DETERMINANTS OF EMPLOYMENT IN THE PLATINUM MINING INDUSTRY IN SOUTH AFRICA

By

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DECLARATION

I declare that the **DETERMINANTS OF EMPLOYMENT IN THE PLATINUM MINING INDUSTRY IN SOUTH AFRICA** hereby submitted to the university of Limpopo, for the degree of Master of Commerce in Economics has not previously been submitted by me for a degree at this or any other university; that this is my work in design and in execution, and that all material contained herein has been duly acknowledged.

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Surname, Initials, (title) Date

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ABSTRACT

The study intends to investigate the determinants of employment in the platinum mining industry in South Africa. Employment levels decreased dramatically in the platinum mining industry in South Africa. This is due to decrease in export demand for platinum, high operating cost, labour unrest, low levels of production and other determinants of employment. The specific objective of the study is to determine the nexus between employment, output, domestic demand and export demand. Annual time series data covering the period between 1992-2013 was used. The study employed the Vector Error Correction Model approach. Johansen Cointegration test results confirmed the existence of a long run relationship amongst variables under investigation. Export demand and output are found to be positively related with employment. The speed of adjustment to equilibrium is -0.283202. Impulse response functions and variance decomposition are also generated to explain the response to shock amongst variables. The results of the study vindicate that the platinum mining industry should implement policies and strategies to increase output which will lead to higher levels of employment as well as economic growth. In addition, government should also create a conducive environment to enable the industry to expand and the industry should also intensify its export drive, these findings are envisaged to contribute significantly to the existing but limited literature on the subject under investigation.

Key Words: Employment, Domestic demand, Export demand, Output, VECM, Johansen Cointegration test, Impulse response, South Africa.

LIST OF ACRONYMS

ADF	Augmented Dickey-Fuller
AIC	Akaike Information Criterion
ARCH	Auto Regressive Conditional Heteroskedasticity
ARMA	Auto Regressive Moving Average
BIC	Bayes Information criterion
CE	Cointegration Equation
CLNRM	Classical Normal Linear Regression Model
COMSA	Chamber of Mines of South Africa
DD	Domestic Demand
DMR	Department of Mineral Resources
ED	Export Demand
EMP	Employment
FPE	Final Prediction Error
GEAR	Growth Employment and Redistribution
JB TEST	Jarque-Bera Test
LM TEST	Langrange Multiplier Test
NCT	Not with Cross Terms
OLS	Ordinary Least Squares
OUT	Output
PGM	Platinum Group Metal
PP	Philips- Perron

SA	South Africa
SARB	South African Reserve Bank
STATSSA	Statistics South Africa
VAR	Vector Autogregression
VECM	Vector Error Correction Model

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CHAPTER 1

INTRODUCTION AND ORIENTATION OF THE STUDY

1.1 INTRODUCTION AND BACKGROUND OF THE STUDY

The platinum group metals (PGM) industry is the largest component of the South African mining sector on the basis of its contribution to Gross Domestic Product (GDP), employment, foreign exchange earnings and overall contribution to the South African economy (Baxter, 2014). In 2012, the South African platinum industry contributed 4.1% of GDP, accounted for 9% for merchandise exports and helped create about 440000 jobs (StatsSA, 2013). According to the Department of Mineral Resources (2013) South Africa is richly endowed with PGMs and holds over 80% of the world's known resources and reserves.

However, employment levels in this industry decreased dramatically due to decreases in export demand for platinum, high operating cost, low levels of production, investment, real wages (labour unrest, Marikana disaster in 2012) and policy and regulations (Solomon, 2013). As a result employment in the platinum industry decreased by 15627 to 191286 jobs between 2012 and 2013 due to restructuring. This is attached to increased competition from lower cost producers in other regions and because of large increases in scrap recycling (Baxter, 2014). The decline in global demand for platinum in South Africa is due to the recession in Europe and slow economic growth in China (Rocsouw, 2014).

In addition, Genc (2014) indicates that South African platinum producers have been affected by a decrease in commodity prices, and rapidly increasing domestic costs driven mostly by electricity prices and labour costs. Furthermore, the large sophisticated international companies are continuing their efforts to either thrift or substitute platinum for palladium (Rocsouw, 2014). Given such a background, it is the intention of this study to investigate the determinants of employment in the platinum mining industry in South Africa.

1.2 STATEMENT OF THE PROBLEM

Despite the significant role and contribution of the platinum mining industry to the South African economy, the industry is currently in a major crisis. The Chamber of Mines of South Africa (COMSA), reported that in 2012, the platinum industry was hit by the combined impact of slowing global demand, market surpluses, the falling prices, increasing domestic production costs and the unprotected strikes (COMSA, 2013). Weakness in the main PGM market of Europe combined with the increased availability of scrap and recycled metal and some substitution of platinum by palladium have exacerbated the weakness in the platinum market (DMR, 2013). Furthermore, the tarnished reputation of South Africa as a reliable supplier of platinum to global markets has accelerated the move to greater secondary recycling.

Employment levels in this industry decreased dramatically due to decreases in export demand for platinum, high operating cost, low levels of production, investment, real wages (labour unrest, Marikana disaster in 2012) and policy and regulations (Solomon, 2013). Furthermore, the impact of high operating costs in structural changes such as declining head grades, increasing mining depths, reducing productivity and increasing capital intensity had negatively affected the platinum industry (Matthey, 2014). Average remuneration paid per worker employed in the South African mining sector grew by 60 per cent in total over five years or by 12 per cent per annum (StatsSA, 2013).

Platinum demand declined significantly especially in the wake of the global slowdown caused by the global financial crisis (Manners, 2014). The slowdown in global economic growth, with a recession in Europe and a slow growing economy in China negatively impacted on PGM demand. Rocsouw (2014) reports that this is caused by the fact that Europe accounted for 25.1 per cent of global platinum and 43 per cent of global platinum auto catalysts consumption in 2012. Also, China is the world's largest consumer of platinum with a 27.9 per cent share, but the slowdown in the economic growth rate also impacted on demand growth for platinum in that country (Matthey, 2014). This resulted to an excess supply of PGMs in the market, and a simultaneous drop in PGM prices.

Lower prices and increasing rand cost pressures are affecting the viability of many companies in the short run and will affect the industry's long-term capability to survive, grow and prosper. This has resulted in a significant 45 per cent of the South African platinum mining industry being in a marginal or loss-making position on a cash production cost (COMSA, 2014). Moreover, Baxter (2014) highlights that even though there has been some compensation in the weakening of rand-dollar exchange rate, the rand platinum price has fallen further placing more shafts and mines into loss-making territory.

It is evident from the background to the problem that, South African platinum industry is facing challenges such as weaker investment inflows, decline in global and domestic demand, lower prices and increase in the cost of production. The study therefore seeks to determine whether the platinum mining industry is able to create employment. More specifically, the researcher seeks to examine the determinants of employment in the industry. Knowledge of these factors may be useful in exploring strategic and policy options with regard to improving the capacity of the industry to create more jobs.

1.3 PURPOSE OF THE STUDY

1.3.1 Research Aim

The study investigates determinants of employment in the platinum mining industry in South Africa.

1.3.2 Research objectives

The specific objectives of the study are:

- To determine the link between employment and output in the platinum mining industry
- To ascertain the relationship between employment and export demand
- To determine the nexus between employment and domestic demand

1.3.3 Research questions

- What is the link between employment and output in the platinum mining industry?
- What is the relationship between employment and export demand?
- What is the nexus between employment and domestic demand?

1.4 SIGNIFICANCE OF THE STUDY

The mining sector, especially the platinum industry, is identified as one of the industries to absorb massive labour by the government and the department of trade and industry. However, based on a comprehensive review of the literature, it was observed that there were very limited studies which focused on employment creation in the platinum mining industry.

Clearly, there is a gap in the existing literature with respect to employment in the platinum industry. The proposed study therefore seeks to fill the gap by investigating the determinants of employment in the platinum mining industry in South Africa. Based on the analysis of factors determining employment in the industry, the study will then propose some recommendations as may be necessary. The study is significant in that it may contribute to knowledge about the employment behaviour of the platinum mining industry and possibly provide some solutions on how the industry could increase employment creation in future.

1.5 STRUCTURE OF THE STUDY

Chapter 1 Background and context

This chapter introduces the study by explaining the centrality of the mining industry in South Africa's economy. It presents some background information on the challenges facing the industry and how these have negatively impacted on employment. The chapter also identifies the research problem which the subject of investigation as well as its aims and objectives. It also highlights ethical considerations. Finally, the chapter explains the significance of the study.

Chapter 2 Literature review

The chapter reviews literature on theoretical frameworks which purport to explain the factors that determine employment in an industry. It also reviews empirical literature in order to find out if there are studies which have been conducted on the topic and if so, to find out how employment was modelled and what results were found. An effort is made to review any studies which specifically focus on the platinum mining industry in South Africa.

Chapter 3 Research methodology

This chapter describes the methodological approach to the investigation. As a quantitative study design, the research is based on estimation of an econometric model where employment is the dependent variable and is regressed on selected independent variables for which secondary national-level data was available. Thus, the chapter presents in detail, the research design, methods of data collection and data analysis, model specification and the procedure followed.

Chapter 4 Presentation and interpretation of results

The focus in this chapter is on the analysis and interpretation of the data that has been collected, that is, the presentation of research results.

Chapter 5 Summary, recommendations and conclusions

The last chapter presents summary and conclusion, recommendations as well as the contribution of the study and the possible areas of future research.

1.6 ETHICAL CONSIDERATIONS

Klave (1996) identified three important ethical issues to consider in any research study design: scientific responsibility or accountability on the part of the researcher, the relation of the researcher to the participants in the research and the independence of the researcher when interpreting and reporting the results. This is supported by (Lo, 2004) when he emphasized on some of the ethical dilemmas in research, which include the issues of informed consent, misconduct in research, conflict of interest and authorship. Therefore, the study will be conducted using reliable secondary data which was not manipulated. The researcher acknowledged all the sources used without committing any plagiarism and also take into account the rules of the University of Limpopo of conducting a research for master’s degree requirements.

1.7 SUMMARY

The unemployment problem facing South Africa is a challenge that needs to be addressed. It is therefore important to explore opportunities for employment creation. The mining industry historically was a major employer but a number of internal and external factors have constrained the capacity of sectors such as the platinum mining industry which have witnessed reductions in employment in the last few years. The chapter explained that the research seeks to find out about the determinants of employment in the platinum mining industry with the hope that knowledge of such factors can contribute towards policy and strategic solutions to increase employment in the sector. The chapter also presented the objectives of the study and a brief on the methodological approach to be adopted. Chapter two reviews the literature in order to explore the different approaches to employment determination and also to assess what prior studies have already been conducted on the subject. The purpose of the review is to identify any knowledge gaps in order to locate the proposed study and its role.

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

This chapter presents the literature on different aspects of the study that is under investigation. It describes the theoretical framework which underpins the study, focusing on the different economic theories on employment determination. The chapter also explores various studies which have been undertaken regarding the link between employment and industry. The purpose of the entire review is to find out what is known about the subject of investigation, identifying any gaps and then locate this particular study and determine how it intends to contribute to knowledge.

2.2 THEORETICAL FRAMEWORK

The theoretical framework aims at providing an overview of different theoretical approaches to the determination of employment levels that have been prominent in various phases in the history of economics up to the present. Theory is important for a number of reasons. Firstly, it helps to identify the key variables that determine the phenomenon under study. In this case, a review of different theoretical approaches should identify some of the important variables which have been included in the analysis of employment determination. Secondly, theory is central in hypothesizing the relationships among the dependent and independent variables, the nature of those relationships and their statistical significance. Finally, theory guides the researcher in developing their methodology of study, the design, model specification and what data is to be collected and analysed.

Evidence shows that there is no uniform approach to employment determination. In economics, that is because there are different schools of thought, each with their own assumptions and ideas about how an economy functions, the roles and limitations (if any), of markets. The next section reviews Keynesian, Classical and Neo-Classical perspectives on employment.

2.2.1 The Keynesian Theory of Employment

The study is primarily supported by the theoretical framework of the general theory prescribed by the economist John Maynard Keynes. The core idea behind the general theory of employment is that the level of employment is determined, by the aggregate demand and not by the price of labour as in neoclassical economics (Wray, 2009). Keynes argues that The General Theory of Employment is necessary in order to explain how unemployment can arise from a lack of aggregate demand.

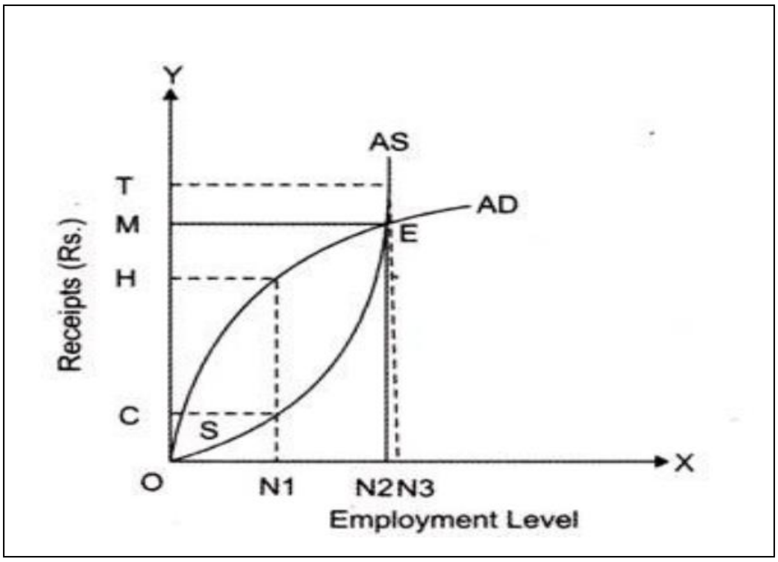
He also argues that it is erroneous to assume that competitive markets will in the long run bring about full employment or that full employment is the expected, self-righting, equilibrium state of a monetary economy (Tcherneva, 2008). Hence, the theory will affect the study by offering solutions to excessive unemployment. These solutions are tied to the idea that employment depends on what firms need to produce and their production level. In turn, it depends on what individuals and firms plan to buy.

Keynes used aggregate demand and aggregate supply prices, for determining effective demand which further helps in estimating the level of employment of an industry at a particular period of time (Wei, 2013). In an industry, the employment level depends on the number of workers that are employed, so that maximum profit can be drawn. Therefore, the employment level of an industry is dependent on the decisions of organizations related to hiring of employee and placing them. The level of employment can be determined by aggregate supply price and aggregate demand price.

Aggregate supply price refers to the total amount of money that all organisations in an industry should receive from the sale of output produced by employing a specific number of workers. Aggregate demand price on the other hand is the total amount of money that an organisation expects to receive from the sale of output produced by a specific number of workers (Aspromourgos, 2000).

The aggregate demand (AD) and aggregate supply (AS) curve are used for determining the equilibrium level of employment, as shown in Figure 2.1:

Figure 2.1: Aggregate Demand (AD) and Aggregate Supply (AS) curve



Source: (Aspromourgos, 2000)

In Figure 2.1, before reaching the employment level of ON2, the employment level keeps on increasing as the organizations want to higher more and more workers to get the maximum profit. However, when the employment level crosses the ON21 level, the AD curve is below the AS curve, which shows that the aggregate supply price exceeds the aggregate demand price. As a result, the organization would start incurring losses; would therefore reduce the employment rate. Thus, the organisation would be in equilibrium when the aggregate supply price and aggregate demand price become equal. In other words, equilibrium can be achieved when the amount of sales receipt necessary and the amount of sales receipt expected to be received by the organization at a specified level of employment are equal. The weakness of this theory is that Keynes advocates that the level of employment is dependent on national income and output. Meaning that the theory fails to capture some of the determinants of employment such as domestic demand and export demand in its model. However, based on the reliability and credibility of this theory, the study will adopt the general theory of employment to carry out the analysis.

2.2.2 The Classical Theory of Employment

The classical economists based their predictions about full employment on a principle known as Say's law stating that supply creates its own demand (Branson & James, 1988). However, this law meets serious limitations when an attempt to make it applicable to the labour market and to the conditions of employment level (Wray, 2009). The argument holds that, if there is general overproduction in the industry, some of the labourers may be asked to leave their jobs. The Classical economists try to solve the implications of this law by arguing that wage rate should be cut or lowered so that employers will be encouraged to employ more workers (Sawyer, 2003). Keynes rejected say's law's statement that supply always created its own demand (Tcherneva, 2008). He maintained that demand created supply. When aggregate demand arises, firms produce more and employ more people in order to meet that demand.

The major weakness of this theory is that it assumes full employment in the economy, whereas in reality there is no economy which can be at full employment. Even the advanced economies cannot have zero percent of unemployment rate. Meaning that full employment is an ideal situation which can rarely be attained by an economy. Another weakness attached with this theory is the issue of over-production and unemployment.

2.2.3 The Neoclassical Theory of Employment

In this theory, it is believed that the labour market is in equilibrium when the real wage rate which links the demand for labour with supply of labour, so that the labour market is cleared (Rosalind & Alexander, 1982). Furthermore, the level of output that can be produced in the long-run depends on the quantities of labour and capital and even on the state of technical knowledge. Thus, capital and labour are presumed to be interchangeable ex ante. This means that there are several production techniques, whereby each represents a particular combination of labour and capital available to produce a given level of output (Melitz, 2003).

This will result to an industry to employ more workers until the marginal product of labour matches the real wage rate (Hicks, 1971). Therefore, with the assumption that marginal product of labour is positive but declining as output increases in the short-run, the real wage rate will be lower and the firms demand for labour will increase. Hence, labour demand diverges contrariwise with the real wage rate (Rosalind et al., 1982). In addition, large falls in wages would be needed to increase employment. For example, to match an increase in population, and this might cause social disruption and economic instability before full employment could be reached (Pigou, 1968).

Therefore, neoclassical theory of employment will assist the study by providing a set of solutions to the issue of low employment levels. The weaknesses of this theory are similar to those of the classical economists. In this theory the issue of full employment, over-production and unemployment are still assumed.

The review of the above theoretical approaches has implications on how the study on employment in the platinum mining industry can be modelled. It suggests that variables such as the real wage rate, output, capital investment, domestic and export demand (which are all part of aggregate demand), should be included in the explanation of employment determination. Therefore, given the availability of data and relevance of each variable to the aim of the study; these theories will inform the econometric model that will be used to fulfil the aim and objectives of the study.

2.3 EMPIRICAL LITERATURE

This section provides a review of existing literature of the subject under investigation. However, there is not a great deal written on this topic, and so the review is necessarily broad rather than deep. In some cases, the study cites related and even tangential literature.

2.3.1 The determinants of employment in the South African platinum industry

a) Wage rate

In South Africa, the wage rate has been at the centre of labour unrest. Generally, wages in the industry have been very low despite government's introduction of minimum wages. The case of the Marikana massacre of 2012 provides evidence about the important role that is played by the wage rate and labour interest in employer hiring decisions. Labour unrest of the Marikana massacre in 2012 started at Lonmin mine near Rustenburg and 34 workers were killed by police (Department of Labour, 2013). A report by the Congress of the South African Trade Unions (2013) indicates that the reason behind the strike was the demand for an increase in the minimum wage from R5000 to R12500 per month, which companies said it was unrealistic. As a result, the strike continued for five months and roughly 40% of the world's platinum production stopped (Deloitte, 2015).

The unprotected strikes that overwhelmed in the platinum mining companies in 2012 added to the viability pressures facing the industry. As a consequence, lives were lost, the industry was brought to a cessation, fixed costs were being incurred but with no production to cover the costs, supplier industries became stagnant and exports earnings declined sharply (Griffith, 2015). A study conducted by Matthey (2014) indicate that approximately 750000oz of production was lost in 2012, due to labour unrest, safety stoppages and mine closures costing in excess of R13 billion in lost revenue. Based on 2013 data, total expenditures by platinum mines before strikes was R215 million and total revenue was R197 million per day (Matthey, 2014). This means the industry made a loss of R17 million per day before long-term projects.

Given that a substantial portion of the South African platinum industry was loss-making in 2013, (Department of Labour, 2013) emphasises that a further substantial wage increases will threaten the viability of many mines and more jobs will be placed in jeopardy. A study by Leon (2013) on the challenges faced by the platinum industry after the Marikana event, recommends working on a tripartite framework agreements signed by government, labour and business on 31 July 2013. In addition, Brand (2012) suggests that improving industrial democracy and collective bargaining, skills, addressing union corruption, reviewing of labour laws and correcting media inaccuracies based on the Marikana massacre would attract more investment and thereby increase employment. In a similar vein, Forrest (2013) indicates that the labour unrest was also due to the concerns about the implementation of the mining charter, laws on labour brokers and high pay gaps.

b) Technological innovations

The minerals industry is misleadingly considered as a low-tech and by repercussion, a low-innovation industry. This is supported by Spiegel (2004) who emphasized that this is so because the South African platinum industry is old-fashioned and labour-intensive compared to other countries. The results by Spiegel insinuate to failure to appreciate the importance of technology and innovation in the industry. In addition, (Taylor, 2015) asserts that mineral exploration activities which involve extensive use of high-tech equipment and innovative approaches are understated in this industry. However, Tilton (2011) argues that all industries in the present day are high tech, meaning that all industries utilise information technology, new types of technology to intensely advance the way they do things. This indicates that there are no low-technology industries, there are only low-technology companies: companies that have not yet woken up to the potential of technology to transform what they do''.

According to Humphreys (2001), technological innovation contributes to mineral exploration, extraction, and processing including, larger environmental concerns linked with the industry. Mineral exploration has turn out to be grimmer over the years and needs ever more sophisticated technology. Humphreys (2001), further indicates that most discovered minerals have been found and techniques are now needed that are tailored to diverse geological terrains and that can look under deep cover. The extraction process hinge on the mining equipment and techniques employed comprising of drilling, blasting, cutting, excavating, loading and hauling, together with mining logistics, equipment monitoring and diagnostics (Crowson, 2006). As a result, the industry tend to use technological tools that promote labour productivity and labour substitutability (Baartjies & Couden, 2012).

Griffith (2015) assert that Amplats is moving away from the past conventional, labour intensive underground mining, which has high demand for people, energy and expensive infrastructure to a modern way of mining. In similar vein Dodgson (2015) show that the adoption of technology is increasingly essential for companies to be highly competitive and to prosper. He also indicates that the development of new technologies benefits every aspect of the mineral industry in terms of exploration, mining, mineral processing, health and safety.

To address some of the challenges associated with labour-intensive drill and blast mining, as conducted on the major South African platinum mines, mechanised mining was used (Manners, 2014). Mechanisation helps to increase South Africa's competitiveness by increasing productivity (Griffith, 2015). He further highlights that mechanisation is also used to reduce the threat of physical harm to people, as well as create greater access to reserves that would otherwise be too dangerous to explore. Hence, the South African platinum industry is committed to using technology and innovation to keep pace with the global industry standards (Dodgson, 2016). From the above review, it is evident that another important variable in employment is technology and innovation.

(Griffith, 2015) indicates that Peterstow Aquapower has established a new drilling system which could save worldwide mining companies millions of dollars in capital and operational costs, whilst dramatically reducing the industry's environmental impact. Pisu (2008) reports that cost challenges have a serious impact on the mining industry, leading to mine closures. Since pumping water and energy down deep mines and removing and depositing of it has proved so expensive that some mines have struggled to stay profitable. Again, deep level mining used to extract platinum, requires high pressure air to be pumped as much as three kilometers down mines to run drills and the current drills also require several tons of water to cool the hot air (Pisu, 2008). For this reason, (Griffith, 2015) accentuate that Peterstow technology can change that through its new drilling system for hardrock deep mine which can use less than 5% of the energy required by some existing systems and a portion of water. In addition to dramatic cost savings it will also help the companies respond to increasing regulatory and political pressure to improve efficiency.

c) Migrant labour

Solomon (2013) indicate that platinum ores lies far below the surface in deep level mines; implying that despite new technologies, mining still relies heavily on people to extract ore. In addition, the migrant labour system provided a flow of cheap labour that allowed the platinum industry to flourish. Similar results were obtained by DMR (2013) that an increase in unemployment in the mining industry in South Africa is due to the large number of migrant labour. The findings show that this high number of migrant labour is due to the fact that migrant labour is cheap to employ.

d) Investment Climate

South Africa is richly endowed with platinum resources and has a relatively open economy (Antin, 2013). In addition, the government has removed nearly all investment approval processes and there are few limitations on incoming direct investment in South Africa (Antini, 2013). To couple this, the World Platinum Investment Council (WPIC) stimulates global investor demand for physical platinum through targeted product development. (Bohlmann, Dixon, Rimmer & Van Heerden, 2014) stress that improved demand would enhance the sustainability of the South African platinum industry, employment and could stimulate further investments in new and existing mines.

