AN INVESTIGATION ON THE RELATIONSHIP BETWEEN COMMODITY PRICES AND ECONOMIC GROWTH IN NAMIBIA

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ABSTRACT

The study investigated the relationship between commodity prices and economic growth in Namibia. The main objective of the study was to investigate the relationship between commodity prices and economic growth in Namibia, specifically focusing on the spot price of uranium and zinc as well as the price per carat of diamond exported. Quarterly time series data was used for the period of 1994Q1 to 2018Q4 and data were collected from the Bank of Namibia, Namibia Statistics Agency, World Bank, Cameco Website and The Global Economy. The Autoregressive Distributed Lag (ARDL) method was used to capture the long run relationships between growth and the commodity prices. The equation was modelled under the ARDL technique, where GDP is the dependent and the prices of the commodities are the independent variables. In order to determine the long run relationship of variables, the study employed ARDL Bound test. The empirical results show that there exists an insignificant long run negative association between GDP and the spot price of uranium as well as between GDP and the spot price for zinc. However, the empirical results show that the long run relationship between GDP and the unit export price for diamonds is positive. Based on the Granger Causality test, the study concluded that there are no causal effects between growth and the spot price of diamond, and between growth and unit export price for diamond debt. Conversely, there is unidirectional causality between the price of zinc and GDP growth rate. Causality runs from price of zinc to growth. Based on the findings, the study recommends that Namibia should invest in value addition on the commodities. Value addition has become a globally accepted remedy for economic growth as it will lead to employment creation, higher commodity prices and an improved balance of trade.

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DEDICATION

This thesis is dedicated to my babies Grace, Joseph and Jayden, for being my motivation throughout this journey.

DECLARATION

I, Hilya Ndeshihafela Lazarus, hereby declare that this study is my own work and is a true reflection of my research, and that this work, or any part thereof has not been submitted for a degree at any other institution.

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CHAPTER ONE

INTRODUCTION AND BACKGROUND OF THE STUDY

1.1. Background of the study

The relationship between commodity prices and economic growth in both importing and exporting countries continues to be of considerable interest among policy makers. Literature highlights that the relationship between commodity prices and economic growth has become increasingly important due to the fact that commodity prices impact economic growth. Commodity prices are volatile and they are frequently influenced by shocks coming from real factors including supply stocks, unexpected demand shocks, as well as nominal factors such as the effects of an appreciating and depreciating USD (Dehn, 2000) . The study by Ge and Tang (2020) indicated that on overall, commodity prices can be considered a leading indicator of economic growth; increasing commodity prices indicate a stronger future economy. Furthermore, McGregor, Spinola and Verspagen (2018), illustrated that there is evidence of a long-term negative impact of commodity prices on per capita GDP, which is limited to energy, with the effects of rising non-energy commodity prices tending to have a positive long term impact on per capita GDP. While, the short-term effects of commodity price growth on per capita GDP growth tend to be positive.

Commodity prices have impacts on the growth of exporting countries as they benefit from the commodity price booms. However, shocks to the price of imported commodities are also likely to matter for growth. For instance, an increase in the price of imported commodities is likely to reduce profit margins for firms and disposable income for households, thereby weighing on domestic demand and output growth. Accordingly, a commodity price increase that would imply a positive (negative) income shock if the economy is a net exporter (net importer) of that commodity would be captured by an increase (decrease) of its NCPI (Gruss, 2014).

Most African countries export more primary commodities than the rest of the world, and export little of everything else. Collier and Goderis (2008) found strong evidence of a natural resource curse, but they also argue that there is hope since countries with sufficiently good institutions can avoid the curse. The natural resources curse is known as the phenomenon of countries with a plenty of natural resources (such diamonds, uranium etc.) having less economic growth, less democracy, or worse development outcomes, than countries with fewer natural resources. Policymakers as well as economists and historians of African economic development have seen these exports as both a hope and a curse (Deaton 1999).

Deaton (1999) also examined commodity prices and growth in Africa and found that the African markets are promising but at the same time problems persist and that these can also be worse. Africa is rich in natural resources such as gold, diamonds, copper, nickel, timber and oil. However, most of the production, refineries and processing of these resources are under contract to expatriates and foreign owned companies. Since the minerals are usually owned or mined by foreign investors, the pricing of the minerals is determined and controlled by these foreign interests. The study by Deaton (1999) further indicated that foreign investors may not be paying a competitive price, which may eventually hurt African countries' profits. In addition, most African countries export more than one commodity.

Namibia is a small open economy, and it highly depends on imports, with almost 66 percent of imports coming from South Africa (Bank of Namibia, 2020). Namibia's economy greatly depends on minerals extraction, fishing and agricultural products that are exported in raw form (National Planning Commission, 2012). The tendency of dependence on the exportation of raw material makes the Namibian economy vulnerable to various risks such as inflationary pressures, tighter conditions in the financial market, high and volatile oil prices and commodity price fluctuations. For example, in 2012, an increase in food inflation in South Africa caused by the strikes in the South African industries and the increases in international food prices led to an increase in inflation in Namibia, from 6.0 in the second quarter, to 6.2 in the last quarter of 2012 (Bank of Namibia, 2012). Wakeford (2017) indicates that real GDP grew by an average rate of 4.4 percent between 2007 and 2016. After a big dip amidst the global economic crisis in 2009, the growth rate remained above 5 percent between 2010 and 2015, but fell sharply to 1.2 percent in 2016 following the collapse in commodity prices. Bank of Namibia (2021) reported that real GDP growth is projected to increase to 2.7 percent and 3.3 percent in 2021 and 2022, respectively, from an estimated contraction of 7.3 percent in 2020. These improvements are attributed to broad based base effects as well as better growth prospects for diamond mining, agriculture, and transport.

Mining is the biggest contributor towards the growth of the Namibian economy in terms of its revenue. The overall production of the mining sector rose in 2018 and it accounted for 11.5 percent of GDP in 2018 (Bank of Namibia, 2018). Its contribution to the GDP over the past years is displayed as follows: (10.4 percent in 2009, 8.5 percent in 2010, 9.5 percent in 2011, 12.3 percent in 2012, 13.2 percent in 2013, and 11.6 percent in 2014). An increase in the production of minerals leads to the creation of employment and surplus in net exports, which may have a positive impact on the economic growth. The Namibian mining sector has improved its ranking in view of policy factors from the ninth position in 2016 to second in 2017 after Botswana (NPC, 2018). Mining recorded a decline by 10.4 percent caused by a contraction of the diamond mining sector and the metal ore sectors by 12.6 and 11.2 percent respectively, while the output of the uranium mining sector improved by 7.6 percent (IPPR 2013).

Namibia's economy remains exposed to world commodity price fluctuations which have an impact on the economic growth. Declines in commodity prices can be unfavourable to Namibia’s balance of trade if they persist into the medium-to-long-run. The UNDP report (2010) indicates that since 2003, prices of many commodities, including copper, uranium, nickel, diamonds, platinum and petroleum rose to high records, and contributed significantly to positive growth in Namibia. However, since September 2008, commodity prices have been declining, with a sharp decline in 2015 and 2016. As the prices of the commodities decline, the already large balance-of-payments deficit for Namibia faces further pressure on its trade account and the value of the currency falls against the US dollar.

The discussions of this study will focus on the prices of uranium, zinc and diamond. Namibia is one of the biggest producers of uranium in the world, and its production increased from 3695 tonnes in 2015 to 13340 tonnes in 2018 (Bank of Namibia, 2018). Namibia is also the world’s fifth-ranked producer of uranium, accounting for about 7.3 percent of world output in 2013 (USGS, 2015). Growth in the uranium sub-sector have been lowered owing to a 3.8 percent decline in the international uranium prices, whereby domestic producers also responded by producing less, thus leading to slower economic growth (Bank of Namibia, 2018). The major buyers of Namibia’s uranium are Japan (41 percent in 2006 and 28 percent in 2007), North America (28 percent in 2006 and 30 percent in 2007), Europe (17 percent in 2006 and 13 percent in 2007) and Asia (14 percent in 2006 and 29 percent in 2007) (Shindondola, 2008). The IPPR report of 2019 states that following the Fukushima disaster in March 2011, uranium prices jumped and they have remained low with prices declining further between March 2015 and September 2019 and staying within a band of US$20-25 per pound. The uranium mining sector is expected to grow by 0.1 percent and 3.7 percent in 2021 and 2022 respectively, from a contraction of 12.4 percent in 2020 (Bank of Namibia, 2021).

McGregor, Emvula and Brown (2017) indicated that the enrichment of uranium is limited to a handful of facilities in thirteen countries: France, Germany, the Netherlands, the UK, Japan, the USA, Russia, China, Argentina, Brazil, India, Pakistan, and Iran. As it stands, there is currently an excess of global enrichment capacity. Beyond this, South Africa is home to unused enrichment facilities and rather imports fuel for its sole nuclear reactor.

Zinc is one of the metals produced in Namibia and it makes a significant contribution towards the Namibian economy because it creates employment and it contributes to the revenue stream in Namibia. Zinc has a multiple of uses, and most of the global supply is used to stimulate steel, protecting it from corrosion, while the rest is used for processes such as producing zinc alloys (brass and bronze), and some of it is converted to produce semi-manufactured products. Namibia produces zinc concentrates which is then sent off to relevant zinc smelters for further beneficiation. The price of zinc fell in 2007 and then had a strong recovery into the first quarter of 2018, but it has weakened during the second quarter to below quarterly averages in the second and third quarter of 2018. When it comes to zinc, the majority of profits are captured in producing zinc concentrates, rather than smelting zinc (McGregor, Emvula & Brown, 2017).

According to Wakeford (2017), Diamonds are Namibia's main mineral export, generating US$1.2bn in forex revenues in 2016, and accounting for a quarter of all exports. Diamond mining is one of the major contributors to economic growth. Its GDP contribution is estimated at an average of 10 percent between 2015 and 2017. Namibia steadily produces gem-quality diamonds while ranking ninth globally in terms of volume. Based on carat value, Namibia consistently ranks highly, coming in at second by dollar per carat. However, there is a fundamental division between mining and beneficiation in the mining industry. Diamond companies mostly do not have significant cutting and polishing operations, the same way cutting and polishing companies are not much involved in the mining process. However, the government of Namibia encourages mining companies to get involved in cutting and polishing as part of a larger deal. This is the case in Namibia, with Namdeb's involvement in NamGem, and also with other types of mining. The Namibian government has taken this route in order to encourage diamond cutting and polishing through access to Namdeb diamonds and the favourable Export Processing Zone status (Shindondola, 2008).

The diamond mining sector is expected to expand by 11.1 percent and 15.9 percent in 2021 and 2022 respectively. This is partly because of a low production in 2020 and due to additional production from the Elizabeth Bay mine from 2021 onwards. Diamond mining companies pay a significantly higher corporate tax rate than non-mining and non-diamond mining companies of 55 percent, whereas the non-diamond mining companies' corporate tax rate is 37.5 percent – higher than the non-mining company tax rate of 32 percent (Price Waterhouse Cooper, 2018).

1.2. Problem statement

The relationship between commodity prices and economic growth has long been investigated by academics and policy makers. The concern of commodity prices is mostly a major issue to countries that depend on commodity exports. Even though the high commodity prices are perceived to bring about high rates of economic growth, this has not been the case in many countries (Abebrese, Pickson, & Abebrese, 2017). The international literature has findings on the relationship between commodity prices and economic growth, and these findings are not uniform as some countries have found a positive relationship and others a negative relationship. The growing concern of the effects of commodity prices on economic growth is also a matter of concern to Namibia (Bank of Namibia, 2018). This is because there are no studies that have been done on commodity prices and economic growth in the Namibian context and academic researcher will be able to pick up from this study using different methodologies and variables.

After strong growth averaging 5.6 percent between 2010 and 2015, driven by high public spending, the construction of new mines, and favourable commodity prices, the economy entered into a recession in 2016. Diamond mining contracted in 2016 while there were developments in uranium mining and sustained growth in metal ores. Real GDP growth contracted by 0.9 percent in 2017 and an estimated 0.1 percent in 2018 (Bank of Namibia, 2018). Could the changes in the state of the economy of Namibia be driven by the changes in the prices of the commodities? This question thus prompted an investigation into the relationship between commodity prices and economic growth.

1.3. Objectives of the study

The main objective of the study is to investigate the relationship between commodity prices and economic growth in Namibia, specifically focusing on the commodities listed in the specific objectives below:

- To investigate the long run relationship between the uranium price and economic growth;
- To investigate the long run relationship between diamond prices and economic growth; and
- To investigate the long run relationship between the zinc price and economic growth.

1.4. Hypotheses of the study

In line with the above objectives, below are the hypotheses made in relation to this study:

- H_0: There is no long run relationship between the price of uranium and economic growth;

  H_1: There is a long run relationship between the price of uranium and economic growth.
- H_0: There is no long run relationship between prices of diamond and economic growth; H_2: There is a long run relationship between prices of diamond and economic.
- H_0: There is no long run relationship between prices of zinc and economic growth;

H_3: There is a long run relationship between price of zinc and economic growth.

1.5. Significance of the study

There is a scarcity of empirical literature on the relationship between GDP and commodity prices in Namibia. The study by Simon and Sheefeni (2016) investigated the causal relationship between Primary Commodity Exports and Economic Growth in Namibia, Therefore, the current study is relevant in that it provides the nature of the relationship between the prices of the aforementioned commodities and the economic growth. The much-needed literature on the subject, which may be useful to the policy makers in their quest for developing the relevant policies that may eventually lead to economic growth and development in Namibia. Therefore, the study makes a contribution to the body of literature on commodity prices and economic growth in Namibia.

1.6. Limitations of the study

In order to obtain robust results, the study could have used a larger sample from years dating further back from 1990: Q1. Unfortunately, data for some of the variables is not available for those years as Namibia had not yet obtained independence.

1.7. Delimitation of the study

Although there are several sectors in the Namibian economy that contribute towards economic growth, the current study focussed mainly on the mining sector as the commodities used in the study are minerals. Additionally, this study only looked at three commodities among all other commodities in the mining sector.

1.8. Organisation of the research

This thesis comprises of six chapters: Chapter 1 outlines the background to the study. Chapter 2 discusses the literature review and unfolds the theoretical and empirical literature. Chapter 3 describes the methodology employed. Chapter 4 focuses on data analysis. Chapter 5 discusses the findings of the study, and lastly chapter six concludes the study and provides some recommendations.

CHAPTER TWO

LITERATURE REVIEW AND THEORETICAL FRAMEWORK

2.1. Introduction

The literature covers the works of other scholars on the concept of commodity prices and economic growth in other countries. Specifically, this chapter covers the theoretical framework where it discusses the theories governing the study and it also covers an empirical review.

2.2. Theoretical literature

Helping to explain the relationship between commodity prices and economic growth, a number of theories have explored various ideas on the relationship between the variables.

2.2.1 Neoclassical Solow Growth Model

The Neoclassical Solow growth model has a theoretical linkage to commodity prices and economic growth, and it relates to the Keynesian national income identity. The Gross domestic product is assumed to be a function of domestic absorption and trade:

$Y(t) = C(t) + I(t) + G(t) + X(t) - M(t)$ ……………………………………………………… (1)

Where: Y is GDP, C is domestic consumption expenditure, I is investment expenditure, G is government expenditure, X is the value of export and M is expenditure on foreign imports. Equation (1) can be expressed as:

$Y(t) = DA + I(t) + NX$ ………..………………………………………………………(2)

DA is domestic consumption which is a sum of private consumption and government expenditure. NX is net export.

Export and imports are associated with prices, so the equation (2) is then expressed as:

$YDA = I(r, y) + P_x ex(y,y^*) - P_m em(y,y^*)$……………………………………………………… (3)

YDA is the expression for Y-DA, I is domestic investment by household, r is real exchange rate, y is domestic output, y* is foreign output and e is the exchange rate between the domestic currency and the foreign currency. In most developing countries, the supply reaction is weak, thereby making the exchange rate elasticity of export supply to be inelastic and price elasticity of export to be almost perfectly elastic but prices can change given the demand. Assuming that different countries specialise in different commodities, and developing countries concentrate in the production and export of primary commodities, while developed foreign countries are specialising in the production and export of manufactured goods, an exchange is possible with a need for domestic primary raw materials products to meet rising foreign output; thus domestic countries' exports is a function of both domestic and foreign outputs.

Some developing countries are import dependent, with exchange rate and import price inelastic demand. Moreover, changes in developed countries' demand for the primary products may be big enough to influence the world price for these commodities. In other words, the export of primary products is foreign-income inelastic. Hence, a rise in foreign income does not necessarily increase the demand for the primary products significantly.

