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CRUDE OIL PRODUCTION, QUALITY INSTITUTIONS, CAPITAL ACCUMULATION AND ECONOMIC GROWTH IN GHANA

SANDRA AMANKRAH

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CRUDE OIL PRODUCTION, QUALITY INSTITUTIONS, CAPITAL ACCUMULATION AND ECONOMIC GROWTH IN GHANA

BY

SANDRA AMANKRAH

Thesis submitted to the Department of Economic Studies of the School of Economics, College of Humanities and Legal studies, University of Cape Coast, in partial fulfillment of the requirements for the award of Master of Philosophy degree in Economics

APRIL 2021

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DECLARATION

Candidate's Declaration

I hereby declare that this thesis is the result of my own original work and that no part of it has been presented for another degree in this university or elsewhere.

Candidate's Signature................................. Date..............................

Name: Sandra Amankrah

Supervisors' Declaration

We hereby declare that the preparation and presentation of the thesis were supervised in accordance with the guidelines on supervision of thesis laid down by the University of Cape Coast.

Supervisor's Signature: .... Date: ....

Name: Mr. Kwabena Nkansah Darfor

Supervisor's Signature: .... Date: ....

Name: Benedict Afful Jr. (PhD)

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ABSTRACT

The study examined the effect of crude oil production, quality institutions and capital accumulation on economic growth in Ghana spanning from January 2011 to December 2018 using the Nonlinear Autoregressive Distributed Lag (NARDL) approach to cointegration. The empirical findings revealed that the expected positive economic multiplier effects of commercial crude oil production in the form of more local employment with high incomes as well as more substantial local business participation has not yet been actualized and hence the resource curse effect is pronounced valid in Ghana. Also, the required capital accumulation and institutional capacity is at a level insufficient to complement the production of crude oil to cause economic expansion and reverse the resource curse. Based on these findings, it is therefore recommended that the institutions of state that oversee crude oil production and other expediencies related to crude oil production should be resourced to ensure efficient capital accumulation and to allow for sustainable economic growth.

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KEY WORDS

Capital accumulation

Crude oil production

Economic growth

Enclave effects

Quality institutions

Resource curse

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DEDICATION

To Mr. and Mrs. Otsibu

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LIST OF ACRONYMS

EPA:	Environmental Protection Agency
FPSO:	Floating Production Storage and Offloading
GDP:	Gross Domestic Product
GNPC:	Ghana National Petroleum Corporation
GoG:	Government of Ghana
IFC:	International Financial Corporation
IMF:	International Monetary Fund
MNOCs:	Multinational Oil Companies
MODEC:	Mitsui Ocean Development & Engineering Company
NARDL:	Nonlinear Autoregressive Distributed Lag
NOCs:	National Oil Companies
NRGI:	Natural Resource Governance Institute
PIAC:	Public Interest and Accountability Committee
PNDC:	Provisional National Defense Council

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CHAPTER ONE

INTRODUCTION

This chapter outlined the background and the statement of the problem. It briefly reviewed the effects of crude oil production, quality institutions, and capital accumulation on economic growth in Ghana. This was followed by the research purpose and objectives, research hypotheses, and the study's significance. This chapter described how the study was organised and provided some limitations and delimitations to the study.

Background to the study

Economies that are endowed with resources are regarded as blessed due to the fact that the resources they possess are key components of their capital assets which they can convert into the provision of educational facilities, housing facilities, port facilities and other forms of physical assets that go a long way in transforming their economies into a developed status (Mehrara, 2009). However, reality has revealed that these natural resource-abundant economies tend to develop slowly as compared to natural resource-scarce economies – the phenomenon which is often known as "resource curse". Unfortunately, studies have also shown that these resource endowed economies have poor institutional capacities that are responsible for the absorption, management and the transformation of these resources into capital assets sufficient for take-off into industrialisation (Perry & Olivera, 2009; Abdulahi, shu, & Khan, 2019).

Studies gleaned from Congo, Liberia, and Sierra Leone point to the fact that the discovery of natural resources poses threats to the economy and in extreme cases plunges the economy into civil war thus eroding whatever benefits the resource discovery could have brought to the economy (Auty, 2001;

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Basedau, 2005; Brahmbhatt, Canuto, & Vostroknutova, 2010; Frankel, 2010; Luong & Weinthal, 2006). Also, developing economies have provided some instances where natural-resource greediness has ignited political violence, corruption, internal contentions as manifested in prolonged political and economic instability and even civil war instead of propelling economic growth and development (Bhattacharya & Ghura, 2006).

Since the 1970s, Ghana's exports have large proportion been dominated by the agricultural sector. Ghana has been a major exporter of agricultural products such as timber, cocoa, palm oil and other minerals such as gold, salt, bauxite and manganese. However, this trend has tilted in favour of crude oil (Breisinger, Diao, Kolavalli, Al Hassan, & Thurlow, 2011) with potential revenues estimated at US$1–1.5 billion annually for the next 20 years (Osei & Domfe, 2008). This has greatly elevated hopes, but also sparked fears of a 'resource curse' where especially the exploitation of crude oil leads to economic instability rather than a solution.

Nevertheless, works from Breisinger et al. (2011) have revealed that Ghana seems to have favourable conditions to avoid the curse, among these conditions include a stable democracy demonstrated by the peaceful transition of political power in seven consecutive free and fair elections (for the years 1992, 1996, 2000, 2004, 2008, 2012, and 2016) which is an enabling environment for oil production and exportation. Also, Ghana is not new when it comes to managing windfalls from natural resources since it has experience in managing windfalls from cocoa and gold throughout its entire modern history. Interestingly, even though Ghana has such an experience corruption and high public debt persists. The issue confronting Ghana at the moment is not only

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restricted to the handling of its petroleum resources but more significantly preventing the resource curse that has bedevilled a lot of oil-rich countries in Africa.

Instead of being a blessing, literature suggests that resource abundance increases the possibility of resource-rich countries experiencing poor political and social outcomes, and economic mismanagement (Rosser, 2006). Underpinned by three hypothesis, Sachs and Warner (1997) concluded that natural resource (particularly oil and gas) abundance has significant negative effect on economic growth. The hypotheses are enumerated as follows:

Natural resource abundance leads to

1. Abysmal performance of the economy;
2. Porous democratic credentials, compromised institutions of state, and elites resorting to rent-seeking behaviours; and
3. Political upheavals as well as civil wars

Interestingly, their work included Ghana even when it has not discovered commercial crude oil. Based on their conclusion that the curse is peculiar with oil and gas production, to validate the resource curse effect in Ghana, it is therefore imperative to empirically reinvestigate these hypotheses using the recently discovered oil as the basis.

Statement of the Problem

The prediction that resource-rich nations in the developing world (with Ghana not being as exception) are mostly seen to be vulnerable to political and economic shocks is quite worrying especially when it is expected that these resources will enable them to generate the wherewithal to industrialise and diversify their economies (Luong & Weinthal, 2006).

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Based on this alarming curse, a body of scholars emerged from various disciplines to investigate the transmission mechanisms and possible ways through which developing countries could escape this curse. The nexus between economic growth and natural resources has been examined from a pragmatic point of view in numerous cross-border analysis, however, within-country studies in Ghana have been scanty (Sarmidi, Law and Jafari, 2013; Abdulahi, Shu, & Khan, 2019). Studies have shown that within-country analysis provides better understanding of the country and as such can capture some economic characteristics and significant structural breaks that may be peculiar to the country under study and hence is powerful in explaining the conditional resources curse effect (Mehlum, Moene, and Torvik, 2006; Mehrara 2009; Mehrara, Maki, & Tavakolian 2010; Ji, Magnus & Wang, 2014). Therefore, it becomes important to undertake a within-country analysis by investigating the resource curse effect in Ghana.

While studies (Bawumia & Halland, 2017; Abdulahi, Shu, and khan, 2019) examine the link between growth in the economy and oil production, the role of capital accumulation or investment has been given less attention especially in Ghana. This is alarming because studies (Mehrara, Maki, & Tavakolian, 2010; Philips, Hailwood, & Brooks, 2016; Venables, 2016) have shown that economic growth cannot be achieved in a vacuum but through capital formation since the exploitation of these resources is highly capital intensive and considering the state of Ghana's infrastructural development, it therefore becomes imperative to investigate particularly the role of domestic capital accumulation in order to rightly inform policy makers in Ghana.

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Literature has established that the effect of quality institutions is nonlinear (Ji, Magnus & wang, 2014). However, studies on the critical role of quality institutions have concentrated on short-run dynamics and have ignored some important long-run dynamics (Beland & Tiagi, 2009; Perry & Olivera 2009; Kuzu & Nantogmah, 2010; Abdulahi, Shu, & khan, 2019). Meanwhile, studies have also shown that analysis made during the short-term may differ when considered on long-term basis (Aregbeyen & Kolawole, 2015; Nweze & Edame, 2016; Damette & Seghir, 2018). This implies that ignoring the time factor of the analysis could lead to the problem of premature conclusion as far as quality institutions are concerned. Considering this issue, the study adopted the nonlinear ARDL technique to simultaneously capture the long- and short-run dynamics recognised in literature (Ji, Magnus & Wang, 2014; Moshiri & Hayati, 2017; Abdulahi, Shu & Khan, 2019)

Finally, the appropriate measurement of the resource curse phenomenon, especially differentiating between the concept of resource dependence and resource abundance have been overlooked in many studies (Ji, Magnus & Wang, 2014). Meanwhile, studies have shown that resource dependence and resource abundance differ in their effect on economic growth and therefore cannot be used interchangeably (Brunnschweiler & Bulte, 2008). Also, measurements of resource dependence suffer from endogeneity (Van der Ploeg & Poelhekke, 2010) and as such need to be avoided to prevent any wrong conclusion as far as resource curse is concerned. Based on the issue of appropriate measurement, the study measured the resource curse effect using crude oil production to capture how resource abundance affects growth in the economy.

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Given Ghana's strategic plan towards achieving SDG 12 (Responsible consumption and production patterns) which includes promoting resource and energy efficiency, long-lasting infrastructure, providing basic services, green and decent job, and better quality of life, the study was motivated to delve into the link between growth in the economy and production of crude oil while also considering how quality institutions and capital accumulation complement the link.

Purpose of the study

The purpose of the study was to examine how production of crude oil , institutional quality, and capital accumulation affect growth in the economy.

Research Objectives

1. To examine the validity of the resource curse hypothesis in Ghana
2. To investigate the role of capital accumulation in the crude oil-growth link
3. To investigate how institutional quality influence the link between production of crude oil and growth in the economy

Research Hypotheses

1. H_0: Resource curse is not present in Ghana

   H_1: Resource curse is present in Ghana

2. H_0: Accumulation of capital does not significantly affect the link between crude oil production and economic growth

   H_1: accumulation of capital significantly affect the link between crude oil production and economic growth

3. H_0: Quality institutions have no significant effect in the crude oil-growth link

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H_1: Quality institutions have significant effect in the crude oil-growth link

Significance of the Study

Findings from the analysis will inform major oil stakeholders on the extent to which the state can absorb the full benefit of the production of crude oil. Also, it will provide evidence for the effect of Quality institutions and capital accumulation on the relationship between crude oil production and economic growth. This will inform the Government, National Oil Companies (NOCs), and other major oil stakeholders on the importance of transparency, realistic and feasible policies and government spending priorities to the growth of the economy. Finally, it will contribute to available knowledge on the resource curse hypothesis by investigating the validity of the phenomenon in the Ghanaian context.

Delimitations

To ascertain reliable results with higher precision and power, and draw meaningful conclusions, the study considered a ninety-six-month period spanning from January 2011 to December 2018. The study limited itself to these periods because Ghana started producing crude oil in commercial quantities during these periods.

Based on economic theory, data on several time series variables; Nonoil real gross domestic product growth rate, crude oil production, institutional quality indices, gross fixed capital formation, government expenditure, exchange rate, and crude oil price were selected for this study to test the hypotheses. Due to some missing data, the non-oil real GDP growth rate was

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calculated and used in the study to measure the real economic growth of all sectors of the country except oil.

Moreover, the Nonlinear Autoregressive Distributed Lagged (NARDL) technique was used purposely to capture the dynamic effect of crude oil production, quality institutions, and capital accumulation on economic growth in the long- and short - run.

Limitations

Most developing nations including Ghana have a problem of quality and limited availability of monthly data on some key variables used in the study. To produce highly reliable estimates especially with cointegration analysis, long span time series data were required. Because of limited monthly data, annual data obtained were quartered using Gandolfo approach and further extrapolated into monthly using Chow-Lin approach for estimation. The use of Gandolfo and the Chow-Lin interpolation algorithm had no negative implication on the findings' credibility due to their nonparametric nature and their flexibility in terms of autocorrelation.

Definition of terms

Asymmetric Cointegration – distinguishing between the positive and negative effects of the errors obtained from the cointegration regression.

Backward linkages – refer to domestic inputs to the crude oil projects which consist of subcontract, supplier contracts, input service collaborations, and therefore can create employment and potentials for enhancing domestic manufacturing capacity.

Control of corruption – captures the rate at which state authority is used for individual interest.

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Economic capacity – looks at the country's financial limit.

Enclave effect – when the economic activity of natural resources produces little or no substantial growth beyond the area where resources are extracted.

Forward linkages – are achieved by adding value to the crude oil extracted by locally processing and refining to produce finished good instead of exporting in its raw form.

Government effectiveness – measures the credibility of the government in the formulation and implementation of state policies.

Horizontal linkages – refer to the skills developed in the oil sector being transferred to other sectors of the economy.

Negative shock – unexpected downturns in an economic variable.

Nonlinear – when the outcome or dependent variable is not proportional to the input or independent variable.

Positive shock – unexpected upturns in an economic variable.

Shared use infrastructure – refers to the opportunity to have crude oil-related infrastructure meet more than one objective.

Stationarity – measures the constancy of the statistical properties such as mean, variance, autocorrelation, etc. of a series or variable overtime.

Voice and accountability – capture perceptions of the extent to which a country's citizens are able to participate in selecting their government, as well as freedom of expression, freedom of association, and a free media.

Organisation of the Study

This study has been structured as Chapter one through to Chapter five with further subdivisions. Chapter one (introductory chapter) presents a background to the study, problem statement, purpose, and objectives of the

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study, hypotheses, limitations and delimitation, and the significance of the study as well as the organisation of the study. Chapter Two focused basically on the overview of the Ghanaian economy with regards to theoretical as well as empirical literature on Crude oil production, Institutions, capital accumulation and Economic Growth. The third Chapter focused on both theoretical and empirical model specifications, as well as estimation technique employed in conducting the study. The results from the estimation was analysed and discussed in Chapter Four. The summary of the findings, conclusion, recommendations and suggestion for further research were presented in Chapter Five.

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CHAPTER TWO

LITERATURE REVIEW

Introduction

The aimed is to appraise studies that are relevant to the effects that crude oil production, quality institutions, and capital accumulation has on economic growth. Specifically, the review focused on the following theoretical framework: The Resource Curse theory, institutional approach to resource curse and the Endogenous growth theory as well as a Brief Overview of Crude oil production and a comparative analysis of Ghana's economy before and after oil production.

An overview of the Ghanaian crude oil sector

In 2007, Kosmos Energy which is based in the US arrived in Ghana and discovered for the first time, a vast reservoir of commercially viable crude oil in the deep waters off the Gulf of Guinea in the Jomoro District of the Western Region now named Jubilee Field (Panford, 2017) due to fact that it coincided with the country's 50th independence anniversary. The stock of oil in the Jubilee Field was estimated to range between 800m to 1.5b barrels of crude oil whose dollar equivalence was estimated between $8 billion and $10 billion respectively whiles the life span of production was estimated to be 20 years (Panford, 2017). The shares of the companies that operate in the Jubilee fields are Tullow Oil with a share of 35.48%, followed by Kosmos Energy with a share of 24%; Anadarko with a share of 23.4%; GNPC with a share of 10% and other private Ghanaian companies namely, E & O with a share of 3.5% and Sabre Oil, with a share of 1.854% (PIAC, 2012).

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In 2010, Tullow made a further discovery of 1.8 billion barrels of crude oil which had the potential of presenting Ghana as one of the leading producers of oil in Africa (Panford, 2017). In spite of its growing oil potential over the years, it must be however, stated that Ghana's oil in terms of export value and stock does not come near that of Libya, Nigeria, Angola, and Equatorial Guinea who are regarded as oil giants in Africa. Owing to the international court ruling in favour of Ghana, by the third quarter of 2016 three more oil fields were developed by Tullow and these oilfields were named TEN. This contributed to an increase in daily oil production of 200,000 barrels from an earlier daily production of 120,000.

There are three main sources of laws and regulations governing crude oil production in Ghana. First is the 1992 Constitution, which is the primary source. The second source encompasses the laws promulgated under erstwhile PNDC government and the act of parliament under the Fourth Republic. The third source relates to the GNPC led Petroleum Agreement in the year 2000 which was done in collaboration with the commonwealth secretariat of Britain as well as lease agreement developed between Ghana government represented by GNPC and MNOCs (Panford, 2017). Currently, the Petroleum Revenue Management Act (Act 815) 2011; the Petroleum Commission (Act 821) 2011; the Petroleum Local Content and Local Participation Regulations, 2013 LI 2204; the Model Petroleum Agreement (2000); the Petroleum Agreements between GoG/ GNPC and MNOCs; and the Petroleum Exploration and Production Bill of 2016 are the laws that cover petroleum extraction in Ghana.

The institutions whose purpose are geared towards petroleum governance include, Ghana National Oil Company (GNPC); the Finance

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Ministry; Energy Ministry; the Central Bank; the Environmental Protection Agency; The Petroleum Commission; Ghana Revenue Authority; The Public Interest and Accountability Committee; Investment Advisory Board; the Legislature; the Cabinet for Oil and Gas and the office of the president.

The Economy of Ghana before and after Crude Oil Production

The discovery of natural resources such as crude oil in emerging economies has often brought about some form of excitement and optimism of economic emancipation. However, puzzling consequences are encountered as these resources tend to slow economic growth (Sachs & Warner, 2001) as in the case of Nigeria, who have experienced the same growth in their economy over the last 40 years despite its massive oil resource endowments and Iran and Venezuela with negative economic growth rate for over 33 years (Gylfason, 2001). Drawing insights from some scholarly works on Ghana's oil sector, the study compares the growth of the economy before and after production of crude oil.

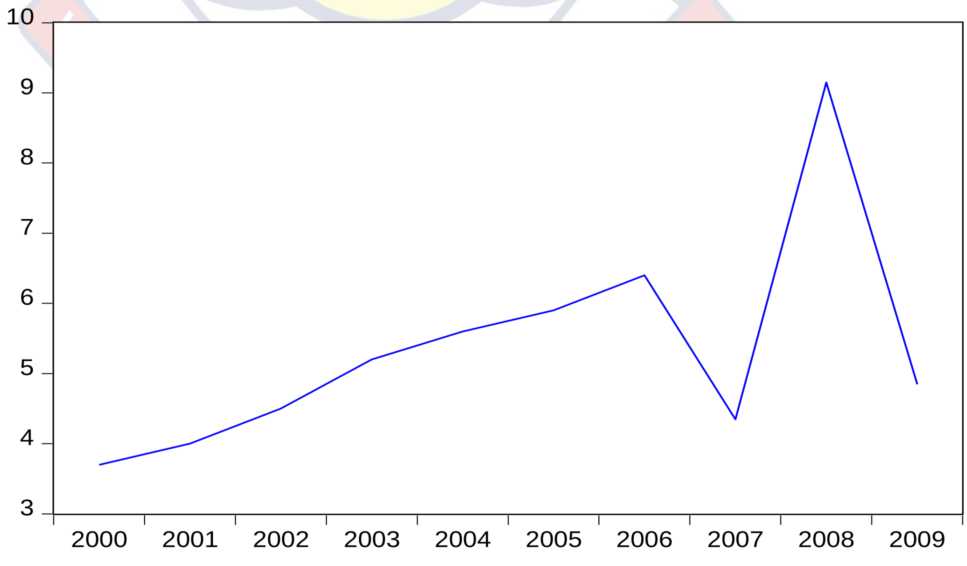

Figure 1: Trends of economic growth in Ghana before crude oil production (2000-2009)

Source: Amankrah (2019)

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The Ghanaian economy for the years 2000 - 2009 has been progressively performing quite well. Ironically, the country recorded one of its highest real gross domestic product (GDP) growth of 9.14 percent in the year 2008 even amid the financial crisis. However, this fell sharply by 4.3 percent to 4.8 percent in 2009 due to the spill overs from the global financial crisis (Dartey- Baah, Amponsah- Tawiah & Aratuo, 2012). In light of commercial oil discovery, huge government expenditure, coupled with the global food and oil crises, the public finance status of Ghana began to deteriorate, and as a result, growth fell from 6.4 to 4.3 in 2007 (Bawumia & Halland, 2017).

However, the 3.7 percent growth rate in 2000 was because of excessive government expenditure incurred before and during the presidential and parliamentary elections in the year 2000. This led to an intense inflation of 40.5 percent, currency depreciation, and a rapid decline in the terms of trade of commodities. The Ghana cedi depreciated by 50% against the US dollar by the end of December 2000 indicating a near collapse of the currency. According to Bawumia and Halland (2017) the gross foreign reserves of Ghana had reduced so much that it could not even cover imports for a month and this culminated into rising external debt stock.

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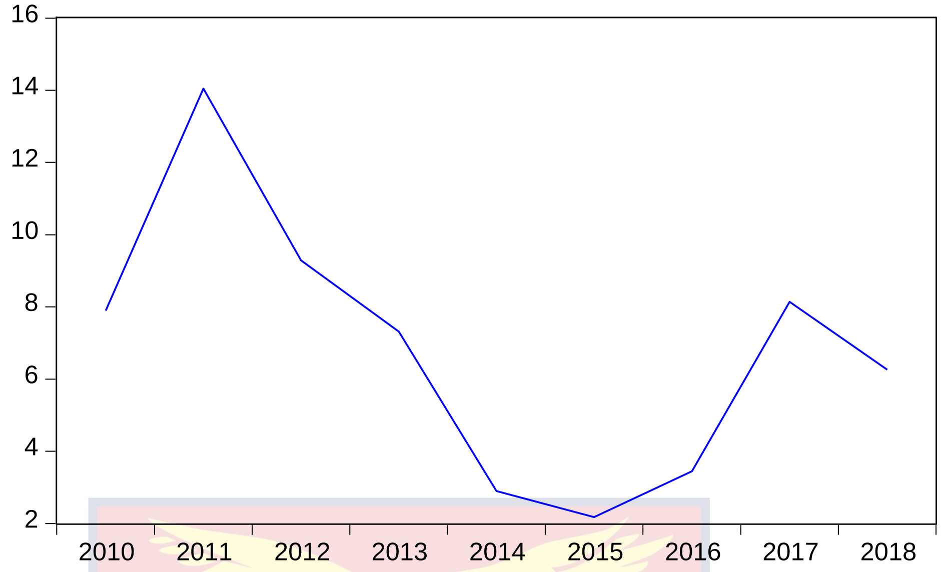

Figure 2: Trends of economic growth in Ghana with crude oil production (2010-2018)

Source: Amankrah (2019)

Unlike the years 2000- 2009, the growth of the economy alongside nine years of crude oil production has experienced a decline which could be attributed to trade openness. Openness in trade rose with imports and exports increasing at a faster rate compared to GDP. This is because Ghana's export trade is dominated by commodities in their raw form such as gold and cocoa, whiles import trade is dominated by high-valued commodities which accounts for about 70 percent of total exports. The oil and gas production provided an avenue for diversification of exports trade to include oil and gas exports. However, this export diversification highly exposed the economy to commodity-price variability particularly because of the lack of value addition to these export commodities.

Also, imports span a wide range of products and capital goods, and about 70 percent of the refined oil products are procured overseas (International Financial Corporation, 2018) leading to an outflow of revenue and hence the

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decline of economic growth even at the years of commercial oil production. Another contributing factor to the decline in economic growth was the power crisis popularly known as "Dumsor" during the years 2013 – 2015. This power disruption led to loss of productivity and output among manufacturing firms (Moyo, 2012).

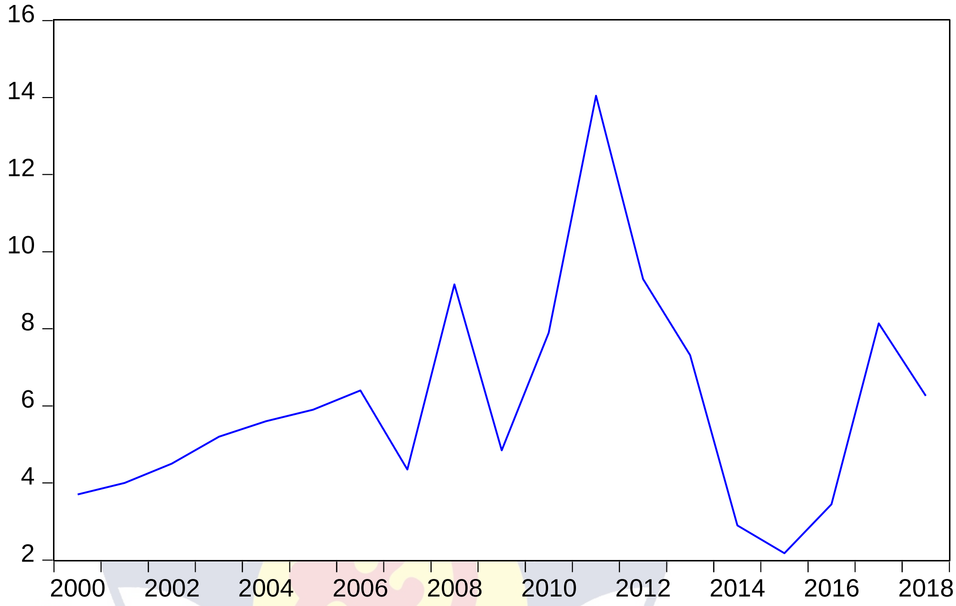

Figure 3: Trends of economic growth in Ghana (2000-2018)
Source: Amankrah (2019)

Comparing the two periods, Ghana has shown mixed economic performance in the past two decades, with significant shocks being intensified by policy slippages and resulting external and domestic imbalances. Growth in 2015 was 2.18 percent, the lowest level in two decades. The actual growth rate in 2016, was less than half the rate achieved in 2008 without oil. Following a sizeable fiscal slippage in 2016, due to excessive fiscal expansion during the elections, the authorities targeted a significant fiscal consolidation in 2017, which called for robust revenue mobilisation to cut the budget deficit and stabilise domestic public debt (Bawumia & Halland, 2017).

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While the contribution of the crude oil fields to the economy is one of the main explanations for GDP growth in 2010–13, apart from the power crisis fiscal and monetary indiscipline remained as one of the reasons for low economic growth during the election years of 2000, 2012 and 2016 (Bawumia & Halland, 2017). As a consequence, Ghana's growth experience suggests that the symptoms of resource curse (slow economic growth) would be inevitable if strong institutions, which includes the ability to enact relevant fiscal and monetary legislation, are overlooked.

Theoretical Review

Several economists and political scientists alike have employed various economic theories in explaining the differences in economic growth in the developed and developing worlds. These theories modified with other contributing variables such as the abundance of natural resources, capital accumulation, and the quality of institutions were used in explaining the economic discrepancies between these worlds. Specifically, some of these theories about oil-producing economies include the curse of resources, endogenous growth theory, and the institutional approach to the resource curse.

The Curse of Resources

The curse of resources prevails when natural resources do not produce the expected blessings but becomes a curse (Asekunowo & Olaiya, 2012). Inspired by the work of Sachs and Warner (1995), both theoretical and empirical evidence have shown that countries with vast resource wealth are more likely to experience poor economic growth as compared to resource – poor countries. This seems to specifically associate with point resources such as petroleum and minerals, rather than diffuse resources such as land (Kolstad, 2009).

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Economists and political scientists (Frankel, 2010; Mehlum, Moene & Torvik, 2006; Auty, 2001; Sachs & Warner, 2001; Auty & Gelb, 2001; Tornell & Lane1999) posit that point resources are distinct compared to other resources because of its large upfront costs, long production timeline, site specific nature, large rents, price and production volatility, non-renewable nature, and the secrecy of the industry (Natural Resource Governance Institute, 2015). Literature provides transmission mechanisms through which natural resource wealth create an additional challenge for resource-rich economies. The study reviews three of these transmission mechanisms that are of importance to its objectives.

The first of these mechanisms is the Dutch disease coined by the economist magazine in 1977 when the publication analysed a crisis that occurred in the Netherlands after the discovery of vast natural gas deposits in the North Sea in 1959. Dutch disease arises when the non-oil sector is neglected especially the manufacturing sector becomes uncompetitive due to a shift of labour, capital and land out of sector to the oil sector (Frankel, 2010).

Therefore, generally, there are two types of effects leading to Dutch disease that has also been recognized in the work of Brahmbhatt, Canuto, and Vostroknutova (2010). These effects include the spending effect and the resource movement effect. The spending effect is associated with increased domestic income from the booming of natural resources leading to higher aggregate demand and spending by both the public and private sectors. This then leads to higher prices and output in the non-tradable sector. Resource movement effect comes into play when a boom in the natural resource sector attracts capital and labour from other parts of the economy reducing output in

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the rest of the economy, particular reduces output in the non-tradable sector which is less likely to occur in low-income economies, where most of the inputs used are imported.

Next, weak institutional capacity has been recognised in the literature as a transmission for the curse of resources. It has been evident in many resource – rich economies that leaders of the state are unable to build effective, stable and broadly applicable institutions that are crucial for fostering state capacity, democratic regimes, and long-term economic growth (Luong & Weinthal (2006)). Also, these resources motivate them to overlook the importance of having institutions that are fundamental factors for good economic performance in order to maximise their personal gains (Frankel, 2010).

Lastly, according to the works of Luong and Weinthal (2006), structures of ownership affect the management, and developmental prospects of most African resource- rich economies. Ownership are very important since the development of these natural resources require huge sums of capital investment, where foreign direct investment or external relief is indispensable. In disaggregating ownership and control, there are four possible resource development strategies which include state ownership with control, state ownership without control, private domestic ownership, and private foreign ownership.

Resources that are owned and controlled by the state enables that the interest of an unidentified population is served by many agents who form part of the elites and bureaucrats within the state (Aharoni, 1982 as cited in Luong & Weinthal, 2006). On the contrary, resources that are owned and managed by domestic private entities ensures that the interest of an identifiable principal is

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served by agents who form part of the elites and domestic owners in the state with a clear managerial structure and a clear distinct between administrative role and political influence.

On the other hand, resource owned by private foreigners but not the state ensures a well-defined control structure with conflicting incitement for promoting quality institutions, where the interests of an identifiable population is served by elites within the state and foreign investors (Luong & Weinthal, 2006). Therefore, the ownership structure of mineral reserves could explain the negative outcomes of economic performances, the emergence of authoritarian regimes, as well as poor institutional capacity in resource-rich developing economies.

The Endogenous Growth Theory

Endogenous growth posits that long-run economic growth is influenced by internal economic factors, particularly those forces the helps to create technological innovations. The endogenous growth theory as developed by Aghion and Howitt (1990), Lucas (1988), Romer (1986), and Arrow (1962) thrives on the assumption that technological innovation leads to an increasing return to all factors and the maximisation of market power and profits. Based on these assumptions, three models including the AK and the innovative- based theories (Product Variety and the Schumpeterian growth models) were developed.

Considering the AK's theory, which did not make an explicit distinction between capital accumulation and technological progress. In effect, it put together with the physical and human capital (Frankel, 1962). Given that the

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marginal product of capital is exactly constant, therefore output Y depends on capital stock K:

$$Y = AK$$

The 'AK theory' was coined from the equation with A being positive and exogenous.

The theory posits that the saving rate s is important to long-run economic growth rate. Therefore, the net investment for output growth is considered as a fixed fraction of savings s and depreciation rate δ:

$$\frac{dK}{dt} = sY - \delta K$$

Where $Y = AK$ implies that the growth rate is given by:

$$g \equiv \frac{1}{Y}\frac{dY}{dt} = \frac{1}{K}\frac{dK}{dt} = sA - \delta$$

This means that when the rate of savings s, rises, it will cause the growth rate to rise as well. The results obtained by Romer (1986) confirms this with a structure of production which is more general. He assumed that savings is engendered by intertemporal utility maximisation rather than a rate of saving that is fixed as observed by Frankel. The work of Lucas (1988) provided a further confirmation of these findings but he focused on human capital instead of physical capital.