According to the Department of Research and Information (2013), autocatalysts and jewellery demand have a significant potential for growth. However, Bohlmann et al., (2014) highlights that the labour unrest tarnished the image of the South African mining industry and deferred further investments and job creation. In addition, the violent behaviour was found to have adversely affected the already fragile business and investor confidence in the economy (SARB, 2013). The concerns of foreign investors resulted in a country credit rating downgrade by Moody's, standard and poor with possibilities of further downgrades (Baxter, 2014). Manners (2014) indicates that improved labour stability is essential for South Africa's development and vital for the country's ability to continue to attract foreign investment.

e) Productivity decline

Baxter (2016) indicates that productivity of the platinum mining industry decreased significantly from 2003 to 2013 and the industry produces 46% less than the output per worker. (Baartjies et al., 2012) report that between 2000 and 2012 the platinum industry's average grade fell by 40% due to a significant shift from the mining of Merenskey Reef towards UG2 ores. (Harvey, 2013) highlights that UG2 ores have far less platinum than the Merenskey ores. In addition, productivity is also hampered by the industry not getting enough blasts per year. This means that fixed costs structures are not being efficiently covered by a more realistic number of productive shifts on an annual basis. Lower productivity then feeds back into rapidly escalating unit production costs and hence restructuring and job losses (Ali, 2015).

f) Regulations and industry uncertainty

Vannoorenberghe (2012) found that during demand uncertainty in which firms face market-specific shocks and short-run convex costs of production, firms react to a shock in one market by adjusting their sales in the other market. Uncertainty in the platinum industry resulted to loss of thousands of jobs in the industry due to limited profitability of the industry (Dodgson, 2016). The mining sector in South Africa is in trouble, with the combined worth of the South Africa's 35 top platinum mining companies having dropped by 55% since June 2014 (StatsSA, 2015). As a result, the mining giant Anglo American made efforts to get rid of underperforming parts of its platinum operations to reduce risk and focus on more profitable areas. Moreover, the three major platinum mining companies in South Africa: Anglo American, Lonmin plc and Impala platinum have all declined on hard times because of strikes, low demand and declining profitability (Niego & Cawood, 2014).

Dodgson (2016) highlights that platinum industry is very labour-intensive in nature and mines are getting deeper but have old infrastructure which makes working conditions very hot and uncomfortable. This means that fresh air has to be continuously pumped down to cool down the pit, which is a very energy consuming process. Therefore, with current falling platinum prices and industry uncertainties, most mines cannot afford these increasing energy and labour costs. Hence, the companies solve these issues by cutting employees.

Manners (2014) indicates that platinum mining companies like the Anglo American are now focusing on their open pit mine in South Africa, which is profitable at the moment. In addition, open pit mines are more capital-intensive and more lucrative which makes sense in the current state of the industry as much work can be done by grinding machinery and large diggers (Manners, 2014). However, for the workers in the industry this has a negative effect since it will result in job cuts.

Baartjies et al., (2012) assert that the decline in the mining industry is attributed to external factors which include changes in the minerals markets and legislation issues related to compliance. In addition, Baartjes et al., (2012), argue that a general decrease in commodity prices can reduce viability of mining projects resulting in closure. Closure according to them may be due to legislation. For example, licensing, environmental or safety requirements may make it difficult for new mining firms to enter the market.

Baxter (2016) highlights that the current instability in the mining industry in South Africa has its roots in the fall in global demand for platinum and other minerals due to recession; the consequences of the Marikana disaster in destabilising labour relations and the structural character of the South African mining industry. His study found that merging mining and manufacturing can lead to extensive job creation, contribution to skills enhancement, industrialization, increasing foreign direct investment, turning the comparative advantages of being resource-rich into a competitive advantage and job creation.

Fucerri (2010) highlighted that the decline in employment was found to be largely due to greater reliance on higher skills, technology and capital since output is not growing fast enough to absorb existing job seekers. This is supported by Musinwini, Cruise & Phillips (2012) in their findings that platinum mines in South Africa experience a growing need for technical skills as they continue to mine at greater depths. Kihn (2012) highlighted that, the requirement of a minimum of 10 years' experience from mining engineers when mines are recruiting new engineers, is also problematic, since, it takes long for an engineer to master all the required skills, before he or she can be promoted to higher levels in the organization.

2.3.2 The relationship between output and employment

Sahin, Tansel & Berument (2013) investigated the nature of the output-employment relationship by using the Turkish quarterly data for the period 1988-2008. The main finding of their study is that there is a long run relationship between employment and output. However, various implications for the economy and the labour market emerge from this outcome. First, Sahin et al., (2013) highlights that increasing employment needs to be maintained with the sustainable income policies rather than short-term stimulus measures. Secondly, in order to help overall employment growth, targeted sectorial policies such as fiscal policies may be implemented to increase the employment level (Sahin et al., 2013).

Caporale & Škare (2011) conducted a study to examine the short and long–run linkages between employment growth, output growth and inflation by applying panel cointegration and causality tests to data for 119 countries over the period 1970-2010. Evidence from the findings of their study reveals a positive granger causality running from output growth to employment growth in the short-run. Landman (2002) concluded that employment and output are strongly and positively correlated over the business cycle in a pro-cyclical way. On the other hand, Marelli & Signorelli (2010) report that high employment growth leads to slower productivity growth in the European area. In addition, a significant negative relationship between real labour costs and employment elasticity was found.

According to Kangasharju & Pelikonen (2001) the relationship between changes in employment and output disappear over time. Their conclusion is based on the fact that there are differences in the employment and output relation between different regions and these existing differences can be partly explained by changes in the industrial specialization (Kangasharju et al., 2001). Cuyvers, Dhyne & Soeng (2010) report that the direct effects of Outflow Foreign Direct Investment (OFDI) may be felt in output and employment, because OFDI activities may either raise or reduce output and employment in the home country.

Ajilore & Yinusa (2011) found that at sectorial level, there is a positive relationship between employment and output in mining, manufacturing and construction. But also, weak even though they are significant at 1% level. Alijore et al., (2011), further indicate that growth experiences in these sectors are more productivity driven than labour-employment driven. This concludes that these sectors are modern industries where processes are permeated by applications of technology and technological tools that promote labour productivity and labour substitutability. In similar vein, Kahn (2001) asserts that employment elasticities gradually fall as a country becomes more developed and more labour threatened.

2.3.3 The nexus between employment, export demand and domestic demand.

According to Wong (2006) export demand consists of encouragement and support of the production for exports. The rationale, going back to the classical authors, is that trade is the engine of growth, in the sense that it can contribute to a more efficient allocation of resources within countries as well as transmit growth across countries and regions. An increase in exports could imply that the demand of a certain product (i.e. platinum) has risen. Thus, increasing output and hence employment since a lot of labour force will be needed to produce a certain amount of output demanded. Moreover, Felipe (2003) affirms that export demand may also give access to advanced technologies, which in turn will stimulate technological diffusion in to the industry. Also, the promotion of exports may eliminate controls that results in an overvaluation of the domestic currency. Lastly, Felipe (2003) emphasise that exports drive a country to higher production and economies of scale, which lead to increasing returns.

However, Felipe (2003) also advises that depending more on exporting has negative effects. For example, most East Asian countries had a series of negative effects from relying more on exporting. Firstly, it prevented the development of domestic market growth. Secondly, there is a relationship between exports and financial instability through overinvestment booms. Thirdly and most importantly, export growth has reinforced the dependency of developing countries on the developed world, thus becoming vulnerable to slowdowns in the latter's markets (Palley 2002).

Blecker (2003) argues that the reliance on export growth suffers from a fallacy of composition. The reason is that if too many countries try simultaneously to rely on export-led growth policies to stimulate growth and employment under a given set of global demand conditions, the market for developing countries' exports is limited by the capacity of the industrialised nations. This implies that, if demand in the developed countries stagnates, it translates into overinvestment and excess capacity in the developing countries.

Going further, there are several intuitive macroeconomic arguments that can explain a negative relationship between domestic demand and exports. Blum (2011) found a negative relationship between domestic demand, export demand and employment with Chilean firm level data. Soderbery (2011) reports similar empirical evidence for Thailand. This suggests that, in face of a negative domestic demand shock, existing firms would sell relatively less to the domestic market and more to foreign markets. Furthermore, it seems credible to believe that new investment by existing firms or new firms entering the market would tend to be export oriented given the depressed domestic demand conditions, strengthening the negative relationship between domestic demand and exports.

The study on the causal relationship between exports, domestic demand and economic growth in Ethiopia by Soressa (2013) has found long run relationship between variables using Johansen cointegration test. The study used time series data covering period 1960 to 2011. In addition, the study also used Granger causality test and found link between export and economic growth, and between domestic demand and economic growth. Similarly, Elena, Paulo, Antonio and Karsten (2015) investigated how pressure on domestic demand link to exports, and the results found suggest that statistically there is important substitution effect between domestic and foreign sales. It is further mentioned in their study that if domestic market is weak, there would be increased effort in serving markets abroad. But, when the economy is booming, exports are not inversely affected by a rise in domestic sales. However, Gumede (2000) provided acknowledgement that in South Africa empirical examination on quantitative impact of policies pertaining to import demand and economic growth is insufficient and not elaborative. In the study it is also mentioned that imports demand is largely influenced by economic activity as compared to relative prices.

Yuhong L, Zhongwen C & Changjian S (2010) conducted co-integration analyses with the data of import, export and economic growth, and the results advises that growth of import significantly promoted economic growth of China, while that of export effected an opposite one. A study by Ramos (2002) investigated the Granger-causality between exports, imports, and economic growth in Portugal over the period 1865-1998. The empirical results do not confirm a unidirectional causality between the variables considered. There is a feedback effect between exports output growth and imports output growth. More interestingly, there is no kind of significant causality between import export growths.

Hussain M & Saaed A (2014) examined the nexus of Exports, Imports and Economic growth in Saudi Arabia, using annual data for the period 1990- 2011. Granger Causality and Cointegration test were employed in the empirical analysis. Both Trace and Maximum Eigenvalue indicated cointegration at 5% level of significance pointing to the fact that the variables have a long-run relationship. There was a unidirectional causality existing between export and import. But the result of the causation between Exports and economic growth and imports and economic growth was statistically insignificant. Hatemi (2002) studied causality between export growth and economic growth in Japan by performing augmented Granger-causality tests using the bootstrap simulation technique. The results show that the Granger-causality is bidirectional, which means the expansion of exports is an integral part of the economic growth process in Japan. However, they point to a causal relationship between international trade and exports and economic growth.

2.4 SUMMARY

This chapter provides the theoretical and empirical reviews used to determine employment in the platinum mining industry. The study relied more on the Keynesian theory of employment, since the theory argues that the level of employment is determined by aggregate demand and not by the price of labour or wages as in the classical and neoclassical theories of employment. Key factors which determine employment according to the empirical literature are: real wages, labour unrest, technology innovations, decline in productivity, investment, regulations and uncertainty, declining commodity prices, export and domestic demand. However, due to lack of aggregate macro data on some variables listed above, the study will only focus on output, employment, domestic and export demand in the industry from this chapter throughout the study.

Indeed, the exclusion of some variables which the literature regards as important is one of the limitations of the study. However, this is beyond the control of the researcher. Lastly, it must be pointed out that the subject under investigation is a grey area. Evidence showed that there no studies that have particularly focused on determinants of employment in the platinum mining industry despite the manner in which it has been affected by both domestic and external crises. As an investigative study, this research therefore hopes to fill that gap.

CHAPTER 3

RESEARCH METHODOLOGY

3.1 INTRODUCTION

This chapter elucidates the quantitative methodology employed to investigate determinants of employment in the platinum mining industry. The Vector Autoregressive (VAR) approach is used to conduct the investigation.

3.2 RESEARCH DESIGN

Research design section presents the description of the data collection and data analysis, the model specification and procedure of the quantitative approach. The study used secondary data to investigate the determinants of employment in the platinum mining industry. Therefore, annual data on the operating platinum mines in South Africa was collected and analysed from the period 1992-2013. Although the number of observations might appear to be insufficient to produce credible results, it is however also important to consider the availability of data gives a way forward in every study. Therefore, only the data that is available can be observed. For it is only in future that there can be an increased number of observations in the data. Since this study is the first of its kind, hence, the uniqueness of the study and the availability of data becomes important to emphasise that 22 observations are sufficient to produce results and come up with conclusion. The researcher employed the non-experimental research by using reliable secondary data and applied econometric techniques. Pilot and Hugler (1999) maintains that non-experimental research is the most appropriate and powerful quantitative method for testing cause-and-effect relationships because of its rigorous control of variables. It is considered the gold standard for demonstrating something in a carefully scientific manner.

3.2.1 Data collection

Secondary data on employment and output levels in the platinum industry, export demand and domestic demand proxied by export and local sales respectively were obtained from Quantec data base (2016). The output data was used to assess the effect of output levels on employment. Data on export demand and domestic demand was employed to assess how the demand for platinum affects employment.

3.2.2 Explanation of variables

Employment (EMP) is defined as the number of people in an economy who provide services for pay under a contract, this includes both full-time and part-time workers in private, public, non-profit, household sectors, as well as the self- employed (Mohr & Associates, 2014). Employment in the platinum mining industry was used in the analysis of data.

Domestic demand (DD) refers to the demand by domestic residents for locally-produced goods and services (Kihn, 2012). Domestic sales were used as proxy for domestic demand in the platinum industry. Domestic demand can be due to the demand for jewelry manufacturing, catalyst converters and other platinum products.

Export demand (ED) is the demand by foreign countries for goods and services produced domestically. Ultimately, these goods are exported to foreign residents. Export demand stimulates domestic economic activity by creating employment, production and revenues (Felipe, 2003). Export sales from platinum mining industry was used as a proxy for export demand.

Output (OUT) refers to the quantity of goods or services produced in a given time period, by a firm, industry or country, whether consumed or used for further production (Mohr et al., 2014). Logically, the total output should be equal to the value of all goods and services produced in an industry. The value added method is used to determine the value of goods and services in order to avoid double counting. Hence, the study only used output in the platinum industry to analyse data.

3.2.3 Data analysis

The study used the unit root test of Augmented-Dickey Fuller test and Philips Perron test to determine the order of cointegration of variables. The unit root test is regarded as a prerequisite for the application of Vector autoregression model (VAR) or Vector error correction model (VECM) analysis. After the stationarity testing, the lag length selection is employed to determine the number of appropriate lags. Cointegration test was run to determine the number of co-integrating vectors. After cointegration has been determined in the model the researcher proceeded to conduct the VAR or (VECM) analysis depending on the absence or presence of cointegration. This was followed by the diagnostic and stability tests to determine the robustness of the model. Finally, the impulse response functions and variance decomposition analyses were employed to analyse the response of employment to its determinants and to determine the amount of information each variable contributes to the other variables. All the econometric tests were analysed using the statistical software package EViews 8.

3.3 MODEL SPECIFICATION

In order to achieve the aim of this study, the following econometric model will be used:

$$EMP = f(DD, ED, OUT) \qquad (1)$$

Equation 1 is expressed in a linear form as follows:

$$EMP_t = \beta_{0t} + \beta_1 DD_t + \beta_2 ED_t + \beta_3 OUT_t + \mu_t \qquad (2)$$

where:

EMP	=	Employment
DD	=	Domestic demand
ED	=	Export demand
OUT	=	Output in the platinum industry

3.4 UNIT ROOT TESTS

The importance of conducting the unit root testing prior to other tests is to determine the order of cointegration between variables. If a series has no unit roots, it is characterized as stationary, and therefore exhibits mean reversion in that it fluctuates around a constant long run mean (Philips & Xiao, 2002). Also, the absence of unit roots implies that the series has a finite variance which does not depend on time and that the effects of shocks dissipate over time. Trend stationarity and difference-stationarity processes were used to transform non-stationary variables to stationary variables. Dougherty (2007) describe the transformation of non-stationary variables to stationary ones by extracting a time trend as the trend stationarity process and the process of differencing non stationary variables once or twice as difference stationarity.

There are several tests for stationarity that are employed to detect whether a particular series is stationary or displays prevalence of a unit root. This study employed Augmented Dickey-Fuller test (ADF) developed by Dickey and Fuller (1979) and the Philips Perron (PP) test developed by Philips and Perron (1988) in order to validate the stationarity of the variables. The null hypothesis (H_0) of the ADF test imply that a time series X_t is integrated of order 1 I(1), against an alternative hypothesis (H_1). That a time series is integrated of order zero I(0) with the presumption that the dynamics in the data have an ARMA structure (Khumalo & Mongale, 2015).

The decision rule for the two stationarity tests (ADF and PP) is thus the same. Particularly, in both tests if the corresponding test statistics is more than the critical value at the given significance level, then we do not reject the null hypothesis and conclude that there exists a unit root in the series. On the other hand, if the corresponding test statistics is less than the critical value at the corresponding test statistics, we reject the null hypothesis and conclude that there is no existence of a unit root in the time series.

The consequence of using non-stationary series is getting spurious results. In essence, using non-stationary variables might produce meaningless and biased results even though there is prevalence of coefficient estimates and high value of the coefficient of correlation R^2 (Dougherty, 2007). Therefore, in order to avoid incorrect explanation and spurious regression the study employed unit root testing. Stationarity tests are conducted informally using the graphical technique and formally using Augmented Dickey- Fuller test and Philips- Perron test for unit root testing. To understand the rationale behind stationarity and non-stationarity, it's important to consider the following equation:

$$\mathrm{Y}_t = \varphi_2 \mathrm{X}_{t-1} + \varepsilon_t \quad \ldots\ldots(3)$$

where Y is the variable, ε is the error term and φ represents the economic shock.

Substituting for Y_{t-1} in equation (3), leads to,

$$Y_t = \varphi_2^2 X_{t-2} + \varphi_2 \varepsilon_{t-1} + \varepsilon_t \quad \text{……………………………………..…………………...…(4)}$$

Continuing with this process of lagging and substituting, the following equation is derived

$$\mathrm{Y}_t = \varphi_2^t X_0 + \varphi_2^{t-1}\varepsilon_1 + \ldots + \varphi_2 \varepsilon_{t-1} + \varepsilon_t \quad \text{…………………………………………………….(5)}$$

The expected value of Y_t is then given by

$$E(X_t) = \varphi_2^t X_0 + \varphi_2^{t-1} E(\varepsilon_1) + \ldots + \varphi_2 E(\varepsilon_{t-1}) + E(\varepsilon_t) \quad \text{……………………………………….(6)}$$

3.4.1 Augmented Dickey-Fuller (ADF) Unit root test

The ADF unit root test is based on the following regression forms:

$$\Delta \mathrm{X}_t = \beta_1 + \beta_{2t} + \delta \mathrm{X}_{t-1} + \alpha_t \sum_{i+1}^{m} \Delta \mathrm{X}_{t-i} + \mu_t \quad \text{………………………………………………...(7)}$$

where μ_t , is the error term and $\Delta \mathrm{X}_{t-1} = (\mathrm{X}_{t-1} - \mathrm{X}_{t-2})$,

$\Delta \mathrm{X}_{t-2} = (\mathrm{X}_{t-2} - \mathrm{X}_{t-3})$ and so on.

The null hypothesis and the alternative hypothesis may be written as,

$\mathrm{H}_0 : \delta = 0$ (i.e. unit root exists).

$\mathrm{H}_1 : \delta \neq 0$ (i.e. unit root does not exist).

The ADF tests the null hypothesis that X_t has a unit root against the alternative hypothesis that X_t does not have a unit root.

3.4.2 Philips-Perron Unit root test

An alternative unit root test, the Phillips–Perron test will be conducted to ensure the stationarity of the data series as this test uses non-parametric correction to deal with any correlation in the error terms (Gujarati & Porter, 2009). The PP unit root test differs from the ADF test mainly in how they deal with serial correlation and heteroskedasticity in the error term. In particular, where the ADF tests use a parametric autoregression to approximate the ARMA structure of the errors in the test regression, the PP test ignores any serial correlation in the test regression.

It uses the following AR(1) process:

$$\Delta Y_{t-1} = \alpha_0 + \gamma Y_{t-1} + \mu_t \quad \text{......(8)}$$

When a unit root has been confirmed for a data series, the existence of some long-run equilibrium relationship between variables can be analysed.

3.5 LAG LENGTH SELECTION CRITERIA

The presence of a long-run equilibrium relationship among economic variables is referred to as cointegration. Before the co-integration test is conducted, the right lag length is estimated to see which number of lags best fits the time series data. The lag length selection criteria will be discussed on the next subsection. It is important to determine the lag length in the VAR estimation process. Therefore, different information criteria for the selection of a model is used to estimate the appropriate lag length such as Akaike information criterion (AIC), Schwarz information criterion (SIC), Hannan–Quinn information criterion (HQ) and Final Prediction Errror (FPE) (Liu, 2007).

As in the autoregression, the Bayes information criterion (BIC) also called Schwarz information criterion and the Akaike information criterion (AIC) are used to estimate the number of lags in the model. The basic forms of BIC and AIC are given by equation (9) and (10) respectively.

$$BIC(K) = \ln\left(\frac{SSR(K)}{T}\right) + K\frac{\ln(T)}{T} \quad \text{......(9)}$$

$$AIC(K) = \ln\left(\frac{SSR}{T}\right) + K\frac{2}{T} \quad \text{......(10)}$$

These information criteria can be used to select the most relevant model by determining the appropriate lag length of the VAR system. The information criterion with the smallest value is preferred (Liu, 2007). Therefore, the lag length determined by these statistical criteria will be used to conduct cointegration test in order to avoid the problem of using too few lags and the problem of adding more lags. Stock & Watson (2012) highlights that employing too few lag can decrease the precision of estimating as well-regarded information will be lost and including additional lags increases estimation ambiguity. Hence, lag selection must attempt to balance the benefit derived from by means of extra information contrary to the expense of estimation of additional coefficients.

3.6 THE JOHANSEN COINTEGRATION TEST

The Johansen cointegration test aids to determine the equations of the long run equilibrium among the variables in the model. According to Dunis & Ho (2005) the concept of cointegration was first introduced by Granger (1981) and elaborated further by Engle and Granger (1987), Phillips (1987), Philips and Perron (1988), Phillips and Ouliaris (1990), Stock and Watson (1988), and Johansen (1988, 1991, & 1995). It is known that trended time series can potentially create major problems in empirical econometrics due to spurious regressions. One way of resolving this is to difference the series successively until stationary is achieved and then use the stationary series for regression analysis. Asteriou & Hall (2007) indicates that this solution, however, is not ideal because it not only differences the error process in the regression, but also no longer gives a unique long-run solution.

This study adopts Johansen and Juselius (2006) multivariate cointegration framework to determine the number of cointegrating vectors. Two tests, the Maximum Eigenvalue and the Trace test are used to achieve this objective. The Maximum Eigenvalue statistic tests the null hypothesis of *r* cointegrating relations against the alternative of $r+1$ cointegrating relations for $r = 0,1,2..n-1$. The associated null hypothesis that there are at most *r* cointegrating vectors is given as:

$\mathrm{H}_0 : \lambda_i = 0$ for $i = r+1,...,k$ and the opposing hypothesis is

$\mathrm{H}_1 : \lambda_i \neq 0$

Dwayer (2014) maintains that cointegration is an econometric methodology used to show the existence of a long run relationship among economic variables as foreseen by economic theory. When working with a multivariate condition, cointegration analysis becomes more complex since the cointegration vector take a broad view with respect to the cointegration space and magnitudes which are not known a priori (Bernstern & Nielson, 2014). A set of k I(1) variables analysed may exist up to $k-1$ independent relationships that are I(0) similarly this suggests that a long run relationship among the variables exist implying that there is a short run instrument that pushes the variables to their long run relationship (Dwayer, 2014).

Practically, Enders (2010) upholds that time series X_t and Y_t are said to be cointegrated of the order d,b where $d \geq b \geq 0$ which can be written as follows:

$$x_t, y_t \sim CI(d,b)$$

This means that X_t and Y_t time series are integrated of order d, and a linear combination of such variables exists. For example, $\alpha_1 x_t + \alpha_2 y$ which is integrated of order $(d-b)$, where vector (α_1, α_2) represents cointegrating vector. When $b=1$ means that I(d) variables can at most produce a linear combination that is I$(d-1)$.

There is a need to make assumptions concerning the underlying trend of the data before cointegration test is conducted. Asteriou et al., (2007) maintain that if the model has more than two variables, then there is a possibility of having more than one co-integrating vector. This implies that the variables in the model might form several equilibrium relationships. In general, for k number of variables, can only have up to $k-1$ co-integrating vectors. To find out how many cointegrating relationships exist among k variables requires the use of Johansen's methodology (Dwayer, 2014). Johansen (1988) suggested two test statistics to test for cointegration based on the hypothesis stated above.

$$\lambda_{trace}(r) = -N \sum_{i=r+1}^{g} \ln\left(1-\hat{\lambda}_i\right) \qquad (11)$$

$$\lambda_{\max}(r, r+1) = -N \ln\left(1-\hat{\lambda}_{r+1}\right) \qquad (12)$$

where r is the number of cointegrating vectors and $\hat{\lambda}_i$ is the estimated value for the i^{th} ordered eigenvalue and N is the number of observations. The λ_{trace} represents a test with a null hypothesis that the number of cointegrating vectors is less than or equal to r against the alternative hypothesis that there are more than r . Whereas $\lambda_{\max}$ tests the null hypothesis that the number of cointegrating vectors is r against the alternative hypothesis that the number of cointegrating vectors is $r+1$. The critical values are directly provided from Eviews after conducting a cointegration test. The null hypotheses for these statistics are rejected if the observed values are greater than the critical values at 5% level of significance. This implies the presence of cointegration among the variables and thus confirms a long run relationship (Sjö, 2008). Thus, Bernsten et al. (2014) accentuated that Vector Error Correction Model (VECM) can be employed to estimate the cointegrating equation once cointegration is determined. Hence, cointegration test is a prerequisite to the estimation of VECM.

3.7 VECTOR AUTOREGRESSIVE MODELS

According to Asteriou and Hall (2007), Vector Autoregressive (VAR) model is an econometric technique used to estimate multivariate time series data. It consists of multiple regression equations characterized by the fact that all variables in a series are endogenous and explained by their own lags. Explanatory variables are the same for all the equations and are mostly lagged variables. Gujarati (2011) explained the VAR model as a model with n equations and n variables in a linear model in which each variable is explained by its own current and past values for the remaining $n-1$ endogenous variables.

