An Analysis of the Potential Impact of Carbon Emission Tax on Unemployment in South Africa

BK Mahlangu

orcid.org 0000-0003-3603-1127

Dissertation accepted in fulfilment of the requirements for the degree *Master of Commerce in Economics* at the North-West University

Supervisor: Prof. OD Daw

Graduation July 2019

Student number: 254 823 78

DECLARATION

I, Bongani Khensani Mhlangu, hereby solemnly declare that all the material that I have used in this study has been properly indicated and acknowledged by means of complete references. This study has not been previously submitted by me for a degree in another university.

Student

Full names : Bongani Khensani

Family name : Mahlangu

Date : _____/_____/_____

Signed : _____

Supervisor

Full names : David Olebogeng

Family Name : Daw

Date : _____/_____/_____

Signature : _____

DEDICATION

Jeremiah 29:11 King James Version (KJV)

[11] For I know the thoughts that I think toward you, saith the Lord, thoughts of peace, and not of evil, to give you an expected end.

James 4:17 King James Version (KJV)

[17] Therefore to him that knoweth to do good, and doeth it not, to him it is sin.

First and foremost, I would like to send praises to the good Lord who has carried me up to this point. A point I never have thought I would reach when I was still packing shelfs, when I struggled with university fees and when serving in the Student Representative Council had consumed most of my time due to the passion one has for mankind and the hunger to transform lives.

I would like to thank my mother Ms Sophy Millicent Mahlangu; a woman who could not offer much materially but compensated with one thing money cannot purchase which is love and my siblings Hlelokhule Ngobeni, Nellisiwe Mtsweni and Sicelokhule Mahlangu; as a first I'm burdened with the responsibility to live by example, the Lord be with you'll always.

ACKNOWLEDGEMENT

I would like to thank Prof Betchani Tchereni for all the positive influences. Thank my supervisor Prof OL Daw and thank the academics that have deposited words of encouragement, guidance and mentorship.

Prof Andrew Maredza for the significant contribution made to the study, all the way from the University of Mpumalanga.

I would like to thank Ms Boitumelo Molefe who would ensure I push on days I felt like quitting and each and every person who has supported through it all thank you and God bless you abundantly.

ABSTRACT

This study sought to investigate the impact of carbon emission tax on unemployment in South Africa. This particular focus of the study comes at a time when the South African unemployment rate is at a staggering 27.5% (Statistics South Africa, 2018) . Moreover, South Africa is ranked the largest emitter of carbon dioxide in the continent (Boden, et al., 2011). To shed light on this fundamental research question, the VAR econometric technique was applied using time-series spanning the period 1980 – 2017. In addition to general tax revenue used as a proxy variable for carbon emission tax, other variables captured in our econometric specification included real GDP, household consumption, electricity power consumption, carbon emission and foreign direct investment outflow. Our empirical results showed a negative relationship between our key variables of interest namely carbon emission tax and unemployment. This implies that on average any increase in carbon emission tax tends to exert a decreasing effect on unemployment. These results therefore stress the need for the government and policy makers to ensure that carbon tax policy in South Africa is well calibrated to optimize its effect on unemployment. The rest of the variables registered expected and theoretically consistent relationships with unemployment.

Keywords: Unemployment, South Africa, Carbon dioxide, Tax

Table of Contents

LIST OF TABLES

LIST OF FIGURES

LIST OF ACRONYMS

ADF	:	Augmented Dickey-Fuller
AFLOLU	:	Agriculture, Forestry and other Land Use
CDE	:	Carbon Dioxide Emission
CDP	:	Carbon Disclosure Project
CO_2	:	Carbon Dioxide
CCT	:	Consumer Consumption
EPC	:	Electric Power Consumption
FDI	:	Foreign Direct Investment
GDP	:	Gross Domestic Product
ICLS	:	International Conference of Labour Statisticians
ILO	:	International Labour Organisation
INDC	:	Intended Nationally Developed Contribution
PP	:	Phillips-Perron
UNE	:	Unemployment
VAR	:	Vector Auto Regression

LIST OF APPENDICE

CHAPTER ONE

INTRODUCTION OF THE STUDY

1.1 INTRODUCTION AND BACKGROUND

South Africa is a fast-paced growing nation and one enabler of this economic growth is consumption of energy which results in carbon emission generated from the burning of coal and other fossil fuels in order to accelerate the growth. (National Treasury, 2010)

However, in 2009 South Africa pledged at the Conference of the Parties (COP 15) in Copenhagen that it will reduce carbon emission below to 34 per cent in 2020 and further down to 42% in 2025. This pledge is complementary to the objectives of South Africa's Intended Nationally Developed Contribution (INDC), a document submitted to the United Nations Framework Convention on Climate Change in September 2015 (Claassen & Bolton, 2016). The National Treasury then set to ensure the materialisation of the pledge by the introduction of the carbon emission tax in South Africa (Market Readiness Proposal (MRP), 2015). In 2017, 76% of the electricity generated in South Africa was generated with the use of coal, 7% was with petroleum liquids, another 7% was from hydro-electric, 6% was from non-hydro renewable energy and 4% was nuclear (EIA Beta, 2017) South Africa is considered as the twelfth largest carbon emitter on the globe, contributing 1.6% of the combined global emission and half of Africa's carbon emission (UNEP, 2004). South Africa's high energy consumption and hence high carbon emission has resulted to the country's per capita carbon emission to be comparatively higher than that of other more developed countries such as Spain, Australia and Iceland, contrary to trends of other developing countries such as Cuba, Mexico and Argentina (Department of Environmental Affairs and Tourism, 2003).

According to the Carbon Disclosure Project (CDP) South Africa 100 Climate Change Report for the year 2012, the top Johannesburg Securities Exchange (JSE) 100 companies in South Africa collectively contributed 64% of the country's total carbon emission in 2012. The report further states that Eskom is by far the highest and direct carbon emitter in the Republic, emitting 231, 1 million tonnes of co_2 in year 2012. Among the JSE 100 listed companies, SASOL was the highest contributor at 61, 4 million tonnes of CO_2, followed by Arcelor Mittal at 10, 9million tonnes, BHP Billiton 3, 2 million, and Anglo American and Sappi at 3 million tonnes each. These companies combined are considered as the biggest employers as they collectively contribute more than 100, 000 jobs in the country (Johannesburg Stock Exchange , 2018)

South Africa's working age population grew by a hundred and fifty-three thousand people (0.4%), which was recorded in the first quarter of 2018 contrasted with the final quarter on 2017. The official unemployment rate has demonstrated at constant rise between the years 2008-2018, increasing from 21.5% to 28%. South Africa's youth makes up 63.5% of the total unemployed, thus making it the dominating group (Statistic South Africa, 2018).

Unemployed has been classified by numerous scholars as the worst out of the economic ills. Unemployment comes with cost at a social and personal level. These cost's cause severe financial hardship which is usually associated with poverty, increased debt, being without shelter, tensions within the family, loss of confidence, negative psychological 0impact and the worst of all being crime (McClelland & Macdonald, 1998).

There are many in-depth studies to the causes of unemployment, but a summary is that cyclical unemployment is caused by a deficit with regards to demand for labour. Structural unemployment may result from the advancement in technology coupled with outsourcing. Frictional unemployment is associated with voluntary unemployment, relocation of those employed, issues of accessing for the first time and re-entering after one had left.

South Africa ranks among the countries with very high inequality and exclusion. This comes as the Gini-coefficient records 0.65 for the year 2014, determined on expenditure data that had excluded tax. The 0.69% is determined with income data that included remuneration along with social grants. The wealthiest 20% of South Africans consume 65% contrary to the 3% consumed by the poor of the poorest of the total expenditure (The World Bank, 2018)

Arguments have been levelled that: low income households in South Africa in particular, consume larger proportions of their income on energy as opposed to their more fortunate counterparts, thus an increase on energy prices due to carbon emission tax imposition would disproportionally affect their budgets (Consumer Goods Council of South Africa , 2014) (African Development Report, 2012). Businesses are not immune to these effects as they become frustrated when having invested for domestic and global expansion, they also have to face the burden of increased energy costs that affect their bottom line which is often passed on to their consumers. (Jeffrey, 2013) . Whom are currently shouldering an increased VAT of 15%, a regressive tax that weighs heavily on the poor.

1.2 PROBLEM STATEMENT

The primary aim of the carbon tax emission bill is to ensure that the social cost of pollution is internalized by the polluting entity. This is one way of implementing the polluter pays principle. The principle states that, those who produce pollution must manage it. They have to, bear the cost of it and prevent environmental damage and its consequences to human health (Pearce, 1989). The assumption is that the carbon emission tax will be an instrument that will, in at least a cost-effective manner, assist the country in reducing GHG emissions and ensure that the nation meets its objectives of reducing carbon emission (The Davis Tax Committee, 2015). This can be considered as an attempt to influence consumption and production through national policy. The National Treasury institute the tax in phases and in a gradual manner. The aim is to charge bio fuel input, to change production techniques and processes by influencing using a soft power approach within the economic context. Furthermore, the aim is to invest in energy efficient technologies that will certify low carbon emission so that households and firms take cognisance of the costs in their production investment and consumption decisions and not necessarily giving attention to the impact of employment in the process.

Secondarily, the carbon tax raises revenue for the government. Government proposes to utilise this revenue to reduce other taxes, such as personal income tax and corporate tax, which would assist in boosting employment and investment through the revenue recycling effect (Parry, 1997). The National Planning Commission (2011) noted that: "South Africa can manage the transition to low carbon economy at a pace consistent with government's public pledge without harming jobs or competiveness", a claim objected by various scholars (Gerhard, 2012). As stated in the Davis Tax Committee 2015 Report, the National Treasury would ensure minimal negative impact on the growth of the economy if the carbon emission tax is merged with revenue recycling. This is believed, will redirect the tax proceeds in the direction of productive investment sectors respectively. If the country's trade partners maintain constant prices and behaviour, the preferred tax incident will reduce absorption and employment at a percentage of 0.6 and 1.2 %, accordingly, by the year 2025.

The sectors that have been identified to be excluded in the initial implementation of the tax are the Agriculture, Forestry and other Land Use (AFLOLU) and waste sectors, due to measurement, monitoring and verification difficulties of non-combustion emissions in these sectors, thus sparring employment. Those less educated will suffer job losses from the transition. This will have detrimental effects on the households that are dependent on their income and those educated will experience slower wage growth (Alton, et al., 2012).Slower

job creation will occur in industries that generally export, and in equally those that are carbon intensive such as mining , manufacturing, construction, trade and transportation (Gerhard, 2012).

The potential detriment of the carbon tax imposition could have far reaching consequences in South Africa as companies' operational expenses will increase in the short run. The speculated consequence to that will be companies either shifting the tax burden to consumers or reducing their labour complement or both. This will not only be confined to the producer, but also to the suppliers of input materials used in production. A company such as Eskom generates electricity by the burning of coal supplied by mines. This implies the mines themselves might see a reduction in demand which will cause a reduction in supply and as such undesired consequence to their labour force. Carbon intense corporations will not be exempted for the tax. This will lead to lowered investor confidence and a reduced pace of industrialisation due to expenses and no available alternative technologies.

As for the household, the imposition means prices will surely increase and strained will their household budgets be. Likely, the households might seek to move to substitute products, but this might not liberate their budgets much on the basis that even the production and transportation of substitutes comes with an emission of carbon emission (Grafstorm, 2009). The implication is that consumers will then seek to reduce spending (consumption), a direct detriment to the Gross Domestic Product (Steindel, 2001) .As such, the economy will shrink as demand reduces, thus forcing an off load of labour.

1.3 AIMS AND OBJECTIVES

1.3.1 Aims

The critical aim of this study is to investigate the impact of carbon emission tax on unemployment in the Republic of South Africa. The study should conclude if indeed these two variables have a relationship at all and if indeed one does exist, the study seeks to elucidate in detail the nature thereof. The South African National Treasury is to propose the bill of carbon tax to parliament after stakeholder participation (National Treasury, 2017). This also occurred after the minister of Energy Jeff Radebe signed IPP (Department of Energy, 2018) deals which was contested by unions on the basis it will cause job losses in the energy sector in particular, and the country in general thus touching on elements of the study. This implies, that the study will assist greatly in policy formulation and provide economic interpretation forecasting.

1.3.2 Objectives

- To examine the trends between carbon emission tax and unemployment in South Africa.
- To use the VAR methodology to analyse the nature of the relationship between unemployment, carbon tax and other hypothesised factors.
- To articulate relevant policy recommendations based on the empirical findings of the study.

1.4 RESEARCH QUESTIONS

- Will Carbon Emission Tax lead to Unemployment in the Republic of South Africa?
- What will be the nature of the relationship between carbon emission tax on unemployment in the Republic of South Africa?
- What will be the policy recommendations derived from the results be?

1.5 HYPOTHESIS OF THE STUDY

The study will test the following hypothesis:

H_0 : There is no significant trend behaviour between carbon emission tax and unemployment in South Africa

H_1 : There is no significant relationship between carbon emission tax and unemployment during the period under study.

1.6 SIGNIFICANCE OF THE STUDY

The study is designed to assist South African policy makers in their process of policy derivation, primarily functionaries of the state in departments such as the National Treasury, Department of Energy and Department of Environmental Affairs. The study will assist labour unions that have constituents in the energy sectors and sectors that emit a lot of the country's carbon emission such as the National Union of Mine Workers and the National Union of Metalworkers of South Africa because any labour movement affects them directly.

The study will also assist in scholarly work as there has been little done to investigate carbon emission tax and its impact on employment in South Africa from an economic sciences perspective. The study will equally be used by the average South African to gain insight and understanding to this unprecedented policy proposition by Treasury and its impact on the layman.

The study will not only provide an economic explanation, but equally an econometric analysis. This will be conducted by means of a regression between carbon emission tax and unemployment.

1.9 LIMITATIONS

- South Africa lacks scholarly empirical literature on Carbon Emission Tax as it has not been levied as of yet.
- The data from 1980-2017 was collected and used in the study was secondary data. With Carbon Emission and Tax Revenue not having a full data set.
- No econometric analysis has been conducted in South Africa to measure the regression of CO_2 and unemployment.

1.10 LAYOUT OF STUDY

This thesis consists of five chapters. Chapter one is the introduction and background of the study, providing the problem statement and aims. Chapter two comprises the literature review separated into theoretical and empirical literature relevant to the topic. Chapter three is the presentation of the methodology of the study and explanation of variables used. Chapter four engages regressions of the study, reports, interprets and discusses the results. Chapter five presents a general discussion of variables, a summary of the whole study and findings; a conclusion drawn from the results of the study and recommendations are made subject to the results obtained from the study.

CHAPTER TWO

LITERATURE REVIEW

2. INTRODUCTION

This chapter delves into the theory and the empirical findings relevant to understanding unemployment and carbon emission tax, the primary variables of the study. The chapter looks at the variables in line with other determinants. Furthermore, the chapter investigates the concept, causes and consequences of unemployment and the outcomes and nature of CO_2 tax from the nations that have it levied. Various unemployment theories are presented in this chapter for better theoretical economic understanding of the concept. The theories pit unemployment against output, full employment, wages, and supply of labour and general demand supply. These are important in understanding the impact a CO_2 will have on unemployment.

