cutler *et al.* (2001) also argued that suicide can be contagious; youths may be prone to commit suicide if relatives or family members have attempted suicide in the past. Moreover, youths commit suicide impulsively as compared to a premeditated act. In addition, South Africa is known to have a high level of unemployment rate, especially among the youth (Schöer *et al.*, 2012). Financial- and psychological stress may be present among unemployed youths, which may increase the risk of committing suicide. Burrows and Laflamme (2008) explained that with the shift from the apartheid regime to a democratic one, there was a more violent presence in South Africa than before. Therefore, the violence and political change could have increased

the level of stress and anxiety among the youths, making it difficult to adapt to changes and thus increase the risk of committing suicide. These arguments may explain why suicide rates are higher among the youths.

The second study that analysed suicide dynamics from a national perspective in South Africa was done by Phiri and Makuka (2017). Their objective was to examine the relationship between unemployment and suicide in South Africa, controlling for divorce and urbanisation rates for the period 1996-2015 (Phiri and Makuka, 2017). In other words, Phiri and Makuka (2017) examined how overall suicide and disaggregated suicide by gender and age groups move with the unemployment rate. The results show that the unemployment rate was statistically insignificant with overall and the different age categories except the 75+ age category where a significant and positive relationship between unemployment and suicide was found. In addition, GDP had mixed results, positive and insignificant for total and male suicide rates and positive and significant at the 10% significance level for the remaining models. However, the inflation rate was found to have mixed results but was statistically significant in all models. A negative relationship between suicide and the inflation rate was found for the overall and 75+ age group whereas the rest of the models were found to have a positive relationship. The reason as to why this was the case was not explained in the paper.

## **2.6 Conclusion**

This chapter reviewed previous international and South African research in relation to the relationship between suicide and the business cycle. Since Durkheim's (1897) study, more research has been done in this field and it is only after the pioneer work of Hamermesh and Soss (1974) that research into the economics of suicide increased. Moreover, this chapter reviewed the different theories set by Henry and Short (1954) and Ginsberg (1966), which gave insight into the counter-cyclical and pro-cyclical movement of suicide with respect to the business cycle.

The different methodologies used by various authors depended on the data available at the time of research. For example, Lin (2006) used a fixed and random effects model. Viren (2005), Altinanahtar and Halicioglu (2009), Andrés and Halicioglu (2010), Chang and Chen (2017), and Phiri and Makuka (2017) used co-integration techniques for time series analysis; Thibodeau and Lachaud (2016) used ARIMA techniques for a time series analysis; Viren (1996), and Koo and Cox (2008) used OLS for time series data or pooled data.

The literature provides insights on how socio-economic and economic factors relate to suicide. Since suicide is affected by many variables as considered in this chapter, it is therefore impossible to incorporate all the variables in one study. It is important to note as well that the majority of the studies found a counter-cyclical relationship between suicide and the business cycle.

In South Africa, it was only in 2006 that Statistics South Africa released monthly data on death-related injuries, which enabled research on suicide at a national level as noted in Botha (2012). Recently, the WHO also released annual data on suicide for the period 1996-2015 as used in Phiri and Makuka (2017). The literature review also notes the gap in the South African context as compared to developed countries. For example, the majority of studies such as Burrows (2005), Burrows and Laflamme (2006), and Stark *et al.*, (2010) were provincial based studies.

The data in South Africa are now sufficiently long for a time series analysis. Compared to Phiri and Makuka (2017) this study will be using monthly data, which will add another dynamic perspective, important in the South African context which will be the population group variable. Thus, this study is interesting and important to undertake at a national level for future reference.

## CHAPTER 3. DATA AND METHOD

### 3.1 Introduction

This chapter provides an overview of the datasets used to achieve the set of objectives outlined in Chapter one. In addition, this chapter discusses the methodology that will be adopted in this study, namely the Autoregressive Distributed Lag Model (ARDL), which is consistent with previous empirical studies such as Altinanahtar and Halicioglu (2009), Andrés and Halicioglu (2010), Chang and Chen (2017), and Phiri and Makuka (2017).

This chapter is structured as follows: Section 3.2 discusses the data and suicide rate calculations, whereas Section 3.3 discusses the methodology used. In this sub-section, the advantages of using the ARDL model will be explained and the diagnostic checks will also be discussed. Section 3.4 concludes the chapter.

### 3.2 Data

This study uses six different sources to collect monthly time series data. The suicide data were obtained from Statistics South Africa's Mortality and Causes of Death Data from Death Notification in South Africa for the period 2006-2015<sup>7</sup> (Statistics South Africa, 2017). The data were obtained from death notification forms<sup>8</sup> that were first received by the Department of Home Affairs. Statistics South Africa then processes all these forms.<sup>9</sup> The dataset includes information such as the deceased's race, 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 Recorded Live Births 1998-2015 dataset was also collected from Statistics South Africa (2017). This dataset was

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<sup>7</sup> A request was made to Statistics South Africa in order to get the population group of the deceased included in the dataset, as the publically available data does not include a person's population group. The request was granted and as mentioned in Chapter one, ethics approval was obtained from the Department of Economics and Economic History's Ethics committee. The dataset does not contain personal information about the deceased and is anonymous.

<sup>8</sup> Different sources were considered in addition to the Statistics South Africa's Mortality and Causes of Death Data from Death Notification. They were the World Health Organisation (WHO) mortality statistics released on an annual basis for gender and age categories only, the National Injury Mortality Surveillance System (NIMSS) but this was not nationally representative (CVILP, 2010; Statistics South Africa, 2017; Phiri and Makuka, 2017). The data used in this study are therefore the only data available to address this study's research question.

<sup>9</sup> Since 2006, Statistics South Africa released the dataset which includes all deaths for that year registered at the Department of Home Affairs. Thus, the data might exclude some deaths that occurred but was not registered or deaths that have been registered but did not reach Statistics South Africa in time for the processing phases.

used to calculate the fertility rate (*fr*) (defined as the number of births/1,000 women aged between 15-44 years) (Statistics South Africa, 2015c; Chang and Chen, 2017). The Marriage and Divorce statistical release from South Africa dataset was used to calculate the divorce rate (*dr*) (defined as the number of divorces per month/1,000 people) (Statistics South Africa, 2015a). The mid-year population estimates were also obtained from Statistics South Africa and was used to calculate various suicide rates (Statistics South Africa, 2015b). In addition, the WHO World Standard Population Distribution weights were used to calculate the age-adjusted suicide rates (see Section 3.2.1) per 100,000 people (Ahmad *et al.*, 2001).

The coincident indicator was chosen as a proxy for the business cycle and collected from the South African Reserve Bank (SARB) (SARB, 2017).<sup>10</sup> The coincident indicator is an indication of the real time of the business cycle: an increase (decrease) in the coincident indicator is an indication of an upswing (downswing) period (Kim and Yoo, 1995; SARB, 2011).

### 3.2.1 Suicide rate calculation

Consistent with previous studies, such as those by Andrés and Halicioglu (2010), and Chang and Chen (2017) this study used two rates, namely suicide rate per 100,000 and the age-standardised suicide rates per 100,000 people which is a two-step calculation. Both suicide rates were respective to their population size. One assumption made in this study was that the mid-year population estimate remains constant for that year since monthly population estimates were unavailable. The suicide rate per 100,000 people was calculated as follows:

$$\frac{\text{Number of suicides within specific race, sex, age groups per month}}{\text{Mid-population per month within specific race, sex, age groups}} \times 100,000 \quad (2)$$

This method was used to calculate suicide rates for overall, gender and racial groups, it is customary to use the rate per 100,000 population (Koo and Cox, 2008; Flisher *et al.*, 2004

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<sup>10</sup> Other economic indicators were considered as proxies for the business cycle, namely the ABSA house price index and the purchasing manager index (PMI), collected from ABSA bank and the Bureau of Economic Research respectively (du Toit, 2017; BER, 2017). These indicators were chosen because they are released on a monthly basis. For the ABSA house price index, an increase (decrease) in the index is a reflection that the business cycle is in the upswing (downswing) phase (de Wynck, 2003). The PMI reflects business conditions in the manufacturing sector. For example, an index value of 50 means that there is no change in business conditions, whereas an index value higher (lower) than 50 indicates that the business condition is expanding (declining) (BER, 2017). Two graphs between the coincident indicator and the ABSA house price index as well as the PMI (in percentage change) were plotted to represent the time plot, which is shown in Appendix B. From the graph it was difficult to see a distinct relationship with the coincident indicator especially with the ABSA house price index. Since the coincident index is an indicator of the real time of the business cycle it was chosen as a proxy for the business cycle.

Luo *et al.*, 2011). The advantage of using this particular method is that it makes the rates comparable to other countries.

In addition, the age-standardised rates per age groups were also calculated for the different age categories. For this purpose, the WHO world standardised population distribution weights were assumed to be representative of South African age group distribution. Firstly, the number of suicides in each month per age group was divided by the total population estimate per 100,000 people, which was then multiplied by WHO world standardised population distribution weights (see Appendix A). Four age groups were used (15-29; 30-44; 45-59; 60+). Since the WHO gives weights for every five year increment, the weight was added in order to match our age groups. For example, for the first age group (15-29) the WHO's weights were added for the 15-19, 20-24, 25-29 age groups so the weight for the 15-29 age group could be calculated (also see Flisher *et al.*, 2004; Andrés and Halicioğlu, 2010; Ceccherini-Nelli and Priebe, 2011; Chang and Chen, 2017). The age groups (15-29; 30-44; 45-59 and 60+) with their respective weights can be found in Appendix A.

For the purpose of this study, four age groups were analysed, informed by data availability. If more categories were generated, there would have been months where no suicides were committed (i.e. the problem present when the variables are logged, one cannot calculate the log of zero). Even with four age groups, the 44-59 and 60+ age categories were classified as the suicide rate per 100,000 because the logarithmic form could not be taken due to the lack of data. A similar problem arose with the white population group where the logarithmic form could not be taken due to the lack of data.