The total derivative of equation (3) is displayed below, assuming that *Px* and *Pm* are foreign prices which are exogenously determined and they do not change as a result of a change in domestic income.

$$d(YDA) = I(r)^{I}\left[\frac{\partial I}{\partial y}dy + \frac{\partial I}{\partial r}dr\right]^{+} d(P_x) + \frac{\partial e}{\partial YDA}d(YDA) + x(y, y*)^{I}\left[\frac{\partial x}{\partial y}dy + \frac{\partial x}{\partial y*}dy*\right] -$$

$$d(P_m) - \frac{\partial e}{\partial YDA}d(YDA) - x(y, y*)^{I}\left[\frac{\partial m}{\partial y}dy + \frac{\partial m}{\partial y*}dy*\right] = 0 \quad (4)$$

Equation (4) is simplified and expressed as:

$$d(YDA)\Bigg[1 - \frac{\partial x(y,y*)}{\partial YDA}\left[\frac{\partial x}{\partial y}dy + \frac{\partial x}{\partial y*}dy*\right] + \frac{\partial m(y,y*)}{\partial YDA}\left[\frac{\partial m}{\partial y}dy + \frac{\partial m}{\partial y*}dy*\right] +$$

$$\frac{\partial I(y,r)}{\partial YDA}\left[\frac{\partial I}{\partial y}dy + \frac{\partial I}{\partial r}dr\right]\Bigg] = d(P_x) - d(P_m) \quad (5)$$

Hence:

$d(YDA)=$

$$\frac{d(Px)-d(Pm)}{1-\frac{\partial x(y,y*)}{\partial YDA}\left[\frac{\partial x}{\partial y}dy+\frac{\partial x}{\partial y*}dy*\right]+\frac{\partial m(y,y*)}{\partial YDA}\left[\frac{\partial m}{\partial y}dy+\frac{\partial m}{\partial y*}dy*\right]+\frac{\partial I(y,r)}{\partial YDA}\left[\frac{\partial I}{\partial y}dy+\frac{\partial I}{\partial r}dr\right]} \quad (6)$$

Where: $\frac{\partial x(y,y*}{\partial YDA}\left[\frac{\partial x}{\partial y}dy + \frac{\partial x}{\partial y*}dy*\right]$ is the Marginal Propensity to Export (MPE), the Marginal Propensity to Import (MPM) is displayed as: $\frac{\partial m(y,y*)}{\partial YDA}\left[\frac{\partial m}{\partial y}dy + \frac{\partial m}{\partial y*}dy*\right]$ and the Marginal Propensity to Invest (MPI): $\frac{\partial I(y,r)}{\partial YDA}\left[\frac{\partial I}{\partial y}dy + \frac{\partial I}{\partial r}dr\right]$.

Each one of them is assumed to be less than one. Hence,

$$\frac{d(YDA)}{d(Px)} > 0 \quad (7)$$

$$\frac{d(YDA)}{d(Pm)} < 0 \quad (8)$$

Equation (7) and (8) recommend that a positive change in prices of export commodities improves the national savings position only when domestic income is greater than domestic absorption and when the marginal propensity to export and invest is greater than zero, while increase in import prices obstructs national savings when domestic absorption is higher than domestic income and marginal propensity to import and invest are greater than zero. It finally implies that domestic consumption and investment is externally sourced. Hence, the theory concluded that increase in export prices is growth enhancing in the short run.

2.2.2. Prebisch–Singer Hypothesis

This theory was designed by Raul Prebisch and Hans Singer in 1950, in effort to explain the impact of primary commodities prices on economic growth. An analysis of long-run commodity prices by Prebisch and Singer implies a secular, negative trend in commodity prices relative to manufactures. The Prebisch–Singer hypothesis stated that the prices of primary commodities decrease comparaed to the prices of manufactured goods over the long term, which leads to a fall in the terms of trade of primary-product-based economies. Prebisch and Singer (1950), argue that specialisation in primary commodities, combined with a relatively slow rate of technical progress in the primary sector and a hostile trend in the commodity terms of trade, caused developing economies to lag behind the industrialized world.

According to Cuddington, Ludema and Jayasuriya (2002), the Prebisch-Singer theory rested its case on three stylised facts, first, that developing countries are indeed highly specialised in the production and export of primary commodities; second, that technical progress was concentrated mainly in the manufacturing industry; and third, that the relative price of primary commodities in terms of manufactures had fallen steadily since the late 19th Century. The aforementioned facts suggest that because of the specialisation in primary commodities by developing countries, little benefit has been obtained from industrial technical progress, either directly, through higher productivity, or indirectly, through improved terms of trade.

Prebisch and Singer assume that developing countries specialise in extracting and exporting primary commodities and industrialised countries specialise in manufacturing. This generalisation led them to treat the relative price of commodities in terms of manufacture as equivalent to the terms of trade of developing countries and its inverse, the terms of trade of industrialised countries. Cuddington, Ludema and Jayasuriya (2002) indicate that developing countries do not only export primary commodities, and industrialised countries do not only export manufactures, and thus commodity prices are different from the terms of trade.

The Prebisch-Singer theory suggests that a temporary increase in revenue may occur as a result of an increase in world commodity prices but this price increase might lead to economic instability. That is, the demand for these primary commodities will fall and the prices will also fall leading to excess government expenditure compared to the revenue from these primary goods and balance of trade deficit. Therefore, as incomes increase, the demand for manufactured goods increases faster than the demand for primary products. One of the reasons why commodity rich countries often experience low economic growth is that the price of primary commodities declines relative to the price of manufactured goods over the long term (Maizels et al., 2017).

Related to the Prebisch-Singer hypothesis, Kalumbu (2014) adds another dimension, that the non-renewable nature of natural resources and its extraction makes them to be depleted over time. The study further assumes that in the long run, natural resources dependent economies might have a balance of trade deficit owing to resources depletion and consequently a reduction in economic growth.

The Prebisch-Singer hypothesis presents a contest to the fundamental finding of the Ricardian model, the idea that countries that specialise in the production of the goods in which they have a comparative advantage will experience an improvement in terms of trade. The theory suggests that the gains from trade are unequally distributed. While industrialised countries will benefit from long run improvements in terms of trade, the same is not true of developing countries that specialise in the production of primary commodities. Primary product producers will instead experience a deterioration in terms of trade over time.

A theoretical condition proposed by Bhagwati (1958) indicates that economic growth could result in a country being worse off, particularly if growth is brought about by primary exports, leading to a fall in terms of trade. Henceforth, the fall in terms of trade may outweigh the gains from growth. However, this is only valid if the growing country is able to influence world commodity prices. Since most developing exporting economies are small, the credibility of this stand is weak.

Furthermore, Tilton (2013) opposes the Prebisch-Singer theory by indicating that the prices of most goods are dependent on their production costs. Henceforth, a fall in the prices of primary products is often accompanied by a corresponding fall in the cost of production, thereby increasing the benefits a country reaps from its primary products, production and trade. The falling costs can conceivably offset the adverse effects of lower prices and the declining terms of trade for primary product producers. Arezki, Lederman and Zhao (2011) made reference of the income elasticity of demand as a factor influencing commodity prices and consequently economic growth. The income elasticity of demand for most commodities is low, therefore, as the income increases, the growth of the commodity demanded is slower, thus resulting in weaker growth.

2.2.3. The Dutch disease

Kojo (2015) explains the Dutch disease theory as a situation in which an extra wealth from an export boom, such as a discovery of major resource deposits (particularly natural resources) leads to a contraction of other sectors by giving rise to a real appreciation of the home currency. If a country discovers substantial amounts of a natural commodity, it will begin to export these goods thereby causing a substantial increase in GDP; this will improve tax revenues, improve the current account and create employment opportunities. The problem of the appreciation in the exchange rate is that other trade-able sectors of the economy will become uncompetitive, and manufacturing industries will see a significant fall in demand due to the higher exchange rate. Therefore, the economy will change from manufacturing to the primary sector.

The large inflow of foreign exchange can potentially cause currency appreciations in the receiving countries and hurt their exports as they appear to be expensive in the importing countries. This Dutch-disease has received relatively little empirical attention until the study by Adams and Page (2005) was done, that most African countries have been receiving allowances from developed countries. Even though, allowances have gained in importance as an effective tool promoting GDP growth and reducing poverty and inequality, they are inflows of foreign exchange. . According to Ratha (2013), the Dutch-disease’s effects on remittances may be attributed to various channels. Remittances can lead to a spending effect, thereby leading to an increase in the consumption of both tradable and non-tradable goods. With prices of tradable goods basically determined in world markets, the relative prices of the domestic, non-tradable goods rise and push up the overall price level in the economy, in exporting countries (Ratha, 2013). The study found out that this translates into a higher real exchange rate, both fuelling and being fuelled by a resource movement effect: rising non-tradable prices divert resources away from the tradable sector towards the non-tradable sector and exercise upward pressure on wages and other production costs, prices, and real exchange rate of the domestic currency. Thus, Ratha (2013) states that an increase in remittance inflows would lead to the incidence of the Dutch Disease and to illustrate this, in order to survive the increasingly competitive world, African countries have been relying on borrowed money from institutions like the World Bank and the IMF.

Some economists protest that the Dutch disease is not a bad thing as economies need to focus on what they are most efficient at producing (Gylfason, 2001). According to the comparative advantage model, each country should specialise in the industry in which it possesses a comparative advantage over other countries. A comparative advantage is an economy's capability to produce a particular good or service at a lower opportunity cost than its trading partners. This gives an economy the ability to sell goods and services at a lower price than its competitors and this enables that specific country to realise stronger sales margins.

2.3. Empirical literature

Much literature has assessed the empirical evidence for economic growth and commodity prices in different sectors and regions. The paper by Abebrese, Pickson and Abebrese (2017), a case study of Ghana and Cote d'Ivoire, examined the relationship between commodity prices, exchange rate and economic growth through making use of time series data for the period 1980 to 2011. Using the autoregressive distributed lag (ARDL) modelling approach, the study discovered that higher commodity prices reduce long-run economic growth in Ghana but cannot be an important ingredient in short-run growth. The study established that cocoa export, exchange rate, and inflation had a positive influence in determining economic growth in Cote d'Ivoire. It was also found that there is a negative long-run relationship between cocoa price and economic growth in Ghana. According to the study, in Cote d'Ivoire, commodity prices do not play any significant role in both long-run and short-run economic growth.

Moreover, Inoue and Okimoto's (2017) results indicate that the increased integration and dependence on commodity exports deepened the Asian region's vulnerability to external shocks. The collapse in commodity prices is yet another reminder of the vulnerability of countries that are highly dependent on volatile commodity exports and the negative impact it has on economic growth.

Furthermore, using the VAR methodology, Collier and Goderis (2007) analysed commodity prices and growth and found that increases in commodity prices significantly raise the growth of commodity exporters. The study adopted the co-integration methodology which enabled it to explore longer term effects than permitted using VARs and analysed a global data set covering 1971-2004. Sharp differences in the effects, both between the short term and the long term and the type of commodity were found. For all types of commodities, the short term results of price booms are not harmful for their exporters: the direct gain from the income terms of trade is reinforced by induced growth in constant price - GDP. The output effects continue over the long term for agricultural commodities, however for both oil and the other non-agricultural commodities, the long term effects on output are unfavourable and sizeable. The results therefore support the 'resource curse' hypothesis.

Tiawara (2015) studied the effects of commodity price shocks on African countries' economic growth. The results indicate that commodity prices are believed to have a huge impact on the African economic market. Fixed effects panel data model was employed on a sample of African countries' data. The impulse response functions pointed out that an increase in commodity prices is more likely to benefit the African economies than hurting them.

Using panel data for 43 developing countries over the period 1980-2010, Emara, Simutowe and Jamison (2015) examined the impact of the Commodity Terms of Trade (CTOT) Index on the real GDP per capita growth. The study found that for all countries in the sample, an increase in the CTOT index immediately leads to a statistically positive impact on the GDP per capita growth rate. Furthermore, the study found confirmation of the resource curse under the Commodity Terms of Trade Index in developing countries.

Olakojo (2015) evaluated the impact of commodity prices on growth dynamics of selected primary commodities-based African economies and the regression analysis showed that primary commodity prices have inelastic positive effects on the economic growth of selected African countries. Hence, an increase in the prices of these commodities enhances economic growth less proportionality. Furthermore, the adjustment of African economies when there is short run disequilibrium emanating from price changes for instance, is weak. This is due to the low level of diversification (both in terms of economic diversification and primary commodity exports diversification) among many African economies, resulting in a limited ability to plan their ways in case of a commodity prices crash. Some of the outcomes of this study are in line with some of the previous studies such as those by Collier and Goderis (2007) and Deaton (1993).

According to Moreira (2014), the higher the volatility in commodities prices, the lower the GDP level and the higher the inflationary expectations in the economy. However, Böwer, Geis and Winkler (2007) confirmed that in the light of rising commodity prices, net oil exporters recorded strong growth rates, whereas net oil-importing countries displayed fairly lower growth rates although they benefited from increases in their major non-oil commodity export prices.

In addition, a paper by Ingram (2014) presented a new approach to the analysis of the cyclical behaviour of world commodity prices. The study displayed long periods of rising and falling commodity prices within booms and slumps, and the commodity prices seem to behave in a similar manner, and surprisingly even among different types of commodities which are influenced by different shocks. The crucial result is that in commodity price booms, the rapid economic growth occurs towards the end of the economic boom.

Moreover, Cavalcanti, Mohaddes and Raissi (2011) investigated commodity price volatility and growth for 118 countries through making use of General Method of Moments (GMM) and augmented version of the pooled mean group (CPMG) estimator. The results showed that commodity terms of trade volatility affect output growth in a negative way. More so, Dehn (2000) indicated that the analysis shows that per capita growth rates are significantly reduced by large isolated negative commodity price shocks. The magnitude of the effects of negative shocks on growth is large and appears to work individually of investment, which suggests that adjustment is achieved through severe reductions in capacity utilisation. The study used difference GMM to estimate the model for all the countries and commodities. Furthermore, the effects before and after price shocks were tested on economic growth using the Burnside and Dollar (1997) data set. The analysis shows that per capita growth rates are significantly reduced by large discrete negative commodity price shocks.

The paper further display that positive shocks have no lasting impact on growth, which is consistent with the findings of both Deaton and Miller (1995) and Collier and Gunning (1999), but it shows a reversal of the aforementioned result, which suggests that the long run effects of positive temporary shocks are negative. Hence, what reduces growth is not the view of volatile world prices, but the actual realisations of negative shocks.

Deaton (1999) examined the hypothesis that commodity prices impact growth in Africa. The study sought to respond to the question as to why the prices behave the way they do, what determines their trends as well as the variability around these trends. The study stated that because of the severe difficulties in handling price fluctuations and dysfunctional policy-making in Africa, price booms and busts are equally dreaded.

2.4. Summary

The studies related to this study used different methods or econometric techniques such as VAR, GMM difference, Hamiltonian, ARDL, and panel data to analyse the relationship between commodity prices and economic growth in different regions and also through looking at different commodities. The results that the study summarised are conflicting as already alluded to. The fact that there are still inconclusive results means that there is a need to carry out further research using more techniques that have proven to give more robust results. Without understanding the direction of the relationships between the variables, it is not possible to draw important lessons and guidelines for policy makers in their pursuit to find more effective policies that promote economic growth in Namibia.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1. Introduction

This chapter explores and analyses the research methods used in conducting this study. The approach and methodology used were determined by the aims of the study. The research design adopted is quantitative and it is concerned with finding the relationship between commodity prices and economic growth in Namibia. The study used data on the following variables; unit export prices of diamonds, spot price of uranium and spot price for zinc as well the GDP as a proxy for economic growth.

3.2. Analytical framework

The research approach is quantitative and it was concerned with finding and elaborating the relationship between commodity prices and economic growth in Namibia. The study investigated the correlation coefficient between variables through the regression method. The Econometric views (Eviews 10) software was used to process and estimate the coefficients of the specified model. The study used the Autoregressive Distributed Lag (ARDL) to examine for the existence of co-integrating and long run relationships.

The ARDL modelling technique developed by Pesaran and Shin (1998), and Pesaran et al. (2001) was used due to its several advantages relative to other single equation cointegration techniques. These advantages are: it can be performed irrespective of whether the series are integrated of order I(0) and I(1) and when there is a single long run relationship between the underlying variables in a small sample size. ARDL modelling takes into account a sufficient number of lags to capture the data generating process (DGP) general to specific modelling framework. However, for variables, whose order of integration is more than I [1] then ARDL model approach cannot be used.

To analyse the time series properties of the dataset, the Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) test statistics were employed in carrying out the unit roots tests to determine whether the variables are stationary or not. The study then performed causality tests by employing the pairwise Granger causality tests.

If the series are cointegrated, Error Correction Model (ECM) was used to analyse the relationship between dependent and independent variables. A test on multicollinearity was also conducted to assess if any relationship exists between the explanatory variables.

3.3. Econometric Framework

The study used data for the following variables; unit export price of diamond, [1]spot price of uranium and zinc, as well the real GDP per capita growth rate as the proxy for economic growth. The general function of the study was presented as follows:

GDP = (Diam, Uran, Zin)..(1)

Where:

GDP = Gross Domestic Product, Diam = Unit export price of diamond, Uran = Spot price of uranium and Zin = Spot price of Zinc

All other control variables that influence economic growth are hold constant

The variables were transformed into a natural logarithm form. This is to remove any uncertainty of non-linear relationship between variable and allow coefficient interpretations. The natural logarithm equation used is (2).

[1] spot prices are for immediate buying and selling, while futures contracts delay payment and delivery to predetermined future dates. The spot price is usually below the futures price.

$$LnGDP_t = \alpha + \beta_1 LnDiam_t + \beta_2 LnUran_t + \beta_3 LnZin_t + \varepsilon_t \ldots\ldots\ldots\ldots\ldots(2)$$

Where:

α= constant, ε = error term , β1, β2, β3= coefficients that have impacts on the commodity prices and LnGDP LnDiam, LnUran, LnZin is the natural logs of GDP, unit export prices of diamond, spot price of uranium and spot price of zinc respectively, holding all other control variables that influence economic growth constant.