2.1 CONCEPTUAL PRELIMINARIES OF UNEMPLOYMENT

Unemployment is a well-known concept which is rather popular and known by people of various and diverse nationalities. The unemployment rate has established itself over the time as a reliable economic indicator (Cain, 1979), and as a means of diagnosing the health of a nations' economy and as a guide and influencer of economic policy. To the laymen, unemployment can be defined in general and simple terms, but the economic definition is much more complex. This is a result of numerous groupings such as: the employed, unemployed or those simply out of the labour force by weighing various considerations. It was in the year 1954 when the International Labour Organisation (ILO) derived a standard definition of unemployment, which then came to the assistance of the nations of the world to categorise individuals between the employed and unemployed. In accordance to the ILO derived definition of unemployment, for an individual to be classified as unemployed, they must either be: I) without work; ii) currently available for work; iii) seeking work.

The definition was later rephrased at the International Conference of Labour Statisticians (ICLS). The initial definition of unemployment demonstrated high levels of rigidity and dismally failed to capture the existing conditions of employment in a lot of countries. The definitions did not do justice to capture the unconventional meanings of employment seeking, which was seen as being of little importance, in situations where the labour market is significantly unorganised or of limited scope, labour absorption insufficient or rather, where the labour force is largely self-employed (Hussmanns, 1990).

Ever since from then, developed and equally developing nations of the world have subscribed to this definition in one way or another. Kuper and Kuper (1996) defined unemployment as: Not employed, available and job hunting. Dwivedi (2005) defined unemployment as: An individual who is willing and able to work at the prevailing wage rate but cannot find a job. Dwivedi later redefined the initial definition of unemployment to: Unemployment, the gap between full employment and the number of employed individuals. This occurred after the realisation that the initial definition was ambiguous from a policy perspective in that it failed to specify individuals who should not be included in the category of job seekers.

2.2 THEORETICAL REVIEW

This chapter reviews the theories that speak to unemployment. These theories are: Okun's Law, Classical Theory, Keynesian Theory, Monetary Theory, Coase Theorem, Pigou's Theory of Unemployment and the theory of demand and supply.

2.2.1 OKUN'S LAW

In the year 1962, Arthur Okun documented his observation of the relationship that existed between unemployment and output. Okun detected an inverse short run relationship between unemployment and output (Ball, et al., 2013). As named after its founder, Okun's Law held true in numerous nations and many studies have testified to this finding hence, it is deemed highly in some of the most reliable works in the sphere of macro-economics.

Okun's Law was defined by O'Hara (1999) as a rigid relationship between unemployment rate annual change and the growth rate of the real gross national product. Okun asserted that the gain or loss of the real GDP in relation with a drop or increase of unemployment of a percentage point above or below four percent to be three percent of the United States of America's (USA) between the period of 1947-1960. The relation known and labelled as the Okun coefficient (Kennedy, 2000) stated that Okun's Law is a measure of the gap in output. It indicates that negative implies loss of actual output and positive implies a boom, which signals that the economy produces over the full employment output.

Okun developed a method in which output and unemployment can be expressed by different methods being: I) the correlation of variations in the unemployment rate with that of the growth rates of real GDP.ii) Unemployment rates with potential deviations from GNP. iii) Utilisation of constant ration assumption between the actual and potential GNP, with a potential growth rate of actual GDP. The initial estimation method is fairly simplified. The combination of

method ii) and iii) needs assumptions related to the development potential of the Gross National Product (GNP) or the stationary rate of inflation of unemployment (Stockhammer, 2000) (O'Hara, 1999). Barreto and Howland (1993) stated that, Okun presented a compelling debate of the high cost associated with unemployment by using the following three methods of relating output to the employment rate and equally weighing of coefficient estimates to derive the equation:

$$P = A[1+0.032(U-4)] \quad (2.1)$$

-where: P is the potential output, A is the actual output and U is the unemployment rate.

Krugman and Wells (2006) gave an explanation on the unemployment rate sensitivity to fluctuations in real GDP around its long run trend. Smaller are the unemployment fluctuations in relation to the corresponding changes in GDP output gaps. Okun has originally estimated that an increase in real GDP of a percent above potential output would provoke a fall in unemployment at half a percentage. Currently, speculations on Okun's Law are that the negative relations between the output gap and unemployment rate concludes that an increase in output gap of a percentage point leads to the reduction of the unemployment rate by half a percentage point. Therefore, the modernised version of Okun's Law is presented as such:

Unemployment rate= natural rate of unemployment- (0.5 x Output gap)

Even though Okun's Law was widely deemed as a reliable and stable relationship, it provoked questions as to whether it was means to achieve an outcome or was the outcome itself. O'Hara, (1999) argued that Okun's Law omitted other variables that impact unemployment and output. These are variables such as investment, technological innovations and endogenous technical progression. This led to varied versions of Okun's Law from the original. The initial version of Okun's Law stipulated the changes in the unemployment rate from a single quarter to the next in the unemployment rate from a single quarter to the next and the down movement of quarterly growth rate in the real output. The second version, also known as the gap version, connected the unemployment level to the gap between potential and actual output. The third version, the dynamic version, reflects some similarities to the initial version. The fourth and last version depicts the production function version, which is the combination of the theoretical production function with the gap version of Okun's Law (Knotek, 2007).

The third version, being the dynamic version, is more expressive as it has more independents variables which includes current and past output growth and historic changes of the

unemployment rate, hence it is the most favoured by economists (Knotek, 2007). The empirical dynamic version function is expressed as:

$$\Delta\mu_1 = \beta_0 + \beta_1 \alpha_{yt} + \beta_2 \alpha_{yt-2} + \beta_3 \alpha_{yt-2} + \beta_4 \Delta \mu_{t-1} + \beta_5 \Delta \mu_{t-2} \quad (2.2)$$

Where:

$\Delta\mu_{t-1}$ is the first lag of the unemployment rate

$\Delta\mu_{t-2}$ is the second lag of the unemployment rate

α_{yt-1} is the first lag of GDP growth

α_{yt-2} is the second lag of GDP growth

According to Prachowny(1993),Okun's Law is accepted not as a theory but rather as an empirical regularity due to it being founded on observation rather than an outcome of from theory.

2.2.2 THE CLASSICAL THEORY OF UNEMPLOYMENT

The Classical Theory of Unemployment states that full employment in an economy which has a capitalist regime is quite a normal occurrence. This implies that general unemployment in a capitalist economy cannot exist. According to the view of Classical economists, full employment guarantees that actual output will equal potential output. The equilibrium level of output thus coincides with full employment. The classical perspective is that total production is at all times enough to maintain the economy at the level of full employment in a free market economy. Classical economists believe that unemployment is a temporary situation. The existence of unemployment results in a wage decreases. The wage rate decrease implies profitable employment of labour, which then leads to increased demand for labour and a decrease and eventual disappearance of unemployment. What remains critical to note is that classical economists recognised the occurrence of voluntary and frictional unemployment in the state of full employment (Dwivedi, 2010).

The Classical Theory of unemployment was derived from Say's law of markets and the flexibility wages, the interest rate and market prices. Say's law stipulates that supply creates its own demand. This simply implies that, the quantity produced will be the quantity sold (demanded). Producers must only place focus on production and worry not about sales for the goods produced. If demand decreases, price decreases and supply will decrease in line. If

supply reduces, the price thereof will follow suite and production will reduce. Should the production reduction be a cause of unemployment, money wage will drop, and the drop will subsequently cause an increase in labour demand thus equate its supply. Due to this, unemployment will disappear, and re-establishment of the full employment situation will occur (Jain & Khanna, 2010)

Classical Theory states that the unemployment level can be associated and detected by the equilibrium of the demand and supply (Jain & Khanna, 2010)

• **Labour Demand**: In an economy labour is demanded because of productivity. Labour is demanded up to the extent that its marginal revenue productivity is equal to its wage;

$$W=MRP=P \times MPP \text{ or } W/P=MPP \quad (2.3)$$

where:

W is the money wage

P is the price level

MRP is the marginal revenue of productivity

MPP is the marginal physical productivity

W/P is the real wage

•**Labour Supply**: Labour supply is defined as the number of individuals prepared to provide labour at a certain wage rate. A positive relationship between labour supply implies that an increase in real wages will result in an increase in supply and vice versa.

The employment level comes as a result of the interaction between supply and demand. Equilibrium is reached where demand and supply cut across each other, at the intersection. Classical economists believed that equilibrium is a result of full employment.

2.2.3 THE KEYNESIAN THEORY

John Maynard Keynes's take came at odds with classical economics. Keynes began his work by contesting the classical economics view with what he described as a "special case", attributes that he believed did not reflect our current economic reality in society (Knights, 2011). Keynes then further formulated a theory that he believed captured our current capitalist economic reality termed The Postulates of Classical Economics (Asimakopulos, 1991).

The General Theory by Keynes' second chapter was introduced with an assumption that the nominal wage was constant, which was an attempt at a simplified argument. Keynes expressed that the basis of his argument was the same whether or not money wages were subject to change. The Keynesian Theory perceived nominal wages as a rule, a function, fluctuating with the fluctuations in employment and output. According to Keynes, a decrease in nominal wages does not imply a decrease in real wages as assumed by classical economists. In the broader economic context, a reduction in the nominal wage without a drop in prices implies what is called" fallacy of composition", in such a case, reduction in nominal wage will not result in unemployment reduction because the wage level would by and large remain unaffected. In general terms, changes in the nominal wage will result in yield compound influences on output and employment which is difficult to generate (Meccheri, 2005).

Keynes analyses is void of a critical component being the rate of equilibrium of unemployment with regards to an unemployment rate equating income claims in regard to unemployment being derived from the equilibrium on the goods market. The short run analysis is that investment or rather autonomous expenditures are exogenously expressed and equally determine output which adjusts in a manner that investment is equal to savings (Einbond, 1995).

It should be noted that investment is not the sole determinant that affects the equilibrium level of employment, but it is regarded a highly important factor due to its strong influence on income and because it's volatile nature of changing suddenly (Einbond, 1995).

Einbond continued to explain that employment is a determinate of two factors; being investment, which in turn affects the total income of the community and the sum of the community's consumption and its investment. Keynes labelled the relationship between the number employed and total income as the aggregate supply function, presented mathematically as $Z = f(N)$: Z stands for aggregate supply. N standing for the number employed. There is a single value for which total income equals the sum of consumption and investment, this point is where equilibrium level is reached (Einbond, 1995).

Asimakopulos(1991) stated that Keynes validated the point that unemployment could be an equilibrium phenomenon, that the economy could have net forces to increase the unemployment level despite workers wanting to supply additional labour at existing real wage rates. In such a case, equilibrium will be in a position of rest. Contrary, firms output, consumption and investment expenditures by households and firms would all be in chosen

positions as a temporary disequilibrium occurrence, a result of cyclical disturbances which Keynes heavily threatened.

With the conclusion of his analyses on the phenomenon of unemployment, Keynes made a conclusion that unemployment's main cause was aggregate demand deficiency. Keynes therefor, made a diagnosis that unemployment could be decreased and removed by the increase of aggregate demand. Aggregate demand has three components, which are: a) Demand for consumption goods, b) demand for investment goods and c) expenditure by the government. Keynes was of the view that the government must intervene and play a role in the economy as that would assist in the combating of unemployment and attracting the objective of full employment (Jain & Khanna, 2010).

2.2.4 NEOCLASSICAL THEORY (MONETARISM)

Milton Friedman gave the interpretation of the General Theory as a market clearing model which states that an increase in the nominal wages gives rise to the increase in the amount of labour supplied as they fail to differentiate between a changes in nominal wages with that of real wages (Garrison, 1984). It was because of this that a counter unemployment theory, popularly known as the Monetarist Theory, was developed for unemployment. Milton Friedman expressed unemployment to be the difference between labour supply and demand. Standard economic theory declares households and firms to make decisions based supply and demand of labour on real wages and not on nominal wages. The implication is that real wages rise where there is excess demand for labour and fall where there is excess supply (Gottschalk, 2002)

Monetary theory describes real wages as money wages that have been adjusted for post inflation (Economics Help, 2017). The natural rate of unemployment materialises when firms and workers correctly estimate prices and as such real wages. Workers would refuse to work longer hours as a reaction to an increase in money wages yet no increase in real wages. If the cost of production increases at the same rate as the selling price, firms will be unwilling to produce more stock.

According to the theory by Friedman , the natural rate of unemployment is a result of all real conditions affecting the supply and demand for labour. According to Chemomas(1983), the natural rate of unemployment as the equilibrium in the labour market, a point where there is no excess supply nor demand in the aggregate for labour. This includes exogenous factors such as

unionisation, women proportion in the workforce, minimum wage legalisation, level of education among workers and so forth. Friedman cited that in the short run, the natural unemployment rate maybe lower or higher in contrast to the rate of unemployment (Ekelund & Herbert, 2013).

Errors in the expectations of the level of price and therefore real wages are a cause of deviations from the natural rate of unemployment. Government expenditure creates demand which then leads to unexpected changes in the price, thus causing real wage to be lowered and thereby driving unemployment below the natural rate. Unemployment is pushed below the natural rate by an excess in demand. An upward pressure on wages is a result of excess employment produced, thus removing the higher rate of employment and equally any real long run change in output. The sustenance of this level of employment is subject to the government's fast trading demand and inflation if the labourers continue in their perception of real wage (Chemomas, 1983)

An assumption of the Monetarist theory is that the level of full employment could be obtained, and unemployment eradicated by changing the money supply (Jain & Khanna, 2010). Monetarists place particular emphasis on the importance of money in macroeconomics on the basis of its temporary effects on output and employment levels or because in the long run, money supply fluctuations had effect only on the price level. The theory also states that the money velocity is constant hence any changes in money supply has direct influence on the aggregate demand. The Monetarist theory places more importance on the monetary policy than it does on fiscal policy.

Monetarists, like Keynesians, give little significance to labour markets and equally to the role of wages in unemployment determination. A majority of monetarists hold a view that any unemployment creates imbalances that would most likely have its origin in the monetary disturbances. For example, a money supply decrease would result in prices and money wages unchanged, a raise in the real wages and thus accelerate the problem of unemployment (Vedder & Gallaway, 1997)

2.2.5 PIGOU'S THEORY OF UNEMPLOYMENT

Great Britain was in an economic down turn in the 1920's and as a reaction to that Prof AC Pigou authored the Theory of Unemployment in 1933. Pigou subscribed to the Classical Theory which states that labour was underutilised in Great Britain because it was expensive (Ventelou,

2005). The view that Pigou had was that the monetary of fiscal policy could indeed be utilised in the moderation of industrial fluctuations, and that the rate of plasticity of the rate of wages could ensure full employment. That then means that the significant item of the theory of unemployment was the elasticity of the real demand curve for labour, which was claimed to be large by Pigou (Collard, 2011). It was Pigou's belief that the labour market was at the centre of unemployment and the cause being extremely high wages.

In Pigou's Theory of Unemployment, an assertion was made that the level would be ascertained in the difference between aggregate supply and demand for labour at any wage rate. The proposition made by the theory of unemployment by Pigou, states that the size of labour as represented by the supply curve does not speak to the wages even though on an individual basis there can be labour supply curves which could be sloped upwards or backwards and therefore could be treated as vertical. Labour demand is downward slopping and depends on labours marginal product. The supply of labour has always been superior to demand for labour, therefore meaning unemployment becomes subjected to wage movements and labour demand (Ahiakpor, 1998).