The product variety theory also postulates that growth in the economic depends on innovativeness which in turn culminates into the creation of fresh varieties that are grouped into the research, intermediate goods sector, and the final goods sectors (Mare, 2004). Romer (1987) provided a growth model with expanding product varieties with long-run growth being stable by using expanding sets of input to mitigate diminishing returns. Romer (1990) modelled

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the product variety, including an R&D sector that generates the designs for new inputs through horizontal innovations (the transfer of knowledge and technology from one sector to another). Also, Grossman and Helpman (1991) used the product variety to examine the relationship between market integration and the growth of an economy while Acemoglu and Zilibotti (2001) integrated directed technological change into the framework of expanding varieties to explain productivity differences across countries.

Last is the Schumpeterian growth model which places emphasis on quality or improved innovation to be an important factor for economic growth hence the name Schumpeterian because it includes the forces that Schumpeter (1942) describes as creative destruction, that is an innovation - driven growth that creates new technology and at the same time making older technology redundant.

An institutional approach to the resource curse

Based on empirical research, two different institutional approaches to resource curse have been recognised: rent-seeking models of Mehlum, Moene, and Torvik (2006) and patronage models by Robinson, Torvik, and Verdier (2006).

Seeking insights from Kolstad (2009), the rent-seeking model of Mehlum, Moene, and Torvik (2006) emphasised the importance of building institutions that will ensure efficient private sector in terms of contract agreements, law and order and effective risk absorption. According to them, natural resources becomes a curse where institutions responsible for the private sector, and the profitability of the productive enterprise are poor.

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Whereas, the patronage model of Robinson, Torvik, and Verdier (2006) emphasises that of public sector accountability as an important institution. The model also emphasise that natural resources becomes a curse only where the institutions governing the allocation and managements of the state wealth are poor. Though rent-seeking and patronage models agree that institution building is crucial, they differ as to which institutions are important.

Empirical Review

The purpose of this literature review is to identify an appropriate approach for the study. The empirical literature presents studies evident from oil-producing or exporting countries that try to analyse the effect of crude oil production on economic growth.

Oil resources could have an impact on government performances and by extension on economic growth. Damette and Seghir (2018) examined the natural resource curse in 26 oil-exporting countries including Nigeria using the panel smooth transition regression, in which the heterogeneity effects across countries overtime were considered. The paper aimed at investigating the quantity as well as the quality of public spending as the main drivers of the curse in these oil-exporting countries from 1996 - 2011. On a whole, they found a detrimental effect of oil resources on government performances and by extension on economic growth. In consonance with their findings, a within country analysis by Aregbeyen and Kolawole (2015) spanning from 1980 -2012 found that oil resources in Nigeria affect government performances and the growth of the economy when using pairwise Granger- causality, however, the impact is positive on economic growth when the vector error correction model was applied.

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The latter finding of Aregbeyen and Kolawole (2015) contradicts the findings from the cross- country analysis by Damette and Seghir (2018). On the other hand, Nweze and Edame (2016) extended the analysis period from 1981 – 2014 using an error correction mechanism and found oil resources in Nigeria to have a positive impact in the long-run but a negative effect in the short-run through embezzlement of funds and reckless spending by government. Their results partially support the findings of Damette and Seghir (2018) and Aregbeyen and Kolawole (2015) that oil resources could affect economic growth through government performance, but it suggests that the direction of the effect may depend on whether the analysis is in the short- or long-run. The differences in their findings may be warranted by the differences in the strengths and weaknesses that are associated with their methodologies including the data span and econometric techniques applied.

Also, while there is much evidence to support the resource curse hypothesis for resource-abundant economies, some studies have found the existence of a threshold effect in this relationship. Empirical evidence by Mehrara (2009) reconsidered the resource curse in 13 oil-exporting countries including Iran with data spanning from 1965 – 2005 using the panel threshold regression model and the structural breakpoint methodology, found the relationship between oil revenue and economic growth to be positive just below a threshold of 18 percent of oil revenue growth.

However, when Mehrara, Maki, and Tavakolian (2010) singled the Iranian economy out, they found that the threshold of oil revenues in Iran is about 37 percent, in a way that increase in the oil revenues beyond this threshold would abort its positively significant impact on economic growth. In contrast,

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findings from Mehrara, Maki, and Tavakolian (2010) suggest that Iranian oil resources could be increased beyond the threshold of 18 percent.

Notwithstanding the advantage of panel data, the contradiction in findings could be because within-country data reduces possible bias caused by economic fluctuations (Ji, Magnus & Wang, 2014) and better capture long-run effects.

Current production levels of crude oil can be achieved without compromising a country's economic growth as confirmed by the empirical work of Tamba (2017) using the vector autoregressive model. This paper analysed the crude oil sector and examined the causal relationship between crude oil production in Cameroon and economic growth. The study which spanned over thirty years from 1977 – 2010 found no causality between crude oil production in Cameroon and economic growth. Also, it concluded that the current low production of crude oil in Cameroon can be done without affecting the country's economic growth. However, without appropriate policies, not increasing crude oil production is not an option since it could hurt crude oil consumption which could harm economic growth.

Natural resources could harm economic growth in both African and nonAfrican countries with regional differences in factors for economic growth. Park and Lee (2006) studied the effects of natural resources on economic growth comparing African and non- African countries from 1976- 2000 by examining the varying role of natural resources according to specific contexts across regions using the generalised method of moments (GMM). They found that inflation and good governance are significant to growth while trade openness is not in Africa. Also, it was found that the Dutch disease effect seems to be a

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much more important channel for resources to exert a negative impact on growth in non- African countries.

Also, Iimi (2007) examined the effect of mineral resources on economic growth in 89 countries including 18 low- income countries, 22 lower-middleincome countries, 19 higher- middle-income countries, and 29 high-income countries using six instrumental variables (IV) spanning from 1998-2000. In consonance with Park and Lee (2006), he also found that the abundance of natural resources does not guarantee growth in all the 89 countries, and good governance was found to be critical for developing countries. On this note, both findings stress the need for an economic policy that takes into account regional differences.

There is the possibility that the resource curse may be a red herring. Contrary to the resource curse consensus, results from Brunnschweiler and Bulte (2008) provided evidence on 60 countries including five regions (Europe, North America, Central, and South America, Africa and the Middle East, Asia and Oceania) spanning from 1970 – 2000, and found resource abundance to be significantly associated with both growth expansion and institutional quality.

Following Brunnschweiler and Bulte (2008), an empirical study by Sarmidi, Hook Law, and Jafari (2014) employed the innovative threshold regression model in examining the resource curse in 90 countries from 1984 – 2005.

Interestingly, their findings supported the fact that the resource curse could lead to a premature conclusion. However, their result failed to reject the fact that resource-abundant countries with weak institutions will be worse off in terms of economic growth compared to their resource-poor counterparts. One striking similarity in their works is the choice of measurement for resource

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curse. Both studies viewed resource curse as a measure of dependence but not as a measure of abundance and due to this found a positive relationship between natural resource and economic growth. Based on their findings, we find that the choice of measurement for the natural resource is imperative in determining the relationship between economic growth and resource abundance.

The abundance of natural resources can be used as a blessing depending on the quality of institutions. Perry and Olivera (2009) examined the effect of quality institutions in Columbia and a panel of 75 countries between the years of 1980 – 2005 using standard controls. Findings from both cross-section and panel results supported the inevitable role of quality institutions in reverting the resource curse. Adopting the empirical models of Perry and Olivera (2009), Eregha and Mesagan (2016) found all the institutional variables to have an insignificant effect on per capita GDP growth in Algeria, Angola, Egypt, Libya, and Nigeria between the years of 1996 – 2013 using fixed effect, random effect and pooled ordinary least square models. This raises further questions on the quality of institutions in facilitating sustainable growth and harnessing the benefits of resources. Notwithstanding the role of quality institutions, one reason for this contradiction could be that apart from the issue of weak institutions there are other pressing factors in these African oil-producing economies that need to be addressed to turn their curse into blessings.

Finally, in solving the controversies surrounding the role of quality institutions, some studies have suggested that the effect of quality institutions in the resource- growth relation could be well captured using nonlinear models. This can be seen in the works of Abdulahi, Shu, and Khan (2019) and Ji, Magnus, and Wang (2014). Ji, Magnus, and Wang (2014) using a time variant

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panel data found strong and positive nonlinear effect of quality institutions in the resource abundance and economic growth relation for the provinces of china. Abdulahi, Shu, and Khan (2019), on the other hand, used the panel threshold model for sub- Saharan Africa and found a significant and dynamic effect of quality institutions over the relationship between natural resources and economic growth.

Summary

This chapter reviewed some economic theories from which the analysis of crude oil production and economic growth have been drawn from including the curse of resources, endogenous growth theories, Norwegian model of oil sector governance, and the institutional approaches to the resource curse. Further, empirical works were reviewed, and we realised the most empirical analysis of crude oil production and economic growth had different results. The varying results in literature were attributed to some regional disparities, level of institutional capacity, and the choice of measurement and econometric technique. Additionally, we realized that most of the empirical works were cross-country analysis with few within-country analyses specifically on Ghana. Therefore, the study intends to consider Ghana, a country with nine years of crude oil production experience to test for any possible early signs of resource curse taking into account the role of capital accumulation and quality institutions as well as some of the methodological issues that have been raised concerning measurement and econometric approach.

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CHAPTER THREE

RESEARCH METHODS

Introduction

The chapter focused on the methods used for the study. It provided the philosophy of the research, research approach, and research design, theoretical models, empirical models, justification for the variables and the estimation procedures employed.

Research Philosophy and Approach

The research philosophy that underpinned this study was the positivist philosophy (positivist paradigm). The positivist philosophy employed the quantitative research approach under the objectivism epistemology where the methods of natural science are applied to the study of social science. This is such that, understanding a phenomenon must be measured and supported by empirical evidence (Hammersley, 2013). The study employed this philosophy and approach to ensure that methodologies, analyses, and findings from the data are situated on statistical evidence. Also, this approach offered the study the advantage of replicability and reliability of its findings, and the making of scientific assumptions and hence provided the foundation for the findings of the study to be generalised.

Research Design

The research design employed for the study was the Quasi Experimental design specifically a time series analysis to examine the effect of crude oil production, quality institutions and capital accumulation on the growth of Ghana's economy. Consistent with the contexts and assumptions of the quantitative research approach, the research design helps the researcher to

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examine the cause and effect relationship between the dependent and independent variable overtime with utmost objectivity.

Theoretical Model Specification

The study adopted the Endogenous growth model described by Arrow, (1962); Romer, (1986); Lucas, (1988); Barro, (1990); and Rebelo, (1991). Specifically, the study adapted the AK model developed by Aghion and Howitt (1992), specified as:

$$Y_t = A_t K_t \quad (1)$$

While A (technology) remained exogenous, Y (output) was represented by real non-oil GDP growth rate (RNGDP), K (capital) was represented by Gross Fixed Capital Formation and Crude Oil Production (COP) since these resources form part of Ghana's capital assets, the model was thus re-specified as:

$$RNGDP_t = f(COP_t GFCF_t) \quad (2)$$

Meanwhile to capture some economic policies that affect economic growth and role of institutions, the study included variables such as Exchange rate (EXR), Government expenditure which was disaggregated into Capital expenditure (CEX) and Recurrent expenditure (REX), International crude oil price (ICP), and Quality institutional (INST) indices. Hence the model was specified as:

$$RNGDP_t = f(COP_t GFCF_t INST_t CEX_t REX_t EXR_t ICP_t) \quad (3)$$

Empirical Model Specification

The study augmented the models used by Perry and Olivera (2009) to determine the effect of the policy variables (COP, GFCF, INST) on Economic Growth (RNGDP). The equation was specified as;

$$RNGDP_t = \beta_0 + X_t{}'\beta_1 + \beta_2 COP_t + \beta_3 GFCF_t + \beta_4 INST_t + \beta_5(COP_t *$$

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$$INST_t) + \beta_6(COP_t * GFCF_t) + \varepsilon_t \quad (4)$$

Where X_t' is a vector of the variables; Recurrent Expenditure (REX), Capital Expenditure (CEX), Exchange Rate (EXR), and International Crude Oil Price (ICP). $(COP_t * INST_t)$, and $(COP_t * GFCF_t)$ are the interactive terms for Crude oil Production (COP) and Institutional Quality (INST), and Gross Fixed Capital Formation (GFCF) respectively.

For the first empirical objective;

To examine the validity of the resource curse hypothesis in the Ghanaian economy, using Crude Oil Production as a proxy, the equation was specified as;

$$RNGDP_t = \beta_0 + X_t'\beta_1 + \beta_2 COP_t + \varepsilon_t \quad (5)$$

For the second empirical objective;

To investigate the role of capital accumulation in the crude oil-growth link, using Gross Fixed Capital Formation formerly Gross Fixed Domestic Investment as a proxy, the equation was specified as;

$$RNGDP_t = \beta_0 + X_t'\beta_1 + \beta_2 COP_t + \beta_3 GFCF_t + \beta_4(COP_t * GFCF_t) + \varepsilon_t \quad (6)$$

For the third empirical objective;

To investigate the moderating effect of institutions in the crude oil-growth link, the quality institution was proxied by Corruption (CORR), Government Effectiveness (GOVE), and Voice and Accountability (ACC) Indices. Equation (4) was thus re-specified and presented as equation (7);

$$RNGDP_t = \beta_0 + X_t'\beta_1 + \beta_2 COP_t + \beta_3 INST_t + \beta_4(COP_t * INST_t) + \varepsilon_t \quad (7)$$

Justification and Measurement of Variables

Economic Growth (GDP)

In this study, real non-oil gross domestic product (RNGDP) growth rate was used as a measure for economic growth. Due to the discovery of oil in

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Ghana, the GDP growth rate consists of both activities from the oil and non-oil sector. Therefore, consistent with the objectives of this study, the nonoil real GDP growth rate was used to ascertain the reflections of the activities of the oil sector on the non-oil sector of the economy adjusting for the effect of inflation. The independent variables included the following:

Crude Oil Production (COP)

Studies associated with the resource curse often employ oil as the unit of their arguments. This idea stems from the Dutch disease experience, where the discovery of oil hurt the competitiveness of the non-oil sector. Globally, crude oil has become an essential factor for economic emancipation, due to its contribution to the supply of the world's energy demands (consumption) and serving as an input in production. Crude oil production was incorporated in the model to examine the effect of the entire activities (production) of the oil sector on the economy. The variable crude oil was measured in volumes of barrels.

Institutional Quality (INST)

The important role of institutions has been recognized in both empirical and theoretical literature. This can be seen in the studies of Acemoglu, Johnson, and Robinson (2001) and Sachs (2003). They claim that economic performance depends on current and past institutions, and as such, once institutions are efficient economic growth becomes inevitable. By this line of reasoning, institutional quality as an indicator was included in the model because evidence of poor institutional quality resulting in poor economic performance has been found in the case of DR Congo, Nigeria, Sierra Leone.

The institutional indicator ranging from -2.5 to 2.5 was measured in the study by three indicators- government effectiveness, voice and accountability

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index, control of corruption. These proxies were used to capture; the respect of citizens and the state for the institutions that govern economic and social interactions, the capacity of the government to effectively formulate and implement sound policies, and the process by which governments, are selected, monitored and replaced respectively.

The Interaction between Crude Oil production and Institutional Quality

Studies have found that there exists a relationship between natural resources, quality institutions, and economic growth. Empirically, studies have shown that institutional quality is imperative for natural resources to be channeled into positive economic performance (Abdulahi, Shu & Khan, 2019; Eregha & Mesagan, 2016; Mehlum, Moene & Torvik, 2006), just to mention but a few. In this respect, the interaction of crude oil production and institutional quality was included in the model to ascertain the indispensable role of quality institutions as seen in the case of Norway, Botswana, and Chile. The study interacted crude oil production with control of corruption, government effectiveness, and voice and accountability indicators to examine whether quality institutions can reverse any possible resource curse in Ghana. Also, it is in the interest of the study to ascertain the effect of both positive (improvement in institutions) and negative (poor institutions) shocks amidst crude oil production on economic growth.

Capital accumulation (GFCF)

Empirical and theoretical evidence indicate the important relationship between capital accumulation and economic growth. In this respect, capital accumulation was included in the model since it remains one key variable in traditional and modern growth models. Capital accumulation was expected to

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have a significant positive effect on economic growth since it serves as an important channel through which resources of an economy could be translated into economic growth. The variable capital accumulation was measured as a gross fixed capital formation defined as improvement in land, plant, machinery and equipment purchases; and the construction of roads, railways and the like, including schools, offices, hospitals, private residential dwellings, and commercial and industrial buildings, that is the net acquisition of valuables.

The Interaction between Crude Oil Production and Capital accumulation

Crude oil as part of natural resources is an important source of national wealth around the world. Yet, reality shows that crude oil riches are neither necessary nor sufficient for economic growth and development but rather the transformation of these riches into capital assets (Gylfason & Zoega, 2006). Therefore, the model included the interaction of crude oil production and capital accumulation to examine its effect on the Ghana's economy. This is because capital accumulation in the form of technological discoveries and innovation improves productivity which has spillovers on the non-oil sector of the economy. Both effects of positive (increase in capital formation) and negative (decrease in capital formation) shocks are examined.

Government Expenditure (CEX and REX)

In literature, the relationship between government expenditure and economic growth has been discussed extensively. Studies that include d'Agostino, Dunne, and Pieroni (2016); Aregbeyen and Kolawole (2015); Bleaney and Halland (2009), have provided evidence for the effect of government spending amidst oil revenue on economic growth. Therefore, government expenditure was included in the model because fiscal discipline is

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crucial for the transformation of oil resources into capital assets necessary for industrialization. The study disaggregated government expenditure into two; capital expenditure (CEX) and Recurrent Expenditure (REX). The variables capital expenditure and recurrent expenditure were measured as net investment in nonfinancial assets and cash payments for operating activities by government respectively.

Exchange Rate (EXR)

The significance of the variable stems from the influence it has the growth of any economy that opens its doors to cross border trade. Exchange rate was also included as a variable in the model due to its role in international trade since no country is an island especially with Ghana being an oil-exporter and practicing international trade, it becomes imperative to include exchange rate as a variable to ascertain its impact on the growth of the economy. The variable exchange rate was measured as national currency per US dollars, period average rate.

Crude Oil Price (ICP)

The growing importance of crude oil as one of the main indicators of economic activities has made issues of oil price a greater concern. Based on this, the crude oil price was included in the model because of the considerable consequences it has on economic activities which have been recognised in the literature (Jiménez-Rodríguez & sanchez, 2009). The variable Crude oil price was measured as crude oil, unit price ($/barrel), also known as international crude oil price.

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Data type and Sources

The research employed secondary and monthly time series data. Annual and quarterly time series data collected from 2011 to 2018 were extrapolated into a monthly data using the Gandolfo (1981) and Chow-Lin (1971) algorithm. The monthly and quarterly time series data on these selected macroeconomic variables; Crude oil production (COP) was drawn from the Ghana National Petroleum Company (GNPC), International Crude oil price (ICP) was drawn from the Bank of Ghana, Government Expenditure; Recurrent Expenditure (REX) and Capital Expenditure (CEX), Real Gross Domestic Product Growth (GDP), and Exchange Rate (EXR) were drawn from the Ministry of Finance (MoF) whereas annual time series data of Gross fixed capital formation (GFCF) was drawn from World Development Indicators (WDI). Also, annual time series data of Institutional Quality indicators; Control of Corruption (CORR), Government effectiveness (GOVE), and Voice and Accountability (ACC) were obtained from World Governance Indicators (WGI).

Estimation Procedure

To ascertain the asymmetric effect of crude oil production, quality institutions, and capital accumulation the Nonlinear ARDL model was applied. This involved the following steps: the study first investigated the time-series properties of the variables involved by using the Augmented Dickey-Fuller (ADF) and the Philips-Perron (PP) tests to check the stationary position of the data. Secondly, to estimate the partial decomposition NARDL model was applied to estimate partial sum decompositions of the parameters. In addition to this, the dynamic multiplier effects of these partial sum decompositions were generated.

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Unit root test

Since time-series data mostly have unit root, testing for the unit root properties, therefore, becomes necessary when with such data series. The study employed two tests for unit root namely the Augmented Dickey-Fuller and Philips-Perron tests. These tests were done to ensure reliable results of the tests for stationarity due to the weaknesses of each technique and they differ in terms of correcting for autocorrelation. Base on this, the PP test is used as an additional test to draw conclusions for unit roots due to the sensitivity of the lag-length selection of the ADF test. Basically, the unit root is formulated as:

$$\Delta Y_t = \mu + \rho Y_{t-1} + \gamma_t + \sum_{i=1}^{p} \beta_i \Delta Y_{t-1} + \varepsilon_t \qquad (8)$$

Where the series is represented by Y_t at time t, the difference operator as Δ, the parameters to be estimated as (μ, γ, β_i) and the stochastic random disturbance term as ε_t. After establishing cointegration among variables, the NARDL approach by Shin, Yu, and Greenwood-Nimmo (2014) was used to determine asymmetric interactions of the policy variables.

NARDL Framework

To develop a strong, robust and reliable model that captures the asymmetric relationship among crude oil production, quality institutions, and economic growth, the Nonlinear Autoregressive Distributed Lag (NARDL) model was proposed. The nonlinearity of many economic variables has been recognized due to the twin problem of non-stationarity and nonlinearity.

Based on this twin problem, the NARDL was employed since the framework can jointly model asymmetries both in the long-run relationship and in the patterns of dynamic adjustment. Also, no matter the order of cointegration, NARDL could be employed. Interestingly, some features of

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ARDL and FMOL of Peseran and Shin (1998) and Philip and Hansen (1991) are embedded in the NARDL model solving for the double issue of serial correlation and endogeneity (Shin, Yu & Greenwood-Nimmo, 2014).

Finally, the NARDL makes it possible to ascertain the asymmetric adjustment patterns following positive and negative shocks in the explanatory variables and shows the changes in the variables from initial equilibrium to a new equilibrium following a shock. The following were the approaches taken to achieve the objectives of the study:

First, before the estimation of the NARDL model, the following asymmetric regression was introduced to test for nonlinear asymmetric cointegration among the variables:

$$\Delta RNGDP_t = \gamma_0 + \delta_{t-1} + \beta_1 RNGDP_{t-1} + \beta_2^+ COP_{t-1}^+ + \beta_3^- COP_{t-1}^- + \beta_4^+ (COP * GFCF)_{t-1}^+ + \beta_5^- (COP * GFCF)_{t-1}^- + \beta_6^+ (COP * INST)_{t-1}^+ + \beta_7^- (COP * INST)_{t-1}^- + \sum_{i=1}^{q} \theta_i \Delta RNGDP_{t-1} + \sum_{i=0}^{q} (\theta_i^+ \Delta COP_{t-i}^+ + \theta_i^- \Delta COP_{t-i}^-) + \sum_{i=0}^{q} (\theta_i^+ \Delta (COP * GFCF)_{t-i}^+ + \theta_i^- \Delta (COP * GFCF)_{t-i}^-) + \sum_{i=0}^{q} (\theta_i^+ \Delta (COP * INST)_{t-i}^+ + \theta_i^- \Delta (COP * INST)_{t-i}^-) + \varepsilon_t \qquad (9)$$

Next, the independent variables (COP, INST, and GFCF) are disintegrated into negative and positive sums as follows:

$$G_x^+ = \sum_{i=1}^{t} \Delta G_x^+ = \sum_{i=1}^{t} \max(\Delta G_x, 0) \; and \; G_x^- = \sum_{i=1}^{t} \Delta G_x^- = \sum_{i=1}^{t} \max(\Delta G_x, 0) \qquad (10)$$

Where G_x denotes COP, INST, and GFCF.

To ascertain the effect of both long- and short-run COP+ and COP-, NARDL(p, q) model was specified as follows;

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$$\Delta RNGDP_t = \gamma_0 + \delta_{t-1} + \beta_1 RNGDP_{t-1} + \beta_2^+ COP_{t-1}^+ + \beta_3^- COP_{t-1}^- + \beta_4 X'_{t-1} + \sum_{i=1}^{p} \Delta Y_{t-i} + \sum_{i=1}^{q} \theta_i \, \Delta RNGDP_{t-1} + \sum_{i=0}^{q} (\theta_i^+ \, \Delta COP_{t-i}^+ + \theta_i^- \Delta COP_{t-i}^-) + \sum_{i=0}^{q} \theta_i \, \Delta X'_{t-i} + \varepsilon_t \quad (11)$$

To ascertain the role of both long- and short-run GFCF+ and GFCF- in the association between production of crude oil and the growth of the economy, NARDL(p, q) model was specified as follow;

$$\Delta RNGDP_t = \gamma_0 + \delta_{t-1} + \beta_1 RNGDP_{t-1} + \beta_2 COP_{t-1} + \beta_3 GFCF_{t-1} + \beta_4^+ (COP * GFCF)_{t-1}^+ + \beta_5^- (COP * GFCF)_{t-1}^- + \beta_6 X'_{t-1} + \sum_{i=1}^{p} \Delta Y_{t-i} + \sum_{i=1}^{q} \theta_i \, \Delta RNGDP_{t-1} + \sum_{i=0}^{q} \theta_i \, \Delta COP_{t-i} + \sum_{i=0}^{q} \theta_i \, \Delta GFCF_{t-i} + \sum_{i=0}^{q} (\theta_i^+ \, \Delta (COP * GFCF)_{t-i}^+ + \theta_i^- \Delta (COP * GFCF)_{t-i}^-) + \sum_{i=0}^{q} \theta_i \, \Delta X'_{t-i} + \varepsilon_t \quad (12)$$

To ascertain the role of both long- and short-run INST+ and INST- in the association between production of crude oil and the growth of the economy, NARDL(p, q) model was specified as follow;

$$\Delta RNGDP_t = \gamma_0 + \delta_{t-1} + \beta_1 RNGDP_{t-1} + \beta_2 COP_{t-1} + \beta_3 INST_{t-1} + \beta_4^+ (COP * INST)_{t-1}^+ + \beta_5^- (COP * INST)_{t-1}^- + \beta_6 X'_{t-1} + \sum_{i=1}^{p} \Delta Y_{t-i} + \sum_{i=1}^{q} \theta_i \, \Delta RNGDP_{t-1} + \sum_{i=0}^{q} \theta_i \, \Delta COP_{t-i} + \sum_{i=0}^{q} \theta_i \, \Delta INST_{t-i} + \sum_{i=0}^{q} (\theta_i^+ \, \Delta (COP * INST)_{t-i}^+ + \theta_i^- \Delta (COP * INST)_{t-i}^-) + \sum_{i=0}^{q} \theta_i \, \Delta X'_{t-i} + \varepsilon_t \quad (13)$$

In Equations (11, 12, and 13), β_j denoted the long-run coefficients, while θ_i denotes the short-run coefficients. The long-run coefficients were estimated to analyse the speed with which the variable of interest will change back to its initial state following a short-run shock. Whereas, the short-run coefficients were estimated to capture the impact analysis of the independent

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variable on the dependent variable. Also, the F-statistics of the Wald test was used to investigate the long-run $(\beta^+ = \beta^- = \beta)$ and short-run $(\theta^+ = \theta^- = \theta)$ asymmetries for all the variables, as identified in Equation (10, 11, and 12). (p, q) Shows the lag for the dependent variable (RNGDP) and the lag length for the policy variables (COP, INST, and GFCF).

After estimating the model in equation (11, 12, 13), the bound- testing asymmetric long-run relationship was investigated. In this respect, Peseran et al. (2001) F-test was introduced to investigate this long-run relationship. The F-statistics tests the null hypothesis of no cointegration $(\emptyset^+ = \emptyset^- = \emptyset = 0)$ against the alternative hypothesis of $\emptyset < 0$. Therefore, it becomes important that the null hypothesis is rejected to indicate the policy variables are cointegrated.

After investigation long-run cointegration, based on $Lm^+ = \theta^+/\delta$ and $Lm^- = \theta^-/\delta$ the long-run coefficients were estimated under the framework of an asymmetric model. To ascertain the asymmetric dynamic multiplier effect, the following equations were used:

$$m_{h1}^+ = \sum_{j=0}^{h} \frac{\partial Y_{t+k}}{\partial RNGDP_t^+}, m_{h1}^- = \sum_{j=0}^{h} \frac{\partial Y_{t+k}}{\partial RNGDP_t^-}, m_{h2}^+ = \sum_{j=0}^{h} \frac{\partial Y_{t+k}}{\partial COP_t^+}, m_{h2}^- = \sum_{j=0}^{h} \frac{\partial Y_{t+k}}{\partial COP_t^-}, m_{h3}^+ = \sum_{j=0}^{h} \frac{\partial Y_{t+k}}{\partial COP*INST_t^+}, m_{h3}^- = \sum_{j=0}^{h} \frac{\partial Y_{t+k}}{\partial COP*INST_t^-}, m_{h4}^+ = \sum_{j=0}^{h} \frac{\partial Y_{t+k}}{\partial COP*GFCF_t^+}, m_{h4}^- = \sum_{j=0}^{h} \frac{\partial Y_{t+k}}{\partial COP*GFCF_t^-} \quad (14)$$

Where $h = 0,1,2, \ldots$ whereas $h \to \infty$, then $m_{hi}^+ \to lm^+$ and $m_{hi}^- \to lm^-$.

The dynamic multiplier in equation (14) depicts the asymmetric reactions of the dependent variable to both negative and positive shocks of the independent variables. In this regard, dynamic multipliers show the rate of adjustments or the possible reactions of the variables in the model from initial state to the new state following a shock.

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Diagnostic and stability tests

The diagnostic and stability tests were also conducted to ensure the model's goodness of fit. The diagnostic test examined the R-square, adjusted R-square, heteroscedasticity, functional form test, and normality associated with the selected model. The study employed cumulative sum (CUSUM) and cumulative sum of squared (CUSUMSQ) tests to test for the stability of the policy variables on economic growth (Brown, Durbin, and Evans, 1975). This test becomes necessary because in Ghana, since 2011, revenues accrued from the production of crude oil has been an important source of fund for developmental projects which have great impact on these economic variables.

Data processing and Analysis

The study applied the natural log transformation on some of the variables – crude oil production (LNCOP), gross fixed capital formation (LNGFCF), capital expenditure (LNCEX), recurrent expenditure (LNREX), and International crude oil price (LNICP) before inferential analysis was employed. Charts such as graphs and tables were presented to aid in the analysis of the study. All estimations carried out in this study were done using E-views package 10.

Summary

This chapter developed and presented the methodological framework suitable for conducting the study. The model was developed from the theoretical underpinnings of the Endogenous growth model, specifically the AK model by Aghion and Howitt (1990) and Romer (1986). Monthly time series data from 2011 to 2018 was employed for the study. The stationarity test was conducted using the Augmented Dickey-Fuller (ADF) and Philips-Perron (PP) tests.

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Moreover, the Nonlinear Autoregressive Distributed Lag (NARDL) model was used to examine the asymmetric long- and short-run dynamics among these policy variables: institutional quality indices (corruption, government effectiveness, and voice and accountability) and gross fixed capital formation (capital accumulation). Finally, the chapter highlighted some diagnostic and stability tests for the variables of interest.

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CHAPTER FOUR

RESULTS AND DISCUSSION

Introduction

The focus for the chapter is on the empirical findings and discussions of the study's results. The chapter started with the presentation and interpretation of the descriptive statistics, followed by discussion of the unit roots using the PP and the ADF tests results. This chapter further dealt with the presentation and discussion of the main results using the NARDL technique.

Descriptive Statistics

In this section, an analysis of the descriptive statistics was carried out. Descriptive analysis of data becomes necessary as it helps to determine the center, the spread and the shape of the data as illustrated in Table 1. As evident from Table 1, the time series data employed in this analysis spans over 96 months. Also, it was found that the variables have positive mean values but control of corruption index (CORR), and government effectiveness index (GOVE) were found to have negative mean values. The negative mean values of control of corruption and government effectiveness imply that on average, the effectiveness of the government and the control of corruption as a nation is poor with mean values of -0.0124 and -0.0117 respectively.

