UNIVERSITY OF GHANA

EFFECTS OF PUBLIC DEBT ON ECONOMIC GROWTH IN GHANA: EVIDENCE FROM AN OPTIMAL THRESHOLD ANALYSIS

BY

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DECLARATION

I, RANDY DONKOR, hereby declare that this thesis was put together by me and has not been submitted in portion or in whole to any accredited university for an academic award. All relevant literature in the past or present have been accordingly accredited.

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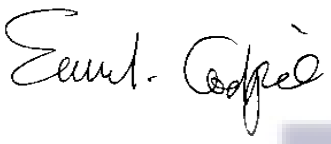
CERTIFICATION

We hereby endorse that this thesis was supervised in harmony with standard procedures outlined by the university and the department of economics.



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DEDICATION

I dedicate this thesis to God for the knowledge bestowed in me. Also, to my family and friends, I dedicate this work to you.

ACKNOWLEDGEMENT

To God be the glory, for His grace and guidance has been sufficient throughout this research. I asked for knowledge and understanding on issues pertaining to this research, and the Lord answered.

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LIST OF ABBREVIATIONS

ADF – Augmented Dickey-Fuller

ARDL – Autoregression Distributed Lag model

CUSUM- Cumulative Sums

CUSUMQ - Cumulative Sum of Squares

ECM - Error Correction Model

GDP - Gross Domestic Product

HIPC - Highly Indebted Poor Country

IMF - International Monetary Fund

LRT- Likelihood Ratio Test

OECD - Organisation for Economic Co-operation and Development

OLS - Ordinary Least Squares

P-P - Phillips Perron

WB - World Bank

WDI - World Development Indicators

WEO - World Economic Outlook

MOF – Ministry of Finance

MOBD – Ministry of Business Development

MOP – Ministry of Planning

MOT – Ministry of Trade

ABSTRACT

This study aims to estimate a prudent level of debt-to-GDP ratio that characterizes sustainable medium-to long-term economic growth in Ghana. To this effect, the relationship between public debt and economic growth was analysed predicated on the rising literature of a debt Laffer-curve effect on economic growth. This effect is deemed to be non-linear in the sense that increases in public debt come with positive effects on economic growth, but only up to a certain threshold. Once this threshold is reached, the positive effects turn into negative effects, which can be daunting on economic growth. This study applied a non-linear term in an Autoregressive Distributed Lag (ARDL) framework to data spanning 1965 to 2018. Similar to other studies, the study found an inverted U-shaped relationship between public debt and economic growth in Ghana. This implied a non-monotonic effect of public debt on economic growth in Ghana. In addition, it was discovered that the optimal debt-to-GDP ratio beyond which public debt is not deemed prudent for sustainable medium-long run growth is 52.4 percent. By and large, the crossover of Ghana's current public debt ratio above the estimated 52.4 percent does not bode well for long-term growth. Per this study, a debt-to-GDP ratio of less than 52.4 percent should be the policy anchor for public debt management to ensure economic growth.

CHAPTER ONE

INTRODUCTION

1.1 Background

Public debt is a financial obligation of a country's central government. It has been a significant source of financing for economic growth and development in developing economies (Ouedraogo, 2015). Neoclassical growth models justify government borrowing for capital-scarce countries in order to boost capital accumulation and output *per capita*. In the 1970s and 1980s, there was a global debt crisis, largely as a result of subpar debt management practices adopted by low- and middle-income economies (IMF, 2022). During this period, a floating United States of America (USA) dollar currency that allowed oil to be traded created problems for many developing countries. As a result of the oil shocks of 1973 and 1979, when oil prices increased tremendously, oil exporters had enough dollar reserves to deposit in western commercial banks (IMF, 2022). These reserves, as it were, became 'petrodollars'. These banks loaned the reserves to oil-importing and developing countries at low nominal and real interest rates, making the cost of borrowing low. Following the USA's stagflation and upward sloping Philip's curve problem in the late 1970s, the Federal Reserve Bank (Fed) sharply increased interest rates to combat inflation. However, unemployment was still on the rise (eventually leading to a recession), and the cost of borrowing for developing countries became higher due to the interest rate hikes. It is estimated that the higher interest rates cost these developing countries not less than $22 billion from 1978 to 1981 (IMF, 2022). In addition, commodity prices from developing countries slumped due to the recession brought forth by the Fed's contractionary monetary policy. As a solution to these shocks, many developing countries adopted expansionary fiscal policies and revalued their currencies, sustained

by colossal loans. In 1982, the failure of Mexico to service its debt obligations to commercial banks in the USA and other creditors led to the debt crisis (IMF, 2022).

The utilization of short-term loans to finance long-term projects is what caused this debt problem. (Marquez, 2000). This implies that short-term obligations could not be met on time. Likewise, these countries further rolled over the huge debts accumulated through large balance of payment deficits in the early 1970s oil shocks (Stambuli, 1998). The gross domestic product (GDP), a measure of economic growth, was falling, and developing nations were looking for sustainable growth alternatives. To address these by-products of the debt crisis, most developing countries took out more loans since they were driven by the need to increase expenditure and prevent low capital inflows (Greenidge *et al*., 2012). For most African countries, it was an avenue to engage with the Euromarket for the first time to borrow more and finance expenditure (Krumm, 1985). Against the backdrop of Keynesian economics, it is widely accepted that governments can run deficits in order to execute projects and policies they deem necessary. Thus, although it is believed the optimal decision for government spending is to rely on nationally generated revenues from taxes, borrowing from the public to bridge the gap between tax revenues and expenditures is not uncommon (African Development Bank, 2018). According to the Caribbean Development Bank (2013), developing countries with poor tax systems (leading to shortages in tax revenues) and low incomes can consider borrowing as an appropriate means of budget financing. Public debt therefore plays a vital role for developing countries.

Several African nations, including Ghana, became heavily indebted during the debt crises of the 1970s and 1980s. This made it challenging to pay back loans. Then, a further debt crisis for most African countries emerged in the 1960s. High African debt throughout the 1970s and early 1980s, according to Yagc *et al*. (1985), caused debt to rise from $140 billion at the start of the crisis in 1982 to at least $270 billion in 1990. Historically, Ghana's economy has mostly experienced increasing public debt, eventually causing some economic challenges. These challenges included high inflation levels and a rapid depreciation of the exchange rate (Adi, 2019). This has lurched Ghana into further unsustainable debt levels since the dependence on foreign financial support was necessary for economic revamping. The highest debt-to-GDP ratio in Ghana stood at 112 percent of GDP in 2000 (Adi, 2019; IMF, 2022). That was an increase of 94 percentage points from the 1970s' average debt-to-GDP ratio of 18 percent (IMF, 2022).

Nevertheless, Ghana's debt stock started to decline with its participation in the World Bank's HIPC Initiative in 2001. Following the conclusion of this initiative in 2006, the nation's debt stock was $780 million, reaching the lowest debt-to-GDP ratio of 25% in the previous 20 years (Adi, 2019; IMF, 2022). Recently, concerns about a potential debt crisis in Africa, including Ghana, have been raised. The World Bank (2019) reports that since the HIPC project, the rate of debt growth in sub-Saharan Africa has accelerated. Sub-Saharan Africa's average sovereign debt-to-GDP ratio climbed from 37 percent in 2012 to 57 percent in 2017 (World Bank, 2019), an increase of 20 percentage points. While other emerging nations in Africa had an average debt-to-GDP ratio of 60 percent, Ghana's debt stock increased once again, reaching the present level of nearly 84 percent of GDP (IMF, 2022).

With the debt problems re-emerging in developing countries after HIPC, concerns about whether public debt might be hitting threshold levels detrimental to economic growth began to surface. Studies on the topic of the non-linear or threshold impacts of debt on economic growth were subsequently conducted as a result. Kaminsky *et al*. (1996), Elbadawi *et al*. (1997), and Deshpande (1997) are a few examples of these early investigations. The global financial crisis of 2008 stretched the threshold campaign to wealthy nations as well. Examples of these studies include those by Reinhart and Rogoff (2010), Cecchetti *et al*. (2011), Pescatori *et al*. (2014), Aschauer (2000), and Checherita-Westphal *et al*. (2012). More discussion about the public debt ceiling and its effects on economic growth was sparked as a result. Instead of using the conventional linear methods of the impact of public debt on growth regression analysis, many have chosen to further explore the relationship between debt and growth using non-linear threshold estimate methodologies (Cai, 2017). In general, the body of literature provides a jumble of information about public debt ceilings and their effects on economic growth in emerging nations.

For instance, Pattillo *et al*. (2011) estimated a threshold between 35 percent and 40 percent of GDP, but Elbadawi *et al*. (1997) reported a public debt threshold around 97 percent of GDP. Similarly, Chudik *et al*. (2017) calculated a debt threshold of 30 percent to 60 percent of GDP, whereas Cordella *et al*. (2005) estimated a debt threshold in the range of 10 percent to 35 percent of GDP. It is obvious that the various samples, modeling options, and coverage areas resulted in various estimations (Egert, 2015b). Elbadawi *et al*. (1997) used a quadratic equation in their research to find a potential U-shaped association between public debt and growth. While Chudik

et al. (2017) employed a panel threshold Autoregressive Distributed Lag (ARDL) model, Pattillo *et al*. (2011) also used quadratic and spline models under fixed effects and system generalized method of moments (GMM). There isn't much research on the debt ceiling in Africa (Ndoricimpa, 2020), and any on Ghana is difficult to come by. The non-linearity of the debt-growth nexus was recently corroborated by Koffi (2019) and Ndoricimpa (2020) in their studies, which they further investigated to determine the thresholds for sub-Saharan Africa and African countries, respectively. In light of recent warnings from the World Bank and IMF, it is critical that policymakers in Ghana are aware of the precise relationship between debt and growth as well as the level of public debt over which growth is compromised. This has the potential to increase public trust, investor confidence, and financial restraint.

1.2 Statement of the Problem

Debt is a two-edged sword (Cecchetti *et al*., 2011). This means debt has the potential to improve wellbeing when used profitably, but could be harmful when used irresponsibly. In a booming economy, issuing debt could expedite investment and consumption and eventually boost economic growth. Increases in government borrowing during recessions can also help the economy by maintaining income and consumption levels. Nevertheless, excessive borrowing in a shrinking economy could reduce the government's credibility and ratings with the international community. The need for deficit financing mostly directs the government into more debt, and it is only a matter of what debt-to-GDP tipping point is required to cause an economic downturn.

Numerous researchers have investigated the connection between governmental debt and economic growth. There are two types of conclusions regarding how public debt affects economic growth: a linear influence and a threshold or non-linear effect (Salmon, 2021). The optimal quantity of public debt that can support economic growth has been a topic of discussion among economists recently. Recent publications using the non-linear technique are based on the ideal threshold influence on growth, whereas those that use the linear form of analysis are interested in the "sign effect" role of debt in emerging nations (Kai, 2017). Since the goal is to just determine whether there is a positive or negative link between debt and growth, the sign effect function is silent on any threshold determination. For instance, Ghourchian *et al*. (2020) examined how national debt affected economic development across 83 economies from 1960 to 2014. They discovered that a 1 percentage point increase in the debt-to-GDP ratio results in a 0.01 percentage point reduction in economic growth as measured by real GDP growth. The threshold level that should be sought when deviating a percentage point from it is not mentioned in this finding. As opposed to this, Alshammary *et al*. (2020) investigated whether there is a non-linear debt-to-GDP threshold that is favorable to economic growth for 20 Middle Eastern and North African countries over the period 1990–2016 and discovered that debt has a positive impact on the economy (GDP growth) when it is not higher than 58 percent debt-to-GDP. When the debt rises above this point, the growth effect, however, becomes undesirable.