*Table 1: Summary statistics*

Variables	Mean	SD	Median	Max	Min
Overall Suicide rate	0.075	0.021	0.071	0.134	0.032
Male suicide rate	0.120	0.036	0.114	0.210	0.054
Female suicide rate	0.031	0.013	0.029	0.083	0.008
Black suicide rate	0.061	0.020	0.058	0.123	0.026
White suicide rate	0.071	0.044	0.066	0.217	0.000
Coloured suicide rate	0.110	0.063	0.104	0.298	0.021
SR1 (15-29)	0.855	0.305	0.835	1.712	0.299
SR2 (30-44)	0.470	0.172	0.437	0.095	0.082
SR3 (44-59)	0.179	0.082	0.162	0.425	0.000
SR4 (60+)	0.007	0.045	0.071	0.273	0.000
Coincident indicator	106.699	6.986	106.850	117.100	94.000
Divorce rate	2.169	0.511	2.136	3.293	1.021
Fertility rate	85.622	6.321	85.939	98.634	64.570

*Notes: SD is the standard deviation. Suicide rate is per 100,000 people and respective to their population size. The Indian/Asian category was omitted due to the lack of data.*

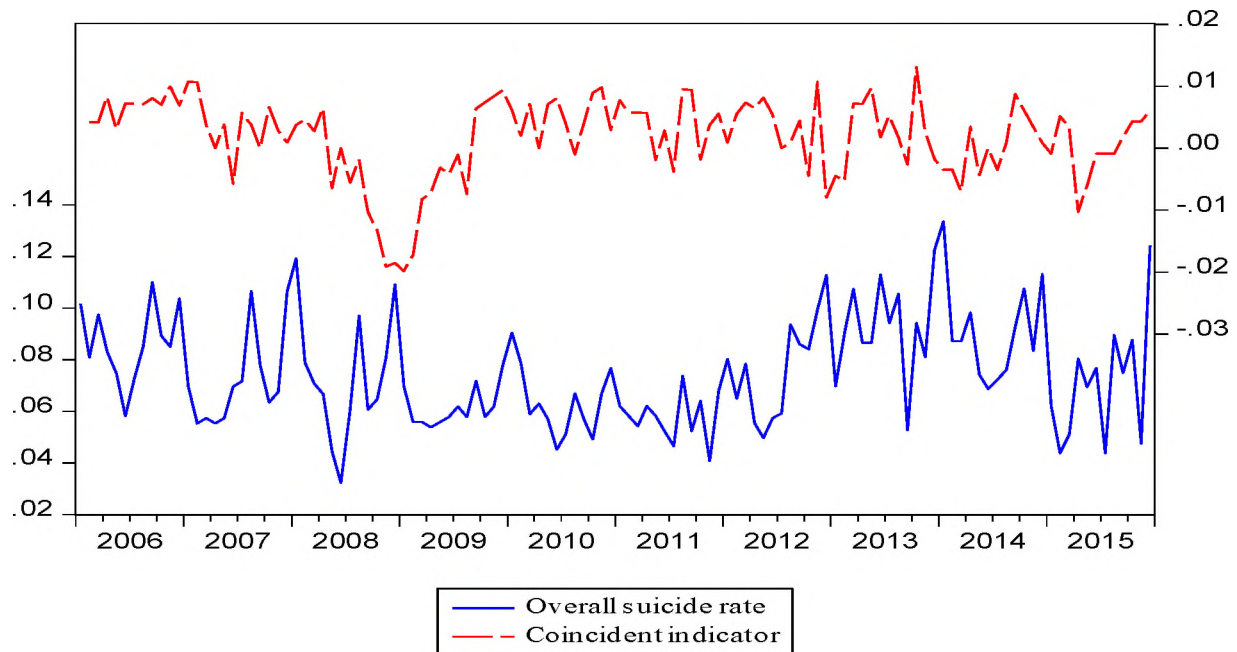
Table 1 provides summary statistics of the variables included in this study. The overall suicide rate ranged from 0.03 to 0.13 per 100,000 people. These rates are extremely low compared to international studies (Andrés and Halicioglu, 2010; Chang and Chen, 2017). For example, in 2004 the suicide rate for Belgium, South Korea and Japan ranged from 19.06 to 23.97 per 100,000 people (Andrés and Halicioglu, 2010). This might indicate that suicide is heavily under-reported in South Africa, which will be elaborated on further in the conclusion chapter. The divorce and fertility rates ranged from 1.02-3.29 and 64.57-98.63 per 1,000 people respectively. Consistent with previous research in South Africa, the male suicide rate is much higher than the female suicide rate (Lin, 2006; Burrows and Laflamme, 2008; Botha, 2012; Phiri and Makuka, 2017) which is also consistent internationally (Koo and Cox, 2008; Andrés and Halicioglu, 2010; Chen and Chen, 2017).

In addition, the average suicide rate was highest for the younger age groups (15-29) (and 45% of the cases were among the 15-29 year old age group), which is consistent with previous South African and international studies (Cutler *et al.*, 2001; Flisher *et al.*, 2004; Burrows and Laflamme, 2008b; Botha, 2012; Helliwell, 2007; Thibodeau and Lachaud, 2016). However, this was contradictory to pioneers Hamermesh and Soss's (1974) theory which predicted that age was positively associated with suicide.

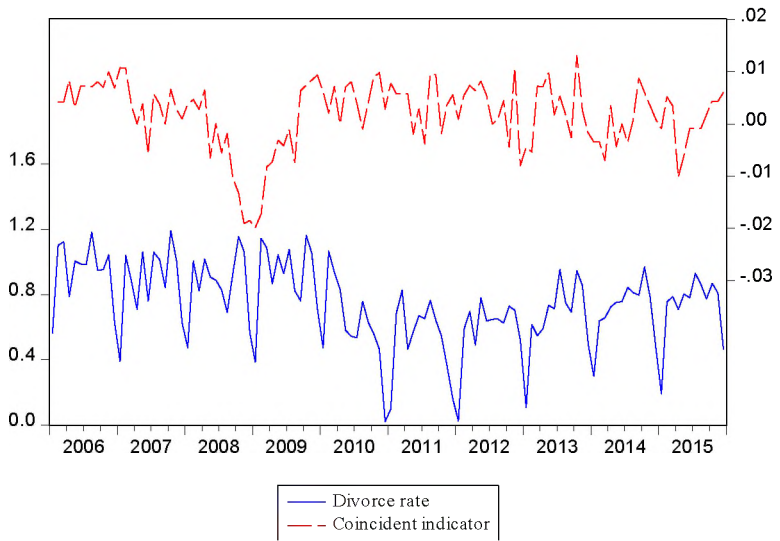
*Table 2: Suicide count by population group (2006-2015)*

Population group	Suicide count 2006-2015	Percentage relative to overall suicide count
Black African	2996	65%
White	394	9%
Coloured	606	13%
Indian or Asian	66	1%
Unspecified	535	12%

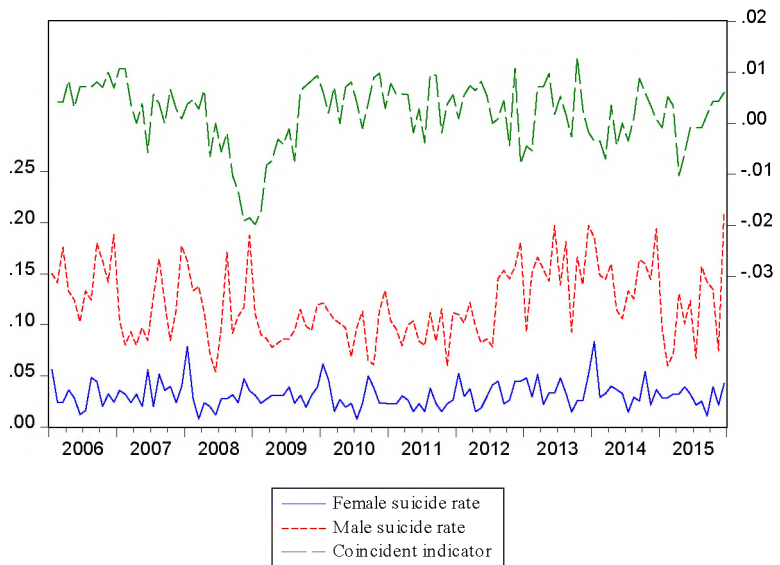
From Table 2, the majority of suicides were among the black population group from 2006-2015, followed by the coloured, white, and Indian/Asian population groups. However, as shown in Table 1, it is important to note that when observing suicide rates for the population group (relative to their population size), the coloured population group was the highest, followed by the white and black population groups. This finding was contrary to other South African studies (Flisher and Parry, 1994; Flisher *et al.*, 2004; Burrows and Laflamme, 2005), which found that the suicide rate was highest among the white population group.



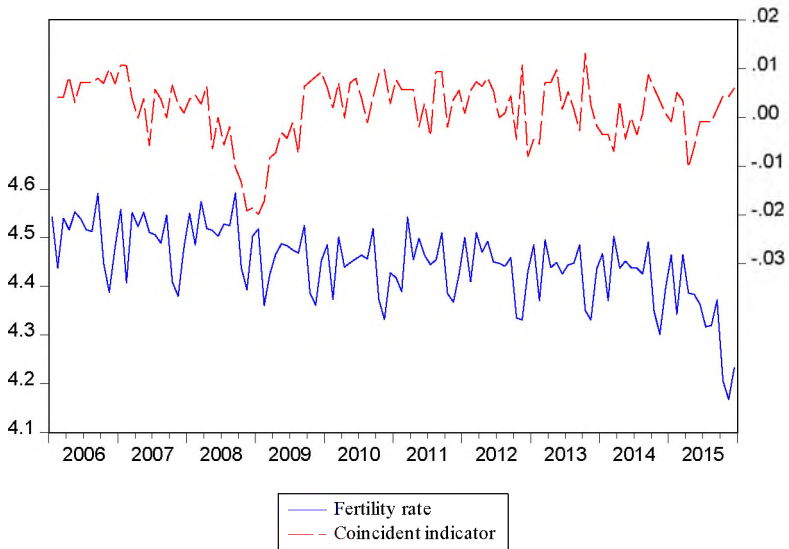
(a) Overall suicide rate with the coincident indicator



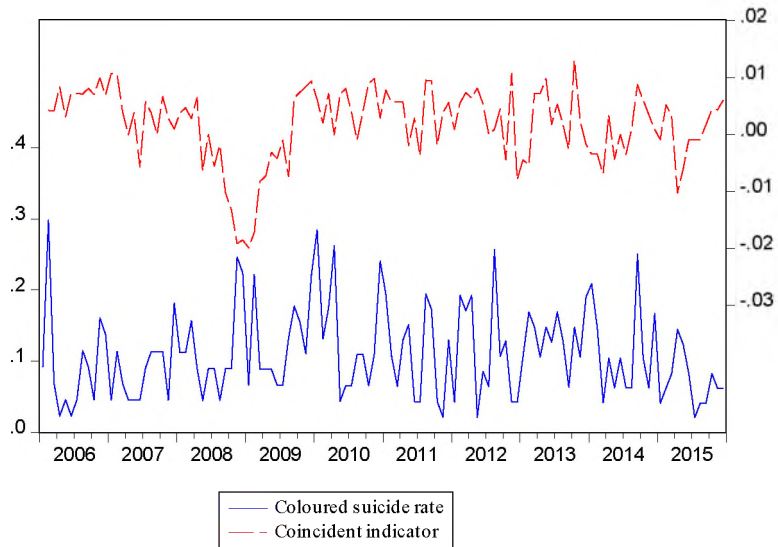
*(b) Coincident indicator and divorce rate*