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Table 1: Summary Statistics

Var.	Mean	Max	Min	Std.Dev.	Skewness	Kurt.	J-Bera	Prob.	Obs.
GDP	0.61933	7.770607	-3.7299	2.37765	0.653846	3.99	10.75	0.005	96
COP	3230051	5506440	1977347	1051242	0.766566	2.37	10.98	0.004	96
CORR	-0.0117	-0.00136	-0.0198	0.005094	0.377296	2.47	3.39	0.183	96
GOVE	-0.0124	-0.00332	-0.0255	0.00687	-0.2228	1.77	6.88	0.032	96
ACC	0.04237	0.056726	0.035291	0.00598	0.64588	2.11	9.83	0.007	96
CEX	662.373	1972.902	107.0565	394.671	1.055810	4.01	21. 89	0.000	96
GFCF	3150	4870	495	1530	-0.6191	1.87	11.27	0.0035	96
REX	2716.22	7531.309	627.6392	1225.43	0.727953	4.02	12.67	0.002	96
ICP	81.9563	124.62	31.93	28.0872	-0.0972	1.39	10.54	0.005	96
EXR	3.11833	4.82	1.4793	1.15136	-0.11574	1.41	10.34	0.006	96

Note: Max represents maximum; Min represents minimum; standard deviation as Std. Dev.; Kurt. represents kurtosis; Jarque-Bera as J-Bera; probability as Prob. and Observation as Obs., Gross fixed capital formation (GFCF) is in billions.

Source: Amankrah (2020)

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However, voice and accountability index (ACC) recorded a positive mean of 0.04237 which could mean that on the average, the quality of democracy in Ghana has improved. The mean of the non-oil real gross domestic product (GDP) growth rate is 0.61933, which could imply that on the average, the economy grows monthly at a rate of 0.62% approximately.

The mean value of crude oil production is 3230051, implying that, 3.2 million barrels of crude oil is produced on the average within a month. The mean value of gross fixed capital formation (GFCF) is 3150. This also implies that on the average, approximately GHs 3.2 billion of capital is accumulated in the economy within a month. Government capital (CEX) and recurrent expenditure (REX) recorded mean values of 662.373 and 2716.22 respectively indicating that on the average, the government of Ghana spends GHs 662.373 million on capital which is less than her recurrent expenditure of GHs 2.7 billion in a given month. Finally, international crude oil price (ICP) recorded a mean value of 81.9563 indicating that on the average crude oil is sold at US$ 81.9563 per barrel within a month. Exchange rate (EXR) on the other hand, recorded a mean value of 3.11833 indicating that on the average, the national currency per US dollar is 3.11833 in a month.

It can also be observed from table 1 that government capital expenditure (CEX), recurrent expenditure (REX), crude oil production (COP), gross fixed capital formation (GFCF), and crude oil price (ICP) have high standard deviation values which implies that their observations are wider spread from their mean values. On the other hand, control of corruption (CORR), government effectiveness (GOVE), voice and

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accountability (ACC) and non-oil real GDP growth rate (GDP) and exchange rate (EXR) have small standard deviation values.

With respect to skewness and kurtosis, non-oil real GDP growth rate, crude oil production, control of corruption, voice and accountability, capital and recurrent expenditure by government were found to be positively skewed to the left, showing that the data points of these variables fall below their mean values. On the other hand, government effectiveness, gross fixed capital formation, crude oil price and exchange rate are negatively skewed to the right, indicating that they have data points above their mean values. In terms of kurtosis, the data points of all the variables are platykurtic except GDP, CEX and REX which are leptokurtic. That is, compared to a normal distribution, all the variables but GDP, CEX and REX have lower and broader central peak. Finally, all the variables except control of corruption are not normally distributed.

Stationarity Test

Although the Nonlinear ARDL does not require the testing of unit root, however, it is important that this test is performed to verify that none of the variables are integrated of order two to prevent spurious results. Due to this reason, before employing the NARDL approach, the Augmented Dickey-Fuller (ADF) and Philips-Perron (PP) tests were conducted. The results of ADF test for unit root (with intercept only, intercept and trend, and none) are presented in Table 2. The null hypothesis is that the variable contains unit root (MacKinnon, 1996).

Table 2 indicated that with the variables having a p-value which is statistically significant, the alternative hypothesis can be accepted only for

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LNCEX (log of capital expenditure by government) both with intercept only and intercept and trend, LNREX (log of recurrent expenditure by government) with intercept and trend, and GDP (non-oil real GDP growth rate) without intercept and trend at alpha level of 1% for LNCEX and LNREX, and 5% for GDP. This implies that, government capital expenditure, recurrent expenditure, and non-oil real GDP growth rate are stationary at levels indicating that they are integrated of order zero denoted by *I*(0). However, this is not the case for the remaining variables because they have p-values that are statistically insignificant.

Table 2: Test of stationarity using the Augmented Dickey-Fuller (ADF)

	Augmented Dickey-Fuller Test					
	At levels			At first difference		
Variables	Intercept only	Intercept & trend	None	Intercept only	Intercept & trend	None
GDP	-3.1971	-3.0269	-1.973**	-6.298***	-6.39***	-6.30***
LNCOP	-0.144	-1.9539	1.87	-4.340***	-4.38***	-3.87***
CORR	-1.8777	0.2114	-0.2916	-4.545***	-5.32***	-4.58***
GOVE	-1.7321	-1.6511	-0.1887	-3.31**	-3.337*	-3.27***
ACC	-1.2632	-1.2812	0.1253	-1.6588	-0.7658	-1.61***
LNCEX	-6.583***	-8.523***	1.1607	-5.639***	-5.74***	-7.62***
LNREX	-1.817	-6.22***	1.3726	-7.257***	-7.26***	-7.06***
LNGFCF	-1.9158	-0.0782	0.0859	-1.5036	-4.57***	-1.7106*
EXR	-0.2519	-2.218	3.3948	- 15.08***	-15.00***	-4.01***
LNICP	-1.4252	-2.1124	-0.7575	-6.775***	-6.737***	-6.77***

Note: ***, **, and * indicate the rejection of the null hypothesis of non-stationary at 1%, 5%, and 10% level of significance respectively.
Source: Amankrah (2020)

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To further confirm the stationarity properties of the variables, the PP test was conducted. As shown in Table 3, the variables have p-values that are statistically not significant and hence indicates that none of the variables are integrated of *I*(0) except for GDP (nonoil real GDP growth rate), LNCEX (log of capital expenditure by the government), LNREX (log of recurrent expenditure by the government) which are significant at 1%, and LNGFCF (log of gross fixed capital formation) which is significant at 10%. This implies that economic growth, capital expenditure by government, recurrent expenditure by government, and gross fixed capital formation are stationary at levels and therefore, integrated of order zero denoted by *I*(0). This is not the case for all the variables at first difference and as such the alternative hypothesis of absence of unit root is accepted for variables without intercept and trend (none) at all the alpha levels.

Table 3: Test of stationarity using Philips-Perron (PP)

	Philips-Perron Test					
	At levels			At first difference		
Variables	Intercept only	Intercept & trend	None	Intercept only	Intercept & trend	None
GDP	-2.977**	-3.1154	-2.76***	-9.75***	-9.91***	-9.76***
LNCOP	-0.3611	-1.8847	1.63	-2.4443	-2.4364	-2.153**
CORR	-2.1344	-0.9266	-0.57	-2.6232*	-2.8919	-2.63***
GOVE	-1.6126	-1.5277	-0.32	-2.7872*	-2.8072	-2.79***
ACC	-1.2632	-1.2812	0.1253	-1.6588	-0.7658	-1.61***

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Table 3: Cont'D

LNCEX	-6.65***	-8.52***	0.720	-44.5***	-50.3***	-34.4***
LNREX	-3.164**	-6.22***	2.013	-29.4***	-33.1***	-19.3***
LNGFCF	-2.771*	0.9679	1.562	-1.9368	-3.2377*	-1.8523*
EXR	-0.3625	-2.4693	2.829	-14.5***	-14.4***	-12.9***
LNICP	-1.1298	-1.544	-0.681	-6.51***	-6.47***	-6.52***

Note: ***, **, and * indicate the rejection of the null hypothesis of non-stationary at 1%, 5%, and 10% level of significance respectively.

Source: Amankrah (2020)

Concerning the ADF and PP tests of unit root, it is obvious that the series is mutually cointegrated without *I*(2) variables, hence NARDL approach becomes appropriate tool for estimating the model. The subsequent sections present and discuss the dynamic cointegration results, the long-run bound testing cointegration, short- and long-run asymmetry tests, and the dynamic multiplier cumulative effects of the policy variables.

Test for Nonlinear Cointegration

After investigating the stationarity properties of the variables, we went further to test for the presence of a nonlinear relationship in equation (7) by employing the bound testing approach of cointegration. With the null hypothesis of no cointegration between the dependent and the independent variables, the bound testing approach was employed to specify the existence of nonlinear cointegration among them. The test provides an F-test which confirms jointly the significance of all independent variables on dependent variables. That is, it provides clarity regarding whether the coefficients of

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respective variables are equal to zero or not, jointly. The NARDL – OLS result of nonlinear cointegration for economic growth and its independent variables is presented in Table 4.

Table 4: Bound test for non-linear cointegration

F-statistics	99% Lower bound	99% Upper bound	Conclusion
9.350053	2.41	3.61	cointegration

Note: Critical values were obtained from Pesaran et al. (2001), case II statistical table, presented in Appendix A, with the number of independents (K) = 10. Source: Amankrah (2020)

As evident from Table 4, the joint hypothesis of the lagged variables of the coefficients being zero (no cointegration) is rejected at a 1 percent significance level when GDP is used as a dependent variable. The F-statistic indicates that economic growth and the policy variables; log of crude oil production (LNCOP), the log of crude oil production and log of gross fixed capital formation interaction term (LNCOP_LNGFCF), the log of crude oil production and control of corruption interaction term (LNCOP_CORR), the log of crude oil production and government effectiveness interaction term (LNCOP_GOVE), and log of crude oil production and voice and accountability interaction term (LNCOP_ACC) co-move in the long term. This is because the computed F-statistic is 9.350053 exceeding the upper bound critical value of 3.61 at a 1% significance level. Based on this result, we can assess the economic growth (GDP) dynamics and its relation to positive and negative changes in the

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policy variables (LNCOP, LNCOP_LNGFCF, LNCOP_CORR, LNCOP_GOVE, and LNCOP_ACC).

First Empirical Objective

Table 5: Results from NARDL Cointegration

Variables	Coefficients	t-statistic
Constant	111.8684	3.487188***
GDP(-1)	-0.860141	-6.481125***
LNCOP_POS(-1)	**7.364707**	**3.778722*****
LNCOP_NEG(-1)	**-16.68993**	**-3.182449*****
D(GDP(-1))	0.222475	1.939607*
D(LNCOP_POS)	**59.65374**	**3.590644*****
D(LNCOP_NEG)	**-122.4990**	**-4.852448*****

Note: ***, **, and * indicate 1%, 5%, and 10% level of significance respectively. The coefficients of the LNCOP have been divided by 100.

Source: Amankrah (2020)

Consistent with the first objective, the long-run results of the NARDL cointegration analysis suggest that the coefficient of positive shock in crude oil production is positive (7.364707) and statistically significant at 1 percent level of significance. The result indicates that a unit increase in the volumes of barrels of crude oil produced would be accompanied by an expansion in economic growth by 0.074 approximately. This implies that the economy benefits from the increased or commercial production of crude oil, in that, the amount of revenue accrued from oil production facilitates public consumption (government expenditure). This is in line with the findings of Kumah-Abiwa, Brenya and Agbodzakey (2015), Obeng-Odoom

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(2014) and Gary (2009), who argue that crude oil production is expected to increase foreign reserves as well as aid socioeconomic transformation.

On the other hand, the coefficient of negative shock in crude oil production is significantly negative (-16.68993) 1% alpha level, suggesting an inverse relationship. This then indicates that a unit reduction in the volumes of barrels of crude oil produced would also be accompanied by an expansion in the output of the Ghanaian economy by 0.167 approximately. Although, both shocks in crude oil production lead to an expansion in economic growth, however, a negative shock (decrease) in crude oil production propels growth twice the effect of a positive shock by a magnitude of 2.266 approximately. This is expected, as acknowledged in the studies of Humphreys, Sachs, and Stiglitz (2007), Stevens (2003) and Auty (1993) that the crude oil sector in developing economies such as Ghana comes with some enclave effects that makes developmental linkages between commercial crude oil production and the domestic economy a challenge.

Also, Panford (2017) affirms this by arguing that the economy of Ghana reveals the enclave effect, in a way that, the positive multiplier effects associated with increased crude oil production manifesting in the form of profitable local job creation, incomes, and business opportunities have been less and hence the country does not fully benefit from booms or increase production of crude oil. Moreover, the horizontal, backward and forward linkages associated with crude oil production has virtually no connection to the economy due to low local content and participation (high foreign content) in the sector, and lack of value-addition to the extracted oil.

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The results of the NARDL cointegration analysis also suggest that the coefficient of a positive shock in crude oil production is positive (59.65374) and statistically significant at a 1 percent level of significance whereas its negative shock depicts an inverse relationship of -122.4990 in the short-run. A unit increase in the volumes of barrels of crude oil production expands economic growth by 0.5965 approximately, while a unit decrease in the volumes of barrels of crude oil produced propels positive economic effect by 1.225 which is also twice the impact of a positive shock (increased production of crude oil) by a magnitude of 2.0535 in the short-run. This is also expected, since commercial production of crude oil is capital-intensive and hence demands exceptionally huge financial sums which is beyond the economic capacity of Ghana and as a matter of fact would require foreign direct investment.

However, foreign investments directed to the crude oil sector of Ghana are found not to foster linkages to the domestic economy and as such benefitting fully from commercial production as a country becomes a challenge in the short-run. This confirms the findings of Auty (1993) who argues that, the crude oil sector is extremely high capital to labour ratio and therefore to finance new discoveries and develop further production of crude oil, huge expenditures of high-techs are required, which is beyond the capacity of a developing country like Ghana and need to be imported. These imported technologies would necessitate the employment of foreign workers who already have the required skills to work with instead of local workers.

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Hence, the expected positive economic multiplier effects of commercial crude oil production in the form of more local employment with high incomes as well as more substantial local business participation will not be greatly actualized. This, therefore, proves that the first hypothesis of Sachs and Warner (1997) stating that natural resource (particularly oil and gas) abundance results in poor economic performance is true in the case of Ghana.

Table 6: Results of Bounds-testing for crude oil production

Variables	Coefficient	F-statistic (Wald test)	P-value
LNCOP_POS	8.562214	13.45822	0.0001
LNCOP_NEG	-19.40373	18.950099	0.0002
Model Diagnostic Tests	**Statistic**		
R-squared	0.853035		
Adjusted R-squared	0.773325		
Durbin-Watson (DW)	2.119430		
Jarque-Berra (J-B)	1.680646 (0.4316)		
Heteroscedasticity	1.029770 (0.4503)		
Ramsey Reset test (FF)	1.328753 (0.2538)		

Note: LNCOP_POS denotes positive shock in crude oil production, LNCOP_NEG denotes negative shock in crude oil production, and FF represents the functional form test of the model. The values in the bracket are P-values of the test-statistic. The long-run coefficients for LNCOP_POS and LNCOP_NEG are presented in Appendix B2, J-B (see Appendix B8), FF (see Appendix B10), and Het. (see Appendix B9).

Source: Amankrah (2020)

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The empirical results of the bound-testing long-run coefficients for both positive and negative shock in crude oil production are thus shown in Table 6. The F-statistic of the Wald test (in Appendix B4) depicts that there exists a long-run relationship in the partial decompositions of the production of crude oil with coefficients 8.562214 for a positive shock and -19.40373 for a negative shock, and statistically significant at a 1% level of significance. This indicates that, if the volume of crude oil produced increases by 1 percent, economic growth will be expanded by 0.0856 approximately, whereas if the volume of crude oil produced decreased by 1 percent, economic growth will be expanded by 0.194 approximately in the long-run. This confirms the findings of the NARDL cointegration results presented in Table 5.

The lower part of Table 6 also presents some diagnostic tests of the estimated model in equation (11). The result showed that the estimated model passed the functional form, normality and the test of heteroscedasticity. This indicates that the model estimated is well specified and normally distributed. Also, the adjusted R-squared is approximately 0.77. This suggests that the independent variables explained about 77 percent of the variations in the dependent variable non-oil real GDP growth rate (growth of the economy). Moreover, a Durbin Watson statistic of approximately 2.12 higher than the R-squared value of 0.85 reveals that the estimated results are not spurious.

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Table 7: Asymmetry Tests for crude oil production in Ghana

Variable	Long-run asymmetry		Short-run asymmetries	
	$\mathbf{W_{LR}}(\boldsymbol{F_{PSS}})$	P-value	$\mathbf{W_{SR}}(\boldsymbol{F_{PSS}})$	P-value
LNCOP	3.685123	0.0597*	9.842151	0.0027***

Note: the long-run asymmetry represented as $W_{LR}(F_{PSS})$ tests the $H_0 : \beta^+ = \beta^-$ for the variable crude oil production (COP) in equation (9). $W_{SR}(F_{PSS})$ denotes the Wald statistic for the long-run asymmetry, which tests the null hypothesis of $\theta^+ = \theta^-$ for the variable crude oil production (COP) in equation (9). (presented in Appendix B6 and B7)

Source: Amankrah (2020).

The empirical results of the long- and short-run asymmetry tests are shown in Table 7. It is evident that, the F_{PSS} tests rejects the null hypothesis. The F-statistic (3.685123) accepts the alternative hypothesis that the effects of the partial composition of the production of crude oil on the growth of the economy are statistically different from each other at 10% level of significance in the long-run, and for short-run the F-statistic (9.842151) also depicts that the effects of the partial decompositions of the production of crude oil are statistically different from each other at 1% level of significance. This implies that there exists strong evidence of short-run and long-run asymmetries. To further enrich the analysis of the asymmetry effects of crude oil production on growth of the economy, the dynamic multiplier was also examined.

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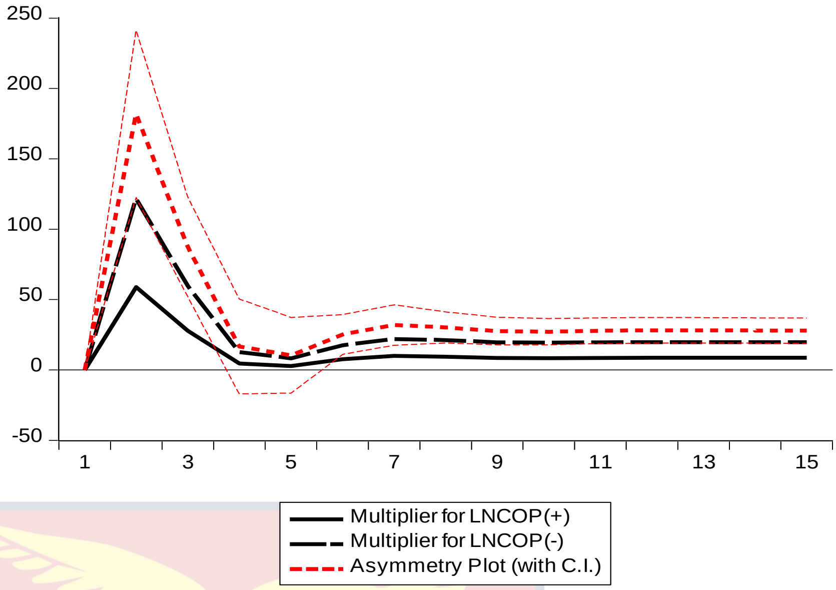

Figure 4: Dynamic Multiplier Cumulative Effect of Crude oil production on growth

Source: Amankrah (2020)

The empirical result from the dynamic multiplier cumulative effect is evident in figure 4. The plot identifies the adjustment of output growth to the new equilibrium position following a positive or negative shock in crude oil production. The black small dashes represent a negative shock whereas the black straight line depicts a positive shock. The red dashed lines also represent the asymmetric curve that measures the differences between the positive and negative shocks of the m_h^+ m_h^- which depicts the dynamic adjustment pattern. The dynamic multiplier confirms the overall existence of a positive economic effect of crude oil production on output growth. The effect of a negative shock in crude oil production is dominant over the positive shock. This indicates that economic growth responds more rapidly and positively to a downturn in crude oil production (negative shock) than it would for an upturn in crude oil production (positive shock) in the very short run, that is, the first 6 months of the analysis period.

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The slow response of economic growth to positive shock in crude oil production confirms the existence of some enclave effects expressed in the form of high capital to labour ratio, less profitable jobs for the indigenes, and lack of value addition to crude oil produced locally (Panford, 2017), also not forgetting the fact that the Ghanaian oil sector is dominated by foreign companies (ownership) who at the end repatriate their profits. Due to these enclave effects, the positive economic multiplier effects of upswings in oil production are not greatly actualized on the non-oil economy. Both the impact of positive and negative shocks in crude oil production becomes highly smooth after 36 months (3 years) period without achieving an equilibrium state over the whole analysis period. The overall impression is that production of crude oil without doubt has positive impact on economic growth, however, the magnitude of this positive economic impact has not been fully actualized in Ghana.

Second Empirical Objective

Table 8: Results from NARDL Cointegration

Variables	Coefficients	t-statistics
Constant	12338.89	3.389888***
GDP(-1)	-0.460102	-5.152416***
LNCOP_LNGFCF_POS(-1)	**20.11807**	**3.382134*****
LNCOP_LNGFCF_NEG(-1)	**18.71763**	**3.323007*****
D(LNCOP_LNGFCF_POS)	**118.9616**	**3.994380*****
D(LNCOP_LNGFCF_NEG)	**116.3706**	**3.966625*****

Note: ***, **, and * indicate 1%, 5%, and 10% level of significance respectively. The coefficients of LNCOP_LNGFCF have been divided by 100.
Source: Amankrah (2020)

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The results from the first objective suggested that crude oil production is linked with positive impact on economic growth. Nevertheless, it has also been established that this positive economic impact be as it may have not been fully actualized over the years (known as the enclave effect). It is therefore the interest of the study to now investigate the role of capital accumulation in this crude oil- growth linkages. Hence the non-linear asymmetric cointegration test (NARDL) is applied and the result is thus presented in Table 8. The coefficients of both the positive and negative shocks in the interactive effect of crude oil production and capital accumulation on economic growth, are positive and statistically significant in the long- and short-run. For instance, a positive shock in capital accumulation could be an increase in the acquisition of infrastructure such as railways, roads, commercial and industrial buildings, hospitals and schools while a negative shock could mean a fall in these infrastructure acquisition. This means that with an oil-producing economy, the acquisition or formation of capital is associated with positive economic growth.

Consistent in the short- and long-run, the coefficient capturing the positive shock in the interactive effect of crude oil production and capital accumulation is positive (20.11807, 118.9616) and significant at 1 percent level of significance. This implies that given a percentage increase in capital accumulation, crude oil production expands economic growth by approximately 0.2 in the long-run and 1.19 in the short-run. Also, the coefficient capturing the negative shock in the interactive effect of crude oil and capital accumulation is positively (18.71763, 116.3706) significant at 1 percent significant level, showing that, for a 1 percent decrease in capital accumulation, crude oil production reduces economic growth by

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approximately 0.187 in the long-run and 1.164 in the short run. This could be argued that capital accumulation is associated with a positive economic multiplier effect, in a way that, capital investment at levels sufficient to support continuing resource and non-resource growth could improve economic performance. This positive economic effect of capital-driven oil production lends support from the works of Philips, Hailwood, and Brooks (2016), Venables (2016), and Mehrara, Maki, and Tavakolian (2010) who found that oil production coupled with the accumulation or investment of capital propels economic growth and development.

Even though both long- and short-run analyses have a positive impact on the growth of the economy, the long-run positive impact of capital is less as compared to its impact in the short-run. This implies that the short-run impact of crude oil production along alongside capital accumulation is at a level sufficient to propel higher economic growth than in the long-run. The reason being that to further develop and have sustained increased oil production requires huge sums of capital investment (or infrastructural development) such as roads or rail transportation, water systems, stable power, reliable telecommunications, ports and pipelines. However, due to the existing infrastructural gap and the level of Ghana’s economic capacity, acquisition of these would require foreign investment which may result in enclave infrastructure investment (NRGI, 2015) where the infrastructure investment benefits only the crude oil sector but not the non-oil economy. Thereby, making it challenging to meet the developmental needs of the nation and as well transform the oil resource wealth into long-term economic growth. Moreover, with the enclave nature of crude oil

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activities, and along with increasing oil resources, there would be more inefficiencies in resource allocation to the public sector, inefficient investment and more unfinished projects (Mehrara, Maki, & Tavakolian, 2010), thereby, making it challenging to amass capital sufficient to complement the production of crude oil and at the same time propel greater economic expansion in the long-run.

As evident in Appendix H1, the joint effect of a positive shock in the production of crude oil and capital accumulation did not maintain its positive impact on economic growth rather it showed a negative impact of approximately 0.889 in the short-run. However, the joint effect of a negative shock depicted an inverse impact of 1.417 on economic growth in the short-run. This suggests that the level of accumulated capital of Ghana would be insufficient to offset the existing enclave effect of crude oil production on economic growth to cause greater positive economic impact.

Consistently, the joint effect of a positive shock in crude oil production and capital accumulation on long-run economic growth is negative at approximately 0.217 and a negative shock depicted an inverse impact of 0.876. The results from the net effect indicates an enclave capital or infrastructure investment where capital investment does not provide the opportunity to leverage economies of scale for Ghana's oil sector and as well meet the developmental needs of the country since the direct benefits from these investment flow outside the country. Hence considering the level of Ghana's capital accumulation, commercial crude oil production does not meet the country's expectations of future benefits.

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Table 9: Results of Bounds-testing for capital accumulation

Variables	Coefficient	F-statistic	P-value
LNCOP_LNGFCF_POS	43.72523	23.78095	0.0000
LNCOP_LNGFCF_NEG	40.68146	23.35319	0.0000
Model Diagnostic Tests	Statistic		
R-square	0.797247		
Adjusted R-square	0.729663		
Durbin-Watson (DW)	1.861884		
Jarque-Berra (J-B)	0.890224 (0.640753)		
Heteroscedasticity	0.701693 (0.8278)		
Ramsey Reset test (FF)	0.505278 (0.6150)		

Note: LNCOP_LNGFCF_POS denotes positive shock in capital accumulation in the crude oil-growth linkages, LNCOP_LNGFCF_NEG denotes negative shock in capital accumulation in the crude oil-growth, and FF represents the functional form test of the model. The values in the bracket are P-values of the test-statistic. The long-run coefficients for LNCOP_LNGFCF_POS and LNCOP_LNGFCF_NEG are presented in Appendix C2, J-B (see Appendix C8), FF (see Appendix C10), and Het. (see Appendix C9).

Source: Amankrah (2020)

The empirical results of the bound-testing long-run coefficients for both positive and negative shock in the interactive effect of crude oil production and capital accumulation are thus shown in Table 9. The F-statistic of the Wald test depicts that there exists a long-run relationship between the partial decompositions of positive and negative shocks in the interaction effect. The long-run coefficients of positive and negative shocks are 43.72523 and 40.68146 respectively, and statistically significant at a 1% level of significance. This indicates that, if the investment in capital should rise, crude oil production could expand economic growth by 0.437

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approximately, whereas if the investment in the capital should fall, crude oil production could dampen economic growth by 0.407 approximately in the long-run. The result is consistent with the findings of the NARDL cointegration results presented in Table 8.

The lower part of Table 9 also presents some diagnostic tests of the estimated model. The result showed that the estimated model passed the functional form, normality, and the test of heteroscedasticity. This indicates that the model estimated is well specified and normally distributed. Also, the adjusted R-squared is approximately 0.7297. This suggests that the independent variables could explain about 72.97 percent of the variations in the dependent variable nonoil real GDP growth rate (growth of the economy). Moreover, a Durbin Watson statistic of 1.862 higher than the R-squared value of 0.797 reveals that the estimated results are not spurious.

Table 10: Asymmetry Tests for capital accumulation

Variable	Long-run asymmetry		Short-run asymmetries	
	$\mathbf{W_{LR}}(\boldsymbol{F_{PSS}})$	P-value	$\mathbf{W_{SR}}(\boldsymbol{F_{PSS}})$	P-value
LNCOP_LNGFCF	3.745628	0.0570*	5.414785	0.0229**

Note: the long-run asymmetry represented as $W_{LR}(F_{PSS})$ tests the $H_0 : \beta^+ = \beta^-$ for the variable crude oil production and gross fixed capital formation interaction (COP_GFCF) in equation (11). $W_{SR}(F_{PSS})$ represents the Wald statistic for the long-run asymmetry, which tests the null hypothesis of $\theta^+ = \theta^-$ for the variable crude oil production and gross fixed capital formation (COP_GFCF) interaction in equation (11). (presented in Appendix C6 and C7)

Source: Amankrah (2020)

The empirical results of the long- and short-run asymmetry tests are shown in Table 10. It is evident that, the F_{PSS} test rejects the null hypotheses.

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The F-statistic (3.745628) for long-run asymmetry accepts the alternative hypothesis to indicate that there is a statistical difference between the partial decompositions of the interaction term at 10% level in the long-run. Also, it was found that the F-statistic (5.414785) of short-run asymmetry fails to accept the null hypothesis as well indicating that there is a statistical difference between the effect of the partial decompositions of the interaction term on the growth of the economy at 5% level of significance. To further enrich the analysis of the asymmetry of the interactive effect of crude oil production and capital accumulation on economic growth, the dynamic multiplier effect was investigated.

Finally, the empirical result from the dynamic multiplier cumulative effect of capital accumulation in the crude oil- growth linkages is evident in figure 5. The plot identifies the adjustment of economic growth to the new equilibrium position following a positive or negative shock in the capital-driven oil production. The dynamic multiplier then again confirms a very rapid economic growth adjustment in the immediate wake of capital investment alongside crude oil production. This implies that economic growth responds greatly to both positive and negative shocks of capital investment-driven oil production in the short-run (that is, within 6 months) than it does in the long-run.

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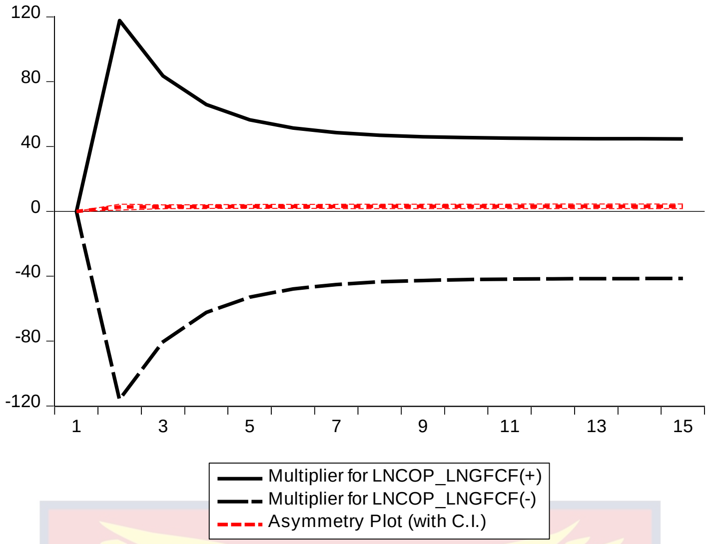

Figure 5: Dynamic Multiplier Cumulative Effect of capital accumulation in crude oil production-growth linkages

Source: Amankrah (2020)

The response of economic growth to both positive and negative shock begins to fall after 9 months reflecting the sensitivity of the economy to capital-driven oil production. Also, both the impact of positive and negative shocks become highly smooth after 36 months (3 years) period without achieving an equilibrium state over the whole analysis period. In sum, the results suggest that domestic investments necessary to cause commercial crude oil production to have greater long-run economic growth are insufficient, reflecting some infrastructural gap and enclave capital or infrastructure investment in the economy.

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Third Empirical Objective

Table 11: Results from NARDL Cointegration

Variables	Coefficients	t-statistics
Constant	479.0097	3.677812***
GDP(-1)	-0.613135	-5.276035***
LNCOP_CORR_POS(-1)	**-1373.045**	**-4.057823*****
LNCOP_CORR_NEG	**-1394.028**	**-3.978483*****
D(LNCOP_CORR_POS)	**-1329.521**	**-3.964211*****
D(LNCOP_CORR_POS(-1))	**47.27633**	**1.253297**

Note: ***, **, and * indicate 1%, 5%, and 10% level of significance respectively. The coefficients of LNCOP_CORR have been divided by 100
Source: Amankrah (2020)

The next after establishing the link between crude oil production and economic growth is to investigate whether quality institutions (control of corruption, government effectiveness, and voice and accountability) have a role to play in this linkage. Therefore, consistent with objective three, the NARDL cointegration result as evident in Table 11 shows the moderating effect of control of corruption. The coefficients of a positive shock in the interactive effect between crude oil production and control of corruption on economic growth is negative (-1373.045) and statistically significant at 1 percent level of significance in the long-run. This means that given the level of corruption control, the relationship between crude oil production and economic growth is significantly negative. This also implies that in the presence of high corruption rates, increased volumes of crude oil production could lead to a fall in long-run economic growth by approximately 13.73.