According to the literature, it is still unclear how exactly public debt affects short-, medium-, and long-term growth (Panizza & Presbitero, 2013; Arabi *et al*., 2018). The growth effects of public debt buildup in the context of the linear and threshold forms previously mentioned have been a topic of long-standing discussion among economists. A section of the literature that used the

threshold form shows that once debt-to-GDP ratios reach a certain point, growth is negatively impacted. Salmon (2021) did a thorough review of the literature from 2010 to 2020 on the relationship between public debt levels (denoted as a percentage of GDP) and economic development in order to better understand the argument between the linear and threshold methods. Salmon (2021) also looked at the claim that there is a nonlinear debt threshold above which public debt negatively affects economic growth. High amounts of public debt were found to have a detrimental effect on economic expansion. Salmon (2021) states explicitly that "the empirical evidence for a nonlinear debt growth threshold suggests that, while such thresholds might exist, there may not be a common threshold level, and they may be largely dependent upon other factors, such as a country's level of development and the quality of its institutions."

Numerous studies have examined the impact of threshold debt on growth, including those by Aschauer (2000), Kumar and Woo (2010), Reinhart and Rogoff (2010), Presbitero (2010), Pattillo *et al*. (2011), Cecchetti *et al*. (2012), Checherita-Westphal *et al*. (2012), Mercinger *et al*. (2014), Baglan and Yoldas (2016), Brida *et al*. (2017), Ahlborn and Schweickert (2018), Koffi (2019), Mensah *et al*. (2019), Caner *et al*. (2019), Bhimjee and Leão (2020), Alshammary *et al*. (2020), Pham *et al*. (2020), Sanusi *et al*. (2019), and Ndoricimpa (2020). In each of these studies, a strong non-linear causal relationship between public debt and economic growth was found, for which threshold estimates are feasible.

However, no substantial threshold non-linear causal association between public debt and economic growth is found in research by Baglan and Yoldas (2013), Eberhardt and Presbitero (2013), and

Pescatori *et al*. (2014) for which threshold calculations are attainable. They can therefore be seen as belonging to the group of researchers who use the linear connection technique. Calderón *et al*. (2013), Zouhaier *et al*. (2014), Anning *et al*. (2016), Siddique *et al*. (2016), Snieska *et al*. (2018), Lim (2019), Abubakar *et al*. (2020), Asteriou *et al*. (2020), and Pegkas *et al*. (2020) are a few of the researchers who fall under this category. These results are all restricted to the linear debt-growth "sign" effects.

The majority of the research on Ghana's public debt's effect on growth has used a linear style of analysis. In the research analyzing the debt-growth nexus, "signs" and marginal effects of public debt on economic growth in Ghana are therefore frequently found. Studies on the threshold effect point beyond which the incurrence of debt hinders economic growth in Ghana are now hard to come by. Similar to how the literature is divided on a suitable threshold level to serve as a country's compass, policymakers in Ghana are divided on what such a threshold ought to be. Nevertheless, there is research on estimating the public debt threshold, some of which concentrates on Africa. Sanusi *et al*. (2019), Koffi *et al*. (2019), Mensah *et al*. (2019), and Ndoricimpa (2020) are a few of the studies on Africa that have all utilized a panel estimation strategy as their econometric techniques. It should be emphasized that, regardless of the differences or similarities among the countries, there is not one threshold that applies to all of them. Their findings support the contention that the public debt threshold is sensitive to nation-specific data, country differences, and the models employed, in line with Egert (2015b), Ndoricimpa (2020), and Bentour (2020). This is also partly due to Africa's lack of convergence in growth. This study finds it necessary to specifically evaluate and estimate the threshold level of public debt in Ghana in response to the suggestion by Salmon (2021) and Adi (2019) that additional research should be done to more

thoroughly evaluate country-specific threshold dynamics. Mupunga *et al*. (2015) and Omotosho *et al*. (2016) for Zimbabwe and Nigeria, respectively, are two similar country-specific studies in Africa.

1.3 Research Objectives

The major goal of this study is to determine the ideal debt-to-GDP ratio for Ghana in order to characterize sustained medium- to long-term economic growth. With an Auto-Regressive Distribution Lag (ARDL) Model, this study aims to:

1. Investigate the existence of a non-linear relationship between public debt and economic growth in Ghana.

2. Estimate, using the ARDL Model's quadratic technique, the debt-to-GDP threshold ratio above which economic growth may be inhibited.

1.4 Research Questions

1. Has Ghana's economic growth since 1965 shown a non-linear link between state debt and it?

2. What is the maximum amount of debt the Ghanaian economy should be able to support?

1.5 Justification of the Study

Ghana's policy goal of increasing and sustaining economic growth over the years has resulted in yearly deficit accumulations. In effect, borrowing has been a key source of financing government policies. Internal and external sources of borrowing constitute the debt stock in Ghana. Intergenerational equity creates the possibility of future generations benefiting in terms of living standards when the government incurs debt now (Gruber, 2009). Although these debts can help governments achieve development to some extent, the literature also suggests that excessive spending and long-term, unsustainable debts can dampen economic growth. This sustainable debt could have a specific debt threshold. After HIPC started in 2001, debt over the next five years increased by 65 percent, the primary school graduation rate increased by around 50 percent, and GDP increased by over 30 percent (Jones, 2016). All these manifested due to prior expenditures and debt accumulation.

The re-emergence of challenges prior to the HIPC economic conditions, coupled with competition from the international market, increased Ghana's debt at a steady rate after 2001 (Jones, 2016). The purpose of this increase in debt was to fund spending for economic growth. Ghana has since 2001 averaged 6 percent GDP growth until 2018 (IMF, 2022). Well-known international credit rating agencies like the IMF, Fitch, and Moody's have touted Ghana's 78 percent debt-to-GDP ratio in the first quarter of 2022 as unsustainable, thereby causing a downgrade of the economy and investor panic. Furthermore, Ghana faces a high probability of debt distress, according to the IMF (2020). Recent IMF (2022) reports on Ghana's debt-to-GDP give an economic prognosis that

appears to differ somewhat from the government's assessment of the status of the economy. Ghana's debt-to-GDP ratio was 84.6 percent as of the second quarter of 2022 (IMF, 2022). The government's electronic levy initiative is thought to be intended to make up for the lack of tax revenue. But should the government actually forgo borrowing in favor of taxing citizens? With the present negotiations with the International Monetary Fund (IMF) for an extended loan line, Ghana's debt problem has taken center stage and needs addressing.

Ndoricimpa (2020) and Bentour (2020) show in their research that no single debt ceiling is indicative of all African nations. They provide evidence supporting Egert's (2015b) claim that the public debt threshold depends on data from individual countries, regional variations, and the modeling approach. The divergent growth trends of Africa can also contribute to this explanation. By taking into account all country-specific data on Ghana in the model, this study evaluates and calculates the threshold level of public debt in Ghana in a unique approach. Additionally, with a focus on Ghana, the study is likely to add to the ongoing discussion on the debt-to-GDP ratio barrier. Policymakers will be able to determine from the results of this study whether the debt threshold effect is significant when making decisions about raising taxes, increasing borrowing, or implementing structural reforms to support economic growth.

1.6 Organization of the Study

There are five chapters to this study. The study's introduction is holistically discussed in Chapter 1. The literature review related to the threshold effect of public debt on economic growth is presented in Chapter 2 and includes both theoretical and empirical works. The methodology is covered in Chapter 3, where we go through how the empirical model is specified as well as estimate strategies, variable descriptions, and data sources. The data analysis and discussion of the empirical findings are reported in Chapter 4. The conclusions, and policy recommendations resulting from the study are presented in Chapter 5.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

The theoretical and empirical foundations of the study are presented in this chapter. Public debt and economic growth-related theories and hypotheses are covered in this chapter. Along with some relevant empirical investigations, the theoretical perspectives of the debt-growth nexus within the framework of the threshold analysis approach are discussed.

2.2 Theoretical Literature

According to Koffi (2019), it is possible to say that the effect of public debt on economic growth may be (i) both positive and negative (a nonlinear approach), or (ii) either positive or negative (attributable to the linear method). The former claim is the main subject of this study. According to Keynesian theory, full employment is not always achieved by the market on its own in the short run. To counteract the effects of market failures, lessen economic instability, and promote balanced economic growth, the government must take measures to that effect. Debt is neither a burden for the present generation nor one for the next generation, according to Keynesian spending and investment multipliers, as it encourages economic recovery, particularly in emerging nations (Koffi, 2019). The classical approach, on the other hand, contends that debt should be avoided since it allows the government to spend more than is necessary to achieve its goals (Novaresi, 2001).

According to the endogenous growth theory, which was developed by Romer (1986), Lucas (1988), and Barro (1990), government debt may have a favorable effect on growth if it is used to fund productive sectors of the economy (Checherita-Westphal *et al*., 2012). Barro (1990) also issued a warning, pointing out that the crowding-out effect caused by public debt has a detrimental long-term effect on economic growth. An examination of the situation in recent literature shows an inverted U-shaped relationship between growth and debt variables. This implies the existence of an ideal public debt to GDP ratio that maximizes growth. The threshold strand of literature contends that when the public debt-to-GDP ratio is below a specific threshold at any period, the crowding-in effect outweighs the crowding-out effect, despite the fact that some economists disagree on the long-term effects of debt on growth. Therefore, rising public debt can spur economic expansion. On the other hand, because the crowding-out effect outweighs the crowding-in effect beyond this ideal threshold, public debt has a negative influence on economic growth. In contrast to the crowding-out effect, which occurs when government expenditure simply pushes out private investment due to high interest rates, the crowding-in effect occurs when more government spending stimulates economic growth, encouraging businesses to invest more in order to make large profits.

The debt Laffer curve by Sachs (1989), when examined in the context of the debt overhang hypothesis, supports the notion of a public debt ceiling that maximizes growth. According to the debt Laffer curve, there is a correlation between rising debt levels and decreased chances of debt repayment. According to the literature on the sovereign debt overhang, when there are large stocks of public debt, economic growth is predicted to slow down because private investment will be crowded out. The debt Laffer curve was developed by Sachs in 1989 using the debt overhang

concept, which Krugman (1988) first proposed. According to Krugman (1988), when a nation's debt grows, financing it will eventually become more challenging because cumulative payment commitments behave like investment taxes or other policy innovations that need a trade-off between future benefits and up-front costs (Pattillo *et al*., 2002). Krugman (1988) did not address the effect of debt on growth directly, but his debt overhang hypothesis suggests that high debt levels may result in low growth due to low investments.

By extension of these theoretical foundations, there is another theory that supports the existence of a nonlinear link between the magnitude of public debt and economic growth. The threshold or nonlinear effect theory is used to describe this. According to this theory, when public debt levels are below a specific ideal threshold, they tend to have positive benefits on economic growth, but when they exceed that threshold, they have negative effects (Reinhart and Rogoff, 2010). A diagrammatic representation of the Laffer curve in connection to the debt-growth nexus is shown in Figure 2.1 below.