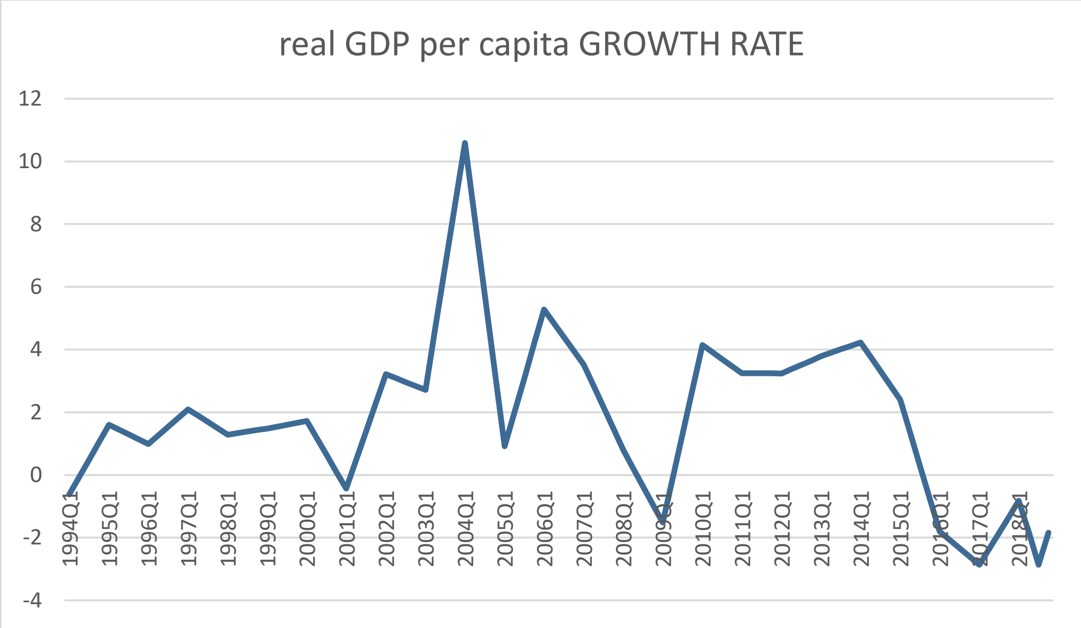
The parameter estimates displaying the impact of commodity prices on economic growth are explained in detail, under section 3.4.

3.4. Justification of variables

3.4.1 Gross Domestic Product

Real GDP per capita growth rate is used as proxy for economic growth. Economic growth is used to indicate the increase in real GDP or in per capita GDP. It measures the total production of goods and services within the country at a given time. In this model, real GDP per capita growth rate is used as one of the variables and how it relates to the prices of commodities, which are diamond, uranium and zinc. The study used real GDP per capita growth rate as a proxy for economic growth. Figure 1 shows the quarterly real GDP per capita growth rate trend from 1994 to 2018.

Figure 1 depicts the quarterly real GDP per capita growth rate for the 1994: Q1-2018:Q4



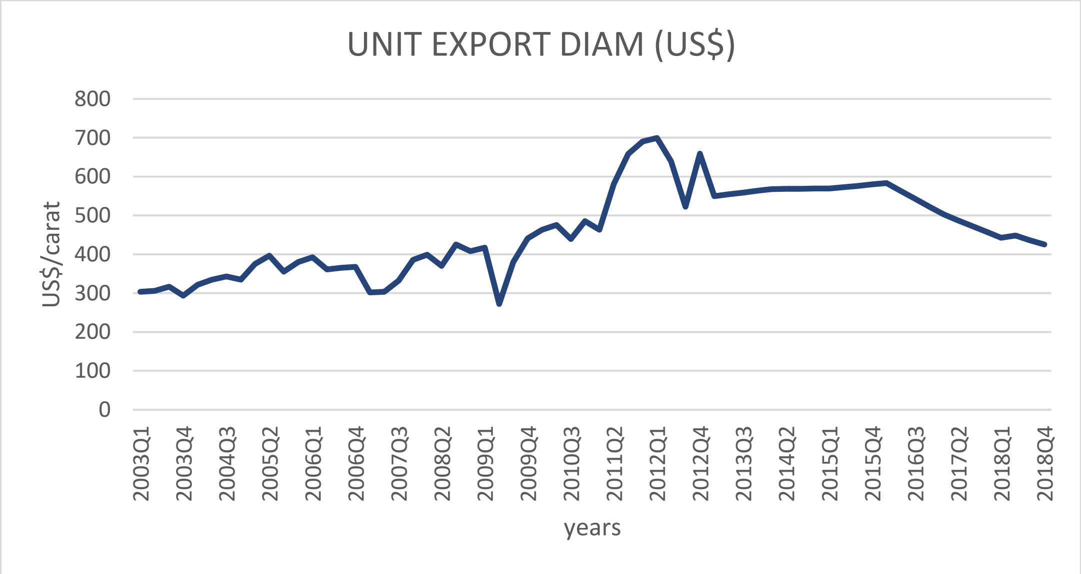
Source: Bank of Namibia and Namibia Statistics Agency

3.4.2. Diamonds

Diamonds is the most economically significant mineral commodity produced by the mining industry of Namibia. The country produced about 2 percent of the world's gem-quality diamonds, which placed it as the eighth-ranked producer of gem diamond in terms of value. Diamonds contribute a significant amount towards the revenue of Namibia. Diamond production makes up approximately 40 percent of the export revenue and 7 percent of the annual government revenue (Bank of Namibia, 2008). Diamond made up 16.3 percent of the exports in Namibia, coming second after copper (NSA, 2021). The mechanism that is used to establish the purchase price of the diamonds is that the price is set based on the expectation of the polished outcome of the rough diamond (All diamond, 2020).

The data used in the study is the unit export price for sorted diamonds. The unit export price for diamonds gives a reflection of what impact the prices of diamonds being exported will have on economic growth. The unit export price is the price per carat of diamonds exported abroad. The study used the unit export price for diamonds from 2003:Q1 to 2018:Q4. This is because the data on the unit export price for diamonds was not available for the period of 1994 to 2012. Diamonds are an important component of export in Namibia, therefore they were included in the study with the data that is available.

Figure 2 depicts quarterly unit export price for Diamonds 2003: Q1-2018:Q4



Data source: ***https://www.theglobaleconomy.com/Namibia/diamond_exports_USD_per_carat/***

The Global Economy collects the data "by hand" without automation and with multiple quality checks, whereby there are routine checks of the entire data set. The data were sourced from central banks and other national authorities, and our data set also includes multiple series from these sources: The World Bank, The United Nations, U.S. Energy Information Administration, International Monetary Fund, UNESCO, Transparency

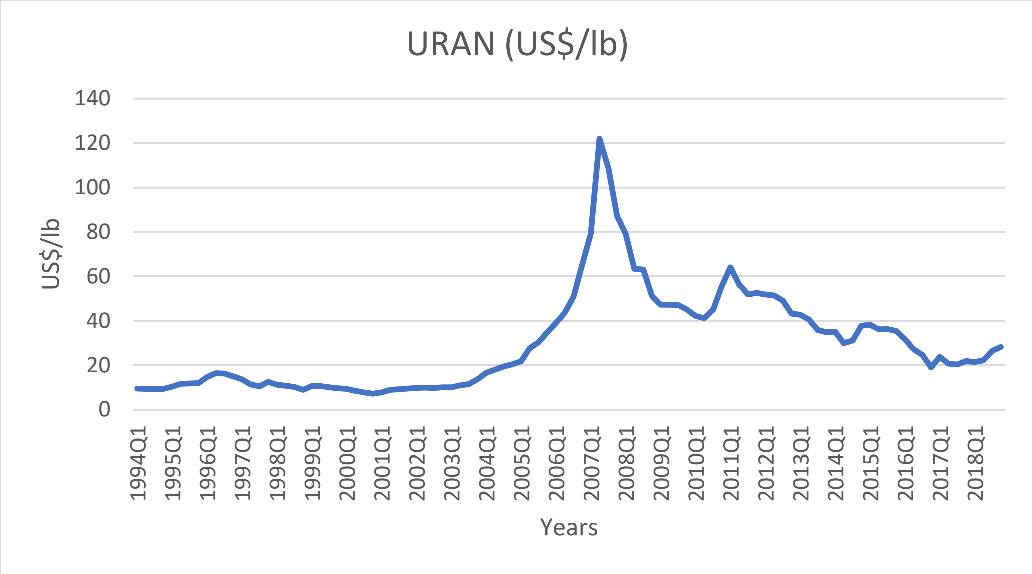
International, World Federation of Exchanges, United Nations Development Program, The World Economic Forum, OECD and Bank for International Settlements.

3.4.3. Uranium

Uranium mining is an important economic factor in Namibia as it has created substantial employment opportunities not only in the mining industry, but also in the supply and service industry. According to Shindondola (2008), the ever increasing global demand to fuel uranium nuclear power has made Namibia an attractive destination for uranium exploration, making Namibia the fourth largest exporter of uranium. The increase in uranium exploration and mining of uranium in Namibia is partly attributed to the increasing worldwide demand for uranium. However, Namibia's uranium is exported in raw form and it is sent to countries that have converters and where it is enriched.

In Namibia, uranium is traded through contracts negotiated directly between a buyer and a seller, and this is also done by thoroughly stipulating in the sales agreement contract that this is done in such a way that uranium is used for peaceful purposes by the buyers. The contracts specify a base price, i.e. the uranium spot price, and the rules for escalation. The uranium price is fundamental in its reaction to unforeseen circumstances, but also quantitative when nuclear power plant development is on the increase. The most important fundamental in determining the price of uranium is the supply and demand, which drives the price up or down. The study used the spot price of uranium in US$ from 1994:Q1 to 2018:Q4. The spot price of uranium is measured in US$ per pound (US$/lb.). The prices were then converted to N$ for estimation purposes.

Figure 3 depicts quarterly spot price for uranium 1994:Q1-2018:Q4



Data source: https://www.cameco.com/invest/markets/uranium-price

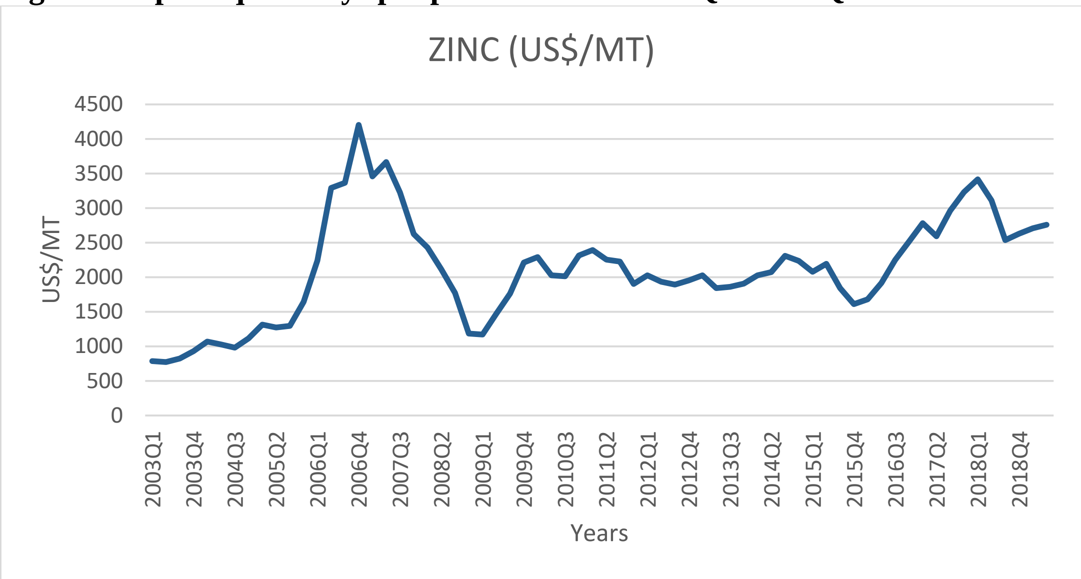
Cameco is a global provider of the fuel needed to energise a clean-air world and a leading supplier of uranium refining, conversion and fuel manufacturing services.

3.4.4. Zinc

Zinc is one of the metals produced in Namibia. It makes a significant contribution towards the Namibian economy because it creates employment and it contributes to the revenue stream in Namibia. Zinc has a multiple of uses and most of the global supply is used to stimulate steel and protecting it from corrosion, while the rest is used for processes such as producing zinc alloys (brass and bronze), and some of it is converted to produce semi-manufactured products. Namibia produces zinc concentrates which are then sent off to relevant zinc smelters for further beneficiation. It is traded on the market, where the prices are determined by the demand and supply of the commodity. The price of zinc has been increasing since 2012, and this was caused by a significant increase in the demand of the commodity from China (Institute for Public Policy Research, 2015).

The data used in study is the spot price for zinc from 1994:Q1 to 2018:Q4, which is in US$ and this was converted to N$ for estimations. The spot price of zinc is measured in US$ per metric tonne (US$/MT). The prices were then converted to N$ for estimation purposes.

Figure 4 depicts quarterly spot price for zinc 1994:Q1-2018:Q4



Data source: www.worldbank.org/en/research/commodity-markets

The World Bank compiles international data sets which are generally based on data generated by national statistical systems. The World Bank supports a number of programmes to collect transnational data. These are data that can only be collected by a globally coordinated programme.

Prices of all the aforementioned commodities fluctuate and they are very volatile and thus their impact on economic growth is expected to be different at different times with different prices.

3.5. Estimating Technique

The estimating technique section clarifies the steps on how the data in the study was analysed.

3.5.1 Unit Root Tests

Gujarati (2014) suggests that it is important to test for stationarity in time series data to ensure that the mean, variance and auto co-variance (at various lags) are time invariant, that is, constant overtime, and that results for the times series date for the period under review can be generalised for the future. The aim was to verify whether the series have a stationary trend, and, if non-stationary, to establish orders of integration. Most time series data are usually non-stationary in levels. These non-stationary time series may result in spurious regressions if used without being transformed. Thus, it is important to test the series for stationarity in order to avert the problem of spurious regression and derive meaningful relationships among the variables. The standard method for testing the stationarity of a time series is to account for a deterministic trend as well as the stochastic trend represented using methods such as Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP). This is because regression with non-stationary variables increases the likelihoods of spurious regression.

A number of tests can be employed to test for unit roots in time series data and this study employed the Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) tests for unit roots as they are considered reliable in literature. The ADF and PP are used to determine the order of integration. The null hypothesis that the series contain unit roots was tested against the alternative that they do not. If the computed t-statistic is greater than the critical values, then the null hypothesis is rejected for non-stationary. But, if the computed t-statistic is less than the critical value, then the null hypothesis is accepted and it can be concluded that the variable is not stationary.

The ADF test does not take into consideration heteroscedasticity and non-normality and it is also unable to discriminate between stationary and non-stationary series with a high degree of autocorrelation. As such, the PP test is employed to resolve this problem. The PP unit root test differs from the ADF tests mainly in how they deal with serial correlation and heteroscedasticity in the errors. In particular, where the ADF tests use a parametric autoregression to approximate the ARMA structure of the errors in the test regression, the PP tests ignore any serial correlation in the test regression. Thus, the PP test can be considered as nonparametric. Whereas, the ADF assumes the error terms are independent with a constant variance, the PP test assumes the error terms are weakly dependent and distributed heterogeneously providing robust estimates over the ADF. The Akaike Information Criterion (AIC) and Schwartz Information Criterion (SIC) were used in the selection of the lag length.

3.5.2. Co-integration Test

Economic analysis suggests that there is a long run relationship between the variables under consideration as stipulated by theory. This means that the long run relationship properties are intact. Testing for co-integration is a necessary step to check if there is an empirically meaningful relationship between the variables. If the variables do not cointegrate, it means there is no long-run relationship among the variables. On the other hand, if the variables do cointegrate, then there is cointegration between the variables. The cointegration test examines how time series, which though may be individually non-stationary and drift extensively away from equilibrium can be paired such that the workings of equilibrium forces will ensure that they do not drift too far apart (Nkoro and Udo, 2016).

Cointegration has several testing techniques, and this study adopted the co-integration procedure suggested by Pesaran et al. (2001). The Autoregressive Distributed Lag (ARDL) is the co-integration technique that is used in determining the long run relationship between series with different orders of integration (Pesaran & Shin, 1999; Pesaran et al., 2001). The ARDL approach was chosen because of its advantages, which include that it can be used irrespective of whether the order of integration of the variables are different e,g, I (0) and I (1) and when there is a single long run relationship between the underlying variables in a small sample size.

The ARDL approach also solves the endogeneity problem found among many macroeconomic variables. Pesaran and Shin (1999) argue that modelling the ARDL with the appropriate lags corrects the problems of endogeneity and serial correlation. A significant feature of this approach is the fact that all the variables are assumed to be endogenous. This implies that both the long-run and short-run parameters of the model are estimated jointly.

The ARDL approach unlike the Johansen and Juselius (1990) cointegration test has superior small sample properties. Invariably, it is more robust and performs better for small sample sizes than other co-integration techniques (Pesaran & Shin, 1999). The error correction model (ECM) can be derived from the ARDL via a simple linear transformation.

The ARDL approach follows three steps, firstly perform a unit root to check the variables order of integration and to ensure that none of them are integrated by second level I(2). Secondly is the determination of the existence of the long run relationship of the variables tested by computing the Bound F-statistic (bound test for co-integration), and then later the diagnostic tests.

The ARDL model is estimated as follows:

$$\Delta LnGDP_t = \alpha_0 + \sum_{i=1}^{L1} \beta_1 LnGDP_{t-i} + \sum_{i=1}^{L2} \beta_2 LnDiam_{t-i} + \sum_{i=1}^{L3} \beta_3 LnUran_{t-i} + \sum_{i=1}^{L4} \beta_4 LnZin_{t-i} +$$

$$\delta_1 LnGDP_{t-1} + \delta_2 LnDiam_{t-1} + \delta_3 LnUran_{t-1} + \delta_4 LnZin_{t-1} + \varepsilon_t \text{ ……………. (3)}$$

Where:

Δ denotes the first difference of the operator,

εt = the random error term,

t = the time period,

α = is the constant,

β1 to β4 represent the short run relationship and

δ1 to δ4 represent the long run relationship.