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On the other hand, the coefficient of the long-run negative shock in the interactive effect of crude oil production and control of corruption is significantly negative (-1394.028) at 1% alpha level. This depicts an inverse relationship which implies that for lower rates of corruption, crude oil production even at decreased volumes could affect the growth of the economy positively by 13.94 approximately in the long-run.

Therefore, the result suggests that the state of corruption control in Ghana is weak and therefore, would not be able to reverse the enclave effects associated with upswings in crude oil production and hence could further dampen the growth of the economy in the long-run. These findings confirm the arguments in Eregha and Mesagan (2016), and Sarmidi, Hook Law, and Jafari (2014) that resource-abundant countries that are weak in controlling corruption will be worse-off in terms of economic growth compared with resource-scarce economies. This is because the activities of the oil sector create an enclave economy with skilled and very limited labour demand and few or no linkages to the non-oil economy. Therefore, improving corruption control as a country and ensuring that resources from these activities are channelled to the right projects and not for private gains could help reduce cost and increase public revenue and hence economic expansion.

In the short-run analysis, a positive shock in the interactive effect of crude oil production and control of corruption maintained its significant negative impact on the growth of the economy by approximately 13.30. This was consistent with the analysis in the long-run where controlling corruption as a way of mitigating the enclave effects of commercial crude

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oil production is poor and insufficient to reverse the negative relationship between crude oil production and economic growth.

As shown in Appendix H2, the joint effect of crude oil production and control of corruption maintained its negative impact on long- and short-run economic growth. A positive shock reveals that for higher rates of corruption, crude oil production could cause a reduction in economic growth at approximately 0.2995 and 1.4169 in the long- and short-run respectively. On the other hand, a negative shock in corruption control depicts an inverse relationship of 0.2955 between crude oil production and economic growth. This confirms that the state of Ghana's corruption control would not be enough to reverse the negative relationship between crude oil production and economic growth.

Table 12: Results of Bounds-testing for control of corruption

Variables	Coefficient	F-statistic	P-value
LNCOP_CORR_POS	-2239.385	21.68663	0.0000
LNCOP_CORR_NEG	-2273.607	31.38904	0.0000
Model Diagnostic Tests	Statistic		
R-square	0.845219		
Adjusted R-square	0.752893		
Durbin-Watson (DW)	2.029233		
Jarque-Berra (J-B)	2.455658 (0.292928)		
Heteroscedasticity	1.514881 (0.0818)		
Ramsey Reset test (FF)	0.013298 (0.9086)		

Note: LNCOP_CORR_POS denotes positive shock in control of corruption in the crude oil-growth linkages, LNCOP_CORR_NEG denotes negative shock in control of corruption in the crude oil-growth, and FF represents the functional form test of the model. The values in the bracket are P-values of the test-statistic. The long-run coefficients for LNCOP_CORR_POS and LNCOP_CORR_NEG are presented in Appendix D2, J-B (see Appendix D8), FF (see Appendix D10), and Het. (see Appendix D9).

Source: Amankrah (2020)

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The empirical results of the bound-testing long-run coefficients for both positive and negative shock in the interactive effect of crude oil production and control of corruption are thus shown in Table 12. The F-statistic of the Wald test depicts that there exists a long-run relationship between the partial decompositions of positive and negative shocks in the interaction effect. The long-run coefficients are -2239.385 for a positive shock and -2273.607 for a negative shock, which are statistically significant at a 1% level of significance. This indicates that, given the rate of Ghana's corruption control, upswings and downswings in crude oil production could dampen economic growth by 22.39 and 22.74 approximately in the long-run. This also confirms the findings of the NARDL cointegration results presented in Table 11.

The lower part of Table 12 also presents some diagnostic tests of the estimated model. The result shows that the functional form test and the test of heteroscedasticity were passed by the estimated model at 5 and 10 percent level of significance. This indicates that the model estimated is well specified. Also, the adjusted R-squared is approximately 0.752893. This suggests that the independent variables could explain about 75.3 percent of the variations in the dependent variable non-oil real GDP growth rate (growth of the economy). Moreover, a Durbin Watson statistic of approximately 2.029233 higher than the R-squared value of 0.845219 reveals that the estimated results are not spurious.

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Table 13: Asymmetry Tests for control of corruption

Variable	Long-run asymmetry		Short-run asymmetries	
	$W_{LR}(F_{PSS})$	**P-value**	**$W_{SR}(F_{PSS})$**	**P-value**
LNCOP_CORR	4.008553	0.0500*	14.21537	0.0004***

Note: the long-run asymmetry represented as $W_{LR}(F_{PSS})$ tests the $H_0 : \beta^+ = \beta^-$ for the variable crude oil production and control of corruption interaction (COP_CORR) in equation (13). $W_{SR}(F_{PSS})$ represents the Wald statistic for the long-run asymmetry, which tests the null hypothesis of $\theta^+ = \theta^-$ for the variable crude oil production and control of corruption (COP_CORR) interaction in equation (13). (see Appendix D6 and D7)
Source: Amankrah (2020)

The empirical results of the long- and short-run asymmetry tests are shown in Table 13. It is evident that, both the F_{PSS} test rejects the null hypothesis. The F-statistic (4.008553) for long-run asymmetry failed to accept the null hypothesis of symmetric adjustment at 10% alpha level indicating that the effect of the positive shock is statistically different from the effect of the negative shock of the interaction term in the long-run.

Also, it was found that the F-statistic (14.21537) for short-run asymmetry failed to accept the null hypothesis as well indicating an evidence of statistical difference between the partial compositions in the interactive effect of crude oil production and control of corruption in Ghana at 1% alpha level. To further enrich the analysis of the asymmetry of the interactive effect of crude oil production and control of corruption on economic growth, the dynamic multiplier was observed.

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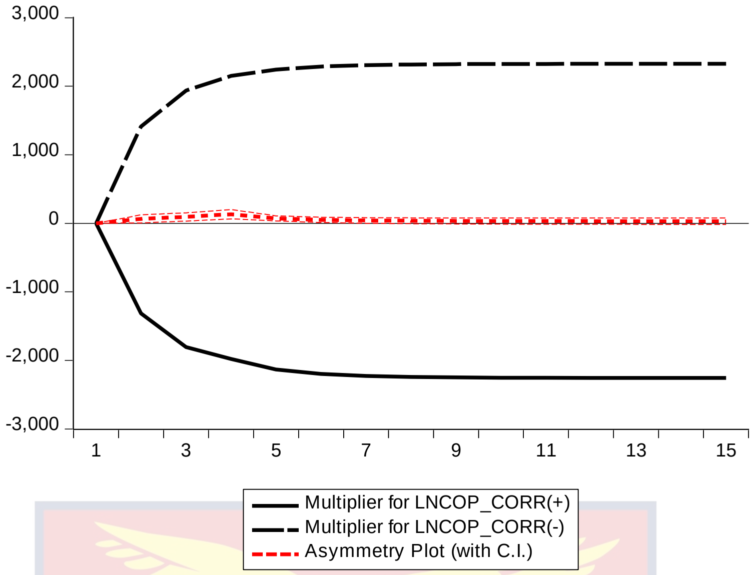

Figure 6: Dynamic Multiplier Cumulative Effect of control of corruption in the crude oil- growth linkages

Source: Amankrah (2020)

Finally, the empirical result from the dynamic multiplier cumulative effect of control of corruption in the crude oil- growth linkages is evident in figure 6. The plot identifies the adjustment of economic growth to the new equilibrium position following a positive or negative shock in the interactive effect. The dynamic multiplier confirms the negative and positive economic effects of positive and negative shocks in the interactive effect of crude oil production and control of corruption respectively. It also depicts that economic growth responds immediately to both shocks (positive and negative) of corruption control amidst the production of crude oil.

Consistent with NARDL cointegration results, positive shock in controlling corruption is associated with a fall in economic growth, whereas a negative shock depicts an expansion in economic growth within the first 6 months of oil production. The effect of both positive and negative shock becomes smooth after 28 months without achieving equilibrium throughout the whole analysis period. The overall impression is that the state of Ghana's

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corruption control is at level that would not be enough to treat the enclave effect associated with booms in crude oil production in Ghana.

Table 14: Results from NARDL Cointegration

Variables	Coefficients	t-Statistics
Constant	-103.4486	-1.956125*
GDP(-1)	-0.402890	-5.059562***
LNCOP_GOVE_POS	**864.1087**	**3.189671*****
LNCOP_GOVE_NEG(-1)	**847.8636**	**3.148237*****
D(LNCOP_GOVE_NEG)	**818.7226**	**3.084646*****

Note: *, **, and *** indicates 10%, 5%, and 1% alpha levels respectively. The coefficients of LNCOP_GOVE have been divided by 100.
Source: Amankrah (2020)

To achieve the objective of investigating the moderating role of government effectiveness in the crude oil- growth linkages, the NARDL cointegration result is thus presented in Table 14. The coefficient of a positive shock in the interactive effect of crude oil production and government effectiveness is significantly positive (864.1087) at 1% alpha level in the long-run. This indicates that, in the long-run, an effective government could affect commercial crude oil production to cause an expansion in growth of the economy by approximately 8.6. The implication is that, the effectiveness of the government, that is, the credibility and the commitment of the government in formulating and implementing sound policies is a potential antidote to curb the enclave effect associated with increased production of oil to result in further economic growth in the long-run.

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Considering a negative shock in the interactive effect of crude oil production and government effectiveness, the coefficient depicts a significant positive effect at 1% alpha level both in the long- and short-run. In the long-run, a negative shock in the interaction effect is positive indicating that the ineffectiveness of the government in terms of quality formulation and implementation of sound policies is detrimental to economic growth by approximately 8.48 in the long-run and also results in economic downturns of 8.19 approximately in the short-run.

In effect, the result suggests that government effectiveness in the Ghanaian case is crucial for economic growth given the production of crude oil. That is, the enclave effect as recognised in the oil sector could be a treatable disease provided the government is effective in its formulation and implementation of sound policies. The findings lend credence to the works of Bawumia and Halland (2017), Okpanachi and Andrews (2012), and Breisinger, Diao, Schweickert, and Weibelt (2010) who argue that reaping the benefits from the oil resources require an improved government capacity in managing macroeconomic policies.

As presented in Appendix H3, the net effects of the shocks (positive and negative) in the production of crude oil and government effectiveness on growth of the economy are negative in the short- and long-run. This implies that increased volumes of crude oil production could dampen long-run economic growth by approximately 0.101 given the poor state of Ghana's government. The net effect of a negative shock (where government effectiveness continues to fall alongside downturns in crude oil production) also confirms a negative

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economic effect by approximately 0.0966 in the long-run and 1.0561 in the long-run.

Table 15: Results of Bounds-testing for government effectiveness

Variables	Coefficient	F-statistic	P-value
LNCOP_GOVE_POS	2144.774	39.27053	0.0000
LNCOP_GOVE_NEG	2104.452	38.41936	0.0000
Model Diagnostic Tests	Statistic		
R-square	0.773465		
Adjusted R-square	0.722117		
Durbin-Watson (DW)	2.012432		
Jarque-Berra (J-B)	10.27579 (0.005870)		
Heteroscedasticity	1.040594 (0.4268)		
Ramsey Reset test (FF)	0.501382 (0.4811)		

Note: LNCOP_GOVE_POS denotes positive shock in government effectiveness in the crude oil-growth linkages, LNCOP_GOVE_NEG denotes a negative shock in government effectiveness in the crude oil-growth, and FF represents the functional form test of the model. The values in the bracket are P-values of the test-statistic. The long-run coefficients for LNCOP_GOVE_POS and LNCOP_GOVE_NEG are presented in Appendix E2, J-B (see Appendix E8), FF (see Appendix E10), and Het. (see Appendix E9).

Source: Amankrah (2020)

The empirical results of the bound-testing long-run coefficients for both positive and negative shock in the interactive effect of crude oil production and government effectiveness are also shown in Table 15. The F-statistic of the Wald test depicts that there exists a long-run relationship between the partial decompositions of positive and negative shocks in the interaction effect. The long-run coefficients of positive and negative shocks are 2144.774 and 2104.452 respectively, and statistically significant at a 1%

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level of significance. This indicates that should the government become effective, crude oil production could increase economic growth by 21.45 approximately, whereas if government effectiveness should fall, crude oil production could cause a downturn in the growth of the economy by 21.04 approximately in the long-run. This confirms the findings of the NARDL cointegration results presented in Table 14.

The lower part of Table 15 also presents some diagnostic tests of the estimated model. The result shows that the estimated model passes the functional form test and the test of heteroscedasticity. This indicates that the model estimated is well specified. Also, the adjusted R-squared is approximately 0.722117. This suggests that about 72.2 percent of the variations in the dependent variable non-oil real GDP growth rate (economic growth) are explained by the independent variables. Moreover, a Durbin Watson statistic of approximately 2.012432 higher than the R-squared value of 0.773465 reveals that the estimated results are not spurious.

Table 16: Asymmetry Tests for government effectiveness

Variable	Long-run asymmetry		Short-run asymmetries	
	$\mathbf{W_{LR}(F_{PSS})}$	P-value	$\mathbf{W_{SR}(F_{PSS})}$	P-value
LNCOP_GOVE	4.181765	0.0444**	4.972738	0.0287**

Note: $W_{LR}(F_{PSS})$ denotes the Wald statistic for the long-run asymmetry, which tests the null hypothesis of $\beta^{+} = \beta^{-}$ for the variable crude oil production and government effectiveness interaction (COP_GOVE) in equation (13). $W_{SR}(F_{PSS})$ represents the Wald statistic for the long-run asymmetry, which tests the null hypothesis of $\theta^{+} = \theta^{-}$ for the variable crude oil production and government effectiveness (COP_GOVE) interaction in equation (13).

Source: Amankrah (2020)

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The empirical results of the long- and short-run asymmetry tests are shown in Table 16. It is evident that, both the F_{PSS} test rejects the null hypothesis. In the case of long-run asymmetry, the F-statistic (4.181765) of the Wald test reject the null hypothesis of (weak-form) summative symmetric adjustment at 5% level of significance indicating that there exists a statistical difference between the effect of positive and negative shocks of crude oil production and government effectiveness interaction term in the long-run.

Turning to the analysis of short-run dynamic asymmetry, we find that the F-statistic (4.972738) of the Wald test strongly rejects the null hypothesis of (weak form) summative symmetry adjustment of the interactive effect of crude oil production and government effectiveness in Ghana at 5% level of significance. This implies that there exists strong evidence of short-run asymmetries, in that; the effect of positive shock is statistically different from the effect of a negative shock in the interaction term (crude oil production and government effectiveness) on economic growth. To further enrich the analysis of the asymmetry of the interactive effect of crude oil production and government effectiveness on economic growth, we furthered on to observe apparent asymmetries in the adjustment patterns traced by the dynamic multiplier.

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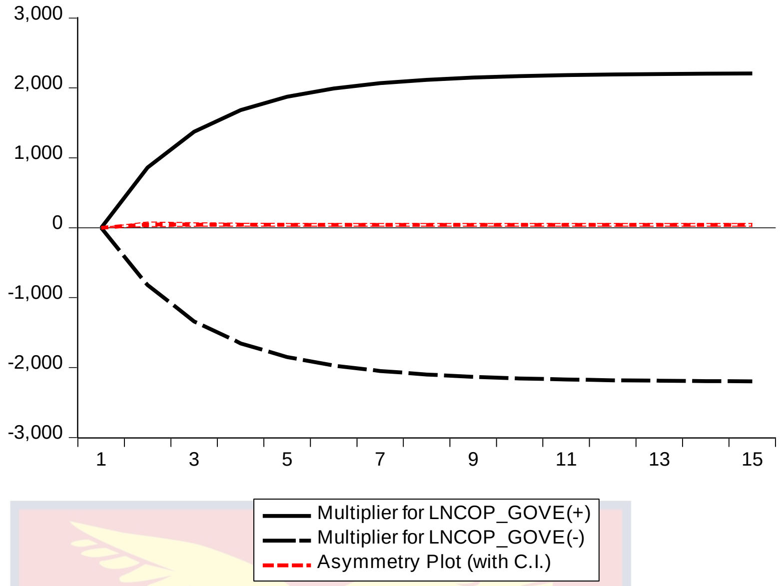

Figure 7: Dynamic Multiplier Cumulative Effect of government effectiveness in the crude oil- growth linkages

Source: Amankrah (2020)

The dynamic multiplier depicts and confirms that a positive shock in the interactive effect of crude oil production and government effectiveness has a positive impact on economic growth, whereas a negative shock leads to downturns in economic growth. The plot also depicts that economic growth response immediately within 6 months and positively to the production of crude oil given the credibility of a well-functioning government. Therefore, in the absence of an effective or well-functioning government, economic growth response negatively to upswings in crude oil production. Moreover, the dynamic multiplier indicates that the reaction of economic growth to an effective government alongside crude oil production becomes stable after 36 months without achieving equilibrium throughout the whole analysis period. In effect, the plot confirms that an improvement in government effectiveness has the potential of moderating the enclave effect associated with increased production of crude oil in Ghana.

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Table 17: Results from NARDL Cointegration

Variable	Coefficients	t-Statistic
Constant	-1669.463	-5.142595***
GDP(-1)	-0.743286	-6.702012***
LNCOP_ACC_POS	**-1358.075**	**-5.231998*****
LNCOP_ACC_NEG(-1)	**-1319.193**	**-5.175140*****
D(GDP(-1))	0.128812	1.162237
D(LNCOP_ACC_NEG)	**-1504.093**	**-5.617413*****
D(LNCOP_ACC_NEG(-1))	-78.00158	-1.292311

Note: ***, **, and * indicate 1%, 5%, and 10% level of significance respectively. The coefficients of LNCOP_ACC have been divided by 100.
Source: Amankrah (2020)

As indicated in Table 17, the long-run coefficient of a positive shock in the interactive effect of crude oil production and voice and accountability index is negative (-1358.075) and statistically significant at 1 percent level of significance. This implies that for any level of public accountability, commercial crude oil production could cause downturns in the growth of the Ghanaian economy by approximately 13.58. This indicates that the state of public accountability in Ghana is poor and insufficient to cause upturns in crude oil production to have greater positive economic impact. The result is in consonance with the arguments raised in Luong and Weinthal (2006) that fostering transparency, encouraging a free press, improved human rights, and accountability could be a solution for oil-producing economies to combat the curse of resources.

Like the coefficient of a positive shock, a negative shock in the interactive effect of crude oil production and voice and accountability depicts an inverse relationship of 13.19 on economic growth in the long-run

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and 15.04 in the short-run. The result indicates that given the level of public accountability, a further decrease in the crude oil production could be detrimental to both long- and short-run economic growth.

In sum, the result suggests that voice and accountability in the Ghana's case is poor for the full realisation of economic growth even amidst upswings in the production of crude oil. That is, the level of fostering transparency, encouraging a free press, improving human rights and accountability could not be enough to reverse the enclave effect associated with booms in crude oil production. Hence strengthening transparency and fostering accountability in the economy is crucial to mitigate the negative effect of commercial crude oil production on economic growth and ensure that enormous linkages from crude oil production are well accounted for within the country.

As evident in Appendix H4, the joint effect of crude oil production and voice and accountability also maintained its negative impact on long- and short-run economic growth. A positive shock reveals that crude oil production could still cause a fall in economic growth at approximately 0.008 in the long-run. On the other hand, a negative shock depicts an inverse relationship of 0.0138 between crude oil production and economic growth in the long-run. This confirms that fostering transparency, encouraging a free press, improved human rights and public accountability in Ghana is poor and would not be enough to reverse the negative relationship between crude oil production and long-run economic growth.

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Table 18: Results of Bounds-testing for voice and accountability

Variables	Coefficient	F-statistic	P-value
LNCOP_ACC_POS	-1827.124	21.21658	0.0000
LNCOP_ACC_NEG	-1774.813	12.32840	0.0000

Model Diagnostic Tests	Statistic
R-square	0.854755
Adjusted R-square	0.762327
Durbin-Watson (DW)	2.049083
Jarque-Berra (J-B)	14.47370 (0.000720)
Heteroscedasticity	0.594492 (0.9483)
Ramsey Reset test (FF)	1.0319 (0.3067)

Note: LNCOP_ACC_POS denotes positive shock in voice and accountability in the crude oil-growth linkages, LNCOP_ACC_NEG denotes negative shock in voice and accountability in the crude oil-growth, and FF represents the functional form test of the model. The values in the bracket are P-values of the test-statistic. The long-run coefficients for LNCOP_ACC_POS and LNCOP_ACC_NEG are presented in Appendix F2, J-B (see Appendix F8), FF (see Appendix F10), and Het. (see Appendix F9).

Source: Amankrah (2020)

The empirical results of the bound-testing long-run coefficients for both positive and negative shock in the interactive effect of crude oil production and voice and accountability are also shown in Table 18. The F-statistic of the Wald test depicts that there exists a long-run relationship between the partial decompositions of positive and negative shocks in the interaction effect. The long-run coefficients of positive and negative shocks are -1827.124 and -1774.813 respectively, and statistically significant at a 1% level of significance.

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This indicates that given the state of transparency and accountability, increased crude oil production could dampen economic growth by 18.27 approximately and downturns in crude oil production could also be detrimental to economic growth by 17.75 approximately in the long-run. This is also in line with the findings of the NARDL cointegration results presented in Table 17.

The lower part of Table 18 also presents some diagnostic tests of the estimated model. The result shows that the estimated model passes the functional form test and the test of heteroscedasticity. This indicates that the model estimated is well specified. Also, the adjusted R-squared is approximately 0.762327. This suggests that about 76.2 percent of the variations in the dependent variable non-oil real GDP growth rate (economic growth) is explained by the independent variables. Moreover, a Durbin Watson statistic of approximately 2.049083 higher than the R-squared value of 0.854755 reveals that the estimated results are not spurious.

Table 19: Asymmetry Tests for voice and accountability

Variable	Long-run asymmetry		Short-run asymmetries	
	$\mathbf{W_{LR}}(\boldsymbol{F_{PSS}})$	P-value	$\mathbf{W_{SR}}(\boldsymbol{F_{PSS}})$	P-value
LNCOP_ACC	5.773451	0.0197**	13.56287	0.0005***

Note: $W_{LR}(F_{PSS})$ denotes the Wald statistic for the long-run asymmetry, which tests the null hypothesis of $\beta^+ = \beta^-$ for the variable crude oil production and voice and accountability interaction (COP_ACC) in equation (13). $W_{SR}(F_{PSS})$ represents the Wald statistic for the long-run asymmetry, which tests the null hypothesis of $\theta^+ = \theta^-$ for the variable crude oil production and voice and accountability (COP_ACC) interaction in equation (13).

Source: Amankrah (2020)

The empirical results of the long- and short-run asymmetry tests are shown in Table 19. It is evident that, both the F_{PSS} test reject the null

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hypothesis. In the case of long-run asymmetry, the F-statistic (5.773451) of the Wald test reject the null hypothesis of (weak-form) summative symmetric adjustment at 5% level of significance indicating that there exists a statistical difference between the effect of positive and negative shocks of crude oil production and voice and accountability interaction term in the long-run.

Turning to the analysis of short-run dynamic asymmetry, we find that the F-statistic (13.56287) of the Wald test strongly rejects the null hypothesis of (weak form) summative symmetry adjustment of the interactive effect of crude oil production and voice and accountability in Ghana at 1% level of significance. This implies that there exists strong evidence of short-run asymmetries, in that, the effect of positive shock is statistically different from the effect of a negative shock in the interaction term (crude oil production and voice and accountability) on economic growth. To further enrich the analysis of the asymmetry of the interactive effect of crude oil production and voice and accountability on economic growth, we moved forward to observe apparent asymmetries in the adjustment patterns traced by the dynamic multiplier.

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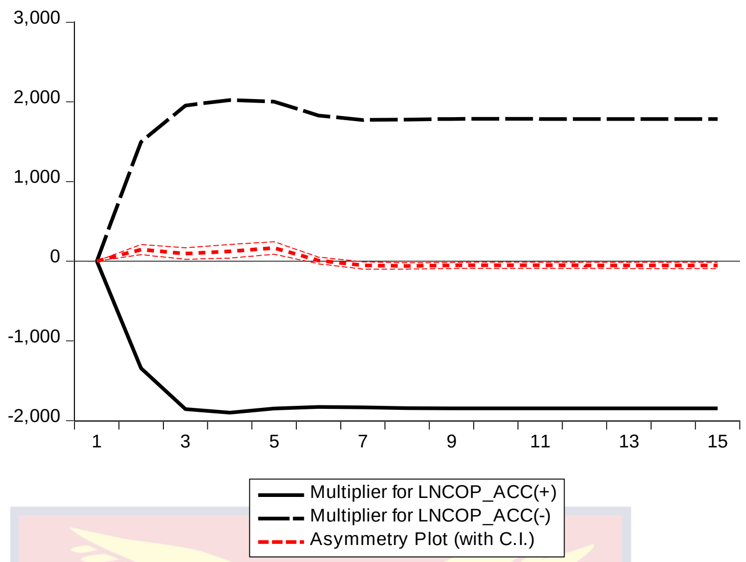

Figure 8: Dynamic Multiplier Cumulative Effect of voice and accountability in the crude oil- growth linkages

Source: Amankrah (2020)

Finally, the empirical result from the dynamic multiplier cumulative effect tracing the adjustment of economic growth to the new equilibrium position following a positive or negative shock in the interaction effect of crude oil production and voice and accountability is evident in figure 8. The dynamic multiplier depicts and confirms that a positive shock in the interactive effect of crude oil production and voice and accountability harms economic growth, whereas a negative shock leads to upturns in economic growth. The plot depicts that the response of economic growth is immediate (within 6 months) and negative to the production of crude oil when democratic governance (public accountability) is poor.

Moreover, the dynamic multiplier indicates that the reaction of economic growth becomes stable after 28 months without achieving equilibrium throughout the whole analysis period. In effect, the plot shows that improved level of voice and accountability is imperative in moderating

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the enclave effect associated with increased production of crude oil in Ghana.

Stability tests

The study employed the NARDL cumulative sum (CUSUM) and the cumulative sum of squares (CUSUMSQ) to investigate the parameter stability of the model. The plots in Appendix B11 show that the estimated model for the asymmetries in crude oil production on economic growth is stable over the entire analysis period since all the coefficients fall within the critical bound of a 5 percent level of significance.

The first plot in Appendix C11 shows that, the CUSUM test has a high power since there is a structural break in the intercept coefficients of the estimated model for the asymmetries in the interactive effect of crude oil production and capital accumulation on economic growth. The structural break took place in the third quarter of 2017 since the coefficients starting from the third quarter of 2017 fall outside the critical bound of 5 percent level of significance. This could be since the Ghanaian economy experienced drastic upswings in the production of crude oil whilst the accumulation of capital, on the other hand, fell during that period. However, the CUSUMSQ test in plot 2 shows that there is constancy in the slope coefficient of the estimated model, as such the variance of the error term is within the critical bound of 5 percent level of significance.

Moreover, plot 1 in Appendix D11 shows that the intercept coefficients of the estimated model for the asymmetries in the interactive effect of crude oil production and control of corruption on economic growth are stable over the entire analysis period since all the coefficients fall within

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the 5 percent critical bound of the CUSUM test. However, the CUSUMSQ test in plot 2 depicts that the variance of the error term is not constant from the second quarter of 2015 through to the second quarter of 2016 indicating a structural break in the slope coefficients during those periods.

Finally, the plots in Appendix E11 and Appendix F11 depict that the estimated model of the interactive effect of crude oil production and government effectiveness, and voice and accountability are stable over the whole analysis period.

Summary

This chapter examined the time-series properties of the data employed using the ADF and PP unit root tests. The tests essentially showed that none of the variables was integrated of an order higher than 1. We found that crude oil production, capital accumulation, and quality institutions co-move asymmetrically with economic growth in the long-run.

The chapter empirically examined the effect crude oil production on economic growth in Ghana using the Nonlinear ARDL cointegration model. The long- and short-run estimates reveal a positive and significant impact of both positive and negative shocks in crude oil production on economic growth in Ghana. This suggests that upswings as well as downswings in crude oil production could foster economic growth. However, the magnitude of this positive economic effect is greater in the case of downswings in crude oil production than it is for upswings in crude oil production.

Concerning the role of capital accumulation in the crude oil-growth linkages, the estimates reveal a positive impact of a positive shock and

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negative impact of a negative shock in capital accumulation in the crude oil-growth link. This suggests that the role of capital accumulation is critical for upturns in economic growth, whereas, the net effect estimates of capital accumulation in the crude oil-growth linkages reveal otherwise.

In examining the moderating effects of quality institutions, the estimates reveal that government effectiveness alongside crude oil production is crucial for the growth of the Ghanaian economy, whereas control of corruption and voice and accountability showed otherwise.

The diagnostic and parameter stability tests revealed that all the models satisfy the test of functional form misspecification, heteroscedasticity, and goodness-of-fit. The graphs of the CUSUM and CUSUMSQ indicate the absence of coefficient instability for the estimated models except for crude oil production and control of corruption interaction model.

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CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

Introduction

This chapter presented the summary of findings, conclusions for the entire study, recommendations, and suggestions for further research. It first summarised the research problem, objectives, methods, and findings of the study. Considering the objectives, conclusions were drawn from the findings of the study. The chapter then provided some recommendations based on the major findings of the study. Thereafter, the chapter presented suggestions for further research.

Summary

The purpose of the study was to examine the effect of crude oil production, quality institutions and capital accumulation on the growth of Ghana's economy using monthly time series data from 2011 to 2018. Controlling government expenditure, exchange rate, and crude oil price, the study investigated the asymmetric short - and long -run relationship between the production of crude oil with other variables including capital accumulation, and quality institutions on economic growth using the NARDL approach. The following were the key findings obtained:

- Empirical evidence from the asymmetric results showed the overall existence of a significant positive economic effect of both a decreased and increased volumes of crude oil production both in the long- and short-run. However, the results suggested that the positive economic impact of higher volumes of crude oil

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production as compared to lower volumes of crude oil production has been less.

- Also, the study found a positive and statistically significant relationship between the interaction effect of positive and negative shocks in crude oil production and capital accumulation in both the long- and short-run. However, the results suggested that the level of capital accumulated amid crude oil production is insufficient to cause a greater economic expansion in the long-run. Also, the results from the net interaction effect of crude oil production and capital accumulation were found to be significantly negative in both long- and short-run indicating that accumulated capital or domestic investment is at a level insufficient to complement the production of crude oil to cause economic expansion.
- The study found a negative and statistically significant relationship between the interaction effect of positive and negative shocks in crude oil production and the rate of corruption control in both the long- and short-run suggesting that the state of corruption control amid crude oil production would not be enough to propel economic expansion in the long- and short-run.
- Moreover, the empirical results from the asymmetries in the interaction effect of crude oil production and government effectiveness were found to have a significantly positive impact on economic growth in the long- and short-run showing the important role of an effective government in economic emancipation. However, the net effect revealed that given the state of government

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effectiveness, upswings in crude oil production could still dampen economic growth.

- Evidence on voice and accountability was negative and statistically significant in both the long- and short-run indicating that the state of public accountability alongside crude oil production is detrimental to the growth of the economy. Consistently, the net effect revealed that state of public accountability would not be enough to reverse the negative relationship between crude oil production and economic growth.

Conclusions

The study supported the resource curse hypotheses of Sachs and Warner (1997). In Ghana, the resource curse effect that accompany booms in crude oil production manifesting in the form of slow economic growth is valid.

Regarding the accumulation of capital, even though investment propels both long- and short-run economic growth, the level of domestic investment is insufficient to complement the activities of the oil sector to propel greater long-run economic impact and in a broader sense mitigate the enclaves of resource curse found in Ghana's economy. This is because crude oil projects require large and sophisticated infrastructure or capital such as water system, power, telecommunication and rail or road transportation support to extract and get to its destination. Therefore, the low level of capital in the country increases the infrastructure gap that makes it difficult to further transform these crude oil resources into long-term development.

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In terms of quality institutions, the effectiveness of the Ghanaian government in the formulation and implementation of strategic policies, controlling corruption and fostering accountability is adjudged poor and insufficient to help bridge the economic discrepancies associated with the enclave effects of crude oil production.

In summary, the level of domestic capital investment as well as institutional capacity of the country is adjudged poor and insufficient to curb the curse and as such need to be reconditioned to turn the curse into blessings; especially improving government effectiveness could be a vital step towards the actualization of the full benefits of crude oil production.

Recommendations

The study found evidence to support the fact that crude oil production could be an engine for economic growth and the enclave effects that come with the improvement and development of crude oil production in Ghana could be pronounced treatable by building quality institutions and increasing the level of capital accumulation.