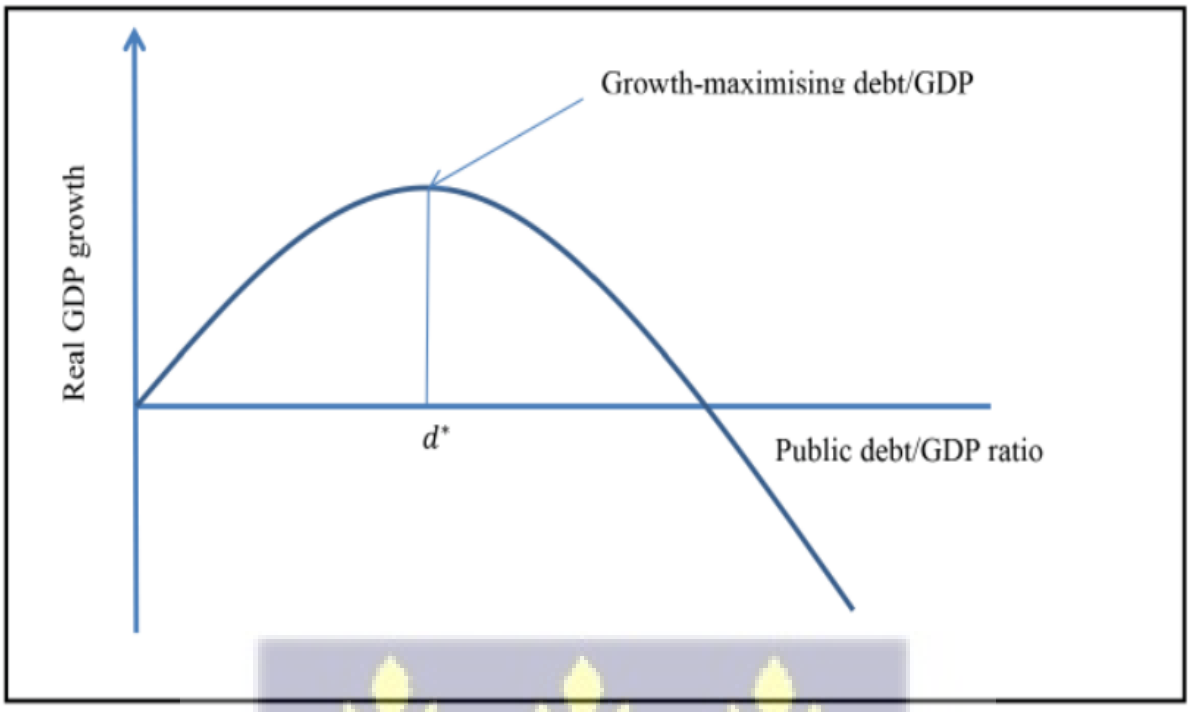

Figure 2. 1 The optimal level or turning point for both public debt and economic expansion.
Source: Pattillo *et al.*, 2002; modified.

These theoretical foundations are used in some of the empirical research that are discussed in the following section.

2.3 Empirical Literature

Using panel data covering the years 1969–1998, Pattillo *et al.* (2002) investigated the relationship between the debt ceiling and growth in 93 developing nations. They used the system generalized method of moments (sGMM) and fixed effects estimates to analyse their data and included a quadratic debt factor in their OLS model. Their research showed that the debt-to-GDP ratio should not exceed 35 to 40 percent. The non-linear impact of external debt on economic growth in 93 developing countries was subsequently investigated by Patillo *et al.* (2011) using spline and quadratic econometric models. The data spanned the years 1969 to 1998. They discovered a non-

linear, bell-shaped association between the ratio of public external debt to GDP and economic growth. Similar to the findings of Patillo *et al*. (2002), their studies also showed that foreign debt becomes harmful to growth if it exceeds a debt-to-GDP ratio of 35 to 40 percent.

Reinhart and Rogoff (2010) examined the connections between total public debt, inflation, and economic growth. Between 1790 and 2009, they studied 44 developing and advanced nations. Their research showed that lower economic growth outcomes were related to debt-to-GDP ratios greater than 90 percent in all economies tested, including advanced and developing market economies. Additionally, they discovered that a percentage point rise in foreign debt exceeding 60 percent of GDP lowers yearly economic growth by over one percentage point. Following these findings**,** Herndon *et al*. (2013) criticized the methodological accuracy of Reinhart and Rogoff (2010), which led to a similar study that corrected for the errors. Some of the criticisms included the deliberate removal of available data, coding errors, and unfitting eights placed on summary data that led to wrong calculations. In an effort to correct such errors, Herndon *et al*. (2013) examined 20 advanced economies between 1946 and 2009 and discovered that while a debt-to-GDP ratio above 90% does occasionally slow economic growth, the relationship between public debt and economic growth depends on the study's time frame and the nation under consideration. The same sample was examined by Minea and Parent (2012) using a panel smooth transmission regression (PSTR) model, who also questioned the relevance of the statistical approach Reinhart and Rogoff (2010) employed. Unlike Reinhart and Rogoff (2010), they discovered a new turning point of 115 percent debt-to-GDP, above which debt is detrimental to growth.

From 1970 to 2007, Kumar and Woo (2010) examined the connection between debt growth and 38 advanced and developing economies. They employed the fixed effects estimator (FE estimator) and the system generalized method of moments (sGMM), two separate econometric approaches. Their research provided strong proof that there is a nonlinear relationship between public debt and economic development. In line with the estimate made by Reinhart and Rogoff (2010), they put a 90 percent ceiling on the debt-to-GDP ratio. In practice, they discovered that a one percent rise in debt levels above this line would result in a 0.02 percent reduction in economic growth.

Caner *et al*. (2010) examined 101 emerging and developed economies using various threshold models. For developed nations, they discovered a debt-to-GDP threshold ratio of 77 percent, whereas for emerging nations, it was 64 percent. They also demonstrated that for industrialized and emerging nations, respectively, a percentage point increase in public debt above these levels lowers annual economic growth by 0.017 and 0.02 percentage points.

Cecchetti *et al*. (2011) attempted to determine a nonlinear threshold effect of governmental, nonfinancial company, and household indebtedness on economic development. They covered the years 1980–2010 in 18 Organization for Economic Cooperation and Development (OECD) nations using a bivariate least squares model and time-period fixed effects. For yearly and five-year growth rates of per capita GDP, they used the bivariate least squares model with fixed effects for the country and time period. The findings showed that every additional 10 percentage point increase lowers the growth trend by roughly 0.10 percentage point when the ratio of public debt to GDP reaches about 85%. While adjusting for some factors under the heading of fiscal indicators, such

as the average tax rate, fiscal equilibrium, and long-term real interest rates, Checherita *et al*. (2012) also used a two-stage least squares regression model in their research. Their research examined the average impact of public debt on GDP per capita growth in twelve economies in the Euro Area between 1970 and 2011. They discovered evidence of the public debt's nonlinear impact on growth, with a debt-to-GDP ratio tipping point between 90 and 100 percent, at which debt tends to have a negative impact on growth.

Baum *et al*. (2013) examined the relationship between public debt and economic development for nations in the Euro Area from 1990 to 2010. They confirmed the Keynesian concept on debt by using least squares regression to discover that debt has a positive short-run influence on growth. Nevertheless, the beneficial effect decreases as the debt-to-GDP ratio rises over a level of about 67 percent and eventually reaches zero. Additionally, they discovered that high debt-to-GDP ratios (above 95 percent) have a detrimental impact on economic activity, suggesting that there may be a nonlinear threshold debt-to-GDP ratio between 67 and 95 percent.

After employing ordinary least squares (OLS) and threshold dynamics, Wright and Grenade (2014) discovered a non-linear link between public debt and economic development in thirteen Caribbean nations. They also discovered that growth is possible with a debt-to-GDP ratio of 61 percent or less, but that public debt above 61 percent likely to have negative consequences on investment and economic growth. Their findings also demonstrated a clear discrepancy between the calibrated optimal debt-to-GDP ratios and the actual country-level debt-to-GDP ratios. After discovering the

inverse relationship between debt and growth, they recommended allowing government borrowing under conditions that would also produce long-term growth dividends.

Using data from the European Union (EU), Mercinger *et al*. (2014) studied and assessed the direct effects of increased debt on economic growth. They addressed endogeneity with instrumental factors and employed a fixed effects (FE) panel regression model and a two-stage Gaussian mixture model (GMM). All of the models' predictions confirm that the public debt-to-GDP ratios have a sizable nonlinear impact on the annual growth rates of GDP. They then calculated the threshold at which debt starts to negatively affect a country to be between 80 and 94 percent for "old" member states and around 54 percent for "new" member states. Countries that have been EU members since 1980 were considered old member states, whereas nations that joined between 1995 and 2010 were considered new member states.

In order to determine whether there is a nonlinear threshold or several thresholds, Topal (2014) examined the relationship between public debt and economic growth in 12 nations within the Eurozone. He used a two-stage least squares regression and a threshold technique similar to Padoan *et al*. (2013) to account for population growth, gross capital formation, and old-age dependency. The findings show that public debt levels below 71.66 percent of GDP often have beneficial effects on economic growth, while debt levels over this threshold have no appreciable positive effects. He continued by saying that economic growth turns negative over a second benchmark of roughly 80.2 percent debt-to-GDP.

On the other hand, Pescatori, Sandri, and Simon (2014) found no proof that debt levels above a certain point undermine long- and medium-term growth estimates. They claimed that the debt's trajectory has a significant impact on the relationship between debt levels and economic growth. Therefore, economies with high debt levels that are also experiencing economic growth have all done so historically. The authors showed that more debt associated with unstable or non-stable output growth, which can be harmful to economic wellbeing, even if they could find no evidence of debt thresholds.

Mupunga *et al*. (2015) estimated an ideal growth-maximizing public debt threshold for Zimbabwe utilizing data from 1980 to 2012 using a bivariate quadratic growth model while adjusting for other growth-affecting factors. Their goal was to determine the relationship between public debt and growth. Their findings supported Zimbabwe's inverted U-shaped relationship between governmental debt and economic development. Additionally, they calculated the optimal public debt level for maximizing economic growth to be between 45% and 50%, indicating that exceeding this level is likely to have detrimental consequences on economic growth.

For the period of 2004 to 2012, Omotosho *et al*. (2016) particularly investigated whether there were threshold effects in Nigeria's relationship between public debt and economic development. They discovered evidence of an inverted U-shape link between three categories of public debt (domestic, external, and total) and economic growth by applying the threshold analysis model from Khan and Senhadji (2001) to the quarterly data. Total public debt types were determined to have

an appropriate growth threshold of 73.1 percent, while foreign and domestic debts had optimal growth thresholds of 49.4 percent and 30.9 percent, respectively.

While Koffi (2019) looked at the effects on Sub-Saharan African (SSA) nations, Sanusi *et al*. (2019) explored the non-linear effects of public debt on economic growth in Southern Africa Development Community (SADC) countries. Koffi (2019) used a sample size that included Ghana; however, the results are not particularly suggestive and representative of Ghana. This is because the panel results are different from the results for each country. But Koffi (2019) and Sanusi *et al*. (2019) both support the presence of a non-linear link between public debt and economic growth. According to Sanusi *et al*. (2019), after a certain threshold is achieved, the favorable effects of public debt on economic development start to reverse. They discovered that, over time, the SADC countries' public debt ceiling is set at 57 percent of GDP. This is in contrast to Koffi's (2019) research, which discovered a debt threshold of 36.18 percent after which it will be harmful to growth.

According to Ndoricimpa (2020), Africa's debt ceiling should be between 62 and 66 percent of GDP. In a similar vein, Mensah *et al*. (2019) discovered a debt ceiling ranging from 20 to 50% of GDP. Because Mensah *et al*. (2019) employed a panel threshold-ARDL regression model and Ndoricimpa (2020) utilized a panel smooth transition model, their estimations differed. One might be tempted to use Ghana as an example of Africa when representing these panel debt threshold estimations. However, Ndoricimpa (2020) and Bentour (2020) showed in their research that there

isn't a single debt ceiling that is typical of all African nations. Country-specific analysis is therefore more tenable.

2.4 Synthesis of the Literature Gap

It is obvious that the majority of the empirical literature examined is based on panel studies and targeted at nations other than Ghana. Both the studies by Mupunga *et al*. (2015) and Omotosho *et al*. (2016) used results that were country-specific, making their estimations particular to that nation. This addressed the claim that there is no universal debt-to-GDP threshold for nations, which was in opposition to the majority of the panel's literature research. The focus on Ghana to empirically determine the relationship between public debt and economic growth would contribute to the paucity of country-specific studies on the topic under examination in this study.

CHAPTER THREE

METHODOLOGY

3.1 Introduction

The theoretical framework, model definition, estimating strategies, data sources, and variable descriptions are all included in this chapter.