The rationale behind employing the VAR model is that the model aims to find out the vigorous responses of economic variables to instabilities by combining time series analysis and economic theory. In the same vein Asteriou et al., (2007) indicate that the VAR model has some good characteristics. First, it is very simple because we do not have to worry about which variables are endogenous or exogenous. Secondly, estimation is very simple as well, in the sense that each equation can be estimated with the usual OLS method separately. Finally, forecasts obtained from VAR models are in most cases better than those obtained from the far more complex simultaneous equation models. Besides forecasting purposes, VAR models also provide framework for causality tests (Brooks, 2002).

The assumptions of the VAR model are as follows:

- Error term is expected to be null, implying that $\mathrm{E}(\varepsilon_t) = 0$
- The variance of the white noise equals the square value of the standard deviation.

  $\mathrm{var}(\varepsilon_t) = \sigma^2$
- Independent relationship between error terms at different points of time or different observations.

  $\mathrm{cov}(\varepsilon_j, \varepsilon_i) = 0$
- Independent relationship between error terms and exogenous variables at different observations.

  $\mathrm{cov}(\varepsilon_t, x_t) = 0$
- The error term follows a normal distribution $\varepsilon_t \sim \mathrm{K}(0, \sigma^2)$

The Vector Autoregressive (VAR) model for the study is given by the following equations:

$$EMP_t = \alpha_0 + \sum_{i=1}^{k} \alpha_{1i} EMP_{t-i} + \sum_{j=1}^{k} \alpha_{2j} D_{D_{t-j}} + \sum_{k=1}^{k} \alpha_{3k} E_{D_{t-k}} + \sum_{i=1}^{k} \alpha_{4l} OUT_{t-1} + \mu_{1t}$$

……………..…(13)

$$D_{D_t} = \beta_0 + \sum_{i=1}^{n} \beta_{1i} EMP_{t-i} + \sum_{j=1}^{n} \beta_{2j} D_{D_{t-j}} + \sum_{k=i}^{n} \beta_{3k} E_{D_{t-k}} + \sum_{i=1}^{n} \beta_{4l} OUT_{t-1} + \mu_{2t} \quad \text{……………(14)}$$

$$E_{Dt} = \delta_0 + \sum_{i=1}^{q} \delta_{1i} EMP_{t-1} + \sum_{j=1}^{q} \delta_{2j} D_{D_{t-j}} + \sum_{k=i}^{q} \delta_{3k} E_{D_{t-k}} + \sum_{i=1}^{q} \delta_{4l} OUT_{t-1} + \mu_{3t} \quad \text{………………(15)}$$

$$OUT_t = \phi_0 + \sum_{i=1}^{f} \phi_{1i} EMP_{t-1} + \sum_{j=1}^{f} \phi_{2j} D_{D_{t-i}} + \sum_{k=i}^{f} \phi_{3k} E_{D_{t-k}} + \sum_{i=1}^{f} \phi_{4l} OUT_{t-1} + \mu_{4t} \quad \text{………………(16)}$$

where $t = 1,2,3,..N,$ $\alpha_0, \beta_0, \delta_0$ and ϕ_0 are intercepts, $\alpha_{(1-4)(i-l)}, \beta_{(1-4)(i-l)}, \delta_{(1-4)(i-l)}$ and $\phi_{(1-4)(i-l)}$ are the coefficients, k, n, q, f are the number of lags and μ_t's are the stochastic error terms or shocks in a VAR model.

3.8 VECTOR ERROR CORRECTION MODEL (VECM)

Vector error correction model serves to estimate both short-term and long-run effects of explanatory time series. It corrects long-run disequilibrium through short-run adjustments, leading the system to short run equilibrium. Vector Error Correction Model (VECM) is a restricted Vector Autoregressive (VAR) designed for both stationary and non-stationery series that are identified to be cointegrated (Enders, 2010). VECM is a model which describes how the system is adjusting in each time period towards its long run equilibrium state (Enders, 2010). The author emphasised that in the short term, deviations from this long run equilibrium will respond to the changes in the dependent variables in order to force their movements towards the long-run equilibrium state. Sreedharan (2004), then concluded that the coefficients of the error-correction terms derived from the cointegrating vectors represent the proportion by which the long run disequilibrium in the dependent variable is corrected in each short-term period. Therefore, the study will apply VECM to evaluate the short run properties of the cointegrated series.

Enders (2010) holds that visual structures of VECM can be derived as follows:

$$\begin{bmatrix} EMP_t \\ D_{D_t} \\ E_{D_t} \\ OUT_t \\ (1) \end{bmatrix} = \begin{bmatrix} \lambda_{11}\lambda_{12}\lambda_{13}\lambda_{14} \\ \lambda_{21}\lambda_{22}\lambda_{23}\lambda_{24} \\ \lambda_{31}\lambda_{32}\lambda_{33}\lambda_{34} \\ \lambda_{41}\lambda_{42}\lambda_{43}\lambda_{44} \\ (2) \end{bmatrix} \begin{bmatrix} EMP_{t-1} \\ D_{Dt-1} \\ E_{Dt-1} \\ OUT_{t-1} \\ (3) \end{bmatrix} + \begin{bmatrix} \delta_{11}\delta_{12}\delta_{13}\delta_{14} \\ \delta_{21}\delta_{22}\delta_{23}\delta_{24} \\ \delta_{31}\delta_{32}\delta_{33}\delta_{34} \\ \delta_{41}\delta_{42}\delta_{43}\delta_{44} \\ (4) \end{bmatrix} \begin{bmatrix} \beta_{11}\beta_{12}\beta_{13}\beta_{14} \\ \beta_{21}\beta_{22}\beta_{23}\beta_{24} \\ \beta_{31}\beta_{32}\beta_{33}\beta_{34} \\ \beta_{41}\beta_{42}\beta_{43}\beta_{44} \\ (5) \end{bmatrix} \begin{bmatrix} EMP_{t-1} \\ D_{Dt-1} \\ E_{Dt-1} \\ OUT_{t-1} \\ (6) \end{bmatrix} + \begin{bmatrix} \mu_{1t} \\ \mu_{2t} \\ \mu_{3t} \\ \mu_{4t} \\ (7) \end{bmatrix}$$

where,

Pilaster 2 represents short run coefficients, pilaster 4 are the adjustment coefficients and pilaster 5 denotes long run cointegrating vectors. The above visual structures can be expressed in the following VECM form assuming there exist at least one cointegrating vector,

$$\begin{bmatrix} EMP_t \\ D_{D_t} \\ E_{D_t} \\ OUT_t \\ (1) \end{bmatrix} = \begin{bmatrix} \lambda_{11}\lambda_{12}\lambda_{13}\lambda_{14} \\ \lambda_{21}\lambda_{22}\lambda_{23}\lambda_{24} \\ \lambda_{31}\lambda_{32}\lambda_{33}\lambda_{34} \\ \lambda_{41}\lambda_{42}\lambda_{43}\lambda_{44} \\ (2) \end{bmatrix} \begin{bmatrix} EMP_{t-1} \\ D_{Dt-1} \\ E_{Dt-1} \\ OUT_{t-1} \\ (3) \end{bmatrix} + \begin{bmatrix} \delta_{11} \\ \delta_{21} \\ \delta_{31} \\ \delta_{41} \\ (4) \end{bmatrix} \begin{bmatrix} \beta_{11}\beta_{21}\ \beta_{31}\beta_{41} \\ \beta_{21} \\ \beta_{31} \\ \beta_{41} \\ (5) \end{bmatrix} \begin{bmatrix} EMP_{t-1} \\ D_{Dt-1} \\ E_{Dt-1} \\ OUT_{t-1} \\ (6) \end{bmatrix} + \begin{bmatrix} \mu_{1t} \\ \mu_{2t} \\ \mu_{3t} \\ \mu_{4t} \\ (7) \end{bmatrix}$$

Pilaster 4 embodies the speed of parameters that goes into various equations and Pilaster 5 indicates one cointegrating vector. Therefore, in this study analysis of the VECM model will be executed using Eviews 8.

3.9 GRANGER CAUSALITY TEST

The study employed Granger causality test in order to determine the direction of causality between two variables. To understand the rationale between Granger causality tests it is crucial to consider two variables X and Y categorized by the following estimates:

$Y = \alpha + \beta X$ ………………………………………………………………………(17)

$X = \sigma + \varphi Y$ ………………………………………………………………………(18)

where $\alpha; \beta; \sigma$ and φ are all regression parameters.

If $\beta = 0$ in equation (17): X is said not to granger cause Y; and if $\beta \neq 0$: X is said to granger cause Y. In equation (18) if $\varphi = 0$: Y is said not to granger cause X; and if $\varphi \neq 0$: Y is said to granger cause X. Given a direct causality between X and Y on one hand, the causality is said to be bidirectional in nature. On the other hand, it is said to be unidirectional when it is one side (Stock et al., 2012).

The VAR Ganger causality/Block Exogeniety Wald test was used to determine whether lags of one variable either EMP, DD, ED or OUT can granger cause any of the other variables in the VAR system using the chi-squared distribution based on the following hypothesis:

H_0 : $\beta = 0$ X does not granger cause Y

H_1 : $\beta \neq 0$ X granger cause Y

Computations by E-views focus on the null hypothesis that X does not Granger cause Y at 5% level of significance. Therefore, if the associated probability value (p-value) is less than 5% then the null hypothesis will be rejected and if the p-value is more than 5% the null hypothesis will not be rejected (Bernstein et al., 2014).

3.10 DIAGNOSTIC TESTS

The classical normal linear regression model (CLNRM) assumes that the error term μ_t in the regression model is normally distributed (Stock et al., 2012). It is thus important to check if the error term is normally distributed. To do so the Jarque-Bera (JB) test for normality will be conducted.

The null hypothesis and the alternative hypothesis are formulated as follows:

H_0 : Residuals are normally distributed

H_1: Residuals are not normally distributed

The formula for the test is as follows:

$$JB = n\left[\frac{S^2}{6} + \frac{(K-3)^2}{24}\right] \sim \chi^2_2 \qquad (19)$$

where n is the sample size, S is the skewness coefficient and K is the kurtosis coefficient (Gujarati, 2011). When $S = 0$ and $K = 3$ the implication is that both components of the JB are zero, hence the hypothesis of normality of the residuals is achieved. The null hypothesis is the joint hypothesis that $S = 0$ and $K = 3$. The null hypothesis is accepted and confirmed if JB statistics is greater than its critical value and the associated p-value is greater than 0.05 (i.e 5% level of significance). The null hypothesis would be rejected in contrary. However, if the null hypothesis is not rejected it means that some assumptions of the OLS are violated and this will require some serious attention.

The Ljung-Box (1978) test is used to test for the presence of autocorrelation in a time series model. If significant autocorrelation is not found in the residuals, then the model is declared to have passed the test. In general, the Ljung-Box test is defined as:

H_0: No autocorrelation in model.

H_1: There is autocorrelation in the model.

Given a time series Y of length n, the test statistic is defined as:

$$Q = n(n+2)\sum_{k-1}^{m}\frac{r^2k}{n-k} \quad \text{……………………………………………………………………(20)}$$

where r_k is the estimated autocorrelation of the series at lag k, and m is the number of lags being tested. As the test is applied to residuals, the degrees of freedom must account for the estimated model parameters so that $h = m - p - q$, where p and q indicate the number of parameters from the ARMA(p,q) model fit to the data. Rejection of the null hypothesis due to lack of evidence in the data will imply that there is a presence of autocorrelation in the model which is a problem and will need to be corrected until the null hypothesis can no longer be rejected.

Breusch-Pagan Godfrey Serial Correlation Lagrange Multiplier (LM) test is an alternative to the *Q*-statistics for testing serial correlation. Its use is recommended whenever there is a possibility that errors exhibit autocorrelation (Gujarati, 2011). The Breusch-Pagan Godfrey LM test can be estimated using the following equation:

$$\mu_t = \rho_1\mu_{t-1} + \rho_2\mu_{t-2} + ... + \rho_p\mu_{t-p} + v_t \quad \text{…………………………………………………….(21)}$$

Therefore, the hypothesis is created as follows:

H_0: $p1 = p2 = ... = pp = 0$ (i.e, there is no autocorrelation in the error term).

H_1: There is autocorrelation in the error.

Accepting the null hypothesis will mean that the model is free from serial correlation which is good for analysis. The null hypothesis of the LM test is that there is no serial correlation up to lag order *p*, where *p* is a pre-specified integer. The local alternative is ARMA(*r*,*q*) errors, where the number of lag terms *p* = max{*r*,*q*}. Note that the alternative includes both AR(*p*) and MA(*p*) error processes, and that the test may have power against a variety of autocorrelation structures (Potter, 2000).

The autoregressive conditional heteroskedasticity (ARCH) tests the variance of the error term μ_t which depends on the size of the squared error term lagged one period, that is, $(\mu)^2{}_{t-1}$ (Asteriou 2007) .The regression model that can be measured is:

$$Y_t = \beta_1 + \beta_2 X_{2t} + \beta_3 X_{3t} + ... + \beta_k X_{kt} + \mu_t \quad \text{…………………………………………………(22)}$$

the variance of the stochastic term will follow an ARCH (1) process then,

$$Var(\mu_t) = \sigma_t^2 = \gamma_0 + \gamma_1 \mu_{t-1}^2 \qquad (23)$$

The coefficient of μ_{t-1}^2 should be equivalent to zero when autocorrelation is absent in $Var(\mu_t)$. This particular specification of heteroskedasticity was motivated by the observation that in many financial time series, the magnitude of residuals appeared to be related to the magnitude of recent residuals (Asteriou & Hall, 2007). ARCH in itself does not invalidate standard OLS inference. However, ignoring ARCH effects may result in loss of efficiency.

According to Gujarati (2011) the Breusch–Pagan (BP) heteroskedasticity test is given by the following model:

$$\varepsilon_t^2 = \beta_1 + \beta_2 K_i + \beta_3 K_i + ... + \beta_p K_i + \nu_i \qquad (24)$$

Thus, the following hypothesis can be estimated

$H_0 : \alpha_1 = \alpha_2 = \alpha_3 = 0$ (i.e, the error term is homoskedastic).

$H_1 : \alpha_1 \neq \alpha_2 \neq \alpha_3 \neq 0$ (there is heteroskedasticity).

The null hypothesis will not be rejected if there is lack of evidence in the data implying that the model will be free from heteroskedasticity. On the other hand, the null hypothesis will be rejected if there is enough evidence in the data to do so.

Alternative tests for heteroskedasticity such as the Glejser and the White tests with no cross terms will be conducted to detect heteroskedasticity on residuals. Therefore, the following equations can be estimated:

For Glejser the equation takes the following structure:

$$|\hat{e}_t| = \phi_1 + \phi_2 N_2 + \phi_3 N_3 + ... + \phi_p N_{pt} + \nu_t \qquad (25)$$

H_0 : the error term is homoscedastic.

H_1 : there is heteroskedasticity.

White's test for heteroskedasticity is given by the following regression equation:

$$e_1^2 = \alpha_1 + \alpha_2 P_2 + \alpha_3 P_3 + \alpha_4 P + \nu_t \qquad (26)$$

The null hypothesis of homoscedasticity will be tested against the alternative of heteroskedasticity. Accepting the null hypothesis due to insufficient evidence in the data will mean that the model is homoscedastic, which is the most desired outcome.

On the other hand, the existence of overwhelming evidence in the data will lead to the rejection of the null hypothesis which usually demands therapies.

If the model suffers from heteroskedasticity, a natural question arises what can be done to solve the problem of heteroskedasticity. In general, there are three solutions. The first one is to change the specification of the model so that the error term was homoskedastic. The second solution is to use the estimator that accounts for heteroskedasticity. For example, Feasible Generalized Least Squares. The third option is to estimate the parameters of the model with the OLS and account for heteroskedasticity while calculating standard errors (Williams, 2015).

3.11 STABILITY TESTS

The Cusum test is based on the cumulative sum of the recursive residuals. This option plots the cumulative sum together with the 5 percent critical lines. The test finds parameter instability if the cumulative sum goes outside the area between the two critical lines. Moreover, the Cusum of squares test provides a plot of S_t against t and the pair of 5 percent critical lines. As with the cusum test, movements outside the critical lines is suggestive of parameter or residual variance instability (Dougherty, 2007).

3.12 IMPULSE RESPONSE FUNCTION

According to Persaran & Shin (1998) an impulse response function (IRF) traces the response to a one-time shock in the innovation. A shock to the i^{th} variable not only directly affects the i^{th} variable but also transmitted to all of the other endogenous variables through the lag structure of the VAR. IRF shows the effects of shocks on the adjustment path of the variables there by tracing the effects of a one-time shock to one of the innovations on current and future values of the endogenous variables (Potter, 2000). Therefore, impulse response computations were used to assess how shocks to economic variables reverberate through a system (Persaran at al., 1998). To analyse responses of employment to its determinants, the IRF was used. From the graphical out, a null value indicates that a particular innovation has no effect on dependent variable which continues on the same path that it would have followed if there was no shock. A positive or negative value indicates that the shock causes the given variable to be above or below its natural path.

3.13 VARIANCE DECOMPOSITION

The variance decomposition indicates the amount of information each variable contributes to the other variables in the VAR system (Enders & Lee, 1990). It determines how much of the forecast error variance of each of the variables can be explained by exogenous shocks to the other variables. IRF hints the properties of an innovation or shock to one endogenous variable on the other variables in the VAR system. On the other hand, variance decomposition splits the variation in an endogenous variable into the constituent shocks to the VAR system (Baharumshah, Lau & Khalid, 2006). Therefore, Engle & Granger (1987) maintains that variance decomposition provides extra evidence regarding the virtual prominence of each random innovation in inducing the variables in the VAR model. Hence, variance decomposition method yields better results than other customary procedures in a VAR methodology (Baharumshah et al., 2006).

3.14 LIMITATIONS OF THE STUDY

Data on employment, export demand, domestic demand and output in the platinum industry in South Africa was available for 22 years (1992-2013), only on a yearly basis. The longer the number of time series data values that are available, the more accurate will be the results of the estimated model. It was felt that the number of time series data values available for all relevant variables was not adequate to conduct meaningful forecasting of future levels of employment in the platinum industry in South Africa. In economic terms twenty-two years of observation is regarded as a short period drawing some meaningful economic conclusions. So the accuracy of the estimated model results may not be high and standard errors are inflated relative to larger time series; accordingly, some *p*-values are a little bigger than 0.05. Additionally, few number of studies on the subject matter were conducted which resulted in difficulties in finding empirical literature, which indicates that the subject under investigation is a grey area and as a consequence, there is a gap in the existing literature which needs to be filled.

3.15 SUMMARY

Chapter three provides appropriate methodology processes used to deal with time series data in order to determine the relationship between employment, domestic demand, export demand and output in the platinum industry in South Africa and the econometric modelling was specified based on both theoretical and empirical foundations. The chapter described the variables used, and also provided the model specification of VECM. Econometrical calculations on the data obtained on the determinants of employments in the platinum industry in South Africa will be performed in chapter four.

CHAPTER 4

DATA ANLYSIS AND INTERPRETATION OF FINDINGS

4.1 INTRODUCTION

This chapter focuses on employing econometrical techniques and tools in order to run all the necessary tests and presentation of results. The chapter is structured in the following order: unit root test, optimal lag selection test, Johansen cointegration test, and the estimation of the VECM followed by diagnostic and stability tests. Impulse response and variance decomposition will be used to interpret economic shocks from the series.

4.2 UNIT ROOT TESTS

To find out the order of integration in the series, the (ADF) test and the (PP) test results were obtained. The decision rule for the two tests entailed comparing t-statistics with their critical values:

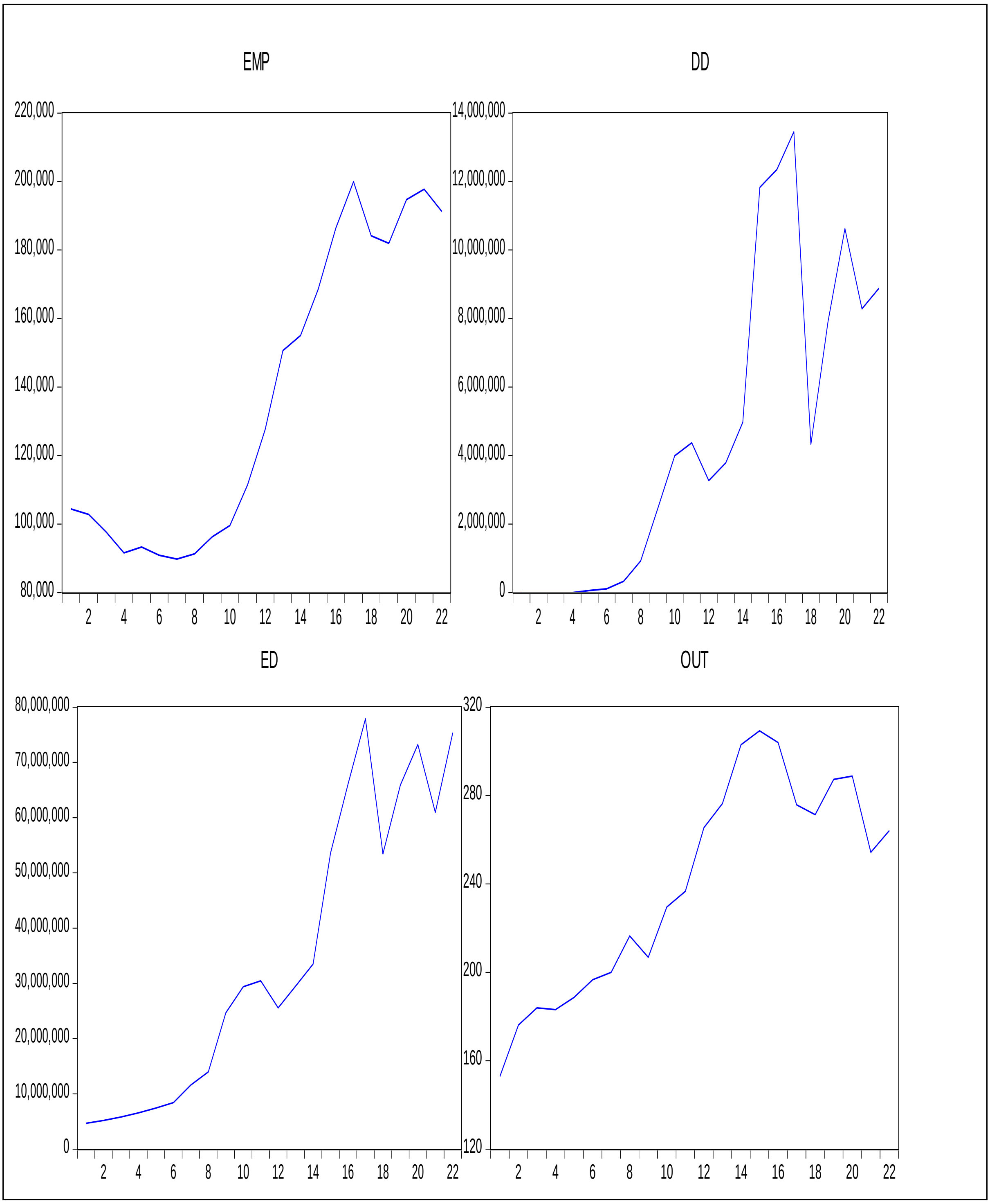
Accept the null hypothesis if $t^* >$ ADF/PP critical values (i.e. unit root exists).

Reject the null hypothesis if $t^* <$ ADF/PP critical values (i.e. unit root does not exist).

Variables in the series are used in their natural values. Graphical inspection of the variables is shown in Figure 4.1 and Figure 4.2. Under the ADF test, the lag length is selected automatically by Eviews using the Schwartz information criterion. For PP test, the Bartlett Kernel with an automatic selection of Newey-West Bandwith is regarded as the default method of estimation. The summary of the ADF and PP tests is shown in Table 4.1

The graphical inspection on EMP, DD, ED and OUT variables in Figure 4.1 shows that the variables are not stationary in levels since their series are not wavering around the mean. However, when the variables are differenced once they appear to be stationary in 1st difference as shown in Figure 4.2.