Studies have shown that the resource curse starts from a value chain analysis perspective, that is, the ability of the natural resource sector to produce and deliver valuable products. Based on the evidence that the Ghanaian economy benefits but not much from the production of crude oil due to the enclave nature of the sector's activities, the recommendation is that GNPC and the Ministry of Finance should channel funds into developing local capacities in the industry's value chain through prioritising spending in skills transfer and expertise development, transfer of technological know-how, and active research and developmental programs.

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Based on the evidence that domestic investment or capital accumulated is insufficient to propel long-run economic growth, it is recommended that the Ministry of Energy together with Ministry of Environment, Science, Technology and Innovation, and Ghana Investment Promotion Centre (GIPC) should create an enabling environment (that is in both policy pronouncement and practices) to help enhance the country's overall capacity to develop by improving its ability to absorb and use technology now and in the future. Also, crude oil activities require investment in large infrastructure projects such as ports and railways, just to mention but a few. Therefore, to successfully bring the resources to market and at the same time meet the development needs of the country, an active intervention by these government agencies is recommended in the investment of these large infrastructure and ensure the possibility of shared use of these infrastructures between the sector and the rest of the economy.

Experiences from natural resource endowed countries like Botswana, Chile, and Norway have shown that effective, efficient extraction or production and usage of natural resources should be planned deliberately and carefully executed and managed with clearly defined socio-economic outcomes in mind. Considering the evidence that institutional building has an antidote for the enclave effects of crude oil production, it is recommended that the institutions of state that oversee crude oil production and other expediencies related to crude oil production for example the Petroleum Commission should be resourced to ensure the full enforcement of the policy Local content and Participation bill of 2013.

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Suggestions for further research

The objective of this study has been to examine the effects of crude oil production, capital accumulation, and quality institutions on Ghana's economy. This study focused on investigating the long-run and the short-run asymmetric relationships among economic growth and its independent variables.

The area for further research that emerges from this study includes covering the gaps that have been left by this study. First, sustainable economic development has many dimensions which economic growth happens to be one the dimensions, therefore, further studies could consider looking at the effect of crude oil production on poverty reduction, employment, fiscal and monetary balance as well as human development (education).

Besides, the Natural Resource Governance Institute provides three dimensions for measuring resource governance which include Enabling Environment, value Realisation, and Revenue Management. The study focused on the Enabling environment dimension which covers the governance indicators of the World Bank. Therefore, future research could consider the other dimensions of resource governance which include value realization and revenue management to analyse the effects of value addition and proper management of natural resource windfalls.

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APPENDICES

APPENDIX A

BOUND TEST FOR NONLINEAR COINTEGRATION

ARDL Long Run Form and Bounds Test
Dependent Variable: D(GDP)
Selected Model: ARDL(2, 3, 0, 3, 4, 4, 4, 4, 4, 4, 3)
Case 2: Restricted Constant and No Trend
Date: 04/14/20 Time: 13:56
Sample: 2011M01 2018M12
Included observations: 91

Conditional Error Correction Regression

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-6.056007	3.309175	-1.830065	0.0739
GDP(-1)*	-1.057401	0.147582	-7.164843	0.0000
LNCOP_POS(-1)	39.26652	11.59219	3.387325	0.0015
LNCOP_NEG**	-67.57601	30.97812	-2.181411	0.0344
LNCOP_LNGFCF_POS(-1)	-0.499568	0.169405	-2.948962	0.0050
LNCOP_LNGFCF_NEG(-1)	1.609173	1.581681	1.017382	0.3144
LNCOP_CORR_POS(-1)	24.10289	45.99210	0.524066	0.6028
LNCOP_CORR_NEG(-1)	44.27486	11.17697	3.961256	0.0003
LNCOP_GOVE_POS(-1)	12.19044	17.99743	0.677343	0.5017
LNCOP_GOVE_NEG(-1)	-66.76519	13.14471	-5.079246	0.0000
LNCOP_ACC_POS(-1)	-173.6790	68.31519	-2.542318	0.0145
LNCOP_ACC_NEG(-1)	0.625885	38.64528	0.016196	0.9871
D(GDP(-1))	0.144155	0.111709	1.290453	0.2035
D(LNCOP_POS)	117.9947	109.0737	1.081789	0.2851
D(LNCOP_POS(-1))	152.8196	152.5328	1.001880	0.3218
D(LNCOP_POS(-2))	-278.1187	88.72390	-3.134654	0.0030
D(LNCOP_LNGFCF_POS)	1.159386	0.899130	1.289453	0.2038
D(LNCOP_LNGFCF_POS(-1))	-0.572907	1.164265	-0.492076	0.6251
D(LNCOP_LNGFCF_POS(-2))	4.467460	1.081960	4.129042	0.0002
D(LNCOP_LNGFCF_NEG)	0.953121	2.174054	0.438407	0.6632
D(LNCOP_LNGFCF_NEG(-1))	-4.894427	1.643402	-2.978228	0.0047
D(LNCOP_LNGFCF_NEG(-2))	3.009997	1.606366	1.873793	0.0675
D(LNCOP_LNGFCF_NEG(-3))	-4.343882	1.388475	-3.128526	0.0031
D(LNCOP_CORR_POS)	13.14964	69.28794	0.189783	0.8503
D(LNCOP_CORR_POS(-1))	46.97982	67.27043	0.698373	0.4885
D(LNCOP_CORR_POS(-2))	47.47280	76.46777	0.620821	0.5378
D(LNCOP_CORR_POS(-3))	-291.9464	70.97551	-4.113341	0.0002
D(LNCOP_CORR_NEG)	43.37461	26.22602	1.653877	0.1051
D(LNCOP_CORR_NEG(-1))	9.512749	31.68159	0.300261	0.7654
D(LNCOP_CORR_NEG(-2))	-62.93031	26.97461	-2.332946	0.0242
D(LNCOP_CORR_NEG(-3))	31.66726	23.26563	1.361118	0.1803
D(LNCOP_GOVE_POS)	-34.20232	56.10434	-0.609620	0.5452
D(LNCOP_GOVE_POS(-1))	1.655039	90.68416	0.018251	0.9855
D(LNCOP_GOVE_POS(-2))	-2.127050	82.63536	-0.025740	0.9796
D(LNCOP_GOVE_POS(-3))	124.1145	56.73955	2.187443	0.0339
D(LNCOP_GOVE_NEG)	-116.1228	38.62335	-3.006544	0.0043
D(LNCOP_GOVE_NEG(-1))	-2.336365	57.30525	-0.040771	0.9677
D(LNCOP_GOVE_NEG(-2))	99.68835	54.44772	1.830900	0.0737
D(LNCOP_GOVE_NEG(-3))	-68.78145	37.18782	-1.849569	0.0709
D(LNCOP_ACC_POS)	-154.3089	92.49282	-1.668334	0.1022

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D(LNCOP_ACC_POS(-1))	46.37910	123.3400	0.376026	0.7087
D(LNCOP_ACC_POS(-2))	-108.8726	116.1546	-0.937308	0.3536
D(LNCOP_ACC_POS(-3))	398.5190	121.1542	3.289354	0.0020
D(LNCOP_ACC_NEG)	-164.5599	65.70448	-2.504546	0.0160
D(LNCOP_ACC_NEG(-1))	102.9309	65.73957	1.565737	0.1244
D(LNCOP_ACC_NEG(-2))	-265.1132	104.8856	-2.527642	0.0151

* 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.
LNCOP_POS	37.13495	11.37514	3.264571	0.0021
LNCOP_NEG	-63.90767	24.96817	-2.559566	0.0139
LNCOP_LNGFCF_POS	-0.472449	0.160148	-2.950081	0.0050
LNCOP_LNGFCF_NEG	1.521820	1.398756	1.087981	0.2824
LNCOP_CORR_POS	22.79447	43.86693	0.519628	0.6059
LNCOP_CORR_NEG	41.87141	10.81986	3.869867	0.0003
LNCOP_GOVE_POS	11.52868	17.56720	0.656262	0.5150
LNCOP_GOVE_NEG	-63.14086	12.04887	-5.240399	0.0000
LNCOP_ACC_POS	-164.2508	66.40122	-2.473612	0.0172
LNCOP_ACC_NEG	0.591909	36.59178	0.016176	0.9872
C	-5.727258	2.794694	-2.049333	0.0463

EC = GDP - (37.1349*LNCOP_POS -63.9077*LNCOP_NEG -0.4724
*LNCOP_LNGFCF_POS + 1.5218*LNCOP_LNGFCF_NEG + 22.7945
*LNCOP_CORR_POS + 41.8714*LNCOP_CORR_NEG + 11.5287
*LNCOP_GOVE_POS -63.1409*LNCOP_GOVE_NEG -164.2508
*LNCOP_ACC_POS + 0.5919*LNCOP_ACC_NEG -5.7273)

F-Bounds Test — Null Hypothesis: No levels relationship

Test Statistic	Value	Signif.	I(0)	I(1)
			Asymptotic: n=1000	
F-statistic	9.350053	10%	1.76	2.77
k	10	5%	1.98	3.04
		2.5%	2.18	3.28
		1%	2.41	3.61
			Finite Sample: n=80	
Actual Sample Size	91	10%	-1	-1
		5%	-1	-1
		1%	-1	-1

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APPENDIX B

APPENDIX B1
NARDL COINTEGRATION FOR CRUDE OIL PRODUCTION

ARDL Long Run Form and Bounds Test
Dependent Variable: D(GDP)
Selected Model: ARDL(2, 1, 1, 1, 0, 3, 4, 4, 4, 0, 2)
Case 2: Restricted Constant and No Trend
Date: 04/14/20 Time: 12:48
Sample: 2011M01 2018M12
Included observations: 92

Conditional Error Correction Regression

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	111.8684	32.07982	3.487188	0.0009
GDP(-1)*	-0.860141	0.132715	-6.481125	0.0000
LNCOP_POS(-1)	7.364707	1.948994	3.778722	0.0004
LNCOP_NEG(-1)	-16.68993	5.244368	-3.182449	0.0023
CORR(-1)	-61.37381	53.96455	-1.137299	0.2600
GOVE**	-381.2925	85.22548	-4.473926	0.0000
ACC(-1)	-319.3510	112.6254	-2.835514	0.0063
LNGFCF(-1)	-3.465509	1.034639	-3.349486	0.0014
LNCEX(-1)	3.312708	0.907578	3.650055	0.0006
LNREX(-1)	-6.268366	1.624996	-3.857465	0.0003
EXR**	-0.627573	0.842315	-0.745058	0.4592
LNICP(-1)	-1.878779	1.689155	-1.112260	0.2705
D(GDP(-1))	0.222475	0.114701	1.939607	0.0572
D(LNCOP_POS)	59.65374	16.61366	3.590644	0.0007
D(LNCOP_NEG)	-122.4990	25.24479	-4.852448	0.0000
D(CORR)	-472.5092	220.0668	-2.147117	0.0359
D(ACC)	-846.5367	444.3548	-1.905092	0.0616
D(ACC(-1))	167.3464	678.4867	0.246647	0.8060
D(ACC(-2))	-1233.152	496.3448	-2.484466	0.0158
D(LNGFCF)	32.82966	13.44625	2.441547	0.0176
D(LNGFCF(-1))	-22.68719	19.26351	-1.177729	0.2436
D(LNGFCF(-2))	56.72453	17.53500	3.234933	0.0020
D(LNGFCF(-3))	-12.87834	10.32774	-1.246966	0.2173
D(LNCEX)	1.012381	0.340870	2.969987	0.0043
D(LNCEX(-1))	-2.297978	0.607564	-3.782283	0.0004
D(LNCEX(-2))	-1.510968	0.501015	-3.015817	0.0038
D(LNCEX(-3))	-0.969323	0.335573	-2.888561	0.0054
D(LNREX)	-1.927426	0.744048	-2.590460	0.0121
D(LNREX(-1))	3.257872	1.152402	2.827028	0.0064
D(LNREX(-2))	2.359147	0.948634	2.486888	0.0157
D(LNREX(-3))	2.226729	0.740855	3.005622	0.0039
D(LNICP)	6.248871	2.193070	2.849372	0.0060
D(LNICP(-1))	2.547898	2.438097	1.045036	0.3003

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

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APPENDIX B2
BOUND TEST LONG-RUN COEFFICIENTS FOR CRUDE OIL PRODUCTION

Levels Equation
Case 2: Restricted Constant and No Trend

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNCOP_POS	8.562214	2.111652	4.054746	0.0001
LNCOP_NEG	-19.40373	4.893137	-3.965499	0.0002
CORR	-71.35324	61.69162	-1.156611	0.2521
GOVE	-443.2909	78.94934	-5.614878	0.0000
ACC	-371.2777	102.8280	-3.610666	0.0006
LNGFCF	-4.029004	0.946760	-4.255571	0.0001
LNCEX	3.851356	1.058755	3.637626	0.0006
LNREX	-7.287607	1.661421	-4.386371	0.0000
EXR	-0.729617	1.002415	-0.727859	0.4696
LNICP	-2.184270	1.957265	-1.115981	0.2690
C	130.0582	29.26250	4.444536	0.0000

EC = GDP - (8.5622*LNCOP_POS -19.4037*LNCOP_NEG -71.3532*CORR -443.2909*GOVE -371.2777*ACC -4.0290*LNGFCF + 3.8514*LNCEX -7.2876*LNREX -0.7296*EXR -2.1843*LNICP + 130.0582)

F-Bounds Test — Null Hypothesis: No levels relationship

Test Statistic	Value	Signif.	I(0)	I(1)
			Asymptotic: n=1000	
F-statistic	4.943841	10%	1.76	2.77
k	10	5%	1.98	3.04
		2.5%	2.18	3.28
		1%	2.41	3.61
			Finite Sample:	
Actual Sample Size	92		n=80	
		10%	-1	-1
		5%	-1	-1
		1%	-1	-1

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APPENDIX B3
NARDL MODEL FOR CRUDE OIL PRODUCTION (RSQUARED, ADJUSTED RSQUARE, AND DW TEST)

Dependent Variable: GDP
Method: ARDL
Date: 06/25/20 Time: 13:15
Sample (adjusted): 2011M05 2018M12
Included observations: 92 after adjustments
Maximum dependent lags: 2 (Automatic selection)
Model selection method: Akaike info criterion (AIC)
Dynamic regressors (4 lags, automatic): LNCOP_POS LNCOP_NEG CORR GOVE ACC LNGFCF LNCEX LNREX EXR LNICP
Fixed regressors: C
Number of models evalulated: 19531250
Selected Model: ARDL(2, 1, 1, 1, 0, 3, 4, 4, 4, 0, 2)
Note: final equation sample is larger than selection sample

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
GDP(-1)	0.362335	0.128803	2.813101	0.0067
GDP(-2)	-0.222475	0.114701	-1.939607	0.0572
LNCOP_POS	59.65374	16.61366	3.590644	0.0007
LNCOP_POS(-1)	-52.28903	15.41441	-3.392218	0.0012
LNCOP_NEG	-122.4990	25.24479	-4.852448	0.0000
LNCOP_NEG(-1)	105.8091	23.68597	4.467163	0.0000
CORR	-472.5092	220.0668	-2.147117	0.0359
CORR(-1)	411.1354	226.5924	1.814427	0.0747
GOVE	-381.2925	85.22548	-4.473926	0.0000
ACC	-846.5367	444.3548	-1.905092	0.0616
ACC(-1)	694.5321	1089.323	0.637581	0.5262
ACC(-2)	-1400.498	1092.279	-1.282180	0.2048
ACC(-3)	1233.152	496.3448	2.484466	0.0158
LNGFCF	32.82966	13.44625	2.441547	0.0176
LNGFCF(-1)	-58.98235	30.79020	-1.915621	0.0603
LNGFCF(-2)	79.41172	34.66675	2.290717	0.0256
LNGFCF(-3)	-69.60288	25.28777	-2.752432	0.0078
LNGFCF(-4)	12.87834	10.32774	1.246966	0.2173
LNCEX	1.012381	0.340870	2.969987	0.0043
LNCEX(-1)	0.002349	0.331519	0.007087	0.9944
LNCEX(-2)	0.787009	0.306521	2.567552	0.0128
LNCEX(-3)	0.541645	0.314361	1.723001	0.0901
LNCEX(-4)	0.969323	0.335573	2.888561	0.0054
LNREX	-1.927426	0.744048	-2.590460	0.0121
LNREX(-1)	-1.083068	0.764986	-1.415801	0.1621
LNREX(-2)	-0.898725	0.697811	-1.287922	0.2028
LNREX(-3)	-0.132418	0.696881	-0.190015	0.8499
LNREX(-4)	-2.226729	0.740855	-3.005622	0.0039
EXR	-0.627573	0.842315	-0.745058	0.4592
LNICP	6.248871	2.193070	2.849372	0.0060
LNICP(-1)	-5.579752	3.058233	-1.824502	0.0731
LNICP(-2)	-2.547898	2.438097	-1.045036	0.3003
C	111.8684	32.07982	3.487188	0.0009

R-squared	0.853035	Mean dependent var	0.691279
Adjusted R-squared	0.773325	S.D. dependent var	2.400289
S.E. of regression	1.142788	Akaike info criterion	3.377959
Sum squared resid	77.05192	Schwarz criterion	4.282514
Log likelihood	-122.3861	Hannan-Quinn criter.	3.743045
F-statistic	10.70172	Durbin-Watson stat	2.119430
Prob(F-statistic)	0.000000		

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

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APPENDIX B4

F-STATISITIC FOR LONG-RUN LNCOP_POS

Wald Test:

Equation: NARDL

Test Statistic	Value	df	Probability
F-statistic	13.45822	(3, 59)	0.0000
Chi-square	40.37466	3	0.0000

Null Hypothesis: C(1)=C(3)=C(4)=0

Null Hypothesis Summary:

Normalized Restriction (= 0)	Value	Std. Err.
C(1)	0.362335	0.128803
C(3)	59.65374	16.61366
C(4)	-52.28903	15.41441

Restrictions are linear in coefficients.

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APPENDIX B5

F-STATISITIC FOR LONG-RUN LNCOP_NEG

Wald Test:

Equation: NARDL

Test Statistic	Value	df	Probability
F-statistic	18.95099	(3, 59)	0.0000
Chi-square	56.85297	3	0.0000

Null Hypothesis: C(1)=C(5)=C(6)=0

Null Hypothesis Summary:

Normalized Restriction (= 0)	Value	Std. Err.
C(1)	0.362335	0.128803
C(5)	-122.4990	25.24479
C(6)	105.8091	23.68597

Restrictions are linear in coefficients.

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APPENDIX B6

LONG-RUN ASYMMETRY TEST FOR LNCOP

Wald Test:
Equation: NARDL

Test Statistic	Value	df	Probability
t-statistic	1.919667	59	0.0597
F-statistic	3.685123	(1, 59)	0.0597
Chi-square	3.685123	1	0.0549

Null Hypothesis: C(4)/C(1)= C(5)/C(1)
Null Hypothesis Summary:

Normalized Restriction (= 0)	Value	Std. Err.
C(4)/C(1) - C(5)/C(1)	193.7710	100.9399

Delta method computed using analytic derivatives.

APPENDIX B7

SHORT-RUN ASYMMETRY TEST FOR LNCOP

Wald Test:
Equation: NARDL

Test Statistic	Value	df	Probability
t-statistic	3.137220	59	0.0027
F-statistic	9.842151	(1, 59)	0.0027
Chi-square	9.842151	1	0.0017

Null Hypothesis: C(4)= C(5)
Null Hypothesis Summary:

Normalized Restriction (= 0)	Value	Std. Err.
C(4) - C(5)	70.20999	22.37968

Restrictions are linear in coefficients.

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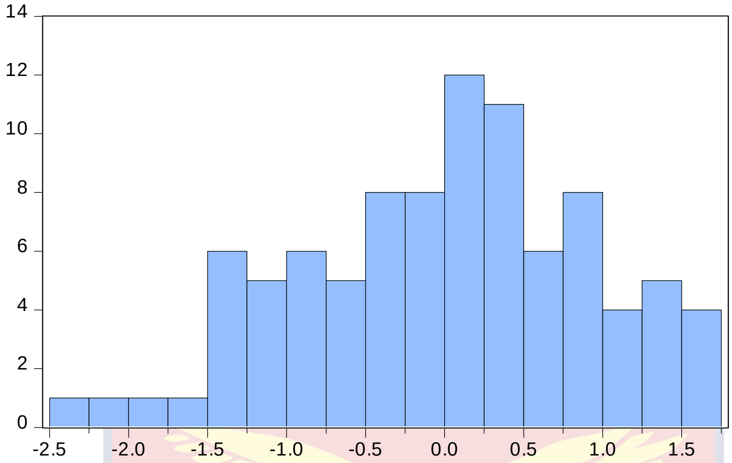
APPENDIX B8
NORMALITY TEST FOR LNCOP



Series: Residuals	
Sample 2011M05 2018M12	
Observations 92	
Mean	1.11e-14
Median	0.152474
Maximum	1.669458
Minimum	-2.436791
Std. Dev.	0.920176
Skewness	-0.255787
Kurtosis	2.579617
Jarque-Bera	1.680646
Probability	0.431571

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APPENDIX B9
HETEROSKEDASTICITY TEST FOR LNCOP

Heteroskedasticity Test: Breusch-Pagan-Godfrey

F-statistic	1.029770	Prob. F(32,59)	0.4503
Obs*R-squared	32.96960	Prob. Chi-Square(32)	0.4195
Scaled explained SS	10.70937	Prob. Chi-Square(32)	0.9999

Test Equation:
Dependent Variable: RESID^2
Method: Least Squares
Date: 04/14/20 Time: 13:18
Sample: 2011M05 2018M12
Included observations: 92

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-10.10046	29.55627	-0.341737	0.7338
GDP(-1)	-0.102623	0.118670	-0.864770	0.3907
GDP(-2)	0.069796	0.105678	0.660454	0.5115
LNCOP_POS	0.854329	15.30675	0.055814	0.9557
LNCOP_POS(-1)	-0.266750	14.20184	-0.018783	0.9851
LNCOP_NEG	-2.160256	23.25891	-0.092879	0.9263
LNCOP_NEG(-1)	4.943729	21.82272	0.226540	0.8216
CORR	225.4742	202.7553	1.112051	0.2706
CORR(-1)	-231.5791	208.7676	-1.109268	0.2718
GOVE	-40.95257	78.52124	-0.521548	0.6039
ACC	175.6199	409.3998	0.428969	0.6695
ACC(-1)	-547.3518	1003.632	-0.545371	0.5876
ACC(-2)	81.33068	1006.355	0.080817	0.9359
ACC(-3)	494.6252	457.3000	1.081621	0.2838
LNGFCF	-6.719563	12.38851	-0.542403	0.5896
LNGFCF(-1)	17.96533	28.36810	0.633293	0.5290
LNGFCF(-2)	-18.45218	31.93970	-0.577719	0.5657
LNGFCF(-3)	23.14429	23.29852	0.993380	0.3246
LNGFCF(-4)	-15.60055	9.515312	-1.639521	0.1064
LNCEX	-0.243061	0.314056	-0.773943	0.4421
LNCEX(-1)	-0.007443	0.305440	-0.024369	0.9806
LNCEX(-2)	-0.111918	0.282409	-0.396299	0.6933
LNCEX(-3)	0.111183	0.289632	0.383875	0.7025
LNCEX(-4)	0.078980	0.309175	0.255453	0.7993
LNREX	0.402832	0.685518	0.587631	0.5590
LNREX(-1)	0.098860	0.704808	0.140265	0.8889
LNREX(-2)	-0.305306	0.642918	-0.474876	0.6366
LNREX(-3)	0.082000	0.642061	0.127714	0.8988
LNREX(-4)	-0.170367	0.682575	-0.249595	0.8038
EXR	-0.879578	0.776055	-1.133397	0.2616
LNICP	-0.717959	2.020553	-0.355328	0.7236
LNICP(-1)	0.365694	2.817658	0.129786	0.8972
LNICP(-2)	-0.257265	2.246305	-0.114528	0.9092

R-squared	0.358365	Mean dependent var	0.837521
Adjusted R-squared	0.010360	S.D. dependent var	1.058388
S.E. of regression	1.052891	Akaike info criterion	3.214097
Sum squared resid	65.40620	Schwarz criterion	4.118651
Log likelihood	-114.8485	Hannan-Quinn criter.	3.579183
F-statistic	1.029770	Durbin-Watson stat	2.060877
Prob(F-statistic)	0.450306		

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APPENDIX B10
RAMSEY TEST FOR LNCOP

Ramsey RESET Test
Equation: NARDL
Specification: GDP GDP(-1) GDP(-2) LNCOP_POS LNCOP_POS(-1) LNCOP_NEG LNCOP_NEG(-1) CORR CORR(-1) GOVE ACC ACC(-1) ACC(-2) ACC(-3) LNGFCF LNGFCF(-1) LNGFCF(-2) LNGFCF(-3) LNGFCF(-4) LNCEX LNCEX(-1) LNCEX(-2) LNCEX(-3) LNCEX(-4) LNREX LNREX(-1) LNREX(-2) LNREX(-3) LNREX(-4) EXR LNICP LNICP(-1) LNICP(-2) C
Omitted Variables: Squares of fitted values

	Value	df	Probability
t-statistic	1.152715	58	0.2538
F-statistic	1.328753	(1, 58)	0.2538

F-test summary:

	Sum of Sq.	df	Mean Squares
Test SSR	1.725688	1	1.725688
Restricted SSR	77.05192	59	1.305965
Unrestricted SSR	75.32623	58	1.298728

Unrestricted Test Equation:
Dependent Variable: GDP
Method: ARDL
Date: 04/14/20 Time: 13:22
Sample: 2011M05 2018M12
Included observations: 92
Maximum dependent lags: 2 (Automatic selection)
Model selection method: Akaike info criterion (AIC)
Dynamic regressors (4 lags, automatic):
Fixed regressors: C

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
GDP(-1)	0.326416	0.132171	2.469652	0.0165
GDP(-2)	-0.210851	0.114827	-1.836258	0.0714
LNCOP_POS	71.27256	19.39281	3.675206	0.0005
LNCOP_POS(-1)	-62.07347	17.55951	-3.535035	0.0008
LNCOP_NEG	-130.6679	26.15318	-4.996254	0.0000
LNCOP_NEG(-1)	109.0415	23.78612	4.584248	0.0000
CORR	-455.5242	219.9504	-2.071032	0.0428
CORR(-1)	459.3178	229.7972	1.998796	0.0503
GOVE	-432.6788	95.97069	-4.508447	0.0000
ACC	-889.0456	444.6538	-1.999411	0.0503
ACC(-1)	587.1695	1090.287	0.538546	0.5923
ACC(-2)	-1332.434	1090.848	-1.221467	0.2269
ACC(-3)	1120.756	504.4803	2.221605	0.0302
LNGFCF	34.09613	13.45388	2.534297	0.0140
LNGFCF(-1)	-60.97679	30.75348	-1.982761	0.0521
LNGFCF(-2)	81.22381	34.60630	2.347082	0.0224
LNGFCF(-3)	-71.43365	25.26758	-2.827087	0.0064
LNGFCF(-4)	12.81509	10.29923	1.244276	0.2184
LNCEX	1.074142	0.344121	3.121405	0.0028
LNCEX(-1)	0.030819	0.331520	0.092962	0.9263
LNCEX(-2)	0.764590	0.306289	2.496303	0.0154

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LNCEX(-3)	0.638672	0.324593	1.967609	0.0539
LNCEX(-4)	1.074668	0.346897	3.097950	0.0030
LNREX	-2.174974	0.772436	-2.815732	0.0066
LNREX(-1)	-1.186431	0.768115	-1.544600	0.1279
LNREX(-2)	-0.980588	0.699489	-1.401864	0.1663
LNREX(-3)	-0.279750	0.706604	-0.395908	0.6936
LNREX(-4)	-2.505399	0.777346	-3.223014	0.0021
EXR	-0.222081	0.910663	-0.243868	0.8082
LNICP	6.380536	2.189966	2.913532	0.0051
LNICP(-1)	-5.669076	3.050732	-1.858268	0.0682
LNICP(-2)	-2.795924	2.440835	-1.145478	0.2567
C	140.3626	40.42835	3.471884	0.0010
FITTED^2	-0.047678	0.041361	-1.152715	0.2538

R-squared	0.856326	Mean dependent var	0.691279
Adjusted R-squared	0.774581	S.D. dependent var	2.400289
S.E. of regression	1.139618	Akaike info criterion	3.377047
Sum squared resid	75.32623	Schwarz criterion	4.309013
Log likelihood	-121.3442	Hannan-Quinn criter.	3.753197
F-statistic	10.47552	Durbin-Watson stat	2.092747
Prob(F-statistic)	0.000000		

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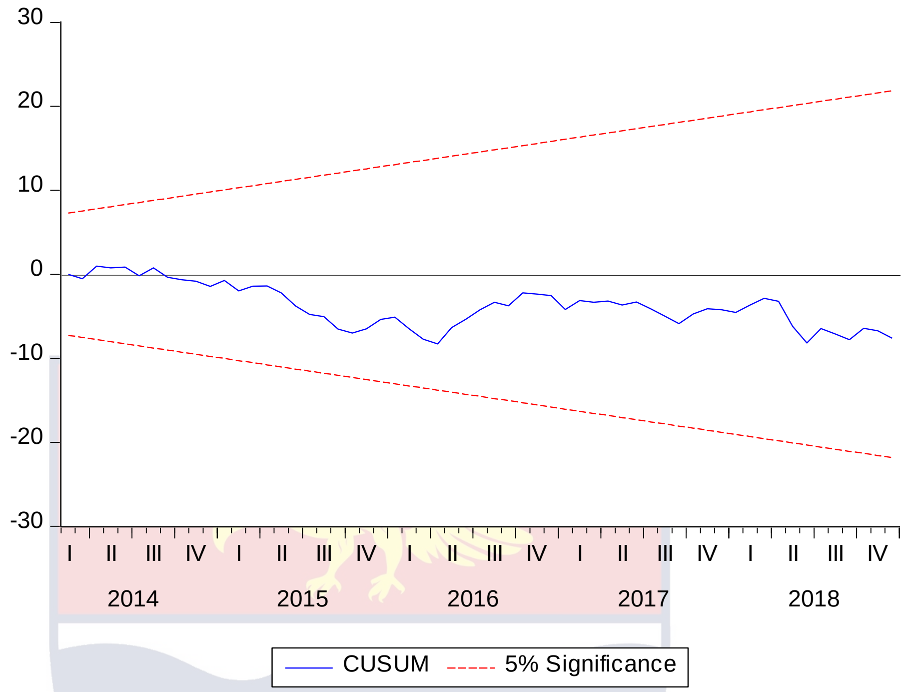
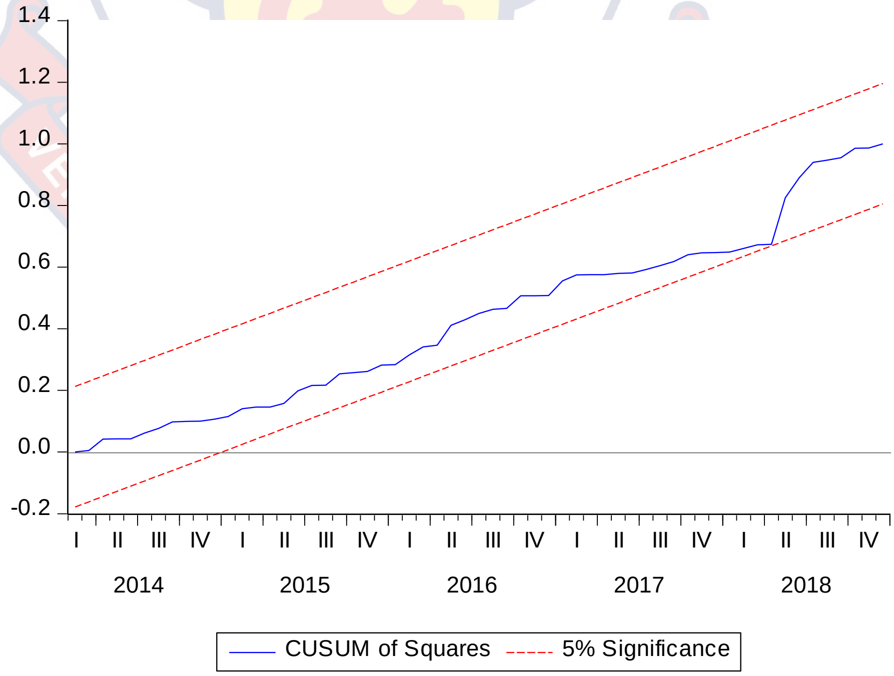
APPENDIX B11

STABILITY TESTS FOR LNCOP



PLOT 1



PLOT 2

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APPENDIX C

APPENDIX C1
NARDL COINTEGRATION FOR LNCOP_LNGFCF

ARDL Long Run Form and Bounds Test
Dependent Variable: D(GDP)
Selected Model: ARDL(1, 1, 1, 3, 1, 1, 0, 3, 0, 3)
Case 2: Restricted Constant and No Trend
Date: 04/14/20 Time: 14:32
Sample: 2011M01 2018M12
Included observations: 93

Conditional Error Correction Regression

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	12338.89	3639.910	3.389888	0.0012
GDP(-1)*	-0.460102	0.089298	-5.152416	0.0000
LNCOP(-1)	-445.7572	131.1470	-3.398913	0.0011
ACC(-1)	-488.4218	136.7775	-3.570922	0.0007
LNGFCF(-1)	-293.4408	86.45353	-3.394203	0.0011
LNCOP_LNGFCF_POS(-1)	20.11807	5.948337	3.382134	0.0012
LNCOP_LNGFCF_NEG(-1)	18.71763	5.632739	3.323007	0.0014
LNCEX**	0.810340	0.333598	2.429092	0.0177
LNREX(-1)	2.722168	1.270424	2.142724	0.0357
EXR**	1.101546	0.685024	1.608040	0.1124
LNICP(-1)	4.035595	1.294260	3.118070	0.0027
D(LNCOP)	-2665.751	665.7842	-4.003926	0.0002
D(ACC)	-2512.361	475.9498	-5.278626	0.0000
D(LNGFCF)	-1689.139	427.6904	-3.949444	0.0002
D(LNGFCF(-1))	-12.29902	15.02084	-0.818797	0.4157
D(LNGFCF(-2))	26.32074	12.30066	2.139783	0.0359
D(LNCOP_LNGFCF_POS)	118.9616	29.78224	3.994380	0.0002
D(LNCOP_LNGFCF_NEG)	116.3706	29.33743	3.966625	0.0002
D(LNREX)	-0.905529	0.782575	-1.157115	0.2512
D(LNREX(-1))	-3.625098	0.943619	-3.841698	0.0003
D(LNREX(-2))	-1.816927	0.682352	-2.662743	0.0096
D(LNICP)	2.100557	2.123449	0.989220	0.3260
D(LNICP(-1))	-1.832938	2.092043	-0.876147	0.3840
D(LNICP(-2))	-6.764002	2.168303	-3.119491	0.0026

* p-value incompatible with t-Bounds distribution.