Sweezy (1934) classified the theory of unemployment in relation to a modified wage fund doctrine. The theory of unemployment divides the economy into two; being the industries that produce wage goods and non-wage goods. A typical wage good industry is the export industry on the basis that the goods produced are produced by way of exchange. Wage goods funds as defined as the quantity of wage goods obtainable for payment as wages, can be changed in the short period of time, making it flexible for subtractions from stocks and prevention of wage goods consumption by non-wage earners. These mechanisms can be exchanged to change the wage goods fund in the short run as well as increase output from the wage good industry. This system seemed to decrease the actual demand for labour in periods set apart to dependence upon a relatively smaller quantity and easily organised set of factors.

The amount of labour that maybe demanded can be determined together with the demand elasticity for minor changes in the real wage rate, with a wage rate given and the supply of labour equally given. This is basically the schematic background of dealing with demand for labour in the aggregate. It displayed four major concepts. All these major concepts seemed to be open to serious criticism (Sweezy, 1934). The four major concepts were: I) Wage and non-wage goods ii) Wage and non-wage good industries iii) the short period IV) Period of production based on wage goods.

Over and above separating industries into wage goods and non-wage goods industries, Pigou went on to separate industries producing wage goods at home and in creating exports, the sale which generates claims to wage goods abroad. Pigou's assumption stated that x men to be employed in the first and y men to be employed in the second. The output in value of wage goods of the *x*-men is termed as $f(x)$ and the general wage rate's as $f'x$. *This* implies that, even though unstated, it was equal to thinking that marginal wage cost is equal to marginal prime cost. He went further to state $x + y = f(x)$, thus implying that the *x* employed men in the wage goods industries is a sum total function of employed. Pigou further expressed that the elasticity of the real demand for labour in the aggregate could be written as:

$$E_r = [f'(x)/f(x)].\ [F'(x)/F''(x)] \qquad (2.4)$$

where:

$$E_{,.} = [f(x)/f(x)].[F'(x)/F''(x)]$$

-Output value of wage goods industries in terms of the wage unit.

Collard (2011) stated that Pigous Unemployment Theory provoked mixed emotions, where as to others it was a work of pure genius and the best book authored in an era, yet this theory did not come without its fair share of criticism. Keynes in his criticism of Pigou's Theory of Unemployment labelled it as no different to the Classical Theory of Unemployment, which he was equally outspoken in criticising (Collard, 2011).

2.2.6 COASE THEOREM

According Coase (1960), if property rights are put in place and properly defined within an economy, then various economic actors will attempt to bargain for the right in order to use it. This will be done with the intent to reach a solution of mutual benefit and the resource usage will then be maximised. Coase states that it is irrelevant who has ownership of property rights as economic efficiency will be achieved either way. In order for the Coase theorem to function, two assumptions have to be meet: The marginal cost and marginal benefit of those participating must be disclosed. Second, transaction cost should not be in the bargaining.

Nicholson (2004) illustrated by means of an example of two firms, being firm X and firm Y. In the illustration by Nicholson firm X is allocated X^t rights to produce and thus pollute. It is upon the firm to decide whether to use those rights for production, captured as X_0 or make a sale to firm Y, with the amount earned being given as $X^t - X_0$. Firm X's gross profit would be illustrated by this profit function (equation):

$$\pi_X = P_x X_0 + r (X^T - X_0) = (P_x - r)X_0 + rx^T = (P_x - r) f(Y_i) + rx^T \quad (2.5)$$

The equation for firm Y being:

$$\pi_Y = P_y g (X_i X_0) - r (X^T - X_0)$$

Profit maximisation will conclude with an equal solution for firm X and firm Y regardless which firm holds the rights.

Coase highlights that the common economics approach with the assumption that there are no transaction costs is unrealistic. The meaning of this, Coase explains, is that whoever wants to engage in market transactions must identify information with those they wish to transact with and what to transact on, therefore there must be contracts drafted.

What Coase implies is that an alternative solution to individuals engaging in bargaining by themselves must cease and the state intervenes, playing a role of a somewhat supper firm. This he believes is because of its ability to influence factors of production through the decisions it makes in terms of policy formulation and regulation, such as the imposition of tax to change behaviour. The state can make decisions that eliminate free riders due to its reach and influence on the people and country. Coase made an example of a big factory emitting pollution since it had the rights and many property owners paying them to reduce their pollution, with some households refusing or underplaying with intent to get a lesser charge.

Coase theory would be impossible to implement in an effort to reduce carbon emissions as everyone can emit without paying a cent to the damaged caused to others.

2.2.7 DEMAND AND SUPPLY

There are numerous factors affecting the pricing of a product or service. Demand is generally determined from the price of a good or service with the price of substitute being of equal importance. The quantity of a good or service decreases as the price increases, this is summarised as the law of demand. Two pivotal reasons explain this: i) the effect of income and ii) the substitution effect. Usually when the prices of goods increase, the relative wages of people generally remain the same or decrease. This makes people feel poorer as they cannot consume as they wish or use as they used too. An increase in the price of a good with the

relative price of another decreases, this is known as the substitution effect, with people altering their consumption mix (Sloman, 2003).

Factors affecting demand can be mathematically specified in the demand function. This function provides the description of the relative factor of all individual factors. A graphical description can be derived for the demand function, which is known as the demand curve. Similar practice can be used to derive the supply curve. At a given price, the curves show what is demanded at what quantity can be supplied with all things held constant, where the two slopes cut through each other, that point of intersection point is known as real quantity demanded and its revealed.

Carbon dioxide cannot be demanded, but it is an externality of demand as to manufacture products and at times the provision of goods comes with the burning of fossil fuels, hence a carbon tax will impact demand and supply of goods and services.

2.3 EMPIRICAL LITERATURE REVIEW

This section of the study will be broken into two parts being the empirical literature review of developed (industrialised) and developing nations.

It has to be understood that South Africa is the only country on the continent of Africa to have carbon tax scheduled for implementation on the first of June2019 (Mboweni, 2018). The Ivory Coast is considering carbon tax. It is only the developing countries outside the continent which have actually implemented carbon tax. The rest that have implemented it are developed countries from predominately the Nordic region of Europe, with Poland and Finland having implemented it in 1990 (The World Bank , 2018) making them joint first at implementation. A general view has been adopted to review the empirical studies concerned.

The distributional effect of a carbon tax should be viewed on one side between the citizens of a country; specifically among the poor and rich families, rural and urban dwellers. The other side is the comparison of developed (industrialised) countries and developing countries, with an abundance of empirical research coming from industrialised as opposed to the handful from developing countries and those on transition. These countries have conducted an analysis on the distributional effects of environmental policies.

According to OECD (1994), apparent and distributional indissoluble matters should be reflected by the distributional effect: The environment should benefit and the efficiency

thereof. Second to that is the financial implications as to who will pay more and who will pay less? Undoubtedly the environment would benefit from a reduction in greenhouse gases (GHG) emissions which carbon tax can assist (Kamm, 2011)

2.3.1 EMPIRICAL STUDIES FROM INDUSTRIALISED COUNTRIES

One of the earliest traceable study was by Poterba (1991) on American households. Poterba sought to investigate if the gasoline tax was regressive. In pursuit of this, it was equally concluded that the tax is regressive as larger fractions of expenditure for low-income households was larger than middle- or high-income households. Therefore, Poterba proposed the creation of offsetting changes in transfer programmes or other taxes in order to lessen the burden on struggling low income households having to spend more of their income on fuel, electricity and gas contrary to their counter parts on the opposite side on the income spectrum.

Pearson and Smith (1991) equally conducted a study that investigated the European carbon tax, i.e., the distributional effects of carbon dioxide taxation on European countries. The tax would be a combination of a tax levied on the carbon content of all fossil fuels, followed by a tax levied on all non-renewable forms of energy. The result reached was that the burden of the carbon dioxide tax was weakly related to income. In other words, it was slightly regressive, contrary to countries such as Ireland and the United Kingdom.

A study by Forstorp (2015) sought to investigate if a green economy can be achieved through carbon taxation as a means to achieve sustainable development as outlined by the United Nations Conference for Sustainable Development (UNCSD) in the year 2012.This was to, also increase how and the extent to which carbon tax can be a vehicle to greener economics in Europe's Nordic countries, which were the first to implement carbon taxes. The study conducted a horizontal review according to ten indicators that measure green economies with the inclusion of energy intensity, carbon and emission intensity for the period 1990-2012. The study concluded that a green economy cannot be solely attributed or achieved just by carbon taxes. Other factors have an influence such as the portfolio of policy instruments, weather patterns, economic development and technological alternatives. The thesis equally discovered that the carbon tax is regressive with the competitiveness of industry remaining not frustrated, yet the study also found that after a review of sustainability reports and interviews with energy managers from leading companies, carbon taxation and other carbon pricing mechanisms had limited effect on the mitigation of carbon dioxide emissions.

Grafström(2009) conducted a study aimed to investigate the carbon dioxide emission tax in Sweden with the intent to investigate its relation to emission level. The thesis used Supply and Demand, Coase Theorem, The Kuznet Curve and the Internalization of Externalities as its theoretical framework. The study ran an Ordinary Least Squares (OLS) technique analysis on tax, emission levels and the development of gross domestic product variables. The study found that households are the main source of carbon dioxide emissions in the non-trading sector. It also found that when a tax is imposed on a firm, the firm can raise the price of its product(s) and by charging more it does not have to carry the full burden of the tax themselves. Most households consume most of their income on items such as electricity, gasoline and heating, and therefore a tax imposition will affect their consumption behaviour, with households paying half of the taxes collected by the state.

The thesis found that the household sector demonstrated a decline in emissions due to tax imposition in the regression. This meant the sector that is the dominant sector among those taxed showed that the policy had effect as per the regression results. Emissions could have fallen without the tax levied since on the aggregated level outcomes in the regression displayed the opposite. One assumption of low reduction per percent of tax increase is the point that tax is not directly visible to the consumer when making purchases, and it also being levied on substitute products limits the consumer. The study found the tax did assist in the change of behaviour due to emission reduction. Grafström(2009) found that CO_2 tax in Sweden was regressive, with low income households paying bigger portions as opposed to high income households, where low income households paying 0.8% of their disposable income on tax and 0.3% for high income households.

Generally industrialised countries demonstrate a regressive tax.

2.3.2 EMPIRICAL REVIEW FROM DEVELOPING COUNTRIES

One of the earliest recorded studies conducted on developing countries was by Shah and Larsen (1992) when they investigated carbon taxes, the greenhouse effect and developing countries. Shah and Larsen in their analysis included amongst other things, the distributional effect of CO_2 taxes in developing countries, the potential of revenue and efficiency thereof. India, Pakistan and Indonesia were included despite the fact that the analysis was only on Pakistan. In an attempt to show the distributional effects, an analysis was made to differentiate between

-full forward shifting, complete absence of forward shifting and partial forward shifting. Forward shifting practically means that tax price is completely translated into consumer pricing. The conclusion was that the burden of the tax decreased as income increased therefor displaying characteristics of regression on the tax incidence.

Boyce, *et al* (2005) conducted a study to investigate distributional impact of carbon taxes in the People's Republic of China. The outcomes were at odds with those found in the majority of studies conducted in developed nations with regards to carbon emission taxes as the carbon emission tax was progressive, as opposed to being regressive. They showed that low income household paid 2.1% in relation to their total household expense and high-income households paid 3.2%. This was suggested to be due to the fact that the patterns of expenditure on items such as transportation, house heating, industrial goods and the use of bio fuels were high for high income households as they bought high carbon intense products as opposed to their poorer counterparts.

Contrary to the Boyce, *et al* study, Corong (2007) sought to look into what would be the potential impact of carbon emission tax both on the economy and the livelihood of the citizens of the Philippines, thus assed the economic and poverty outcomes of an autonomous deduction of carbon in the Philippines. The outcomes of levying a carbon tax, even small, caused a reduction of income and a slight increase in the country's poverty level.

Yusuf and Resosudarm (2007) discovered that in Indonesia the carbon tax would not necessarily be regressive. Instead the carbon abatement policy demonstrated to be highly progressive and equally robust due to multiple alternative recycling schemes in the rural parts of the country. In the urban parts of Indonesia it appeared to be neutral or slightly progressive, with a general nationwide distribution effect being progressive, with inequality indicators reflecting accordingly. The detail in the findings is the fact that the population working in rural areas engaged less on energy intensive surroundings, as most worked as unskilled farmers. As a consequence, the intent to achieve growth in the distributional effect, increases in rural areas that have less energy intense industries would be a prerequisite for an acceptable solution to the state. This would require the country to remain in a phase of development in its growth.

A lot of the discussed developing countries demonstrate a progressive tax regime on carbon emission.

2.3.3 CONCLUSION

The results for developing countries with dominating agricultural sectors, differ from developing countries that have higher energy-intensive sectors and least agricultural active sectors. In those countries the distributional effect maybe similar to the effect witnessed in developed countries; which is generally regressive in character.

Therefore, the positive result of CO_2 tax would be a drop in poverty, specifically in the rural areas. This is proved correct with regards to revenue from carbon tax being reversed back in terms of uniform lump-sum transfers.

The Indonesian study of the effect of carbon taxation was a progressive step in the correct direction. It is believed that other countries in that phase of development will follow this positive precedence and investigate the effect a CO_2 tax would have on their citizens, especially on more poor households. If it yields positive returns as witnessed in Indonesia, governments could consider the development and introduction of such a CO_2 tax.

CHAPTER 3

METHODOLOGY

3.1 INTRODUCTION

Chapter three lays out the study's methodological structure which includes data analysis, model specification and definitions of variables utilised. The theoretical reference outlined in chapter three is used as a guide for analysis. The explanations of the variables as well as the type of the data to be used are described. Stationarity testing procedure and Vector Auto Regressive (VAR) estimation technique are used, followed by diagnostic tests to evaluate the estimated VAR model.

Chapter one highlighted the fundamental objectives of this study for which their relevant techniques and procedures are introduced in this chapter. To analyse the impacts of current account deficit and the effect of exchange rate and trade openness on economic growth, VAR technique was employed.

3.2 DATA ANALYSIS

Yearly secondary data collected from South African Reserve Bank (SARB) and The World Bank was used in this study. The sample period is from1980-2017 yearly. The variables for which the data were sourced for are Gross Domestic Product (GDP), Tax (TAX), Unemployment (UNE), Foreign Direct Investment (FDI), Consumer Consumption (CCT) and Electric Power Consumption. Data for Unemployment (UNE) for the year 1980-1993, Carbon Dioxide Emission (CDE) for the year 2015-2017 and Tax(TAX) 2017 is missing therefore none was collected during those periods.