The following two hypotheses tested for co-integration

$\boldsymbol{H_0}$: $\delta_1 = \delta_2 = \delta_3 = \delta_4 = 0$ (there is no co-integration among the variables)

$\boldsymbol{H_1}$: $\delta_1 \neq \delta_2 \neq \delta_3 \neq \delta_4 \neq 0$ (Cointegration exist among the variables)

The decision criteria is that if the value of F-statistics exceeds the upper bounds value I(1) then the null hypothesis for no cointegration is rejected and conclude that there is cointegration. On the other hand, if the F- statistics is less than the lower bound I (0), then the null hypothesis cannot be rejected and that implies there is no cointegration among the variables and if the F- statistics lies between the upper and lower bounds value then the test is inconclusive.

Assuming that the bounds test leads to the conclusion of cointegration, that is, the variables does exhibit a long run relationship, the study should estimate both the long run and short run model. However, if series are not cointegrated, then the study only estimates the short run model.

When the cointegration relationship between the variables is established, the ARDL model can be estimated in order to obtain the long run coefficients using the Error Correction Model (ECM). The ECM can only be estimated if the variables in the model are cointegrated, which means that there is long run relationship between the variables. The long-run ARDL model is estimated as:

$$LnGDP_t = \alpha_0 + \delta_1 LnGDP_{t-1} + \delta_2 LnDiam_{t-1} + \delta_3 LnUran_{t-1} + \delta_4 LnZin_{t-1} + \varepsilon_t$$

…………….(4).

Once the long-run ARDL model is estimated, then the short-run elasticities of the variables used in the study will be estimated using the ECM ARDL model. The long run model specification gets the errors from the long run model so that they can be used in the Error Correction Model. The error that is generated is called the Error Correction Term (ECT) and this is used in the ARDL ECM model. The long-run relationship between the variables is shown as:

$$\Delta LnGDP_t = \alpha_0 + \sum_{i=1}^{L1} \beta_1 LnGDP_{t-i} + \sum_{i=1}^{L2} \beta_2 LnDiam_{t-i} + \sum_{i=1}^{L3} \beta_3 LnUran_{t-i} + \sum_{i=1}^{L4} \beta_4 LnZin_{t-i} +$$

$$\Delta\delta ECM_{t-1} + \varepsilon_t \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (5)$$

Where δ is the speed of adjustment and ECM is the long-run representation in the model, while all other components of the equation represent the short-run coefficients, and ε is the error term. ECM is the residual obtained from the long-run model and it is the one that gives information about the speed of adjustment of the variables towards the long run equilibrium. For the speed of adjustment to be considered significant, which is δ, in this model, it should be negative.

3.5.3. Granger Causality

It is significant to establish causality between economic variables as unidirectional or bidirectional so that the actual way the variables relate can be established. To examine the question of whether economic variables cause each other, the Granger causality approach is usually employed.

Granger's (1969) definition states that Granger causality is a statistical concept of causality that is founded on prediction. According to Granger Causality, *Yt* is said to be Granger caused by *Xt* if *Xt* helps in the prediction of *Yt,* or equivalently if the coefficients of the lagged *Xt* are statistically significant. If *Xt* Granger cause *Yt*, then the past values of *Xt* should contain information that helps predict *Yt.* This type of causality is useful principally for two purposes. First, it is equivalent to the econometric exogeneity such that the unidirectional causality that runs from the explanatory variables to the dependent variables is necessary for the consistent estimation of distributed lag models that do not involve lagged dependent variables. Secondly, it is related to leading indicators and rational expectations. Granger (1969) argued that testing for Granger causality provides a useful way of evaluating the information used in forming economically rational expectations.

3.5.4. Diagnostic analysis

To test for the goodness or the fitness of the ARDL model, diagnostic tests were conducted. Diagnostics tests examine whether the model does not suffer from problems associated with non-normality of errors, serially correlated errors, heteroscedasticity and functional form misspecification. Gujarati (2014) asserts that homoscedasticity and non-serial correlation assumptions are critical for the valid interpretation of regression estimates. The Jarque-Bera Normality Test was used to test if the model is normally distributed. The Breusch-Godfrey LM test and Breusch-Pagan-Godfrey tests were used to test for serial correlation and heteroscedasticity among residuals. Lastly, a CUSUM test was used to examine the stability of the model.

3.6. Data, data sources and data measurements

The study was conducted on a macro level and as such, quarterly data covering the period from 1994Q1 to 2018Q4 was used for real GDP per capital growth rate, spot price for zinc and uranium. The unit export price for diamond covers the period of 2003Q1 to 2018Q4, and this is because of the unavailability of data. The variables considered in the study are the spot prices of uranium, the unit export price for diamonds, and the spot price for zinc as well as the real GDP per capita growth rate. The data for real GDP per capita growth rate was sourced from Namibia Statistics Agency and Bank of Namibia. The negative values of real GDP per capita growth rate were modified to be treated like positive values, for estimation purposes in Eviews, using the equation lngdp=@recode(gdp>0, log (1+gdp),-log (1-gdp)). This was done because the log of negative values is undefined.

The spot price of uranium was sourced from the Cameco website, spot price of zinc was sourced from the World Bank website, and the export price per carat of diamond was sourced from The Global Economy website. The prices of uranium, zinc and diamond was converted from US dollars to Namibian dollars. Due to the high volatility in the exchange rate, the study considered the exchange rate at the beginning of each month, for the US dollar and Namibian dollar from 1994 to 2018. The exchange rate between the Namibian dollar and US dollar was then used to convert the prices of the commodities from the US dollar to the Namibian dollar, as they are also recorded on a monthly basis. After the prices were converted to Namibian dollars, the data was converted from monthly to quarterly data using Eviews frequency conversion. A difference in time period for variables was benchmarked to a study by Bemis and Morgan (1975) on the personal distribution of income and wealth.

3.7. Research Ethics

The study follows the University of Namibia guideline, and the study makes use of secondary data. The data is obtained from the Bank of Namibia, Namibia Statistics Agency, the World Bank, and the Global Economy websites. This is entirely a desktop study. The institutions from which the data is sourced are mandated to publish data. Moreover, the researcher uses this data only for the purpose of this study. As a result, the analysis of this study is universally available and does not pose any ethical risk.

3.8. Conclusion

The methodology involved regressing the dependent variable (GDP) on the explanatory variables through the following procedures: testing for stationary properties of the variables using ADF and PP, followed by ARDL cointegration procedure suggested by Pesaran et al. (2001) in checking for the existence of cointegrating and long run relationships. Granger Causality tested for causality among the variables. Finally, the study estimated the goodness fit of the model through diagnostics tests. The analysis and empirical results are discussed in the next chapter.

CHAPTER FOUR

MODEL ESTIMATION AND INTERPRETATION OF RESULTS

4.1. Introduction

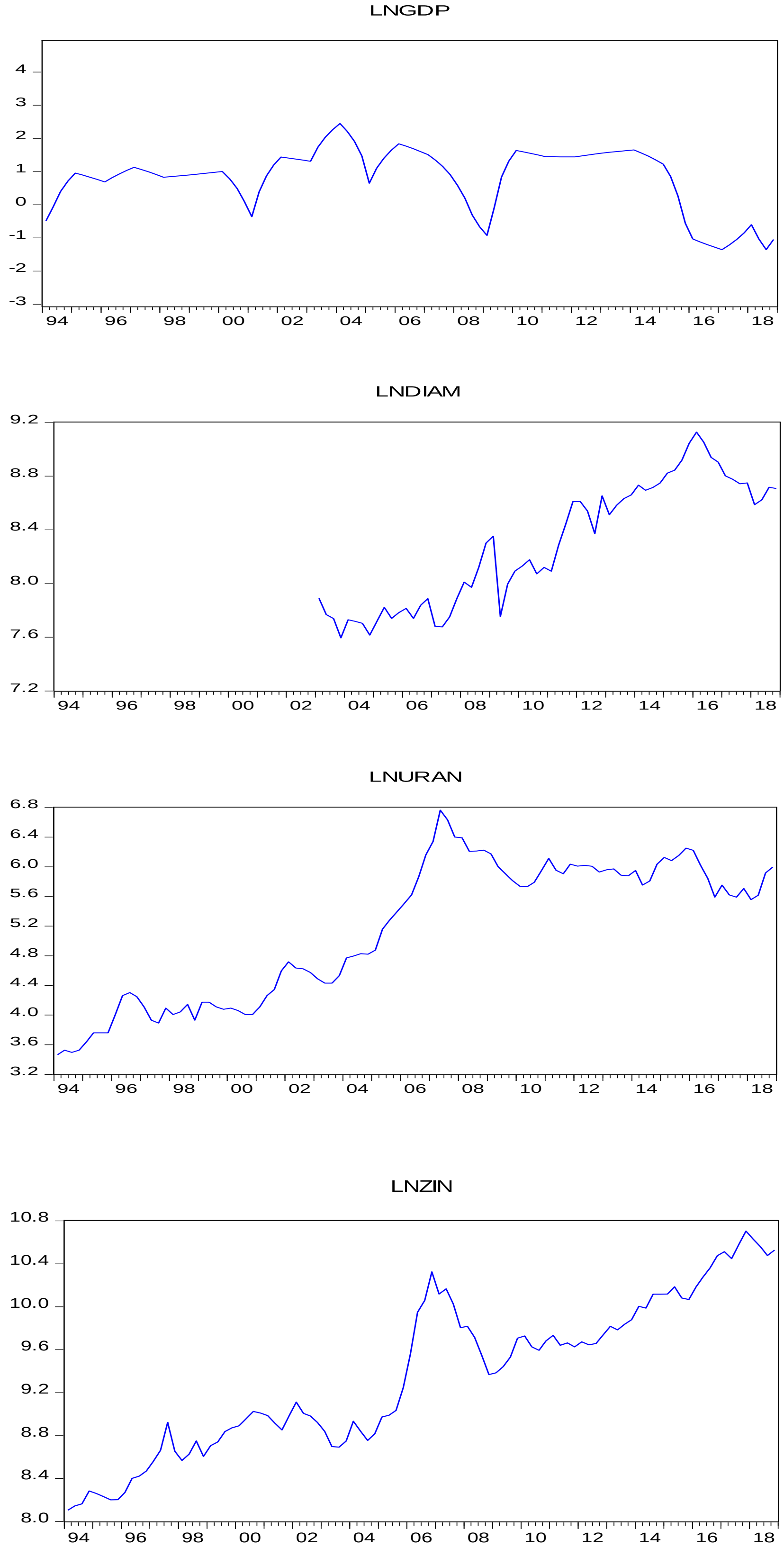
The previous chapter explained all the necessary tests that needed to be conducted in the study, and the current chapter presents the results of the study. The results provide an understanding of the relationship between the commodity prices and economic growth in Namibia as per the methodology used. Section 4.2 presents the unit root test graphical analysis of the variables that are shown to be stationary in levels and order 1. Section 4.3 discusses the unit root results of variables, while section 4.4 discusses the ARDL bounds test for cointergration. The results relating to ECM, Granger Causality and validity of the model are presented in sections 4.5, 4.6 and 4.7 respectively. The last part of the chapter is the conclusion.

Unit root test for stationary properties of the variables using Augmented Dickey–Fuller (ADF) and Phillips-Perron (PP) is employed, and if the variables are integrated of an order not higher than one then the next step is estimating the Autoregressive Distributed Lag (ARDL). ARDL examines the existence of cointegrating and long run relationships. If the series are cointegrated or have long run relationships, the Error Correction Model (ECM) is used to analyse the relationships between dependent and independent variables. Causality is then established between economic variables using Granger Causality and then validity tests.

4.2. Graphical analysis

The figures below present the unit root tests' graphical analysis of the variables.

Figure 5 Unit Root Test using the diagrammatic approach



These results are boosted by the ADF and PP unit root tests that are explained below.

4.3. Unit Root Test

The empirical estimation process regarding the study began with testing for unit roots. The unit root tests of the variables included in the model were conducted, even though the bounds approach does not necessarily require the pre-testing of variables for the presence of unit roots. The bounds test requires that none of the series be integrated of an order higher than one. This is to avert the problem of spurious regression. The Augmented Dickey-Fuller (ADF) and the Phillips-Perron (PP) tests for unit root were employed and the results are shown in Table 1 below.

Table 1: Augmented Dickey Fuller (ADF) and Phillips-Perron (PP) Unit Root

Variables	**Model**	**ADF**		**PP**		**Order of**
	Specification	**Levels**	**First Difference**	**Levels**	**First Difference**	**Intergration**
LNDIAM	Intercept	-2.908420	-2.909206**	-2.908420	-2.909206**	I(1)
	Intercept and Trend	-3.482763	-3.483970**	-3.482763	-3.483970**	I(1)
LNGDP	Intercept	-2.891234	-2.891234**	-2.890926**	-2.891234**	I(0)
	Intercept and Trend	-3.456319**	-3.456319**	-3.458319**	-3.455842**	I(0)
LNURAN	Intercept	-2.891234	-2.891234**	-2.890926	-2.891234**	I(1)
	Intercept and Trend	-3.456319	-3.456319**	-3.455842	-3.456319**	I(1)
LNZIN	Intercept	-2.891234	-2.891234**	-2.890926	-2.891234**	I(1)
	Intercept and Trend	-3.456319	-3.456319**	-3.455842	-3.456319**	I(1)

*Note: ** indicates the rejection of the null hypothesis of non-stationary at 5 percent level of significance*

Sources: Author's compilation using Eviews

The unit root tests were done using Augmented Dickey-Fuller and Phillips-Perron, in levels and first difference for all the variables using the intercepts only and intercept and trend. The results show that only GDP was found stationary in levels for both intercept and intercept and trend, and this means that lnGDP is integrated of one order I (0). All the other variables *LnDiam, LnUran and LnZin* are non-stationary in levels, but they become stationary after first differencing. LnDiam, LnUran and LnZin are integrated of order I (1). This means that the variables do not contain unit root in levels at 5 percent level of significance.

In view of this, the results from the unit root tests gave the green light to proceed with the cointegration test. Therefore, the study used the Autoregressive Distributed Lag (ARDL) bounds model to test for both the short and the long run relationships.

4.4. ARDL Bounds Tests for cointegration

The study considered the Autoregressive distributed lag (ARDL) modelling technique developed by Pesaran and Shin (1998), and Pesaran et al. (2001) due to its several advantages relative to other single equation cointegration techniques. It is capable of computing the long-run and short-run parameters of the model concurrently in order to prevent the problems posed by time series data which are nonstationary.

The first step is to estimate a VAR in which GDP is the endogenous variable and the prices of the commodities are treated as exogenous variables and the results from this estimation are used to determine the lag order. Prior to the bounds test, optimum lag selection was carried out to determine the number of lags to be included in the model. Hence, Final prediction error (FPE), Akaike Information Criteria (AIC) and Hannan-Quinn information (HQ) criterion are used to determine the optimal lag length in the equation. The maximum lag length was found to be 2.

TABLE 2: VAR Lag Order Selection

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-140.814	NA	0.002071	5.171943	5.316611	5.228030
1	117.9397	471.3021	3.56e-07	-3.497847	-2.774507*	-3.21741
2	**149.3822**	**52.77853***	**2.07e-07***	**-4.049366***	**-2.747354**	**-3.544579***
3	156.8466	11.46304	2.88e-07	-3.74452	-1.863836	-3.015383
4	164.4477	10.58733	4.06e-07	-3.444561	-0.985206	-2.491074
5	180.5710	20.15409	4.36e-07	-3.448964	-0.410936	-2.271127
6	194.4053	15.31651	5.29e-07	-3.371616	0.245083	-1.96943
7	201.9906	7.314481	8.50e-07	-3.071094	1.124277	-1.444558
8	223.2908	17.49652	9.07e-07	-3.260384	1.513659	-1.409498

Source: Author's compilation using Eviews

4.4.1 Bound Test

ARDL was chosen because it accepts the mix level of integration, which means that time series can either be at levels or first difference and that none of the variables integrate of order two. From the stationary test, the variable satisfies the ARDL assumption and it is appropriate for small sample sizes. Therefore, the ARDL bound test examined the cointegration between the variables. It is crucial to establish whether the variables have some long-term relationships, that is, the existence of a long-run equilibrium to which an economic system converges over time.

Table 3: Bound Test Result

Bound Tests	Value	Level of Significance	I(0)	I(1)
F Statistics	3.002504	5%	2.79	3.67

Source: Author's compilation using Eviews

The bound test consists of rejecting the null hypothesis of no cointegration when the probability of the F-Statistic is above the I(1) bound at 5% level of significance. Since the computed F-statistic of 3.002504 is higher than the lower bound of the critical value, the study rejects the null hypothesis of no cointegration. This means that there is a long run relationship between the variables. Therefore, the bound test has statistically proven that there is cointegration between commodity prices (diamond, uranium and zinc) and GDP, thus the next step is to estimate the Error Correction Model.