3.2 Theoretical Framework

This theoretical model relates economic growth to public debt and other important variables using a straightforward macroeconomic model. Examine the following production function:

$$Y_t = F\ (K_t, P_t, L_t, O_t) \tag{1}$$

where t is time, Y_t is aggregate output measured by GDP, K_t denotes private capital, P_t denotes public capital, L_t denotes labor, and O_t denotes a vector of other factors that influence output. F is a production function that follows the marginal returns assumptions of $F_a > 0$ and $F_{aa} < 0$, where a = {K, P, L, O}.

Solow (1957) claimed that households make decisions over time based on an assumed fixed percentage of income. These savings are subsequently applied to finance both public and private investment, as well as tax obligations.

Thus,

$$sY_t = I_{K,t} + m_p I_{P,t} + T_t \quad (2)$$

Where s stands for the savings percentage, $I_{K,t}$ denotes private capital investment, $I_{P,t}$ denotes public capital investment, T_t denotes taxes, and assumed to be a lump sum for ease of calculation. The parameter m_p is a variable that describes how effectively public investments produce results in comparison to private investments. It is influenced by institutional considerations, and as it increases, public investment becomes less effective. For instance, m_p would rise if public corruption increased.

The equation of motion for private capital is given as:

$$\Delta K_{t+1} = I_{K,t} - \delta_K K_t \quad (3)$$

where $0 < \delta_K < 1$ represents the rate at which private capital depreciates.

Let's say the private capital level starts out at zero, then equation (3) implies:

$$K_{t+1} = \sum_{r=0}^{t} (I_{K,r} - \delta_K K_r) \quad (4)$$

Similarly, the equation of motion for public capital is given as:

$$\Delta P_{t+1} = I_{P,t} - \delta_P P_t \quad (5)$$

where $0 < \delta_P < 1$ represents the depreciation rate of public capital.

Suppose the public capital level is initially zero, then equation (5) implies:

$$P_{t+1} = \sum_{r=0}^{t}(I_{P,r} - \delta_P P_r) \quad (6)$$

From equation (2),

$$I_{K,t} = sY_t - m_p I_{P,t} - T_t \quad (7)$$

Substituting equation (7) into equation (4) gives:

$$K_{t+1} = \sum_{r=0}^{t}(sY_t - m_p I_{P,t} - T_t - \delta_K K_r) \quad (8)$$

Substituting equations (6) and (8) into equation (1) gives:

$$Y_{t+1} = F\left(\sum_{r=0}^{t}(sY_t - m_p I_{P,t} - T_t - \delta_K K_r), \sum_{r=0}^{t}(I_{P,r} - \delta_P P_r), L_{t+1}, O_{t+1}\right) \quad (9)$$

Government's budget constraint is given as:

$$G_t + I_{P,t} = \Delta D_t + T_t \quad (10)$$

where G_t stands for government consumption, and ΔD_t for changes in the public debt.

From equation (10),

$$I_{P,t} = \Delta D_t + T_t - G_t \quad (11)$$

Substituting equation (11) into equation (9) gives:

$$Y_{t+1} = F\left(\sum_{r=0}^{t}(sY_r + G_r - T_r - \delta_K K_r) - m_p \Delta D_t, D_t + \sum_{r=0}^{t}(T_r - G_r - \delta_P P_r), L_{t+1}, O_{t+1}\right) \quad (12)$$

It should be noted that

$$D_t \equiv \sum_{r=0}^{t}(\Delta D_r)$$

The derivative of Y_{t+1} with respect to D_t gives:

$$\frac{dY_{t+1}}{dD_t} = \frac{\partial F}{\partial P} - m_p \frac{\partial F}{\partial K} \tag{13}$$

From equation (13), the term $\frac{\partial F}{\partial P}$ represents the change in output due to a change in public investment financed by debt. This term is positive. The term $m_p \frac{\partial F}{\partial K}$ represents the private investment crowding out. This term is influenced by m_p. Thus, the less efficient the government sector becomes, the higher the crowding out becomes. This term negative. Due to the ambiguous sign of equation (13), the various effects of public debt on economic growth observed in the literature are confirmed. An empirical study is needed to determine whether the effects are positive, negative, or both. According to this study, both effects are possible. Hence, the predication of this study on the debt Laffer curve by Sachs (1989) and Krugman (1988) discussed in the theoretical literature.

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3.3 Model Specification

This study uses an optimal threshold approach to examine the connection between public debt and economic development. Numerous exogenous and endogenous frameworks have been used in the literature to analyse data (Ndoricimpa, 2017). For instance, Reinhart and Rogoff (2010) examined the relationship between public debt and economic growth using the mean and median. The generalized method of moments (GMM), fixed effects, and ordinary least squares (OLS) were also employed by other researchers (Patillo *et al*., 2002; Woo and Kumar, 2010; Patillo *et al*., 2011; Ndoricimpa, 2017). In addition, multiple researchers have employed both quadratic specifications and spline equations, with more recent research favoring the spline equation in comparison to the quadratic technique (Patillo *et al*., 2011; Ndoricimpa, 2017). Most of these studies are panel oriented. The underlying assumption is usually some level of country convergence or country homogeneity. Chudik (2017) emphasizes that these studies are predicated on the supposition that the economies involved are similar on many yardsticks. This buttresses Ada's (2019), Bentour's (2020), and Salmon's (2021) suggestions of a unique country-specific analysis for such threshold analysis.

On the country level, several researchers have used models that impose trial-and-error public debt thresholds on growth, while others deduce these thresholds from the available data using Autoregressive Distributed Lag (ARDL) or quadratic methods. The econometric investigation of the relationship between public debt and economic growth, where an estimated model connects growth to public debt and other pertinent variables, served as the basis for this study. However, an Autoregressive Distributed Lag (ARDL) approach was used because the study is interested in the

non-linear (threshold) relationship between public debt and growth, and the ARDL can achieve this interest.

3.3.1 The Autoregressive Distributed Lag (ARDL) Model

This work follows Sanusi *et al*. (2018) in using the ARDL technique with a squared variable. Pesaran *et al*. (2001) proposed the ARDL model. It is possible to generate a mixture of integrated variables of order 0, 1, 2, or more after the stationarity tests. This means testing for cointegration under a framework is necessary. Cointegration tests permit us to ascertain long run relationships that exist among the variables. The ARDL model offers several advantages relative to other models. The ARDL does not require the same order of integration of variables as other modes do in order to test for cointegration. Whether the variables are integrated to order 0, order 1, or partially to orders 0 and 1, the ARDL model enables researchers to evaluate long-run correlations (Sanusi *et al*., 2019). The ARDL model may provide both short-run and long-run coefficients for conclusions while also being suited for small sample numbers. The general ARDL equation with the squared term (debt squared) is specifically given as:

$$\Delta GDP_t = \alpha_0 + \alpha_1 GDP_{t-1} + \alpha_2 PDR_{t-1} + \alpha_3 PDR^2{}_{t-1} + \alpha_4 TRADE_{t-1} + \alpha_5 GOVE_{t-1} + \alpha_6 GOVI_{t-1} + \alpha_7 POPG_{t-1} + \alpha_8 INF_{t-1} + \sum_{i=1}^{\omega} \rho_{1i} \Delta GDP_{t-i} + \sum_{i=1}^{\omega} \rho_{2i} \Delta PDR_{t-i} + \sum_{i=1}^{\omega} \rho_{3i} \Delta TROPE_{t-i} + \sum_{i=1}^{\omega} \rho_{4i} \Delta GOVE_{t-i} + \sum_{i=1}^{\omega} \rho_{5i} \Delta GOVI_{t-i} + \sum_{i=1}^{\omega} \rho_{6i} \Delta POPG_{t-i} + \sum_{i=1}^{\omega} \rho_{7i} \Delta INF_{t-i} + \epsilon_t \quad (14)$$

where Δ stands for the first difference operator, ω is the maximum lag order determined by the Akaike Information Criterion (AIC) or Schwarz Information Criterion (BIC or SIC) Information Criterion, α_0 is the constant term, and ϵ_t is the normally distributed error term with a constant

variance and a zero mean. The long-run parameters are α_1 to α_8 are the long-run parameters while the short-run parameters are ρ_{1i} to ρ_{7i}. GDP represents economic growth, PDR represents public-debt-ratio, TROPE represents trade openness, GOVE represents government spending, GOVI represents government investment, POPG represent population growth, and INF represents inflation. The data for these variables ranged from 1965 to 2018.

Table 3. 1 Data Sources

Variable	Description	Sources of Data
GDP	Real GDP growth rate	World Bank
PDR	Public Debt Ratio	Historical Public Debt Database (of the IMF)
TROPE	Sum of Exports and Imports as a percentage of GDP	World Bank
GOVE	Government Expenditure as a percentage of GDP	International Fiscal Statistics (of the IMF)
GOVI	Government Investment as a percentage of GDP	International Fiscal Statistics (of the IMF)
POPG	Population Growth rate	World Bank
INF	Inflation rate	World Bank

3.4 Testing for the Threshold (Non-Linear) Relationship

Usually, a scatter plot is able to give a fair idea on possible non-linear relationship that exists between two variables. Nevertheless, it is not the best or reliable approach since the graph could be interpreted by different viewers of it. For this reason, this study adopts the likelihood ratio test (LRT) also known as the Wink's test where we simply test the linearity assumption against the non-linearity assumption. The LRT allows one to statistically compare the goodness of fit between two hierarchically nested models (Felsenstein, 1981; Huelsenbeck *et al*., 1997, Li & Babu, 2019). The hypothesis for the LRT is written as:

H_0: The relationship between economic expansion and governmental debt is linear.

H_1: There is a nonlinear (quadratic) relationship between public debt and growth.

Regression estimates for both linear and non-linear models are tested to determine whether the null hypothesis should be rejected or not. In addition, this test could be done based on the ARDL equations specified in equation (14) of this chapter. These regression equations are then run, and the linear and non-linear parameters are checked to see if they differ considerably from zero. If they diverge from zero significantly, the quadratic equation must exist, and we may determine the threshold using the model.

3.5 The Bounds Test

A co-integration test is necessary to find the long-term relationships between the variables in the ARDL model. The bounds test by Pesaran *et al*. (2001) is among the tests that are plausible following an ARDL calculation. This is because integrated variables with values of 0 and 1 are

both accepted. Based on the Wald test and two crucial values (lower and upper bounds), this test provides an F-statistic.

The hypothesis for this test is as follows:

H_0: There is no cointegration.

H_1: There is cointegration.

The null hypothesis is rejected if the F-statistic value exceeds the specified upper bound critical value. In contrast, we fail to reject the null hypothesis if the F-statistic value is lower than the specified lower bound crucial value. In the event that the null hypothesis is not accepted, the error correction model is estimated as follows:

$$\Delta GDP_t = \rho_t + \sum_{i=1}^{\omega} \rho_{1i} \Delta GDP_{t-i} + \sum_{i=1}^{\omega} \rho_{2i} \Delta PDR_{t-i} + \sum_{i=1}^{\omega} \rho_{3i} \Delta PDR^2_{t-i} + \sum_{i=1}^{\omega} \rho_{4i} \Delta TROPE_{t-i} + \sum_{i=1}^{\omega} \rho_{5i} \Delta GOVE_{t-i} + \sum_{i=1}^{\omega} \rho_{6i} \Delta GOVI_{t-i} + \sum_{i=1}^{\omega} \rho_{7i} \Delta POPG_{t-i} + \sum_{i=1}^{\omega} \rho_{8i} \Delta INF_{t-i} + \exists ECM_{t-1} + \tau_t \quad (15)$$

where $\exists$ and $\exists ECM_{t-1}$ are the speed of adjustment and the error correction specification model, respectively.