Table 3.1 Summary of all key variables

Variable	**Abbreviation**	**Measure**	**Frequency**	**Data Source**
Gross Domestic Product	GDP	Percentage	Yearly	World Bank

Tax	TAX	Percentage	Yearly	World Bank
Carbon Dioxide Emission	CDE	Units	Yearly	World Bank
Unemployment	UNE	Percentage	Yearly	World Bank
Foreign Direct Investment	FDI	Percentage	Yearly	World Bank
Consumer Consumption	CCT	Percentage	Yearly	South African Reserve Bank
Electrical Power Consumption	EPC	Units	Yearly	South African Reserve Bank

3.3 MODEL SPECIFICATION

Grafström (2010) conducted a study to investigate the effect of Swedish carbon dioxide tax (an econometric analysis) using a linear regression model over the period of 1985 to 2008. The following model was utilized in the study…

$$Ln(\hat{E})_t = \delta_0 + \hat{\delta}_1 LnT_t + \hat{\delta}_2 LnQ_t + \hat{\delta}_3 LnU_t + e_t \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3.1)$$

where E denotes CO_2 emissions, T represents tax, Q real GDP growth rate and U represents dummy variable. This study adopts the model presented by equation 4.1. However, the model is modified by adding additional four key variables and discarding the dummy variable. Furthermore, the dependent variable has also been changed from carbon dioxide emissions to unemployment in this study. Hence the following equation presents the fundamental model of this study…

$$UNE = f(GDP, TAX, CDE, FDI, CCT, EPC) \quad \text{.....(3.2)}$$

where UNE denotes unemployment as a total percentage of total labour force, GDP denotes real Gross Domestic Product growth rate, TAX denotes tax revenue, CDE denotes Carbon Dioxide Emission, FDI denotes Foreign Direct Investment outflows, CCT denotes Consumer Consumption at constant prices and EPC denotes Electrical Power Consumption (Housing, water, electricity, gas and other fuels)

CCT and EPC measurement scales are not in percentage. Therefore, they are supposed to be logged. Hence, the following equation represents the fundamental model to be estimated in this study…

$$UNE = f(GDP, TAX, CDE, FDI, LCCT, LEPC) \quad \text{.....(3.3)}$$

where UNE denotes unemployment as a total percentage of total labour force, GDP denotes real Gross Domestic Product growth rate, TAX denotes tax revenue, CDE denotes Carbon Dioxide Emission, FDI denotes Foreign Direct Investment outflows, LCCT denotes logged Consumer Consumption at constant prices and LEPC denotes logged Electrical Power Consumption (Housing, water, electricity, gas and other fuels.

3.4 DEFINITIONS AND EXPECTED THEORETICAL RELATIONS OF VARIABLES

3.4.1 Unemployment rate ~ % of total labour force (UNE)

The unemployment rate can be defined variously, i.e. either the national definition, the International Labour Organisation (ILO) harmonized definition, or the OECD harmonized definition. The OECD harmonized unemployment rate provides the number of unemployed persons as a percentage of the labour force, which is the total number of people employed and unemployed. As defined by the ILO, unemployed workers are those who are currently not working but are willing and able to work for income, currently available to work, and have actively searched for work (The World Bank, 2018). Unemployment is treated as the dependent variable in this study.

3.4.2 Real Gross Domestic Product (GDP)

Real GDP is an inflation adjusted estimation of economic output. It represents the total national output as if prices never went up or down, which gives a more practical evaluation of growth.

There are four main components of GDP which are private consumption, investment, government expenditure and net exports. Private consumption is the most essential driver of GDP growth.

Real Gross Domestic Product is expected to have a theoretically negative relationship with unemployment, that is an increase in one variable will lead to a decrease in another as described in Okun's Law (Podgorska & Lesniowska-Gontarz, 2016).

3.4.3 Tax -Tax Revenue (Tax) [Proxy variable to Carbon Tax]

Taxes are involuntary charges levied on individuals or firms and enforced and regulated by a government entity, in South Africa being the South African Receiver of Revenue (SARS). The taxes collected by SARS are used to finance government activities such as social welfare, education and health. In economics, taxes are incurred by whomever pays the burden of the tax, whether this is the entity being taxed or a person.

Considering the fact that carbon tax has not been levied by the government, tax will serve as a proxy variable with intent to analyse the likely relationship between unemployment and carbon emission tax once imposed

The expected relationship between unemployment and tax revenue is positive, thus implying that an increase in tax will lead to an increase in unemployment. It must be noted that the opposite, in literature, can also be true subject to how the government uses taxes. A study by Helms (1985) found that when tax revenue is used to finance improved public service instead of transfer payments that will then contribute positively on labour and business as it incentivises productivity. However, but when tax revenue is consumed on transfer payments or redistribution of income, then a negative relationship between tax, unemployment and economic growth (productivity) will exist. The Laffer curve should be utilised along Helms theory for better understanding (Laffer, 2004).

3.4.4 Foreign Direct Investment Net Outflows (FDI)

FDI net outflows is the amount of outward direct investment made by the residents, individuals or/and corporations of the reporting economy to external economies (other countries) in the world (The World Bank, 2018).

Foreign Direct Investment is defined as an investment made by a firm or an individual outside the country of residence into another country fashioned as business interest. This practically materialises when an investor establishes foreign business operations or acquires foreign investment assets, which includes the establishment of ownership or a lion's share in a foreign enterprise

The expected results are that Foreign Direct Investment Net Outflows will reflect a negative relationship with unemployment (Makhoba, *et al.*, 2017)

3.4.5 Carbon Dioxide Emission (CDE)

Carbon dioxide (CO_2) is a colorless, odorless and non-poisonous gas formed by combustion of carbon through the burning of mainly fossil fuels, and in the respiration of living organisms. It is considered a greenhouse gas. The release of greenhouse gases and/or their precursors into the atmosphere over a specified area and period of time have with disastrous implications to the environment (United Nations. United Nations Framework Convention on Climate Change, 2005).

A positive relationship is expected. This assumption is based on the case study of the United States of America's companies moving to Asia in general and China particular. This meant that jobs moved to China whereas CO_2 emission is rising in the USA thus creating a positive relationship between unemployment and carbon dioxide emission. The current trade war between China and the USA strengthens this assumption.

3.4.6 Consumer Consumption (CCT)

Consumer Consumption is also known as a voluntary private household consumption, or the transaction of money for goods and services in an economy. Common measures of consumer consumption includes all private purchases of durable goods, nondurables and services. Consumption by households contributes by far the largest part of South Africa's gross domestic product. As a percentage of GDP in the years preceding 1960, consumer consumption expenditure grew from a low of 50% in 1980 to as high of 61% in the year 1992 (Pretorius & Knox, 1995).

The expected relationship between consumer consumption and unemployment is negative (Malley & Moutos, 1996).

3.4.7 Electric Power Consumption (EPC)

Electric power consumption can be measured as kWh per capita. Electric power consumption calculates the production of power plants plus combined heat and power plants less the transmission, distribution, and transformation losses and own use by heat and power plants. Electric energy consumption is actually energy demanded on existing electricity supply. Mining and manufacturing industries are the majority consumers of electricity in South Africa as they account for roughly 60% of the national consumption but only 22% of GDP contribution (Deloitte Consulting Pty (Ltd), 2017)

A negative relationship is expected. Various studies have been conducted such as the one by Moyo, Dingela, Kolisi, Khobai, & Anyikwa (2017) and many other researchers on the same topic with similar outcomes as the relationship between the two variables.

3.5 ESTIMATION METHOD AND PROCEDURES

The methodology used in the study and also expresses the outlined data analysis, model specification and definition of the variables used in the study. Theory guided and ensured that theoretical consistency is adhered to as and when interpretation is given. Stationary Testing procedure and Vector Auto Regressive (VAR) estimation technique are utilised, which is then diagnostic tests are used to evaluate the estimated VAR model.

3.5.1 Estimation Method

3.5.1.1 Vector Auto Regression (VAR)

According to Gujarati and Porter (2009), the vector auto regression (VAR) is an econometric model utilised to capture the straight interdependencies among various time series. VAR models sum up the univariate autoregressive model (AR) by taking into account more than one advancing variables. All variables in a VAR enter the model similarly as in linear regression model, every variable has a condition clarifying its development in light of its own lagged values, the lagged values of the other model variables, and an error term. VAR modelling does not require as much learning about the forces impacting a variable as auxiliary models do with concurrent equations. The main earlier information required is a list of variables which can be theorized to influence each other inter-temporally.

Reduced standard form for VAR model:

$$Y_t = \sum_{i=1}^{P} A_i Y_{t-i} + BX_t + \varepsilon_t \quad \text{.....(3.3)}$$

where t = 1,…,T, Y_t denotes a k vector of endogenous variables and X_t represents a d vector of exogenous variables. A_i and B are the matrices of the coefficients to be estimated and ε_t follows an unobservable Gaussian zero mean vector white noise process with a time invariant positive definite variance-covariance matrix $E(\varepsilon_t \varepsilon_t') = \Sigma_\mu$ hence…

$$\varepsilon_t \sim NID(0; \Sigma_\mu) \quad \ldots (3.4)$$

3.5.1.2 Advantages of VAR

- It is assumed that all variables are endogenous and as such there is no need to classify them as endogenous nor exogenous.

This is a critical point to note, a prerequisite for simultaneous equations structural models to be estimated is that all equations in the system are to be identified. Primarily, this necessity boils down to a condition that some variables are observed as exogenous, and that the conditions contain distinctive right-hand side variables. In reality, this limitation ought to emanate generally from economic theory. Nevertheless, practically speaking, theory will not be precise in its recommendations of which variables ought to be classified as exogenous.

Consequently, a lot of discretion is applied concerning how to characterize the variables will arise. Since Hausman tests are regularly not utilized when they ought to be, the specification of certain variables as exogenous, required to form identifying limitations, is likely to be invalid. Sims (1980) named these identifying limitations 'unimaginable'. VAR estimation, then again, requires no such limitations to be imposed (Brooks, 2008).

- VAR' enables an estimation of a variable to rely upon more than its lags or combinations of the error terms i.e. white noise terms, so VARs are then more adaptable than univariate AR models; the latter can be seen as a limited version of VAR models. VAR models can in this manner offer an exceptionally rich structure, implying that they might have the capacity to capture more elements of the data that could have otherwise been ignored.

- Should there be no contemporaneous terms on the right-hand side of the equations, it is possible to just utilize Ordinary Least Squares (OLS) independently on each equation. This emerges from the fact that all variables on the right-hand side are pre decided (pre-determined) that is, at time *t*, they are known. This suggests that there is no probability

for input from any of the left-hand side variables to any of the right-hand side variables. Pre-decided variables incorporate every exogenous variable and lagged values of the endogenous variables.

- Created forecasts by VARs are frequently superior as opposed to traditional structural models. It has been contended in various articles by scholars that large scale structural models performed poorly as far as their out-of-sample forecast accuracy is concerned. This may arise because of the idea of the limitations put on the structural models to guarantee the identification discussed above.

3.5.1.3 Disadvantages and Limitations associated with VARs

- VARs are theoretical, since they utilize less theoretical information about the correlations between or among the variables to control the specification of the model. Then again, valid restrictions or limitations that guarantee identification of equations from a simultaneous structural system will give light on the structure of the model.

An upshot of this is that VARs are less amiable to theoretical analysis and in this manner to policy prescriptions. There likewise exists an expanded probability under the VAR approach that spurious relationship could be obtained by mining the data. It is regularly not clear how the VAR coefficient estimates ought to be interpreted.

- VARs have many parameters, on the off chance that there are g-equations, one for each of g-variables and with k-lags of each of the variables in every equation, $(g + kg^2)$ parameters should be estimated.

- For moderately small sample sizes, degrees of freedom will quickly be used up, inferring large standard errors and accordingly wide confidence intervals for model coefficients hence type one error (a type of error that is committed by rejecting a true null hypothesis) is more likely to be committed.

3.5.1.4 Procedure for building a VAR model

Step 1: Specify the model in the standard VAR form hence the form of equation

Step 2: Estimate the model

"Estimation of the model is done by feasible generalised least squares (GLS)" (Boreiko et al, 2006). The individual equations are estimated through OLS first and obtained residuals are used to estimate the white noise covariance matrix Σ_μ as:

$$\hat{\Sigma}_\mu = T^{-1} \sum_{t=1}^{T} \hat{\varepsilon}_t \hat{\varepsilon}_t{}' \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3.5)$$

Equation 4.25 is then used to calculate/estimate the GLS estimator. Should the regressors in equations be the same, then the estimator reduces to an equation by equation OLS estimator (Boreiko *et al*, 2006).

Step 3: Model specification and selection

Specification of the model in the form of step one, includes specification of the maximum lag order for the endogenous and exogenous variables, and an introduction of a zero on the parameter matrices. The decisions of the maximum lag order and model selection are subjected on the utilisation of the information criteria that will be highlighted in the next section. The value for the all information criteria must be small as far as possible in the chosen maximum lag order and model.

Step 4: Diagnostic and Stability checking

Obtained residuals must be tested against diagnostic tests and the estimated VAR model must also be tested against the stability test which will be fully discussed in section 4.6. If the model passes through all the diagnostic and stability tests, then the model could be used for inference and forecasting.

3.5.1.5 The likelihood ratio test and Information criteria for VAR lag length selection

The likelihood ratio (LR) test which is a statistical test used for contrasting the goodness of fit of two models, one of which is a special case of the other, is naturally and genuinely simple to perform, however, it has its restrictions. Essentially, one of the two VARs must be a special case of the other and, all the more genuinely, only pairwise comparisons can be made. The likelihood ratio test statistic is characterized as ...

$$\mathrm{LR} = \mathrm{T}\left[\log\left|\widehat{\Sigma \mathrm{r}}\right| - \log\left|\widehat{\Sigma \mu}\right|\right] \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3.6)$$

where $|\widehat{\Sigma r}|$ is the determinant of the variance covariance matrix of the residuals for the restricted model (with 4 lags), $|\widehat{\Sigma \mu}|$ is the determinant of the variance covariance matrix of the residuals for the unrestricted VAR (with 8 lags) and T is the sample size.

A disadvantage of the LR-test approach is that the χ^2 test will entirely be substantial asymptotically only under the presumption that the errors from every equation are normally distributed. This assumption is probably not going to be maintained for financial data.

An optional approach for choosing the suitable VAR lag length is to utilize an information criterion. Information criteria requires no such normality assumptions concerning the distribution of the error terms. Instead, the criteria trade off a fall in the residuals sum of squares (RSS) of every equation as more lags are included, with an increment in the value of the penalty term. The univariate criteria could be utilized independently to every equation except, once more, that it is typically considered desirable to require the number of lags to be the same for every equation. This requires the utilization of multivariate versions of the information criteria namely: Akaike Information Criterion (AIC), Schwarz Bayesian Information Criterion (SBIC), Hannah Quinn Information Criterion (HQIC) and Final Prediction Error (FPE), which can be characterized as…

$$\text{AIC} = \log|\hat{\Sigma}_\mu| + 2\frac{k'}{T} \quad \ldots (3.6.1)$$

$$\text{SBIC} = \log|\hat{\Sigma}_\mu| + \frac{k'}{T}\log(T) \quad \ldots (3.6.2)$$

$$\text{HQIC} = \log|\hat{\Sigma}_\mu| + \frac{k'}{T}\log(\log(T)) \quad \ldots (3.6.3)$$

$$\text{FPE} = \left(\frac{T + n^*}{T - n^*}\right)^{k'} |\hat{\Sigma}_\mu| \quad \ldots (3.6.4)$$

where $\hat{\Sigma}_\mu$ is the variance- covariance matrix of the residuals, T is the sample size, n^* represents the total number of parameters in each equation of the model when n is the lag order of the endogenous variables and k' represents the total number of regressors in all equations which will be equal to $P^2k + P$ for P equations in VAR system, each with k lags of the P variables, plus a constant in each equation (Brooks, 2008).

3.5.1.6 Impulse Response Function (IRFs)

Impulse responses trace out the responsiveness of the response variables in the VAR to shocks to each of the variables. As a result, for every variable from every equation independently, a unit shock is connected to the error, and the impacts upon the VAR system across time are noted. Hence, if there are g variables in a system, an aggregate of g^2 impulse responses could be generated. Practically this is accomplished by representing the VAR model as a Vector Moving Average (VMA) that seems to be the vector autoregressive model, composed as a vector moving average. Given that the system is steady, the shock ought to wither away gradually (Brooks, 2008).