4.5. Error Correction Model

The Error Correction Model (ECM) can only be estimated if the variables in the model are cointegrated, which means that there are long run relationships between the variables. The long run model specification gets the errors from the long run model so that they can be used in the Error Correction Model. The errors that are generated are called ECT for the purposes of the ARDL ECM model that is estimated in the next section. Since the bound test's results confirm the existence of the long run relationship between the variables, the long run model is specified as:

Lngdp c lngdp(-2) lndiam(-2) lnuran(-2) lnzin(-2)

This is the model that was used to extract the residual which was then inserted in the ARDL ECM model. The -2 indicates the optimal lag length. The variables were estimated separately in order to determine the effect of each commodity price on GDP as follows:

Lngdp c lngdp(-2) lndiam(-2)
Lngdp c lngdp(-2) lnuran(-2)
Lngdp c lngdp(-2) lnzinc(-2)

Table 4: The short-run model specification

Table 4.a Short-run model specification for the price of diamond and GDP

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	3.231505	1.563994	2.066188	0.0432
LNGDP(-2)	0.823994	0.077746	10.5986	0
LNDIAM(-2)	-0.382458	0.184158	-2.076791	0.0422
R-squared	0.773699	Mean dependent var		0.790492
Adjusted R-squared	0.766028	S.D. dependent var		1.144049
S.E. of regression	0.553384	Akaike info criterion		1.701648
Sum squared resid	18.06779	Schwarz criterion		1.804573
Log likelihood	-49.75107	Hannan-Quinn criter.		1.742059
F-statistic	100.8575	Durbin-Watson stat		0.470051
Prob(F-statistic)	0			

Table 4.b Short-run model specification for the price of uranium and GDP

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.82482	0.287236	2.871579	0.005
LNGDP(-2)	0.861185	0.055988	15.38163	0
LNURAN(-2)	-0.141389	0.053839	-2.626136	0.0101
R-squared	0.723191	Mean dependent var		0.830825
Adjusted R-squared	0.717363	S.D. dependent var		0.937282
S.E. of regression	0.498293	Akaike info criterion		1.474876
Sum squared resid	23.58809	Schwarz criterion		1.554008
Log likelihood	-69.26893	Hannan-Quinn criter.		1.506883
F-statistic	124.0982	Durbin-Watson stat		0.487367
Prob(F-statistic)	0			

Table 4.c Short-run model specification for the price of zinc and GDP

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	2.749875	0.688323	3.995034	0.0001
LNGDP(-2)	0.810598	0.055847	14.5147	0
LNZINC(-2)	-0.279263	0.072003	-3.878516	0.0002
R-squared	0.743682	Mean dependent var		0.830825
Adjusted R-squared	0.738286	S.D. dependent var		0.937282
S.E. of regression	0.479494	Akaike info criterion		1.397964
Sum squared resid	21.8419	Schwarz criterion		1.477096
Log likelihood	-65.50026	Hannan-Quinn criter.		1.429972
F-statistic	137.817	Durbin-Watson stat		0.492948
Prob(F-statistic)	0			

Source: Author's compilation using Eviews

Table 4. a, b and c displays the outcomes of the short run specification, with the short run coefficients. The short run results show that all the three commodity prices,

namely, export price of diamond per carat, spot price of uranium and zinc have significant negative short-run relationships with GDP.

Error Correction Model Specification:

d(lngdp) c d(lngdp(-2)) d(lndiam(-2)) d(lnuran(-2)) d(lnzin(-2)) ecm(-2)

Ecm is the long-run representation in the model, while all other components of the equation represent the short-run coefficients. Ecm is the residual obtained from the long-run model and it is the one that gives information about the speed of adjustment of GDP towards its long run equilibrium. The variables were estimated separately in order to determine the long run effect of each commodity price on GDP as follows:

d(lngdp) c d(lngdp(-2)) d(lndiam(-2)) ecm1(-2)
d(lngdp) c d(lngdp(-2)) d(uran(-2)) ecm2(-2)
d(lngdp) c d(lngdp(-2)) d(zin(-2)) ecm3(-2)

Table 5: ARDL Error Correction Model

Table 5a ARDL Error Correction Model: GDP and unit export price for diamond

Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
C	-0.016357	0.040672	-0.402158	0.6891
D(LNGDP(-2))	0.741694	0.234559	3.162081	0.0025
D(LNDIAM(-2))	0.081104	0.315334	0.2572	0.798
ECM1(-2)	-0.370271	0.134128	-2.760584	0.0078
R-squared	0.157149	Mean dependent var		-0.055147
Adjusted R-squared	0.111996	S.D. dependent var		0.31892
S.E. of regression	0.300531	Akaike info criterion		0.497806
Sum squared resid	5.057846	Schwarz criterion		0.637429
Log likelihood	-10.93419	Hannan-Quinn criter.		0.552421
F-statistic	3.480387	Durbin-Watson stat		1.25599
Prob(F-statistic)	0.021712			

Table 5b ARDL Error Correction Model: GDP and uranium

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.005803	0.028436	-0.204068	0.8388
D(LNGDP(-2))	0.664782	0.16728	3.974062	0.0001
D(LNURAN(-2))	-0.09129	0.212417	-0.429768	0.6684
ECM2(-2)	-0.347512	0.10051	-3.457468	0.0008
R-squared	0.148612	Mean dependent var		-0.01834
Adjusted R-squared	0.120849	S.D. dependent var		0.291789
S.E. of regression	0.27359	Akaike info criterion		0.286401
Sum squared resid	6.886334	Schwarz criterion		0.393249
Log likelihood	-9.747255	Hannan-Quinn criter.		0.329591
F-statistic	5.35295	Durbin-Watson stat		1.2808
Prob(F-statistic)	0.001922			

Table 5c ARDL Error Correction Model: GDP and zinc

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.006784	0.028091	-0.241496	0.8097
D(LNGDP(-2))	0.658555	0.147234	4.472847	0
D(LNZINC(-2))	-0.094575	0.25039	-0.377712	0.7065
ECM3(-2)	-0.371248	0.091359	-4.063609	0.0001
R-squared	0.18653	Mean dependent var		-0.01834
Adjusted R-squared	0.160004	S.D. dependent var		0.291789
S.E. of regression	0.267428	Akaike info criterion		0.240842
Sum squared resid	6.57964	Schwarz criterion		0.34769
Log likelihood	-7.560427	Hannan-Quinn criter.		0.284032
F-statistic	7.031921	Durbin-Watson stat		1.322451
Prob(F-statistic)	0.000261			

Source: Author's compilation using Eviews

Table 5a, b and c shows the long run coefficients with the error correction term of the model; the (-2) is the appropriate lag length for the model. The error correction term is negative for all the commodity prices, which implies that there will be corrections of the previous errors in the subsequent periods and they are statistically significant. The coefficient determination R-squared of 0.157, 0.148 and 0.186 indicates that 15, 14 and 18 percent of the change in GDP is explained by the unit export price of diamonds, spot price of uranium and spot price of zinc, respectively. The long run results in Table 5a, 5b and 5c illustration that the unit export price of diamond has a positive relationship to GDP, while the spot price of uranium and zinc have a negative relationship with GDP.

Table 5a displays that the ECM coefficient is -0.3702, which indicates that the speed of adjustment from the short-run to the long run is at 32 percent. If there is any disequilibrium in the model, it will take the speed of 37 percent to adjust into equilibrium. The ECM for spot price of uranium and zinc is 34 and 37 percent, respectively, as shown in table 5b and 5c. This means that it will take the speed 34 and 37 percent for the spot price of uranium and zinc to adjust into equilibrium. The remaining percentages are explained by other factors not included in the equation.

There is an insignificant positive relationship between the unit export price of diamonds and economic growth in the long run, with the coefficient of -0.81104, which alludes to the fact that a one percent increase in the unit export price of diamonds rises economic growth by 0.81 percent. This is similar to the findings by Tiawara (2015) who found that an increase in commodity prices is more likely to benefit the economies than hurting them.

The insignificant inverse relationship between the spot price of uranium and economic growth displays that one percent increase in the spot price of uranium will reduce economic growth by 0.09 percent. Furthermore, there is an insignificant negative long run relationship between the spot price of zinc and economic growth, with the coefficient of -0.094575. This implies that a one percent increase in the spot price of zinc decrease economic growth by 0.094 percent. This result is similar to the findings by Barclay (2008) who concluded that the revenue generated from commodities do not always guarantee an enhanced economic.

4.6. Granger Causality

Granger Causality tests for causality among the variables. Different possible results can be expected when the Granger Causality test between variables is being carried out. There is a possibility that one variable may Granger Cause the other variable, in this case there is univariate causality, and in other cases, both variables can Granger Cause each other. This is called bivariate causality.

Granger Causality tests between two variables X and Y concluded that there is unidirectional causality from X to Y, if X Granger Causes Y, but Y does not Granger Cause X. On the other hand, Granger Causality tests conclude that there is bidirectional causality between X and Y if X Granger Causes Y and Y Granger Causes X. The table below shows the pairwise Granger Causality tests for the four variables used in the study.

Table 6: Pairwise Granger Causality Test results

Null Hypothesis:	F-Statistic	Prob.	Decision
LNZINC does not Granger Cause LNURAN	1.14792	0.3217	Fail to reject the null hypothesis
LNURAN does not Granger Cause LNZINC	0.89658	0.4115	Fail to reject the null hypothesis
LNGDP does not Granger Cause LNURAN	1.33477	0.2682	Fail to reject the null hypothesis
LNURAN does not Granger Cause LNGDP	1.46377	0.2366	Fail to reject the null hypothesis
LNDIAM does not Granger Cause LNURAN	0.35455	0.703	Fail to reject the null hypothesis
LNURAN does not Granger Cause LNDIAM	1.28679	0.2841	Fail to reject the null hypothesis
LNGDP does not Granger Cause LNZINC	1.29024	0.2801	Fail to reject the null hypothesis
LNZINC does not Granger Cause LNGDP	2.98321	0.0555	Reject the null hypothesis
LNDIAM does not Granger Cause LNZINC	1.53897	0.2234	Fail to reject the null hypothesis
LNZINC does not Granger Cause LNDIAM	1.27293	0.2878	Fail to reject the null hypothesis
LNDIAM does not Granger Cause LNGDP	0.77025	0.4677	Fail to reject the null hypothesis
LNGDP does not Granger Cause LNDIAM	0.93547	0.3983	Fail to reject the null hypothesis

Null hypothesis rejected at 5% level of significance

Source: Author's compilation using Eviews

The results in Table 6 indicate that GDP does not Granger Cause the price of diamonds and price of diamond do not Granger Cause GDP. This means that there is no causality between GDP and the price of diamonds. Similarly, the price of uranium does not Granger Cause the price of diamonds and the price of diamonds does not Granger

Cause the price of uranium. This means that there is no causality between the prices of diamonds and uranium. Furthermore, the price of zinc does not Granger Cause the price of diamonds and the price of diamonds also does not Granger Cause the price of zinc. The price of uranium and GDP do not Granger Cause each other. However, there is a unidirectional causality between the price of zinc and GDP growth rate. Causality runs from the price of zinc to GDP but GDP does not Granger Cause the prices of zinc. Table 6 further indicates that there is no causality between the price of uranium and zinc. The study failed to reject the null hypothesis of no causality between the two variables.

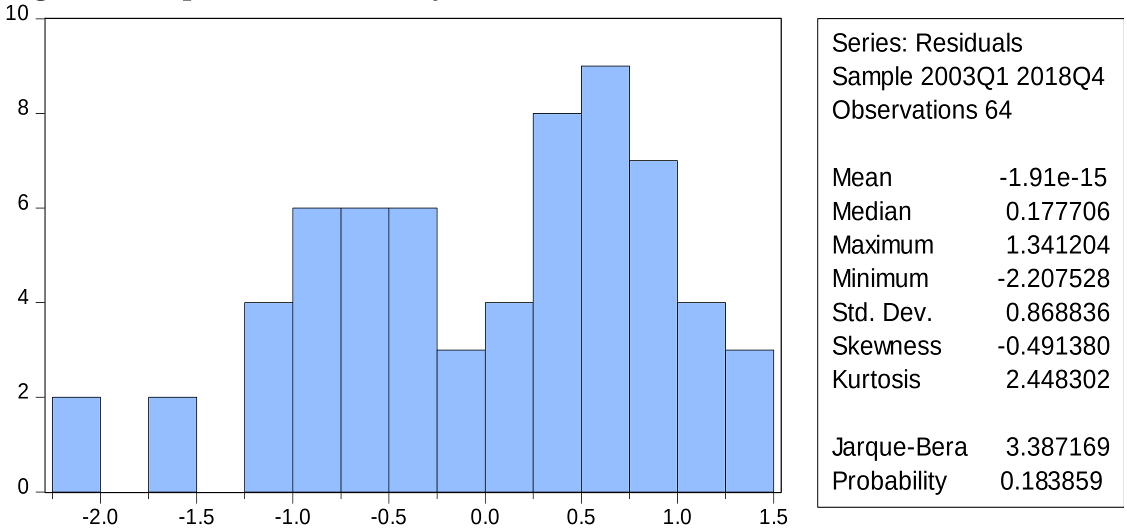
4.7. Validity of the model

To test for the statistical validity of the model, normality, autocorrelation, heteroscedasticity and stability tests were used in the study. The results of these tests are explained as follows:

4.7.1 Normality test

The normality test shows that the residuals in the ARDL ECM are normally distributed as the probability of 0.183859 is above 5% level of significance. This is what is considered good for the model because the probability is greater than 5% level of significance.

Figure 5 Jarque-Bera Normality Test



Source: Authors compilation using Eviews

4.7.2 Autocorrelation Test

Table 7: Breusch-Godfrey Serial Correction LM Test

F-statistic	1.484495	Prob. F(1,31)	0.2320
Obs*R-squared	1.729018	Prob. Chi-Square(1)	0.1885

Source: Author's compilation using Eviews

The study fails to reject the null hypothesis of no serial correlation and thus it can be concluded that there is no serial correlation.

4.7.3 Heteroscedasticity Test

Table 8: Breusch-Pagan-Godfrey Test

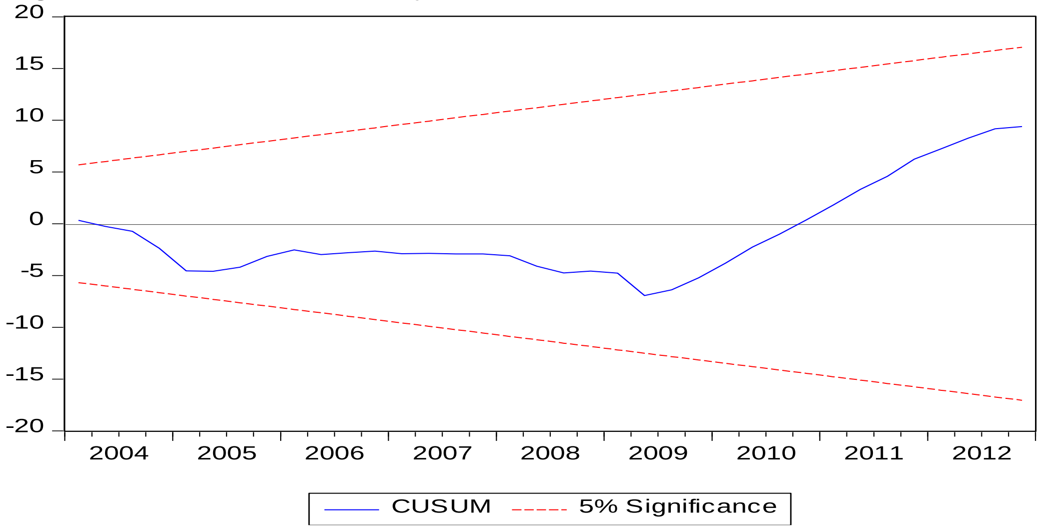
F-statistic	1.451640	Prob. F(11,24)	0.2321
Obs*R-squared	7.031358	Prob. Chi-Square(11)	0.2183
Scaled explained SS	4.594889	Prob. Chi-Square(11)	0.4673

Source: Author's compilation using Eviews

The Breusch-Pagan-Godfrey test for heteroscedasticity indicates that the data set is homoscedastic.

4.7.4 The CUSUM Stability Test

Figure 6 The CUSUM Stability Test



Source: Author's compilation using Eviews

The CUSUM Test shows that the variables in the model are stable. All the tests conducted above indicate that the results in the ARDL ECM are valid. This proves the fact that there is no problem with the results obtained.

4.8. Conclusion

The current chapter discussed the results related to the study. Unit root tests results indicated that only GDP was found stationary in level, the prices of the commodities were found stationary after first differencing. The bound test results confirmed the long run relationship between the commodity prices and economic growth. The study established that there is no causal relationship between GDP, the price of diamonds, and uranium, but there is a unidirectional causal relationship between zinc and GDP as the price of zinc Granger Causes GDP. The study further established that the models estimated were valid and this was tested by using the normality, autocorrelation, heteroscedasticity, and the CUSUM tests.

CHAPTER FIVE

CONCLUSION AND RECOMMENDATIONS

5.1. Conclusion

The study aimed to examine the relationship between the commodity prices and economic growth in Namibia. The study used the unit export price for diamonds, spot price of uranium, spot price of zinc and the real GDP growth rate as a proxy for economic growth. The data set covered the period of 1994Q1 to 2018Q4 for GDP growth rate, spot price of uranium and zinc. The data for the unit export price for diamonds covered the period of 2003Q1 to 2018Q4. This is because the data for the other periods was not available. Through the ARDL approach, the study used analysis tests such as unit root, bound test, Error Correction Model (ECM), and Granger Causality. To check the statistical validity of the model, normality, autocorrelation, heteroscedasticity and CUSUM stability tests were used.

The unit root test results revealed that the GDP growth rate was found stationary in levels; the unit export for diamonds, spot price of uranium and zinc were found stationary in order (1). Since none of the variables is integrate of order two from the stationary test, the variables satisfy the ARDL assumption which was carried out to examine if the variables have long run relationships or not. The cointergration test results established that there is a long run relationship between the commodity prices and economic growth, and this means that the variables are cointergrated.

Though insignificant, there is a positive relationship between economic growth and unit export price for diamond, and negative relationship between economic growth and the spot price of uranium and zinc. According to the error correction model, the deviation in the system from the short run to the long run equilibrium can be adjusted at a speed of percent of 15, 14 and 18 percent for unit export price of diamond, spot price of uranium and zinc, respectively. The Granger Causality test indicates that there is a bidirectional causality relationship from spot prices of zinc to GDP growth rate, and there are no causal relationships between GDP, unit export price of diamonds and the spot price of uranium.