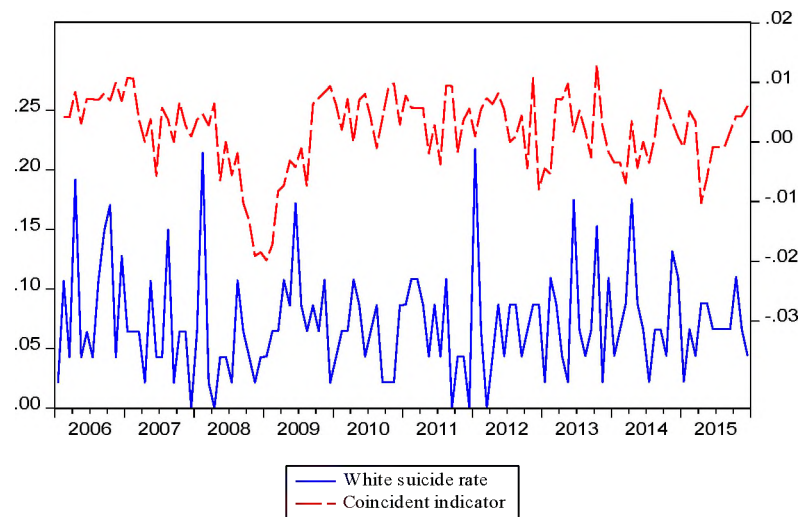
*(d) Male, female and the coincident indicator*



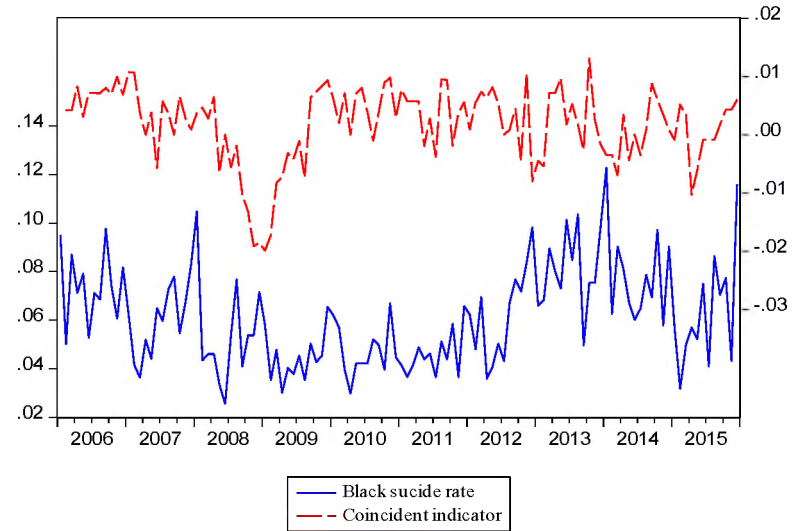
(c) Coincident indicator and fertility rate



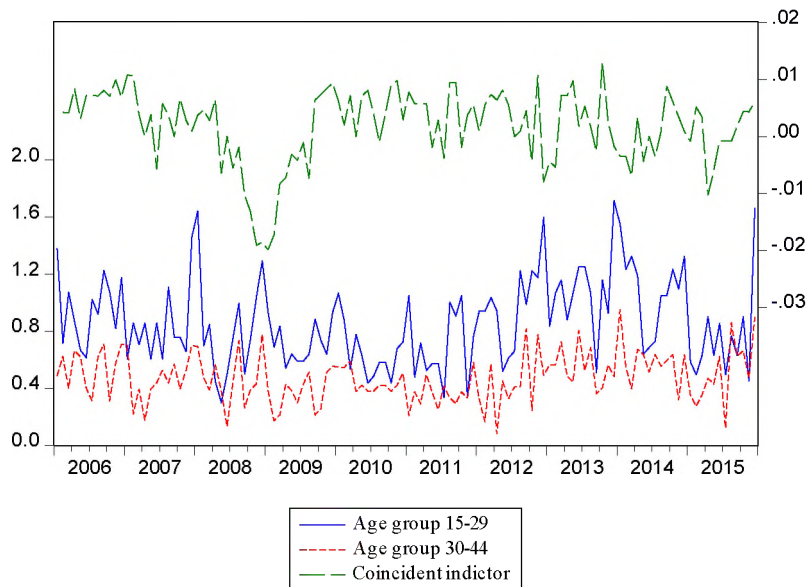
(e) Coloured suicide rate and the coincident indicator



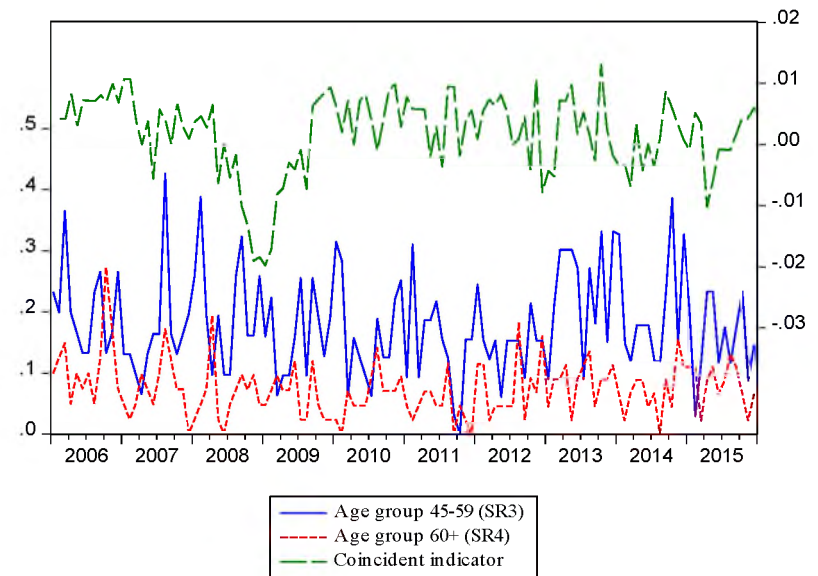
(f) White suicide rate and the coincident indicator



(g) Black suicide rate and the coincident indicator



(h) Coincident indicator and age groups



(i) Coincident indicator and age groups

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

Figure 1 plots the relationships of the coincident indicator (in percentage change) with the overall suicide rate and suicide rate disaggregated by gender, race, and age. The figures also plot the coincident indicator against the divorce- and fertility rate. As shown in Figure 1 (a), a positive relationship between overall suicide rate and the coincident indicator can be expected. As mentioned in Chapter two, Ginsberg (1966) argued that suicide can move with the business cycle because during an economic upswing, the assumption was that an individual's consumption increases, leisure time declines and stress rises due to longer working hours. However, it is important to note that this relationship is ambiguous for the period 2008-2009, which was marked by the financial crisis, and for the 2014 period. There is a pro-cyclical relationship for the period between April 2008 to June 2008 and thereafter a counter-cyclical relationship until January 2009. Similar pro-cyclical patterns between suicide and the coincident indicator are evident for males, blacks, whites, and the 15-29 and 30-44 age groups (see Figure 1 (d), (g), (f) and (h) respectively). Therefore, from Figure 1, the expectation would be a pro-cyclical relationship between suicide and the South African business cycle.

Figures 2 (b) and (c) show the relationship between the divorce and fertility rate and the coincident indicator and from the graphs the relationship is not entirely clear.

### **3.3 Methodology**

#### **3.3.1 Model specification**

Based on the literature discussed in Chapter two and data availability, ten different regressions will be analysed where the dependent variable will be the suicide rate for the overall sample, as well as by age group, population group and gender consistent with previous studies such as Altinanahtar and Halicioglu (2009), Andrés and Halicioglu (2010), Chang and Chen (2017), and Phiri and Makuka (2017). The control variables are divorce and fertility rate (Chuang and Huang, 1997; Altinanahtar and Halicioglu, 2009; Andrés and Halicioglu, 2010; Thibodeau and Lachaud, 2016; Phiri and Makuka, 2017). Consistent with Altinanahtar and Halicioglu (2009), Andrés and Halicioglu (2010), Chang and Chen (2017), and Phiri and Makuka (2017) the long run relationship between suicide, the coincident indicator, divorce and fertility in linear logarithmic form. It is important to note that due to the availability of data, three suicide rates (i.e. the white suicide rate as well as 45-59 and 60+

age categories), were classified as the suicide rate per 100,000 because the logarithmic form could not be taken as explained in the earlier section. Thus, the long run relationship is established as follows:

$$S_t = a_0 + a_1ci_t + a_2dr_t + a_3fr_t + \varepsilon_t \quad (3)$$

Where  $S_t$  is the suicide rate per 100,000,  $ci_t$  the coincident indicator,  $dr_t$  the divorce rate,  $fr_t$  is the fertility rate and  $\varepsilon_t$  the error term. 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). Therefore, as divorce increases, suicides should increase as well. The divorce variable has been used extensively internationally and in South Africa (Yang 1992; Heikkinen *et al.*, 1995; Altinanahtar and Halicioglu, 2009; Botha, 2012; Chang and Chen, 2017; Phiri and Makuka, 2017). Yang (1992), Chuang and Huang (1997), Koo and Cox (2008), Andrés and Halicioglu (2010), and Chang and Chen (2017) argued that families with children promoted social ties and increases social integration, and thus reduce the probability of committing suicide. Therefore, the expectation is that as fertility increases (decrease) suicide should decrease (increase).

### 3.3.2 Cointegration Methodology

This study will make use of an Autoregressive Distributed Lag (ARDL) bounds testing approach (Pesaran and Shin, 1999; Pesaran *et al.*, 2001). It is important to note that the ARDL approach has four distinct econometric advantages when compared to other cointegration procedures. First, “endogeneity problems and inability to test hypotheses on the estimated coefficients in the long-run associated with the Engle–Granger method are avoided” (Altinanahtar and Halicioglu, 2009: 905). Secondly, both short-run and long-run parameters of the model being estimated are estimated at the same time. Thirdly, one of the main advantages of using the ARDL approach is that the model allows for a combination of both I(0) and I(1) variables in the model being estimated (Altinanahtar and Halicioglu, 2009). Finally, the model can be used in small samples as well (Phiri and Makuka, 2017). The variables included in equation (3) were first checked through the Augmented Dickey-Fuller (ADF) and the Kwiatkowski-Phillips-Schmidt-Shin (KPSS) tests in order to make sure that none of the variables were integrated at an order higher than I(1). The empirical model is specified as follows:

$$\Delta \ln S_t = b_0 + \sum_{i=0}^m b_{1i} \Delta \ln S_{t-i} + \sum_{i=0}^m b_{2i} \Delta \ln ci_{t-i} + \sum_{i=0}^m b_{3i} \Delta \ln dr_{t-i} + \sum_{i=0}^m b_{4i} \Delta fr_{t-i} + b_5 S_{t-1} + b_6 ci_{t-1} + b_7 dr_{t-1} + b_8 fr_{t-1} + D_t + v_t \quad (4)$$

Where  $\Delta$  is a first difference operator,  $b_0$  is the intercept and the variables  $b_{1i}$  to  $b_{4i}$  and  $b_5$  to  $b_8$  are the short and long run elasticities,  $D_t$  is a dummy, and  $v_t$  is the error term. As mentioned in the previous section, due to the ambiguity of the relationship between the suicide rate and the coincident indicator as well as the severity of the 2008 financial crisis, this study controlled for the financial crisis by incorporating a dummy variable equal to one for the period October 2007 to March 2009, and zero otherwise<sup>11</sup>. The lag length was determined using Akaike Information Criterion (AIC). Since there are a large number of observations, the maximum lag length is set to six (also see Chang and Chen, 2017). The long-run relationship can be tested using the modified F-statistic with the null hypothesis of no cointegration ( $\rho = b_5 = b_6 = b_7 = b_8 = 0$ ) against the alternative hypothesis of cointegration ( $\rho \neq b_5 \neq b_6 \neq b_7 \neq b_8 \neq 0$ ) (Pesaran *et al.*, 2001). The testing procedure by Pesaran *et al.* (2001) used two critical bounds, the upper and the lower bound. 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.