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** Variable interpreted as Z = Z(-1) + D(Z).

APPENDIX C2

BOUND TEST LONG-RUN COEFFICIENTS FOR LNCOP_LNGFCF

Levels Equation
Case 2: Restricted Constant and No Trend

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNCOP	-968.8221	301.5005	-3.213335	0.0020
ACC	-1061.551	272.2819	-3.898719	0.0002
LNGFCF	-637.7732	198.6326	-3.210817	0.0020
LNCOP_LNGFCF_POS	43.72523	13.66751	3.199210	0.0021
LNCOP_LNGFCF_NEG	40.68146	12.95844	3.139379	0.0025
LNCEX	1.761219	0.799290	2.203479	0.0309
LNREX	5.916434	3.086097	1.917125	0.0594
EXR	2.394132	1.376100	1.739795	0.0864
LNICP	8.771085	2.877114	3.048571	0.0033
C	26817.72	8359.642	3.207998	0.0020

EC = GDP - (-968.8221*LNCOP -1061.5505*ACC -637.7732*LNGFCF + 43.7252*LNCOP_LNGFCF_POS + 40.6815*LNCOP_LNGFCF_NEG + 1.7612*LNCEX + 5.9164*LNREX + 2.3941*EXR + 8.7711*LNICP + 26817.7166)

F-Bounds Test — Null Hypothesis: No levels relationship

Test Statistic	Value	Signif.	I(0)	I(1)
			Asymptotic: n=1000	
F-statistic	4.820481	10%	1.8	2.8
k	9	5%	2.04	2.08
		2.5%	2.24	3.35
		1%	2.5	3.68
Actual Sample Size	93		Finite Sample: n=80	
		10%	-1	-1
		5%	-1	-1
		1%	-1	-1

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APPENDIX C3
NARDL MODEL FOR LNCOP_LNGFCF (RSQUARED, ADJUSTED RSQUARE, AND DW TEST)

Dependent Variable: GDP
Method: ARDL
Date: 04/14/20 Time: 14:32
Sample (adjusted): 2011M04 2018M12
Included observations: 93 after adjustments
Maximum dependent lags: 2 (Automatic selection)
Model selection method: Akaike info criterion (AIC)
Dynamic regressors (4 lags, automatic): LNCOP ACC LNGFCF LNCOP_LNGFCF_POS LNCOP_LNGFCF_NEG LNCEX LNREX EXR LNICP
Fixed regressors: C
Number of models evalulated: 3906250
Selected Model: ARDL(1, 1, 1, 3, 1, 1, 0, 3, 0, 3)
Note: final equation sample is larger than selection sample

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
GDP(-1)	0.539898	0.089298	6.046009	0.0000
LNCOP	-2665.746	665.7836	-4.003922	0.0002
LNCOP(-1)	2219.989	597.5594	3.715093	0.0004
ACC	-2512.358	475.9495	-5.278623	0.0000
ACC(-1)	2023.937	416.8889	4.854858	0.0000
LNGFCF	-1689.136	427.6900	-3.949440	0.0002
LNGFCF(-1)	1383.397	381.3332	3.627789	0.0005
LNGFCF(-2)	38.61971	25.79185	1.497361	0.1389
LNGFCF(-3)	-26.32070	12.30066	-2.139780	0.0359
LNCOP_LNGFCF_POS	118.9614	29.78221	3.994376	0.0002
LNCOP_LNGFCF_POS(-1)	-98.84332	26.71261	-3.700249	0.0004
LNCOP_LNGFCF_NEG	116.3704	29.33740	3.966621	0.0002
LNCOP_LNGFCF_NEG(-1)	-97.65275	26.51070	-3.683521	0.0005
LNCEX	0.810340	0.333598	2.429092	0.0177
LNREX	-0.905530	0.782575	-1.157117	0.2512
LNREX(-1)	0.002597	0.682040	0.003808	0.9970
LNREX(-2)	1.808169	0.712354	2.538300	0.0134
LNREX(-3)	1.816925	0.682352	2.662741	0.0096
EXR	1.101544	0.685024	1.608038	0.1124
LNICP	2.100557	2.123449	0.989219	0.3260
LNICP(-1)	0.102099	3.197515	0.031931	0.9746
LNICP(-2)	-4.931064	3.196648	-1.542573	0.1275
LNICP(-3)	6.764000	2.168303	3.119490	0.0026
C	12338.88	3639.910	3.389886	0.0012

R-squared	0.797247	Mean dependent var	0.661933
Adjusted R-squared	0.729663	S.D. dependent var	2.403925
S.E. of regression	1.249896	Akaike info criterion	3.501633
Sum squared resid	107.7945	Schwarz criterion	4.155208
Log likelihood	-138.8260	Hannan-Quinn criter.	3.765528
F-statistic	11.79633	Durbin-Watson stat	1.861884
Prob(F-statistic)	0.000000		

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

APPENDIX C4
F-STATISTIC FOR LONG-RUN LNCOP_LNGFCF_POS

Wald Test:
Equation: NARDL01

Test Statistic	Value	df	Probability
F-statistic	23.78095	(3, 69)	0.0000
Chi-square	71.34285	3	0.0000

Null Hypothesis: C(1)=C(10)=C(11)=0
Null Hypothesis Summary:

Normalized Restriction (= 0)	Value	Std. Err.
C(1)	0.539898	0.089298
C(10)	118.9614	29.78221
C(11)	-98.84332	26.71261

Restrictions are linear in coefficients.

APPENDIX C5
F-STATISTIC FOR LONG-RUN LNCOP_LNGFCF_NEG

Wald Test:
Equation: NARDL01

Test Statistic	Value	df	Probability
F-statistic	23.35319	(3, 69)	0.0000
Chi-square	70.05958	3	0.0000

Null Hypothesis: C(1)=C(12)=C(13)=0
Null Hypothesis Summary:

Normalized Restriction (= 0)	Value	Std. Err.
C(1)	0.539898	0.089298
C(12)	116.3704	29.33740
C(13)	-97.65275	26.51070

Restrictions are linear in coefficients.

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APPENDIX C6
LONG-RUN ASYMMETRY TEST FOR LNCOP_LNGFCF

Wald Test:
Equation: NARDL01

Test Statistic	Value	df	Probability
t-statistic	-1.935363	69	0.0570
F-statistic	3.745628	(1, 69)	0.0570
Chi-square	3.745628	1	0.0529

Null Hypothesis: -C(10)/C(1)= -C(12)/C(1)
Null Hypothesis Summary:

Normalized Restriction (= 0)	Value	Std. Err.
-C(10)/C(1) + C(12)/C(1)	-4.799078	2.479679

Delta method computed using analytic derivatives.

APPENDIX C7
SHORT-RUN ASYMMETRY TEST FOR LNCOP_LNGFCF

Wald Test:
Equation: NARDL

Test Statistic	Value	df	Probability
t-statistic	-2.326969	69	0.0229
F-statistic	5.414785	(1, 69)	0.0229
Chi-square	5.414785	1	0.0200

Null Hypothesis: -C(10)= -C(12)
Null Hypothesis Summary:

Normalized Restriction (= 0)	Value	Std. Err.
-C(10) + C(12)	-2.591016	1.113472

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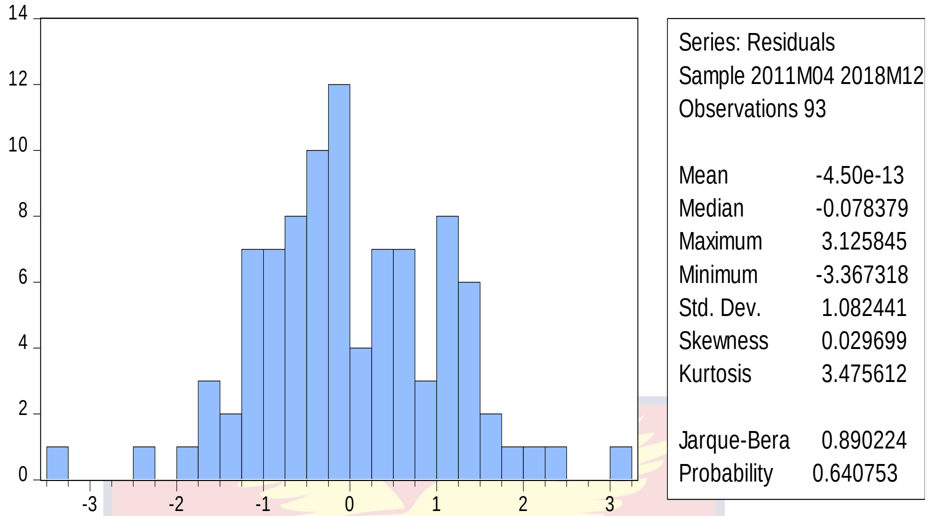
APPENDIX C8
NORMALITY TEST FOR LNCOP_LNGFCF



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APPENDIX C9
HETEROSKEDASTICITY TEST FOR LNCOP_LNGFCF

Heteroskedasticity Test: Breusch-Pagan-Godfrey

F-statistic	0.701693	Prob. F(23,69)	0.8278
Obs*R-squared	17.62907	Prob. Chi-Square(23)	0.7773
Scaled explained SS	12.01198	Prob. Chi-Square(23)	0.9703

Test Equation:
Dependent Variable: RESID^2
Method: Least Squares
Date: 04/14/20 Time: 14:51
Sample: 2011M04 2018M12
Included observations: 93

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-7880.958	5550.725	-1.419807	0.1602
GDP(-1)	0.116497	0.136176	0.855490	0.3952
LNCOP	604.3538	1015.298	0.595248	0.5536
LNCOP(-1)	-320.6911	911.2583	-0.351921	0.7260
ACC	447.1331	725.8063	0.616050	0.5399
ACC(-1)	-129.2185	635.7406	-0.203257	0.8395
LNGFCF	357.0990	652.2131	0.547519	0.5858
LNGFCF(-1)	-154.4360	581.5205	-0.265573	0.7914
LNGFCF(-2)	-24.03181	39.33157	-0.611006	0.5432
LNGFCF(-3)	8.988705	18.75803	0.479192	0.6333
LNCOP_LNGFCF_POS	-26.60552	45.41689	-0.585807	0.5599
LNCOP_LNGFCF_POS(-1)	13.70464	40.73584	0.336427	0.7376
LNCOP_LNGFCF_NEG	-26.44448	44.73856	-0.591089	0.5564
LNCOP_LNGFCF_NEG(-1)	14.18392	40.42794	0.350844	0.7268
LNCEX	-0.673045	0.508724	-1.323007	0.1902
LNREX	1.298439	1.193395	1.088020	0.2804
LNREX(-1)	-0.942257	1.040085	-0.905942	0.3681
LNREX(-2)	-0.522832	1.086313	-0.481291	0.6318
LNREX(-3)	-0.481633	1.040560	-0.462860	0.6449
EXR	-0.183812	1.044634	-0.175959	0.8608
LNICP	-1.429889	3.238176	-0.441572	0.6602
LNICP(-1)	0.764126	4.876084	0.156709	0.8759
LNICP(-2)	0.181433	4.874763	0.037219	0.9704
LNICP(-3)	-1.203098	3.306577	-0.363850	0.7171

R-squared	0.189560	Mean dependent var	1.159081
Adjusted R-squared	-0.080587	S.D. dependent var	1.833592
S.E. of regression	1.906042	Akaike info criterion	4.345571
Sum squared resid	250.6767	Schwarz criterion	4.999145
Log likelihood	-178.0690	Hannan-Quinn criter.	4.609465
F-statistic	0.701693	Durbin-Watson stat	2.304475
Prob(F-statistic)	0.827828		

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APPENDIX C10
RAMSEY TEST FOR LNCOP_LNGFCF

Ramsey RESET Test
Equation: NARDL01
Specification: GDP GDP(-1) LNCOP LNCOP(-1) ACC ACC(-1) LNGFCF LNGFCF(-1) LNGFCF(-2) LNGFCF(-3) LNCOP_LNGFCF_POS LNCOP_LNGFCF_POS(-1) LNCOP_LNGFCF_NEG LNCOP_LNGFCF_NEG(-1) LNCEX LNREX LNREX(-1) LNREX(-2) LNREX(-3) EXR LNICP LNICP(-1) LNICP(-2) LNICP(-3) C
Omitted Variables: Squares of fitted values

	Value	df	Probability
t-statistic	0.505278	68	0.6150
F-statistic	0.255306	(1, 68)	0.6150

F-test summary:

	Sum of Sq.	df	Mean Squares
Test SSR	0.403201	1	0.403201
Restricted SSR	107.7945	69	1.562239
Unrestricted SSR	107.3913	68	1.579284

Unrestricted Test Equation:
Dependent Variable: GDP
Method: ARDL
Date: 04/14/20 Time: 14:54
Sample: 2011M04 2018M12
Included observations: 93
Maximum dependent lags: 2 (Automatic selection)
Model selection method: Akaike info criterion (AIC)
Dynamic regressors (4 lags, automatic):
Fixed regressors: C

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
GDP(-1)	0.536223	0.090078	5.952848	0.0000
LNCOP	-2707.401	674.4631	-4.014157	0.0002
LNCOP(-1)	2280.302	612.5533	3.722618	0.0004
ACC	-2506.662	478.6716	-5.236706	0.0000
ACC(-1)	2000.259	421.7684	4.742553	0.0000
LNGFCF	-1717.680	433.7116	-3.960420	0.0002
LNGFCF(-1)	1425.039	392.1656	3.633769	0.0005
LNGFCF(-2)	37.75722	25.98829	1.452855	0.1509
LNGFCF(-3)	-26.43725	12.36973	-2.137254	0.0362
LNCOP_LNGFCF_POS	120.8781	30.18358	4.004765	0.0002
LNCOP_LNGFCF_POS(-1)	-101.6032	27.40774	-3.707100	0.0004
LNCOP_LNGFCF_NEG	118.1504	29.70663	3.977239	0.0002
LNCOP_LNGFCF_NEG(-1)	-100.3316	27.17710	-3.691771	0.0004
LNCEX	0.825948	0.336832	2.452106	0.0168
LNREX	-1.009977	0.813532	-1.241471	0.2187
LNREX(-1)	-0.021741	0.687441	-0.031627	0.9749
LNREX(-2)	1.790403	0.717093	2.496754	0.0150
LNREX(-3)	1.768926	0.692609	2.554004	0.0129
EXR	1.284417	0.778053	1.650808	0.1034
LNICP	2.132001	2.135908	0.998171	0.3217
LNICP(-1)	0.121772	3.215146	0.037874	0.9699
LNICP(-2)	-5.169517	3.248502	-1.591354	0.1162
LNICP(-3)	7.066223	2.260663	3.125731	0.0026
C	11825.62	3798.071	3.113585	0.0027
FITTED^2	-0.017177	0.033995	-0.505277	0.6150

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R-squared	0.798005	Mean dependent var	0.661933
Adjusted R-squared	0.726713	S.D. dependent var	2.403925
S.E. of regression	1.256696	Akaike info criterion	3.519391
Sum squared resid	107.3913	Schwarz criterion	4.200198
Log likelihood	-138.6517	Hannan-Quinn criter.	3.794281
F-statistic	11.19345	Durbin-Watson stat	1.853921
Prob(F-statistic)	0.000000		

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

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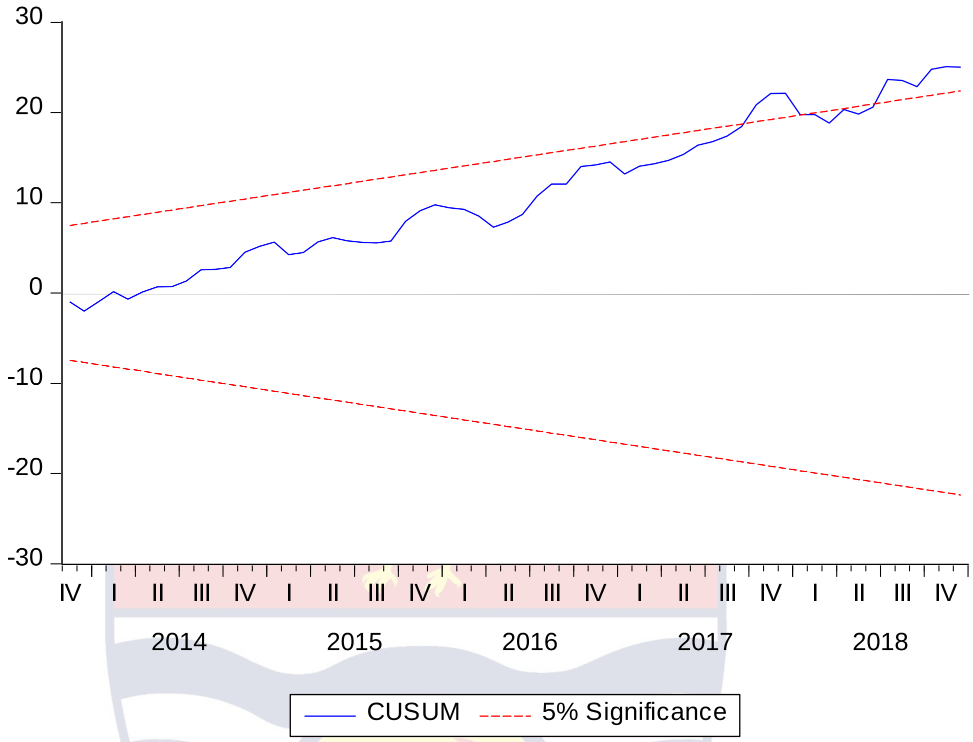
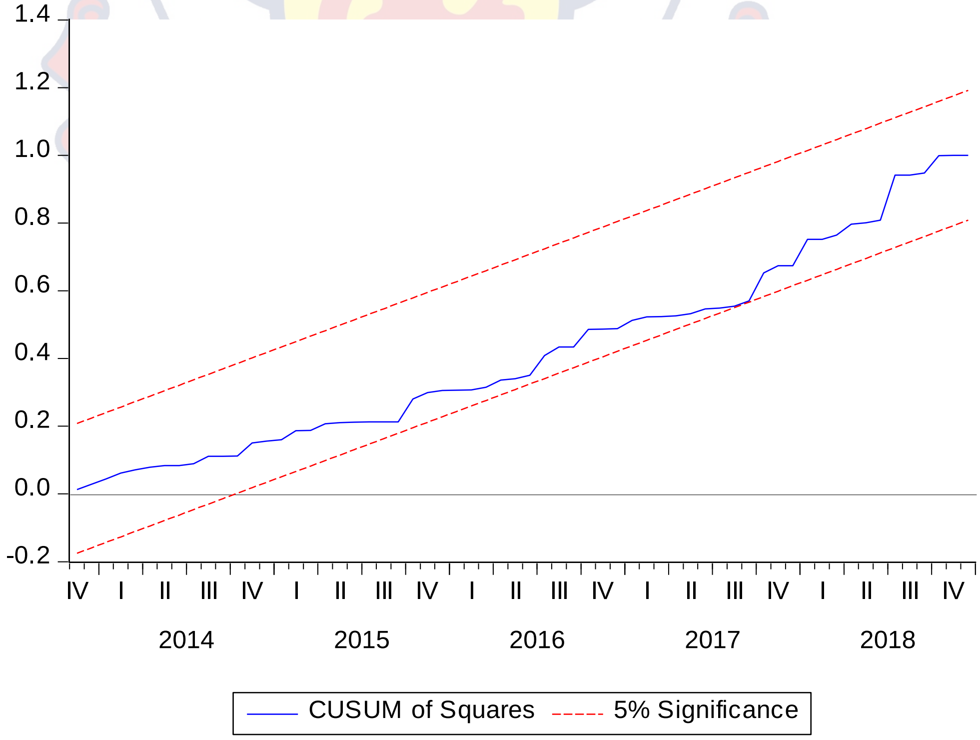
APPENDIX C11

STABILITY TEST FOR LNCOP_LNGFCF



PLOT 1



PLOT 2

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APPENDIX D

APPENDIX D1
NARDL COINTEGRATION FOR LNCOP_CORR

ARDL Long Run Form and Bounds Test
Dependent Variable: D(GDP)
Selected Model: ARDL(1, 4, 0, 3, 0, 4, 3, 4, 4, 2)
Case 2: Restricted Constant and No Trend
Date: 05/06/20 Time: 10:46
Sample: 2011M01 2018M12
Included observations: 92

Conditional Error Correction Regression

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	479.0097	130.2431	3.677812	0.0005
GDP(-1)*	-0.613135	0.116211	-5.276035	0.0000
LNCOP(-1)	-34.42925	8.112841	-4.243797	0.0001
CORR**	20997.65	5231.599	4.013620	0.0002
LNCOP_CORR_POS(-1)	-1373.045	338.3700	-4.057823	0.0002
LNCOP_CORR_NEG**	-1394.028	350.3918	-3.978483	0.0002
GOVE(-1)	-192.7068	67.17352	-2.868791	0.0058
ACC(-1)	-145.5149	126.5475	-1.149883	0.2550
LNGFCF(-1)	3.397548	1.013569	3.352064	0.0014
LNCEX(-1)	2.128407	1.023641	2.079252	0.0421
LNREX(-1)	4.783889	1.560743	3.065135	0.0033
D(LNCOP)	-157.2434	68.15218	-2.307239	0.0247
D(LNCOP(-1))	66.96509	119.0937	0.562289	0.5761
D(LNCOP(-2))	-11.81023	117.2628	-0.100716	0.9201
D(LNCOP(-3))	101.2182	71.16991	1.422206	0.1604
D(LNCOP_CORR_POS)	-1329.521	335.3811	-3.964211	0.0002
D(LNCOP_CORR_POS(-1))	47.27633	37.72157	1.253297	0.2152
D(LNCOP_CORR_POS(-2))	74.60226	43.96266	1.696946	0.0952
D(GOVE)	-163.1317	479.2996	-0.340354	0.7348
D(GOVE(-1))	-283.2421	799.6281	-0.354217	0.7245
D(GOVE(-2))	89.72994	742.2694	0.120886	0.9042
D(GOVE(-3))	-1093.538	396.3523	-2.759004	0.0078
D(ACC)	-1791.734	739.1657	-2.423995	0.0185
D(ACC(-1))	-119.9051	958.8456	-0.125052	0.9009
D(ACC(-2))	-2413.369	931.4479	-2.590987	0.0121
D(LNGFCF)	30.26376	13.14919	2.301568	0.0250
D(LNGFCF(-1))	-17.57072	19.19983	-0.915150	0.3640
D(LNGFCF(-2))	41.29161	17.57520	2.349425	0.0223
D(LNGFCF(-3))	-34.05739	10.50837	-3.240976	0.0020
D(LNCEX)	0.187876	0.363908	0.516274	0.6077
D(LNCEX(-1))	-2.398342	0.680435	-3.524720	0.0008
D(LNCEX(-2))	-1.569980	0.522044	-3.007368	0.0039
D(LNCEX(-3))	-0.639825	0.325038	-1.968459	0.0539
D(LNREX)	2.081867	0.856737	2.429995	0.0183
D(LNREX(-1))	-0.991111	0.773343	-1.281594	0.2052

* p-value incompatible with t-Bounds distribution.

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** Variable interpreted as Z = Z(-1) + D(Z).

APPENDIX D2
BOUND TEST LONG-RUN COEFFICIENTS FOR LNCOP_CORR

Levels Equation
Case 2: Restricted Constant and No Trend

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNCOP	-56.15279	10.57264	-5.311144	0.0000
CORR	34246.37	7186.700	4.765242	0.0000
LNCOP_CORR_POS	-2239.385	466.4462	-4.800950	0.0000
LNCOP_CORR_NEG	-2273.607	479.2444	-4.744149	0.0000
GOVE	-314.2975	95.23639	-3.300182	0.0017
ACC	-237.3293	192.7615	-1.231207	0.2233
LNGFCF	5.541272	1.798208	3.081553	0.0032
LNCEX	3.471352	1.716277	2.022606	0.0478
LNREX	7.802341	2.542719	3.068503	0.0033
C	781.2466	167.4848	4.664582	0.0000

EC = GDP - (-56.1528*LNCOP + 34246.3667*CORR -2239.3850
*LNCOP_CORR_POS -2273.6068*LNCOP_CORR_NEG -314.2975
*GOVE -237.3293*ACC + 5.5413*LNGFCF + 3.4714*LNCEX + 7.8023
*LNREX + 781.2466)

F-Bounds Test — Null Hypothesis: No levels relationship

Test Statistic	Value	Signif.	I(0)	I(1)
			Asymptotic: n=1000	
F-statistic	4.602597	10%	1.8	2.8
k	9	5%	2.04	2.08
		2.5%	2.24	3.35
		1%	2.5	3.68
			Finite Sample: n=80	
Actual Sample Size	92			
		10%	-1	-1
		5%	-1	-1
		1%	-1	-1

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APPENDIX D3
NARDL MODEL FOR LNCOP_CORR (RSQUARED, ADJUSTED RSQUARE, AND DW TEST)

Dependent Variable: GDP
Method: ARDL
Date: 05/06/20 Time: 10:44
Sample (adjusted): 2011M05 2018M12
Included observations: 92 after adjustments
Maximum dependent lags: 2 (Automatic selection)
Model selection method: Akaike info criterion (AIC)
Dynamic regressors (4 lags, automatic): LNCOP CORR LNCOP_CORR_POS LNCOP_CORR_NEG GOVE ACC LNGFCF LNCEX LNREX
Fixed regressors: C
Number of models evalulated: 3906250
Selected Model: ARDL(1, 4, 0, 3, 0, 4, 3, 4, 4, 2)
Note: final equation sample is larger than selection sample

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
GDP(-1)	0.386865	0.116211	3.328978	0.0015
LNCOP	-157.2434	68.15218	-2.307239	0.0247
LNCOP(-1)	189.7792	177.9179	1.066667	0.2906
LNCOP(-2)	-78.77532	217.7524	-0.361766	0.7189
LNCOP(-3)	113.0285	178.5961	0.632872	0.5293
LNCOP(-4)	-101.2183	71.16991	-1.422206	0.1604
CORR	20997.65	5231.599	4.013620	0.0002
LNCOP_CORR_POS	-1329.521	335.3811	-3.964211	0.0002
LNCOP_CORR_POS(-1)	3.752114	54.33408	0.069056	0.9452
LNCOP_CORR_POS(-2)	27.32593	57.62199	0.474227	0.6371
LNCOP_CORR_POS(-3)	-74.60226	43.96266	-1.696946	0.0952
LNCOP_CORR_NEG	-1394.028	350.3918	-3.978483	0.0002
GOVE	-163.1317	479.2996	-0.340354	0.7348
GOVE(-1)	-312.8172	1208.363	-0.258877	0.7967
GOVE(-2)	372.9721	1458.191	0.255777	0.7990
GOVE(-3)	-1183.268	1061.679	-1.114525	0.2697
GOVE(-4)	1093.538	396.3523	2.759004	0.0078
ACC	-1791.734	739.1657	-2.423995	0.0185
ACC(-1)	1526.314	1567.417	0.973777	0.3343
ACC(-2)	-2293.464	1647.904	-1.391746	0.1694
ACC(-3)	2413.369	931.4479	2.590987	0.0121
LNGFCF	30.26376	13.14919	2.301568	0.0250
LNGFCF(-1)	-44.43693	30.47106	-1.458332	0.1502
LNGFCF(-2)	58.86233	34.34174	1.714017	0.0920
LNGFCF(-3)	-75.34900	26.37909	-2.856391	0.0060
LNGFCF(-4)	34.05739	10.50837	3.240976	0.0020
LNCEX	0.187876	0.363908	0.516274	0.6077
LNCEX(-1)	-0.457811	0.375904	-1.217894	0.2283
LNCEX(-2)	0.828362	0.356049	2.326543	0.0236
LNCEX(-3)	0.930155	0.323335	2.876757	0.0056
LNCEX(-4)	0.639825	0.325038	1.968459	0.0539
LNREX	2.081867	0.856737	2.429995	0.0183
LNREX(-1)	1.710911	0.857017	1.996357	0.0507
LNREX(-2)	0.991111	0.773343	1.281594	0.2052
C	479.0097	130.2431	3.677812	0.0005

R-squared	0.845219	Mean dependent var	0.691279
Adjusted R-squared	0.752893	S.D. dependent var	2.400289
S.E. of regression	1.193180	Akaike info criterion	3.473254
Sum squared resid	81.14973	Schwarz criterion	4.432630

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Log likelihood	-124.7697	Hannan-Quinn criter.	3.860466
F-statistic	9.154749	Durbin-Watson stat	2.029233
Prob(F-statistic)	0.000000		

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

APPENDIX D4
F-STATISTIC FOR LONG-RUN LNCOP_CORR_POS

Wald Test:
Equation: NARDL

Test Statistic	Value	df	Probability
F-statistic	21.68663	(3, 57)	0.0000
Chi-square	65.05989	3	0.0000

Null Hypothesis: C(1)=C(8)=C(11)=0
Null Hypothesis Summary:

Normalized Restriction (= 0)	Value	Std. Err.
C(1)	0.386865	0.116211
C(8)	-1329.521	335.3811
C(11)	-74.60226	43.96266

Restrictions are linear in coefficients.

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APPENDIX D5
F-STATISTIC FOR LONG-RUN LNCOP_CORR_NEG

Wald Test:
Equation: NARDL

Test Statistic	Value	df	Probability
F-statistic	31.38904	(2, 57)	0.0000
Chi-square	62.77809	2	0.0000

Null Hypothesis: C(1)=C(12)=0
Null Hypothesis Summary:

Normalized Restriction (= 0)	Value	Std. Err.
C(1)	0.386865	0.116211
C(12)	-1394.028	350.3918

Restrictions are linear in coefficients.

APPENDIX D6
LONG-RUN ASYMMETRY TEST FOR LNCOP_CORR

Wald Test:
Equation: NARDL

Test Statistic	Value	df	Probability
t-statistic	2.002137	57	0.0500
F-statistic	4.008553	(1, 57)	0.0500
Chi-square	4.008553	1	0.0453

Null Hypothesis: C(11)/C(1)= C(12)/C(1)
Null Hypothesis Summary:

Normalized Restriction (= 0)	Value	Std. Err.
C(11)/C(1) - C(12)/C(1)	3410.559	1703.459

Delta method computed using analytic derivatives.