3.5.1.7 Variance Decomposition

Variance decompositions offer a marginally unique technique for analysing VAR system elements. They give the extent of the variations in the response variables that are expected to their shocks, versus shocks to the other variables. A shock to the *ith* variable will automatically influence that variable, yet it will likewise be transmitted to all other variables in the system through the dynamic structure of the VAR. Variance decompositions decide the amount of the s-step ahead forecast error variance of a given variable is explained by advancements to each explanatory variable for s = 1, 2, . . . n. Practically, it is normally observed that own series shocks clarify the greater part of the (estimate) error variance of the series in a VAR. To some degree, impulse responses and variance decompositions offer the same fundamental information (Brooks, 2008).

3.5.2 Estimation Procedures

3.5.2.1 Stationarity and Stationary Tests

Stationarity is characterised by a situation where there are three properties being: i) mean ii) variance iii) covariance, of the time series remains unchanged over time. A pivotal reason that justifies stationarity is because the trend of non-stationarity variables could lead a researcher astray with regards to forecasting hence resulting in false conclusions regarding the trend of the variables. The danger of running with non-stationary variables, over and above other things, includes unreliable and inconsistent predictions, this will lead to undesirable consequences for policy makers as they derive economic policies.

3.5.2.2 Augmented Dickey-Fuller (ADF) Test

The ADF-Test tests for the presence of a unit root with the null hypothesis (H_0) stating that: The time series does have a unit root (non- stationarity). The alternative hypothesis (H_1) stating that: The time series does not have a unit root (stationarity), the H_0 tends to vary in line with the version of the test used. The Augmented version of the Dicky-Fuller test for a bigger and equally more complicated data set of the time series models. When conducting an analysis on time series data, the initial point of call is to first test the data for stationarity. Time series data is usually non-stationary, thus implying that the mean, variance and covariance change over time.

The ADF test was invented by Dickey Fuller (1976) to test for the presence of the unit root for a given time series data set. The test derives its basis in pursuing the objective at which the assumption of non-autocorrelation between the disturbance terms is violated. Dickey-Fuller expressed the tendency of time series data to contain a unit root. This implies that attention be activated with deliberate intent to render stationary for model specification and estimation. Residuals of non-stationarity time series could be correlated with their own specific lagged values, the assumption of the disturbance terms ought not to be correlated with each other as then becomes a violation.

Unit Root Model General Form:

$$\Delta Y_t = \alpha + \beta_t + \gamma Y_{t-1} + \sigma_1 \Delta Y_{t-2} + \cdots + \sigma_{p-1} \Delta Y_{t-p+1} + \varepsilon_t \ldots\ldots\ldots\ldots \quad (3.7)$$

If $\alpha = 0$ and $\beta = 0$, then equation (4.4) can be written as

$$\Delta Y_t = \gamma Y_{t-1} + \varepsilon_t \ldots\ldots$$

The unit root model specification

Using the equation 4.5, the unit root models for the key variables in this study can be specified as follows…

$$\Delta UNE_t = \gamma UNE_{t-1} + \varepsilon_t \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (3.7.1)$$

$$\Delta GDP_t = \gamma GDP_{t-1} + \varepsilon_t \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (3.7.2)$$

$$\Delta TAX_t = \gamma TAX_{t-1} + \varepsilon_t \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (3.7.3)$$

$$\Delta FDI_t = \gamma FDI_{t-1} + \varepsilon_t \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (3.7.4)$$

$$\Delta CDE_t = \gamma CDE_{t-1} + \varepsilon_t \ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (3.7.5)$$

$$\Delta Log(CCT)_t = \gamma Log(CCT)_{t-1} + \varepsilon_t \ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (3.7.6)$$

$$\Delta Log(EPC)_t = \gamma Log(EPC)_{t-1} + \varepsilon_t \ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (3.7.7)$$

where GDP denotes Gross Domestic Product, TAX stands tax, CDE carbon dioxide emission, UNE for unemployment, FDI for foreign direct investment, CCT for consumer consumption (tax) and EPC for electric power consumption.

3.5.2.2.1 Decision Rule

The null hypothesis(H_0) $\gamma = 1$, a unit root exists in UNE, GDP, TAX, FDI, CDE, LCCT and LEPC meaning that these variables are non-stationary but when $\gamma < 1$, a unit root does not exist hence the variables UNE, GDP, TAX, FDI, CDE, LCCT and LEPC are stationary. If the probability of ADF statistic is less than the critical probability (0.01, 0.05 and 0.10), then a unit root does not exist hence the variables are stationary.

3.5.2.3 Phillips-Perron (PP) test

Phillips Perron (1988) constructed a substitute to the ADF, which has the method of manipulating for serial relationship when testing for unit root. The PP-test method assesses the non ADF equation and improves the t-ratio of u-coefficient so that serial correlation does not influence the asymptotic distribution of the statistic.

General form of the unit root model

$$\Delta Y_t = \mu + \varphi Y_{t-1} + \varepsilon_t \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (3.8)$$

Unit root model specification

$$\Delta UNE_t = \mu + \varphi UNE_{t-1} + \varepsilon_t \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (3.8.1)$$

$$\Delta GDP_t = \mu + \varphi GDP_{t-1} + \varepsilon_t \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (3.8.2)$$

$$\Delta TAX_t = \mu + \varphi TAX_{t-1} + \varepsilon_t \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (3.8.3)$$

$$\Delta FDI_t = \mu + \varphi FDI_{t-1} + \varepsilon_t \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (3.8.4)$$

$$\Delta CDE_t = \mu + \varphi CDE_{t-1} + \varepsilon_t \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (3.8.5)$$

$$\Delta Log(CCT)_t = \mu + \varphi Log(CCT)_{t-1} + \varepsilon_t \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (3.8.6)$$

$$\Delta Log(EPC)_t = \mu + \varphi Log(EPC)_{t-1} + \varepsilon_t \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (3.8.7)$$

where GDP denotes Gross Domestic Product, TAX stands for tax, CDE carbon dioxide emission, UNE for unemployment, FDI for foreign direct investment, CCT for consumer consumption (tax) and EPC for electric power consumption.

3.5.2.3.4 Decision Rule

The null hypothesis(H_0) $\varphi = 1$, a unit root exists in UNE, GDP, TAX, FDI, CD, LCCT and LEPC, meaning that these variables are non-stationary but when $\varphi < 1$, a unit root does not exist hence, the variables UNE, GDP, TAX, FDI, CDE, LCCT and LEPC are stationary. If the probability for the PP-statistic is less than the critical probability (0.01, 0.05 and 0.10), then a unit root does not exist hence the variables are stationary.

3.5.3 Stability and residuals diagnostic tests

3.5.3.1 Stability test

3.5.3.1.1 Inverse roots of the AR characteristic polynomial test

An inverse root of AR characteristic polynomial test is used for testing VAR/VEC model stability. All the AR characteristic polynomials should be within the unit circle so that the model can be confirmed or even declared stable.

3.5.3.2 Residuals diagnostic tests

3.5.3.2.1 Normality test

There are various tests for normality such as histogram of residuals normal probability plot, Anderson Darling and Jarque Bera tests. The Jarque Bera test for normality is utilized in this study. The Jarque Bera test is mainly utilized in large sample cases. The Jarque Bera test statistic for normality is characterized as…

$$JB = \frac{N - K + 1}{6}\left(S^2 \frac{1}{4}(C - 3)^2\right) \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3.9)$$

where N denotes number of observations, K denotes number of predictor variables, S represents the skewedness of the sample's distribution and C denotes the kurtosis of the sample's distribution. The residuals in the model are assumed to be normally distributed, failure for the satisfaction of this assumption would make the results biased hence forecasts generated by the model would be unreliable. The following hypothesis is tested…

H_0: The residuals are multivariate normally distributed.

3.5.3.2.2Heteroscedasticity test

As indicated by Stock and Watson (2012), heteroscedasticity is a condition in which the variance of the regression error term conditional on the regressor is not constant. This study utilizes the White heteroscedasticity (1980) test, which will assess if the residuals variance is constant (homoscedastic). It is important for the residuals to be homoscedastic in order for the model to produce reliable and unbiased results hence failure to satisfy this assumption would make standard hypothesis testing unreliable due to wider confidence interval which consequently makes type 1 error (type of an error that is committed when the true null hypothesis is rejected) be easily committed. The regression test is performed by regressing each cross product of the residuals on the cross product of the regressions and testing the joint significance of the regression. The No Cross Terms option utilizes just the levels and squares of the first regressors while the With Cross Terms option includes all non-excess cross product of the first regressors in the test equation. Utilizing of OLS with the presence of heteroskedasticity may bring about wrong standard errors and subsequently any inference made could misdirect. The following hypothesis is tested:

H0: There is no heteroscedasticity among the residuals.

3.5.3.2.3 The LM Serial Auto Correlation test

Serial correlation is a relationship between the collective of the series of error terms ordered in time which in turn is the violation of the assumption of independence of error terms. Violation of this assumption concludes to unreliable standard hypothesis testing due to a wider confidence interval which makes it simple to commit a type 1 error. It is important for the residuals to pass through a serial correlation test in order for the model to produce reliable and unbiased results suitable for improved forecasting. It is generally caused by: i) Wrong functional forms, ii) Auto regressions, iii) Manipulation of data, iv) Data transformation and v) Non-stationarity of the data (Wooldridge, 2009). The autocorrelation LM test exposes the multivariate LM statistics for residuals serial correlation up to the specified order. The test statistics for lag order is processed by running an auxiliary regression of the residuals (μ), on the original on the right hand regressors and the lagged residuals where the missing first estimations of μ_{t-h} are loaded with zeros hence the following hypothesis is tested…

H_0: The residuals are not serially correlated.

3.6 CONCLUSION

The chapter has explicitly discussed the variables, model framework, theoretical expected relationships (results) and the relevant estimation techniques as well as procedures used in this thesis. VAR estimation technique has been explicitly discussed as well as stationarity testing procedure. This chapter also discussed the stability and diagnostic tests used to diagnose the estimated model and residuals so that impacts of carbon emission tax on unemployment in South Africa may be fully and correctly analyzed. EViews 9 software was used to run the specified models

CHAPTER 4

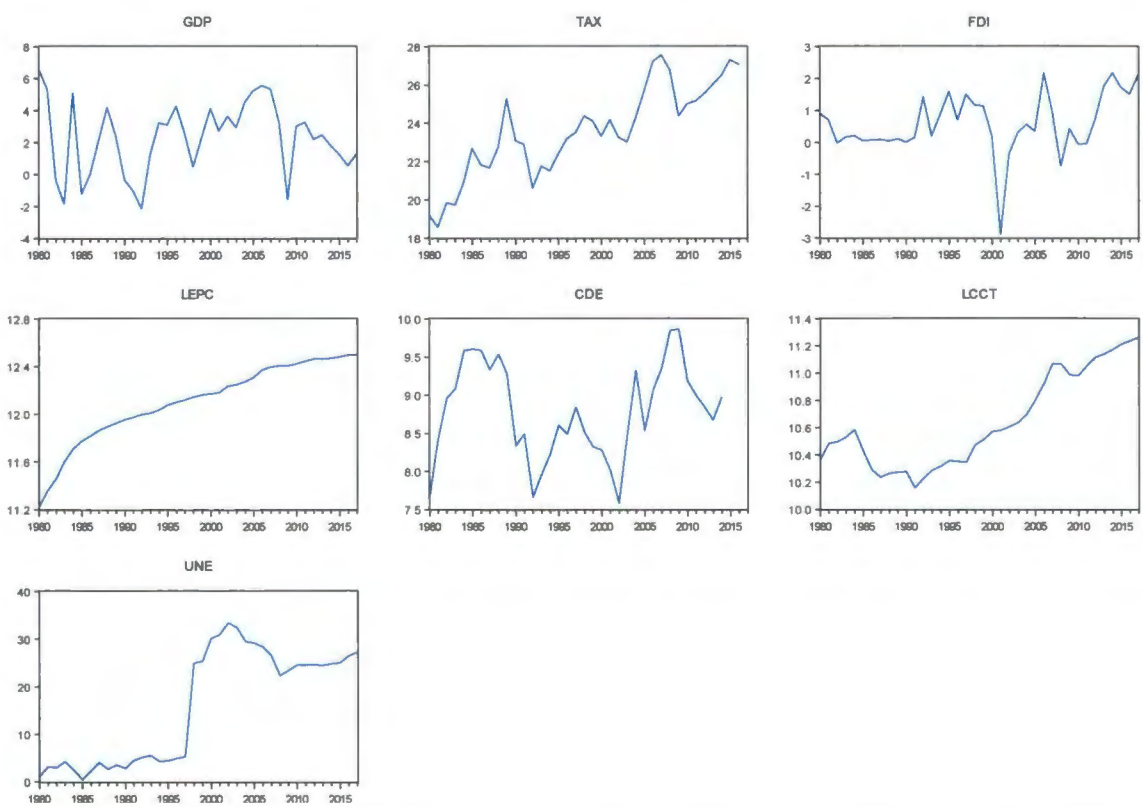
ESTIMATION, PRESENTATION AND INTERPRETATION OF RESULTS

4.1 INTRODUCTION

This chapter presents the results, analysis and interpretation of the discussed methodology in the previous chapter. Firstly, the time series of all the key variables are visually inspected against stationarity by means of the three stationarity properties of the time series (constant mean, variance and covariance). Secondly, unit root results for all the key variables will are shown and interpreted. Thirdly, VAR estimations, VAR residuals and stability tests were estimated and interpreted. Concluding remarks conclude the chapter.

4.2 VISUAL INSPECTION

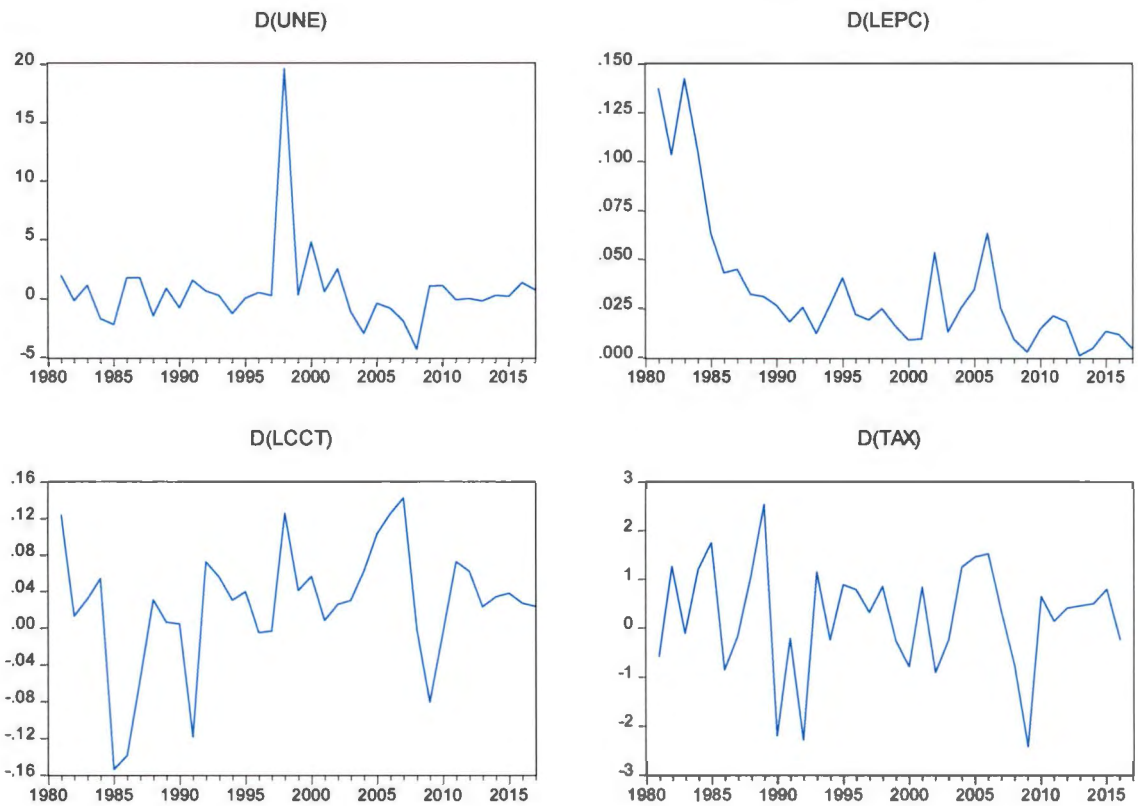
Figure 4.1 Graphical representations of all key variables (at level) in the specified model



Variant in the mean, variance and covariance of the time series implies that the trend of the time series is not constant across time. The trend of GDP, FDI and CDE variables seems to be constant or uniform in mean and variance over time which means that the trends of GDP, FDI

and CDE are stationary at level, hence the order of integration is zero. Time series UNE, LEPC, LCCT and TAX need to be integrated so that their trends become invariant across time, hence constant or uniform trends.