3.6 Description of Variables

Economic Growth: According to Spencer *et al*. (1993), this is the annual change in an economy's output at a set of constant prices. Economic growth is also defined by the OECD (2002) as an increase in total production value, which is the total of all gross added values of all units of production. Some economists define economic growth as growth in real GDP or production

(Nwanna *et al*., 2019). The measurement of production growth could be nominal, which comprises inflation, or in real value which is inflation-adjusted. There are several definitions for economic growth and its measurements. According to Blanchard *et al*. (2014), economic growth is a reflection of labour productivity and labour force. Hence, growth in output results from an increase in the productivity of labour than just increases in the labour force. Productivity is the output per-man-hour. According to Contreras (2007), a country's national income is primarily determined by the components of its domestic total value-added production, or GDP. GDP has invariably been used as a measure of economic growth since it measures economic activity in an economy. It is also used as a measure of a healthy economy and the standard of living. Thus, an economy experiences economic growth whenever there is an increase in the economy's GDP. Samuelson *et al*. (2010) posited that economic growth overtime is congruent to an outward shift in the country's production possibility curve (PPF) where all resources including natural resources, human resources, and other assets have been increased. GDP growth, real GDP growth, GNP growth, or GDP per capita growth have all been employed as indicators of economic growth in several empirical studies examining the relationship between debt growth and debt. To evaluate economic growth, however, this study employs real GDP growth (expressed in percentages).

Public Debt: A country's indebtedness is largely made-up government or public debt. It is defined as the financial liabilities of a government. The government debt comprises of internal and external borrowing. Whenever the government runs deficits (i.e., expenditure exceeding revenues) over a period of time, it accrues to more public debt. Deficit expenditure, however, is most likely to result in improved infrastructure and be a catalyst for economic expansion (Nwannebuike *et al*., 2016). According to Nwannebuike *et al*. (2016), tax-cutting periods encourage people to spend more

money, which boosts economic growth and makes it possible for taxes to rise in the future along with increasing government spending, employment, and output levels. Having said that, governmental debt can impede development. Through programs for sustainable fiscal reform, governments have up until now occasionally received advice on how to manage their spending (Anning *et al*., 2016). The debt-to-GDP ratio is used in this study to gauge Ghana's state debt.

Government Consumption Spending. This consists of all current public expenditures for the purchase of products and services (together with staff compensation) that result in individual or group satisfaction. While Keynesian model posits that government spending boosts economic growth, ne-classical models believe it negatively impacts growth. Government spending has a negative influence on long-term economic growth when it is financed by tax revenues, but a positive impact when it is financed by other sources, such as non-tax income, according to Chen *et al*. (2020). They went on to say that when the expenditures were broken down, spending on wages and salaries, agriculture, interest payments, and health care had a tendency to independently have an impact on long-term growth greater than other deconstructed spending. It is anticipated that government spending will either be positive or negative as indicated by the general government final consumption expenditure (percent of GDP).

Government Investment: This refers to gross fixed capital formation and capital transfers. It solely comprises of infrastructure such as roads, office buildings, housing, schools and hospitals. Investment grants as well as other capital transfers make up capital transfers in the country. By and large, government's leading goal is to boost economic growth through financing public

infrastructure enterprises like roads, colleges, hospitals, houses and communication networks. Several theories about the impact of government investment exist in the literature. Keynesians believe in the short run where aggregate demand and output is below potential, government investment can catapult output growth since aggregate demand and private investment go up. However, they believe there is a limit to this impact. Neoclassical economists believe public investment channels all resources into public projects causing shortage available to the private sector. This tends to have negative impact on both private and public sectors and eventually economic growth (Sandler & Hartley 1995). This study uses general government investment (percent of GDP) as a measure of government investment.

Inflation: This refers to the rise in general price level in an economy. It is sometimes a proxy for macro-economic stability since stabilized inflation encourages growth (Demchuk, 2003). Higher inflation rates reduce real interest rates. In effect, the real cost of borrowing is reduced and investment increases as well as the capital-labour ratio (Tobin, 1965). On the contrary, Barro (2013) asserts that inflation causes negative impact on the economy's progress. Bittencourt (2012) and Orphanides *et al*. (1999) also argue that high inflation and economic growth are adversely connected and advise government uses macroeconomic policies to ensure stable inflation levels. Fisher (1993) identified a nonlinear relation between the low inflation rates and economic growth. Albeit there are benefits attributable to inflation, no economy wants an inflation that de-stabilizes the macroeconomic indicators. This study therefore expects a negative sign for the impact of inflation rate.

Trade Openness: It measures how much of the GDP is made up of total imports and exports of goods and services. In an open economy, trade is a crucial growth factor. An open nation is more susceptible to external shocks and vulnerabilities, which slows economic growth and total income. However, according to Berg *et al*. (2003), trade openness fosters economic growth. Most open economies are able to generate the trade surpluses required to reduce public external debt through competitive trade, making it unlikely that they would experience a debt overhang (Daniel *et al*., 2003).

Population: This refers to all inhabitants of a given country or area. Increases in this population leads to population growth. Therefore, population growth refers to the rise in population from one year to the next. It is calculated as the percentage change in population level from year to year. Literature findings on how population growth affects economic growth are conflicting. While some researchers find population growth inimical to economic growth due to burdens on economic resources, others like Lartey *et al*. (2018) argue population growth provides a quantity and possible quality of labour force for economic growth. Chang *et al*. (2014) posited that owing to the growing population, household consumption, investment, and manufacturing tend to increase in an economy, which is needed for economic growth. Therefore, this study expects a positive sign for the impact of population growth.

Table 3. 2 Summary of Variables and their Expected Long Run Signs

Independent Variable	**Expected Sign in Quadratic Specification**
Public Debt/GDP (PDR)	Positive
(Public Debt/GDP)^2 (PDR^2)	Negative
Openness (TROPE)	Positive
Government Expenditure (GOVE)	Negative or Positive
Government Investment (GOVI)	Positive
Population (POPG)	Positive
Inflation (INF)	Negative

3.7 The Estimation Techniques

The underlying technique used in the ARDL model is the Ordinary Least Squares (OLS) technique. This means all assumptions underlying to the OLS such as no serial correlation, no heterogeneity, and stability must be satisfied. Post estimation diagnostic checks are done to that effect. Prior to any analysis of the variables involved, the nature of these time series variables requires tests of stationarity. So, data assessment methods such as the Augmented Dickey-Fuller (ADF), Phillips-

Perron (P-P) tests are employed. Since non-stationary time series variables are known to provide statistical results that are unreliable for inferences and ultimately have lower predictive power, stationarity is crucial to this study. All the time series variables utilized in this study, including economic growth, government spending, gross fixed capital formation, population growth, trade openness, and inflation, are put through a stationarity test to ensure accurate results. The following is the null hypothesis for the stationarity or unit root test:

H_0: Time series variable is non-stationary.

H_1: Time series variable is stationary.

The null hypothesis (H_0) is either rejected or otherwise. Failure to reject implies the series is non-stationary and confirms the existence of a unit root. This means analyzing with level data is not credible and spurious regressions arise when regressions are done on the level data. Ideally, all variables must be stationary before any further analysis can be done. Stationarity test is a necessary step for the cointegration test. It allows forecasting and finding correlations between variables to be void of errors. The presence of non-stationarity or order of integration suggests the presence of long run relationship between the variables of interest. So, this relationship must be tested for to ascertain its presence. Hence, the cointegration test.

3.7.1 The Stationary Tests Applied

The Augmented Dickey-Fuller test and the Phillips-Perron (P-P) test of stationarity are both used in this study. The above-stated hypothesis is followed by both the ADF and P-P tests. The ADF has, however, faced harsh criticism. ADF and P-P have little efficacy against the alternative

hypothesis that the series is stationary when a large autoregressive root is present (Dejong *et al*., 1992). To put it another way, a stationary series that has a root that is close to the non-stationary border is referred to as having an absolute root presence or being non-stationary. To address some of the issues of ADF, additional tests like the Kwiatkowski-Phillips-Schmidt-Shin (KPSS) exam and the Zivot-Andrews (Z-A) test were developed. This indicates that the literature is ambiguous regarding the precise test to employ for stationarity. Nevertheless, for comparison and verification reasons, the ADF and P-P tests will be utilized side by side. The P-P test is thought to be beneficial for economic data. P-P tests are superior to ADF tests, according to Phillips *et al*. (1988), since the user is not required to specify the maximum delays and because the P-P test is resistant to all common types of heteroskedasticity in the error term.

CHAPTER FOUR

ESTIMATION RESULTS AND DISCUSSIONS

4.1 Introduction

In this chapter, estimation results or findings are presented and subsequently discussed. Summary statistics are presented. Stationarity tests and bound test results are also discussed.

4.2 Descriptive Statistics

Descriptive statistics are summary statistics that quantitatively describe features of a sample or population (Mann, 1995). In conducting research, one of the important steps before inferential comparisons is to calculate descriptive statistics (Kaur *et al*., 2018).

Table 4. 1 Summary Statistics (1965-2018)

	GDP (%)	PDR (%)	GOVE (%)	GOVI (%)	INF (%)	POPG (%)	TROPE (%)
Mean	3.675486	41.23981	10.79970	16.09640	27.98513	2.546747	54.77594
Median	4.551230	33.85500	10.87726	14.30478	18.03709	2.521037	45.92086
Maximum	14.04712	111.9500	16.76471	29.00214	122.8745	3.045341	116.0484
Minimum	-12.43163	5.040000	5.861290	3.749769	-8.422486	1.856668	6.320343
Std. Dev.	4.520759	25.19618	2.514224	6.895384	27.38030	0.282826	27.35155
Observations	54	54	54	54	54	54	54

According to table 4.1 above, the average annual percentage of economic growth in Ghana over the study period was 3.68 percent, with a standard deviation of 4.52 percentage points. The

minimum and maximum growth rates recorded in Ghana during this period were -12.43 percent and 14.05 percent, respectively. During this time, Ghana's governmental debt as a percentage of GDP averaged 41.23 percent. A debt-to-GDP ratio deviates from the average by 25.20 percentage points. The minimum debt-to-GDP ratio for this period was 5.04 percent, while the highest debt-to-GDP ratio recorded was 111.95 percent.

4.3 Trend Series of Public Debt and Economic Growth

Both public debt and economic growth time series are plotted on the same graph below:

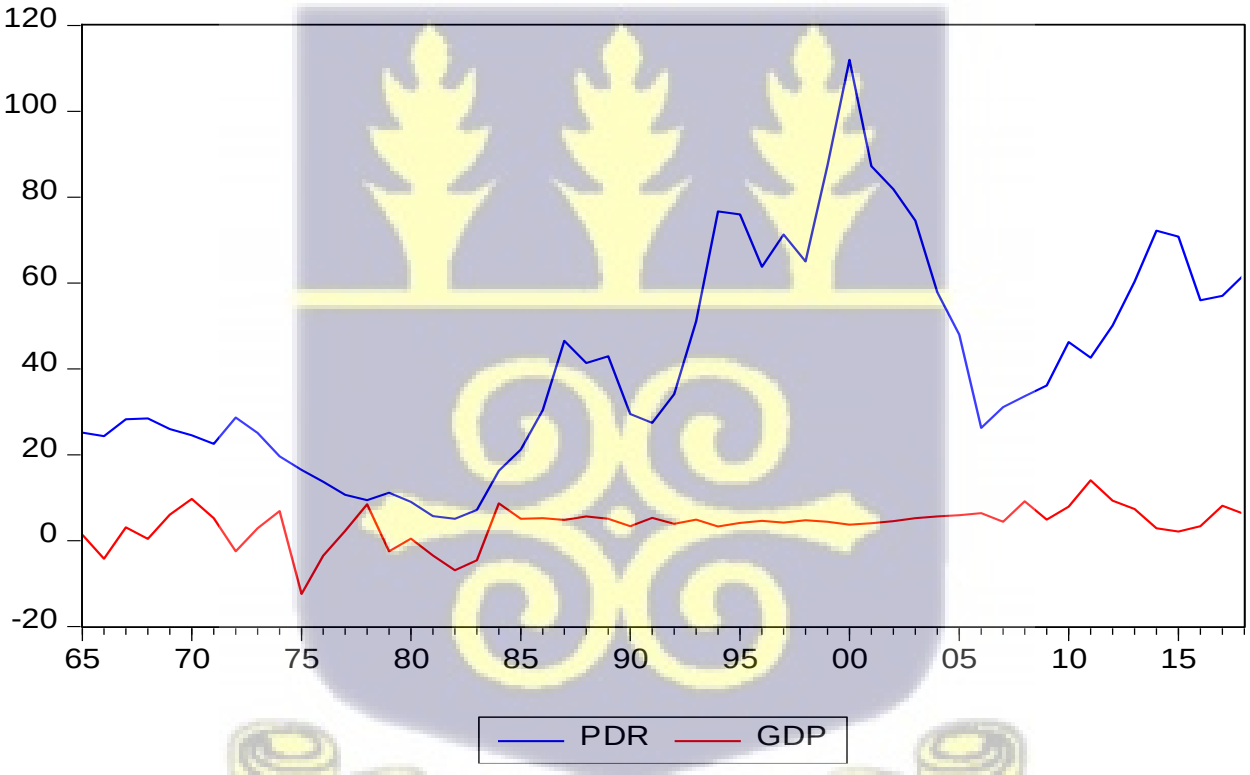

Figure 4. 1 Ghana's economic growth and public debt trend from 1965 to 2018.
Source: Author's own construction of data from the World Bank.