The Jarque-Bera normality test shows that the residuals in the ARDL ECM are normally distributed and the Breusch-Godfrey Test concluded that there is no serial correlation in the model. The Breusch-Pagan-Godfrey test for heteroscedasticity indicates that the data set is homoscedastic. The CUSUM Tests show that the variables in the model are stable. This points to the fact that the ARDL ECM results are valid.

In response to the question on the relationship between the commodity prices and economic growth in Namibia, the study established that there is an existence of a long run relationship between GDP, the unit export price of diamonds and the spot price of zinc and uranium. The results displayed that there is an insignificant inverse long run relationship between spot price of uranium, zinc and GDP. However, a positive insignificant long run relationship between the unit export price of diamonds and GDP was identified.

5.2. Recommendations

The recommendations are based on the results of the relationship between the unit export price of diamonds, spot price of uranium, zinc price and GDP growth rate. According to the Bank of Namibia (2014), only 10 percent of cuttable diamond production is made available to local cutting and polishing companies and the rest is exported in raw form, hence the need to increase the 10 percent for local cutting and polishing. The study found a an insignificant positive relationship between the unit export price of diamonds and economic growth in the long run and a significant positive relationship in the short run, thus increasing the percentage for local cutting and polishing will have a positive impact on economic growth as Namibia will export diamonds in raw form and polished ones, and at higher prices because of the beneficiation. For Namibia to boost further beneficiation of cut and polished diamonds into jewellery, significant investment is needed. This investment should focus on costs in equipment purchases, finding skills in a country that is new to the industry and saddled with a majority-unskilled workforce.

An insignificant negative relationship between the price of zinc and economic growth can be improved by focusing on zinc concentrates as most of its proceeds are captured in producing zinc concentrates rather than smelting zinc. The study recommends that mining and producing zinc concentrates should be encouraged in Namibia, and upstream integration should be the focus for this commodity as it would benefit more from exposure to the commodity price, and may lead to greater impact on economic growth.

Uranium enrichment is expensive as it requires a very high degree of skills from a very small number of people, and the initial conversion generates very little additional value. Once converted into fuel rods, however, uranium can be used to power nuclear power stations. For Namibia, it appears unlikely that nuclear power-stations will be of use. Given the fact that Namibia needs access to cheap power in order to industrialise, and would need to sell the excess (expensive) power into the region (where cheaper thermal power is available), it is highly unlikely that a nuclear power plant will be viable in Namibia for a number of decades. However, on the off-chance that such a plant becomes viable, it is still likely to be more efficient to purchase enriched uranium from one of the global enrichers than to carry out that phase of the value-chain in Namibia.

Namibia should invest in beneficiation or value addition of some commodities. Value-addition has become a globally accepted remedy for economic growth as it leads to employment creation, higher commodity prices and an improved balance of trade.

5.3 Areas of further study

The study suggests that further research be carried out on the impact of commodity prices and economic growth in Namibia. There are several commodities in Namibia which were not included in the study hence a suggestion that future researchers review those other commodities and how they relate to GDP. Furthermore, other researchers can extend the period of data coverage for the commodities used in this study as they may get different results. Researchers may also consider using different methodologies such as VAR which uses analysis as impulse response and variance decomposition and yield different results. Therefore, the given scenario suits well for future research in search for how commodity prices relate to economic growth.

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APPENDICES FOR REGRESSIONS
ADF LEVEL INTERCEPT

Null Hypothesis: LNGDP has a unit root
Exogenous: Constant
Lag Length: 1 (Automatic - based on SIC, maxlag=12)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-2.984028	0.0399
Test critical values:	1% level	-3.498439	
	5% level	-2.891234	
	10% level	-2.582678	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LNGDP)
Method: Least Squares
Date: 02/26/22 Time: 00:42
Sample (adjusted): 1994Q3 2018Q4
Included observations: 98 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNGDP(-1)	-0.078404	0.026275	-2.984028	0.0036
D(LNGDP(-1))	0.625903	0.081813	7.650445	0.0000
C	0.061448	0.032388	1.897274	0.0608

R-squared	0.388432	Mean dependent var	-0.010041
Adjusted R-squared	0.375557	S.D. dependent var	0.294675
S.E. of regression	0.232857	Akaike info criterion	-0.046650
Sum squared resid	5.151132	Schwarz criterion	0.032482
Log likelihood	5.285826	Hannan-Quinn criter.	-0.014642
F-statistic	30.16916	Durbin-Watson stat	1.838758
Prob(F-statistic)	0.000000		

FIRST DIFFERENCE INTERCEPT

Null Hypothesis: D(LNGDP) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=12)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-5.146258	0.0000
Test critical values:	1% level	-3.498439	
	5% level	-2.891234	
	10% level	-2.582678	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LNGDP,2)
Method: Least Squares
Date: 02/26/22 Time: 00:44

Sample (adjusted): 1994Q3 2018Q4
Included observations: 98 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LNGDP(-1))	-0.427437	0.083058	-5.146258	0.0000
C	-0.004953	0.024482	-0.202319	0.8401

R-squared	0.216224	Mean dependent var	-0.001155
Adjusted R-squared	0.208060	S.D. dependent var	0.272223
S.E. of regression	0.242254	Akaike info criterion	0.022537
Sum squared resid	5.633951	Schwarz criterion	0.075291
Log likelihood	0.895691	Hannan-Quinn criter.	0.043875
F-statistic	26.48397	Durbin-Watson stat	1.748022
Prob(F-statistic)	0.000001		

FIRST DIFFERENCE INTERCEPT AND TREND

Null Hypothesis: D(LNGDP) has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 0 (Automatic - based on SIC, maxlag=12)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-5.130492	0.0003
Test critical values:	1% level	-4.054393	
	5% level	-3.456319	
	10% level	-3.153989	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LNGDP,2)
Method: Least Squares
Date: 02/26/22 Time: 00:44
Sample (adjusted): 1994Q3 2018Q4
Included observations: 98 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LNGDP(-1))	-0.437541	0.085282	-5.130492	0.0000
C	0.020102	0.051004	0.394137	0.6944
@TREND("1994Q1")	-0.000498	0.000888	-0.560589	0.5764

R-squared	0.218808	Mean dependent var	-0.001155
Adjusted R-squared	0.202362	S.D. dependent var	0.272223
S.E. of regression	0.243124	Akaike info criterion	0.039643
Sum squared resid	5.615375	Schwarz criterion	0.118774
Log likelihood	1.057516	Hannan-Quinn criter.	0.071650
F-statistic	13.30452	Durbin-Watson stat	1.738617
Prob(F-statistic)	0.000008		

LEVELS INTERCEPT AND TREND

Null Hypothesis: LNGDP has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 1 (Automatic - based on SIC, maxlag=12)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-3.272530	0.0770
Test critical values:	1% level	-4.054393	
	5% level	-3.456319	
	10% level	-3.153989	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LNGDP)
Method: Least Squares
Date: 02/26/22 Time: 00:45
Sample (adjusted): 1994Q3 2018Q4
Included observations: 98 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNGDP(-1)	-0.088666	0.027094	-3.272530	0.0015
D(LNGDP(-1))	0.607380	0.082384	7.372565	0.0000
C	0.133385	0.059653	2.236026	0.0277
@TREND("1994Q1")	-0.001257	0.000877	-1.432736	0.1553

R-squared	0.401501	Mean dependent var	-0.010041
Adjusted R-squared	0.382400	S.D. dependent var	0.294675
S.E. of regression	0.231578	Akaike info criterion	-0.047844
Sum squared resid	5.041047	Schwarz criterion	0.057665
Log likelihood	6.344351	Hannan-Quinn criter.	-0.005168
F-statistic	21.01989	Durbin-Watson stat	1.827054
Prob(F-statistic)	0.000000		

PP LEVELS INTERCEPT

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

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-2.051967	0.2646
Test critical values:	1% level	-3.497727	
	5% level	-2.890926	
	10% level	-2.582514	

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

Residual variance (no correction)	0.085531
HAC corrected variance (Bartlett kernel)	0.177837

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

Method: Least Squares
Date: 02/26/22 Time: 00:46
Sample (adjusted): 1994Q2 2018Q4
Included observations: 99 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNGDP(-1)	-0.040449	0.032197	-1.256302	0.2120
C	0.027769	0.039895	0.696042	0.4881

R-squared	0.016011	Mean dependent var	-0.005703
Adjusted R-squared	0.005866	S.D. dependent var	0.296327
S.E. of regression	0.295457	Akaike info criterion	0.419408
Sum squared resid	8.467595	Schwarz criterion	0.471834
Log likelihood	-18.76068	Hannan-Quinn criter.	0.440620
F-statistic	1.578294	Durbin-Watson stat	0.815839
Prob(F-statistic)	0.212024		

FIRST DIFFERENCE INTERCEPT

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

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-5.280200	0.0000
Test critical values:	1% level	-3.498439	
	5% level	-2.891234	
	10% level	-2.582678	

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

Residual variance (no correction)	0.057489
HAC corrected variance (Bartlett kernel)	0.062813

Phillips-Perron Test Equation
Dependent Variable: D(LNGDP,2)
Method: Least Squares
Date: 02/26/22 Time: 00:47
Sample (adjusted): 1994Q3 2018Q4
Included observations: 98 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LNGDP(-1))	-0.427437	0.083058	-5.146258	0.0000
C	-0.004953	0.024482	-0.202319	0.8401

R-squared	0.216224	Mean dependent var	-0.001155
Adjusted R-squared	0.208060	S.D. dependent var	0.272223
S.E. of regression	0.242254	Akaike info criterion	0.022537
Sum squared resid	5.633951	Schwarz criterion	0.075291
Log likelihood	0.895691	Hannan-Quinn criter.	0.043875
F-statistic	26.48397	Durbin-Watson stat	1.748022
Prob(F-statistic)	0.000001		

FIRST DIFFERENCE INTERCEPT AND TREND

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

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-5.279500	0.0002
Test critical values:	1% level	-4.054393	
	5% level	-3.456319	
	10% level	-3.153989	

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

Residual variance (no correction)	0.057300
HAC corrected variance (Bartlett kernel)	0.062859

Phillips-Perron Test Equation
Dependent Variable: D(LNGDP,2)
Method: Least Squares
Date: 02/26/22 Time: 00:48
Sample (adjusted): 1994Q3 2018Q4
Included observations: 98 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LNGDP(-1))	-0.437541	0.085282	-5.130492	0.0000
C	0.020102	0.051004	0.394137	0.6944
@TREND("1994Q1")	-0.000498	0.000888	-0.560589	0.5764

R-squared	0.218808	Mean dependent var	-0.001155
Adjusted R-squared	0.202362	S.D. dependent var	0.272223
S.E. of regression	0.243124	Akaike info criterion	0.039643
Sum squared resid	5.615375	Schwarz criterion	0.118774
Log likelihood	1.057516	Hannan-Quinn criter.	0.071650
F-statistic	13.30452	Durbin-Watson stat	1.738617
Prob(F-statistic)	0.000008		

LEVELS INTERCEPT AND TREND

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

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-2.447991	0.3531
Test critical values:	1% level	-4.053392	
	5% level	-3.455842	
	10% level	-3.153710	

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

Residual variance (no correction)	0.080917
HAC corrected variance (Bartlett kernel)	0.162865

Phillips-Perron Test Equation
Dependent Variable: D(LNGDP)
Method: Least Squares
Date: 02/26/22 Time: 00:49
Sample (adjusted): 1994Q2 2018Q4
Included observations: 99 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNGDP(-1)	-0.060770	0.032655	-1.860955	0.0658
C	0.167875	0.071465	2.349057	0.0209
@TREND("1994Q1")	-0.002466	0.001054	-2.339733	0.0214

R-squared	0.069095	Mean dependent var	-0.005703
Adjusted R-squared	0.049701	S.D. dependent var	0.296327
S.E. of regression	0.288870	Akaike info criterion	0.384152
Sum squared resid	8.010784	Schwarz criterion	0.462792
Log likelihood	-16.01552	Hannan-Quinn criter.	0.415970
F-statistic	3.562723	Durbin-Watson stat	0.846077
Prob(F-statistic)	0.032171		

LNURAN

ADF

LEVELS, INTERCEPT

Null Hypothesis: LNURAN has a unit root
Exogenous: Constant
Lag Length: 1 (Automatic - based on SIC, maxlag=12)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-1.542904	0.5078
Test critical values:	1% level	-3.498439	
	5% level	-2.891234	
	10% level	-2.582678	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LNURAN)
Method: Least Squares
Date: 04/20/21 Time: 17:29
Sample (adjusted): 1994Q3 2018Q4
Included observations: 98 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNURAN(-1)	-0.021746	0.014094	-1.542904	0.1262

D(LNURAN(-1))	0.265925	0.097675	2.722538	0.0077
C	0.130731	0.073949	1.767856	0.0803

R-squared	0.094954	Mean dependent var	0.025205
Adjusted R-squared	0.075901	S.D. dependent var	0.134030
S.E. of regression	0.128844	Akaike info criterion	-1.230301
Sum squared resid	1.577065	Schwarz criterion	-1.151169
Log likelihood	63.28473	Hannan-Quinn criter.	-1.198294
F-statistic	4.983542	Durbin-Watson stat	1.983131
Prob(F-statistic)	0.008747		

LEVEL, INTERECPT AND TREND

Null Hypothesis: LNURAN has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 1 (Automatic - based on SIC, maxlag=12)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-1.731918	0.7296
Test critical values:	1% level	-4.054393	
	5% level	-3.456319	
	10% level	-3.153989	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LNURAN)
Method: Least Squares
Date: 04/20/21 Time: 17:49
Sample (adjusted): 1994Q3 2018Q4
Included observations: 98 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNURAN(-1)	-0.048960	0.028269	-1.731918	0.0866
D(LNURAN(-1))	0.288533	0.099659	2.895194	0.0047
C	0.218434	0.108152	2.019689	0.0463
@TREND("1994Q1")	0.001032	0.000930	1.110090	0.2698

R-squared	0.106666	Mean dependent var	0.025205
Adjusted R-squared	0.078155	S.D. dependent var	0.134030
S.E. of regression	0.128686	Akaike info criterion	-1.222917
Sum squared resid	1.556657	Schwarz criterion	-1.117408
Log likelihood	63.92293	Hannan-Quinn criter.	-1.180241
F-statistic	3.741251	Durbin-Watson stat	1.999481
Prob(F-statistic)	0.013725		

FIRST DIFFERENCE, INTERCEPT

Null Hypothesis: D(LNURAN) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=12)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-7.432495	0.0000
Test critical values:	1% level	-3.498439	

	5% level	-2.891234
	10% level	-2.582678

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LNURAN,2)
Method: Least Squares
Date: 04/20/21 Time: 17:50
Sample (adjusted): 1994Q3 2018Q4
Included observations: 98 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LNURAN(-1))	-0.731022	0.098355	-7.432495	0.0000
C	0.018479	0.013337	1.385552	0.1691

R-squared	0.365256	Mean dependent var	0.000200
Adjusted R-squared	0.358644	S.D. dependent var	0.162037
S.E. of regression	0.129767	Akaike info criterion	-1.225959
Sum squared resid	1.616583	Schwarz criterion	-1.173205
Log likelihood	62.07200	Hannan-Quinn criter.	-1.204621
F-statistic	55.24198	Durbin-Watson stat	1.983390
Prob(F-statistic)	0.000000		

FIRST DIFFERENCE, INTERCEPT AND TREND
Null Hypothesis: D(LNURAN) has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 0 (Automatic - based on SIC, maxlag=12)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-7.457007	0.0000
Test critical values:	1% level	-4.054393	
	5% level	-3.456319	
	10% level	-3.153989	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LNURAN,2)
Method: Least Squares
Date: 04/20/21 Time: 17:51
Sample (adjusted): 1994Q3 2018Q4
Included observations: 98 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LNURAN(-1))	-0.740351	0.099283	-7.457007	0.0000
C	0.037106	0.027401	1.354193	0.1789
@TREND("1994Q1")	-0.000364	0.000468	-0.778698	0.4381

R-squared	0.369281	Mean dependent var	0.000200
Adjusted R-squared	0.356003	S.D. dependent var	0.162037
S.E. of regression	0.130034	Akaike info criterion	-1.211914
Sum squared resid	1.606330	Schwarz criterion	-1.132782
Log likelihood	62.38377	Hannan-Quinn criter.	-1.179906
F-statistic	27.81092	Durbin-Watson stat	1.977896
Prob(F-statistic)	0.000000		

PP, LEVEL, INTERCEPT

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

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-1.575050	0.4915
Test critical values:	1% level	-3.497727	
	5% level	-2.890926	
	10% level	-2.582514	

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

Residual variance (no correction)	0.017173
HAC corrected variance (Bartlett kernel)	0.026379

Phillips-Perron Test Equation
Dependent Variable: D(LNURAN)
Method: Least Squares
Date: 04/20/21 Time: 17:54
Sample (adjusted): 1994Q2 2018Q4
Included observations: 99 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNURAN(-1)	-0.022471	0.014240	-1.578068	0.1178
C	0.141094	0.074410	1.896173	0.0609

R-squared	0.025031	Mean dependent var	0.025563
Adjusted R-squared	0.014979	S.D. dependent var	0.133392
S.E. of regression	0.132390	Akaike info criterion	-1.186140
Sum squared resid	1.700119	Schwarz criterion	-1.133714
Log likelihood	60.71394	Hannan-Quinn criter.	-1.164928
F-statistic	2.490298	Durbin-Watson stat	1.464939
Prob(F-statistic)	0.117806		

LEVELS, INTERCEPT AND TREND

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

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-1.619815	0.7782
Test critical values:	1% level	-4.053392	
	5% level	-3.455842	
	10% level	-3.153710	

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

Residual variance (no correction)	0.017126
HAC corrected variance (Bartlett kernel)	0.026980