Assuming the existence of a long run relationship, the unrestricted error correction model (UECM) is estimated as follows;

$$\Delta \ln S_t = c_0 + \sum_{i=0}^m c_{1i} \Delta \ln S_{t-i} + \sum_{i=0}^m c_{2i} \Delta \ln ci_{t-i} + \sum_{i=0}^m c_{3i} \Delta \ln dr_{t-i} + \sum_{i=0}^m c_{4i} \Delta \ln fr_{t-i} + \lambda EC_{t-1} + u_t \quad (5)$$

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

### 3.3.3 Diagnostic checks

The ARDL models are examined for serial correlation, heteroscedasticity and functional form. Breusch-Pagan Godfrey's serial correlation LM test will be used to test for autocorrelation (Altinanahtar and Halicioglu, 2009; Chang and Chen, 2017). The null

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<sup>11</sup> For completeness of this study, all models were tested without the dummy variable and the results were similar. Therefore, the dummy variable was included in all models.

hypothesis is no autocorrelation. If autocorrelation is present, different models with different lag length will be used (Andrés and Halicioglu, 2010). Breusch-Pagan Godfrey's test for heteroscedasticity was used, with the null hypothesis of homoscedasticity. If the p-value is below the threshold of 0.05 ( $p < 0.05$ ) the null-hypothesis is rejected and heteroscedasticity is assumed. If heteroscedasticity is present, the model needs to be adjusted appropriately and re-estimated (Chang and Chen, 2017). The Ramsey RESET test for functional form was used to check whether there was any sign of non-linearity in the estimated models (i.e. whether the fitted value is significant different from zero). In other words, falling to reject the null-hypothesis shows that there is no sign of non-linearity.

### **3.4 Conclusion**

This chapter reviewed the methodology and data used in order to achieve the set of objectives set in Chapter one. Interestingly, the dataset revealed that the suicide rate for the coloured population group was the highest relative to their population size followed by the white and black population groups. The male suicide rate was higher compared to female suicide rate and the first age category (i.e. 15-29) shows the highest suicide rate compared to the other groups, consistent with previous studies done in South Africa (Burrows and Laflamme, 2008; Botha, 2012; Phiri and Makuka, 2017). From preliminary graphical analyses, a pro-cyclical relationship between suicide and the South African business cycle can be expected.

The coincident indicator was chosen as a proxy for the South African business cycle. Ten ARDL models will be analysed where each model will have a different suicide rate as the dependent variable. They are the overall, gender, population and age groups. Consistent with previous studies the control variables will be the divorce and fertility rate (Chuang and Huang, 1997; Altinanahtar and Halicioglu, 2009; Andrés and Halicioglu, 2010; Thibodeau and Lachaud, 2016; Phiri and Makuka, 2017). Six data sources were used in this study; the Mortality and Causes of Death Data from Death Notification, Marriage and Divorces statistical release, Recorded Live Births, the South African Reserve Bank, Mid-Year Population Estimate and the WHO world standardised population distribution weights (SARB, 2017; Ahmad *et al.*, 2001; Statistics South Africa, 2017). The results will be presented in the next chapter.

## CHAPTER 4. RESULTS AND DISCUSSION

### 4.1 Introduction

This chapter reports the results from the ARDL models. Ten different models will be analysed in order to examine how overall suicide and disaggregated suicide by age, gender and population groups change with the South African business cycle. From Figure 1 (a) the prediction was that the overall suicide rate follows a pro-cyclical relationship with the South African business cycle. However, it was difficult to predict other variables such as the divorce, fertility and other suicide rates. From the predicted theory, a positive (negative) relationship between suicide and divorce (fertility) can be expected.

This chapter is structured as follows: Section 4.2 presents the empirical findings. Thereafter, cointegration tests were performed, which is followed by estimating the ten different models that tested simultaneously for the short- and long run asymmetric effect. This is followed by a discussion of the results and diagnostic checks. This chapter will end with a conclusion.

### 4.2 Empirical findings

#### 4.2.1 Stationarity tests

*Table 3: ADF and KPSS unit root tests*

Variables	ADF		KPSS		Order
	Level	1 <sup>st</sup> difference	Level	1 <sup>st</sup> difference	
$S_t$	-6.604*** (0)		0.271		I(0)
$MSR_t$	-6.819*** (0)		0.271		I(0)
$FSR_t$	-9.675*** (0)		0.117		I(0)
$BSR_t$	-3.967*** (1)		0.371		I(0)
$WSR_t$	-11.941*** (0)		0.077		I(0)
$CSR_t$	-8.688*** (0)		0.184		I(0)
$SR1_t$	-7.571*** (0)		0.272		I(0)
$SR2_t$	-10.308*** (0)		0.248		I(0)
$SR3_t$	-9.214*** (0)		0.098		I(0)
$SR4_t$	-8.835*** (0)		0.289		I(0)
$CI_t$	-1.483 (2)	-3.425*** (1)	0.908	0.082	I(1)
$DR_t$	-1.242 (12)	-4.997*** (11)	0.679	0.244	I(1)
$FR_t$	1.172 (12)	-2.522 (11)	1.131	0.096	I(1)

*Notes:  $S_t$  is the overall suicide rate,  $MSR_t$  is the male suicide rate,  $FSR_t$  is the female suicide rate,  $BSR_t$  is the black suicide rate,  $WSR_t$  is the white suicide rate,  $CSR_t$  is the coloured suicide rate,  $SR1_t$   $SR2_t$   $SR3_t$   $SR4_t$  are the suicide rates for the age categories 15-29, 30-44, 45-59 and 60+ respectively,  $CI_t$ ,  $DR_t$ ,  $FR_t$  are the coincident indicator, divorce and fertility rate, respectively. \*\*\* and \*\* represent the 1% and 5% significance levels, respectively. The values in brackets are the optimal lag structure of the ADF test. The null-hypothesis for the ADF test is a unit root and stationarity for the KPSS test.*

As mentioned in the previous chapter, one advantage of using ARDL bounds testing is that the variables can be of order I(0) or I(1), whereas other cointegration techniques such as the

Johansen procedure stipulate that all variables should be of order I(1) (Enders, 2014). From Table 3, all suicide rates were integrated of order I(0) and the coincident indicator, divorce and fertility rates were integrated of order I(1). The fertility rate was integrated of order I(1) using the KPSS test but not the ADF test. The KPSS is known to be a more robust test for stationarity when compared to the ADF test since the rejection rule (i.e. reject the null-hypothesis) for stationary is rejected less frequently. As indicated in Table 3, the KPSS showed that all the above variables can be used in the ARDL testing.

#### 4.2.2 Cointegration testing

Table 4: ARDL cointegration test

	ARDL	Bounds Test
		F-statistic
$S_t   CI_t, DR_t, FR_t$	(1,0,5,5)	9.549***
$MSR_t   CI_t, DR_t, FR_t$	(1,0,0,3)	10.307***
$FSR_t   CI_t, DR_t, FR_t$	(1,0,0,5)	19.058***
$BSR_t   CI_t, DR_t, FR_t$	(2,0,3,3)	5.399***
$WSR_t   CI_t, DR_t, FR_t$	(5,0,0,2)	10.458***
$CSR_t   CI_t, DR_t, FR_t$	(1,0,5,5)	13.245***
$SR1_t   CI_t, DR_t, FR_t$	(2,0,0,5)	6.108***
$SR2_t   CI_t, DR_t, FR_t$	(2,0,3,1)	10.807***
$SR3_t   CI_t, DR_t, FR_t$	(1,0,3,0)	18.403***
$SR4_t   CI_t, DR_t, FR_t$	(1,0,0,0)	16.567***

Notes:  $S_t$  is the overall suicide rate,  $MSR_t$  is the male suicide rate,  $FSR_t$  is the female suicide rate,  $BSR_t$  is the black suicide rate,  $WSR_t$  is the white suicide rate,  $CSR_t$  is the coloured suicide rate,  $SR1_t$   $SR2_t$   $SR3_t$   $SR4_t$  are the suicide rates for the age categories 15-29, 30-44, 45-59 and 60+, respectively,  $CI_t$ ,  $DR_t$ ,  $FR_t$  are the coincident indicator, divorce and fertility rate, respectively. \*\*\* represents the 1% significance level.

Table 4 shows the linear ARDL cointegration test results for the original ten models examined where the maximum lag length was set to six. The bounds test results indicate the presence of linear cointegration in all the models.

Table 5: ARDL results

$S_t   CI_t, DR_t, FR_t$		$MSR_t   CI_t, DR_t, FR_t$		$FSR_t   CI_t, DR_t, FR_t$		$BSR_t   CI_t, DR_t, FR_t$		$WSR_t   CI_t, DR_t, FR_t$	
Var	Coeff	Var	Coeff	Var	Coeff	Var	Coeff	Var	Coeff
$C$	-11.338(4.241)***	$C$	-5.938(4.031)	$C$	-8.707(6.994)	$C$	-11.149(4.159)***	$C$	0.338(0.575)
$S_{t-1}$	-0.613(0.0890)***	$MSR_{t-1}$	-0.616(0.086)***	$MSR_{t-1}$	-0.912(0.094)***	$BSR_{t-1}$	-0.493(0.099)***	$WSR_{t-1}$	1.881(0.265)***
$CI_{t-1}$	1.342(0.450)***	$CI_{t-1}$	0.110(0.131)	$CI_{t-1}$	0.837(0.710)	$CI_{t-1}$	1.577(0.494)***	$CI_{t-1}$	-0.015(0.068)
$DR_{t-1}$	0.293(0.166)*	$DR_{t-1}$	0.960(0.453)**	$DR_{t-1}$	0.235(0.208)	$DR_{t-1}$	0.341(0.165)**	$DR_{t-1}$	0.060(0.021)***
$FR_{t-1}$	0.728(0.166)	$FR_{t-1}$	0.007(0.608)	$FR_{t-1}$	0.311(1.089)	$FR_{t-1}$	0.480(0.595)	$FR_{t-1}$	-0.039(0.086)
$\Delta DR_t$	-0.027(0.635)	$\Delta FR_t$	0.090(0.438)	$\Delta FR_t$	0.887(0.692)	$\Delta BSR_t$	-0.286(0.090)***	$\Delta WSR_{t-1}$	0.702(0.223)***
$\Delta DR_{t-1}$	-0.192(0.152)	$\Delta FR_{t-1}$	0.671(0.627)	$\Delta FR_{t-1}$	-0.2891.191)	$\Delta DR_t$	-0.121(0.156)	$\Delta WSR_{t-2}$	0.432(0.183)**
$\Delta DR_{t-2}$	-0.292(0.168)*	$\Delta FR_{t-2}$	-1.453(0.442)***	$\Delta FR_{t-2}$	-2.610(1.089)***	$\Delta DR_{t-1}$	-0.260(0.138)*	$\Delta WSR_{t-3}$	0.330(0.138)**
$\Delta DR_{t-3}$	-0.046(0.128)	$D_t$	-0.021(0.073)	$\Delta FR_{t-3}$	-2.475(0.931)***	$\Delta DR_{t-2}$	-0.274(0.130)**	$\Delta WSR_{t-4}$	0.164(0.089)**
$\Delta DR_{t-4}$	-0.352(0.120)***			$\Delta FR_{t-4}$	-1.913(0.716)***	$\Delta FR_t$	0.527(0.422)	$\Delta FR_t$	0.046(0.067)
$\Delta FR_t$	0.151(0.398)			$D_t$	-0.091(0.118)	$\Delta FR_{t-1}$	-0.431(0.659)	$\Delta FR_{t-1}$	0.148(0.078)*
$\Delta FR_{t-1}$	-1.066(0.726)					$\Delta FR_{t-2}$	-1.396(0.539)**	$D_t$	-0.041(0.013)***
$\Delta FR_{t-2}$	-2.156(0.753)***					$D_t$	-0.122(0.071)*		
$\Delta FR_{t-3}$	-0.637(0.715)								
$\Delta FR_{t-4}$	-1.064(0.525)**								
$D_t$	-0.094(0.067)								