Figure 4.1 above depicts Ghana's economic growth and sovereign debt trends from 1965 to 2018. The red line denotes real GDP growth, which is a proxy for economic growth. Clearly, economic

growth has been fluctuating. Growth reached its lowest point in 1975 at a rate of -12.4 percent. Several reasons accounted for such abysmal growth. The main reason was political upheavals and coups d'état in 1965 that ensured economic growth plunged into the negatives. From 1985 to 2010, economic growth seemed to have remained stable, attributable to political stability and a conducive environment for local and foreign investment. The highest GDP growth was recorded in 2011, at 14.04 percent. Coupled with political stability, Ghana's engagement with HIPC in 2001 relieved the nation's debt obligations while pursuing some long- and medium-term policies to ensure accelerated growth.

In contrast, the public debt as a proportion of GDP peaked in 2000 at 111.95 percent. It's interesting to note that public debt appeared to be rising starting in 1985, when economic growth started to normalize, after falling to its lowest level of 5.04 percent in 1982. Prior to 1985, when the public debt was at its lowest, in 1982, economic growth appeared to be erratic or slowing down. This implies that some amounts of borrowing contributed positively to Ghana's growth. It should be highlighted, though, that endogeneity—the prospect that economic growth may also cause an increase in the public debt—is a possibility. This was taken into account in the post-estimation test model, which demonstrated the lack of such an endogeneity problem.

4.4 Results of Stationarity Tests

Two tests were conducted to confirm stationarity of all the variables. These tests include the ADF test, and the Phillips-Perron (P-P) test as discussed earlier. The results are presented below:

Table 4. 2 Results for Augmented-Dickey Fuller (ADF) Unit Root Test

AUGMENTED DICKEY-FULLER UNIT ROOT TEST (TREND AND CONSTANT)							
	AT LEVELS			AT FIRST DIFFERENCE			ORDER OF INTEGRATION
VARIABLE	T-STATISTIC	5% CRITICAL VALUE	P-VALUE	T-STATISTIC	5% CRITICAL VALUE	P-VALUE	
GDP	-5.573908	-3.496960	0.0001				I(0)
PDR	-2.446369	-3.498692	0.3525	-5.674577	-3.498692	0.0001	I(1)
PDR^2	-1.260206	-1.947119	0.1885	-6.714158	-1.947248	0.0000	I(1)
TRADE	-1.976452	-3.496960	0.6004	-6.533277	-3.500495	0.0000	I(1)
GOVE	-3.390540	-3.496960	0.0635	-7.529814	-3.498692	0.0000	I(1)
GOVI	-2.973436	-3.496960	0.1492	-7.136583	-3.500495	0.0000	I(1)
POPG	-1.693816	-2.928142	0.4275	-3.602333	-2.933158	0.0099	I(1)
INF	-2.637966	-2.918778	0.0920	-12.56076	-2.918778	0.0000	I(1)

Note: Chosen level of significance = 5%

Table 4. 3 Phillips-Perron (P-P) Test Results for Stationarity

PHILLIPS-PERRON UNIT ROOT TEST (TREND AND CONSTANT)							
	AT LEVELS			AT FIRST DIFFERENCE			ORDER OF INTEGRATION
VARIABLE	T-STATISTIC	5% CRITICAL VALUE	P-VALUE	T-STATISTIC	5% CRITICAL VALUE	P-VALUE	
GDP	-3.331193	-1.947119	0.0013				I(0)
PDR	-2.197766	-3.496960	0.4809	-5.687379	-3.498692	0.0001	I(1)
PDR^2	-1.333978	-1.947119	0.1666	-6.716662	-1.947248	0.0000	I(1)
TRADE	-1.944659	-3.496960	0.6172	-6.958778	-3.498692	0.0000	I(1)
GOVE	-3.431532	-3.496960	0.0580	-9.010112	-3.498692	0.0000	I(1)
GOVI	-3.048044	-3.496960	0.1294	-6.831450	-3.498692	0.0000	I(1)
POPG	-2.389185	-2.917650	0.1496	-3.332219	-2.918778	0.0183	I(1)
INF	-4.569124	-2.917650	0.0005				I(0)

Note: Chosen level of significance = 5%

The above stationarity tests present similar results. This means both can be relied on to achieve the objectives of this study. According to the ADF unit root test, the series for economic growth (GDP) is stationary at levels. This means this variable is integrated of order zero (I(0)). Conversely, public debt ratio (PDR), trade openness (TROPE), government spending (GOVE), and government investment (GOVI), population growth (POPG) and inflation (Inf) are all stationary at first difference. Thus, these variables are integrated of order one (I(1)).

On the other hand, P-P test suggest economic growth (GDP) and inflation (INF) are I(0)s while the other variables are I(1). Comparing the two tests, there is no major discrepancy except the identification of inflation (Inf) as stationary by the P-P test. Overall, we have a mixture of I(0) and I(0)variables. The beauty and flexibility of the ARDL model, unlike other cointegration models is its disregard to a strict same integrated series. As long as there is no I(2) series, the ARDL model allows researchers to examine long-run relationships irrespective of whether the variables are integrated of the order 0, 1, or partially integrated or orders 0 and 1 (Sanusi *et al*., 2019). Thus, ARDL is applicable as long as there is no series integrated of order above one. Appropriately, this study adopted the ARDL model which required a bounds test of cointegration between the dependent variable (GDP) and the explanatory variables.

4.5 Optimal Lag Choice

The optimal lag for the specification was decided upon in order to move forward with our ARDL regression study. It is important for our small sample size not to have many lags since degrees of freedom can be affected. After running the data in vector autoregression (VAR) model, Table 4.4 below offered the optimal lags chosen by different information criteria available for time series. For the analysis, the following metrics were used: likelihood ratio (LR), final prediction error (FPE), akaike information criterion (AIC), schwarz information criterion (SIC), and hannan-quinn information criterion (HQ). This study agreed with the majority of the criterions. Thus, the study an optimal lag of two (2) was used.

Table 4. 4 Results for Lag Structure Criteria

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-135.0763	NA	17.95644	5.723052	6.028976*	5.839550
1	-134.9509	0.205686	18.61791	5.758036	6.102200	5.889095
2	-131.6821	5.230053*	17.02823*	5.667284*	6.049689	5.812906*
3	-131.6451	0.057672	17.72969	5.705806	6.126451	5.865990
4	-131.6236	0.032705	18.47865	5.744945	6.203830	5.919691

4.6 Results of the Bounds Test

The ARDL bounds test identifies long-run cointegrating relationships among the variables. The results are presented I Table 4.5 below:

Table 4. 5 Results for the Bounds Test

F-Bounds Test		**Null Hypothesis: No levels relationship**		
Test Statistic	Value	Significance	I(0)	I(1)
F-statistic	5.146394	10%	1.92	2.89
k	7	5%	2.17	3.21
		2.5%	2.43	3.51
		1%	2.73	3.9

Note: k is the number of regressors in the model.

I(0) is the lower bound I(1) is the upper bound

The null hypothesis in Table 4.5 is the absence of cointegration among variables. To conclude whether there is long-run cointegration among the variables, the F-statistic in the bounds test above must be higher than the upper bound I(1) value of 3.21, assuming a 5-percent level of significance.

From the table, the F-statistic, which is 5.146394, is greater than all the upper bounds at the 1 percent, 2.5 percent, 5 percent, and 10 percent levels. In conclusion, the bounds test above indicates the existence of long-run cointegration among the variables of the model.

4.7 Results of Tests of Nonlinear (Threshold) Link between Growth and Public Debt

By visualization, this study establishes a non-linear relationship between public debt and economic growth. This is presented in Figure 4.2 below:

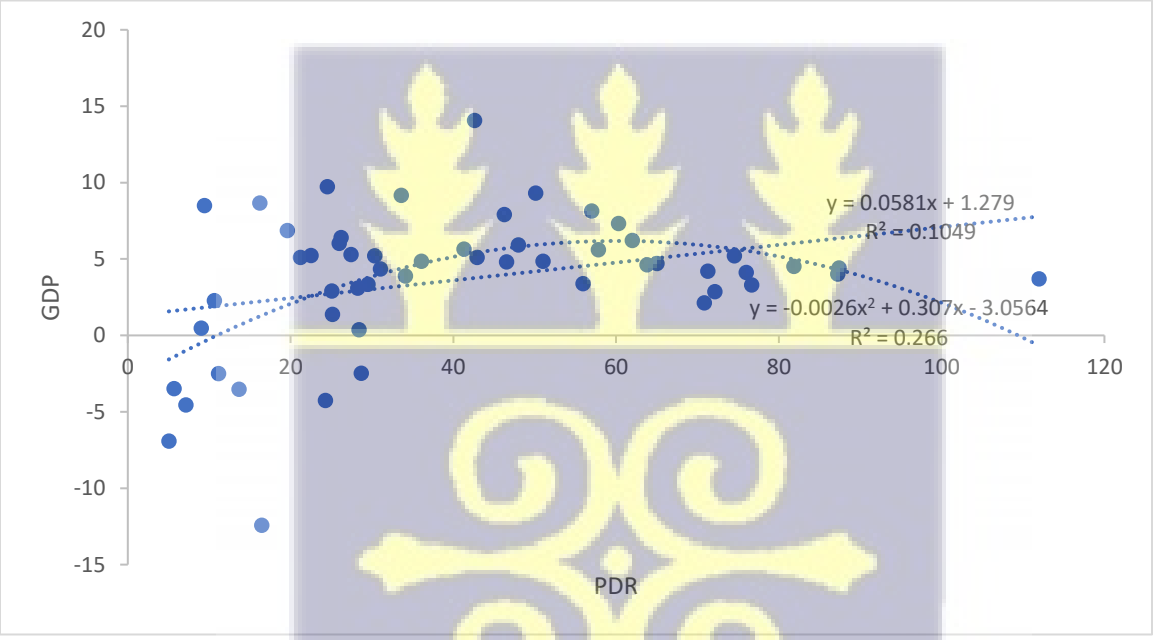

Figure 4. 2 A Non-Linear Relationship between Economic Growth and Public Debt-to-GDP Ratio, 1965-2018.