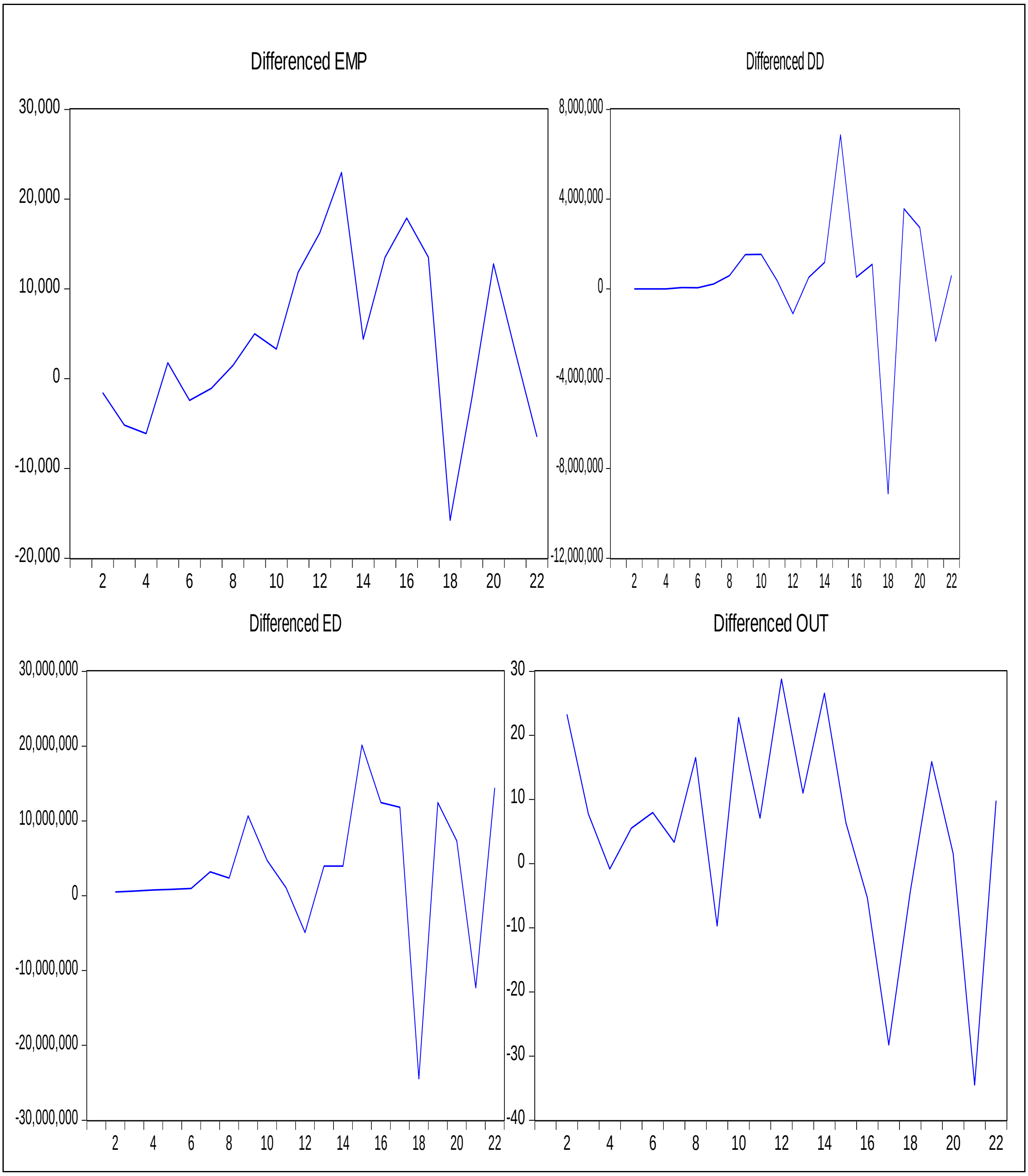
Figure 4.1: Levels Series



Source: Author

Despite that the 1st differenced series seem to waver around the mean of the respective variables, there was a need to verify the graphical claim with much more robust techniques such as the ADF and the PP unit root tests. The ADF and PP results computed are summarised in Table 4.1 and full results are shown in Appendix 1A to 4D.

Figure 4.2: Differenced Series



Source: Author

The ADF and PP unit root test results in Table 4.1 reveal that all variables in the model are not stationary at levels since the null hypothesis of the existence of a unit root cannot be rejected at 1%, 5%, 10% level of significance. Even after the application of the trend stationary process the variables were still not stationary. However, after applying the difference stationary process stationarity was found at first difference. For the differenced EMP (DEMP)'s null hypothesis of the presence of unit root was not rejected at all levels of significance (1%, 5% and 10%) in all models (τ_τ , τ_μ, τ) when using the ADF test.

However the PP unit root test confirmed stationarity of DEMP by rejecting the null hypothesis of unit root presence at both 5% and 10% level of significance for τ_μ (-2.716745 *) and τ (-2.494828 **) models with one and two stars respectively. Therefore, the rejection of the null hypothesis of existence of a unit root indicates that EMP is stationary in first difference using the PP unit root test and hence EMP is an I(1) variable. The ADF unit root results show that the differenced DD (DDD) is stationary at first difference as shown by the computed ADF statistic values, τ_τ(-1.799447), τ_μ (-5.067613***) and τ (-5.061818***). The null hypothesis of a unit root existence is also rejected at 1%, 5% and 10% of significance as shown by the PP statistics results, τ_τ (-5.864420***), τ_μ (-6.064673***), and τ (-5.494753***). Hence, DD is an I(1) variable given that it is stationary in 1st difference.

The differenced ED (DED)'s ADF unit root test results show that the null hypothesis of a unit root existence is rejected at 1%, 5% and 10% level of significance respectively with respect to the τ_τ (-5.733900***), τ_μ(-5.209819***) and τ (-4.620155***) models. This outcome is reinforced by the PP unit root test results which shows that the null hypothesis of a unit root presence is rejected by all models, τ_τ (-5.565200***), τ_μ (-5.711318***) and τ (-4.620155***) at 1%, 5% and 10% level of significance. Therefore, it can be concluded that ED is stationary in 1st difference and therefore it is an I(1) variable.

ADF unit root test results on differenced OUT (DOUT), τ_τ (-4.192096**), τ_μ (-4.041274***) and τ (-3.898447***) show stationarity on the series. This is confirmed by the PP unit root test results which exhibit the rejection of the null hypothesis of the existence of a unit root which is rejected at 1%, 5% and 10% level of significance for all the models, τ_τ (-4.192096**), τ_μ (-4.041274***) and τ (3.892942***).

Table 4. 1: Results of the Unit Root Test

Series	Model	ADF Lags	ADF Statistics	PP Bandwith	PP statistics	Conclusion
EMP	τ_τ	4	-4.165903	1	-2.044968	Do not reject H_0: Series contains unit root, meaning that the series is not stationary, I(1)
	τ_μ	0	0.043872	1	-0.126583	
	τ	0	1.876406	1	-1.558923	
DEMP	τ_τ	4	-3.190677	4	-2.540271	Reject H_0: series contains unit root, therefore it's stationery
	τ_μ	3	- 2.585634	5	-2.716745 *	
	τ	4	-1.3330583	4	-2.494828 **	
DD	τ_τ	0	-2.907166	1	-2.958186	Do not reject H_0: Series contains unit root, indicating that the series is series not stationary, I(1)
	τ_μ	0	-1.467525	2	-1.36621	
	τ	0	-0.528490	2	-0.362865	
DDD	τ_τ	0	-1.799447	5	-5.864420***	Reject H_0: Series contains unit root, thus it's stationary
	τ_μ	0	-5.067613***	5	-6.064673***	
	τ	0	-5.061818***	4	-5.494753***	
ED	τ_τ	0	-3.001239	2	-2.967924	Do not reject H_0: the series contains unit root, denoting that the series
	τ_μ	0	-0.477407	5	-0.038840	
	τ	0	-0.956214	4	-1.629087	

						is not stationary,I (1)
DED	τ_τ		-5.733900***	4	-5.565200***	Reject H_0: series contains unit root, showing that the series is not stationary.
	τ_μ	0	-5.209819***	4	-5.711318***	
	τ	0	-4.620155***	0	-4.620155***	
OUT	τ_τ	0	-0.903914	1	-0.990445	Do not reject H_0: Series contains unit root, meaning that the series is not stationary,I (1)
	τ_μ	0	-1.872478	1	-1.856467	
	τ	0	1.111657	1	-1.046094	
DOUT	τ_τ	0	-4.192096**	0	-4.192096**	Reject H_0: Series contains unit root, therefore it's stationary
	τ_μ	0	-4.041274***	0	-4.041274***	
	τ	0	-3.898447***	1	-3.892942***	

Source: Author

Note: Ho: Series contains a unit root
: * [**] (***) indicate rejection of the null hypothesis of the existence of the unit root that 10% [5%] (1%) level of significance.
: τ_τ - Trend & Intercept; τ_μ - Intercept; τ- None

Results shown in Table 4.1 show that all the variables, EMP, DD, ED and OUT are integrated at order one (I(1)) and their first differences were stationary satisfying the requirement needed to employ the Johansen (1998) multivariate cointegrating procedures (Seddighi et al., 2000). Given that all variables were regarded to be suitable for estimation by the long run cointegration technique, such outcome led to the determination of VAR lags since a specific la length of the VAR was to be chosen.

4.3 THE VAR LAG ORDER SELECTION CRITERIA

The conclusion that the time series variables are cointegrated allows us to proceed with cointegration, but, firstly the appropriate lag length of the VAR that will be suitable for the study need to be determined to insure that the error term was white noise (Liu, 2007). Partial results of lag order selection after calculations with E-views are provided in Table 4.2. Complete results are provided in appendix 5A.

Table 4.2: Partial results of the lag selection test

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-989.9465	NA	1.73e+38	99.39465	99.59380	99.43353
1	-919.8384	105.1621*	8.05e+35*	93.98384	94.97957*	94.17822*
2	-903.4527	18.02431	9.79e+35	93.94527*	95.73759	94.29515

Source: Author
∗ Indicates lag order selected by the criterion, AIC: Akaike information criterion, SC: Schwarz information criterion and Hannan Quinn.

The number of lags that minimizes the value of the information criteria is chosen (Liu, 2007). Based on the results of the lag length determination lag 1 was selected as indicate by the sequential Modified LR test statistic (LR), the Final Prediction Error (FPE), the Akaike information criterion (AIC), the Schwarz information criterion (SC) and the Hannan–Quinn (HQ) information criteria in building the model specifically to avoid some misspecification problems in the analysis. The next step is to perform the Johansen Cointegration test since we have selected the correct lag length.

4.4 THE JOHANSEN COINTEGRATION TEST

The Johansen cointegration test was conducted after specifying the number of lags selected as 1 and tested the null hypothesis of no cointegrating vectors at 5% level of significance. The Johansen cointegration test uses the trace and maximum eigen-value techinques to determine the number of cointegrating vectors. The summarized results are reported in Table 4.3 and full results computed are provided in Appendix 5B.

Table 4.3: Results of the Johansen Cointegration test

Unrestricted cointegration rank tests (Trace and Maximum Eigen Value)

Hypothesisd No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob	Max-Eigen Statistic	0.05 Critical Value	Prob
None *	0.849090	82.84456	63.87610	0.0006	37.82138	32.11832	0.0090
At most 1 *	0.650685	45.02318	42.91525	0.0303	21.03561	25.82321	0.1891
At most 2	0.587923	23.98757	25.87211	0.0843	17.73091	19.38704	0.0856
At most 3	0.268628	6.256660	12.51798	0.4284	6.256660	12.51798	0.4284

Source: Author

Note: Trace test indicates 2 cointegrating eqn(s) at the 0.05 level.

Max-eigenvalue test indicates 1 cointegrating eqn(s) at the 0.05 level.

* Denotes rejection of the hypothesis at the 0.05 level.

** MacKinnon-Haug-Michelis (1999) p-values

The null hypothesis of no cointegrating equation (CE) is rejected at 5% level of significance for both trace and maximum eigenvalue tests since the trace statistic (82.84456) is greater than the critical value (63.87610) and the max statistic (37.82138) is more than the critical value (32.11832). The rejection of the null hypothesis of no cointegrating vectors is confirmed by the trace's probability value (0.0006) and max's probability value (0.0090) which are all greater than the 5% level of significance.

However, trace test suggests 2 cointegrating equations and the maximum eigenvalue suggests 1 cointegrating equations at the 5% significance level. Banerjee (1993) emphasized that if there comes up a different result between trace and maximum eigenvalue test, maximum eigenvalue result is preferred. Hence, the result of maximum eigenvalue in the model of one cointegrating vector is selected. The presence of cointegrating vectors implies the existence of linear combination among the four series, indicating the presence of a long run relationship between them. The computed normalized long run parameters are reported in Table 4.4 obtained from the complete results provided in Appendix 5B.

Table 4.4: Normalised Cointegration Equation

Normalized cointegrating coefficients (standard error in parantheses)			
EMP	DD	ED	OUT
1.000000	0.022005	-0.008057	-1238.553
	(0.00365)	(0.00087)	(234.791)

∗ standard error in paranthesis

Source: Author

Employment (EMP) is normalised to unity as endogenous variable of the regression. With the estimated cointegrated vector, the associated coefficients represent the long run equilibrium relationship. The cointegrated vector can be expressed as follows:

$$EMP = 0.022005DD - 0.008057ED - 1238.553OUT = 0 \quad (4.1)$$

The normalised coefficients associated with a unique cointegrating vector from the Johansen procedure led to the derivation of the following long run equation:

$$EMP = -0.022005DD + 0.008057ED + 1238.553OUT = 0 \quad (4.2)$$

Equation (4.2) illustrates a positive relationship between employment (EMP), export demand (ED) and output (OUT). This implies that when Export demand for platinum increase, employment in that industry also increase. Again, when Output or the production of platinum increase, the level of employment increases since a lot of workers will be required to produce a given level of output. These results are in line with the Keynesian theory of employment (Keynes, 1936) and the neoclassical theory of employment. The existence of cointegrating vectors in the long run indicates the presence of corresponding vector error correction model for short run dynamics in the series.

4.5 VECTOR ERROR CORRECTION MODEL (VECM)

Now the focus is on VECM's short run results, considering the presence of 1 cointegrating vector derived from Johansen cointegration test. Summary of short run effects of the VECM estimates are provided in Table 4.5. The Error Correction Term (ECT) represented by the CointEq1 of -0.283202 is a speed of adjustment. It has an expected sign of the alpha coefficient in the error term which implies that any deviation of a variable away from long run equilibrium in one period is immediately corrected in the next period. The speed of adjustment suggests that 28.32 % of the disequilibrium of the previous year is adjusted towards long run equilibrium in the next year. Thus, meeting the a priori expectation. The results also suggest that full convergence process will take place in approximately 3 years and 6 months to reach the stable path of equilibrium. Implying that the correction process is very fast for the South African economy in any shock to the employment equation. Appendix 5C provides full result of VECM estimates.

Table 4.5: Vector Error Correction Model

variables	Coefficients	Standard error	t-statistics
D(EMP)	1.000000		
D(DD)	-0.012411	0.00102	-12.1901
D(ED)	0.000836	0.00017	5.04224
D(OUT)	-321.6603	-321.6603	-3.96601
CointEq1	-0.283202	0.15554	-1.82071
C	-27173.85		
R- Squared	0.769089		
Adjusted R Squared	0.538178		

Source: Author

The R- squared (R^2) of 0.769089 means that 77% of the variation in Employment (EMP) is explained by changes in Domestic demand (DD), Export demand (ED) and Output (OUT). The following Granger causality tests were used to complement the VECM results.

4.6 GRANGER CAUSALITY TEST RESULTS FOR VECM

The results of Granger causality test show that all other variables collectively cause EMP. Individually, EMP is granger caused by OUT. DD is collectively caused by EMP, ED and OUT. But individually is caused by OUT. ED is individually granger caused by OUT. In a nutshell, the VAR Granger causality/ Block Exogeneity Wald test show that output (OUT) granger causes domestic demand (DD), export demand, (ED) but output does not granger cause output.

Table 4.6: VAR Granger causality test results

OUT ⇒→ EMP
OUT⇒→DD
OUT⇒→ED

Source**:** Author

4.7 DIAGNOSTIC TESTS

Diagnostic tests were used to determine whether the classical assumptions were violated or not in order to justify the efficiency of the results. These tests help to insure that the model is fit and does not contain spurious regressions. Jarque-Bera normality test was conducted to check for normality in the model. Ljung – Box Q and Breusch-Pagan – Godfrey LM Tests were conducted to detect the problem of autocorrelation/ serial correlation in the model. Moreover, ARCH, White with no cross terms (NCT), Glejser, and Breusch – Pagan Godfrey Heteroskedasticity were also employed to detect the problem of heteroskedasticity, while the CUSUM and CUSUMSQ tests were used to analyse the stability of both long- run and short- run coefficients.

Table 4.7: Results from the Diagnostic Tests

Test	H_0	T-statistic	P-values	Conclusion
Jarque-Bera	Residuals are normally distributed	0.388092	0.823620	Do not reject H_0 since PV (0.823) >L.O.S (0.05). Thus, residuals are normally distributed.
Ljung- Box Q Autocorrelation Test	No Autocorelation	29.694	0.106	Do not reject H_0 since PV (0.106) > LOS (0.05). Therefore, there is no Autocorrelation in the model.
Breusch – Pagan Godfrey: Serial	No Serial Correlation	17.32325	0.1378	Do not reject H_0 since PV (0.137) > L.O.S (0.05). Hence, there is no serial correlation in the model.

Correlation LM Test				
ARCH	No Arch Heteroskedasticity	3.383406	0.1842	Do not reject H_0 since PV (0.18) $>$ L.O.S (0.05). Meaning, there is no heteroskedasticity in the model.
Glejser Heteroske dasticity	No Heteroskedasticity	3.279402	0.3505	Do not reject H_0 since PV (0.350) $>$ L.O.S (0.05). Therefore, there is no heteroskedasticity in the model.
White (NCT) Heteroske dasticity	No Heteroskedasticity	2.712851	0.4380	Do not reject H_0 since PV (0.43) $>$ L.O.S (0.05). Hence, there is no heteroskedasticity in the model.
Bruesh-Pegan Godfrey Heteroske dasticity	No Heteroskedasticity	2.159448	0.5400	Do not reject H_0 since PV (0.54) $>$ L.O.S (0.05). Therefore, there is no heteroskedasticity in the model.

Note: L.O.S means "level of significance"
: P-v means probability value
Source: Author

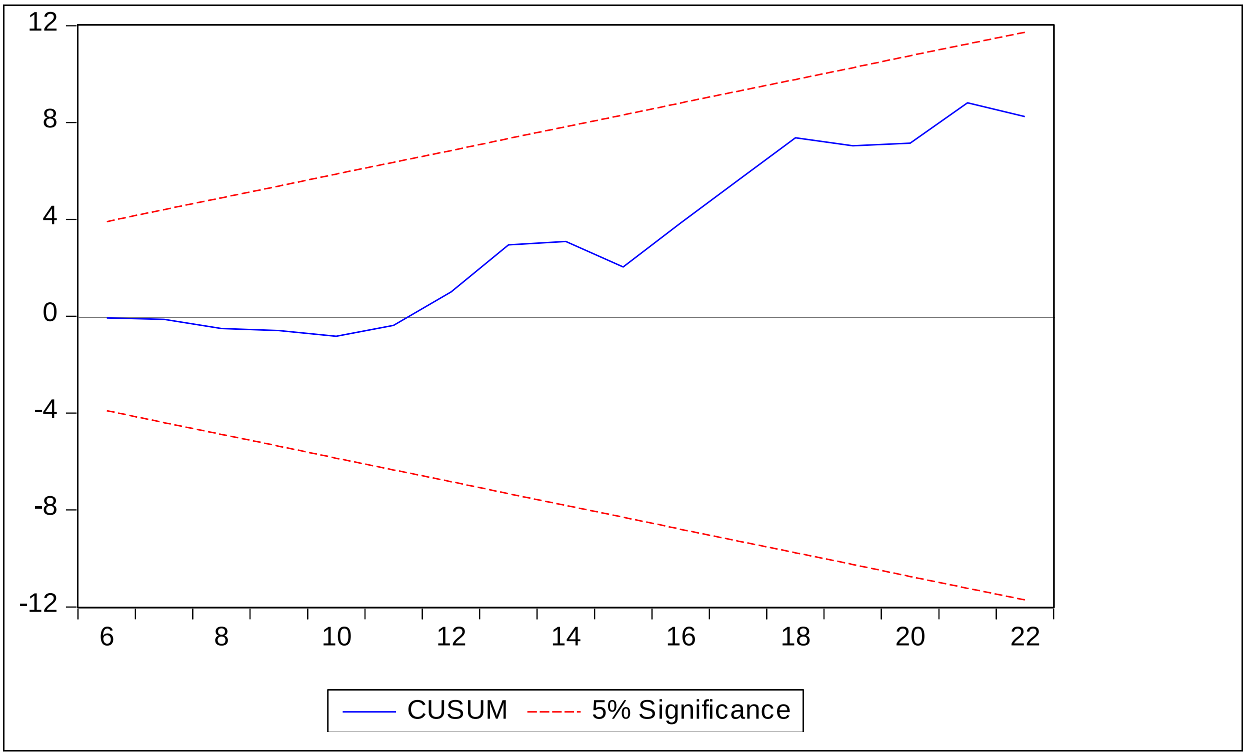
These results are tested based on the level of significance (L.O.S) 1%, 5% and 10%. As can be noted from Table 4.7, the Jarque-Bera test indicates that the residuals of the regression are normally distributed in the model given that the probability value of 0.8236 is greater than the 1%, 5% and 10% level of significance. The Ljung –Box Q test was applied to detect the presence of autocorrelation in the model. The null hypothesis was not rejected since the probability value (0.106) is greater than all the level of significance. Implying that the model is free from autocorrelation. This was confirmed by the Breusch–Pagan Godfrey Lagrange Multiplier test which indicated failure to reject the null hypothesis because probability value 0.138 is more than the 10% level of significance.

The ARCH test shows that the errors are not homoskedastic. This is confirmed by a probability value of 0.184 which is greater than all the three levels of significance. The White test with “no cross terms” (NCT), also confirms that the errors do not reveal heteroskedasticity. This is evidenced by the p-value of 43.80%, which is compared against the levels of significance at 1%, 5% and 10%. The Breusch-Pagan Godfrey and Glejser also confirms the null hypothesis of no heteroskedasticity in the model with the p-values of 0.54 and 0.3505 which is greater than all the significance levels respectively. Therefore, this means that the results represent the true estimations of the error correction model.

4.9 STABILITY TESTS

The structural stability of the estimated model and the stability of parameters in the model were assessed using CUSUM and CUSUM of squares tests of stability The CUSUM test in Figure 4.3 illustrates that the model is fairly stable as the cumulative sum moves inside the critical lines up to the end of the period. This movement along the lines of significance at 5 percent is therefore an indication of stability (Dougherty, 2007).

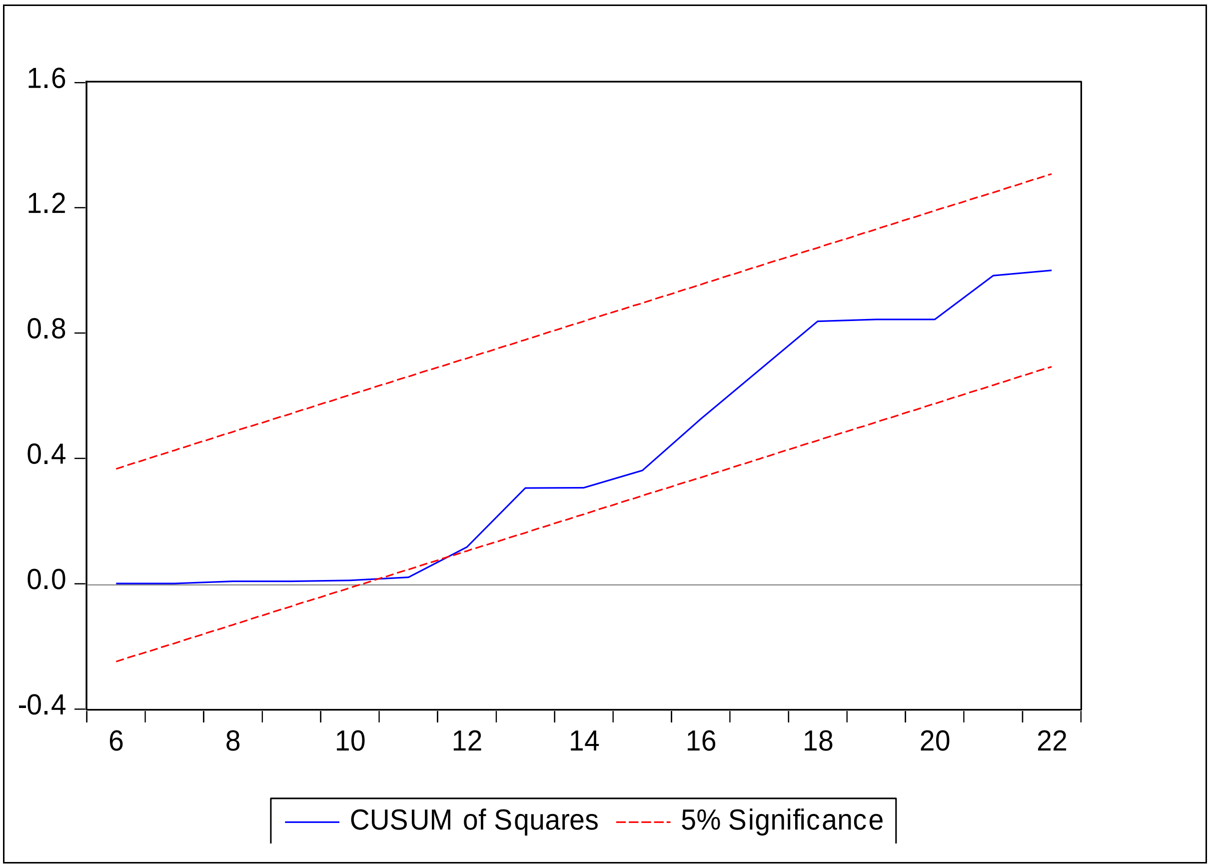
Figure 4.3: CUSUM test Results



Source: Author

In Figure 4.4 the CUSUM of squares test also indicates that the cumulative sum of squares falls within the 5% significance lines. This confirms stability in the equation throughout the study period. This implies that, the model is correctly specified and thus, the equation is worthy to be analyzed.