Figure 4.2 Graphical representations of first differenced key variables specified in the model



After differencing variables UNE, LEPC, LCCT and TAX once, their trends seem to be invariant, which means that the mean and variance is constant across time hence they are now stationary. The order of integration is one.

4.3 UNIT ROOT TESTS

Augmented Dickey Fuller (ADF) and Phillips Perron (PP) tests are utilised for stationarity or -unit root testing. Porter and Gujarati (2009) state that if a model is estimated with non-stationary data, results will be spurious. Stationarity testing acts as the first step in determining the order of integration of all key variables. Hence, Table 4.1 and Table 4.2 present the results for the unit root tests on all key variables of the study

Table 4.1 Unit root tests for all of the key variables at level

Level					
		With Intercept		**With Trend and Intercept**	
Variable	**Test**	**Statistic**	**P-Value**	**Statistic**	**P-Value**
CDE	ADF	-2.69947	0.0845***	-2.62047	0.2742
	PP	-2.91563	0.0540***	-2.83977	0.1938
GDP	ADF	-4.41399	0.0012*	-4.477657	0.0053*
	PP	-4.42592	0.0012*	-4.477657	0.0053*
TAX	ADF	-1.18099	0.4321	-4.107912	0.0142*
	PP	-1.40055	0.5712	-2.600588	0.2823
FDI	ADF	-1.40055	0.0156**	-3.788858	0.0285**
	PP	-3.44432	0.0161**	-3.807016	0.0273**
LCCT	ADF	0.152733	0.9863	-2.461916	0.3439
	PP	0.299890	0.9752	-1.463253	0.8242
LEPC	ADF	-8.48869	0.0000*	-7.996830	0.0000*
	PP	-5.44875	0.0001*	-7.100343	0.0000*
UNE	ADF	-1.06298	0.7200	-1.512002	0.8073
	PP	-1.12776	0.6977	-1.784546	0.6919

NB: */**/*** denotes significance at 1%, 5% and 10% respectively

: N/A denotes that the unit root test is not applicable

Summarizing the results obtained on the unit root tests in Table 4.1, variables such as GDP, TAX, FDI and LEPC are stationary in level when utilizing ADF unit root test at 1, 5 and 10 percent level of significance under intercept and trend model specification. Hence, GDP, TAX, FDI, and LEPC are integrated to the order of zero (*I (0)*).

Table 4.2 Unit root tests for some of the key variables at first difference

First Difference					
		With Intercept		With Trend and Intercept	
Variable	**Test**	**Statistic**	**P-Value**	**Statistic**	**P-Value**
CDE	ADF	N/A	N/A	-5.606360	0.0003*
	PP	N/A	N/A	-5.606360	0.0003*
TAX	ADF	-4.44176	0.0013*	N/A	N/A
	PP	-7.21304	0.0000*	-7.187008	0.0000*
LCCT	ADF	-4.13568	0.0026*	-4.513830	0.0050*
	PP	-4.10524	0.0029*	-4.59143	0.0057*
UNE	ADF	-5.74721	0.0000*	-5.665693	0.0002*
	PP	-5.77169	0.0000*	-5.695065	0.0002*

NB: */**/*** denotes significance at 1%, 5% and 10% respectively

: N/A denotes that the unit root test is not applicable

According to the results obtained on the unit root tests in Table 4.2, variables such as CDE, LCCT, and UNE are stationary after first difference at 1, 5 and 10 percent level of significance respectively under trend and intercept model specification using ADF unit root test. Hence, CDE, LCCT and UNE are integrated to the order of one (*I (1)*).

Since the attention is given to the nature of the trend of the time series, the results obtained on intercept and trend model specification using ADF unit root test are used to make the final decision on the order of integration for all key variables of this study.

4.4 LAG LENGTH SELECTION CRITERIA

Choosing the optimal lag order, the six information criteria as discussed in chapter four are used as the tools. In this study, the selection is made using a maximum of 4 lags in order for

the model to generate well behaved residuals. Table 4.3 presents the lag length selected by the six information criteria (see appendix 2).

Table 4.3 Lag order selection criteria

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-188.6943	N/A	0.000334	11.86026	12.17770	11.96707
1	-86.68017	**154.5669***	**1.44e-05***	**8.6472833***	**11.18681***	**9.501757***

Table 4.3 above indicates that information criteria LR selected lag 1, FPE selected lag 1, AIC selected lag 1, SC selected lag 1 and HQ selected 1. Therefore, lag 1 is selected as an optimal lag. Subsequently, the VAR model is estimated within the lag interval of 1:1.

4.5 VECTOR AUTOREGRESSIVE (VAR) MODEL ESTIMATES

As revealed by the unit root tests, not all key variables are stationary after first difference. Due to this, co-integration test (VECM) cannot be conducted since it requires all key variables to stationary after first difference (Brooks, 2008). Subsequently, the VAR model is estimated to test the relationship between independent and dependent variables. The model generates the endogenous variables that impact unemployment in South Africa (see appendix 3).

Table 4.4 Long run VAR estimates

VARIABLE	COEFFICIENT	STANDARD ERR.	T-STATISTIC
Constant	6.356865	12.2186	0.52026
UNE (-1)	0.950777	0.09061	10.4935*
GDP (-1)	0.084380	0.43098	0.19579
TAX (-1)	-0.171420	0.53983	-0.31754
FDI (-1)	0.704978	0.92479	0.76231
D(CDE)(-1)	0.242106	1.73111	0.13986
D(LCCT)(-1)	-11.16672	14.7292	-0.75814

D(EPC)(-1)	-31.20669	27.5145	-1.13419

NB: * denotes significance at 5% level of significance

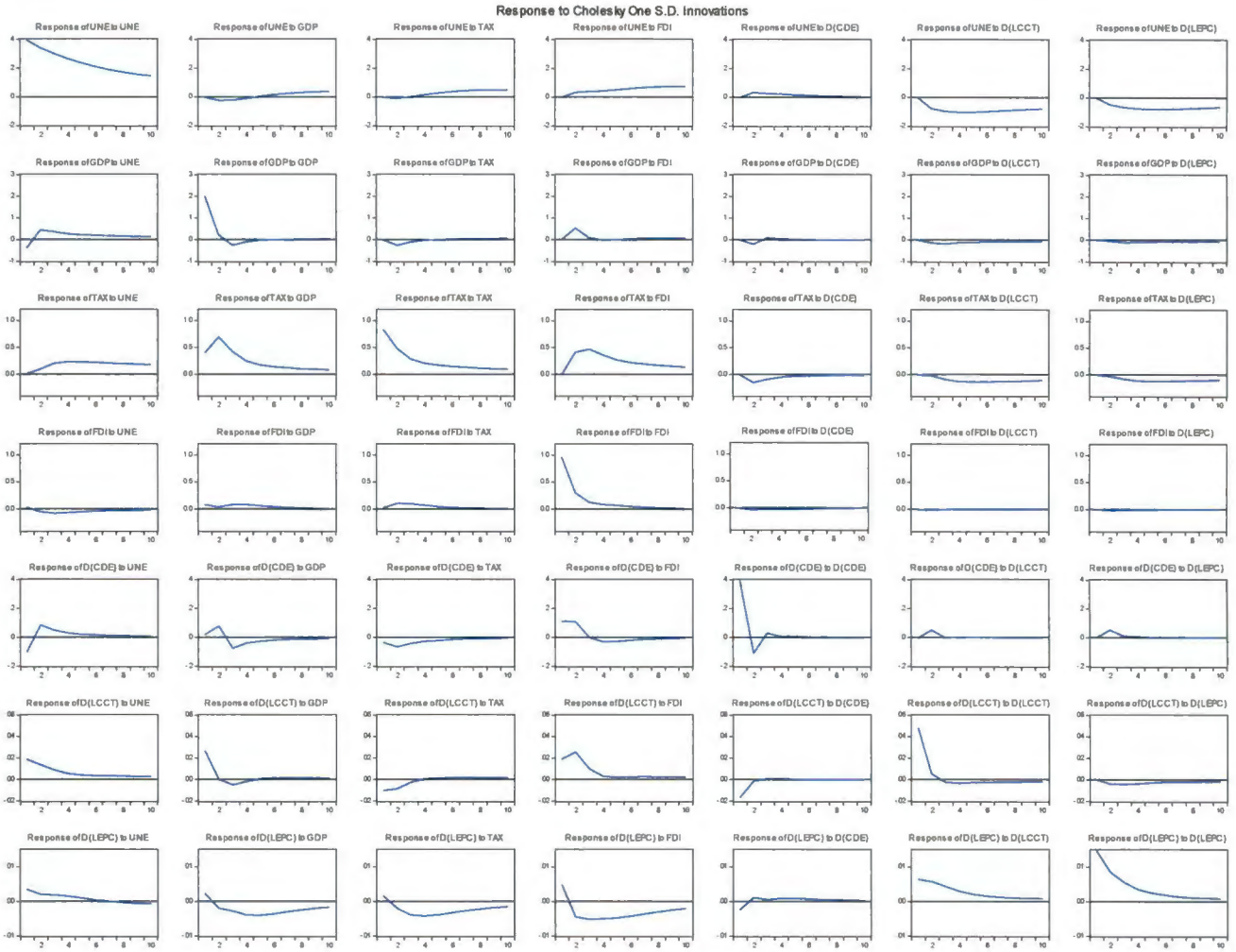
R*Squared	0.9161
F statistic	39.03330

The estimated VAR model suggests that there is an insignificant positive relationship between unemployment and gross domestic product in South Africa, hence 1% increase in GDP would results in a 0.08% increase in UNE. The model also articulates that there is a negative and insignificant relationship between UNE and TAX in South Africa, hence 1% increase in TAX would result in a 0.17% decrease in UNE. The model again shows a positive and insignificant relationship between UNE and FDI in South Africa hence 1% increase in FDI would result in a 0.70% increase in UNE. There exists a positive and insignificant relationship between UNE and CDE hence1% increase in CDE would result in a 0.24 % increase in UNE. There is a negative and insignificant relationship between UNE and LCCT in South Africa hence 1% increase in LCCT would result in an 11.17% decrease in UNE. The model also suggests that there is a negative and insignificant relationship between UNE and LEPC in South Africa, hence 1% increase in LPEC would result in a 31.21% decrease in UNE. The coefficient of determination (R squared) is 91.61% which implies that 91.61% of variation in the dependent variable UNE, is explained in the independent variables GDP, TAX, FDI, CDE, LCCT and LEPC. The individual effects on unemployment are not significant. However, since the F statistic is 39.03, which is greater than 5 for the 5 percent level of significance, then the overall effects by the independent variables on unemployment are significant.

4.6 IMPULSE RESPONSE FUNCTIONS (IRFs)

The impulse response function recognizes the responsiveness of the dependent variable in the VAR system when the shock is put on the error term. It demonstrates the dynamic reaction of real gross domestic product to a one period standard deviation shock to the innovations of the system. Furthermore, it shows the direction and persistence of the reaction to each of the shocks (see figure 4.4 and appendix 4).

Figure 4.3 Impulse Response Functions



The response of UNE to UNE, one period standard deviation shock on UNE produces a positively deteriorating impact on itself for the whole entire period. The response of UNE to GDP, one period standard deviation shock on GDP produces a negative but closer to zero impact between period zero and the fifth period, and a positive impact between the sixth and the tenth period. The response of UNE to TAX, one period standard deviation shock on TAX produces a positive impact for the entire period. The response of UNE to FDI, one period standard deviation shock on FDI produces a positive impact for the entire period. The response of UNE to CDE, one period standard deviation shock on CDE produces a positive but closer to zero impact for the entire period. The response of UNE to LCCT, one period standard deviation shock on LCCT produces a negative impact for the entire period.

The response of UNE to LEPC, one period standard deviation shock on LEPC produces a negative impact for the entire period.

4.7 VARIANCE DECOMPOSITION

Table 4.5 Variance decomposition of RGDP (see appendix 4).

VARIANCE DECOMPOSITION OF UNE

PERIOD	SE	UNE	GDP	TAX	FDI	D(CDE)	D(LCCT)	D(LEPC)
1	3.95830	100	0	0	0	0	0	0
2	5.32294	96.3060	0.1461	0.0161	0.4114	0.4341	1.9366	0.7480
3	6.25447	93.2309	0.1937	0.0170	0.6880	0.4995	3.7242	1.6466
4	6.93939	90.5780	0.1725	0.0896	0.9566	0.5271	5.1631	2.5130
5	7.47290	88.2339	0.1561	0.2498	1.3257	0.5160	6.2590	3.2596
6	7.90887	86.0644	0.1939	0.4742	1.8006	0.4915	7.0951	3.8804
7	8.27607	84.0510	0.2856	0.7345	2.3411	0.4641	7.7356	4.3881
8	8.59082	82.2057	0.4153	1.0074	2.9032	0.4380	8.2295	4..8008
9	8.86332	80.5391	0.5663	1.2761	3.4541	0.4150	8.6133	5.1362
10	9.10057	79.0529	0.7248	1.5300	3.9731	0.3953	8.9144	5.4095

The variance decomposition analysis covers period a 10 year period in order to examine the effects when the variances were allowed to affect UNE for a longer time. In the first year, all of the variances in UNE are explained by its own shock. In the 5th year, UNE explains about 88.23% of its own variation.

Explanatory variables account for 11.77% of the variation with GDP explaining about 0.16%, TAX about 0.25%, FDI about 1.33%, CDE about 0.52%, LCCT about 6.26%, and LPEC about

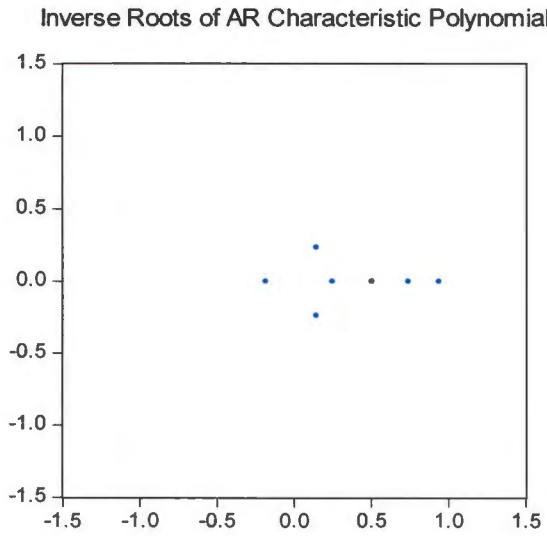
3.26%. Over the period of 10 years, UNE explains about 79.05 % of its own variation. Explanatory variables account for 20 .95% of the variation with GDP explaining about 0.72%, TAX about 1.53%, FDI about 3.97%, CDE about 0.40%, LCCT about 8.91 and LPEC about 5.41%.