Symmetric long-run coefficients									
Var	Coeff	Var	Coeff	Var	Coeff	Var	Coeff	Var	Coeff
$C$	-18.487(6.633)***	$C$	-9.639(6.466)	$C$	-9.550(7.692)	$C$	-22.606(8.178)***	$C$	0.180(0.309)
$CI_t$	2.187(0.681)***	$CI_t$	1.559(0.713)**	$CI_t$	0.919(0.779)	$CI_t$	3.198(0.897)***	$CI_t$	0.008(0.036)
$DR_t$	0.477(0.262)*	$DR_t$	0.179(0.213)	$DR_t$	0.258(0.229)	$DR_t$	0.691(0.326)**	$DR_t$	0.032(0.011)**
$FR_t$	1.187(1.037)	$FR_t$	0.012(0.987)	$FR_t$	0.341(1.196)	$FR_t$	0.973(1.227)	$FR_t$	-0.021(0.046)

Error correction coefficients									
Var	Coeff	Var	Coeff	Var	Coeff	Var	Coeff	Var	Coeff
$ECT_{t-1}$	-0.613(0.087)***	$ECT_{t-1}$	-0.616(0.084)***	$ECT_{t-1}$	-0.912(0.092)***	$ECT_{t-1}$	-0.493(0.093)***	$ECT_{t-1}$	-1.881(0.255)***

Notes:  $S_t$  is the overall suicide rate,  $MSR_t$  is the male suicide rate,  $FSR_t$  is the female suicide rate,  $BSR_t$  is the black suicide rate,  $WSR_t$  is the white suicide rate,  $CSR_t$  is the coloured suicide rate,  $CI_t$ ,  $DR_t$ ,  $FR_t$  are the coincident indicator, divorce and fertility rate, respectively. The values in brackets are the standard errors. \*\*\*, \*\* and \* represent the 1%, 5% and the 10% significance levels, respectively.

Table 6: ARDL results

$CSR_t   CI_t, DR_t, FR_t$		$SR1_t   CI_t, DR_t, FR_t$		$SR2_t   CI_t, DR_t, FR_t$		$SR3_t   CI_t, DR_t, FR_t$		$SR4_t   CI_t, DR_t, FR_t$	
Var	Coeff	Var	Coeff	Var	Coeff	Var	Coeff	Var	Coeff
$C$	-2.151(10.449)	$C$	-9.300(0.5.990)*	$C$	-8.184(5.316)	$C$	-1.287(0.960)	$C$	-0.438(0.508)
$SR1_{t-1}$	-0.748(0.0940)***	$SR1_{t-1}$	-0.580(0.108)***	$SR2_{t-1}$	0.929(0.132)***	$SR3_{t-1}$	-0.874(0.091)***	$SR4_{t-1}$	-0.833(0.092)***
$CI_{t-1}$	-0.772(1.080)	$CI_{t-1}$	1.171(0.565)**	$CI_{t-1}$	1.796(0.704)**	$CI_{t-1}$	0.224(0.137)	$CI_{t-1}$	0.066(0.072)
$DR_{t-1}$	-0.292(0.414)	$DR_{t-1}$	0.133(0.159)	$DR_{t-1}$	0.749(0.235)***	$DR_{t-1}$	0.050(0.047)	$DR_{t-1}$	0.034(0.018)*
$FR_{t-1}$	0.940(1.627)	$FR_{t-1}$	0.809(0.832)	$FR_{t-1}$	-0.341(0.664)	$FR_{t-1}$	0.080(0.111)	$FR_{t-1}$	0.038(0.060)
$\Delta DR_t$	0.142(0.388)	$\Delta SR1_{t-1}$	-0.139(0.098)	$\Delta SR3_{t-1}$	-0.151(0.092)	$\Delta DR_t$	-0.008(0.037)	$D_t$	-0.015(0.012)
$\Delta DR_{t-1}$	-0.184(0.492)	$\Delta FR_t$	0.339(0.532)	$\Delta DR_t$	-0.245(0.220)	$\Delta DR_{t-1}$	-0.085(0.040)**		
$\Delta DR_{t-2}$	0.208(0.426)	$\Delta FR_{t-1}$	-1.351(0.908)	$\Delta DR_{t-1}$	-0.588(0.213)***	$\Delta DR_{t-2}$	-0.068(0.037)*		
$\Delta DR_{t-3}$	-0.013(0.320)	$\Delta FR_{t-2}$	-3.330(0.829)***	$\Delta DR_{t-2}$	-0.335(0.190)*	$D_t$	0.006(0.022)		
$\Delta DR_{t-4}$	-0.855(0.308)***	$\Delta FR_{t-3}$	-1.520(0.731)**	$\Delta FR_t$	1.077(0.645)*				
$\Delta FR_t$	0.140(1.001)	$\Delta FR_{t-4}$	-1.427(0.553)**	$D_t$	-0.140(0.108)				
$\Delta FR_{t-1}$	-1.766(1.861)	$D_t$	-0.066(0.090)						
$\Delta FR_{t-2}$	-2.515(1.924)								
$\Delta FR_{t-3}$	0.037(1.799)								
$\Delta FR_{t-4}$	-3.051(1.331)**								
$D_t$	0.034(0.173)								

Symmetric long-run coefficients									
Var	Coeff	Var	Coeff	Var	Coeff	Var	Coeff	Var	Coeff
$C$	-2.877(14.036)	$C$	-16.047(9.326)*	$C$	-8.812(5.554)	$C$	-1.473(1.093)	$C$	-0.525(0.609)
$CI_t$	-1.032(1.427)	$CI_t$	2.020(0.935)**	$CI_t$	1.933(0.724)***	$CI_t$	0.257(0.156)	$CI_t$	0.079(0.086)
$DR_t$	-0.390(0.550)	$DR_t$	0.229(0.274)	$DR_t$	0.806(0.257)***	$DR_t$	0.057(0.054)	$DR_t$	0.041(0.021)*
$FR_t$	1.2258(2.201)	$FR_t$	1.396(1.457)	$FR_t$	-0.367(0.719)	$FR_t$	0.092(0.127)	$FR_t$	0.045(0.072)

Error correction coefficients									
Var	Coeff	Var	Coeff	Var	Coeff	Var	Coeff	Var	Coeff
$ECT_{t-1}$	-0.746(0.090)***	$ECT_{t-1}$	-0.580(0.104)***	$ECT_{t-1}$	-0.929(0.124)***	$ECT_{t-1}$	-0.874(0.089)***	$ECT_{t-1}$	-0.833(0.090)***

Notes:  $CSR_t$  is the coloured suicide rate,  $SR1_t$   $SR2_t$   $SR3_t$   $SR4_t$  are the suicide rates for the age categories 15-29, 30-44, 45-59 and 60+, respectively,  $CI_t$ ,  $DR_t$ ,  $FR_t$  are the coincident indicator, divorce and fertility rate, respectively. The values in brackets are the standard errors. \*\*\*, \*\* and \* represent the 1%, 5% and the 10% significance levels, respectively.

### 4.2.3 Suicide and the business cycle

Tables 5 and 6 report the results of the ARDL models (refer to Equation 4) as mentioned in Chapter three with the short-run and long-run parameters, and the speed-of-adjustment back to equilibrium. Since the 2008 financial crisis was a large event, a dummy variable was added in all models to control for that event. In most models the dummy coefficients were negative, indicating a pro-cyclical relationship between suicide and the business cycle. However, most dummy variables were statistically insignificant apart from for the black and white population groups, which were statistically significant at the 1% and 10% level of significance respectively. Therefore, these results suggest that suicide rates were lower during the financial crisis compared to any other periods.

As indicated in Table 5 and 6, the results confirm the existence of a long run relationship between the variables, with the negative lagged error correction term being significant at the 1% level. It suggests that any deviation from the long-term equilibrium path is corrected each month by 49%-93%. In addition, the coincident indicator had a significant positive relationship between the overall, male, black population and for the 15-29 and 30-44 age categories' suicide rates. The results suggest that in the long run suicide moves with the South African business cycle: On average, a 1% increase in the coincident indicator increases the above suicide rates by 1.6% to 3.2%. Although the pro-cyclical relationship between suicide and the business cycle obtained in this study was not generally expected, this finding is consistent with previous research. For example, in Germany (Crombie, 1990; Neumayer, 2004) and in South Africa (Phiri and Makuka, 2017) a pro-cyclical relationship was found between suicide rates and economic indicators. In South Africa, a pro-cyclical relationship was found between the inflation rate and suicides among males, and for the 5-14, 15-24, 25-34, 35-54 and 55-75 age categories (Phiri and Makuka, 2017). However, no further explanation was given as to why this was the case.

With the high South African unemployment rate as well as the majority of the population being poor and without jobs, perhaps the positive outweighs the negative relationship between suicide and the coincident indicator. Ginsberg (1966) argued that suicide may follow a pro-cyclical relationship because during upswings, consumption increases, working hours increase, leisure time decreases and stress rises, which increases the likelihood of suicide. In addition, Ruhm (2000) and Pridemore (2006) attested the above mentioned points and also

argued that suicide rates could increase during upswings due to greater alcohol consumption; Coovadia *et al.* (2009) reported a positive relationship between alcohol consumption and suicide in South Africa. Furthermore, Durkheim (1897) highlighted the significance of social integration and regulation as factors that would increase suicides. During economic upswings, individuals are less socially integrated (i.e. individuals work longer hours, families break down which causes an increase in divorce, alcohol abuse, and people feeling that they do not belong in society) and are therefore more likely to commit suicide (Durkheim, 1897; Chuang and Huang, 1997; Noh, 2010). Furthermore, during economic upswings, the increase in income may actually make individuals less happy. This can also be true for individuals where their social status or income is lower compared to their counterparts which may increase suicide (Easterlin, 1974, 1995; Jungeilges and Kirchgässner, 2002; Daly and Wilson, 2009; Posel and Casale, 2011). Therefore, Durkheim's (1897) and Ginsberg's (1966) arguments may hold true in South Africa.