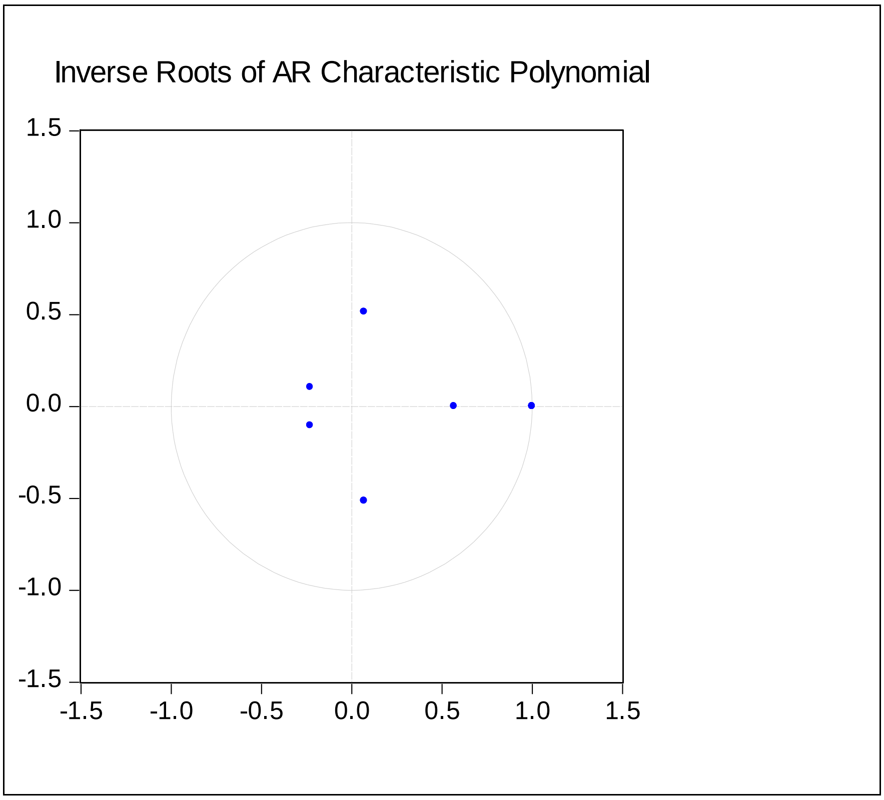
Figure 4.4: CUSUM of squares Results



Source: Author

The stability of the VECM results was also complemented by the AR root graph shown in Figure 4.5 which highlights the inverse roots of the characteristic AR polynomial.

Figure 4.5 AR Roots Graph



Source: Author

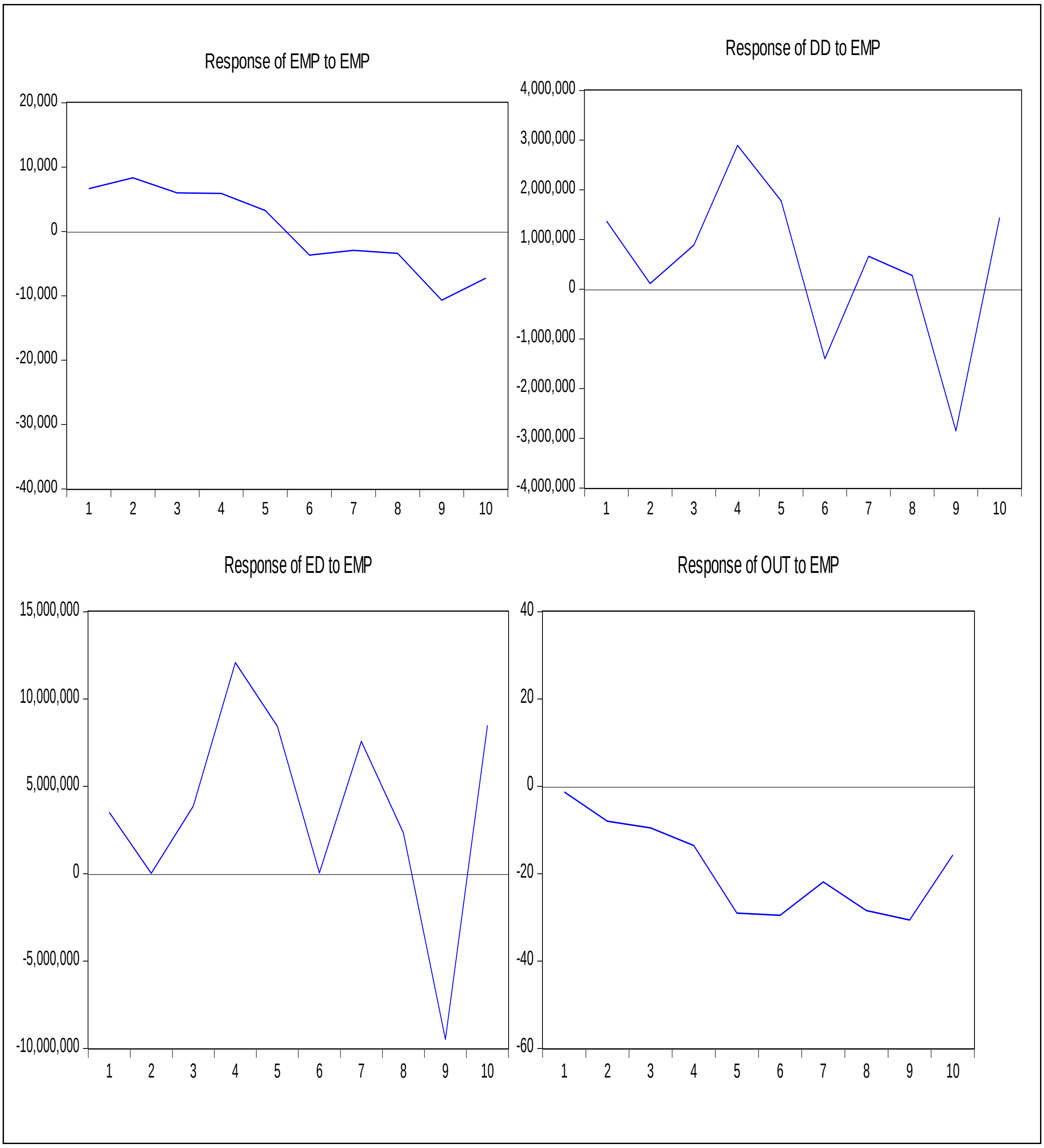
Figure 4.5 indicates that the VAR is constant (stationary), the impulse response standard errors are valid and also the roots have a modulus which is smaller than one since they all lie within a unit root circle. The empirical evidence for diagnostic test discovered that the model has successfully passed all the major tests for normality of residuals, autocorrelation, serial correlation, heteroskedasticity and structural stability. Hence, a conclusion can be drawn that the model is reliable and stable for policy formulation tenacities (Lütkepohl & Saikkonnen, 2000).

4.10 ANALYSIS OF IMPULSE RESPONSE FUNCTION

The impulse response function aided in examining the reaction of endogenous variables (employment, domestic demand, export demand and output) in the VAR when a shock was effected on the error terms. In order to determine the effects on the VAR system a unit shock was applied to each variable. A positive shock of one standard deviation to the error terms in the VAR model was applied to determine the responses of variables. The impulse response was applied to the unrestricted VAR given that all variables are endogenous.

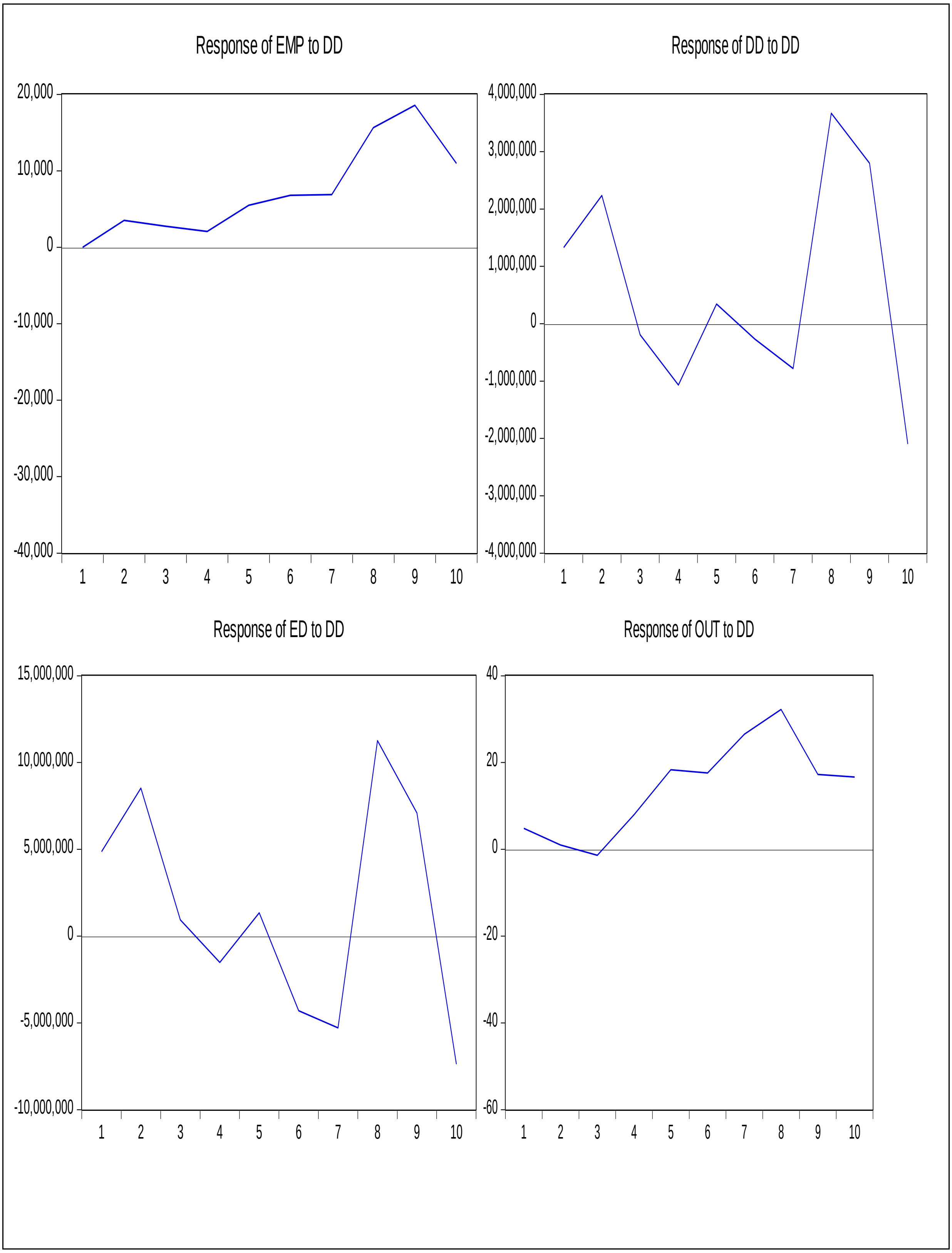
When one standard deviation shock was given to EMP, it initially reacted positively until year two but dropped from year 2 until year 5 then it stated to react negatively from that period until year 10 as shown in Figure 4.5. The reaction of DD to an innovation applied to EMP was positive until year 5, then became negative in year 6 and 7 and thereafter became positive in year 9. But the reaction of ED was positive up to period 8 and became negative from period 8 until period 9 and then was positive in period 10 meaning that ED has a positive significant impact on EMP in the long- run. Under a shock of EMP, OUT is negative throughout the period.

Figure 4.6 Response to EMP shock



Source: Author

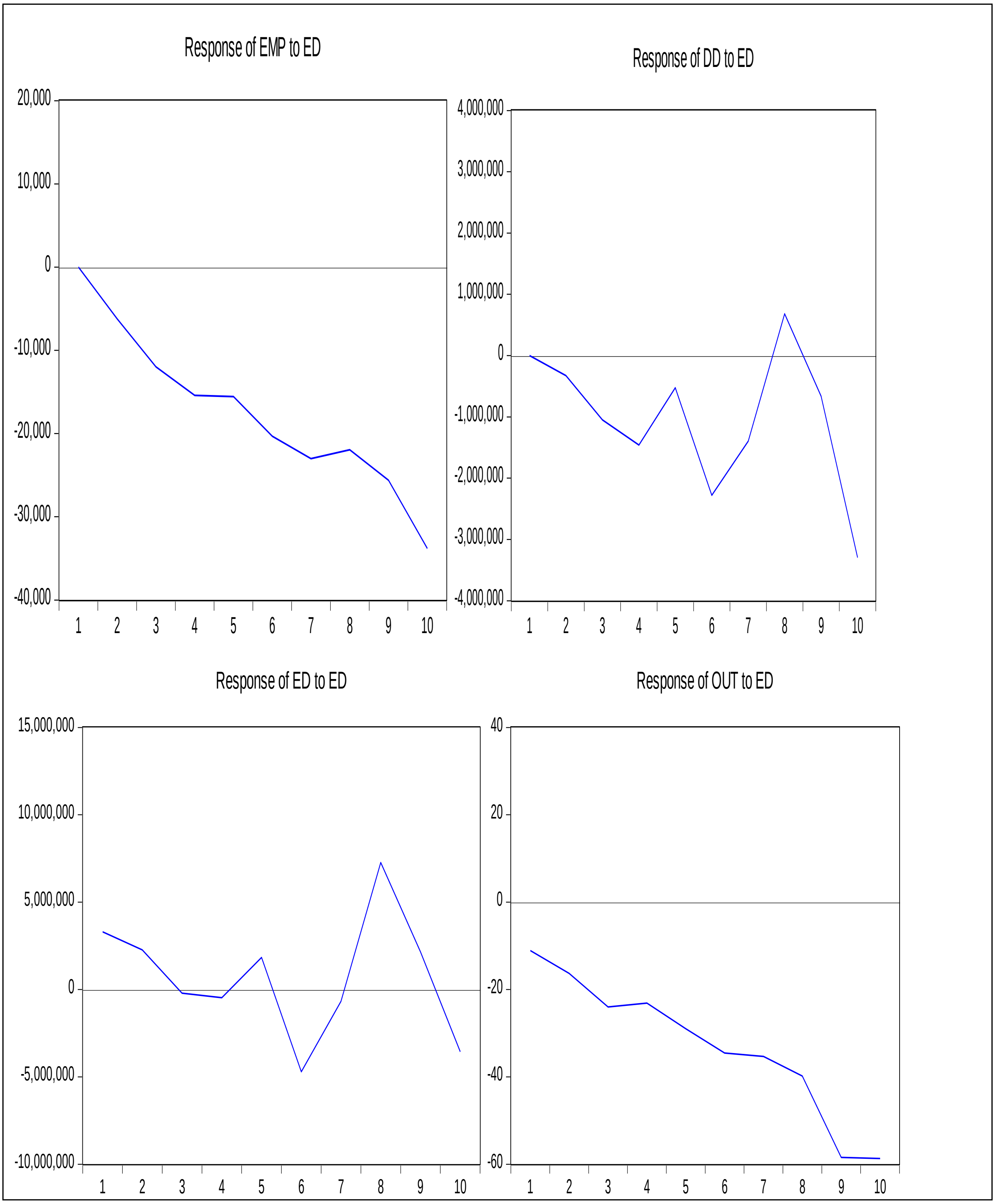
Figure 4.7 Response to DD Shock



Source: Author

The results in figure 4.7 showed that a shock to DD of one standard deviation increases employment throughout the 10 years. DD reacted positively to own innovative shock until year 2 and then started to decrease from year 2 until it became negative in year 3 until year 7. It became positive in year 7 until year 9 and became negative in year 10. ED responded positively until year 4 and then started fluctuating like DD from the same year until the 10th year. OUT responded very well to DD throughout the 10 years' period.

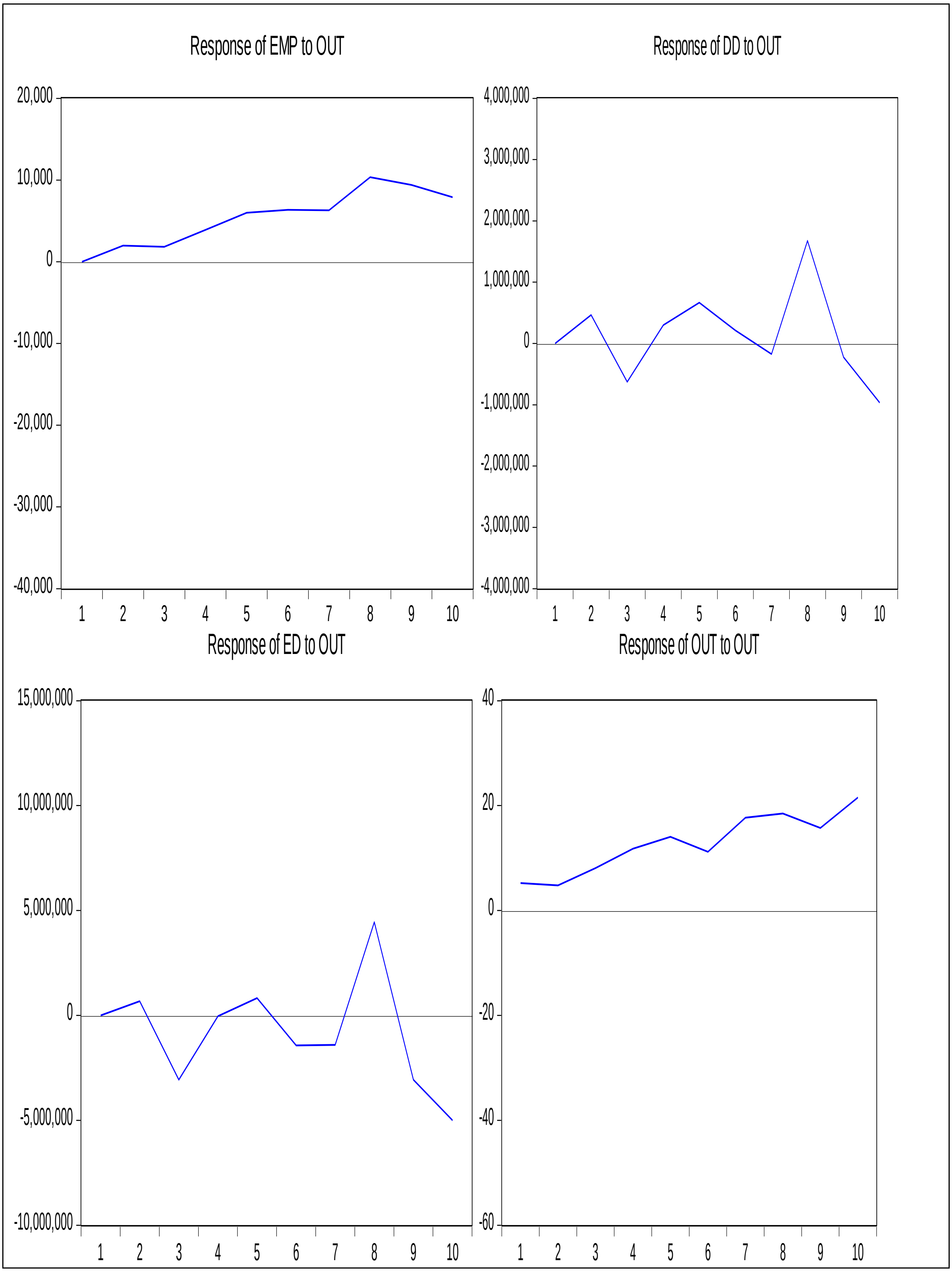
Figure 4.8 Response to ED shock



Source: Author

When one standard deviation shock was applied to ED, EMP’s reaction was negative throughout the 10 years. DD reacted the same way but became positive in year 7 until year 8 and decreased until it became negative until year 10. ED own innovative shock reacted positively at first and then started to be negative in period 5 and 7 and became positive thereafter until period 9. OUT reacted negatively throughout the 10 years in Figure 4.8.

Figure 4.9 Response to OUT shock



Source: Author

According to Figure 4.9 EMP responded positively to a shock of OUT of one standard deviation implying a positive impact on EMP throughout the 10 years' period. The reaction of DD to innovations OUT was positive from year 1 till year 2, then it started fluctuating i.e. positive/ negative until 10 years. Likewise, the reaction of ED was very unstable and mostly negative and immaterial. However, OUT responded positively to own innovative shock in all the 10 years. These results are in line with the VAR Granger Causality/Block Exogeneity Wald (GCBEW) test results shortened in Table 4.6 which illustrates that OUT Granger cause EMP, DD and ED.

4.11 VARIANCE DECOMPOSITION

The generalized forecast error variance decomposition technique was implemented using the VAR system to test employment, domestic demand, export demand and output relationship in the platinum mining industry in South Africa. Variance decomposition results enabled forecasting to be possible for the next 10 years. Using results in Table 4.8, fluctuations of EMP are 100% explained by EMP (own innovative shock) in the first year. Also in the short-run, that is in year 3, an innovative shock stemming in EMP, DD, ED and OUT accounts for 49.87%, 5.08%, 0.41% and 44.5% of the variation in EMP respectively.

Table 4.8 Variance Decomposition of EMP

Variance Decomposition of EMP:

Period	S.E.	EMP	DD	ED	OUT
1	6390.830	100.0000	0.000000	0.000000	0.000000
2	9236.764	79.11874	0.510897	0.146110	20.22426
3	12713.66	49.86540	5.076482	0.408344	44.64978
4	16485.99	31.66242	10.02442	0.677030	57.63613
5	19924.81	22.18307	13.43905	0.933358	63.44452
6	22758.93	17.13332	15.54628	1.178205	66.14220
7	24966.78	14.27260	16.80611	1.408702	67.51259
8	26634.42	12.55239	17.54709	1.619913	68.28061
9	27875.94	11.46395	17.97570	1.807626	68.75273
10	28797.65	10.74501	18.21862	1.969648	69.06673

Source: Author

Therefore, total fluctuation in EMP accumulates to 100%. But in the long-run, that is in year 10, one standard shock stemming in EMP, DD, ED and OUT attribute to EMP by 10.75%, 18.22%, 1.97% and 69.07% respectively. Therefore OUT's contribution to EMP increases significantly from the short- run in to the long run while EMP's contribution diminishes overtime.

Using results in year 3 depicted in Table 4.10, an impulse to EMP, DD (own innovative shock), ED and OUT explain 11.87%, 53.78%, 0.11% and 34.24% fluctuation in DD respectively in the short- run.

Table 4.9 Variance Decomposition of DD

Variance decomposition of DD:

Period	S.E.	EMP	DD	ED	OUT
1	2064742.	18.02398	81.97602	0.000000	0.000000
2	2316797.	15.82951	65.19215	0.015164	18.96318
3	2680749.	11.86801	53.78488	0.105548	34.24156
4	2983126.	9.591823	48.52482	0.253829	41.62953
5	3190473.	8.408814	45.89612	0.424143	45.27092
6	3324075.	7.765104	44.40420	0.591643	47.23906
7	3409070.	7.392082	43.47329	0.741802	48.39283
8	3463918.	7.162844	42.85293	0.868258	49.11596
9	3500457.	7.014462	42.41878	0.970317	49.59644
10	3525849.	6.913843	42.10258	1.050474	49.93311

Source: Author

An innovation to EMP, DD, ED and OUT can cause 6.91%, 42.10%, 1.05% and 49.93% variation in DD respectively in the long- run defined by year 10. The variance decomposition results show that an innovation from OUT can greatly contribute DD, followed by DD (own innovative shock) and then EMP.

The variance decomposition results in Table 4.10 reveal that a shock to EMP, DD, ED (own innovative shock) and OUT in year 3 can cause 10.61%, 45.95%, 22.68% and 20.76% fluctuations in ED in the short- run.

Table 4.10 Variance Decomposition Of OUT

Variance Decomposition of ED:

Period	S.E.	EMP	DD	ED	OUT
1	8418792.	10.24073	70.14823	19.61104	0.000000
2	9608922.	11.22763	57.04623	23.17469	8.551450
3	10722589	10.60970	45.95152	22.67857	20.76021
4	11913944	9.426565	38.54933	20.66411	31.35999
5	13087941	8.254544	33.96464	18.56041	39.22041
6	14172128	7.276954	31.14596	16.81030	44.76679
7	15129048	6.513977	29.37782	15.46497	48.64323
8	15946753	5.934670	28.23180	14.46260	51.37093
9	16629504	5.499093	27.46018	13.72426	53.31647
10	17190454	5.171837	26.92025	13.18139	54.72652

Source: Author

While an innovation to EMP, DD, ED and OUT in the 10th year account for 5.17%, 26.92%, 13.18% and 54.73% variation in ED respectively in the long- run. OUT contributes significantly to ED, followed by innovation to DD.

The results shown in Table 4.11 reveal that an innovation to EMP, DD, ED and OUT (own innovative shock) can cause 0.51%, 17.08%, 1.44% and 80.98% variation in OUT respectively in the short- run defined by 3rd year. But a shock to EMP, DD, ED and OUT in year 10 can contribute 0.46%, 19.71%, 2.56% and 77.26% of the changes in OUT respectively in the long-run.

Table 4.11 Variance Decomposition of OUT

Variance Decomposition of OUT:

Period	S.E.	EMP	DD	ED	OUT
1	14.81460	1.082501	2.191468	1.206066	95.51997
2	22.63679	0.529002	12.84738	1.238479	85.38514
3	27.35956	0.508517	17.07605	1.440134	80.97530
4	30.09535	0.517724	18.77627	1.684389	79.02161
5	31.68329	0.511547	19.44971	1.918552	78.12019
6	32.63231	0.496523	19.69430	2.119335	77.68984
7	33.22815	0.481288	19.76246	2.280145	77.47611
8	33.62599	0.469967	19.76222	2.403542	77.36428
9	33.90914	0.463134	19.73908	2.495923	77.30187
10	34.12255	0.459737	19.71152	2.564319	77.26443

Source: Author

In this case own shock contributes significantly to OUT, followed by innovations to DD.

4.12 SUMMARY

Chapter four focused on the computations of the empirical results and their interpretations. In order to do so it was ensured that all series are stationary through the use of unit root test. Unit root results revealed that all variables are I (1) meaning that that they met the prerequisite criterion for the application of VECM methodology. The Johansen cointegration test result reinforced the unit root outcome by showing that the variables are cointegrated in the long- run. For the optimal lag length selection AIC-criterion indicated maximum lag length of two (2) lags. But for accuracy sake, one (1) lag length was chosen instead of (2) lags since it is less than the optimal lag. Hence VECM was estimated with one lag and it followed that all parameters associated to the cointegrating equations were significant. The variables decomposition results supported by the impulse response and the GCBEW test results. Furthermore, the diagnostic tests results justified the use of the model by endorsing that residuals were normally distributed, there was no heteroscedasticity in the model and the model was stable and fit for analysis.