4.8 VAR STABILITY AND RESIDUALS DIAGNOSTIC TESTS

Stability and residuals diagnostic tests are essential to the estimated model because they validate the estimated parameters and goodness of fit generated by the model. If the residuals are validated by the diagnostic tests, the estimated parameters will be efficient, hence unbiased estimated parameters (Adrino, 2012).

4.8.1 VAR stability test

Figure 4.4 Inverse Roots of AR Characteristic Polynomial



The estimated VAR model is stable because the inverse roots of AR characteristic polynomial are within the unit circle as shown in figure 4.5.

4.8.2 Residuals diagnostic tests

Firstly, the results for White's heteroscedasticity test with both cross term and no cross term will be presented, followed by Langrage Multiplier (LM) serial correlation test and Jarque-Bera's normality test (see appendix 6).

Table 4.6 Residuals Diagnostic tests results

Test	Null Hypothesis	Probability	Decision
White Heteroscedasticity (with no cross term)	There is no heteroscedasticity	0.3382	Fail to reject the null hypothesis at 0.01, 0.05 and 0.10 level of significance.
Langrage Multiplier Serial Correlation	There is no serial correlation	0.0784	Fail to reject the null hypothesis at 0.01 and 0.05 level of significance.
Jarque-Bera Normality	The residuals are multivariate normal	0.0000	Reject the null hypothesis

Under heteroscedasticity and serial correlation residuals diagnostic tests, the null hypothesis fails to be rejected at 1 %, 5% and 10% significance level which implies that there is no heteroscedasticity and serial correlation among the residuals. As for normality test, the null hypothesis is rejected at all levels of significance, hence the residuals are not multivariate normal.

4.9 CONCLUSION

The chapter estimated, presented, analysed and interpreted the relationship between unemployment and tax (proxy for carbon emission tax), along with other variables. The data used in this chapter underwent various diagnostic tests in order to accurately conclude that the relationship between unemployment and the explanatory variables were theoretically consistent with each other.

CHAPTER FIVE

SUMMARY, CONCLUSION AND POLICY RECOMMENDATIONS

5.1 INTRODUCTION

This study sought to explore and analyse the impact of carbon emission tax imposition's impact on unemployment in South Africa. The VAR econometric technique was then employed to

assist in the investigation of these two variable's relationship. The study was organised into five chapters, being: Chapter 1 Introduction, Chapter 2 Literature Review, Chapter 3 Methodology, Chapter 4 Estimation, Presentation and Interpretation of Results and the last chapter being Chapter 5 Summary, Conclusion and Policy Recommendations.

5.2 SUMMARY

The study utilised six variables: Unemployment (UNE) rate being the explained variable, Real Gross Domestic Product (GDP), Tax Revenue (TAX), and Foreign Direct Investment out flow (FDI), Carbon Dioxide Emission (CDE), Consumer Consumption (CCT) and Electricity Power Consumption (EPC). The explanatory variables proved theoretically consistent with regards to their relationship with the explained variable, being unemployment. Carbon emission tax has not been implemented in South Africa and therefor Tax was used a proxy variable with the intent to understand and predict what would happen when the government decides to levy a tax on CO_2 in the Republic of South Africa.

The R-squared was 0.92 (98%), that being above 0.5 (50%) hence implies that the regressions are a good fit as more than 50% of the variations in the explained variable are explained by the independent variables. The F-stat was 39.03 which is greater than 5 for the 5 % level of significance, then the overall effects by the independent variables on unemployment are significant. The model fared well in all the diagnostic tests conducted on it.

5.3 KEY FINDINGS

According to the regression result between unemployment and tax; unemployment and tax have a negative relationship, implying that an increase by 1% in tax will result to a 0.17% decrease in unemployment. This result simply means that a tax levied on carbon emission will necessarily result in the decrease of unemployment. New sectors can be established with the state channelling proceeds from the tax revenue collected to assist in the funding such of such sectors. Sectors such as the electric car market which currently remains non-existent in South Africa, a sector projected to be $75.7 billion in 2017, grow to $127.7 billion by 2022 globally (Report Linker, 2017) (Frost & Sullivan, 2018). Helms (1985) found that when tax revenue is used to finance improved public service instead of transfer payments that will then contribute positively on labour and business.

Understanding the limitations of the study that there is no carbon emission tax imposed as yet and that the relationship between tax revenue and unemployment can either be negative or positive subject to how the tax revenue is consumed by the state, we cannot say the answer is definite until the tax is in place and we observe revenue usage from the state, but until then we remain with this conclusion.

The relationship between carbon dioxide emission and unemployment was concluded to be positive thus implying that as carbon emission increases so will unemployment hence and that any decrease in carbon emission may lead to the decrease in unemployment. This could be because to reduce carbon emission new technologies would be required and this may lead to new sectors being created and those sectors may create new work opportunities that are not as labour intensive.

Electricity power consumption proved to have a negative relationship with unemployment, where a 1% increase in electricity power consumption led to a 31.21% decrease in unemployment. This further proves true on the basis that the demand for electricity outweighs the supply and should alternative electricity sources be found, employment will be created leading to more revenue for the state.

All variables have proved that South Africa can create jobs and not negatively impact employment with the imposition of a carbon emission tax, but this is subject to how the tax revenue are used. These proceeds can equally be used to subsidise firms to find cleaner sources of production, retain the operational cost structure and not to retrench employees nor pass the burden to the consumer thus sparring poor households. Firms can also fund new technologies or ventures that can see them saving money, hence making them more competitive, increasing revenue and creating more jobs as witnessed currently being done in Dubai (Etihad ESCO , 2018).

5.4 POLICY IMPLICATIONS AND RECOMMENDATIONS

South Africa is the biggest carbon emitter on the continent, and as it was done in Indonesia, classified as one of the largest carbon emitter's among developing countries, must ensure that the carbon emission tax imposed is progressive in nature. Indonesia has a progressive regime, and is characteristically robust in comparison to various alternative recycling-schemes in the rural geographic, and found to be either neutral or a bit progressive in urban geographic's

within the country. The overall nationwide distributive effect is progressive, and this is the line South Africa must emulate.

South Africa ought to invest in industries and technologies that are less carbon intensive such as the development of electric and hybrid cars that do not rely intensively on the combustion of fossil fuels. This will not only be a job creator, but it will assist the country reach its emission budget with the economy growing in the process.

South Africa must ensure that the implementation of the tax will complement national objective such as industrialization and not undermine it, therefore a proper balance will be required.

5.5 LIMITATIONS OF THE STUDY AND AREAS OF FURTHER RESEARCH

The government has adopted a carbon pricing strategy which is the imposition of tax on emission. However, the number of studies as to its impact on various industries and sectors that will not be exempted are not satisfactory. It is critical to conduct such studies as this will provide an understanding of this new phenomenon in South Africa, and its potential on the already high South African unemployment rate.

Majority of poor South African households still use coal stoves for heating and cooking and as such release severe missions into the ozone. There is a need to investigate the extent of the tax in those households. This will require regulation mechanism that the state will be burdened to develop.

With the tax not imposed as yet, this study needs to be revisited after imposition, after a sufficient period as proper data and empirics would have developed and as such a more in-depth study would materialize.

The insufficiency of studies investigating carbon tax on various sectors or economic variables in not only a South African problem but a continental problem.

REFERENCES

Economics Help, 2017. *Economics Help.* [Online]
Available at: https://www.economicshelp.org/blog/2637/economics/real-wages-in-uk/
[Accessed 1 October 2018].

African Development Report, 2012. *Towards Green Growth in Africa,* s.l.: s.n.

Ahiakpor, J. C., 1998. Some Modern Variations and Distortions. In: *Classical Macroeconomics.* s.l.:Routledge.

Alton, T. et al., 2012. *The Economic Implications of Introducing Carbon Taxes in South Africa.* 2012/46 ed. Helsinki: UNU-WIDER 2012.

Asimakopulos, A., 1991. Keynes General Theory and Accumulation.. In: Cambridge: University of Cambridge.

Ball, L. M., Leigh, D. & Loungani, P., 2013. *Okun's Law: Fit at Fifty.* [Online]
Available at: http://wv.rvv.nber.org/papers/w18668
[Accessed 20 September 2018].

Boden, T., Marland, G. & Andres, R., 2011. *Global, Regional, and National Fossil-Fuel CO2 Emissions,* Oak Ridge: Carbon Dioxide Information Analysis Center.

Cain, G., 1979. Monthly Labor Review. pp. 24-35.

Chemomas, B., 1983. Keynesian, Monetarist and Post-Keynesian Policy: A Marxist Analysis.. *Studies in Political Economy,* Volume 10, pp. 123-142.

Claassen, S. & Bolton, J., 2016. Carbon Tax in South Africa. *ENERGY + ENVIROFICIENCY: CARBON TAX,* p. 2.

Collard, D., 2011. *Generations of Economists.* London: Routledge.

Consumer Goods Council of South Africa , 2014. s.l.: s.n.

Deloitte Consulting Pty (Ltd), 2017. *An overview of electricity consumption and pricing in South Africa,* s.l.: Eskom Holdings SOC Ltd.

Department of Energy, 2018. *Department of Energy.* [Online]
Available at: http://www.energy.gov.za/files/media/pr/2018/IPP-judgement-statement-29March2018.pdf
[Accessed 29 March 2018].

Department of Environmental Affairs and Tourism, 2003. Greenhouse gas emissions.

Dwivedi, F., 2010. *Macroeconomics: Themy and Policy..* 2 ed. New Delhi: Tata-McGraw Hill Publishing Company Limited..

EIA Beta, 2017. [Online]
Available at: https://www.eia.gov/beta/international/analysis.cfm?iso=ZAF

Einbond, A., 1995. *To What Extent was Keynes's General Theory Revolutionary and To What Extent was it Based on Past Economic Theories?.* [Online]
Available at: http://www.tcr.org/tcr/essays/EPrize Kevnes.pdf
[Accessed 2018].

Ekelund, R. J. & Herbert, R., 2013. *A History of Economic Theory and Method.* 6th ed. Long Grove: Waveland Press Inc.

Etihad ESCO , 2018. *Etihad ESCO.* [Online]
Available at: http://www.etihadesco.ae/about-etihad-esco/index.html
[Accessed 2 November 2018].

Frost & Sullivan, 2018. *Global Electric Vehicle Market Outlook,* s.l.: s.n.

Garrison, C., 1984. Friedman versus Keynes on the Theory of Employment. In: *Journal of Post Keynesian Economics.* s.l.:s.n., pp. 114-127.

Gerhard, R. A., 2012. *A Critique of the Proposed South African Carbon Tax With Particular Analysis on Economic Consequences and Employment-Related Implications.* Johannesburg: University of the Witwatersrand.

Gottschalk, J., 2002. Keynesian and Monetarist Views on the German Unemployment Problem:Theory and Evidence. *Kiel Institute of the World Economy,* Volume Working PaperNo. 1096.

Grafstorm, J., 2009. The Effect of the Swedish Carbon Dioxide Tax an Econometric Analysis.

Hussmanns, R., 1990. Measurement of Employment, Unemployment and Underemployment:Current International Standards and Issues in their Application (Geneva, ILO Bureau of Statistics)..

Jain, T. & Khanna, O., 2010. *Macroeconomics and Elementary Statistics.* New Delhi: Vilma Kumari Jain Publications.

Jain, T. R. & Khanna, O. P., 2010. *Macroeconomics and Elementary Statistics.* New Delhi: Vilma Kumari Jain Publications.

Jeffrey, R., 2013. RENEWABLES AND CARBON TAX. *A negative impact on mining and economic growth* , Sep, pp. 18-20.

Johannesburg Stock Exchange , 2018. *Johannesburg Stock Exchange.* [Online] Available at: https://www.jse.co.za/current-companies/companies-and-financial-instruments [Accessed 14 October 2018].

Kamm, N., 2011. *Taxation – an instrument for achieving carbon dioxide emission reductions?.* Cape Town : University of Cape Town .

Kennedy, P., 2000. *Macroeconomic Essentials: Understanding Economics in the News.* 2 ed. United States of America: Massachusetts Institute of Technology: s.n.

Knights, F., 2011. Unemployment and Mr. Keynes's Revolution in Economic Theory. *The Canadian Journal of Economics and Political Science,* 3(1), pp. 100-123.

Knotek, E., 2007. "How Useful is Okun's Law?". In: *Federal Reserve Bank of Kansas City Economic Review, Fourth Quarter, 92(4).* s.l.:s.n., pp. 73-103.

Laffer, A. B., 2004. *The Laffer Curve: Past, Present, and Future,* Washington DC : The Heritage Foundation.

Makhoba, B. P., Contogiannis, E. & Kaseeram., I., 2017. *The Contribution of Foreign Direct Investment (FDI) on Employment and Economic Growth in South Africa: A Vector Autoregressive (VAR/VECM) Approach.* s.l.:s.n.

MALLEY, J. & MOUTOS, T., 1996. UNEMPLOYMENT AND CONSUMPTION. *Oxford Economic Papers 48* , pp. 584-600.

Market Readiness Proposal (MRP), 2015. SOUTH AFRICA The Carbon Tax Policy Package. *The Carbon Tax Policy Package: Market Readiness Proposal for South Africa,* p. 122.

Mboweni, T., 2018. *2018 Medium Term Budget Policy Statement Speech* , Cape Town : South African Treasury .

McClelland, A. & Macdonald, F., 1998. *The social consequences of unemployment,* s.l.: Business Council of Australia.

Meccheri, N., 2005. Wage Behaviour and Unemployment in Keynes's and New Keynesians'Views. In: *A Comparison. European Journal of the History of Economic Thought.* s.l.:s.n., pp. 701-24.

National Treasury, 2010. DISCUSSION PAPER FOR PUBLIC COMMENT. *Reducing Greenhouse Gas Emissions:The Carbon Tax Option,* p. 75.

National Treasury, 2017. *National Treasury.* [Online]
Available at:
http://www.treasury.gov.za/comm_media/press/2017/2017121401%20MEDIA%20STATEMENT%20-%20CARBON%20TAX%20BILL.pdf
[Accessed 17 June 2018].

O'Hara, P., 1999. Encyclopaedia of Political Economy L-Z. Volume 2.

Parry, I., 1997. Revenue recycling and the costs of reducing carbon emissions. *Resources for the Future,* Issue Resources for the Future.

Pearce, D., 1989. The Polluter Pays Principle. *Briefing papers on key issues in environmental economics* , Volume 3, p. 1of4.

Podgorska & Lesniowska-Gontarz, 2016. *Analysis of the Relationship between Unemployment and GDP in Poland and Spain in the Years 2002-2015.* s.l.:s.n.

Pretorius, C. & Knox, S., 1995. Private consumption expenditure in the macroeconometric model of the Reserve Bank. *Quarterly Bulletin,* June.