Figure 4.2 seems to portray a non-linear pattern between economic growth and public debt ratio. A comparison of the fitted curves show that the curve fits the data better with a higher coefficient of determination (R^2). Thus, with debt-to-GDP ratio increasing on the horizontal axis, economic growth increases on the vertical axis until a point, where debt-to- GDP ratio causes economic

growth to decline. This squared debt variable is justified due to the theoretical underpinnings and the ability to fit properly for a non-linear relationship instead of a linear one. The other variables used do not follow the same reasons hence, making this debt-growth relationship unique. However, this study acknowledges the unreliability of plotted analysis without thorough tests. Albeit the curve visually looks more fitting to the data, the next section applies a likelihood ratio test (LRT) discussed in chapter two to ascertain the graphical claim.

4.7.1 The Likelihood-Ratio Test (LRT)

This test enables the comparison of goodness of fit between two statistical models (Li & Babu, 2019). Here, it compares the linear claim of public debt on economic growth against the non-linear claim as raised in this study and recent literature. The results are presented in Table 4.6 below:

Table 4. 6 Results for the Likelihood-Ratio Test (LRT)

Source	SS	df	MS	Number of obs	=	54
				F(2, 51)	=	9.24
Model	288.136076	2	144.068038	Prob > F	=	0.0004
Residual	795.038817	51	15.5889964	R-squared	=	0.2660
				Adj R-squared	=	0.2372
Total	1083.17489	53	20.4372621	Root MSE	=	3.9483

GDP	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
PDR	.3069628	.0774279	3.96	0.000	.1515198	.4624058
PDR²	-.0025506	.0007623	-3.35	0.002	-.004081	-.0010202
CONSTANT	-3.05644	1.660017	-1.84	0.071	-6.389063	.276183

Likelihood-ratio test — LR chi2(1) = 10.72
(Assumption: linear nested in .) — Prob > chi2 = 0.0011

LR chi2 (1) = 10.72 is the likelihood -ratio test statistic. For the null hypothesis of linearity to be rejected, the probability value of the likelihood ratio test-statistic must be significant at 5percent level of significance. From the table, the probability value of the likelihood ratio test statistic is 0.0011 which is less than the 0.05 significance level. This indicates rejection of the null hypothesis and accepting the alternative hypothesis of non-linear quadratic model between economic growth and public debt-to GDP ratio. The process, codes, and complete output used for this test are provided in Appendix 1 below.

4.8 Long-Run Results of the ARDL Model

Having established the cointegration relationship through bounds test, the ARDL-cointegration was used to estimate the long run equation embedded in equation (1). The output is presented in Table 4.7 below:

Table 4. 7 Long-Run Results of the ARDL Model

Dependent Variable: GDP

Selected Model: ARDL (1, 0, 0, 0, 0, 1, 1, 0) selected based on AIC

Variable	Coefficient	Std. Error	t-Statistic	Prob.
PDR	0.288237**	0.132291	2.178807	0.0350
PDR^2	-0.002750**	0.001070	-2.569591	0.0138
GOVE	-0.156978	0.252778	-0.621011	0.5379
GOVI	-0.315847*	0.185265	-1.704840	0.0956
TROPE	0.110042**	0.048371	2.274965	0.0281
INF	0.015696	0.036153	0.434148	0.6664
POPG	-1.727425	2.380522	-0.725650	0.4721
C	2.845105	8.337241	0.341253	0.7346

Note: **, * represents significance level of 5 % and 10% percent respectively.

From Table 4.7 above, public debt ratio (PDR and PDR^2) and trade openness (TROPE) are statistically significant at 5 percent level of significance in the long run while the other variables are not. An increase in trade openness by 1 percentage point increases GDP by 0.11 percentage points in the long run. In addition, the coefficient on the squared term of public debt ratio (PDR^2) is statistically significant and negative as expected. This further confirms the non-linear effect of

public debt on economic growth. Thus, public debt tends to enhance economic growth before counteracting growth when a certain debt threshold is achieved. In the long run, the significance of the coefficients for PDR and PDR^2 imply that in Ghana, the marginal effect of public debt on economic growth is an increasing function of the debt but to a certain level. Upon reaching this level, the marginal effect of public debt on growth tends to slow economic growth. Hence, policies geared towards ensuring less reliance on accumulated debt due to initial positive benefits realized would ensure growth is enhanced in a sustainable manner. This finding is consistent with earlier research from Iyoha (1999), Drine and Nabi (2010), Cordella *et al*. (2010), Mupunga *et al*. (2015), Reinhart and Rogoff (2010), Omotosho *et al*. (2016), and Sanusi *et al*. (2019), which indicates that a public debt stock that is too high is detrimental to economic growth in developing nations.

Due to the non-linear relationship between debt and growth, it is possible to calculate the equation algebraically or plot the results on an inverted U graph of public debt vs growth to determine the optimal public debt threshold. This threshold is derived algebraically as follows:

$$\frac{\partial GDP}{\partial PDR} = 0.288237 - (2 \times 0.002750)\,PDR = 0$$

$$PDR^* = \frac{0.288237}{0.0055} = 52.40672 \approx 52.4\%$$

4.9 Short-Run Results of the ARDL Model

Due to the bounds test of cointegration, the error correction model was used to obtain short run results. The short run results are provided in Table 4.8 below**:**

Table 4. 8 Short-Run Results of the ARDL Model

Dependent Variable: D(GDP)

Selected Model: ARDL (1, 0, 0, 0, 0, 1, 1, 0) selected based on AIC

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	2.631541	7.727547	0.340540	0.7351
D(PDR)	0.266600**	0.122024	2.184814	0.0345
D(PDR^2)	-0.002544**	0.000987	-2.577066	0.0136
D(GOVE)	-0.145194	0.235092	-0.617607	0.5402
D(TROPE)	0.101782**	0.044670	2.278541	0.0278
D(POPG)	-1.597758	2.194168	-0.728184	0.4705
D(GOVI)	0.046100	0.201878	0.228357	0.8205
D(INF)	-0.015074	0.025550	-0.589969	0.5584
ECT(-1)	-0.924936***	0.146065	-6.332376	0.0000

R-squared	0.530447	F-statistic	18.45151
Adjusted R-squared	0.501699	Prob(F-statistic)	0.000000
Durbin-Watson stat	1.983064		

Note: ***, ** represents significance level of 1 % and 5 % respectively.

The short-run results in Table 4.8 above show that public debt and trade openness are statistically significant at a 5 percent level of significance in the short run. The coefficients for public debt (PDR and PDR^2), which are statistically significant at the 5 percent level of significance, reinforce the non-linear effect on economic growth seen in the long run. This means in the short run, the marginal effect of public debt tends to have a positive impact on economic growth until a certain threshold, where the impact becomes negative. Irrespective of whether it's in the short run or long run, public debt benefits the country, but only up to a certain level. This threshold level in the short run can also be computed as:

$$\frac{\partial GDP}{\partial PDR} = 0.266600 - (2 \times 0.002544)\,PDR = 0$$

$$PDR^* = \frac{0.266600}{0.005088} = 52.397798 \approx 52.4\%$$

Interestingly, the short-run optimal public debt threshold is no different from the long-run optimal threshold. This means even though the marginal coefficients on PDR and PDR^2 may differ in the short and long runs, a debt trajectory is created such that a threshold of 52.4 percent debt-to-GDP or a lower debt-to-GDP ratio is plausible for faster economic growth. It should be noted that the negative impact in the long run is more than the decline in the short run. So, government should be careful exceeding this threshold especially in the long run. In terms of trade openness, an increase in trade openness by 1 percentage point increases economic growth by 0.10 percentage points in the short run. Although this effect is less than the long-run impact, the statistical significance in both the short and long runs implies Ghana's growth is partially rooted in international trade (exports and imports).

Another vital result is the error correction term (ECT). Theoretically, this term must be statistically significant, less than unity in absolute value, and bear a negative sign. From Table 4.8. this ECT is statistically significant at 1percent significance level, less than one in absolute value, and has a negative sign. This ECT further justifies the strong long-run causal relationship indicated by the bounds test. The ECT suggests that 92.4 percent of disequilibrium in economic growth for the past years is corrected within a year. This implies a high rate of convergence toward the long-run equilibrium.

4.10 Diagnostic Checks

To ensure the significance of variables and results discussed are robust, diagnostic tests such as serial correlation, functional form, heteroskedasticity, and structural stability are presented in the tables and figures below:

Table 4. 9 Test for Serial Correlation

Breusch-Godfrey Serial Correlation LM Test:

F-statistic	2.308674	Prob. F(2,40)	0.1125
Obs*R-squared	5.484849	Prob. Chi-Square(2)	0.0644

The null hypothesis for the Breusch-Godfrey Serial Correlation LM Test is the absence of or no serial correlation in our model. The decision rule of this test lies in the p-value (Prob. F(2,40) and the level of significance. Given a p-value of 0.1125 for the F-statistic, which is greater than 1 percent and 5 percent level of significance, we fail to reject the null hypothesis. Thus, the ARDL model is devoid of serial correlation.

Table 4. 10 Test for Functionality

	Value	df	Probability
t-statistic	1.259599	41	0.2149
F-statistic	1.586590	(1, 41)	0.2149

The null hypothesis for the RAMSEY test is the robustness of our specified ARDL model. Given a p-value of 0.2149 for the F-statistic, which is greater than 1 percent and 5 percent level of significance, we fail to reject the null hypothesis. Thus, the ARDL model is devoid of mis-specification.

Table 4. 11 Test for Heteroskedasticity

Heteroskedasticity Test: Breusch-Pagan-Godfrey

F-statistic	1.462680	Prob. F(10,42)	0.1876
Obs*R-squared	13.68999	Prob. Chi-Square(10)	0.1876
Scaled explained SS	22.57472	Prob. Chi-Square(10)	0.0124

The null hypothesis for the Breusch-Pagan-Godfrey test is the absence of heteroskedastic error term in our specified ARDL model. Given a p-value of 0.1876 for the F-statistic, which is greater than 1 percent and 5 percent level of significance, we fail to reject the null hypothesis. Thus, the ARDL model has homoskedastic error term.

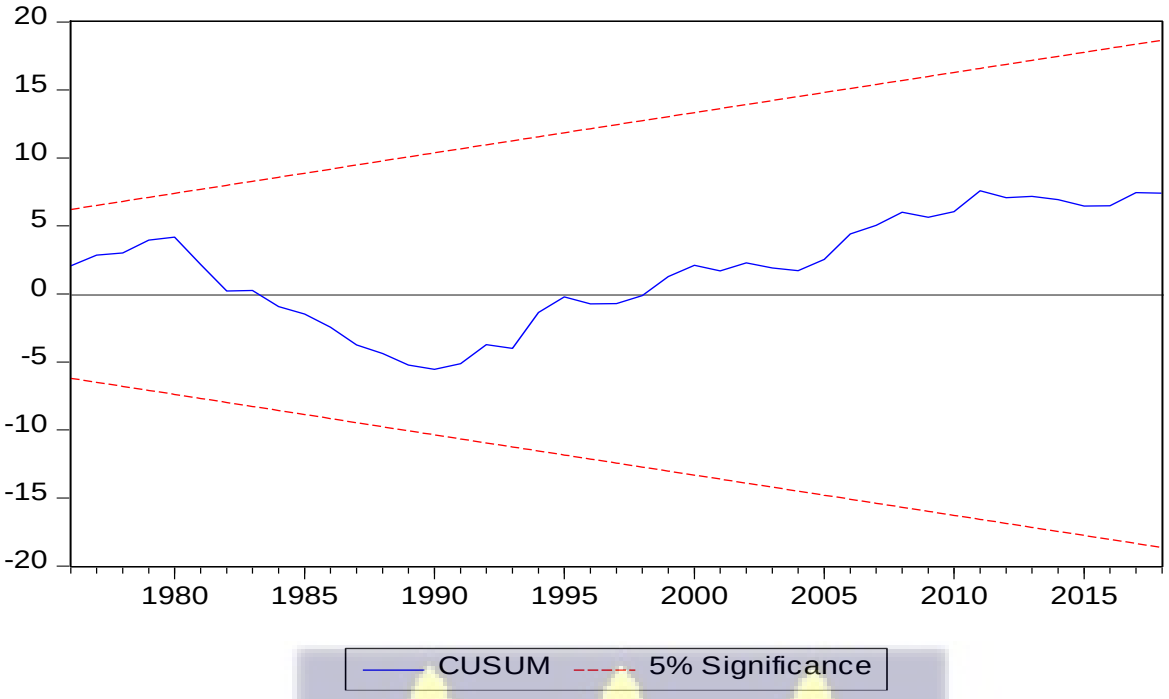

Figure 4. 3 A Plot of the Cumulative Sums (CUSUM).