An additional possible explanation as to suicide's pro-cyclical relationship among the black population group is that the majority are unemployed and individuals who have work use their salary to take care of their families and extended families. This can be referred to as the "black tax" (Nt'sekhe, 2017). During the upswing periods the increase in income could result in an increase in stress and anxiety because an individual's family members could have higher expectations.

For the white population group, cointegration was present; however, the lagged error correction term was not between -1 and 0 but was statistically significant at the 1% level. A simple t-test was performed in order to check if the test result was useable. The test revealed that the error correction term was significantly different from -1 (t-statistic = -3.45, p-value = 0.008). Since the error correction term is significantly different from -1 the model cannot be used.

For the coloured population group, there was a long run relationship between the variables in the model but none of the long run coefficients were statistically significant. However, it is worth noting that there was a negative (albeit insignificant) relationship between the coincident indicator and the business cycle, which is opposite to that found in all the other models.

The results show that the 15-29 age category was the most affected by the economic indicator followed by the 30-44 age category. One possible explanation lies in the fact that economic times have been harder for the youth because of extreme youth unemployment as well as political change and the societal transition in South Africa (Burrows and Laflamme, 2008b; Schöer *et al.*, 2012). For example, financial stress and psychological stress may be present among unemployed youths, which may increase the risk of committing suicide.

#### **4.2.4 Divorce and fertility rates**

As mentioned in Chapters two and three, divorce and fertility are important social indicators (Koo and Cox, 2008; Altinanahtar and Halicioglu, 2009; Andrés and Halicioglu, 2011; Botha, 2012; Thibodeau and Lachaud, 2016; Chang and Chen, 2017; Phiri and Makuka, 2017). As predicted in Chapter three, the divorce rate coefficient was positive and statistically significant at the 10% level for the overall suicide rate and for the 60+ age category; at the 5% level for the black population group and for the 30-44 age category. It suggests that on average, a 1% increase in the divorce rate would increase the suicide rate by 0.48%-0.81% in the long run. This can be explained by Durkheim's (1987) argument where being married brings social integration whereas the opposite is found for divorce. In addition, as expected and argued by Durkheim (1987), divorce results in psychological breakdowns and plunges an individual into anomie (the feeling of not belonging or being disconnected from society), which increases the chance of someone committing suicide (Botha, 2012; Chang and Chen, 2017; Phiri and Makuka, 2017). For the 60+ age category the results are practically meaningless as it is a small change (i.e. on average a 1% increase in the divorce rate would increase suicide by 0.00041 per 100,000 people in the long run).

In terms of the fertility rate, mixed results were observed although the long run coefficients were statistically insignificant at the 5% significance level. All coefficients were positive apart from the second age category (i.e. 30-44). From the theory, a negative coefficient is expected because when fertility increases, suicides should decrease due to the social bond that children bring to the family, which increases family integration and promote social ties. However, a positive coefficient could imply that fertility increases stress, which could be linked to the burden of care for families (Classen and Dunn, 2011; Schaede, 2013; Chang and Chen, 2017).

### 4.2.5 Diagnostic checks

Table 7 reports all post-estimation diagnostic checks for autocorrelation, heteroscedasticity and functional form. The LM test reported no autocorrelation; the Breusch-Pagan-Godfrey test reported no heteroscedasticity for all the models and the Ramsey RESET test for functional form indicated that there were no sign of non-linearity in all models. These diagnostic tests have been used in previous studies such as Andrés *et al.* (2010) and Chang and Chen (2017). The CUSUM test for all the models were also performed and were reported in Appendix C. The test confirmed that all models were stable.

*Table 7: Diagnostic checks*

	LM test	p-value	HET	p-value	Ramsey	p-value
$S_t   CI_t, DR_t, FR_t$	0.117	0.98	18.600	0.23	1.404	0.16
$MSR_t   CI_t, DR_t, FR_t$	0.724	0.58	9.813	0.28	1.819	0.07
$FSR_t   CI_t, DR_t, FR_t$	0.674	0.61	5.960	0.81	0.337	0.74
$BSR_t   CI_t, DR_t, FR_t$	0.280	0.89	6.039	0.91	1.353	0.18
$CSR_t   CI_t, DR_t, FR_t$	0.328	0.54	10.020	0.82	0.181	0.86
$SR1_t   CI_t, DR_t, FR_t$	1.541	0.20	12.087	0.36	0.684	0.50
$SR2_t   CI_t, DR_t, FR_t$	0.360	0.84	11.202	0.34	0.754	0.45
$SR3_t   CI_t, DR_t, FR_t$	0.204	0.94	7.918	0.44	0.638	0.53
$SR4_t   CI_t, DR_t, FR_t$	0.918	0.46	3.624	0.60	0.546	0.58

*Notes:*  $S_t$  is the overall suicide rate,  $MSR_t$  is the male suicide rate,  $FSR_t$  is the female suicide rate,  $BSR_t$  is the black suicide rate,  $CSR_t$  is the coloured suicide rate,  $SR1_t$   $SR2_t$   $SR3_t$   $SR4_t$  are the suicide rates for the age categories 15-29, 30-44, 45-59 and 60+, respectively,  $CI_t$ ,  $DR_t$ ,  $FR_t$  are the coincident indicator, divorce and fertility rate, respectively. LM test, HET and Ramsey RESET test represent the test of residual correlation, heteroscedasticity and functional form tests.

### 4.3 Conclusion

This chapter reported the ARDL results for the different models analysed in order to examine how suicide changes with the South African business cycle and how, if at all, the relationship between suicide and the business cycle differs across age-, gender-, and racial groups.

The ADF and the KPSS tests reported that all variables could be used in the models since they were not integrated of an order higher than I(1). This was followed by cointegration testing using the testing procedure by Pesaran and Shin (1999), and Pesaran *et al.* (2001). When cointegration was confirmed, the models were subsequently estimated with the relevant diagnostic checks.

The study reports that there was a long run relationship between the variables in all the models. Due to the 2008 financial crisis being a large event, a dummy variable was added in order to control for this event. Although most dummy coefficients were negative indicating a pro-cyclical relationship between suicide and the South African business cycle in the short

run, they were statistically insignificant. In addition, it was shown that there was a long run relationship between suicide and the coincident indicator for the overall, male, black population and for the 15-29 and 30-44 age categories (at the 1% and 5% significance level). This was an indication that suicide moves with the South African cycle. The results were consistent with Ginsberg's (1966) and the Durkheim's (1897) arguments. Durkheim (1897) emphasized the role of social integration and regulation as factors causing an increase in suicide rates.

The results of this study found that any improvement of the economy would increase suicide in South Africa, which is not what generally can be expected. Therefore, the government should focus more on people-orientated intervention, for example, providing care for affected families (this will be elaborated on further in Chapter five). With the high unemployment rate and the majority of the South African population being poor, it is possible that the positive outweighs the negative relationship between suicide and the coincident indicator.

In terms of the control variables, the divorce rate had a positive and significant relationship with the suicide rates of the overall black population group and for the 30-44 and 60+ age categories, which was consistent with previous studies (Cutler *et al.*, 2001; Chang and Chen, 2017; Phiri and Makuka, 2017). The fertility rate had mixed relationships with suicide, with insignificant coefficients.

## CHAPTER 5. CONCLUSION

### 5.1 Summary

The principal objective of this study was to examine how aggregate suicide rates relate to the South African business cycle for the period 2006-2015. Using monthly data, the study also considered possible age, gender, and racial differences in how suicide rates were related to the South African business cycle. In order to achieve these objectives, the coincident indicator was used as a proxy for the business cycle. The coincident indicator was chosen since it is an indication of the real time of the business cycle and is published on a monthly basis. Consistent with previous studies, the control variables were the divorce and fertility rates (Chuang and Huang, 1997; Altinanahtar and Halicioglu, 2009; Andrés and Halicioglu, 2010; Thibodeau and Lachaud, 2016; Phiri and Makuka, 2017).

Chapter two provided the theoretical framework and presented the empirical studies from an international and a South African perspective. Durkheim (1897) argued that individuals commit suicide because of psychological as well as societal factors. The more socially integrated individuals are, the less likely they are to commit suicide because they feel connected and have a sense of belonging to society. Thus, Durkheim (1897) reasoned that as social integration decreases, suicides increase. Durkheim (1897) explained how societal factors could lead to suicide through the anomie-, altruistic-, egoistic- and fatalistic suicide effects.

Hamermesh and Soss (1974) were the first to significantly contribute to the field of suicide from an economic perspective. Their model predicted that suicide was positively related to age but inversely related to income. Ginsberg (1966) and Henry and Short (1954) argued that suicide may follow either a pro-cyclical or counter-cyclical relationship with respect to the business cycle. Ginsberg (1966) debated 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. On the other hand, Henry and Short (1954) argued that suicide may be counter-cyclical, for example 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).

Most studies have found counter-cyclical relationships between suicide and the business cycle (Viren, 2005; Lin, 2006; Koo and Cox, 2008; Altinanahtar and Halicioglu, 2009; Andrés and Halicioglu, 2010; Thibodeau and Lachaud, 2016; Chang and Chen, 2017; Phiri and Makuka, 2017) whereas some studies have found a pro-cyclical relationship (Crombie, 1990; Hintikka *et al.*, 1999; Neumayer, 2004; Coope *et al.*, 2014). It is important to note that most studies have used the unemployment rate (Yang, 1992; Koo and Cox, 2008; Luo *et al.*, 2011; Thibodeau and Lachaud, 2016; Chang and Chen, 2017) or GDP (Viren, 1996; Hintikka *et al.*, 1999; Granados, 2008; Thibodeau and Lachaud, 2016) as a proxy for the business cycle. It was not possible to control for these economic indicators as examined in previous studies due to the data for these variables being unavailable on a monthly basis.

In South Africa, the majority of studies were provincial and city-based analyses because of the unavailability of data (Burrows *et al.*, 2003; Burrows and Laflamme, 2005; Burrows and Laflamme, 2008; Stark *et al.*, 2010). It was not until 2006 with the release of Statistics South Africa's Mortality and Causes of Death Data from Death Notification and in 2017 with the newly WHO dataset released yearly which enabled researchers to analyse suicide dynamics nationally (Statistics South Africa, 2016). Botha (2012) and Phiri and Makuka (2017) were the first studies in South Africa to have analysed suicide from an economic and nationally representative perspective. This study aimed to fill the gap in the South African literature by using monthly data, an alternative business cycle indicator, and adding racial groups as an important dynamic in the South African context.