CHAPTER 5

SUMMARY, RECOMMENDATIONS AND CONCLUSION

5.1 INTRODUCTION

This chapter summarises the main findings of the study and gives recommendations to the policy makers and the platinum industry based on the empirical results and conclusion. Summary and conclusion are discussed first. This will be followed by recommendations, contributions of the study as well as the possible areas for future research.

5.2 SUMMARY AND CONCLUSION

This study investigated the determinants of employment in the platinum mining industry in South Africa. This is achieved by determining the nexus between employment, output, domestic demand and export demand. The study adopted the Keynesian theory of employment given its reliability and credibility. The platinum mining industry was perceived as a major employer in the entire mining sector. However, external conditions are likely to become even more unfavourable for our mining industries. For example, weakness in the platinum industry of Europe combined with the increased availability of scrap and recycled metal and some substitution of platinum by palladium exacerbated the weakness in the platinum market. The study adopted the Vector autoregressive approach to estimate the model. The estimation covered the period 1992-2013. The Johansen cointegration results indicated one cointegrating equation in the model meaning that the variables are integrated in one way in the long run. The results also indicate the incidence of a positive long run relationship between export demand, output and employment and a negative relationship between domestic demand and employment.

The results from VECM showed the existence of short-run relationship between the variables. The speed of adjustment of 28.3202% suggests that the disequilibrium of the previous year is adjusted towards long run equilibrium in the next year. The results also suggest that full convergence process will take place in approximately 3 year 6 months to reach the stable path of equilibrium meaning that the adjustment process is very fast for the South African platinum industry in any shock to the employment equation. The results of the VECM were in line with theory even though they were insignificant.

Results from diagnostic tests indicate that residuals are free from serial correlation, heteroskedasticity and normality problems. Stability of the model was confirmed by the CUSUM and CUSUM of squares test implying that the model was correctly specified and fit for analysis and forecasting. Granger causality results revealed that the causal relationship between the series is unidirectional. This is so because causality emerges from output to export demand, domestic demand and employment. Empirical literature has also confirmed the positive impact that output and export demand has on employment.

5.3 POLICY RECOMMENDATIONS

The study investigated the determinants of employment in the platinum mining industry in South Africa. Following the results of the normalised cointegration equation, the granger causality test and the evidence from empirical literature which shows a positive relationship between employment, output and export demand, the following policy recommendations are suggested. The platinum mining industry should implement policies and strategies such as mineral beneficiation in order to increase output which will lead to higher levels of employment. Government can also create a conducive environment to enable the industry to expand (for example, fiscal policies). The platinum mining industry should also intensify its export drive, especially to diversify those markets.

5.4 CONTRIBUTIONS OF THE STUDY

The study made contributions to research in the field of economics, most specifically with regard to the determinants of employment in the platinum mining industry since it is a grey area and very few similar studies were conducted. The general contribution of the study is the disclosure that employment is mostly determined by output (production) and export demand.

5.5 POSSIBLE AREAS FOR FURTHER RESEARCH

From the reviewed literature, most studies used yearly data to investigate the relationship that exists between employment and its determinants. However, it must be noted that monthly data or quarterly data provide more useful results than yearly data. It is therefore, suggested that the significance of this study's results can be improved by applying monthly or quarterly data. Using more frequent observations better captures dynamics of employment, export demand, domestic demand and output interrelationships. More predictor variables and longer time series datasets may be used in the future to analyze the relationship amongst these variables with greater precision.

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Appendices

APPENDIX A: RAW DATA

YEAR	EMP	OUT	ED	DD
1992	104 360	152.9	4 677 841	0
1993	102 809	176.2	5 188 809	0
1994	97 643	183.9	5 809 613	0
1995	91 528	183.1	6 572 506	0
1996	93 304	188.6	7 428 137	58 110
1997	90 876	196.6	8 403 862	105 822
1998	89 781	200.0	11 602 274	327 475
1999	91 269	216.5	13 964 729	922 726
2000	96 273	206.8	24 645 761	2 448 867
2001	99 575	229.5	29 381 009	3 989 841
2002	111 419	236.6	30 459 188	4 369 585
2003	127 672	265.4	25 553 565	3 270 365
2004	150 630	276.4	29 527 109	3 786 133
2005	155 034	303.0	33 481 439	4 969 108
2006	168 530	309.3	53 614 207	11 829 608
2007	186 411	304.0	66 064 133	12 350 290
2008	199 948	275.8	77 904 355	13 448 280
2009	184 163	271.4	53 459 307	4 322 869
2010	181 969	287.3	65 894 341	7 892 570
2011	194 745	288.9	73 234 047	10 619 219
2012	197 752	254.3	60 918 939	8 285 235
2013	191 261	264.2	75 348 535	8 886 103

Appendix 1A: Augmented Dickey Fuller Unit Root Test-EMP

Null Hypothesis: EMP has a unit root
Exogenous: None
Lag Length: 0 (Automatic - based on SIC, maxlag=4)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		1.876406	0.9818
Test critical values:	1% level	-2.679735	
	5% level	-1.958088	
	10% level	-1.607830	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(EMP)
Method: Least Squares
Date: 08/17/16 Time: 14:29
Sample (adjusted): 2 22
Included observations: 21 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
EMP(-1)	0.028309	0.015087	1.876406	0.0753

R-squared	-0.014732	Mean dependent var	4138.143
Adjusted R-squared	-0.014732	S.D. dependent var	9642.853
S.E. of regression	9713.621	Akaike info criterion	21.24689
Sum squared resid	1.89E+09	Schwarz criterion	21.29663
Log likelihood	-222.0924	Hannan-Quinn criter.	21.25769
Durbin-Watson stat	1.185109		

Null Hypothesis: EMP has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=4)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		0.043872	0.9528
Test critical values:	1% level	-3.788030	
	5% level	-3.012363	
	10% level	-2.646119	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(EMP)
Method: Least Squares
Date: 08/17/16 Time: 14:31
Sample (adjusted): 2 22
Included observations: 21 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
EMP(-1)	0.002256	0.051423	0.043872	0.9655
C	3835.656	7224.834	0.530899	0.6016

R-squared	0.000101	Mean dependent var	4138.143
Adjusted R-squared	-0.052525	S.D. dependent var	9642.853
S.E. of regression	9892.858	Akaike info criterion	21.32741
Sum squared resid	1.86E+09	Schwarz criterion	21.42688
Log likelihood	-221.9378	Hannan-Quinn criter.	21.34900
F-statistic	0.001925	Durbin-Watson stat	1.171851
Prob(F-statistic)	0.965464		

Null Hypothesis: EMP has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 4 (Automatic - based on SIC, maxlag=4)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-4.165903	0.0224
Test critical values:	1% level	-4.616209	
	5% level	-3.710482	
	10% level	-3.297799	

*MacKinnon (1996) one-sided p-values.
Warning: Probabilities and critical values calculated for 20 observations
and may not be accurate for a sample size of 17

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(EMP)
Method: Least Squares
Date: 08/17/16 Time: 14:31
Sample (adjusted): 6 22
Included observations: 17 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
EMP(-1)	-0.587814	0.141101	-4.165903	0.0019
D(EMP(-1))	0.434805	0.179118	2.427474	0.0356
D(EMP(-2))	0.070830	0.199068	0.355806	0.7294
D(EMP(-3))	0.215334	0.192745	1.117196	0.2900
D(EMP(-4))	0.707193	0.205835	3.435735	0.0064
C	31393.21	6880.818	4.562424	0.0010
@TREND("1")	3890.750	1127.621	3.450405	0.0062

R-squared	0.768562	Mean dependent var	5762.176
Adjusted R-squared	0.629699	S.D. dependent var	9953.690
S.E. of regression	6057.052	Akaike info criterion	20.54874
Sum squared resid	3.67E+08	Schwarz criterion	20.89182
Log likelihood	-167.6642	Hannan-Quinn criter.	20.58284
F-statistic	5.534691	Durbin-Watson stat	1.870750
Prob(F-statistic)	0.009099		

Appendix 1B: Augmented Dicky Fuller Unit Root Test- DD

Null Hypothesis: DD has a unit root
Exogenous: None
Lag Length: 0 (Automatic - based on SIC, maxlag=4)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-0.528490	0.4756
Test critical values:	1% level	-2.679735	
	5% level	-1.958088	
	10% level	-1.607830	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(DD)
Method: Least Squares
Date: 08/17/16 Time: 14:37
Sample (adjusted): 2 22
Included observations: 21 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
DD(-1)	-0.052555	0.099443	-0.528490	0.6030

R-squared	-0.009094	Mean dependent var	423147.7
Adjusted R-squared	-0.009094	S.D. dependent var	2847567.
S.E. of regression	2860486.	Akaike info criterion	32.61733
Sum squared resid	1.64E+14	Schwarz criterion	32.66707
Log likelihood	-341.4820	Hannan-Quinn criter.	32.62812
Durbin-Watson stat	2.208774		

Null Hypothesis: DD has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 0 (Automatic - based on SIC, maxlag=4)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-2.907166	0.1800
Test critical values:	1% level	-4.467895	
	5% level	-3.644963	
	10% level	-3.261452	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(DD)
Method: Least Squares
Date: 08/17/16 Time: 14:38
Sample (adjusted): 2 22
Included observations: 21 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
DD(-1)	-0.645247	0.221951	-2.907166	0.0094
C	-1024940.	1234494.	-0.830251	0.4173
@TREND("1")	391408.4	163060.5	2.400387	0.0274

R-squared	0.319605	Mean dependent var	423147.7
Adjusted R-squared	0.244006	S.D. dependent var	2847567.
S.E. of regression	2475900.	Akaike info criterion	32.41367
Sum squared resid	1.10E+14	Schwarz criterion	32.56289
Log likelihood	-337.3435	Hannan-Quinn criter.	32.44605
F-statistic	4.227619	Durbin-Watson stat	1.837388
Prob(F-statistic)	0.031250		

Null Hypothesis: DD has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=4)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-1.467525	0.5298
Test critical values:	1% level	-3.788030	
	5% level	-3.012363	
	10% level	-2.646119	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(DD)
Method: Least Squares
Date: 08/17/16 Time: 14:38
Sample (adjusted): 2 22
Included observations: 21 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
DD(-1)	-0.199317	0.135818	-1.467525	0.1586
C	1305800.	852536.1	1.531665	0.1421

R-squared	0.101809	Mean dependent var	423147.7
Adjusted R-squared	0.054536	S.D. dependent var	2847567.
S.E. of regression	2768832.	Akaike info criterion	32.59614
Sum squared resid	1.46E+14	Schwarz criterion	32.69562
Log likelihood	-340.2595	Hannan-Quinn criter.	32.61773
F-statistic	2.153629	Durbin-Watson stat	2.139995
Prob(F-statistic)	0.158593		

Appendix 1C: Augmented Dicky- Fuller Unit Root Test ED

Null Hypothesis: ED has a unit root
Exogenous: None
Lag Length: 0 (Automatic - based on SIC, maxlag=4)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		0.956214	0.9037
Test critical values:	1% level	-2.679735	
	5% level	-1.958088	
	10% level	-1.607830	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(ED)
Method: Least Squares
Date: 08/17/16 Time: 14:43
Sample (adjusted): 2 22
Included observations: 21 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
ED(-1)	0.050801	0.053127	0.956214	0.3504

R-squared	-0.079849	Mean dependent var	3365271.
Adjusted R-squared	-0.079849	S.D. dependent var	9593005.
S.E. of regression	9968648.	Akaike info criterion	35.11424
Sum squared resid	1.99E+15	Schwarz criterion	35.16398
Log likelihood	-367.6995	Hannan-Quinn criter.	35.12503
Durbin-Watson stat	2.304258		

Null Hypothesis: ED has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=4)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-0.477407	0.8774
Test critical values:	1% level	-3.788030	
	5% level	-3.012363	
	10% level	-2.646119	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(ED)
Method: Least Squares
Date: 08/17/16 Time: 14:43
Sample (adjusted): 2 22
Included observations: 21 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
ED(-1)	-0.041477	0.086879	-0.477407	0.6385
C	4723703.	3557337.	1.327876	0.2000

R-squared	0.011853	Mean dependent var	3365271.
Adjusted R-squared	-0.040154	S.D. dependent var	9593005.
S.E. of regression	9783709.	Akaike info criterion	35.12073
Sum squared resid	1.82E+15	Schwarz criterion	35.22021
Log likelihood	-366.7676	Hannan-Quinn criter.	35.14232
F-statistic	0.227918	Durbin-Watson stat	2.306358
Prob(F-statistic)	0.638518		

Null Hypothesis: ED has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 0 (Automatic - based on SIC, maxlag=4)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-3.001239	0.1549
Test critical values:	1% level	-4.467895	
	5% level	-3.644963	
	10% level	-3.261452	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(ED)
Method: Least Squares
Date: 08/17/16 Time: 14:44
Sample (adjusted): 2 22
Included observations: 21 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
ED(-1)	-0.625795	0.208512	-3.001239	0.0077
C	-3983262.	4170652.	-0.955069	0.3522
@TREND("1")	2531306.	846202.5	2.991371	0.0078

R-squared	0.339972	Mean dependent var	3365271.
Adjusted R-squared	0.266635	S.D. dependent var	9593005.
S.E. of regression	8215134.	Akaike info criterion	34.81242
Sum squared resid	1.21E+15	Schwarz criterion	34.96164
Log likelihood	-362.5304	Hannan-Quinn criter.	34.84480
F-statistic	4.635782	Durbin-Watson stat	1.955022
Prob(F-statistic)	0.023772		

Appendix 1D: Augmented Dicky-Fuller Unit Root OUT

Null Hypothesis: OUT has a unit root
Exogenous: None
Lag Length: 0 (Automatic - based on SIC, maxlag=4)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		1.111657	0.9250
Test critical values:	1% level	-2.679735	
	5% level	-1.958088	
	10% level	-1.607830	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(OUT)
Method: Least Squares
Date: 08/17/16 Time: 14:49
Sample (adjusted): 2 22
Included observations: 21 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
OUT(-1)	0.016389	0.014742	1.111657	0.2795

R-squared	-0.049892	Mean dependent var	5.299857
Adjusted R-squared	-0.049892	S.D. dependent var	16.03082
S.E. of regression	16.42586	Akaike info criterion	8.482038
Sum squared resid	5396.175	Schwarz criterion	8.531778
Log likelihood	-88.06140	Hannan-Quinn criter.	8.492833
Durbin-Watson stat	1.715924		

Null Hypothesis: OUT has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=4)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-1.872478	0.3378
Test critical values:	1% level	-3.788030	
	5% level	-3.012363	
	10% level	-2.646119	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(OUT)
Method: Least Squares
Date: 08/17/16 Time: 14:50
Sample (adjusted): 2 22
Included observations: 21 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
OUT(-1)	-0.129379	0.069095	-1.872478	0.0766
C	36.14459	16.79952	2.151525	0.0445

R-squared	0.155787	Mean dependent var	5.299857
Adjusted R-squared	0.111355	S.D. dependent var	16.03082
S.E. of regression	15.11193	Akaike info criterion	8.359238
Sum squared resid	4339.035	Schwarz criterion	8.458716
Log likelihood	-85.77200	Hannan-Quinn criter.	8.380828
F-statistic	3.506174	Durbin-Watson stat	1.834663
Prob(F-statistic)	0.076613		

Null Hypothesis: OUT has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 0 (Automatic - based on SIC, maxlag=4)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-0.903914	0.9366
Test critical values:	1% level	-4.467895	
	5% level	-3.644963	
	10% level	-3.261452	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(OUT)
Method: Least Squares
Date: 08/17/16 Time: 14:50
Sample (adjusted): 2 22
Included observations: 21 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
OUT(-1)	-0.141143	0.156147	-0.903914	0.3780
C	37.80414	26.12951	1.446799	0.1651
@TREND("1")	0.104097	1.230722	0.084582	0.9335

R-squared	0.156123	Mean dependent var	5.299857
Adjusted R-squared	0.062358	S.D. dependent var	16.03082
S.E. of regression	15.52294	Akaike info criterion	8.454079
Sum squared resid	4337.312	Schwarz criterion	8.603296
Log likelihood	-85.76783	Hannan-Quinn criter.	8.486463
F-statistic	1.665056	Durbin-Watson stat	1.813640
Prob(F-statistic)	0.217027		

Appendix 2A: Augmented Dicky- Fuller Unit Root Test DEMP

Null Hypothesis: D(EMP) has a unit root
Exogenous: None
Lag Length: 4 (Automatic - based on SIC, maxlag=4)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-1.333058	0.1615
Test critical values:	1% level	-2.717511	
	5% level	-1.964418	
	10% level	-1.605603	

*MacKinnon (1996) one-sided p-values.
Warning: Probabilities and critical values calculated for 20 observations
and may not be accurate for a sample size of 16

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(EMP,2)
Method: Least Squares
Date: 08/17/16 Time: 14:32
Sample (adjusted): 7 22
Included observations: 16 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(EMP(-1))	-0.335917	0.251990	-1.333058	0.2095
D(EMP(-1),2)	-0.028337	0.312846	-0.090578	0.9295
D(EMP(-2),2)	-0.143266	0.296317	-0.483488	0.6382
D(EMP(-3),2)	0.054644	0.295951	0.184638	0.8569
D(EMP(-4),2)	0.672558	0.279590	2.405516	0.0349

R-squared	0.630221	Mean dependent var	-253.9375
Adjusted R-squared	0.495755	S.D. dependent var	11773.68
S.E. of regression	8360.512	Akaike info criterion	21.15073
Sum squared resid	7.69E+08	Schwarz criterion	21.39217
Log likelihood	-164.2059	Hannan-Quinn criter.	21.16310
Durbin-Watson stat	1.630569		

Null Hypothesis: D(EMP) has a unit root
Exogenous: Constant
Lag Length: 4 (Automatic - based on SIC, maxlag=4)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-2.585634	0.1160
Test critical values:	1% level	-3.920350	
	5% level	-3.065585	
	10% level	-2.673459	

*MacKinnon (1996) one-sided p-values.
Warning: Probabilities and critical values calculated for 20 observations
and may not be accurate for a sample size of 16

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(EMP,2)
Method: Least Squares
Date: 08/17/16 Time: 14:32

Sample (adjusted): 7 22
Included observations: 16 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(EMP(-1))	-0.805720	0.311614	-2.585634	0.0272
D(EMP(-1),2)	0.319382	0.317847	1.004829	0.3387
D(EMP(-2),2)	0.092325	0.280863	0.328719	0.7491
D(EMP(-3),2)	0.211139	0.268030	0.787741	0.4491
D(EMP(-4),2)	0.787594	0.249407	3.157868	0.0102
C	5533.670	2606.234	2.123244	0.0597

R-squared	0.745123	Mean dependent var	-253.9375
Adjusted R-squared	0.617685	S.D. dependent var	11773.68
S.E. of regression	7279.859	Akaike info criterion	20.90361
Sum squared resid	5.30E+08	Schwarz criterion	21.19333
Log likelihood	-161.2289	Hannan-Quinn criter.	20.91844
F-statistic	5.846930	Durbin-Watson stat	1.890845
Prob(F-statistic)	0.008826		

Null Hypothesis: D(EMP) has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 4 (Automatic - based on SIC, maxlag=4)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-3.190677	0.1210
Test critical values:	1% level	-4.667883	
	5% level	-3.733200	
	10% level	-3.310349	

*MacKinnon (1996) one-sided p-values.
Warning: Probabilities and critical values calculated for 20 observations
and may not be accurate for a sample size of 16

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(EMP,2)
Method: Least Squares
Date: 08/17/16 Time: 14:33
Sample (adjusted): 7 22
Included observations: 16 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(EMP(-1))	-1.352462	0.423879	-3.190677	0.0110
D(EMP(-1),2)	1.034330	0.503145	2.055730	0.0700
D(EMP(-2),2)	0.745207	0.454585	1.639312	0.1356
D(EMP(-3),2)	0.860304	0.446304	1.927617	0.0860
D(EMP(-4),2)	1.393610	0.416236	3.348125	0.0085
C	-8639.746	8492.122	-1.017384	0.3355
@TREND("1")	1284.091	738.6217	1.738496	0.1161

R-squared	0.809198	Mean dependent var	-253.9375
Adjusted R-squared	0.681997	S.D. dependent var	11773.68
S.E. of regression	6639.386	Akaike info criterion	20.73906
Sum squared resid	3.97E+08	Schwarz criterion	21.07707
Log likelihood	-158.9125	Hannan-Quinn criter.	20.75637
F-statistic	6.361558	Durbin-Watson stat	2.426978
Prob(F-statistic)	0.007378		

Appendix 2B: Augmented Dicky-fuller Unit Root Test DDD

Null Hypothesis: D(DD) has a unit root
Exogenous: None
Lag Length: 0 (Automatic - based on SIC, maxlag=4)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-5.061818	0.0000
Test critical values:	1% level	-2.685718	
	5% level	-1.959071	
	10% level	-1.607456	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(DD,2)
Method: Least Squares
Date: 08/17/16 Time: 14:39
Sample (adjusted): 3 22
Included observations: 20 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(DD(-1))	-1.149491	0.227091	-5.061818	0.0001

R-squared	0.574181	Mean dependent var	30043.38
Adjusted R-squared	0.574181	S.D. dependent var	4477957.
S.E. of regression	2922083.	Akaike info criterion	32.66220
Sum squared resid	1.62E+14	Schwarz criterion	32.71198
Log likelihood	-325.6220	Hannan-Quinn criter.	32.67192
Durbin-Watson stat	2.045926		

Null Hypothesis: D(DD) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=4)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-5.067613	0.0007
Test critical values:	1% level	-3.808546	
	5% level	-3.020686	
	10% level	-2.650413	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(DD,2)
Method: Least Squares
Date: 08/17/16 Time: 14:39
Sample (adjusted): 3 22
Included observations: 20 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(DD(-1))	-1.175360	0.231936	-5.067613	0.0001

C	516949.9	667337.7	0.774645	0.4486

R-squared	0.587919	Mean dependent var	30043.38
Adjusted R-squared	0.565025	S.D. dependent var	4477957.
S.E. of regression	2953330.	Akaike info criterion	32.72940
Sum squared resid	1.57E+14	Schwarz criterion	32.82898
Log likelihood	-325.2940	Hannan-Quinn criter.	32.74884
F-statistic	25.68070	Durbin-Watson stat	2.070783
Prob(F-statistic)	0.000080		

Null Hypothesis: D(DD) has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 4 (Automatic - based on SIC, maxlag=4)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		1.799447	1.0000
Test critical values:	1% level	-4.667883	
	5% level	-3.733200	
	10% level	-3.310349	

*MacKinnon (1996) one-sided p-values.
Warning: Probabilities and critical values calculated for 20 observations
and may not be accurate for a sample size of 16

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(DD,2)
Method: Least Squares
Date: 08/17/16 Time: 14:39
Sample (adjusted): 7 22
Included observations: 16 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(DD(-1))	5.970015	3.317694	1.799447	0.1055
D(DD(-1),2)	-7.269828	3.249436	-2.237258	0.0521
D(DD(-2),2)	-5.014008	2.241336	-2.237062	0.0521
D(DD(-3),2)	-5.204509	2.109468	-2.467214	0.0357
D(DD(-4),2)	-5.268651	2.028452	-2.597376	0.0289
C	7754085.	2902493.	2.671526	0.0256
@TREND("1")	-952995.4	353210.1	-2.698097	0.0245

R-squared	0.823450	Mean dependent var	34572.27
Adjusted R-squared	0.705750	S.D. dependent var	5039744.
S.E. of regression	2733800.	Akaike info criterion	32.77992
Sum squared resid	6.73E+13	Schwarz criterion	33.11793
Log likelihood	-255.2394	Hannan-Quinn criter.	32.79723
F-statistic	6.996179	Durbin-Watson stat	1.578587
Prob(F-statistic)	0.005346		

Appendix 2C: Augmented Dicky-Fuller Unit Root Test DED

Null Hypothesis: D(ED) has a unit root
Exogenous: None
Lag Length: 0 (Automatic - based on SIC, maxlag=4)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-4.620155	0.0001
Test critical values:	1% level	-2.685718	
	5% level	-1.959071	
	10% level	-1.607456	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(ED,2)
Method: Least Squares
Date: 08/17/16 Time: 14:45
Sample (adjusted): 3 22
Included observations: 20 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(ED(-1))	-1.111092	0.240488	-4.620155	0.0002

R-squared	0.528024	Mean dependent var	695931.4
Adjusted R-squared	0.528024	S.D. dependent var	15138020
S.E. of regression	10399898	Akaike info criterion	35.20120
Sum squared resid	2.05E+15	Schwarz criterion	35.25098
Log likelihood	-351.0120	Hannan-Quinn criter.	35.21092
Durbin-Watson stat	1.916475		

Null Hypothesis: D(ED) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=4)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-5.209819	0.0005
Test critical values:	1% level	-3.808546	
	5% level	-3.020686	
	10% level	-2.650413	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(ED,2)
Method: Least Squares
Date: 08/17/16 Time: 14:45
Sample (adjusted): 3 22
Included observations: 20 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(ED(-1))	-1.236598	0.237359	-5.209819	0.0001
C	4173312.	2295231.	1.818254	0.0857

R-squared	0.601260	Mean dependent var	695931.4

Adjusted R-squared	0.579108	S.D. dependent var	15138020
S.E. of regression	9820972.	Akaike info criterion	35.13258
Sum squared resid	1.74E+15	Schwarz criterion	35.23215
Log likelihood	-349.3258	Hannan-Quinn criter.	35.15202
F-statistic	27.14221	Durbin-Watson stat	2.054085
Prob(F-statistic)	0.000059		