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APPENDIX D7

SHORT-RUN ASYMMETRY TEST FOR LNCOP_CORR

Wald Test:
Equation: NARDL

Test Statistic	Value	df	Probability
t-statistic	3.770328	57	0.0004
F-statistic	14.21537	(1, 57)	0.0004
Chi-square	14.21537	1	0.0002

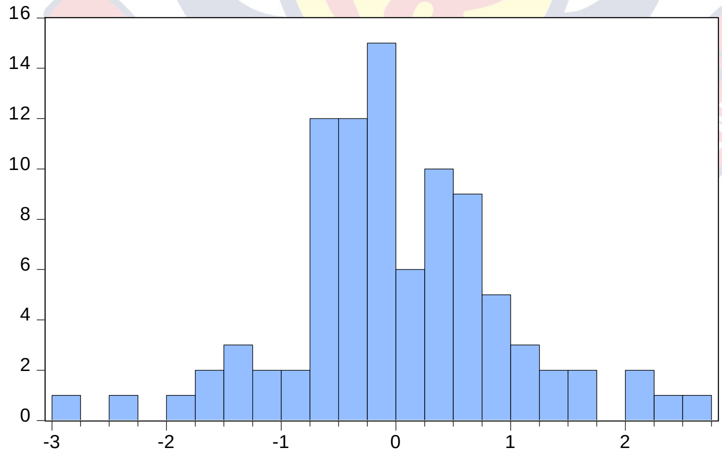
Null Hypothesis: C(11)= C(12)
Null Hypothesis Summary:

Normalized Restriction (= 0)	Value	Std. Err.
C(11) - C(12)	1319.426	349.9499

Restrictions are linear in coefficients.

APPENDIX D8

NORMALITY TEST FOR LNCOP_CORR



Series: Residuals
Sample 2011M05 2018M12
Observations 92

Mean	-6.09e-13
Median	-0.081193
Maximum	2.524923
Minimum	-2.771330
Std. Dev.	0.944328
Skewness	0.042121
Kurtosis	3.795933
Jarque-Bera	2.455658
Probability	0.292928

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APPENDIX D9
HETEROSKEDASTICITY TEST FOR LNCOP_CORR

Heteroskedasticity Test: Breusch-Pagan-Godfrey

F-statistic	1.514881	Prob. F(34,57)	0.0818
Obs*R-squared	43.67086	Prob. Chi-Square(34)	0.1238
Scaled explained SS	23.43487	Prob. Chi-Square(34)	0.9133

Test Equation:
Dependent Variable: RESID^2
Method: Least Squares
Date: 05/06/20 Time: 11:04
Sample: 2011M05 2018M12
Included observations: 92

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-68.58551	148.2444	-0.462652	0.6454
GDP(-1)	-0.255027	0.132273	-1.928030	0.0588
LNCOP	83.81983	77.57172	1.080546	0.2844
LNCOP(-1)	-183.7183	202.5085	-0.907213	0.3681
LNCOP(-2)	67.33822	247.8487	0.271691	0.7868
LNCOP(-3)	94.39421	203.2804	0.464355	0.6442
LNCOP(-4)	-58.99315	81.00654	-0.728252	0.4694
CORR	-1196.721	5954.675	-0.200972	0.8414
LNCOP_CORR_POS	85.44386	381.7352	0.223830	0.8237
LNCOP_CORR_POS(-1)	-29.17382	61.84377	-0.471734	0.6389
LNCOP_CORR_POS(-2)	53.12678	65.58611	0.810031	0.4213
LNCOP_CORR_POS(-3)	-38.06167	50.03888	-0.760642	0.4500
LNCOP_CORR_NEG	95.66460	398.8207	0.239869	0.8113
GOVE	440.9003	545.5451	0.808183	0.4223
GOVE(-1)	-815.9160	1375.375	-0.593232	0.5554
GOVE(-2)	245.5390	1659.732	0.147939	0.8829
GOVE(-3)	16.88308	1208.417	0.013971	0.9889
GOVE(-4)	-51.19243	451.1335	-0.113475	0.9101
ACC	901.0002	841.3282	1.070926	0.2887
ACC(-1)	-1168.009	1784.055	-0.654693	0.5153
ACC(-2)	-1228.155	1875.666	-0.654784	0.5152
ACC(-3)	1842.558	1060.186	1.737957	0.0876
LNGFCF	-11.05047	14.96658	-0.738343	0.4633
LNGFCF(-1)	36.46395	34.68256	1.051363	0.2975
LNGFCF(-2)	-40.06528	39.08823	-1.024996	0.3097
LNGFCF(-3)	41.91307	30.02503	1.395938	0.1681
LNGFCF(-4)	-27.03073	11.96077	-2.259949	0.0277
LNCEX	-1.044460	0.414204	-2.521605	0.0145
LNCEX(-1)	-0.464947	0.427858	-1.086683	0.2818
LNCEX(-2)	-0.331910	0.405259	-0.819006	0.4162
LNCEX(-3)	0.370902	0.368024	1.007822	0.3178
LNCEX(-4)	0.206736	0.369963	0.558802	0.5785
LNREX	1.461546	0.975149	1.498792	0.1394

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LNREX(-1)	-0.591929	0.975468	-0.606815	0.5464
LNREX(-2)	0.760979	0.880229	0.864524	0.3909

R-squared	0.474683	Mean dependent var	0.882062
Adjusted R-squared	0.161336	S.D. dependent var	1.482982
S.E. of regression	1.358094	Akaike info criterion	3.732174
Sum squared resid	105.1319	Schwarz criterion	4.691550
Log likelihood	-136.6800	Hannan-Quinn criter.	4.119386
F-statistic	1.514881	Durbin-Watson stat	2.334398
Prob(F-statistic)	0.081849		

APPENDIX D10
RAMSEY TEST FOR LNCOP_CORR

Ramsey RESET Test
Equation: NARDL
Specification: GDP GDP(-1) LNCOP LNCOP(-1) LNCOP(-2) LNCOP(-3) LNCOP(-4) CORR LNCOP_CORR_POS LNCOP_CORR_POS(-1) LNCOP_CORR_POS(-2) LNCOP_CORR_POS(-3) LNCOP_CORR_NEG GOVE GOVE(-1) GOVE(-2) GOVE(-3) GOVE(-4) ACC ACC(-1) ACC(-2) ACC(-3) LNGFCF LNGFCF(-1) LNGFCF(-2) LNGFCF(-3) LNGFCF(-4) LNCEX LNCEX(-1) LNCEX(-2) LNCEX(-3) LNCEX(-4) LNREX LNREX(-1) LNREX(-2) C
Omitted Variables: Squares of fitted values

	Value	df	Probability
t-statistic	0.115316	56	0.9086
F-statistic	0.013298	(1, 56)	0.9086

F-test summary:

	Sum of Sq.	df	Mean Squares
Test SSR	0.019265	1	0.019265
Restricted SSR	81.14973	57	1.423680
Unrestricted SSR	81.13047	56	1.448758

Unrestricted Test Equation:
Dependent Variable: GDP
Method: ARDL
Date: 05/06/20 Time: 11:06
Sample: 2011M05 2018M12
Included observations: 92
Maximum dependent lags: 2 (Automatic selection)
Model selection method: Akaike info criterion (AIC)
Dynamic regressors (4 lags, automatic):
Fixed regressors: C

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Variable	Coefficient	Std. Error	t-Statistic	Prob.*
GDP(-1)	0.386733	0.117236	3.298752	0.0017
LNCOP	-154.8780	71.74469	-2.158738	0.0352
LNCOP(-1)	185.6386	183.0346	1.014227	0.3148
LNCOP(-2)	-77.02947	220.1830	-0.349843	0.7278
LNCOP(-3)	113.8348	180.2979	0.631371	0.5304
LNCOP(-4)	-101.4701	71.82724	-1.412697	0.1633
CORR	20608.85	6262.534	3.290817	0.0017
LNCOP_CORR_POS	-1305.724	396.2926	-3.294849	0.0017
LNCOP_CORR_POS(-1)	3.036894	55.16036	0.055056	0.9563
LNCOP_CORR_POS(-2)	28.12179	58.53558	0.480422	0.6328
LNCOP_CORR_POS(-3)	-73.88918	44.77722	-1.650151	0.1045
LNCOP_CORR_NEG	-1368.105	418.8936	-3.265997	0.0019
GOVE	-182.9698	513.1958	-0.356530	0.7228
GOVE(-1)	-267.2645	1281.369	-0.208577	0.8355
GOVE(-2)	337.9208	1502.055	0.224972	0.8228
GOVE(-3)	-1174.520	1073.672	-1.093929	0.2787
GOVE(-4)	1093.770	399.8331	2.735566	0.0083
ACC	-1790.502	745.7241	-2.401025	0.0197
ACC(-1)	1571.031	1628.020	0.964995	0.3387
ACC(-2)	-2342.087	1714.997	-1.365651	0.1775
ACC(-3)	2432.393	953.9887	2.549709	0.0135
LNGFCF	30.21144	13.27226	2.276285	0.0267
LNGFCF(-1)	-44.16749	30.82695	-1.432756	0.1575
LNGFCF(-2)	58.47589	34.80460	1.680119	0.0985
LNGFCF(-3)	-74.84196	26.97123	-2.774882	0.0075
LNGFCF(-4)	33.67116	11.11705	3.028785	0.0037
LNCEX	0.185823	0.367530	0.505600	0.6151
LNCEX(-1)	-0.450779	0.384072	-1.173682	0.2455
LNCEX(-2)	0.833720	0.362164	2.302054	0.0251
LNCEX(-3)	0.932902	0.327039	2.852572	0.0061
LNCEX(-4)	0.643676	0.329585	1.952988	0.0558
LNREX	2.060770	0.883401	2.332768	0.0233
LNREX(-1)	1.688805	0.885531	1.907111	0.0616
LNREX(-2)	0.972842	0.796049	1.222087	0.2268
C	470.4139	151.0577	3.114135	0.0029
FITTED^2	0.004730	0.041020	0.115316	0.9086

R-squared	0.845255	Mean dependent var	0.691279
Adjusted R-squared	0.748540	S.D. dependent var	2.400289
S.E. of regression	1.203644	Akaike info criterion	3.494756
Sum squared resid	81.13047	Schwarz criterion	4.481543
Log likelihood	-124.7588	Hannan-Quinn criter.	3.893031
F-statistic	8.739618	Durbin-Watson stat	2.038766
Prob(F-statistic)	0.000000		

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

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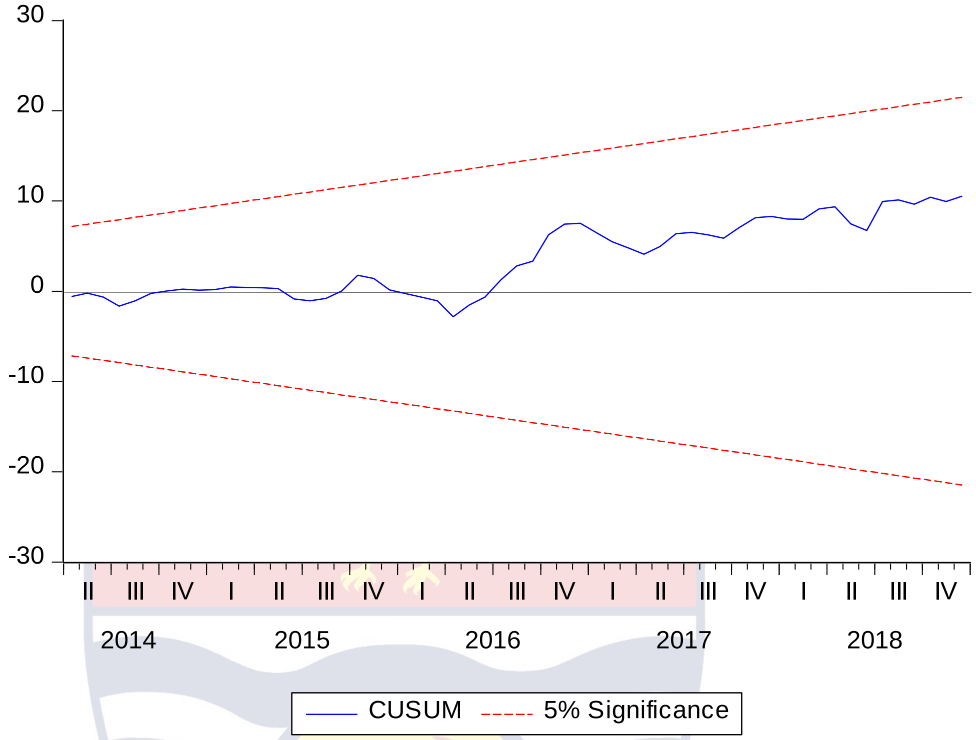
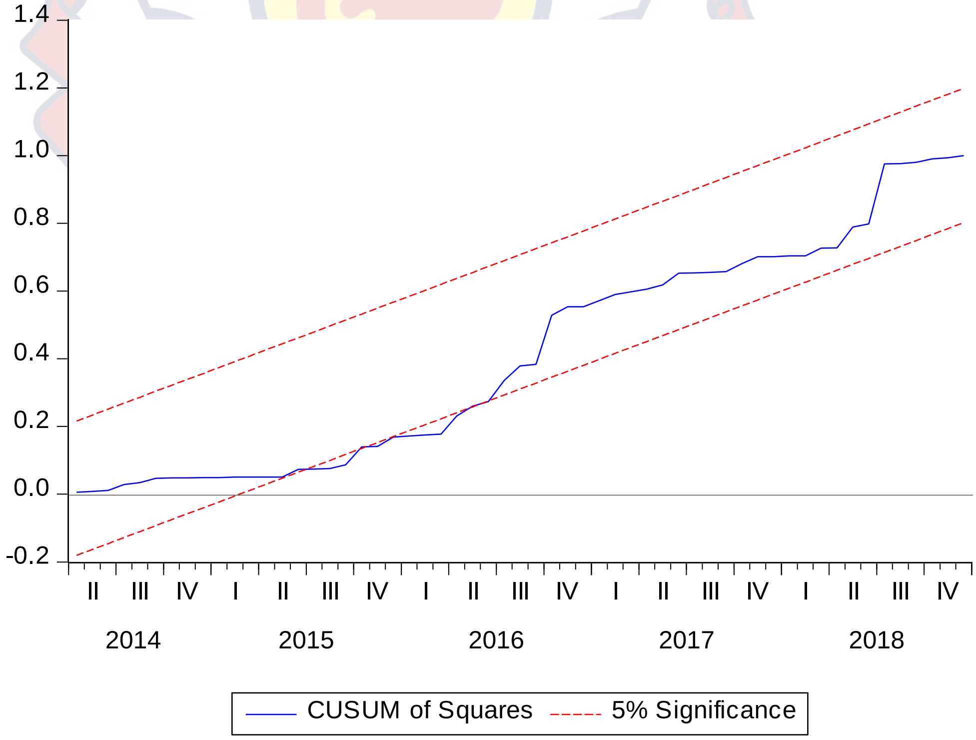
APPENDIX D11

STABILITY TEST FOR LNCOP_CORR



PLOT 1



PLOT 2

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APPENDIX E

APPENDIX E1
NARDL COINTEGRATION FOR LNCOP_GOVE

ARDL Long Run Form and Bounds Test
Dependent Variable: D(GDP)
Selected Model: ARDL(1, 2, 0, 0, 0, 1, 1, 1, 3)
Case 2: Restricted Constant and No Trend
Date: 05/06/20 Time: 11:13
Sample: 2011M01 2018M12
Included observations: 93

Conditional Error Correction Regression

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-103.4486	52.88447	-1.956125	0.0542
GDP(-1)	-0.402890	0.079629	-5.059562	0.0000
LNCOP(-1)	6.619917	3.509136	1.886480	0.0631
CORR	144.2872	59.07109	2.442603	0.0169
GOVE	-12922.70	4072.548	-3.173125	0.0022
LNCOP_GOVE_POS	864.1087	270.9084	3.189671	0.0021
LNCOP_GOVE_NEG(-1)	847.8636	269.3138	3.148237	0.0024
ACC(-1)	6.466204	59.24814	0.109138	0.9134
LNGFCF(-1)	-2.861923	0.979753	-2.921065	0.0046
LNCEX(-1)	2.018955	0.658822	3.064495	0.0030
D(LNCOP)	-95.46137	44.54007	-2.143269	0.0353
D(LNCOP(-1))	107.0828	47.05902	2.275501	0.0257
D(LNCOP_GOVE_NEG)	818.7226	265.4187	3.084646	0.0029
D(ACC)	-1582.709	323.9961	-4.884962	0.0000
D(LNGFCF)	30.33496	6.364141	4.766545	0.0000
D(LNCEX)	0.534981	0.289993	1.844808	0.0690
D(LNCEX(-1))	-1.437435	0.421497	-3.410309	0.0010
D(LNCEX(-2))	-0.459405	0.284041	-1.617393	0.1100

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

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APPENDIX E2
BOUND TEST LONG-RUN COEFFICIENTS FOR LNCOP_GOVE

Levels Equation
Case 2: Restricted Constant and No Trend

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNCOP	16.43106	9.110267	1.803576	0.0753
CORR	358.1303	147.1588	2.433631	0.0173
GOVE	-32074.99	10878.59	-2.948451	0.0043
LNCOP_GOVE_POS	2144.774	722.4635	2.968695	0.0040
LNCOP_GOVE_NEG	2104.452	719.7166	2.924002	0.0046
ACC	16.04954	148.6633	0.107959	0.9143
LNGFCF	-7.103478	2.488629	-2.854374	0.0056
LNCEX	5.011178	1.932034	2.593732	0.0114
C	-256.7662	140.7728	-1.823976	0.0721

EC = GDP - (16.4311*LNCOP + 358.1303*CORR -32074.9851*GOVE + 2144.7737*LNCOP_GOVE_POS + 2104.4524*LNCOP_GOVE_NEG + 16.0495*ACC -7.1035*LNGFCF + 5.0112*LNCEX -256.7662)

F-Bounds Test		Null Hypothesis: No levels relationship		
Test Statistic	Value	Signif.	I(0)	I(1)
			Asymptotic : n=1000	
F-statistic	4.868859	10%	1.85	2.85
k	8	5%	2.11	3.15
		2.5%	2.33	3.42
		1%	2.62	3.77
			Finite Sample:	
Actual Sample Size	93		n=80	
		10%	-1	-1
		5%	-1	-1
		1%	-1	-1

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APPENDIX E3

NARDL MODEL FOR LNCOP_GOVE (RSQUARED, ADJUSTED RSQUARE, AND DW TEST)

Dependent Variable: GDP
Method: ARDL
Date: 05/06/20 Time: 11:10
Sample (adjusted): 2011M04 2018M12
Included observations: 93 after adjustments
Maximum dependent lags: 2 (Automatic selection)
Model selection method: Akaike info criterion (AIC)
Dynamic regressors (4 lags, automatic): LNCOP CORR GOVE LNCOP_GOVE_POS LNCOP_GOVE_NEG ACC LNGFCF LNCEX
Fixed regressors: C
Number of models evaluated: 781250
Selected Model: ARDL(1, 2, 0, 0, 0, 1, 1, 1, 3)
Note: final equation sample is larger than selection sample

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
GDP(-1)	0.597110	0.079629	7.498599	0.0000
LNCOP	-95.46136	44.54007	-2.143269	0.0353
LNCOP(-1)	209.1641	90.69136	2.306329	0.0239
LNCOP(-2)	-107.0828	47.05902	-2.275501	0.0257
CORR	144.2872	59.07109	2.442603	0.0169
GOVE	-12922.70	4072.548	-3.173125	0.0022
LNCOP_GOVE_POS	864.1087	270.9084	3.189671	0.0021
LNCOP_GOVE_NEG	818.7226	265.4187	3.084646	0.0029
LNCOP_GOVE_NEG(-1)	29.14102	18.24363	1.597326	0.1144
ACC	-1582.709	323.9961	-4.884962	0.0000
ACC(-1)	1589.175	351.4209	4.522141	0.0000
LNGFCF	30.33496	6.364141	4.766545	0.0000
LNGFCF(-1)	-33.19689	6.694097	-4.959128	0.0000
LNCEX	0.534981	0.289993	1.844808	0.0690
LNCEX(-1)	0.046539	0.282925	0.164491	0.8698
LNCEX(-2)	0.978030	0.287623	3.400391	0.0011
LNCEX(-3)	0.459405	0.284041	1.617393	0.1100
C	-103.4486	52.88447	-1.956125	0.0542

R-squared	0.773465	Mean dependent var	0.661933
Adjusted R-squared	0.722117	S.D. dependent var	2.403925
S.E. of regression	1.267219	Akaike info criterion	3.483512
Sum squared resid	120.4383	Schwarz criterion	3.973692
Log likelihood	-143.9833	Hannan-Quinn criter.	3.681433
F-statistic	15.06323	Durbin-Watson stat	2.012432
Prob(F-statistic)	0.000000		

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

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APPENDIX E4

F-STATISTIC FOR LONG-RUN LNCOP_GOVE_POS

Wald Test:
Equation: NARDL01

Test Statistic	Value	df	Probability
F-statistic	39.27053	(2, 75)	0.0000
Chi-square	78.54107	2	0.0000

Null Hypothesis: C(1)=C(7)=0
Null Hypothesis Summary:

Normalized Restriction (= 0)	Value	Std. Err.
C(1)	0.597110	0.079629
C(7)	864.1087	270.9084

Restrictions are linear in coefficients.

APPENDIX E5

F-STATISTIC FOR LONG-RUN LNCOP_GOVE_NEG

Wald Test:
Equation: NARDL01

Test Statistic	Value	df	Probability
F-statistic	38.41936	(2, 75)	0.0000
Chi-square	76.83872	2	0.0000

Null Hypothesis: C(1)=C(8)=0
Null Hypothesis Summary:

Normalized Restriction (= 0)	Value	Std. Err.
C(1)	0.597110	0.079629
C(8)	818.7226	265.4187

Restrictions are linear in coefficients.

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APPENDIX E6

LONG-RUN ASYMMETRY TEST FOR LNCOP_GOVE

Wald Test:
Equation: NARDL01

Test Statistic	Value	df	Probability
t-statistic	-2.044936	75	0.0444
F-statistic	4.181765	(1, 75)	0.0444
Chi-square	4.181765	1	0.0409

Null Hypothesis: -C(7)/C(1)= -C(8)/C(1)
Null Hypothesis Summary:

Normalized Restriction (= 0)	Value	Std. Err.
-C(7)/C(1) + C(8)/C(1)	-76.00962	37.16968

Delta method computed using analytic derivatives.

APPENDIX E7

SHORT-RUN ASYMMETRY TEST FOR LNCOP_GOVE

Wald Test:
Equation: NARDL01

Test Statistic	Value	df	Probability
t-statistic	-2.229964	75	0.0287
F-statistic	4.972738	(1, 75)	0.0287
Chi-square	4.972738	1	0.0257

Null Hypothesis: -C(7)= -C(8)
Null Hypothesis Summary:

Normalized Restriction (= 0)	Value	Std. Err.
-C(7) + C(8)	-45.38608	20.35283

Restrictions are linear in coefficients.

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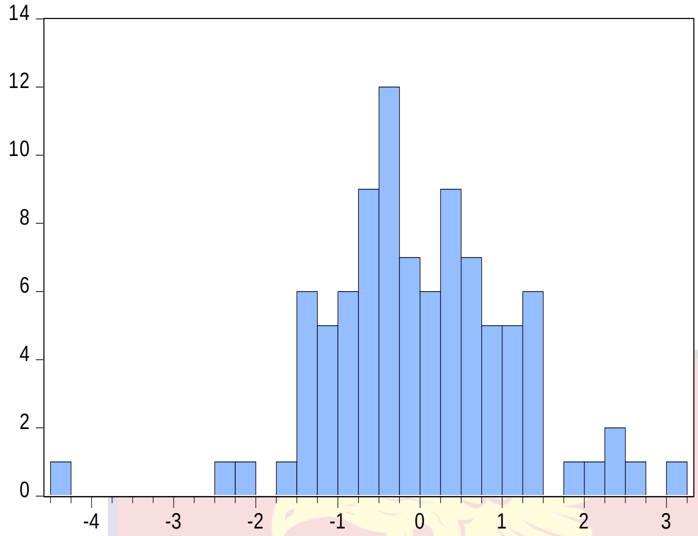
APPENDIX E8

NORMALITY TEST FOR LNCOP_GOVE



Series: Residuals
Sample 2011M04 2018M12
Observations 93

Mean	3.93e-14
Median	-0.049797
Maximum	3.120609
Minimum	-4.335493
Std. Dev.	1.144164
Skewness	-0.163441
Kurtosis	4.595295
Jarque-Bera	10.27579
Probability	0.005870

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APPENDIX E9

HETEROSKEDASTICITY TEST FOR LNCOP_GOVE

Heteroskedasticity Test: Breusch-Pagan-Godfrey

F-statistic	1.040594	Prob. F(17,75)	0.4268
Obs*R-squared	17.74925	Prob. Chi-Square(17)	0.4048
Scaled explained SS	20.75110	Prob. Chi-Square(17)	0.2376

Test Equation:
Dependent Variable: RESID^2
Method: Least Squares
Date: 05/06/20 Time: 11:25
Sample: 2011M04 2018M12
Included observations: 93

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-1.307215	102.6479	-0.012735	0.9899
GDP(-1)	0.216134	0.154560	1.398387	0.1661
LNCOP	64.50924	86.45158	0.746189	0.4579
LNCOP(-1)	-141.0030	176.0305	-0.801014	0.4257
LNCOP(-2)	74.73673	91.34081	0.818218	0.4158
CORR	132.8441	114.6560	1.158631	0.2503
GOVE	6670.088	7904.751	0.843807	0.4015
LNCOP_GOVE_POS	-448.8265	525.8289	-0.853560	0.3961
LNCOP_GOVE_NEG	-380.6459	515.1735	-0.738869	0.4623
LNCOP_GOVE_NEG(-1)	-52.74585	35.41060	-1.489550	0.1405
ACC	779.5381	628.8713	1.239583	0.2190
ACC(-1)	-704.1566	682.1024	-1.032333	0.3052
LNGFCF	-15.12443	12.35270	-1.224383	0.2246
LNGFCF(-1)	18.28749	12.99314	1.407473	0.1634
LNCEX	-0.620166	0.562872	-1.101788	0.2741
LNCEX(-1)	-1.004309	0.549153	-1.828834	0.0714
LNCEX(-2)	-0.396987	0.558271	-0.711100	0.4792
LNCEX(-3)	0.271407	0.551318	0.492287	0.6240

R-squared	0.190852	Mean dependent var	1.295035
Adjusted R-squared	0.007445	S.D. dependent var	2.468860
S.E. of regression	2.459652	Akaike info criterion	4.809902
Sum squared resid	453.7416	Schwarz criterion	5.300083
Log likelihood	-205.6605	Hannan-Quinn criter.	5.007823
F-statistic	1.040594	Durbin-Watson stat	2.125071
Prob(F-statistic)	0.426759		

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APPENDIX E10
RAMSEY TEST FOR LNCOP_GOVE

Ramsey RESET Test
Equation: NARDL01
Specification: GDP GDP(-1) LNCOP LNCOP(-1) LNCOP(-2) CORR GOVE LNCOP_GOVE_POS LNCOP_GOVE_NEG LNCOP_GOVE_NEG(-1) ACC ACC(-1) LNGFCF LNGFCF(-1) LNCEX LNCEX(-1) LNCEX(-2) LNCEX(-3) C
Omitted Variables: Squares of fitted values

	Value	df	Probability
t-statistic	0.708084	74	0.4811
F-statistic	0.501382	(1, 74)	0.4811

F-test summary:

	Sum of Sq.	df	Mean Squares
Test SSR	0.810530	1	0.810530
Restricted SSR	120.4383	75	1.605844
Unrestricted SSR	119.6278	74	1.616591

Unrestricted Test Equation:
Dependent Variable: GDP
Method: ARDL
Date: 05/06/20 Time: 11:24
Sample: 2011M04 2018M12
Included observations: 93
Maximum dependent lags: 2 (Automatic selection)
Model selection method: Akaike info criterion (AIC)
Dynamic regressors (4 lags, automatic):
Fixed regressors: C

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
GDP(-1)	0.598559	0.079922	7.489314	0.0000
LNCOP	-87.82542	45.97161	-1.910427	0.0600
LNCOP(-1)	197.3656	92.50737	2.133512	0.0362
LNCOP(-2)	-102.4562	47.66619	-2.149452	0.0349
CORR	177.5501	75.62725	2.347700	0.0216
GOVE	-13342.72	4128.983	-3.231478	0.0018
LNCOP_GOVE_POS	894.8530	275.2594	3.250944	0.0017
LNCOP_GOVE_NEG	845.8325	269.0435	3.143851	0.0024
LNCOP_GOVE_NEG(-1)	28.82460	18.31003	1.574252	0.1197
ACC	-1572.500	325.3980	-4.832543	0.0000
ACC(-1)	1519.812	365.9494	4.153067	0.0001
LNGFCF	30.04040	6.398939	4.694590	0.0000
LNGFCF(-1)	-33.05845	6.719306	-4.919921	0.0000
LNCEX	0.511789	0.292800	1.747917	0.0846

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LNCEX(-1)	0.004200	0.290099	0.014480	0.9885
LNCEX(-2)	0.961147	0.289567	3.319258	0.0014
LNCEX(-3)	0.447379	0.285495	1.567028	0.1214
C	-105.7051	53.15676	-1.988554	0.0504
FITTED^2	-0.025033	0.035353	-0.708084	0.4811

R-squared	0.774990	Mean dependent var	0.661933
Adjusted R-squared	0.720257	S.D. dependent var	2.403925
S.E. of regression	1.271452	Akaike info criterion	3.498265
Sum squared resid	119.6278	Schwarz criterion	4.015677
Log likelihood	-143.6693	Hannan-Quinn criter.	3.707181
F-statistic	14.15966	Durbin-Watson stat	2.014675
Prob(F-statistic)	0.000000		

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

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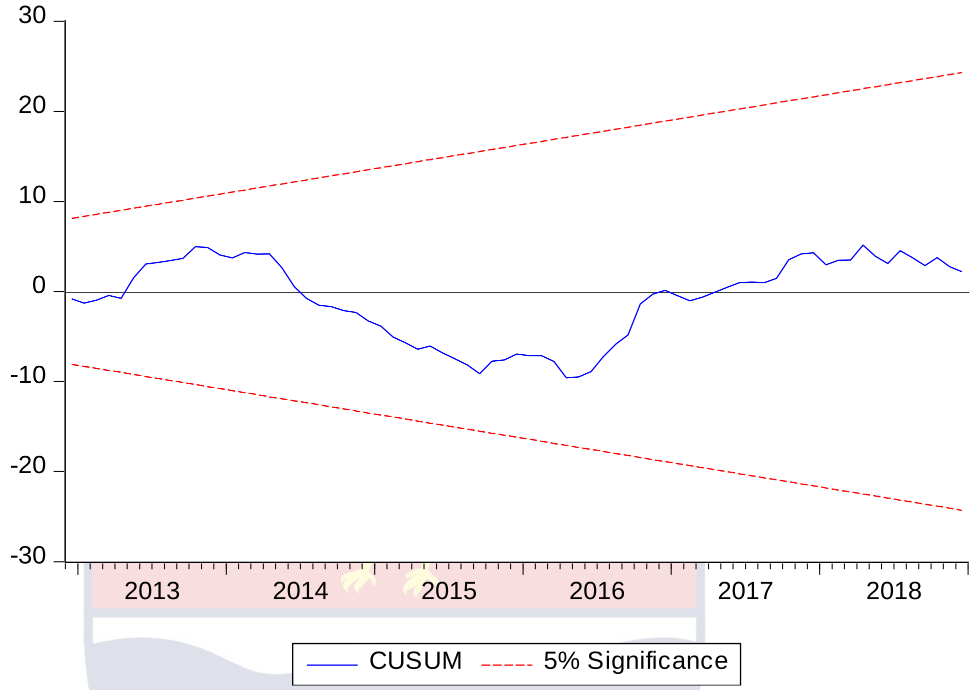
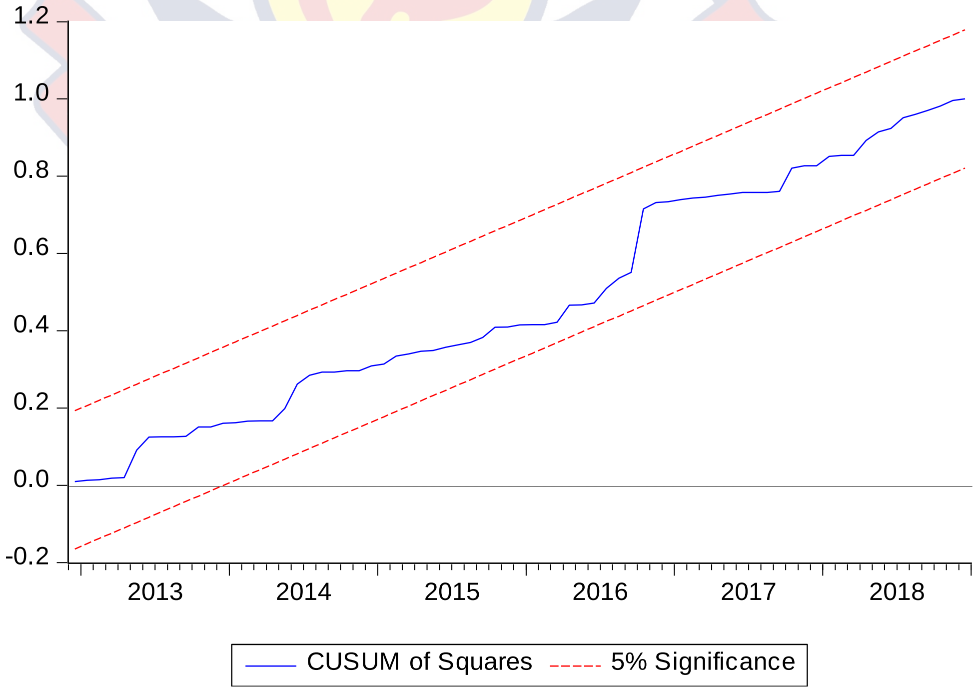
APPENDIX E11