Phillips-Perron Test Equation
Dependent Variable: D(LNURAN)
Method: Least Squares
Date: 04/20/21 Time: 17:55
Sample (adjusted): 1994Q2 2018Q4
Included observations: 99 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNURAN(-1)	-0.035258	0.028725	-1.227450	0.2227
C	0.182736	0.110285	1.656947	0.1008
@TREND("1994Q1")	0.000482	0.000939	0.513213	0.6090

R-squared	0.027698	Mean dependent var	0.025563
Adjusted R-squared	0.007442	S.D. dependent var	0.133392
S.E. of regression	0.132895	Akaike info criterion	-1.168678
Sum squared resid	1.695468	Schwarz criterion	-1.090038
Log likelihood	60.84957	Hannan-Quinn criter.	-1.136860
F-statistic	1.367387	Durbin-Watson stat	1.450509
Prob(F-statistic)	0.259688		

FIRST DIFFERENCE, INTERCEPT

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

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-7.450883	0.0000
Test critical values:	1% level	-3.498439	
	5% level	-2.891234	
	10% level	-2.582678	

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

Residual variance (no correction)	0.016496
HAC corrected variance (Bartlett kernel)	0.016782

Phillips-Perron Test Equation
Dependent Variable: D(LNURAN,2)
Method: Least Squares
Date: 04/20/21 Time: 17:56
Sample (adjusted): 1994Q3 2018Q4
Included observations: 98 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LNURAN(-1))	-0.731022	0.098355	-7.432495	0.0000
C	0.018479	0.013337	1.385552	0.1691

R-squared	0.365256	Mean dependent var	0.000200

Adjusted R-squared	0.358644	S.D. dependent var	0.162037
S.E. of regression	0.129767	Akaike info criterion	-1.225959
Sum squared resid	1.616583	Schwarz criterion	-1.173205
Log likelihood	62.07200	Hannan-Quinn criter.	-1.204621
F-statistic	55.24198	Durbin-Watson stat	1.983390
Prob(F-statistic)	0.000000		

FIRST DIFFERENCE, INTERCEPT AND TREND

Null Hypothesis: D(LNURAN) has a unit root
Exogenous: Constant, Linear Trend
Bandwidth: 3 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-7.495102	0.0000
Test critical values:	1% level	-4.054393	
	5% level	-3.456319	
	10% level	-3.153989	

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

Residual variance (no correction)	0.016391
HAC corrected variance (Bartlett kernel)	0.016972

Phillips-Perron Test Equation
Dependent Variable: D(LNURAN,2)
Method: Least Squares
Date: 04/20/21 Time: 17:57
Sample (adjusted): 1994Q3 2018Q4
Included observations: 98 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LNURAN(-1))	-0.740351	0.099283	-7.457007	0.0000
C	0.037106	0.027401	1.354193	0.1789
@TREND("1994Q1")	-0.000364	0.000468	-0.778698	0.4381

R-squared	0.369281	Mean dependent var	0.000200
Adjusted R-squared	0.356003	S.D. dependent var	0.162037
S.E. of regression	0.130034	Akaike info criterion	-1.211914
Sum squared resid	1.606330	Schwarz criterion	-1.132782
Log likelihood	62.38377	Hannan-Quinn criter.	-1.179906
F-statistic	27.81092	Durbin-Watson stat	1.977896
Prob(F-statistic)	0.000000		

LNZINC

ADF

LEVELS, INTERCEPT

Null Hypothesis: LNZIN has a unit root
Exogenous: Constant
Lag Length: 1 (Automatic - based on SIC, maxlag=12)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-1.073041	0.7239
Test critical values:	1% level	-3.498439	
	5% level	-2.891234	
	10% level	-2.582678	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LNZIN)
Method: Least Squares
Date: 04/20/21 Time: 17:58
Sample (adjusted): 1994Q3 2018Q4
Included observations: 98 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNZIN(-1)	-0.016877	0.015728	-1.073041	0.2860
D(LNZIN(-1))	0.248286	0.099158	2.503937	0.0140
C	0.176316	0.147533	1.195099	0.2350

R-squared	0.069736	Mean dependent var	0.024315
Adjusted R-squared	0.050152	S.D. dependent var	0.111008
S.E. of regression	0.108188	Akaike info criterion	-1.579753
Sum squared resid	1.111947	Schwarz criterion	-1.500622
Log likelihood	80.40791	Hannan-Quinn criter.	-1.547746
F-statistic	3.560801	Durbin-Watson stat	2.020337
Prob(F-statistic)	0.032269		

FIRST DIFFERENCE, INTERCEPT

Null Hypothesis: D(LNZIN) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=12)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-7.654016	0.0000
Test critical values:	1% level	-3.498439	
	5% level	-2.891234	
	10% level	-2.582678	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LNZIN,2)
Method: Least Squares
Date: 04/20/21 Time: 17:59

Sample (adjusted): 1994Q3 2018Q4
Included observations: 98 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LNZIN(-1))	-0.758162	0.099054	-7.654016	0.0000
C	0.018463	0.011197	1.648972	0.1024

R-squared	0.378978	Mean dependent var	0.000117
Adjusted R-squared	0.372509	S.D. dependent var	0.136684
S.E. of regression	0.108274	Akaike info criterion	-1.588114
Sum squared resid	1.125424	Schwarz criterion	-1.535360
Log likelihood	79.81759	Hannan-Quinn criter.	-1.566776
F-statistic	58.58397	Durbin-Watson stat	2.016274
Prob(F-statistic)	0.000000		

LEVELS, TREND AND INTERCEPT

Null Hypothesis: LNZIN has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 1 (Automatic - based on SIC, maxlag=12)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-3.005225	0.1362
Test critical values:	1% level	-4.054393	
	5% level	-3.456319	
	10% level	-3.153989	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LNZIN)
Method: Least Squares
Date: 04/20/21 Time: 18:02
Sample (adjusted): 1994Q3 2018Q4
Included observations: 98 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNZIN(-1)	-0.132374	0.044048	-3.005225	0.0034
D(LNZIN(-1))	0.307147	0.098078	3.131669	0.0023
C	1.103578	0.361235	3.055012	0.0029
@TREND("1994Q1")	0.003023	0.001082	2.793519	0.0063

R-squared	0.141046	Mean dependent var	0.024315
Adjusted R-squared	0.113632	S.D. dependent var	0.111008
S.E. of regression	0.104511	Akaike info criterion	-1.639097
Sum squared resid	1.026711	Schwarz criterion	-1.533588
Log likelihood	84.31576	Hannan-Quinn criter.	-1.596421
F-statistic	5.145130	Durbin-Watson stat	2.080885
Prob(F-statistic)	0.002447		

FIRST DIFFERENCE, INTERCEPT AND TREND

Null Hypothesis: D(LNZIN) has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 0 (Automatic - based on SIC, maxlag=12)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-7.614345	0.0000
Test critical values:	1% level	-4.054393	
	5% level	-3.456319	
	10% level	-3.153989	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LNZIN,2)
Method: Least Squares
Date: 04/20/21 Time: 18:04
Sample (adjusted): 1994Q3 2018Q4
Included observations: 98 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LNZIN(-1))	-0.758306	0.099589	-7.614345	0.0000
C	0.019957	0.022668	0.880425	0.3809
@TREND("1994Q1")	-2.95E-05	0.000389	-0.075932	0.9396

R-squared	0.379016	Mean dependent var	0.000117
Adjusted R-squared	0.365943	S.D. dependent var	0.136684
S.E. of regression	0.108839	Akaike info criterion	-1.567767
Sum squared resid	1.125356	Schwarz criterion	-1.488635
Log likelihood	79.82056	Hannan-Quinn criter.	-1.535759
F-statistic	28.99150	Durbin-Watson stat	2.016103
Prob(F-statistic)	0.000000		

PP, LEVELS, INTERCEPT

Null Hypothesis: LNZIN has a unit root
Exogenous: Constant
Bandwidth: 3 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-1.056429	0.7303
Test critical values:	1% level	-3.497727	
	5% level	-2.890926	
	10% level	-2.582514	

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

Residual variance (no correction)	0.011973
HAC corrected variance (Bartlett kernel)	0.017723

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

Method: Least Squares
Date: 04/20/21   Time: 18:08
Sample (adjusted): 1994Q2 2018Q4
Included observations: 99 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNZIN(-1)	-0.014424	0.015783	-0.913928	0.3630
C	0.159340	0.147986	1.076726	0.2843

R-squared	0.008537	Mean dependent var	0.024473
Adjusted R-squared	-0.001684	S.D. dependent var	0.110451
S.E. of regression	0.110544	Akaike info criterion	-1.546810
Sum squared resid	1.185339	Schwarz criterion	-1.494384
Log likelihood	78.56711	Hannan-Quinn criter.	-1.525598
F-statistic	0.835265	Durbin-Watson stat	1.507038
Prob(F-statistic)	0.363021		

FIRST DIFFERENCE, INTERECPT

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

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-7.654016	0.0000
Test critical values:	1% level	-3.498439	
	5% level	-2.891234	
	10% level	-2.582678	

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

Residual variance (no correction)	0.011484
HAC corrected variance (Bartlett kernel)	0.011484

Phillips-Perron Test Equation
Dependent Variable: D(LNZIN,2)
Method: Least Squares
Date: 04/20/21   Time: 18:09
Sample (adjusted): 1994Q3 2018Q4
Included observations: 98 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LNZIN(-1))	-0.758162	0.099054	-7.654016	0.0000
C	0.018463	0.011197	1.648972	0.1024

R-squared	0.378978	Mean dependent var	0.000117
Adjusted R-squared	0.372509	S.D. dependent var	0.136684
S.E. of regression	0.108274	Akaike info criterion	-1.588114
Sum squared resid	1.125424	Schwarz criterion	-1.535360
Log likelihood	79.81759	Hannan-Quinn criter.	-1.566776
F-statistic	58.58397	Durbin-Watson stat	2.016274
Prob(F-statistic)	0.000000		

LEVELS, INTERECEPT AND TREND

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

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-2.893300	0.1692
Test critical values:	1% level	-4.053392	
	5% level	-3.455842	
	10% level	-3.153710	

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

Residual variance (no correction)	0.011453
HAC corrected variance (Bartlett kernel)	0.019135

Phillips-Perron Test Equation
Dependent Variable: D(LNZIN)
Method: Least Squares
Date: 04/20/21 Time: 18:10
Sample (adjusted): 1994Q2 2018Q4
Included observations: 99 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNZIN(-1)	-0.101767	0.044611	-2.281229	0.0247
C	0.861240	0.366251	2.351505	0.0207
@TREND("1994Q1")	0.002295	0.001099	2.088275	0.0394

R-squared	0.051619	Mean dependent var	0.024473
Adjusted R-squared	0.031861	S.D. dependent var	0.110451
S.E. of regression	0.108677	Akaike info criterion	-1.571033
Sum squared resid	1.133833	Schwarz criterion	-1.492393
Log likelihood	80.76612	Hannan-Quinn criter.	-1.539215
F-statistic	2.612549	Durbin-Watson stat	1.446617
Prob(F-statistic)	0.078557		

FIRST DIFFERENCE, INTERCEPT AND TREND

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

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-7.614345	0.0000
Test critical values:	1% level	-4.054393	
	5% level	-3.456319	
	10% level	-3.153989	

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

Residual variance (no correction)	0.011483

HAC corrected variance (Bartlett kernel)	0.011483

Phillips-Perron Test Equation
Dependent Variable: D(LNZIN,2)
Method: Least Squares
Date: 04/20/21 Time: 18:11
Sample (adjusted): 1994Q3 2018Q4
Included observations: 98 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LNZIN(-1))	-0.758306	0.099589	-7.614345	0.0000
C	0.019957	0.022668	0.880425	0.3809
@TREND("1994Q1")	-2.95E-05	0.000389	-0.075932	0.9396

R-squared	0.379016	Mean dependent var	0.000117
Adjusted R-squared	0.365943	S.D. dependent var	0.136684
S.E. of regression	0.108839	Akaike info criterion	-1.567767
Sum squared resid	1.125356	Schwarz criterion	-1.488635
Log likelihood	79.82056	Hannan-Quinn criter.	-1.535759
F-statistic	28.99150	Durbin-Watson stat	2.016103
Prob(F-statistic)	0.000000		

LNDIAM

ADF,

LEVELS, INTERCEPT

Null Hypothesis: LNDIAM has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=10)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-1.086185	0.7162
Test critical values:	1% level	-3.538362	
	5% level	-2.908420	
	10% level	-2.591799	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LNDIAM)
Method: Least Squares
Date: 05/04/21 Time: 22:01
Sample (adjusted): 2003Q2 2018Q4
Included observations: 63 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNDIAM(-1)	-0.038551	0.035492	-1.086185	0.2817
C	0.332242	0.294384	1.128601	0.2635

R-squared	0.018974	Mean dependent var	0.012971
Adjusted R-squared	0.002892	S.D. dependent var	0.128778
S.E. of regression	0.128592	Akaike info criterion	-1.233115
Sum squared resid	1.008688	Schwarz criterion	-1.165079
Log likelihood	40.84313	Hannan-Quinn criter.	-1.206356
F-statistic	1.179797	Durbin-Watson stat	2.226817
Prob(F-statistic)	0.281671		

INTERCEPT AND TREND, LEVELS

Null Hypothesis: LNDIAM has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 0 (Automatic - based on SIC, maxlag=10)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-3.144299	0.1053
Test critical values:	1% level	-4.110440	
	5% level	-3.482763	
	10% level	-3.169372	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LNDIAM)
Method: Least Squares
Date: 05/04/21 Time: 22:24
Sample (adjusted): 2003Q2 2018Q4
Included observations: 63 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNDIAM(-1)	-0.279461	0.088879	-3.144299	0.0026
C	1.883473	0.598461	3.147193	0.0026
@TREND("1994Q1")	0.006528	0.002231	2.926059	0.0048

R-squared	0.141482	Mean dependent var	0.012971
Adjusted R-squared	0.112865	S.D. dependent var	0.128778
S.E. of regression	0.121293	Akaike info criterion	-1.334760
Sum squared resid	0.882726	Schwarz criterion	-1.232706
Log likelihood	45.04495	Hannan-Quinn criter.	-1.294622
F-statistic	4.943935	Durbin-Watson stat	1.991423
Prob(F-statistic)	0.010292		

FIRST DIFFERENCE, INTERCEPT

Null Hypothesis: D(LNDIAM) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=10)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-9.039712	0.0000

Test critical values:	1% level	-3.540198	
	5% level	-2.909206	
	10% level	-2.592215	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LNDIAM,2)
Method: Least Squares
Date: 05/04/21 Time: 22:27
Sample (adjusted): 2003Q3 2018Q4
Included observations: 62 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LNDIAM(-1))	-1.144636	0.126623	-9.039712	0.0000
C	0.017055	0.016389	1.040605	0.3022

R-squared	0.576619	Mean dependent var	0.001776
Adjusted R-squared	0.569563	S.D. dependent var	0.195650
S.E. of regression	0.128361	Akaike info criterion	-1.236210
Sum squared resid	0.988596	Schwarz criterion	-1.167593
Log likelihood	40.32252	Hannan-Quinn criter.	-1.209269
F-statistic	81.71639	Durbin-Watson stat	2.054311
Prob(F-statistic)	0.000000		

FIRST DIFFERENCE, INTERCEPT AND TREND

Null Hypothesis: D(LNDIAM) has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 0 (Automatic - based on SIC, maxlag=10)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-8.964520	0.0000
Test critical values:	1% level	-4.113017	
	5% level	-3.483970	
	10% level	-3.170071	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LNDIAM,2)
Method: Least Squares
Date: 05/04/21 Time: 22:28
Sample (adjusted): 2003Q3 2018Q4
Included observations: 62 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LNDIAM(-1))	-1.144411	0.127660	-8.964520	0.0000
C	0.028742	0.065029	0.441981	0.6601
@TREND("1994Q1")	-0.000171	0.000918	-0.185814	0.8532

R-squared	0.576867	Mean dependent var	0.001776
Adjusted R-squared	0.562523	S.D. dependent var	0.195650

S.E. of regression	0.129407	Akaike info criterion	-1.204537
Sum squared resid	0.988018	Schwarz criterion	-1.101611
Log likelihood	40.34066	Hannan-Quinn criter.	-1.164126
F-statistic	40.21800	Durbin-Watson stat	2.055922
Prob(F-statistic)	0.000000		

PP, INTERCEPT, LEVELS

Null Hypothesis: LNDIAM has a unit root
Exogenous: Constant
Bandwidth: 8 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-0.834772	0.8021
Test critical values:	1% level	-3.538362	
	5% level	-2.908420	
	10% level	-2.591799	

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

Residual variance (no correction)	0.016011
HAC corrected variance (Bartlett kernel)	0.009620

Phillips-Perron Test Equation
Dependent Variable: D(LNDIAM)
Method: Least Squares
Date: 05/04/21 Time: 22:30
Sample (adjusted): 2003Q2 2018Q4
Included observations: 63 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNDIAM(-1)	-0.038551	0.035492	-1.086185	0.2817
C	0.332242	0.294384	1.128601	0.2635

R-squared	0.018974	Mean dependent var	0.012971
Adjusted R-squared	0.002892	S.D. dependent var	0.128778
S.E. of regression	0.128592	Akaike info criterion	-1.233115
Sum squared resid	1.008688	Schwarz criterion	-1.165079
Log likelihood	40.84313	Hannan-Quinn criter.	-1.206356
F-statistic	1.179797	Durbin-Watson stat	2.226817
Prob(F-statistic)	0.281671		

LEVELS, INTERCEPT AND TREND

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

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-3.144299	0.1053
Test critical values:	1% level	-4.110440	
	5% level	-3.482763	

	10% level	-3.169372	

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

Residual variance (no correction)	0.014012
HAC corrected variance (Bartlett kernel)	0.014012

Phillips-Perron Test Equation
Dependent Variable: D(LNDIAM)
Method: Least Squares
Date: 05/04/21 Time: 22:33
Sample (adjusted): 2003Q2 2018Q4
Included observations: 63 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNDIAM(-1)	-0.279461	0.088879	-3.144299	0.0026
C	1.883473	0.598461	3.147193	0.0026
@TREND("1994Q1")	0.006528	0.002231	2.926059	0.0048

R-squared	0.141482	Mean dependent var	0.012971
Adjusted R-squared	0.112865	S.D. dependent var	0.128778
S.E. of regression	0.121293	Akaike info criterion	-1.334760
Sum squared resid	0.882726	Schwarz criterion	-1.232706
Log likelihood	45.04495	Hannan-Quinn criter.	-1.294622
F-statistic	4.943935	Durbin-Watson stat	1.991423
Prob(F-statistic)	0.010292		

FIRST DIFFERENCE, INTERCEPT

Null Hypothesis: D(LNDIAM) has a unit root
Exogenous: Constant
Bandwidth: 9 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-9.876120	0.0000
Test critical values:	1% level	-3.540198	
	5% level	-2.909206	
	10% level	-2.592215	

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

Residual variance (no correction)	0.015945
HAC corrected variance (Bartlett kernel)	0.008644

Phillips-Perron Test Equation
Dependent Variable: D(LNDIAM,2)
Method: Least Squares
Date: 05/04/21 Time: 22:35
Sample (adjusted): 2003Q3 2018Q4
Included observations: 62 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.