Null Hypothesis: D(ED) has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 4 (Automatic - based on SIC, maxlag=4)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-5.733900	0.0016
Test critical values:	1% level	-4.667883	
	5% level	-3.733200	
	10% level	-3.310349	

*MacKinnon (1996) one-sided p-values.
Warning: Probabilities and critical values calculated for 20 observations
and may not be accurate for a sample size of 16

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(ED,2)
Method: Least Squares
Date: 08/17/16 Time: 14:46
Sample (adjusted): 7 22
Included observations: 16 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(ED(-1))	-8.911605	1.554196	-5.733900	0.0003
D(ED(-1),2)	7.184108	1.453525	4.942542	0.0008
D(ED(-2),2)	5.106963	1.052655	4.851508	0.0009
D(ED(-3),2)	4.328364	0.898458	4.817546	0.0010
D(ED(-4),2)	3.757313	0.832209	4.514866	0.0015
C	-7442089.	6655573.	-1.118174	0.2924
@TREND("1")	3300370.	832234.1	3.965675	0.0033

R-squared	0.900730	Mean dependent var	840866.9
Adjusted R-squared	0.834550	S.D. dependent var	17033989
S.E. of regression	6928661.	Akaike info criterion	34.63987
Sum squared resid	4.32E+14	Schwarz criterion	34.97787
Log likelihood	-270.1189	Hannan-Quinn criter.	34.65718
F-statistic	13.61034	Durbin-Watson stat	2.287365
Prob(F-statistic)	0.000462		

Appendix 2D: Augmented Dicky-Fuller Unit Root Test DOUT

Null Hypothesis: D(OUT) has a unit root
Exogenous: None
Lag Length: 0 (Automatic - based on SIC, maxlag=4)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-3.898447	0.0005
Test critical values:	1% level	-2.685718	
	5% level	-1.959071	
	10% level	-1.607456	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(OUT,2)
Method: Least Squares
Date: 08/17/16 Time: 14:51
Sample (adjusted): 3 22
Included observations: 20 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(OUT(-1))	-0.847411	0.217371	-3.898447	0.0010

R-squared	0.443859	Mean dependent var	-0.671300
Adjusted R-squared	0.443859	S.D. dependent var	21.87579
S.E. of regression	16.31383	Akaike info criterion	8.470611
Sum squared resid	5056.682	Schwarz criterion	8.520397
Log likelihood	-83.70611	Hannan-Quinn criter.	8.480329
Durbin-Watson stat	2.022538		

Null Hypothesis: D(OUT) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=4)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-4.041274	0.0061
Test critical values:	1% level	-3.808546	
	5% level	-3.020686	
	10% level	-2.650413	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(OUT,2)
Method: Least Squares
Date: 08/17/16 Time: 14:51
Sample (adjusted): 3 22
Included observations: 20 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(OUT(-1))	-0.919305	0.227479	-4.041274	0.0008
C	3.991737	3.817508	1.045640	0.3096

R-squared	0.475706	Mean dependent var	-0.671300

Adjusted R-squared	0.446579	S.D. dependent var	21.87579
S.E. of regression	16.27390	Akaike info criterion	8.511642
Sum squared resid	4767.116	Schwarz criterion	8.611215
Log likelihood	-83.11642	Hannan-Quinn criter.	8.531079
F-statistic	16.33190	Durbin-Watson stat	2.001637
Prob(F-statistic)	0.000766		

Null Hypothesis: D(OUT) has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 0 (Automatic - based on SIC, maxlag=4)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-4.192096	0.0182
Test critical values:	1% level	-4.498307	
	5% level	-3.658446	
	10% level	-3.268973	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(OUT,2)
Method: Least Squares
Date: 08/17/16 Time: 14:52
Sample (adjusted): 3 22
Included observations: 20 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(OUT(-1))	-1.030091	0.245722	-4.192096	0.0006
C	13.47833	9.152934	1.472569	0.1591
@TREND("1")	-0.776056	0.681685	-1.138438	0.2707

R-squared	0.512846	Mean dependent var	-0.671300
Adjusted R-squared	0.455533	S.D. dependent var	21.87579
S.E. of regression	16.14170	Akaike info criterion	8.538170
Sum squared resid	4429.426	Schwarz criterion	8.687530
Log likelihood	-82.38170	Hannan-Quinn criter.	8.567327
F-statistic	8.948273	Durbin-Watson stat	1.951130
Prob(F-statistic)	0.002214		

Appendix 3A: Philips Perron Unit Root Test – EMP

Null Hypothesis: EMP has a unit root
Exogenous: None
Bandwidth: 1 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		1.558923	0.9661
Test critical values:	1% level	-2.679735	
	5% level	-1.958088	
	10% level	-1.607830	

*MacKinnon (1996) one-sided p-values.

Residual variance (no correction)	89861365
HAC corrected variance (Bartlett kernel)	1.23E+08

Phillips-Perron Test Equation
Dependent Variable: D(EMP)
Method: Least Squares
Date: 08/17/16 Time: 14:35
Sample (adjusted): 2 22
Included observations: 21 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
EMP(-1)	0.028309	0.015087	1.876406	0.0753

R-squared	-0.014732	Mean dependent var	4138.143
Adjusted R-squared	-0.014732	S.D. dependent var	9642.853
S.E. of regression	9713.621	Akaike info criterion	21.24689
Sum squared resid	1.89E+09	Schwarz criterion	21.29663
Log likelihood	-222.0924	Hannan-Quinn criter.	21.25769
Durbin-Watson stat	1.185109		

Null Hypothesis: EMP has a unit root
Exogenous: Constant
Bandwidth: 1 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-0.126583	0.9341
Test critical values:	1% level	-3.788030	
	5% level	-3.012363	
	10% level	-2.646119	

*MacKinnon (1996) one-sided p-values.

Residual variance (no correction)	88547812
HAC corrected variance (Bartlett kernel)	1.22E+08

Phillips-Perron Test Equation
Dependent Variable: D(EMP)
Method: Least Squares
Date: 08/17/16 Time: 14:36
Sample (adjusted): 2 22
Included observations: 21 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
EMP(-1)	0.002256	0.051423	0.043872	0.9655
C	3835.656	7224.834	0.530899	0.6016

R-squared	0.000101	Mean dependent var	4138.143
Adjusted R-squared	-0.052525	S.D. dependent var	9642.853
S.E. of regression	9892.858	Akaike info criterion	21.32741
Sum squared resid	1.86E+09	Schwarz criterion	21.42688
Log likelihood	-221.9378	Hannan-Quinn criter.	21.34900
F-statistic	0.001925	Durbin-Watson stat	1.171851
Prob(F-statistic)	0.965464		

Null Hypothesis: EMP has a unit root
Exogenous: Constant, Linear Trend
Bandwidth: 1 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-2.044968	0.5446
Test critical values:	1% level	-4.467895	
	5% level	-3.644963	
	10% level	-3.261452	

*MacKinnon (1996) one-sided p-values.

Residual variance (no correction)	69349041
HAC corrected variance (Bartlett kernel)	90583177

Phillips-Perron Test Equation
Dependent Variable: D(EMP)
Method: Least Squares
Date: 08/17/16 Time: 14:36
Sample (adjusted): 2 22
Included observations: 21 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
EMP(-1)	-0.223341	0.111352	-2.005727	0.0602
C	15127.06	8290.787	1.824563	0.0847
@TREND("1")	1723.346	772.0041	2.232301	0.0385

R-squared	0.216897	Mean dependent var	4138.143
Adjusted R-squared	0.129886	S.D. dependent var	9642.853
S.E. of regression	8994.844	Akaike info criterion	21.17825
Sum squared resid	1.46E+09	Schwarz criterion	21.32747
Log likelihood	-219.3717	Hannan-Quinn criter.	21.21064
F-statistic	2.492748	Durbin-Watson stat	1.243293
Prob(F-statistic)	0.110756		

Appendix 3B: Philips Perron Unit Root Test – DD

Null Hypothesis: DD has a unit root
Exogenous: None
Bandwidth: 2 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-0.362865	0.5416
Test critical values:	1% level	-2.679735	
	5% level	-1.958088	
	10% level	-1.607830	

*MacKinnon (1996) one-sided p-values.

Residual variance (no correction)	7.79E+12
HAC corrected variance (Bartlett kernel)	6.23E+12

Phillips-Perron Test Equation
Dependent Variable: D(DD)
Method: Least Squares
Date: 08/17/16 Time: 14:40
Sample (adjusted): 2 22
Included observations: 21 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
DD(-1)	-0.052555	0.099443	-0.528490	0.6030

R-squared	-0.009094	Mean dependent var	423147.7
Adjusted R-squared	-0.009094	S.D. dependent var	2847567.
S.E. of regression	2860486.	Akaike info criterion	32.61733
Sum squared resid	1.64E+14	Schwarz criterion	32.66707
Log likelihood	-341.4820	Hannan-Quinn criter.	32.62812
Durbin-Watson stat	2.208774		

Null Hypothesis: DD has a unit root
Exogenous: Constant
Bandwidth: 2 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-1.366261	0.5786
Test critical values:	1% level	-3.788030	
	5% level	-3.012363	
	10% level	-2.646119	

*MacKinnon (1996) one-sided p-values.

Residual variance (no correction)	6.94E+12
HAC corrected variance (Bartlett kernel)	5.85E+12

Phillips-Perron Test Equation
Dependent Variable: D(DD)

Method: Least Squares
Date: 08/17/16 Time: 14:41
Sample (adjusted): 2 22
Included observations: 21 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
DD(-1)	-0.199317	0.135818	-1.467525	0.1586
C	1305800.	852536.1	1.531665	0.1421

R-squared	0.101809	Mean dependent var	423147.7
Adjusted R-squared	0.054536	S.D. dependent var	2847567.
S.E. of regression	2768832.	Akaike info criterion	32.59614
Sum squared resid	1.46E+14	Schwarz criterion	32.69562
Log likelihood	-340.2595	Hannan-Quinn criter.	32.61773
F-statistic	2.153629	Durbin-Watson stat	2.139995
Prob(F-statistic)	0.158593		

Null Hypothesis: DD has a unit root
Exogenous: Constant, Linear Trend
Bandwidth: 1 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-2.958186	0.1660
Test critical values:	1% level	-4.467895	
	5% level	-3.644963	
	10% level	-3.261452	

*MacKinnon (1996) one-sided p-values.

Residual variance (no correction)	5.25E+12
HAC corrected variance (Bartlett kernel)	5.63E+12

Phillips-Perron Test Equation
Dependent Variable: D(DD)
Method: Least Squares
Date: 08/17/16 Time: 14:41
Sample (adjusted): 2 22
Included observations: 21 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
DD(-1)	-0.645247	0.221951	-2.907166	0.0094
C	-1024940.	1234494.	-0.830251	0.4173
@TREND("1")	391408.4	163060.5	2.400387	0.0274

R-squared	0.319605	Mean dependent var	423147.7
Adjusted R-squared	0.244006	S.D. dependent var	2847567.
S.E. of regression	2475900.	Akaike info criterion	32.41367
Sum squared resid	1.10E+14	Schwarz criterion	32.56289
Log likelihood	-337.3435	Hannan-Quinn criter.	32.44605
F-statistic	4.227619	Durbin-Watson stat	1.837388
Prob(F-statistic)	0.031250		

Null Hypothesis: D(DD) has a unit root
Exogenous: None
Bandwidth: 4 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-5.494753	0.0000
Test critical values:	1% level	-2.685718	
	5% level	-1.959071	
	10% level	-1.607456	

*MacKinnon (1996) one-sided p-values.

Residual variance (no correction)	8.11E+12
HAC corrected variance (Bartlett kernel)	4.41E+12

Phillips-Perron Test Equation
Dependent Variable: D(DD,2)
Method: Least Squares
Date: 08/17/16 Time: 14:41
Sample (adjusted): 3 22
Included observations: 20 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(DD(-1))	-1.149491	0.227091	-5.061818	0.0001

R-squared	0.574181	Mean dependent var	30043.38
Adjusted R-squared	0.574181	S.D. dependent var	4477957.
S.E. of regression	2922083.	Akaike info criterion	32.66220
Sum squared resid	1.62E+14	Schwarz criterion	32.71198
Log likelihood	-325.6220	Hannan-Quinn criter.	32.67192
Durbin-Watson stat	2.045926		

Appendix 3C: Philips Perron Unit Root Test – ED

Null Hypothesis: ED has a unit root
Exogenous: None
Bandwidth: 4 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		1.629087	0.9703
Test critical values:	1% level	-2.679735	
	5% level	-1.958088	
	10% level	-1.607830	

*MacKinnon (1996) one-sided p-values.

Residual variance (no correction)	9.46E+13
HAC corrected variance (Bartlett kernel)	5.17E+13

Phillips-Perron Test Equation
Dependent Variable: D(ED)
Method: Least Squares
Date: 08/17/16 Time: 14:46
Sample (adjusted): 2 22
Included observations: 21 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
ED(-1)	0.050801	0.053127	0.956214	0.3504

R-squared	-0.079849	Mean dependent var	3365271.
Adjusted R-squared	-0.079849	S.D. dependent var	9593005.
S.E. of regression	9968648.	Akaike info criterion	35.11424
Sum squared resid	1.99E+15	Schwarz criterion	35.16398
Log likelihood	-367.6995	Hannan-Quinn criter.	35.12503
Durbin-Watson stat	2.304258		

Null Hypothesis: ED has a unit root
Exogenous: Constant
Bandwidth: 5 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		0.038840	0.9523
Test critical values:	1% level	-3.788030	
	5% level	-3.012363	
	10% level	-2.646119	

*MacKinnon (1996) one-sided p-values.

Residual variance (no correction)	8.66E+13
HAC corrected variance (Bartlett kernel)	3.64E+13

Phillips-Perron Test Equation
Dependent Variable: D(ED)

Method: Least Squares
Date: 08/17/16 Time: 14:47
Sample (adjusted): 2 22
Included observations: 21 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
ED(-1)	-0.041477	0.086879	-0.477407	0.6385
C	4723703.	3557337.	1.327876	0.2000

R-squared	0.011853	Mean dependent var	3365271.
Adjusted R-squared	-0.040154	S.D. dependent var	9593005.
S.E. of regression	9783709.	Akaike info criterion	35.12073
Sum squared resid	1.82E+15	Schwarz criterion	35.22021
Log likelihood	-366.7676	Hannan-Quinn criter.	35.14232
F-statistic	0.227918	Durbin-Watson stat	2.306358
Prob(F-statistic)	0.638518		

Null Hypothesis: ED has a unit root
Exogenous: Constant, Linear Trend
Bandwidth: 2 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-2.967924	0.1634
Test critical values:	1% level	-4.467895	
	5% level	-3.644963	
	10% level	-3.261452	

*MacKinnon (1996) one-sided p-values.

Residual variance (no correction)	5.78E+13
HAC corrected variance (Bartlett kernel)	5.41E+13

Phillips-Perron Test Equation
Dependent Variable: D(ED)
Method: Least Squares
Date: 08/17/16 Time: 14:47
Sample (adjusted): 2 22
Included observations: 21 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
ED(-1)	-0.625795	0.208512	-3.001239	0.0077
C	-3983262.	4170652.	-0.955069	0.3522
@TREND("1")	2531306.	846202.5	2.991371	0.0078

R-squared	0.339972	Mean dependent var	3365271.
Adjusted R-squared	0.266635	S.D. dependent var	9593005.
S.E. of regression	8215134.	Akaike info criterion	34.81242
Sum squared resid	1.21E+15	Schwarz criterion	34.96164
Log likelihood	-362.5304	Hannan-Quinn criter.	34.84480
F-statistic	4.635782	Durbin-Watson stat	1.955022
Prob(F-statistic)	0.023772		

Appendix 3D: Philips Perron Unit Root Test – OUT

Null Hypothesis: OUT has a unit root
Exogenous: None
Bandwidth: 1 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		1.046094	0.9165
Test critical values:	1% level	-2.679735	
	5% level	-1.958088	
	10% level	-1.607830	

*MacKinnon (1996) one-sided p-values.

Residual variance (no correction)	256.9607
HAC corrected variance (Bartlett kernel)	282.4187

Phillips-Perron Test Equation
Dependent Variable: D(OUT)
Method: Least Squares
Date: 08/17/16 Time: 14:52
Sample (adjusted): 2 22
Included observations: 21 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
OUT(-1)	0.016389	0.014742	1.111657	0.2795

R-squared	-0.049892	Mean dependent var	5.299857
Adjusted R-squared	-0.049892	S.D. dependent var	16.03082
S.E. of regression	16.42586	Akaike info criterion	8.482038
Sum squared resid	5396.175	Schwarz criterion	8.531778
Log likelihood	-88.06140	Hannan-Quinn criter.	8.492833
Durbin-Watson stat	1.715924		

Null Hypothesis: OUT has a unit root
Exogenous: Constant
Bandwidth: 1 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-1.856467	0.3449
Test critical values:	1% level	-3.788030	
	5% level	-3.012363	
	10% level	-2.646119	

*MacKinnon (1996) one-sided p-values.

Residual variance (no correction)	206.6207
HAC corrected variance (Bartlett kernel)	221.5234

Phillips-Perron Test Equation
Dependent Variable: D(OUT)

Method: Least Squares
Date: 08/17/16 Time: 14:53
Sample (adjusted): 2 22
Included observations: 21 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
OUT(-1)	-0.129379	0.069095	-1.872478	0.0766
C	36.14459	16.79952	2.151525	0.0445

R-squared	0.155787	Mean dependent var	5.299857
Adjusted R-squared	0.111355	S.D. dependent var	16.03082
S.E. of regression	15.11193	Akaike info criterion	8.359238
Sum squared resid	4339.035	Schwarz criterion	8.458716
Log likelihood	-85.77200	Hannan-Quinn criter.	8.380828
F-statistic	3.506174	Durbin-Watson stat	1.834663
Prob(F-statistic)	0.076613		

Null Hypothesis: OUT has a unit root
Exogenous: Constant, Linear Trend
Bandwidth: 1 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-0.990445	0.9239
Test critical values:	1% level	-4.467895	
	5% level	-3.644963	
	10% level	-3.261452	

*MacKinnon (1996) one-sided p-values.

Residual variance (no correction)	206.5386
HAC corrected variance (Bartlett kernel)	223.8454

Phillips-Perron Test Equation
Dependent Variable: D(OUT)
Method: Least Squares
Date: 08/17/16 Time: 14:53
Sample (adjusted): 2 22
Included observations: 21 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
OUT(-1)	-0.141143	0.156147	-0.903914	0.3780
C	37.80414	26.12951	1.446799	0.1651
@TREND("1")	0.104097	1.230722	0.084582	0.9335

R-squared	0.156123	Mean dependent var	5.299857
Adjusted R-squared	0.062358	S.D. dependent var	16.03082
S.E. of regression	15.52294	Akaike info criterion	8.454079
Sum squared resid	4337.312	Schwarz criterion	8.603296
Log likelihood	-85.76783	Hannan-Quinn criter.	8.486463
F-statistic	1.665056	Durbin-Watson stat	1.813640
Prob(F-statistic)	0.217027		

Appendix 4A: Philips Perron Unit Root Test – DEMP

Null Hypothesis: D(EMP) has a unit root
Exogenous: None
Bandwidth: 4 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-2.494828	0.0155
Test critical values:	1% level	-2.685718	
	5% level	-1.959071	
	10% level	-1.607456	

*MacKinnon (1996) one-sided p-values.

Residual variance (no correction)	82553224
HAC corrected variance (Bartlett kernel)	87290221

Phillips-Perron Test Equation
Dependent Variable: D(EMP,2)
Method: Least Squares
Date: 08/17/16 Time: 14:34
Sample (adjusted): 3 22
Included observations: 20 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(EMP(-1))	-0.490203	0.199783	-2.453672	0.0240

R-squared	0.240197	Mean dependent var	-247.0000
Adjusted R-squared	0.240197	S.D. dependent var	10694.35
S.E. of regression	9321.917	Akaike info criterion	21.16683
Sum squared resid	1.65E+09	Schwarz criterion	21.21662
Log likelihood	-210.6683	Hannan-Quinn criter.	21.17655
Durbin-Watson stat	1.869827		

Null Hypothesis: D(EMP) has a unit root
Exogenous: Constant
Bandwidth: 5 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-2.716745	0.0887
Test critical values:	1% level	-3.808546	
	5% level	-3.020686	
	10% level	-2.650413	

*MacKinnon (1996) one-sided p-values.

Residual variance (no correction)	77338753
HAC corrected variance (Bartlett kernel)	79094704

Phillips-Perron Test Equation
Dependent Variable: D(EMP,2)

Method: Least Squares
Date: 08/17/16   Time: 14:34
Sample (adjusted): 3 22
Included observations: 20 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(EMP(-1))	-0.599740	0.222162	-2.699561	0.0147
C	2553.546	2317.933	1.101648	0.2851

R-squared	0.288189	Mean dependent var	-247.0000
Adjusted R-squared	0.248644	S.D. dependent var	10694.35
S.E. of regression	9269.949	Akaike info criterion	21.20158
Sum squared resid	1.55E+09	Schwarz criterion	21.30116
Log likelihood	-210.0158	Hannan-Quinn criter.	21.22102
F-statistic	7.287629	Durbin-Watson stat	1.808189
Prob(F-statistic)	0.014665		

Null Hypothesis: D(EMP) has a unit root
Exogenous: Constant, Linear Trend
Bandwidth: 4 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-2.540271	0.3076
Test critical values:	1% level	-4.498307	
	5% level	-3.658446	
	10% level	-3.268973	

*MacKinnon (1996) one-sided p-values.

Residual variance (no correction)	77186515
HAC corrected variance (Bartlett kernel)	77333019

Phillips-Perron Test Equation
Dependent Variable: D(EMP,2)
Method: Least Squares
Date: 08/17/16   Time: 14:34
Sample (adjusted): 3 22
Included observations: 20 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(EMP(-1))	-0.614424	0.242047	-2.538445	0.0212
C	1797.384	4767.649	0.376996	0.7108
@TREND("1")	71.71560	391.6490	0.183112	0.8569

R-squared	0.289591	Mean dependent var	-247.0000
Adjusted R-squared	0.206013	S.D. dependent var	10694.35
S.E. of regression	9529.306	Akaike info criterion	21.29961
Sum squared resid	1.54E+09	Schwarz criterion	21.44897
Log likelihood	-209.9961	Hannan-Quinn criter.	21.32877
F-statistic	3.464933	Durbin-Watson stat	1.789355
Prob(F-statistic)	0.054679		

Appendix 4B: Philips Perron Unit Root Test – DDD

Null Hypothesis: D(DD) has a unit root
Exogenous: Constant
Bandwidth: 5 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-6.064673	0.0001
Test critical values:	1% level	-3.808546	
	5% level	-3.020686	
	10% level	-2.650413	

*MacKinnon (1996) one-sided p-values.

Residual variance (no correction)	7.85E+12
HAC corrected variance (Bartlett kernel)	2.88E+12

Phillips-Perron Test Equation
Dependent Variable: D(DD,2)
Method: Least Squares
Date: 08/17/16 Time: 14:42
Sample (adjusted): 3 22
Included observations: 20 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(DD(-1))	-1.175360	0.231936	-5.067613	0.0001
C	516949.9	667337.7	0.774645	0.4486

R-squared	0.587919	Mean dependent var	30043.38
Adjusted R-squared	0.565025	S.D. dependent var	4477957.
S.E. of regression	2953330.	Akaike info criterion	32.72940
Sum squared resid	1.57E+14	Schwarz criterion	32.82898
Log likelihood	-325.2940	Hannan-Quinn criter.	32.74884
F-statistic	25.68070	Durbin-Watson stat	2.070783
Prob(F-statistic)	0.000080		

Null Hypothesis: D(DD) has a unit root
Exogenous: Constant, Linear Trend
Bandwidth: 5 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-5.864420	0.0007
Test critical values:	1% level	-4.498307	
	5% level	-3.658446	
	10% level	-3.268973	

*MacKinnon (1996) one-sided p-values.

Residual variance (no correction)	7.84E+12
HAC corrected variance (Bartlett kernel)	2.83E+12

Phillips-Perron Test Equation
Dependent Variable: D(DD,2)
Method: Least Squares
Date: 08/17/16 Time: 14:42
Sample (adjusted): 3 22
Included observations: 20 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(DD(-1))	-1.175896	0.238594	-4.928448	0.0001
C	683769.9	1520403.	0.449729	0.6586
@TREND("1")	-14486.77	117812.8	-0.122964	0.9036

R-squared	0.588285	Mean dependent var	30043.38
Adjusted R-squared	0.539848	S.D. dependent var	4477957.
S.E. of regression	3037601.	Akaike info criterion	32.82852
Sum squared resid	1.57E+14	Schwarz criterion	32.97787
Log likelihood	-325.2852	Hannan-Quinn criter.	32.85767
F-statistic	12.14534	Durbin-Watson stat	2.071820
Prob(F-statistic)	0.000530		

Appendix 4C: Philips Perron Unit Root Test – DED

Null Hypothesis: D(ED) has a unit root
Exogenous: None
Bandwidth: 0 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-4.620155	0.0001
Test critical values:	1% level	-2.685718	
	5% level	-1.959071	
	10% level	-1.607456	

*MacKinnon (1996) one-sided p-values.