In order to achieve the objectives set in this study, the period 2006-2015 was chosen as it was the only monthly time series data available at a national level. Consistent with Altinanahtar and Halicioglu (2009), Andrés and Halicioglu (2010), Chang and Chen (2017), and Phiri and Makuka (2017), an ARDL approach was used. Ten different models were analysed in logarithm form apart from three regressions (i.e. the white population group and the 45-59 and 60+ age categories). This was due to the lack of data in the dataset and calculating the log of zero is impossible. Therefore, the suicide rate per 100,000 people was used for these three categories.

The results confirmed the existence of a long run relationship between the variables in all the models, with a significant lagged error correction term. However, the result for the white population group was not useable because the lagged error correction term was not between -

1 and 0. Since the error correction term was significantly different from -1, the model could not be used.

The long run coefficient for the coincident indicator was positive and statistically significant for the overall-, male-, and black as well as for the 15-29 and 30-44 age categories suicide rates. The results suggest that in the long run suicide moves with the South African business cycle: On average, a 1% increase in the coincident indicator increases the suicide rates for the overall, male, and black samples, as well as for the 15-29 and 30-44 age categories rate by 1.6% to 3.2% in the long run.

The results in this study were not as expected when compared to the majority of studies that found a counter-cyclical relationship between economic indicators and the business cycle. However, there were a few studies that found a pro-cyclical relationship in Germany (Crombie, 1990; Neumayer, 2004) and in South Africa (Phiri and Makuka, 2017). Possible explanations as to why suicides increase during upswing phases may be explained by Durkheim's (1897) and Ginsberg's (1966) theories. With respect to Durkheim's (1897) theory of social regulation and social integration, suicide would increase during economic upswings because individuals are less socially integrated and less happy (i.e. the increase in income may make some less content). Since the majority of the South African population are poor and unemployed, individuals may be more prone to suicide in an economic upswing where the stress can be experienced more compared to downswing periods.

In other words, this study shows that an improvement in the economy would increase the suicide rates in the South African context. From an economic view point, there is little that the government can do to reduce suicides (i.e. grow the economy). Therefore, there would be a need for the government to focus on setting up people-orientated interventions that would decrease the likelihood of suicide. For example, the government could provide counselling services to affected families, especially during economic upswings (see Section 5.2).

The long-run coefficients for the divorce rate were also found to be statistically significant for the overall suicide rate, the black population group, and the 30-44 and 60+ age categories. The results suggest that a 1% increase in the divorce rate will increase suicide by 0.5%-0.8% in the long run. For the 60+ age category, the coefficient was significant but very small. In the literature review, divorce was found to be associated with isolation and psychological breakdowns (Altinanahtar and Halicioglu, 2009; Botha, 2012; Chang and Chang, 2017). Therefore, as divorce rates increase suicides should increase as well.

The fertility rate depicted a positive relationship with suicide rates in almost all models apart from the 30-44 age categories. The results suggested that fertility may increase stress, which is associated with a burden on the families. Hence as fertility rates increase so does suicide rates (Classen and Dunn, 2011; Schaede, 2013; Chang and Chen, 2017). However, it is important to note that the long-run coefficient was statistically insignificant in all models.

## **5.2 Limitations and recommendations**

This study has limitations that should be noted. One limitation is that it appears as if suicide is heavily under-reported in the data used. This is not necessarily surprising, with the WHO stating that “reported suicide mortality statistics are likely to underestimate the true magnitude of the problem as religious and cultural sanctions may lead to suicide being under-reported, misclassified or deliberately concealed” (Mars *et al.*, 2014: 821).

Burrows and Schlebusch (2008) reported an estimated 5,000-7,000 suicides annually in South Africa. The National Injury Mortality Surveillance System (NIMSS) reported over 3,000 suicides cases in 2008 (CVILP, 2010) whereas the Mortality and Causes of Death Data from Death Notification only reported 438 cases in 2008. In addition, some news articles stated that South Africa has the 8<sup>th</sup> highest suicide rate in the world, with 8,000 suicides annually (Newman, 2004; Sapa, 2014). The World Health Organisation (WHO, 2017) has reported that in 2015 suicide deaths in South Africa amounted to 20.7 per 100,000 population implying that there were over 11,000 suicides in that year (WHO, 2017). Therefore, there seem to be substantial inconsistencies across the different datasets.-In addition, South African mortuaries are heavily under-staffed and recently there have been allegations in the news that cleaners and drivers were performing autopsies in Gauteng since 2006 (Erasmus, 2017; Villiers, 2017).

It is also important to elaborate on the issue of undetermined intent. Botha (2012) stated that suicide could be reported under undetermined intent, which would explain why suicide is officially underreported. Suicide is defined as self-inflicted injuries on oneself which result in death when there is enough evidence confirming it was intentional, while undetermined intent is defined as a death 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). The problem is that South African forensic

pathologists are not required by law to state whether or not a person has 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 additional evidence (see Botha, 2012). Statistics South Africa (2014: 50) stated in their report that:

“...in the absence of medical records at the time of death; dead on arrival cases; and lack of sufficient details to indicate the manner of death at the time of registration (i.e. accident, suicide and homicide), it may be difficult for certifying officials to assign causes of death. Furthermore, certifying officials may ignorantly fail to provide sufficient details required to code the causes of death appropriately. For example, there are a number of cases where a cause of death is specified as multiple injuries, without indication of what causes such injuries, be it transport accident, suicide or homicide.”

Therefore, Botha (2012) reported that deaths by undetermined intent may be actual suicides but due to the lack of evidence were reported otherwise.

Middleton *et al.* (2003), Burrows and Laflamme (2007), Pritchard and Amanullah (2007), and Värnik *et al.* (2010) also argued that most deaths by undetermined intent were actually suicides. In addition, Kelleher *et al.* (1996) and Speechley and Stavrakis (1991) have contributed to the under-reporting of suicide in the United Kingdom by investigating the difference between suicide and the undetermined intent cases. Recently, the United Kingdom “added injury/poisoning of undetermined intent and sequelae of intentional self-harm/event of undetermined intent to the official suicide rate, in the belief it will provide a more reliable suicide rate” (Tøllefsen *et al.*, 2012: 9). Going further, in England “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).

*Table 8: Overall undetermined intent and category-specific undetermined intent*

	Undetermined intent (Y10-Y34)	Hanging, strangulation and suffocation, undetermined intent (Y20)	Drowning and submersion, undetermined intent (Y21)	Exposure to smoke, fire and flames, undetermined intent (Y26)
2006	32411	2897	934	1645
2007	18418	1536	370	742
2008	6162	49	14	8
2009	6425	12	-	-
2010	6369	1	-	-
2011	5965	1	-	-
2012	6777	-	-	-
2013	7553	-	-	-
2014	7664	-	-	-
2015	3127	-	-	-

Table 8 shows the number of deaths of undetermined intent in South Africa; there was a large decrease in the number of undetermined intent from around 32,000 in 2006 to 3,000 in 2015. In addition, Table 8 shows three different sub-categories of undetermined intent (Y20; Y21; Y26), which strongly indicates possible suicide; however, there was a large decrease in their numbers as well. As suggested by Middleton *et al.* (2003), Burrows and Laflamme (2007), Pritchard and Amanullah (2007), and Värnik *et al.* (2010), undetermined intent should be included in the analysis as actual suicides. The large decrease in undetermined intent as well as in the sub-categories of undetermined intent such as Y20, Y21 and Y26 would be a strong indication of suicide. Therefore, the inclusion of these numbers in the data would not be representative of suicides in South Africa.

Statistics South Africa (2007: 7) explains that the decrease was due to a change in coding methodology, “previously, the majority of non-natural causes (about two-thirds) were coded to event of undetermined intent, mainly unspecified event (Y34)”. Since then, improvements have been made from the deaths notification form. For example:

“...gunshot wound, which was previously coded predominantly to other and unspecified firearm discharge (Y24), but is now coded as discharge from other and unspecified firearms (W34) which includes gunshot wound not otherwise specified or shot not otherwise specified. This change in coding methodology affects two broad groups Y10-Y34 and W00-X59 by

reducing the number of deaths resulting from Y10-Y34 and increasing the number of deaths due to W00-X59<sup>12</sup> (Statistics South Africa, 2007: 7).

With the large decrease in undetermined intent, the difference in data recording between the datasets (i.e. NIMSS and Mortality and Causes of Death Data from Death Notification) as well as suicide not being recorded properly by pathologists, suicide in South African could possibly be under-reported.

Another possible limitation of this study was that a large proportion (12%)<sup>13</sup> of the population groups were not specified. Therefore, the results of this study must be treated with relative caution. Going forward, due to suicide being recorded incorrectly by pathologists because more proof is needed, perhaps the South African government should change the South African law in order to require pathologists to record one's death correctly, in particular in the case of suicide.<sup>14</sup> This will enable comprehensive dynamic research on suicide. In the meantime, suicide prevention should focus on the targeted groups as well as during the upswing phase of the business cycle.

By having a better understanding of the relationship between suicide and the business cycle, it will facilitate the coordination between developing and implementing suicide-prevention measures by policy makers and health workers during the relevant stages. Shepard *et al.* (2016) reasoned that preventing suicide requires a multifactorial approach where communities, schools, health sectors and workplaces work together. Despite these recommendations, it is important to note that Shepard *et al.* (2016) found that 10% to 15% of the patients admitted to hospital for serious self-inflicted injuries will commit suicide in the next ten years. Therefore, additional measures should be put in place before discharging patients from hospital. For example, patients should get a comprehensive suicide risk assessment and on-going treatments (i.e. behavioural and other social services) should be available for patients to be periodically monitored. The Research Prioritization Task Force (RPTF) estimated that suicide can be reduced by 20% through a successful implementation of the following policies. "Providing brief psychotherapy treatments in emergency care, parity coverage for mental health care, adding a car safety feature, improving firearm safety, and

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<sup>12</sup> W00-X59 refers to "Other external causes of accidental injury" and Y10-Y34 refers to "Event of undetermined intent" (Statistics South Africa, 2007).

<sup>13</sup> There were 535 suicides which were not specified out of a total of 4,597 cases.

<sup>14</sup> One possible problem which needs to be addressed is that perhaps family members are not willing to report suicide due to insurance claim problems.

implementing a school-based prevention program” (RPTF, 2014: 7) Therefore, these policies can be implemented in South Africa as well.

In addition to the above-mentioned recommendations, the government should also have a long term strategy where its goals would be to:

1. Improve the care for individuals who have attempted suicide.
2. Support families/friends and others who were affected by suicide and attempted suicide especially if they are young (i.e. social support and counselling services).
3. Encourage mental health and well-being.
4. Training for medical service providers to support the ones in need.

These are some of the goals also adopted in New Zealand (Ministry of Health, 2017). In addition, as call centers such as the South African and Depression and Anxiety Group (SADAG) and the MobieG group have fixed operating hours, the government should provide additional resources in order to always be open (MobieG, 2017) .