D(LNDIAM(-1))	-1.144636	0.126623	-9.039712	0.0000
C	0.017055	0.016389	1.040605	0.3022

R-squared	0.576619	Mean dependent var	0.001776
Adjusted R-squared	0.569563	S.D. dependent var	0.195650
S.E. of regression	0.128361	Akaike info criterion	-1.236210
Sum squared resid	0.988596	Schwarz criterion	-1.167593
Log likelihood	40.32252	Hannan-Quinn criter.	-1.209269
F-statistic	81.71639	Durbin-Watson stat	2.054311
Prob(F-statistic)	0.000000		

FIRST DIFFERENCE, INTERCEPT AND TREND

Null Hypothesis: D(LNDIAM) has a unit root
Exogenous: Constant, Linear Trend
Bandwidth: 9 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-9.819619	0.0000
Test critical values:	1% level	-4.113017	
	5% level	-3.483970	
	10% level	-3.170071	

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

Residual variance (no correction)	0.015936
HAC corrected variance (Bartlett kernel)	0.008453

Phillips-Perron Test Equation
Dependent Variable: D(LNDIAM,2)
Method: Least Squares
Date: 05/04/21 Time: 22:37
Sample (adjusted): 2003Q3 2018Q4
Included observations: 62 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LNDIAM(-1))	-1.144411	0.127660	-8.964520	0.0000
C	0.028742	0.065029	0.441981	0.6601
@TREND("1994Q1")	-0.000171	0.000918	-0.185814	0.8532

R-squared	0.576867	Mean dependent var	0.001776
Adjusted R-squared	0.562523	S.D. dependent var	0.195650
S.E. of regression	0.129407	Akaike info criterion	-1.204537
Sum squared resid	0.988018	Schwarz criterion	-1.101611
Log likelihood	40.34066	Hannan-Quinn criter.	-1.164126
F-statistic	40.21800	Durbin-Watson stat	2.055922
Prob(F-statistic)	0.000000		

OPTIMAL LAG LENGTH DETERMINATION

VAR Lag Order Selection Criteria
Endogenous variables: LNGDP LNDIAM LNURAN LNZINC
Exogenous variables: C
Date: 02/26/22 Time: 09:29
Sample: 1994Q1 2018Q4
Included observations: 56

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-140.8144	NA	0.002071	5.171943	5.316611	5.228030
1	117.9397	471.3021	3.56e-07	-3.497847	-2.774507*	-3.217410
2	149.3822	52.77853*	2.07e-07*	-4.049366*	-2.747354	-3.544579*
3	156.8466	11.46304	2.88e-07	-3.744520	-1.863836	-3.015383
4	164.4477	10.58733	4.06e-07	-3.444561	-0.985206	-2.491074
5	180.5710	20.15409	4.36e-07	-3.448964	-0.410936	-2.271127
6	194.4053	15.31651	5.29e-07	-3.371616	0.245083	-1.969430
7	201.9906	7.314481	8.50e-07	-3.071094	1.124277	-1.444558
8	223.2908	17.49652	9.07e-07	-3.260384	1.513659	-1.409498

* 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

ARDL

Dependent Variable: LNGDP
Method: ARDL
Date: 02/26/22 Time: 10:14
Sample (adjusted): 2003Q2 2018Q4
Included observations: 63 after adjustments
Maximum dependent lags: 4 (Automatic selection)
Model selection method: Akaike info criterion (AIC)
Dynamic regressors (4 lags, automatic): LNDIAM LNURAN LNZINC
Fixed regressors: C
Number of models evalulated: 500
Selected Model: ARDL(2, 1, 0, 2)
Note: final equation sample is larger than selection sample

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
LNGDP(-1)	1.502944	0.103732	14.48875	0.0000
LNGDP(-2)	-0.638819	0.104639	-6.104985	0.0000
LNDIAM	-0.513573	0.242920	-2.114162	0.0391
LNDIAM(-1)	0.521066	0.247067	2.109005	0.0396
LNURAN	0.139159	0.086883	1.601678	0.1151
LNZINC	-0.018548	0.283517	-0.065422	0.9481
LNZINC(-1)	0.194276	0.445522	0.436064	0.6645
LNZINC(-2)	-0.494413	0.294916	-1.676453	0.0994
C	2.340810	0.789573	2.964653	0.0045

R-squared	0.964225	Mean dependent var	0.805510
Adjusted R-squared	0.958925	S.D. dependent var	1.141029
S.E. of regression	0.231251	Akaike info criterion	0.040942
Sum squared resid	2.887772	Schwarz criterion	0.347104
Log likelihood	7.710333	Hannan-Quinn criter.	0.161357
F-statistic	181.9299	Durbin-Watson stat	1.885461
Prob(F-statistic)	0.000000		

*Note: p-values and any subsequent tests do not account for model selection.

BOUND TEST FOR COINTERGRATION

ARDL Long Run Form and Bounds Test
Dependent Variable: D(LNGDP)
Selected Model: ARDL(2, 1, 0, 2)
Case 2: Restricted Constant and No Trend
Date: 02/26/22 Time: 10:15
Sample: 1994Q1 2018Q4
Included observations: 63

Conditional Error Correction Regression

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	2.340810	0.789573	2.964653	0.0045
LNGDP(-1)*	-0.135875	0.037137	-3.658766	0.0006
LNDIAM(-1)	0.007492	0.096768	0.077425	0.9386
LNURAN**	0.139159	0.086883	1.601678	0.1151
LNZINC(-1)	-0.318685	0.117165	-2.719962	0.0088
D(LNGDP(-1))	0.638819	0.104639	6.104985	0.0000
D(LNDIAM)	-0.513573	0.242920	-2.114162	0.0391
D(LNZINC)	-0.018548	0.283517	-0.065422	0.9481
D(LNZINC(-1))	0.494413	0.294916	1.676453	0.0994

* p-value incompatible with t-Bounds distribution.
** Variable interpreted as Z = Z(-1) + D(Z).

Levels Equation
Case 2: Restricted Constant and No Trend

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNDIAM	0.055141	0.713845	0.077245	0.9387
LNURAN	1.024169	0.617320	1.659057	0.1029
LNZINC	-2.345436	0.788428	-2.974826	0.0044
C	17.22771	4.519606	3.811773	0.0004

EC = LNGDP - (0.0551*LNDIAM + 1.0242*LNURAN -2.3454*LNZINC + 17.2277)

F-Bounds Test — Null Hypothesis: No levels relationship

Test Statistic	Value	Signif.	I(0)	I(1)
			Asymptotic: n=1000	
F-statistic	3.002504	10%	2.37	3.2
K	3	5%	2.79	3.67
		2.5%	3.15	4.08
		1%	3.65	4.66
			Finite Sample: n=65	
Actual Sample Size	63			
		10%	2.492	3.35

5%	2.976	3.896
1%	4.056	5.158
	Finite Sample: n=60	
10%	2.496	3.346
5%	2.962	3.91
1%	4.068	5.25

SHORT RUN GDP DIAMOND

Dependent Variable: LNGDP
Method: Least Squares
Date: 02/26/22 Time: 14:35
Sample (adjusted): 2003Q3 2018Q4
Included observations: 62 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	3.231505	1.563994	2.066188	0.0432
LNGDP(-2)	0.823994	0.077746	10.59860	0.0000
LNDIAM(-2)	-0.382458	0.184158	-2.076791	0.0422

R-squared	0.773699	Mean dependent var	0.790492
Adjusted R-squared	0.766028	S.D. dependent var	1.144049
S.E. of regression	0.553384	Akaike info criterion	1.701648
Sum squared resid	18.06779	Schwarz criterion	1.804573
Log likelihood	-49.75107	Hannan-Quinn criter.	1.742059
F-statistic	100.8575	Durbin-Watson stat	0.470051
Prob(F-statistic)	0.000000		

ECM- DIAM

Dependent Variable: D(LNGDP)
Method: Least Squares
Date: 02/26/22 Time: 16:20
Sample (adjusted): 2004Q1 2018Q4
Included observations: 60 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.016357	0.040672	-0.402158	0.6891
D(LNGDP(-2))	0.741694	0.234559	3.162081	0.0025
D(LNDIAM(-2))	0.081104	0.315334	0.257200	0.7980
ECM1(-2)	-0.370271	0.134128	-2.760584	0.0078

R-squared	0.157149	Mean dependent var	-0.055147
Adjusted R-squared	0.111996	S.D. dependent var	0.318920
S.E. of regression	0.300531	Akaike info criterion	0.497806
Sum squared resid	5.057846	Schwarz criterion	0.637429
Log likelihood	-10.93419	Hannan-Quinn criter.	0.552421
F-statistic	3.480387	Durbin-Watson stat	1.255990
Prob(F-statistic)	0.021712		

URAN SHORT RUN

Dependent Variable: LNGDP
Method: Least Squares
Date: 02/26/22 Time: 16:21
Sample (adjusted): 1994Q3 2018Q4
Included observations: 98 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.824820	0.287236	2.871579	0.0050
LNGDP(-2)	0.861185	0.055988	15.38163	0.0000
LNURAN(-2)	-0.141389	0.053839	-2.626136	0.0101

R-squared	0.723191	Mean dependent var	0.830825
Adjusted R-squared	0.717363	S.D. dependent var	0.937282
S.E. of regression	0.498293	Akaike info criterion	1.474876
Sum squared resid	23.58809	Schwarz criterion	1.554008
Log likelihood	-69.26893	Hannan-Quinn criter.	1.506883
F-statistic	124.0982	Durbin-Watson stat	0.487367
Prob(F-statistic)	0.000000		

URAN ECM

Dependent Variable: D(LNGDP)
Method: Least Squares
Date: 02/26/22 Time: 16:23
Sample (adjusted): 1995Q1 2018Q4
Included observations: 96 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.005803	0.028436	-0.204068	0.8388
D(LNGDP(-2))	0.664782	0.167280	3.974062	0.0001
D(LNURAN(-2))	-0.091290	0.212417	-0.429768	0.6684
ECM2(-2)	-0.347512	0.100510	-3.457468	0.0008

R-squared	0.148612	Mean dependent var	-0.018340
Adjusted R-squared	0.120849	S.D. dependent var	0.291789
S.E. of regression	0.273590	Akaike info criterion	0.286401
Sum squared resid	6.886334	Schwarz criterion	0.393249
Log likelihood	-9.747255	Hannan-Quinn criter.	0.329591
F-statistic	5.352950	Durbin-Watson stat	1.280800
Prob(F-statistic)	0.001922		

ZINC SHORT RUN

Dependent Variable: LNGDP
Method: Least Squares
Date: 02/26/22 Time: 16:25
Sample (adjusted): 1994Q3 2018Q4
Included observations: 98 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	2.749875	0.688323	3.995034	0.0001
LNGDP(-2)	0.810598	0.055847	14.51470	0.0000
LNZINC(-2)	-0.279263	0.072003	-3.878516	0.0002

R-squared	0.743682	Mean dependent var	0.830825
Adjusted R-squared	0.738286	S.D. dependent var	0.937282
S.E. of regression	0.479494	Akaike info criterion	1.397964
Sum squared resid	21.84190	Schwarz criterion	1.477096
Log likelihood	-65.50026	Hannan-Quinn criter.	1.429972
F-statistic	137.8170	Durbin-Watson stat	0.492948
Prob(F-statistic)	0.000000		

ZINC ECM

Dependent Variable: D(LNGDP)
Method: Least Squares
Date: 02/26/22 Time: 16:28
Sample (adjusted): 1995Q1 2018Q4
Included observations: 96 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.006784	0.028091	-0.241496	0.8097
D(LNGDP(-2))	0.658555	0.147234	4.472847	0.0000
D(LNZINC(-2))	-0.094575	0.250390	-0.377712	0.7065
ECM3(-2)	-0.371248	0.091359	-4.063609	0.0001

R-squared	0.186530	Mean dependent var	-0.018340
Adjusted R-squared	0.160004	S.D. dependent var	0.291789
S.E. of regression	0.267428	Akaike info criterion	0.240842
Sum squared resid	6.579640	Schwarz criterion	0.347690
Log likelihood	-7.560427	Hannan-Quinn criter.	0.284032
F-statistic	7.031921	Durbin-Watson stat	1.322451
Prob(F-statistic)	0.000261		

GRANGER CAUSALITY

Pairwise Granger Causality Tests
Date: 02/26/22 Time: 21:09
Sample: 1994Q1 2018Q4
Lags: 2

Null Hypothesis:	Obs	F-Statistic	Prob.
LNZINC does not Granger Cause LNURAN	98	1.14792	0.3217
LNURAN does not Granger Cause LNZINC		0.89658	0.4115
LNGDP does not Granger Cause LNURAN	98	1.33477	0.2682
LNURAN does not Granger Cause LNGDP		1.46377	0.2366
LNDIAM does not Granger Cause LNURAN	62	0.35455	0.7030
LNURAN does not Granger Cause LNDIAM		1.28679	0.2841
LNGDP does not Granger Cause LNZINC	98	1.29024	0.2801
LNZINC does not Granger Cause LNGDP		2.98321	0.0555

LNDIAM does not Granger Cause LNZINC	62	1.53897	0.2234
LNZINC does not Granger Cause LNDIAM		1.27293	0.2878
LNDIAM does not Granger Cause LNGDP	62	0.77025	0.4677
LNGDP does not Granger Cause LNDIAM		0.93547	0.3983

Autocorrelation

Breusch-Godfrey Serial Correlation LM Test:

F-statistic	280.6693	Prob. F(2,58)	0.0000
Obs*R-squared	58.00651	Prob. Chi-Square(2)	0.0000

Test Equation:
Dependent Variable: RESID
Method: Least Squares
Date: 02/26/22 Time: 21:45
Sample: 2003Q1 2018Q4
Included observations: 64
Presample missing value lagged residuals set to zero.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNDIAM	0.058542	0.109694	0.533683	0.5956
LNURAN	0.027527	0.091055	0.302306	0.7635
LNZINC	-0.082559	0.112986	-0.730701	0.4679
C	0.163642	0.691573	0.236622	0.8138
RESID(-1)	1.536204	0.105031	14.62616	0.0000
RESID(-2)	-0.685329	0.109346	-6.267549	0.0000

R-squared	0.906352	Mean dependent var	-1.91E-15
Adjusted R-squared	0.898279	S.D. dependent var	0.868836
S.E. of regression	0.277105	Akaike info criterion	0.360218
Sum squared resid	4.453649	Schwarz criterion	0.562613
Log likelihood	-5.526965	Hannan-Quinn criter.	0.439951
F-statistic	112.2677	Durbin-Watson stat	1.902235
Prob(F-statistic)	0.000000		

DIAGNOSTIC TESTS

Breusch-Godfrey Serial Correlation LM Test:

F-statistic	1.484495	Prob. F(1,32)	0.2320
Obs*R-squared	1.729018	Prob. Chi-Square(1)	0.1885

Test Equation:
Dependent Variable: RESID
Method: Least Squares
Date: 04/21/21 Time: 20:20
Sample: 2003Q3 2013Q1
Included observations: 39
Presample missing value lagged residuals set to zero.

Variable	Coefficient	Std. Error	t-Statistic	Prob.

C	0.006534	0.188421	0.034676	0.9726
D(LNGDP(-1))	-0.006937	0.189932	-0.036526	0.9711
D(LNDIAM(-1))	0.264663	1.249430	0.211827	0.8336
D(LNURAN(-1))	-0.242445	1.451010	-0.167087	0.8684
D(LNZIN(-1))	0.080250	1.528516	0.052502	0.9585
ECM(-1)	-0.915928	0.793459	-1.154347	0.2569
RESID(-1)	0.947385	0.777566	1.218398	0.2320

R-squared	0.044334	Mean dependent var	6.83E-17
Adjusted R-squared	-0.134854	S.D. dependent var	1.052088
S.E. of regression	1.120784	Akaike info criterion	3.227082
Sum squared resid	40.19701	Schwarz criterion	3.525670
Log likelihood	-55.92811	Hannan-Quinn criter.	3.334213
F-statistic	0.247416	Durbin-Watson stat	2.004287
Prob(F-statistic)	0.956817		