Residual variance (no correction)	1.03E+14
HAC corrected variance (Bartlett kernel)	1.03E+14

Phillips-Perron Test Equation
Dependent Variable: D(ED,2)
Method: Least Squares
Date: 08/17/16 Time: 14:48
Sample (adjusted): 3 22
Included observations: 20 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(ED(-1))	-1.111092	0.240488	-4.620155	0.0002

R-squared	0.528024	Mean dependent var	695931.4
Adjusted R-squared	0.528024	S.D. dependent var	15138020
S.E. of regression	10399898	Akaike info criterion	35.20120
Sum squared resid	2.05E+15	Schwarz criterion	35.25098
Log likelihood	-351.0120	Hannan-Quinn criter.	35.21092
Durbin-Watson stat	1.916475		

Null Hypothesis: D(ED) has a unit root
Exogenous: Constant
Bandwidth: 4 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-5.711318	0.0002
Test critical values:	1% level	-3.808546	
	5% level	-3.020686	
	10% level	-2.650413	

*MacKinnon (1996) one-sided p-values.

Residual variance (no correction)	8.68E+13
HAC corrected variance (Bartlett kernel)	4.57E+13

Phillips-Perron Test Equation
Dependent Variable: D(ED,2)
Method: Least Squares
Date: 08/17/16 Time: 14:48
Sample (adjusted): 3 22
Included observations: 20 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(ED(-1))	-1.236598	0.237359	-5.209819	0.0001
C	4173312.	2295231.	1.818254	0.0857

R-squared	0.601260	Mean dependent var	695931.4
Adjusted R-squared	0.579108	S.D. dependent var	15138020
S.E. of regression	9820972.	Akaike info criterion	35.13258
Sum squared resid	1.74E+15	Schwarz criterion	35.23215
Log likelihood	-349.3258	Hannan-Quinn criter.	35.15202
F-statistic	27.14221	Durbin-Watson stat	2.054085
Prob(F-statistic)	0.000059		

Null Hypothesis: D(ED) has a unit root
Exogenous: Constant, Linear Trend
Bandwidth: 4 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-5.565200	0.0012
Test critical values:	1% level	-4.498307	
	5% level	-3.658446	
	10% level	-3.268973	

*MacKinnon (1996) one-sided p-values.

Residual variance (no correction)	8.62E+13
HAC corrected variance (Bartlett kernel)	4.43E+13

Phillips-Perron Test Equation
Dependent Variable: D(ED,2)
Method: Least Squares
Date: 08/17/16 Time: 14:49
Sample (adjusted): 3 22
Included observations: 20 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(ED(-1))	-1.236673	0.243431	-5.080181	0.0001
C	2661777.	5070584.	0.524945	0.6064
@TREND("1")	131456.3	390583.1	0.336564	0.7406

R-squared	0.603899	Mean dependent var	695931.4
Adjusted R-squared	0.557299	S.D. dependent var	15138020
S.E. of regression	10072195	Akaike info criterion	35.22594
Sum squared resid	1.72E+15	Schwarz criterion	35.37530
Log likelihood	-349.2594	Hannan-Quinn criter.	35.25509
F-statistic	12.95920	Durbin-Watson stat	2.066211
Prob(F-statistic)	0.000381		

Appendix 4D: Philips Perron Unit Root Test – DOUT

Null Hypothesis: D(OUT) has a unit root
Exogenous: None
Bandwidth: 1 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-3.892942	0.0005
Test critical values:	1% level	-2.685718	
	5% level	-1.959071	
	10% level	-1.607456	

*MacKinnon (1996) one-sided p-values.

Residual variance (no correction)	252.8341
HAC corrected variance (Bartlett kernel)	243.8298

Phillips-Perron Test Equation
Dependent Variable: D(OUT,2)
Method: Least Squares
Date: 08/17/16 Time: 14:54
Sample (adjusted): 3 22
Included observations: 20 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(OUT(-1))	-0.847411	0.217371	-3.898447	0.0010

R-squared	0.443859	Mean dependent var	-0.671300
Adjusted R-squared	0.443859	S.D. dependent var	21.87579
S.E. of regression	16.31383	Akaike info criterion	8.470611
Sum squared resid	5056.682	Schwarz criterion	8.520397
Log likelihood	-83.70611	Hannan-Quinn criter.	8.480329
Durbin-Watson stat	2.022538		

Null Hypothesis: D(OUT) has a unit root
Exogenous: Constant
Bandwidth: 0 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-4.041274	0.0061
Test critical values:	1% level	-3.808546	
	5% level	-3.020686	
	10% level	-2.650413	

*MacKinnon (1996) one-sided p-values.

Residual variance (no correction)	238.3558
HAC corrected variance (Bartlett kernel)	238.3558

Phillips-Perron Test Equation
Dependent Variable: D(OUT,2)
Method: Least Squares
Date: 08/17/16 Time: 14:54
Sample (adjusted): 3 22
Included observations: 20 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(OUT(-1))	-0.919305	0.227479	-4.041274	0.0008
C	3.991737	3.817508	1.045640	0.3096

R-squared	0.475706	Mean dependent var	-0.671300
Adjusted R-squared	0.446579	S.D. dependent var	21.87579
S.E. of regression	16.27390	Akaike info criterion	8.511642
Sum squared resid	4767.116	Schwarz criterion	8.611215
Log likelihood	-83.11642	Hannan-Quinn criter.	8.531079
F-statistic	16.33190	Durbin-Watson stat	2.001637
Prob(F-statistic)	0.000766		

Null Hypothesis: D(OUT) has a unit root
Exogenous: Constant, Linear Trend
Bandwidth: 0 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-4.192096	0.0182
Test critical values:	1% level	-4.498307	
	5% level	-3.658446	
	10% level	-3.268973	

*MacKinnon (1996) one-sided p-values.

Residual variance (no correction)	221.4713
HAC corrected variance (Bartlett kernel)	221.4713

Phillips-Perron Test Equation
Dependent Variable: D(OUT,2)
Method: Least Squares
Date: 08/17/16 Time: 14:55
Sample (adjusted): 3 22
Included observations: 20 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(OUT(-1))	-1.030091	0.245722	-4.192096	0.0006
C	13.47833	9.152934	1.472569	0.1591
@TREND("1")	-0.776056	0.681685	-1.138438	0.2707

R-squared	0.512846	Mean dependent var	-0.671300
Adjusted R-squared	0.455533	S.D. dependent var	21.87579
S.E. of regression	16.14170	Akaike info criterion	8.538170
Sum squared resid	4429.426	Schwarz criterion	8.687530
Log likelihood	-82.38170	Hannan-Quinn criter.	8.567327
F-statistic	8.948273	Durbin-Watson stat	1.951130
Prob(F-statistic)	0.002214		

Appendix 5A: Lag Length Selection Criteria

VAR Lag Order Selection Criteria
Endogenous variables: EMP DD ED OUT
Exogenous variables: C
Date: 05/16/16 Time: 12:09
Sample: 1 22
Included observations: 20

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-989.9465	NA	1.73e+38	99.39465	99.59380	99.43353
1	-919.8384	105.1621*	8.05e+35*	93.98384	94.97957*	94.17822*
2	-903.4527	18.02431	9.79e+35	93.94527*	95.73759	94.29515

* 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 5B: Johansen Cointegration Test

Date: 05/16/16 Time: 13:27
Sample (adjusted): 3 22
Included observations: 20 after adjustments
Trend assumption: Linear deterministic trend (restricted)
Series: EMP DD ED OUT
Lags interval (in first differences): 1 to 1

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.849090	82.84456	63.87610	0.0006
At most 1 *	0.650685	45.02318	42.91525	0.0303
At most 2	0.587923	23.98757	25.87211	0.0843
At most 3	0.268628	6.256660	12.51798	0.4284

Trace test indicates 2 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.849090	37.82138	32.11832	0.0090
At most 1	0.650685	21.03561	25.82321	0.1891
At most 2	0.587923	17.73091	19.38704	0.0856
At most 3	0.268628	6.256660	12.51798	0.4284

Max-eigenvalue test indicates 1 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegrating Coefficients (normalized by b'*S11*b=I):

EMP	DD	ED	OUT	@TREND(2)
-7.02E-05	-1.54E-06	5.66E-07	0.086934	-1.496568
3.73E-05	-1.34E-06	1.63E-07	0.031468	-0.405057
6.84E-05	9.20E-07	-2.10E-07	-0.082125	0.327772
5.26E-05	-1.05E-07	-4.14E-09	-0.027134	0.089195

Unrestricted Adjustment Coefficients (alpha):

D(EMP)	-1235.691	-3118.640	-4052.154	-230.5595
D(DD)	-1649770.	178976.1	-1020625.	231748.9
D(ED)	-7517423.	-1218624.	-2319877.	361113.6
D(OUT)	-0.831274	5.148218	-3.252180	-6.199120

1 Cointegrating Equation(s): Log likelihood -913.8600

Normalized cointegrating coefficients (standard error in parentheses)

EMP	DD	ED	OUT	@TREND(2)
1.000000	0.022005	-0.008057	-1238.553	21321.76
	(0.00365)	(0.00087)	(234.791)	(2955.00)

Adjustment coefficients (standard error in parentheses)

D(EMP)	0.086733

	(0.12350)
D(DD)	115.7968
	(29.6884)
D(ED)	527.6456
	(87.9186)
D(OUT)	5.83E-05
	(0.00027)

2 Cointegrating Equation(s): Log likelihood -903.3422

Normalized cointegrating coefficients (standard error in parentheses)

EMP	DD	ED	OUT	@TREND(2)
1.000000	0.000000	-0.003342	-448.4132	9110.275
		(0.00040)	(175.131)	(2097.04)
0.000000	1.000000	-0.214259	-35907.80	554948.9
		(0.01719)	(7443.86)	(89133.4)

Adjustment coefficients (standard error in parentheses)

D(EMP)	-0.029520	0.006093
	(0.12316)	(0.00317)
D(DD)	122.4685	2.307915
	(33.3998)	(0.85985)
D(ED)	482.2192	13.24590
	(96.1244)	(2.47463)
D(OUT)	0.000250	-5.62E-06
	(0.00028)	(7.2E-06)

3 Cointegrating Equation(s): Log likelihood -894.4767

Normalized cointegrating coefficients (standard error in parentheses)

EMP	DD	ED	OUT	@TREND(2)
1.000000	0.000000	0.000000	-734.0283	-3368.097
			(289.674)	(2255.80)
0.000000	1.000000	0.000000	-54217.56	-244994.5
			(21392.8)	(166594.)
0.000000	0.000000	1.000000	-85455.98	-3733526.
			(90402.9)	(704001.)

Adjustment coefficients (standard error in parentheses)

D(EMP)	-0.306625	0.002367	-0.000357
	(0.11621)	(0.00249)	(0.00069)
D(DD)	52.67363	1.369309	-0.689656
	(33.5199)	(0.71716)	(0.19975)
D(ED)	323.5757	11.11245	-3.962977
	(108.882)	(2.32953)	(0.64886)
D(OUT)	2.79E-05	-8.62E-06	1.05E-06
	(0.00036)	(7.7E-06)	(2.1E-06)

Appendix 5C: Vector Error Correction Model (VECM) Estimates

Vector Error Correction Estimates
Date: 05/09/16 Time: 18:42
Sample (adjusted): 4 22
Included observations: 19 after adjustments
Standard errors in ( ) & t-statistics in [ ]

Cointegrating Eq:	CointEq1
EMP(-1)	1.000000
DD(-1)	-0.012411
	(0.00102)
	[-12.1901]
ED(-1)	0.000836
	(0.00017)
	[5.04224]
OUT(-1)	-321.6603
	(81.1042)
	[-3.96601]
C	-27173.85

Error Correction:	D(EMP)	D(DD)	D(ED)	D(OUT)
CointEq1	-0.283202	34.67149	-70.68388	-0.000716
	(0.15554)	(44.6255)	(159.780)	(0.00031)
	[-1.82071]	[0.77694]	[-0.44238]	[-2.31192]
D(EMP(-1))	0.205347	-234.6064	-870.0388	-0.000196
	(0.28049)	(80.4733)	(288.132)	(0.00056)
	[0.73209]	[-2.91533]	[-3.01958]	[-0.35066]
D(EMP(-2))	0.066072	229.9049	960.1604	0.000329
	(0.26134)	(74.9775)	(268.454)	(0.00052)
	[0.25282]	[3.06632]	[3.57662]	[0.63266]
D(DD(-1))	-2.01E-05	0.056222	0.954342	-4.64E-06
	(0.00180)	(0.51556)	(1.84594)	(3.6E-06)
	[-0.01120]	[0.10905]	[0.51699]	[-1.29730]
D(DD(-2))	0.003876	2.547283	10.76260	-3.54E-06
	(0.00251)	(0.71876)	(2.57351)	(5.0E-06)
	[1.54706]	[3.54398]	[4.18207]	[-0.71020]
D(ED(-1))	-0.000371	0.171048	0.182823	-1.27E-06
	(0.00054)	(0.15479)	(0.55423)	(1.1E-06)
	[-0.68836]	[1.10501]	[0.32987]	[-1.18100]
D(ED(-2))	-0.001579	-0.855394	-3.810624	-9.61E-07
	(0.00086)	(0.24638)	(0.88217)	(1.7E-06)
	[-1.83834]	[-3.47178]	[-4.31959]	[-0.56229]
D(OUT(-1))	287.0651	99965.36	106569.3	-0.316246
	(122.867)	(35250.2)	(126212.)	(0.24463)
	[2.33639]	[2.83588]	[0.84437]	[-1.29274]
D(OUT(-2))	-290.2116	-106333.0	-548382.5	0.596904
	(219.160)	(62876.7)	(225128.)	(0.43636)

	[-1.32420]	[-1.69114]	[-2.43587]	[1.36792]
C	9110.843	2032477.	13707487	11.86111
	(3578.93)	(1026788)	(3676380)	(7.12581)
	[2.54569]	[1.97945]	[3.72853]	[1.66453]
R-squared	0.769089	0.796877	0.768940	0.669496
Adj. R-squared	0.538178	0.593754	0.537880	0.338992
Sum sq. resids	3.99E+08	3.29E+13	4.21E+14	1582.642
S.E. equation	6660.234	1910807.	6841580.	13.26081
F-statistic	3.330672	3.923121	3.327884	2.025683
Log likelihood	-187.1356	-294.6590	-318.8934	-68.97275
Akaike AIC	20.75111	32.06937	34.62035	8.312921
Schwarz SC	21.24819	32.56644	35.11743	8.809994
Mean dependent	4927.263	467689.6	3659943.	4.224316
S.D. dependent	9800.588	2997934.	10064199	16.31048

Determinant resid covariance (dof adj.)	2.34E+34
Determinant resid covariance	1.18E+33
Log likelihood	-831.2412
Akaike information criterion	92.13065
Schwarz criterion	94.31778

Appendix 6A: VAR Granger Causality/Block Exogeneity Wald Tests

VAR Granger Causality/Block Exogeneity Wald Tests
Date: 08/18/16 Time: 09:32
Sample: 1 22
Included observations: 21

Dependent variable: EMP

Excluded	Chi-sq	df	Prob.
DD	0.009166	1	0.9237
ED	0.014779	1	0.9032
OUT	24.78604	1	0.0000
All	29.52842	3	0.0000

Dependent variable: DD

Excluded	Chi-sq	df	Prob.
EMP	0.335930	1	0.5622
ED	0.078837	1	0.7789
OUT	14.00764	1	0.0002
All	18.16765	3	0.0004

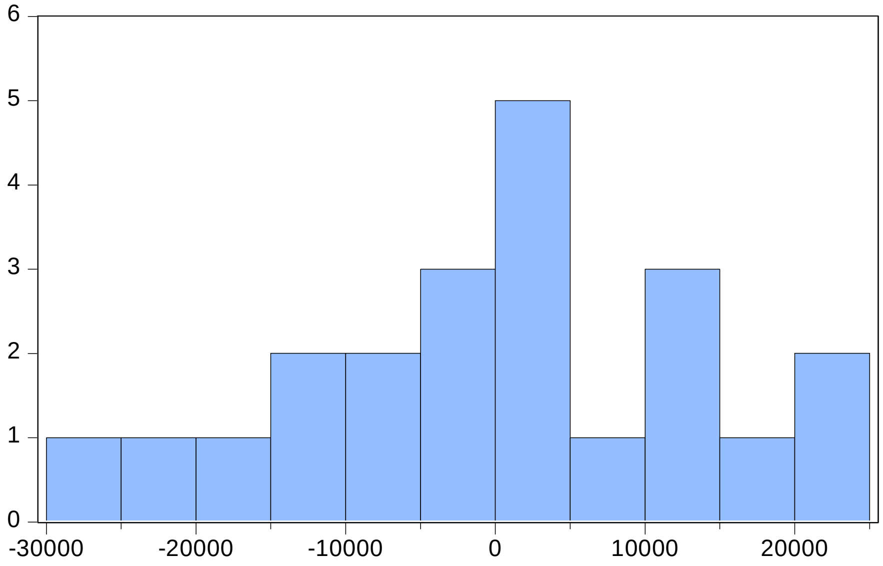
Dependent variable: ED

Excluded	Chi-sq	df	Prob.
EMP	0.973615	1	0.3238
DD	0.927035	1	0.3356
OUT	6.535802	1	0.0106
All	9.660260	3	0.0217

Dependent variable: OUT

Excluded	Chi-sq	df	Prob.
EMP	0.083853	1	0.7721
DD	1.786551	1	0.1813
ED	0.010968	1	0.9166
All	3.770314	3	0.2874

Appendix 7A: Jarque- Bera Normality Test Results



Series: Residuals
Sample 1 22
Observations 22

Mean	-1.46e-11
Median	562.5804
Maximum	22912.71
Minimum	-28126.83
Std. Dev.	13639.56
Skewness	-0.202495
Kurtosis	2.490730
Jarque-Bera	0.388092
Probability	0.823620

Appendix 7B: Ljung – Box Q Autocorrelation Test Results

Date: 08/24/16 Time: 12:19
Sample: 1 22
Included observations: 22

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
. |**** |	. |**** |	1	0.536	0.536	7.2212	0.007
. |**. |	. *| . |	2	0.233	-0.076	8.6554	0.013
. |* . |	. | . |	3	0.105	0.016	8.9636	0.030
. *| . |	. *| . |	4	-0.095	-0.204	9.2269	0.056
. *| . |	. | . |	5	-0.179	-0.052	10.221	0.069
.**| . |	.**| . |	6	-0.306	-0.233	13.303	0.038
.**| . |	. | . |	7	-0.312	-0.037	16.724	0.019
.**| . |	. *| . |	8	-0.298	-0.152	20.078	0.010
.**| . |	. *| . |	9	-0.289	-0.102	23.477	0.005
. *| . |	. | . |	10	-0.186	-0.055	24.992	0.005
. | . |	. | . |	11	-0.058	0.015	25.153	0.009
. | . |	. | . |	12	0.054	-0.006	25.305	0.013
. | . |	. *| . |	13	0.030	-0.161	25.360	0.021
. | . |	. *| . |	14	-0.022	-0.156	25.392	0.031
. | . |	. | . |	15	0.031	-0.030	25.466	0.044
. | . |	. | . |	16	0.063	-0.031	25.818	0.057
. | . |	. *| . |	17	0.051	-0.066	26.094	0.073
. | . |	. *| . |	18	0.005	-0.120	26.097	0.098
. | . |	. | . |	19	0.070	0.066	**26.948**	**0.106**

APPENDIX 7C: Breusch-Godfrey Serial Correlation LM Test Results

Breusch-Godfrey Serial Correlation LM Test:

F-statistic	1.852062	Prob. F(12,6)	0.2314
Obs*R-squared	**17.32325**	**Prob. Chi-Square(12)**	**0.1378**

Test Equation:
Dependent Variable: RESID
Method: Least Squares
Date: 08/24/16 Time: 10:16
Sample: 1 22
Included observations: 22
Presample missing value lagged residuals set to zero.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
DD	-0.000753	0.003622	-0.207815	0.8422
ED	-0.000654	0.000924	-0.707749	0.5057
OUT	-42.75077	205.6897	-0.207841	0.8422
C	28272.78	35450.85	0.797521	0.4555
RESID(-1)	0.258384	0.326944	0.790299	0.4594
RESID(-2)	-0.646490	0.475250	-1.360316	0.2226
RESID(-3)	-0.396265	0.555401	-0.713477	0.5023
RESID(-4)	-0.054594	0.590618	-0.092436	0.9294
RESID(-5)	-0.617179	0.680956	-0.906342	0.3997
RESID(-6)	-0.849315	0.623215	-1.362797	0.2219
RESID(-7)	-0.307807	0.689801	-0.446225	0.6711
RESID(-8)	-0.232772	0.656589	-0.354516	0.7351
RESID(-9)	-0.600744	0.643305	-0.933839	0.3864
RESID(-10)	-0.602720	0.682323	-0.883336	0.4110
RESID(-11)	-0.879513	0.758241	-1.159939	0.2901
RESID(-12)	-0.667817	0.704517	-0.947907	0.3798

R-squared	0.787421	Mean dependent var	-1.46E-11
Adjusted R-squared	0.255972	S.D. dependent var	13639.56
S.E. of regression	11765.08	Akaike info criterion	21.73892
Sum squared resid	8.31E+08	Schwarz criterion	22.53241
Log likelihood	-223.1281	Hannan-Quinn criter.	21.92584
F-statistic	1.481650	Durbin-Watson stat	1.673588
Prob(F-statistic)	0.327998		

Appendix 7 D: Heteroskedasticity Test: ARCH
Test Results

F-statistic	1.730737	Prob. F(2,17)	0.2069
Obs*R-squared	**3.383406**	**Prob. Chi-Square(2)**	**0.1842**

Test Equation:
Dependent Variable: RESID^2
Method: Least Squares
Date: 05/24/16 Time: 17:04
Sample (adjusted): 3 22
Included observations: 20 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	1.15E+08	64803405	1.776978	0.0935
RESID^2(-1)	0.463116	0.248928	1.860439	0.0802
RESID^2(-2)	-0.209795	0.252613	-0.830501	0.4178

R-squared	0.169170	Mean dependent var	1.58E+08
Adjusted R-squared	0.071426	S.D. dependent var	2.21E+08
S.E. of regression	2.13E+08	Akaike info criterion	41.32661
Sum squared resid	7.69E+17	Schwarz criterion	41.47597
Log likelihood	-410.2661	Hannan-Quinn criter.	41.35577
F-statistic	1.730737	Durbin-Watson stat	1.853641
Prob(F-statistic)	0.206944		

Appendix 7E: Glejser Heteroskedasticity Test Results

Heteroskedasticity Test: Glejser

F-statistic	1.051057	Prob. F(3,18)	0.3942
Obs*R-squared	**3.279402**	**Prob. Chi-Square(3)**	**0.3505**
Scaled explained SS	2.960892	Prob. Chi-Square(3)	0.3977

Test Equation:
Dependent Variable: ARESID
Method: Least Squares
Date: 08/24/16 Time: 12:10
Sample: 1 22
Included observations: 22

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	20878.63	14515.18	1.438400	0.1675
DD	-0.001203	0.001304	-0.922192	0.3686
ED	0.000190	0.000217	0.874515	0.3934
OUT	-48.31553	73.01186	-0.661749	0.5165

R-squared	0.149064	Mean dependent var	10313.68
Adjusted R-squared	0.007241	S.D. dependent var	8637.140
S.E. of regression	8605.812	Akaike info criterion	21.12123
Sum squared resid	1.33E+09	Schwarz criterion	21.31960
Log likelihood	-228.3335	Hannan-Quinn criter.	21.16796
F-statistic	1.051057	Durbin-Watson stat	1.242013
Prob(F-statistic)	0.394202		

Appendix 7F: Heteroskedasticity Test: White: NCT Test Results

F-statistic	0.843935	Prob. F(3,18)	0.4876
Obs*R-squared	**2.712851**	**Prob. Chi-Square(3)**	**0.4380**
Scaled explained SS	1.353613	Prob. Chi-Square(3)	0.7164

Test Equation:
Dependent Variable: RESID^2
Method: Least Squares
Date: 05/24/16 Time: 17:12
Sample: 1 22
Included observations: 22

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	3.10E+08	1.59E+08	1.946140	0.0674
DD^2	-1.18E-06	1.82E-06	-0.650124	0.5238
ED^2	1.31E-08	4.81E-08	0.271751	0.7889
OUT^2	-1811.677	3180.108	-0.569690	0.5759

R-squared	0.123311	Mean dependent var	1.78E+08
Adjusted R-squared	-0.022803	S.D. dependent var	2.22E+08
S.E. of regression	2.24E+08	Akaike info criterion	41.45905
Sum squared resid	9.07E+17	Schwarz criterion	41.65742
Log likelihood	-452.0496	Hannan-Quinn criter.	41.50578
F-statistic	0.843935	Durbin-Watson stat	1.209874
Prob(F-statistic)	0.487621		

Appendix 7G: Heteroskedasticity Test: Breusch-Pagan-Godfrey Test Results

F-statistic	0.653041	Prob. F(3,18)	0.5914
Obs*R-squared	**2.159448**	**Prob. Chi-Square(3)**	**0.5400**
Scaled explained SS	1.077485	Prob. Chi-Square(3)	0.7825

Test Equation:
Dependent Variable: RESID^2
Method: Least Squares
Date: 05/24/16 Time: 17:15
Sample: 1 22
Included observations: 22

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	5.72E+08	3.84E+08	1.488746	0.1539
DD	-7.455155	34.49285	-0.216136	0.8313
ED	2.399216	5.737039	0.418198	0.6807
OUT	-1847886.	1931251.	-0.956834	0.3513

R-squared	0.098157	Mean dependent var	1.78E+08
Adjusted R-squared	-0.052150	S.D. dependent var	2.22E+08
S.E. of regression	2.28E+08	Akaike info criterion	41.48734
Sum squared resid	9.33E+17	Schwarz criterion	41.68571
Log likelihood	-452.3608	Hannan-Quinn criter.	41.53407
F-statistic	0.653041	Durbin-Watson stat	1.198859
Prob(F-statistic)	0.591356		