In the future, Statistics South Africa should obtain more detailed data on a national and provincial level in order to unlock several research opportunities. For example, as previously mentioned, all deaths should be recorded correctly as well as the variables in the dataset such as the population groups, the education of the deceased and marital status, to name a few. At the time of writing, the only monthly indicators available to analyse suicide across provinces were new car sales and the inflation rate (Botha, 2012). Therefore, additional economic indicators for all provinces would be beneficial for further analysis. Additional psychological, sociological and economic studies are needed in order to gain a better understanding as to why suicide follows a pro-cyclical relationship.

After all, suicides are preventable and so by having a better understanding of suicides in South Africa, valuable insight will be added to this field of research.

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## APPENDICES

### APPENDIX A: Supplementary note on age-standardised suicide rate

*Table 9: WHO World Standard Population Distribution (%)*

<b>Age group</b>	<b>World Average 2000-2050</b>
0-4	8.86
5-9	8.69
10-14	8.60
15-19	8.47
20-24	8.22
25-29	7.93
30-34	7.61
35-39	7.15
40-44	6.59
45-49	6.04
50-54	5.37
55-59	4.55
60-64	3.72
65-69	2.96
70-74	2.21
75-79	1.52
80-84	0.91
85-89	0.44
90-94	0.15
95-99	0.04
100+	0.005

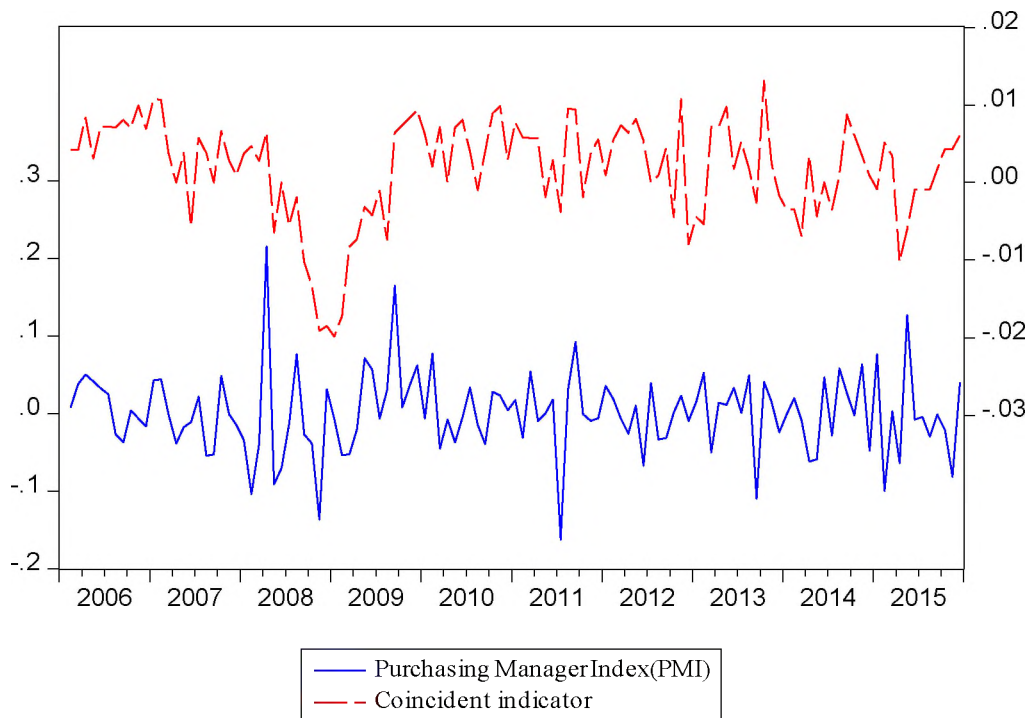
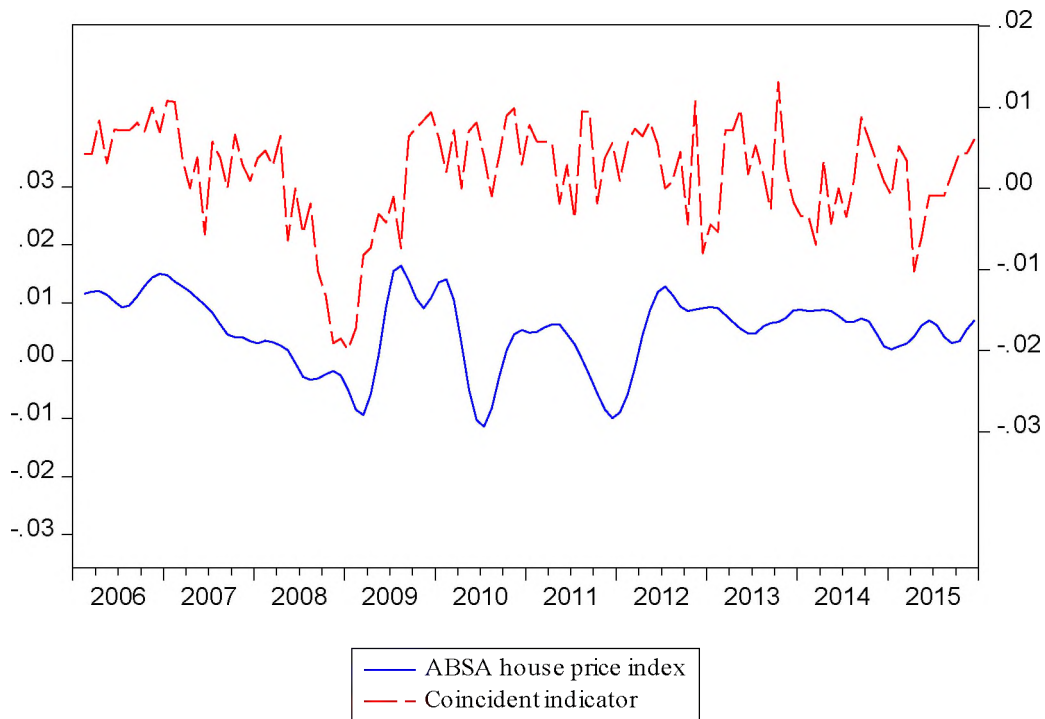
Source: Extracted from Ahmad *et al.* (2001).

*Table 10: WHO's weights for the four age groups*

<b>Age groups</b>	<b>WHO weights</b>
SR1 (15-29)	24.62
SR2 (30-44)	21.35
SR3 (45-59)	15.96
SR4 (60+)	11.955

Source: Extracted from Ahmad *et al.* (2001).

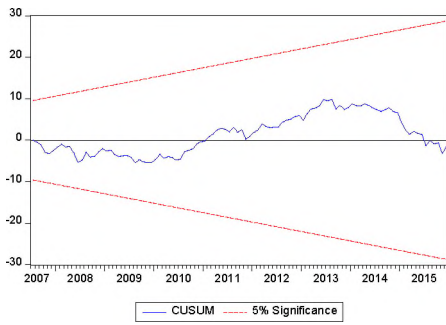
**APPENDIX B: Other economic indicators considered in this study**



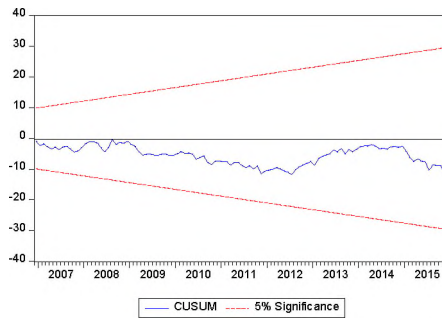
*Figure 2: Coincident indicator plotted against PMI and ABSA house price index*

## APPENDIX C: Diagnostic Check

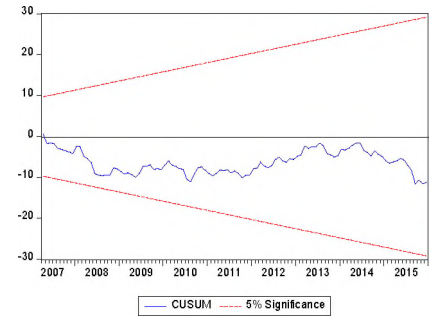
$SR_t | CI_t, DR_t, FR_t$



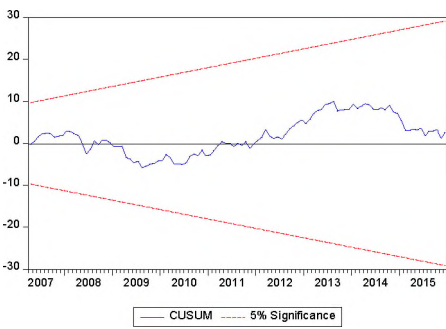
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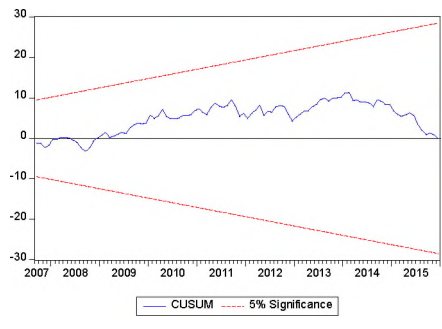
$FSR_t | CI_t, DR_t, FR_t$



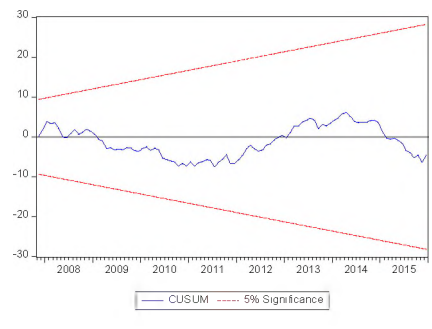
$BSR_t | CI_t, DR_t, FR_t$



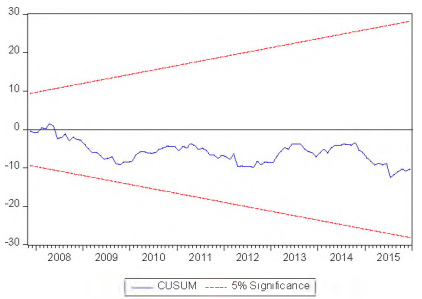
$CSR_t | CI_t, DR_t, FR_t$



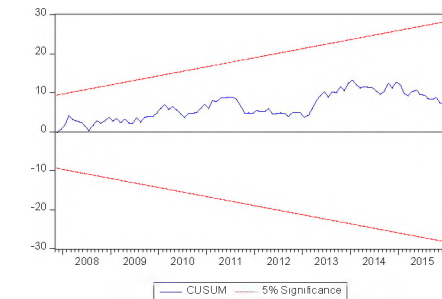
$SR1_t | CI_t, DR_t, FR_t$



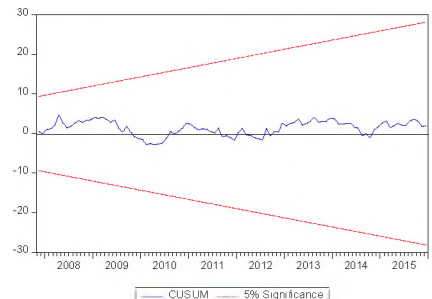
$SR2_t | CI_t, DR_t, FR_t$



$SR3_t | CI_t, DR_t, FR_t$



$SR4_t | CI_t, DR_t, FR_t$



*Figure 3: CUSUM test diagrams*