Report Linker, 2017. *Electric Vehicles and Fuel Cell Vehicles: Global Markets to 2022.* [Online]
Available at: https://www.reportlinker.com/p05242342/Electric-Vehicles-and-Fuel-Cell-Vehicles-Global-Markets-to.html
[Accessed 2 December 2018].

Sloman, J., 2003. *Economics.* Edinburgh : Pearson Education Limited .

Statistic South Africa, 2018. *Statistics South Africa.* [Online]
Available at: http://www.statssa.gov.za/?p=11129
[Accessed 06 November 2018].

Statistics South Africa, 2018. *Quarterly Labour Force Survey – QLFS Q2:2018.* [Online]
Available at: http://www.statssa.gov.za/?p=11361
[Accessed 28 November 2018].

Steindel, C., 2001. The Effect of Tax Changes on Consumer Spending. *Current Issues in Economics and Finance* , 7(11).

Stockhammer, E., 2000. Explaining European Unemployment: Testing the NAIRU Theory and a Keynesian Approach. In: *Working Paper No. 68: Vienna University of Economics & B.A.*. s.l.:Department of Economics Working Paper Series..

Sweezy, P., 1934. Professor Pigou' s Theory of Unemployment. *The Journal of Political Economy,* 6(42), pp. 800-811.

The Davis Tax Committee, 2015. *A CARBON TAX FOR SOUTH AFRICA,* s.l.: s.n.

The World Bank , 2018. *Carbon Pricing Dashboard.* [Online]
Available at: https://carbonpricingdashboard.worldbank.org/map_data
[Accessed 20 November 2018].

The World Bank, 2018. *TCdata360.* [Online]
Available at:
https://tcdata360.worldbank.org/indicators/unemp.lbr.all?country=BRA&indicator=3296&viz=line_chart&years=1980,2023

The World Bank, 2018. *The World Bank In South Africa.* [Online]
Available at: https://www.worldbank.org/en/country/southafrica/overview
[Accessed 23 November 2018].

The World Bank, 2018. What is the difference between Foreign Direct Investment (FDI) net inflows and net outflows?. In: s.l.:s.n.

UNEP, 2004. Climate Policy Frameworks Beyond 2012: Development and Climate. November, pp. 1-20.

United Nations. United Nations Framework Convention on Climate Change, 2005. *Carbon Dioxide Emissions.* [Online]
Available at: https://stats.oecd.org/glossary/detail.asp?ID=6323

Vedder, R. K. & Gallaway, L. E., 1997. *Out of Work: Unemployment and Government in Twentieth Centwy America.* New York: New York University Press.

Ventelou, B., 2005. *Millennia! Keynes: An Introduction to the Origin, Developments and Later Currents of Keynesian Thoughts.* New York: M.E. Sharpe Inc.

APPENDIX

APPENDIX 1: DATA

Year	Cde	gdp	Tax	Fdi	cct	epc	une
1980	7.676428	6.620585	19.1759	0.909813	31701	74840	1.23352
1981	8.429201	5.360737	18.59774	0.718402	35868	85866	3.234143

1982	8.96096	-0.38339	19.8572	-0.00665	36337	95237	3.115634
1983	9.092508	-1.84654	19.75459	0.175927	37499	109817	4.306728
1984	9.590599	5.099115	20.95895	0.21973	39570	122066	2.646829
1985	9.611999	-1.21148	22.70725	0.068426	33941	130049	0.51736
1986	9.592666	0.017835	21.85509	0.086448	29549	135810	2.358108
1987	9.339282	2.100735	21.69525	0.104385	27953	142089	4.154545
1988	9.537116	4.200133	22.7654	0.054564	28821	146810	2.735495
1989	9.284154	2.394784	25.30205	0.126219	28994	151504	3.667797
1990	8.341332	-0.31779	23.11194	0.024209	29123	155637	2.949078
1991	8.491907	-1.01822	22.90377	0.166558	25869	158554	4.55457
1992	7.664787	-2.13706	20.62165	1.441171	27808	162739	5.277112
1993	7.966457	1.23352	21.77523	0.217344	29401	164817	5.603665
1994	8.228462	3.234143	21.53464	0.901957	30307	169241	4.4
1995	8.607153	3.115634	22.42024	1.604213	31533	176322	4.51
1996	8.494484	4.306728	23.2065	0.709971	31377	180297	5.1
1997	8.844658	2.646829	23.53246	1.522814	31280	183838	5.4
1998	8.512704	0.51736	24.38843	1.186001	35465	188557	25
1999	8.327718	2.358108	24.13044	1.159453	36950	191682	25.37
2000	8.280765	4.154545	23.34369	0.203267	39086	193483	30.2293
2001	8.020756	2.735495	24.18558	-2.89039	39416	195413	30.896
2002	7.583814	3.667797	23.27842	-0.34753	40449	206220	33.4733
2003	8.488351	2.949078	23.03755	0.315276	41692	209020	32.4557
2004	9.330796	4.55457	24.2821	0.57021	44359	214458	29.576
2005	8.539756	5.277112	25.7433	0.352936	49176	222127	29.2531
2006	9.0732	5.603665	27.26987	2.18122	55730	236751	28.4893
2007	9.352665	5.360465	27.59604	0.99725	64271	242821	26.6662
2008	9.854219	3.191052	26.81322	-0.73827	64179	245162	22.4327
2009	9.870597	-1.5381	24.3968	0.441193	59203	245928	23.5383
2010	9.190699	3.039777	25.0415	-0.04298	58905	249599	24.6929
2011	9.004033	3.284165	25.17982	-0.0368	63325	255040	24.653
2012	8.845033	2.213354	25.58813	0.731423	67375	259807	24.7316
2013	8.673963	2.485186	26.04391	1.777359	68948	260143	24.5688

2014	8.980119	1.847008	26.54119	2.192071	71318	261447	24.8976
2015		1.279538	27.33622	1.735668	74077	265049	25.156
2016		0.565363	27.09698	1.518271	76108	268219	26.5507
2017		1.320061		2.129458	77923	269538	27.3266

APPENDIX 2: LAG LENGTH SELECTION INFORMATION CRITERIA

VAR Lag Order Selection Criteria
Endogenous variables: UNE GDP TAX FDI D(CDE) D(LCCT) D(LEPC)
Exogenous variables: C
Date: 11/26/18 Time: 20:27
Sample: 1980 2017
Included observations: 33

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-188.6943	NA	0.000334	11.86026	12.17770	11.96707
1	-86.68017	154.5669*	1.44e-05*	8.647283*	11.18681*	9.501757*

* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

APPENDIX 3: THE VAR MODEL ESTIMATES

Vector Autoregression Estimates
Date: 11/26/18 Time: 20:13
Sample (adjusted): 1982 2014
Included observations: 33 after adjustments
Standard errors in ( ) & t-statistics in [ ]

	UNE	GDP	TAX	FDI	D(CDE)	D(LCCT)	D(LEPC)
UNE(-1)	0.950777	0.125006	0.032944	-0.016565	0.013926	0.002793	-3.82E-05
	(0.09061)	(0.04639)	(0.02146)	(0.02210)	(0.00962)	(0.00147)	(0.00040)
	[10.4935]	[2.69457]	[1.53540]	[-0.74967]	[1.44782]	[1.90295]	[-0.09500]
GDP(-1)	0.084380	0.193780	0.220545	-0.012899	0.042818	-0.001089	-0.001414
	(0.43098)	(0.22067)	(0.10206)	(0.10510)	(0.04575)	(0.00698)	(0.00191)
	[0.19579]	[0.87815]	[2.16096]	[-0.12273]	[0.93586]	[-0.15598]	[-0.73919]
TAX(-1)	-0.171420	-0.359511	0.554309	0.113251	-0.086779	-0.008255	-0.002273
	(0.53983)	(0.27640)	(0.12783)	(0.13165)	(0.05731)	(0.00874)	(0.00240)

	[-0.31754]	[-1.30069]	[4.33613]	[0.86026]	[-1.51427]	[-0.94401]	[-0.94888]
FDI(-1)	0.704978	0.669750	0.487698	0.329990	0.110160	0.024702	-0.009420
	(0.92479)	(0.47351)	(0.21900)	(0.22553)	(0.09818)	(0.01498)	(0.00410)
	[0.76231]	[1.41444]	[2.22696]	[1.46319]	[1.12208]	[1.64903]	[-2.29510]
D(CDE(-1))	0.242106	-0.586564	-0.381549	-0.085062	-0.222476	0.002114	0.008471
	(1.73111)	(0.88636)	(0.40994)	(0.42216)	(0.18377)	(0.02804)	(0.00768)
	[0.13986]	[-0.66177]	[-0.93075]	[-0.20149]	[-1.21060]	[0.07539]	[1.10257]
D(LCCT(-1))	-11.16672	-2.076646	0.012131	-0.027334	0.624744	0.159208	0.043007
	(14.7292)	(7.54155)	(3.48796)	(3.59197)	(1.56363)	(0.23858)	(0.06537)
	[-0.75814]	[-0.27536]	[0.00348]	[-0.00761]	[0.39955]	[0.66731]	[0.65787]
D(LEPC(-1))	-31.20669	-2.762157	-1.850526	-0.959158	3.625891	-0.279294	0.583844
	(27.5145)	(14.0878)	(6.51561)	(6.70989)	(2.92091)	(0.44568)	(0.12212)
	[-1.13419]	[-0.19607]	[-0.28401]	[-0.14295]	[1.24136]	[-0.62667]	[4.78096]
C	6.356865	8.177240	9.541910	-2.003076	1.546932	0.170586	0.071537
	(12.2186)	(6.25609)	(2.89344)	(2.97971)	(1.29711)	(0.19792)	(0.05423)
	[0.52026]	[1.30708]	[3.29778]	[-0.67224]	[1.19260]	[0.86191]	[1.31914]
R-squared	0.916173	0.350833	0.838227	0.169312	0.327058	0.321475	0.756801
Adj. R-squared	0.892701	0.169066	0.792931	-0.063281	0.138634	0.131488	0.688705
Sum sq. resids	391.7054	102.6894	21.96579	23.29530	4.414417	0.102773	0.007716
S.E. equation	3.958310	2.026716	0.937353	0.965304	0.420210	0.064117	0.017568
F-statistic	39.03330	1.930126	18.50536	0.727932	1.735755	1.692089	11.11379
Log likelihood	-87.64601	-65.55579	-40.10912	-41.07875	-13.63305	48.40867	91.13070
Akaike AIC	5.796728	4.457927	2.915704	2.974470	1.311094	-2.449010	-5.038224
Schwarz SC	6.159518	4.820717	3.278494	3.337260	1.673883	-2.086221	-4.675435
Mean dependent	15.82487	2.216231	23.66249	0.468757	0.016695	0.020827	0.033741
S.D. dependent	12.08406	2.223359	2.059897	0.936139	0.452765	0.068799	0.031488

Determinant resid covariance (dof adj.)	3.15E-06
Determinant resid covariance	4.51E-07
Log likelihood	-86.68017
Akaike information criterion	8.647283
Schwarz criterion	11.18681

APPENDIX 4: THE RESPONSE OF UNE

Response of UNE:

Period	UNE	GDP	TAX	FDI	D(CDE)	D(LCCT)	D(LEPC)
1	3.958310	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
2	3.408647	-0.203441	-0.067600	0.341404	0.350705	-0.740751	-0.460911
3	3.030411	-0.185449	0.045643	0.390603	0.269109	-0.952962	-0.657040
4	2.673474	-0.085406	0.191034	0.437624	0.241734	-1.014628	-0.752326
5	2.378159	0.063867	0.310404	0.528831	0.185237	-1.004473	-0.781118
6	2.135385	0.184675	0.396354	0.621262	0.138874	-0.970930	-0.779048
7	1.932832	0.272672	0.454417	0.690844	0.101965	-0.927566	-0.760503
8	1.760769	0.333047	0.490302	0.734248	0.073767	-0.880429	-0.733185
9	1.612676	0.371926	0.508919	0.755511	0.052376	-0.832422	-0.701277
10	1.483764	0.394228	0.514483	0.759682	0.036339	-0.785141	-0.667265

VARIANCE DECOMPOSITION FOR UNE

Variance Decomposition of UNE:

Period	S.E.	UNE	GDP	TAX	FDI	D(CDE)	D(LCCT)	D(LEPC)
1	3.958310	100.0000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
2	5.322946	96.30596	0.146074	0.016128	0.411371	0.434091	1.936602	0.749775
3	6.254474	93.23091	0.193718	0.017007	0.687982	0.499544	3.724196	1.646641
4	6.939389	90.57802	0.172513	0.089600	0.956582	0.527149	5.163143	2.512993
5	7.472902	88.23392	0.156064	0.249797	1.325659	0.516010	6.258982	3.259564
6	7.908869	86.06439	0.193856	0.474170	1.800587	0.491522	7.095081	3.880394
7	8.276068	84.05099	0.285587	0.734508	2.341157	0.464053	7.735598	4.388107
8	8.590821	82.20568	0.415337	1.007402	2.903241	0.438045	8.229459	4.800831
9	8.863324	80.53911	0.566275	1.276099	3.454054	0.415015	8.613260	5.136184
10	9.100566	79.05294	0.724789	1.530031	3.973145	0.395254	8.914355	5.409485

APPENDIX 5: RESIDUALS DIAGNOSTIC TESTS

1. **Heteroscedasticity Test**

VAR Residual Heteroskedasticity Tests: No Cross Terms (only levels and squares)
Date: 11/27/18 Time: 08:57
Sample: 1980 2017
Included observations: 33

Joint test:

Chi-sq	Df	Prob.
403.1237	392	0.3382

2. *Langrage Multiplier (LM) Serial Correlation Test*

VAR Residual Serial Correlation LM Tests

Null Hypothesis: no serial correlation at lag order h

Date: 11/27/18 Time: 09:00

Sample: 1980 2017

Included observations: 33

Lags	LM-Stat	Prob
1	63.60979	0.0784

Probs from chi-square with 49 df.

3. *Normality Test*

VAR Residual Normality Tests
Orthogonalization: Cholesky (Lutkepohl)
Null Hypothesis: residuals are multivariate normal
Date: 11/27/18 Time: 09:03
Sample: 1980 2017
Included observations: 33

Component	Skewness	Chi-sq	df	Prob.
1	3.431499	64.76352	1	0.0000
2	0.116906	0.075169	1	0.7840
3	0.271440	0.405238	1	0.5244
4	-1.107405	6.744903	1	0.0094
5	-0.244026	0.327518	1	0.5671
6	-0.122129	0.082035	1	0.7746
7	0.941759	4.878010	1	0.0272

Joint	77.27639	7	0.0000

Component	Kurtosis	Chi-sq	df	Prob.
1	17.10415	273.5248	1	0.0000
2	2.489063	0.358952	1	0.5491
3	3.288534	0.114472	1	0.7351
4	6.035726	12.67150	1	0.0004
5	2.997438	9.03E-06	1	0.9976
6	2.414557	0.471272	1	0.4924
7	5.130309	6.240046	1	0.0125
Joint		293.3810	7	0.0000

Component	Jarque-Bera	Df	Prob.
1	338.2883	2	0.0000
2	0.434121	2	0.8049
3	0.519709	2	0.7712
4	19.41640	2	0.0001
5	0.327527	2	0.8489
6	0.553307	2	0.7583
7	11.11806	2	0.0039
Joint	370.6574	14	0.0000