STABILITY TEST FOR LNCOP_GOVE



PLOT 1



PLOT 2

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APPENDIX F
APPENDIX F1
NARDL COINTEGRATION FOR LNCOP_ACC

ARDL Long Run Form and Bounds Test
Dependent Variable: D(GDP)
Selected Model: ARDL(2, 4, 1, 4, 0, 0, 4, 3, 4, 4)
Case 2: Restricted Constant and No Trend
Date: 05/06/20 Time: 14:39
Sample: 2011M01 2018M12
Included observations: 91

Conditional Error Correction Regression

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-1669.463	324.6343	-5.142595	0.0000
GDP(-1)*	-0.743286	0.110905	-6.702012	0.0000
LNCOP(-1)	56.92065	12.03494	4.729617	0.0000
CORR(-1)	-172.0491	81.45150	-2.112289	0.0392
GOVE(-1)	-146.7046	59.95520	-2.446904	0.0176
ACC**	20777.34	3938.458	5.275501	0.0000
LNCOP_ACC_POS**	-1358.075	259.5710	-5.231998	0.0000
LNCOP_ACC_NEG(-1)	-1319.193	254.9096	-5.175140	0.0000
LNGFCF(-1)	-2.479541	1.245975	-1.990041	0.0516
LNCEX(-1)	3.197438	1.029448	3.105974	0.0030
LNREX(-1)	0.496578	1.773261	0.280037	0.7805
D(GDP(-1))	0.128812	0.110832	1.162237	0.2502
D(LNCOP)	-26.74303	61.18463	-0.437087	0.6638
D(LNCOP(-1))	-7.206429	114.4035	-0.062991	0.9500
D(LNCOP(-2))	2.976552	114.0974	0.026088	0.9793
D(LNCOP(-3))	111.0188	68.96885	1.609694	0.1132
D(CORR)	-763.1563	241.7985	-3.156167	0.0026
D(GOVE)	-31.68377	428.8967	-0.073873	0.9414
D(GOVE(-1))	-303.5046	725.4227	-0.418383	0.6773
D(GOVE(-2))	507.0428	713.0965	0.711044	0.4801
D(GOVE(-3))	-1189.466	444.0171	-2.678874	0.0097
D(LNCOP_ACC_NEG)	-1504.093	267.7554	-5.617413	0.0000
D(LNCOP_ACC_NEG(-1))	-78.00158	60.35820	-1.292311	0.2017
D(LNCOP_ACC_NEG(-2))	-147.1950	63.16651	-2.330270	0.0235
D(LNCOP_ACC_NEG(-3))	-168.0356	61.93637	-2.713036	0.0089
D(LNGFCF)	50.36804	14.15955	3.557179	0.0008
D(LNGFCF(-1))	-9.039061	17.54917	-0.515071	0.6086
D(LNGFCF(-2))	39.50337	13.49508	2.927242	0.0050
D(LNCEX)	0.809412	0.355694	2.275583	0.0268
D(LNCEX(-1))	-2.401982	0.701454	-3.424288	0.0012
D(LNCEX(-2))	-1.637694	0.565547	-2.895772	0.0054
D(LNCEX(-3))	-0.819584	0.355069	-2.308239	0.0248
D(LNREX)	0.144001	0.813163	0.177087	0.8601
D(LNREX(-1))	0.001450	1.206619	0.001202	0.9990
D(LNREX(-2))	1.204126	0.967568	1.244487	0.2186
D(LNREX(-3))	1.368439	0.744413	1.838280	0.0714

* p-value incompatible with t-Bounds distribution.

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**** Variable interpreted as Z = Z(-1) + D(Z).**

APPENDIX F2
BOUND TEST LONG-RUN COEFFICIENTS FOR LNCOP_ACC

Levels Equation
Case 2: Restricted Constant and No Trend

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNCOP	76.57979	18.04178	4.244582	0.0001
CORR	-231.4711	101.5020	-2.280459	0.0265
GOVE	-197.3732	75.64067	-2.609353	0.0117
ACC	27953.37	5722.064	4.885190	0.0000
LNCOP_ACC_POS	-1827.124	378.0462	-4.833072	0.0000
LNCOP_ACC_NEG	-1774.813	368.5476	-4.815696	0.0000
LNGFCF	-3.335920	1.695226	-1.967832	0.0541
LNCEX	4.301762	1.411875	3.046844	0.0035
LNREX	0.668085	2.396898	0.278729	0.7815
C	-2246.058	483.5625	-4.644815	0.0000

EC = GDP - (76.5798*LNCOP -231.4711*CORR -197.3732*GOVE + 27953.3729*ACC -1827.1242*LNCOP_ACC_POS -1774.8131 *LNCOP_ACC_NEG -3.3359*LNGFCF + 4.3018*LNCEX + 0.6681 *LNREX -2246.0582)

F-Bounds Test — Null Hypothesis: No levels relationship

Test Statistic	Value	Signif.	I(0)	I(1)
			Asymptotic: n=1000	
F-statistic	6.091846	10%	1.8	2.8
k	9	5%	2.04	2.08
		2.5%	2.24	3.35
		1%	2.5	3.68
			Finite Sample: n=80	
Actual Sample Size	91			
		10%	-1	-1
		5%	-1	-1
		1%	-1	-1

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APPENDIX F3

NARDL MODEL FOR LNCOP_ACC (RSQUARED, ADJUSTED RSQUARE, AND DW TEST)

Dependent Variable: GDP
Method: ARDL
Date: 05/06/20 Time: 14:36
Sample (adjusted): 2011M06 2018M12
Included observations: 91 after adjustments
Maximum dependent lags: 2 (Automatic selection)
Model selection method: Akaike info criterion (AIC)
Dynamic regressors (4 lags, automatic): LNCOP CORR GOVE ACC
LNCOP_ACC_POS LNCOP_ACC_NEG LNGFCF LNCEX LNREX
Fixed regressors: C
Number of models evalulated: 3906250
Selected Model: ARDL(2, 4, 1, 4, 0, 0, 4, 3, 4, 4)

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
GDP(-1)	0.385527	0.122984	3.134783	0.0028
GDP(-2)	-0.128812	0.110832	-1.162237	0.2502
LNCOP	-26.74303	61.18463	-0.437087	0.6638
LNCOP(-1)	76.45726	169.3038	0.451598	0.6533
LNCOP(-2)	10.18296	211.6266	0.048118	0.9618
LNCOP(-3)	108.0422	173.9432	0.621135	0.5371
LNCOP(-4)	-111.0188	68.96886	-1.609694	0.1132
CORR	-763.1563	241.7985	-3.156167	0.0026
CORR(-1)	591.1072	231.9239	2.548712	0.0136
GOVE	-31.68377	428.8967	-0.073873	0.9414
GOVE(-1)	-418.5255	1096.176	-0.381805	0.7041
GOVE(-2)	810.5475	1370.136	0.591582	0.5566
GOVE(-3)	-1696.509	1085.686	-1.562614	0.1239
GOVE(-4)	1189.466	444.0171	2.678874	0.0097
ACC	20777.34	3938.458	5.275502	0.0000
LNCOP_ACC_POS	-1358.075	259.5710	-5.231998	0.0000
LNCOP_ACC_NEG	-1504.093	267.7554	-5.617413	0.0000
LNCOP_ACC_NEG(-1)	106.8984	81.79696	1.306875	0.1967
LNCOP_ACC_NEG(-2)	-69.19342	91.86935	-0.753172	0.4546
LNCOP_ACC_NEG(-3)	-20.84058	92.45661	-0.225409	0.8225
LNCOP_ACC_NEG(-4)	168.0356	61.93637	2.713036	0.0089
LNGFCF	50.36804	14.15955	3.557179	0.0008
LNGFCF(-1)	-61.88665	30.05486	-2.059123	0.0442
LNGFCF(-2)	48.54243	28.93646	1.677552	0.0991
LNGFCF(-3)	-39.50337	13.49508	-2.927242	0.0050
LNCEX	0.809412	0.355694	2.275583	0.0268
LNCEX(-1)	-0.013956	0.337536	-0.041346	0.9672
LNCEX(-2)	0.764287	0.337140	2.266975	0.0273
LNCEX(-3)	0.818110	0.353262	2.315873	0.0243
LNCEX(-4)	0.819584	0.355069	2.308239	0.0248
LNREX	0.144001	0.813163	0.177087	0.8601
LNREX(-1)	0.354027	0.795427	0.445078	0.6580
LNREX(-2)	1.202676	0.818276	1.469769	0.1473
LNREX(-3)	0.164313	0.750617	0.218904	0.8275
LNREX(-4)	-1.368439	0.744413	-1.838280	0.0714
C	-1669.463	324.6343	-5.142595	0.0000

R-squared	0.854755	Mean dependent var	0.721270
Adjusted R-squared	0.762327	S.D. dependent var	2.396192
S.E. of regression	1.168186	Akaike info criterion	3.436463

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Sum squared resid	75.05616	Schwarz criterion	4.429770
Log likelihood	-120.3591	Hannan-Quinn criter.	3.837200
F-statistic	9.247742	Durbin-Watson stat	2.049083
Prob(F-statistic)	0.000000		

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

APPENDIX F4
F-STATISTIC FOR LONG-RUN LNCOP_ACC_POS

Wald Test:
Equation: NARDL02

Test Statistic	Value	df	Probability
F-statistic	21.21658	(3, 55)	0.0000
Chi-square	63.64975	3	0.0000

Null Hypothesis: C(1)=C(16)=C(17)=0
Null Hypothesis Summary:

Normalized Restriction (= 0)	Value	Std. Err.
C(1)	0.385527	0.122984
C(16)	-1358.075	259.5710
C(17)	-1504.093	267.7554

Restrictions are linear in coefficients.

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APPENDIX F5

F-STATISTIC FOR LONG-RUN LNCOP_ACC_NEG

Wald Test:
Equation: NARDL02

Test Statistic	Value	df	Probability
F-statistic	12.32840	(2, 55)	0.0000
Chi-square	24.65680	2	0.0000

Null Hypothesis: C(1)=C(21)=0
Null Hypothesis Summary:

Normalized Restriction (= 0)	Value	Std. Err.
C(1)	0.385527	0.122984
C(21)	168.0356	61.93637

Restrictions are linear in coefficients.

APPENDIX F6

LONG-RUN ASYMMETRY TEST FOR LNCOP_ACC

Wald Test:
Equation: NARDL02

Test Statistic	Value	df	Probability
t-statistic	2.402801	55	0.0197
F-statistic	5.773451	(1, 55)	0.0197
Chi-square	5.773451	1	0.0163

Null Hypothesis: C(16)/C(1)= C(17)/C(1)
Null Hypothesis Summary:

Normalized Restriction (= 0)	Value	Std. Err.
C(16)/C(1) - C(17)/C(1)	378.7488	157.6281

Delta method computed using analytic derivatives.

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APPENDIX F7

SHORT-RUN ASYMMETRY TEST FOR LNCOP_ACC

Wald Test:
Equation: NARDL02

Test Statistic	Value	df	Probability
t-statistic	3.682780	55	0.0005
F-statistic	13.56287	(1, 55)	0.0005
Chi-square	13.56287	1	0.0002

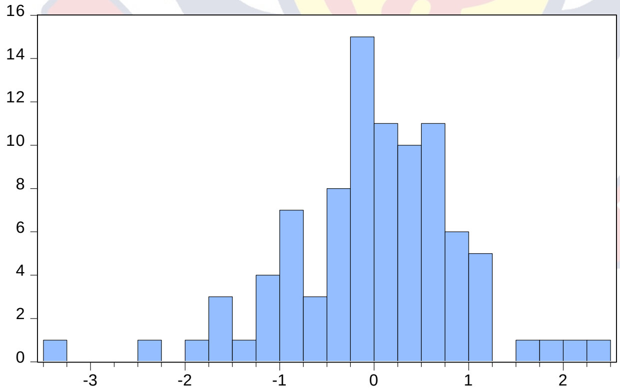
Null Hypothesis: C(16)= C(17)
Null Hypothesis Summary:

Normalized Restriction (= 0)	Value	Std. Err.
C(16) - C(17)	146.0179	39.64882

Restrictions are linear in coefficients.

APPENDIX F8

NORMALITY TEST FOR LNCOP_ACC



Series: Residuals	
Sample 2011M06 2018M12	
Observations 91	
Mean	1.15e-12
Median	0.022892
Maximum	2.323478
Minimum	-3.375542
Std. Dev.	0.913213
Skewness	-0.546242
Kurtosis	4.619789
Jarque-Bera	14.47370
Probability	0.000720

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APPENDIX F9

HETEROSKEDASTICITY TEST FOR LNCOP_ACC

Heteroskedasticity Test: Breusch-Pagan-Godfrey

F-statistic	0.594492	Prob. F(35,55)	0.9483
Obs*R-squared	24.97727	Prob. Chi-Square(35)	0.8952
Scaled explained SS	16.51356	Prob. Chi-Square(35)	0.9966

Test Equation:
Dependent Variable: RESID^2
Method: Least Squares
Date: 05/06/20 Time: 14:51
Sample: 2011M06 2018M12
Included observations: 91

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-327.3097	477.7872	-0.685053	0.4962
GDP(-1)	-0.101053	0.181004	-0.558292	0.5789
GDP(-2)	0.103235	0.163119	0.632883	0.5294
LNCOP	1.436066	90.04974	0.015947	0.9873
LNCOP(-1)	33.07091	249.1763	0.132721	0.8949
LNCOP(-2)	-29.47055	311.4658	-0.094619	0.9250
LNCOP(-3)	7.492206	256.0045	0.029266	0.9768
LNCOP(-4)	-0.862639	101.5063	-0.008498	0.9933
CORR	852.8406	355.8719	2.396482	0.0200
CORR(-1)	-751.5088	341.3388	-2.201651	0.0319
GOVE	-14.18040	631.2376	-0.022464	0.9822
GOVE(-1)	431.1997	1613.319	0.267275	0.7903
GOVE(-2)	-934.9694	2016.526	-0.463654	0.6447
GOVE(-3)	712.6410	1597.881	0.445991	0.6574
GOVE(-4)	-205.0374	653.4914	-0.313757	0.7549
ACC	3515.671	5796.506	0.606516	0.5467
LNCOP_ACC_POS	-243.1579	382.0290	-0.636491	0.5271
LNCOP_ACC_NEG	-163.7721	394.0746	-0.415587	0.6793
LNCOP_ACC_NEG(-1)	-125.2191	120.3864	-1.040143	0.3028
LNCOP_ACC_NEG(-2)	-7.721555	135.2106	-0.057108	0.9547
LNCOP_ACC_NEG(-3)	99.70047	136.0749	0.732688	0.4669
LNCOP_ACC_NEG(-4)	-8.602137	91.15613	-0.094367	0.9252
LNGFCF	-38.50414	20.83960	-1.847643	0.0700
LNGFCF(-1)	60.44304	44.23385	1.366443	0.1774
LNGFCF(-2)	-21.47744	42.58784	-0.504309	0.6161
LNGFCF(-3)	-0.510313	19.86166	-0.025693	0.9796
LNCEX	-1.031950	0.523501	-1.971248	0.0537
LNCEX(-1)	-0.397795	0.496776	-0.800754	0.4267
LNCEX(-2)	-0.205355	0.496192	-0.413862	0.6806
LNCEX(-3)	0.158779	0.519921	0.305391	0.7612
LNCEX(-4)	0.232141	0.522580	0.444220	0.6586
LNREX	2.142901	1.196789	1.790542	0.0789
LNREX(-1)	0.689723	1.170685	0.589162	0.5582
LNREX(-2)	-0.513699	1.204314	-0.426549	0.6714
LNREX(-3)	0.782039	1.104737	0.707896	0.4820
LNREX(-4)	0.092055	1.095605	0.084022	0.9333

R-squared	0.274475	Mean dependent var	0.824793
Adjusted R-squared	-0.187222	S.D. dependent var	1.577924

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S.E. of regression	1.719301	Akaike info criterion	4.209395
Sum squared resid	162.5798	Schwarz criterion	5.202702
Log likelihood	-155.5275	Hannan-Quinn criter.	4.610133
F-statistic	0.594492	Durbin-Watson stat	2.125879
Prob(F-statistic)	0.948257		

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APPENDIX F10
RAMSEY TEST FOR LNCOP_ACC

Ramsey RESET Test
Equation: NARDL02
Specification: GDP GDP(-1) GDP(-2) LNCOP LNCOP(-1) LNCOP(-2) LNCOP(-3) LNCOP(-4) CORR CORR(-1) GOVE GOVE(-1) GOVE(-2) GOVE(-3) GOVE(-4) ACC LNCOP_ACC_POS LNCOP_ACC_NEG LNCOP_ACC_NEG(-1) LNCOP_ACC_NEG(-2) LNCOP_ACC_NEG(-3) LNCOP_ACC_NEG(-4) LNGFCF LNGFCF(-1) LNGFCF(-2) LNGFCF(-3) LNCEX LNCEX(-1) LNCEX(-2) LNCEX(-3) LNCEX(-4) LNREX LNREX(-1) LNREX(-2) LNREX(-3) LNREX(-4) C
Omitted Variables: Squares of fitted values

	Value	df	Probability
t-statistic	1.031874	54	0.3067
F-statistic	1.064765	(1, 54)	0.3067

F-test summary:

	Sum of Sq.	df	Mean Squares
Test SSR	1.451330	1	1.451330
Restricted SSR	75.05616	55	1.364657
Unrestricted SSR	73.60483	54	1.363052

Unrestricted Test Equation:
Dependent Variable: GDP
Method: ARDL
Date: 05/06/20 Time: 14:52
Sample: 2011M06 2018M12
Included observations: 91
Maximum dependent lags: 2 (Automatic selection)
Model selection method: Akaike info criterion (AIC)
Dynamic regressors (4 lags, automatic):
Fixed regressors: C

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
GDP(-1)	0.400335	0.123746	3.235130	0.0021
GDP(-2)	-0.152357	0.113092	-1.347196	0.1835
LNCOP	-20.88497	61.41161	-0.340082	0.7351
LNCOP(-1)	61.14838	169.8534	0.360007	0.7202
LNCOP(-2)	13.95302	211.5337	0.065961	0.9477
LNCOP(-3)	111.9649	173.8824	0.643912	0.5224
LNCOP(-4)	-111.5743	68.93039	-1.618652	0.1113
CORR	-793.1667	243.4000	-3.258696	0.0019
CORR(-1)	613.1437	232.7692	2.634127	0.0110
GOVE	-124.9280	438.0658	-0.285181	0.7766
GOVE(-1)	-235.8828	1109.737	-0.212557	0.8325
GOVE(-2)	783.1833	1369.587	0.571839	0.5698
GOVE(-3)	-1812.201	1090.825	-1.661312	0.1024
GOVE(-4)	1238.757	446.3196	2.775493	0.0076
ACC	19975.75	4012.065	4.978919	0.0000
LNCOP_ACC_POS	-1305.899	264.3003	-4.940966	0.0000
LNCOP_ACC_NEG	-1458.176	271.2725	-5.375318	0.0000
LNCOP_ACC_NEG(-1)	137.2994	86.89579	1.580046	0.1199
LNCOP_ACC_NEG(-2)	-97.53983	95.83682	-1.017770	0.3133
LNCOP_ACC_NEG(-3)	-7.958386	93.24177	-0.085352	0.9323

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LNCOP_ACC_NEG(-4)	167.2521	61.90459	2.701772	0.0092
LNGFCF	49.40127	14.18220	3.483330	0.0010
LNGFCF(-1)	-61.06964	30.04761	-2.032429	0.0470
LNGFCF(-2)	47.96552	28.92485	1.658281	0.1031
LNGFCF(-3)	-38.69379	13.50994	-2.864097	0.0059
LNCEX	0.801751	0.355563	2.254879	0.0282
LNCEX(-1)	-0.002055	0.337535	-0.006089	0.9952
LNCEX(-2)	0.747462	0.337336	2.215780	0.0309
LNCEX(-3)	0.788453	0.354222	2.225871	0.0302
LNCEX(-4)	0.805918	0.355107	2.269504	0.0273
LNREX	0.296344	0.825986	0.358776	0.7212
LNREX(-1)	0.346161	0.794995	0.435425	0.6650
LNREX(-2)	1.277815	0.821030	1.556356	0.1255
LNREX(-3)	0.234564	0.753259	0.311400	0.7567
LNREX(-4)	-1.222886	0.757229	-1.614948	0.1122
C	-1606.602	330.1130	-4.866825	0.0000
FITTED^2	0.036222	0.035103	1.031874	0.3067

R-squared	0.857564	Mean dependent var	0.721270
Adjusted R-squared	0.762606	S.D. dependent var	2.396192
S.E. of regression	1.167498	Akaike info criterion	3.438915
Sum squared resid	73.60483	Schwarz criterion	4.459814
Log likelihood	-119.4706	Hannan-Quinn criter.	3.850784
F-statistic	9.031024	Durbin-Watson stat	2.115825
Prob(F-statistic)	0.000000		

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

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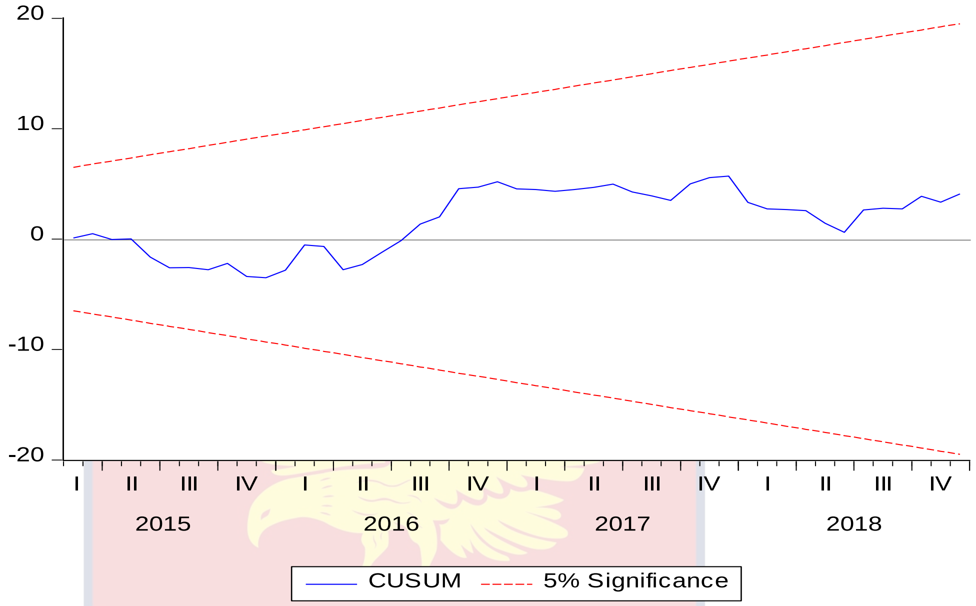
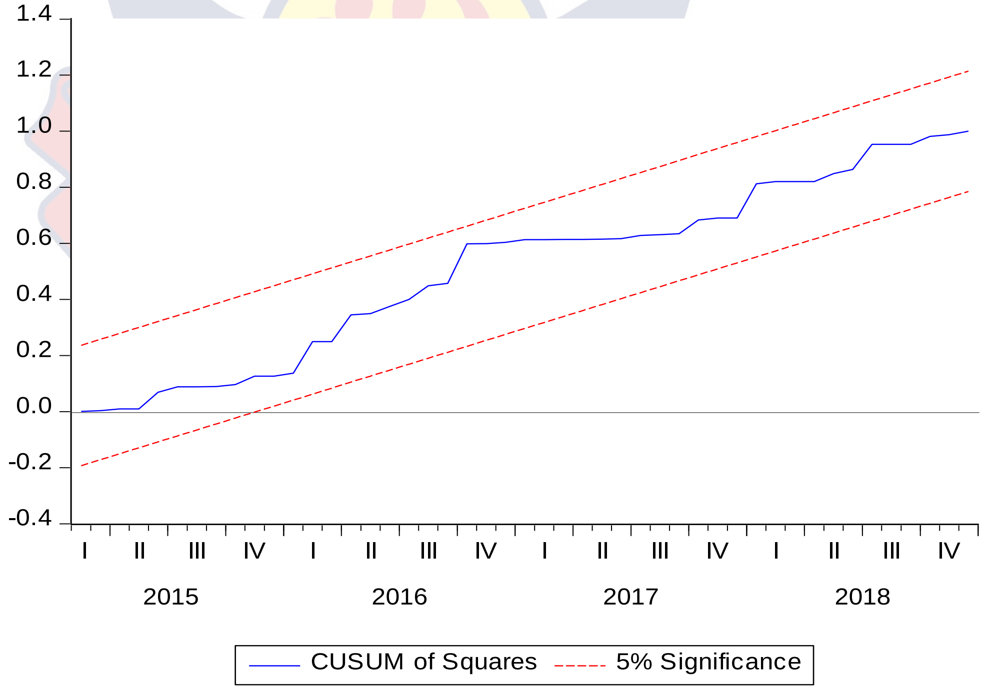
APPENDIX F11

STABILITY TEST FOR LNCOP_ACC



PLOT 1



PLOT 2

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APPENDIX H1

Long-run net effect for a positive shock in capital accumulation

$$GDP = -968.8221(lnCOP) - 637.7732(lnGFCF) + 43.7252(lnCOP * lnGFCF)$$

$$\frac{dGDP}{dlnCOP} = -968.8221 + 43.7252(lnGFCF)$$

$= -968.8221 + 43.7252(21.6614)$

$= -968.8221 + 947.1490473$

$= -21.67305272$

$= -{}^{21.673}/_{100}$

$= -0.2167$

Test of significance for the interaction

$H_0: lnCOP * lnGFCF = 0$

$prob. > F = 0.0021$

Long-run net effect for a negative shock in capital accumulation

$$GDP = -968.8221(lnCOP) - 637.7732(lnGFCF) + 40.6815(lnCOP * lnGFCF)$$

$$\frac{dGDP}{dlnCOP} = -968.8221 + 40.6815(lnGFCF)$$

$= -968.8221 + 40.6815(21.6614)$

$= -968.8221 + 881.2182441$

$= -87.6038559$

$= -{}^{87.604}/_{100}$

$= -0.8760$

Short-run net effect for a positive shock in capital accumulation

$$GDP = -2665.751(lnCOP) - 1689.139(lnGFCF) + 118.9616(lnCOP * lnGFCF)$$

$$\frac{dGDP}{dlnCOP} = -2665.751 + 118.9616(lnGFCF)$$

$= -2665.751 + 118.9616(21.6614)$

$= -2665.751 + 2576.874802$

$= -88.87619776$

$= -{}^{88.876}/_{100}$

$= -0.8888$

Short-run net effect for a negative shock in capital accumulation

$$GDP = -2665.751(lnCOP) - 1689.139(lnGFCF) + 116.3706(lnCOP * lnGFCF)$$

$$\frac{dGDP}{dlnCOP} = -2665.751 + 116.3706(lnGFCF)$$

$= -2665.751 + 116.3706(21.6614)$

$= -2665.751 + 2520.750115$

$= -145.0008852$

$= -{}^{145.001}/_{100}$

$= -1.45$

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APPENDIX H2

Long-run net effect for a positive shock in control of corruption

$$GDP = -56.15279(lnCOP) + 34246.3667(CORR) - 2239.385(lnCOP * CORR)$$

$$\frac{dGDP}{dlnCOP} = -56.15279 - 2239.385(CORR)$$

$= -56.15279 - 2239.385(-0.0117)$

$= -56.15279 + 26.2008045$

$= -29.9519855$

$= -{}^{29.952}/_{100}$

$= -0.2995$

Long-run net effect for a negative shock in control of corruption

$$GDP = -56.15279(lnCOP) + 34246.3667(CORR) - 2273.6068(lnCOP * CORR)$$

$$\frac{dGDP}{dlnCOP} = -56.15279 - 2273.6068(CORR)$$

$= -56.15279 - 2273.6068(-0.0117)$

$= -56.15279 + 26.60119956$

$= -29.55159044$

$= -{}^{29.552}/_{100}$

$= -0.2955$

Short-run net effect for a positive shock in control of corruption

$$GDP = -157.2434(lnCOP) - 1329.521(lnCOP * CORR)$$

$$\frac{dGDP}{dlnCOP} = -157.2434 - 1329.521(CORR)$$

$= -157.2434 - 1329.521(-0.0117)$

$= -157.2434 + 15.5553957$

$= -141.6880043$

$= -{}^{141.688}/_{100}$

$= -1.41688$

APPENDIX H3

Long-run net effect for a positive shock in government effectiveness

$$GDP = 16.43106(lnCOP) - 32074.99(GOVE) + 2144.774(lnCOP * GOVE)$$

$$\frac{dGDP}{dlnCOP} = 16.43106 + 2144.774(GOVE)$$

$= 16.43106 + 2144.774(-0.0124)$

$= 16.43106 - 26.5951976$

$= -10.1641376$

$= -{}^{10.164}/_{100}$

$= -0.1016$

Long-run net effect for a negative shock in government effectiveness

$$GDP = 16.43106(lnCOP) - 32074.99(GOVE) + 2104.452(lnCOP * GOVE)$$

$$\frac{dGDP}{dlnCOP} = 16.43106 + 2104.4452(GOVE)$$

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$= 16.43106 + 2104.4452(-0.0124)$
$= 16.43106 - 26.0952048$
$= -9.6641448$
$= -{}^{9.664}/_{100}$
$= -0.0966$

Short-run net effect for a negative shock in government effectiveness

$GDP = -95.46137(lnCOP) + 818.7226(lnCOP * GOVE)$

$\frac{dGDP}{dlnCOP} = -95.46137 + 818.7226(GOVE)$

$= -95.46137 + 818.7226(-0.0124)$
$= -95.46137 - 10.15216024$
$= -105.6135302$
$= -{}^{105.614}/_{100}$
$= -1.0561$

APPENDIX H4

Long-run net effect for a positive shock in voice and accountability

$GDP = 76.57979(lnCOP) + 27953.3729(ACC) - 1827.124(lnCOP * ACC)$

$\frac{dGDP}{dlnCOP} = 76.57979 - 1827.124(ACC)$

$= 76.57979 - 1827.124(0.04237)$
$= 76.57979 - 77.41524388$
$= -0.83545388$
$= -{}^{0.8355}/_{100}$
$= -0.0084$

Long-run net effect for a negative shock in voice and accountability

$GDP = 76.57979(lnCOP) + 27953.3729(ACC) - 1774.813(lnCOP * ACC)$

$\frac{dGDP}{dlnCOP} = 76.57979 - 1774.813(ACC)$

$= 76.57979 - 1774.813(0.04237)$
$= 76.57979 - 75.19882681$
$= -1.38096319$
$= -{}^{1.381}/_{100}$
$= -0.0138$

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