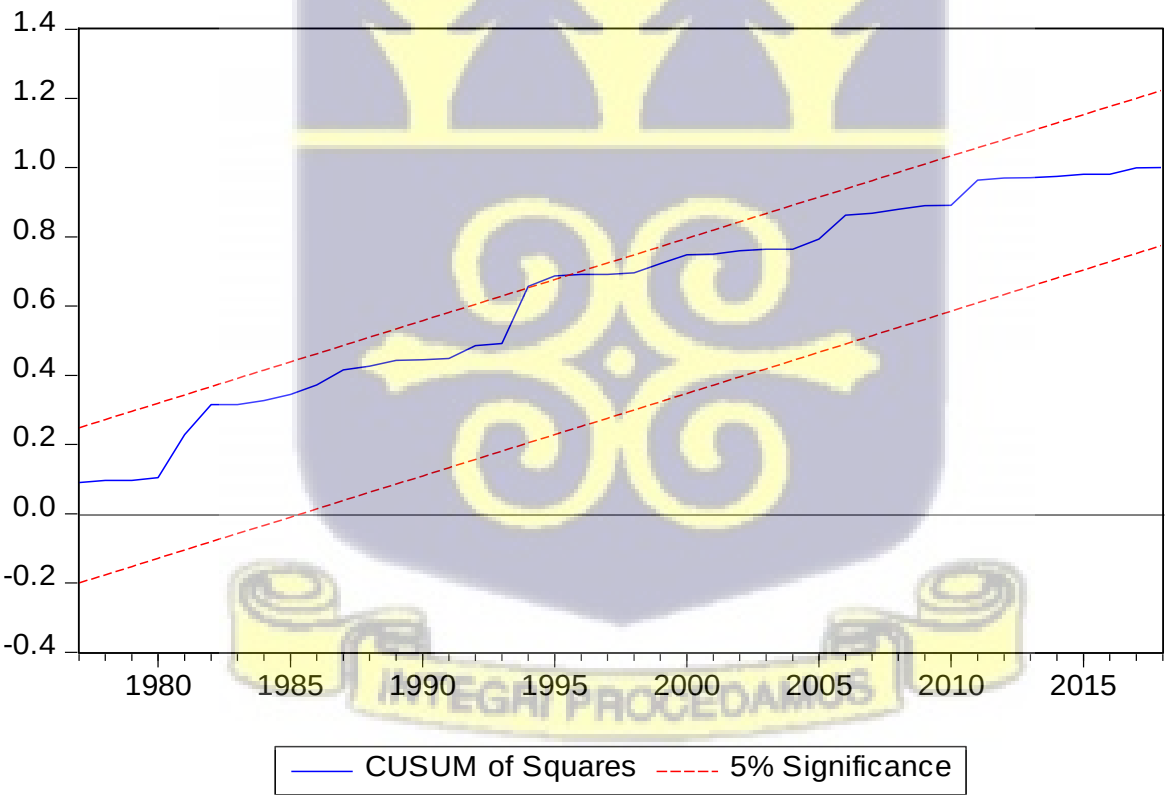

Figure 4. 4 A Plot of the Cumulative Sum of Squares (CUSUMQ).

Figures 4.3 and 4.4 represents the CUSUM and CUSUMSQ (denoted by the middle lines) for the estimated ARDL model. As shown by the graphs, both CUSUM and CUSUMSQ lie within the 5 percent level of significance boundary line. This means the model is stable.

CHAPTER FIVE

SUMMARY, CONCLUSION AND POLICY RECOMMENDATIONS

5.1 Introduction

This study set out to examine the relationship between public debt and economic growth in a non-linear fashion. In this chapter, an appropriate summary with recourse to the overall objective is provided. The results are also summarized in accordance with the study objectives. In addition, final conclusions and appropriate policy recommendations are discussed in this chapter.

5.2 Summary

After the debt crisis in the 1970s and 1980s, public debt in developing countries has been the subject of several debates about its relevance to economic growth. Ghana has had such debates about her after experiencing economic problems in the 1980s. There is some correlation between public debt and economic growth, according to studies by Fosu (1999), Presbitero and Panizza (2012), Cecchetti *et al*. (2011), Anning *et al*. (2016), Lim (2019), Abubakar *et al*. (2020), Asteriou *et al*. (2020), and Pegkas *et al*. (2020). While some researchers found a negative correlation between public debt and economic growth in Ghana, others, including Erickson and Owusu-Nantwi (2016), found a positive correlation.

This study made use of current, fascinating viewpoints on public debt and economic growth that have been discussed in the literature in addition to this spectrum of results from Ghana. The literature has given a lot of attention to discussions on the nonlinear relationship between public

debt and economic development. The traditional linear impacts of public debt on economic growth have been avoided in favor of this strategy. As long as a certain threshold is maintained, according to many of these research that analyse this nonlinear relationship, public debt seems to always have a positive impact on economic growth. The optimal public debt ratio for economic growth has been identified at this value by Mupunga *et al*. (2015), Omotosho *et al*. (2016), and Mensah *et al*. (2019). Numerous researches have been published in the literature on the subject, the majority of which focused on panel techniques. The few African researchers that have made such estimations have all used a panel estimation approach, including Koffi (2019), Mensah *et al*. (2019), Sanusi *et al*. (2019), and Ndoricimpa (2020). However, regardless of sample size, there isn't a single threshold that applies to all nations. The public debt threshold is sensitive to nation-specific statistics, country differences, and the models employed, according to Ndoricimpa (2020) and Bentour (2020). According to Mensah *et al*. (2019), Adi (2019), and Salmon (2021), future studies ought to concentrate on threshold estimation or dynamics specific to particular nations.

This study therefore deemed it necessary to uniquely investigate and estimate the threshold level of public debt in Ghana. This study analysed the impact of public debt on economic growth in Ghana by adopting a non-linear approach. By adopting an ARDL model, this study investigated the relationship between public debt and economic growth with the aim of finding a non-linear optimal debt threshold for economic growth in Ghana from 1965 to 2018. Thorough testing and graphical analysis showed that public debt in Ghana and economic growth have an inverse U-shaped relationship. This was initially demonstrated on a scatter graph representation. Then, the likelihood ratio test as well as the significance of the quadratic terms used in the models confirmed

the non-linear effect of public debt on growth. This meant that the study's initial objective had been achieved.

The study then went on to determine the optimal public debt threshold for Ghanaian economic growth with the proper parameterization and deductive model specification. The threshold was discovered to be 52.4 percent debt-to-GDP using the model that was utilized. This is in contrast to Koffi (2019), who found a threshold of 36.18 percent for sub-Saharan Africa. Additionally, although Mensah *et al*. (2019) discovered a debt barrier of 20 percent to 50 percent for Africa, Ndoricimpa (2020) discovered a debt threshold of 58–63 percent for middle-income nations in Africa, including Ghana. It is obvious that depending on Ndoricimpa (2020) and Mensah *et al*. (2019) for a specific debt threshold that describes a specific country like Ghana could be deceiving. This study's analysis determined that 52.4 percent is the debt ceiling the government should not cross in order to preserve economic growth in the medium to long term. It did this by taking into account enough time series for Ghana. These results' robustness was taken into account. The models used in this study were stable, well-specified, free of serial correlation and heteroskedasticity.

5.3 Conclusion

In light of recent literature talking of a potential non-linear relationship, the primary goal of this study was to determine the precise link between public debt and economic growth in Ghana. Ho and Njindan (2020) discovered a negative impact of debt on economic growth in Ghana, contrary to the findings of Adi (2019), which show a beneficial influence of public debt on growth both in

the short and long terms. There is no doubt that Ghana's economic growth is significantly impacted by governmental debt. The non-linear term (quadratic) form is the most effective way to represent the dual-sign impacts of public debt on growth that are included in this study. The results in this study confirm the existence of a non-linear relationship between public debt and economic growth in Ghana. This means every percentage point increase in the debt-to-GDP ratio in Ghana leads to an effect that could be positive or negative, contingent on whether the optimal threshold level of 52.4 percent has been reached. A positive impact implies that whatever public debt was incurred was engaged in real-sector developmental projects. However, a negative effect due to a departure beyond the threshold could be attributed to less credit given to the private sector, low private investment, capital flight, and the inception of the debt overhang hypothesis. The statistical significance of trade openness means intensifying Ghana's international trade with foreigners would propel economic growth.

5.4 Policy Recommendations

Ghana's debt-to-GDP ratio is currently over 80 percent. Per this study, this is not good for long-term economic growth. Before the impact of the recent COVID-19 pandemic and the Russia-Ukraine war, international organizations like the IMF and Moody's had described Ghana as a debt-stricken country. The recent shutout of Ghana from the international capital market means investors are losing confidence in the government and the country's investment environment. By and large, the crossover of Ghana's public debt ratio above the estimated 52.4 percent does not bode well for long-term growth. According to this study's findings, the country would be able to continue and sustain steady economic growth in both the short and long terms as long as the debt-to-GDP ratio is brought down from its current level of over 80%. Based on this study, Ghana's

government should strive for a debt-to-GDP ratio of less than 52.4% since it will enable faster economic growth. The following concrete recommendations are made by this study:

- Legislate with consequences for each government in power not to exceed a 52.4% debt-to-GDP ratio. This will prohibit excessive borrowing unless GDP growth increases to match the borrowing. It should be incumbent on the Finance Ministry to abide by this threshold if it wants to achieve consistent economic growth. The Parliament of Ghana should check with the Ministry of Finance this legislation. This could also go a long way toward ensuring Ghana's debt is always at sustainable levels since consistent economic growth will generate more tax revenue, thereby making it easy not to default on loans.

- An increase in productive investments can yield positive economic growth. Borrowing to fund social policies or low-yielding projects is not plausible. Borrowing comes at a cost. Therefore, whatever the borrowed amount is invested in should yield high returns, both nominally and in real terms. Since emerging and developing economies have been identified as having a considerably more binding debt threshold than developed countries, the risk of inhibited growth beyond this threshold is inevitable for Ghana. Also, the change in political parties in government poses an abandonment threat to projects and investments made by the leaving government. These risks, however, can be reduced through private sector financing. The Ministry of Business Development should, in conjunction with the private sector, undertake viable and profitable projects since private sector projects mostly thrive irrespective of the government in power.

- Avoid using short-term loans to fund long-term projects. This was a habit for developing countries during the debt crisis. It also easily increases the debt-to-GDP ratio in the short run. And the study found that once the debt-to-GDP threshold of 52.4% is exceeded in the short run, there will be consequences for economic growth. Much of Ghana's plans for economic growth and development focus too much on the long run, overlooking the fact that short-term growth is the stepping stone. The Ministry of Planning (MOP) in conjunction with the Ministry of Business Development (MOBD) can research short-term projects that short-term loans can be diverted into for feasible returns and re-payment of debts.

- Ensuring a stable exchange rate. The Bank of Ghana should ensure it independently maintains a stable exchange rate. This will reduce the depreciation shocks on the external debt, enabling timely payments of the external debt. Without this, debt distress may continue to loom, which is not good for economic growth.

- Improve revenue mobilization measures. Ghana's tax-to-GDP ratio has been below its estimated targets and usually falls below the rate for the sub-Saharan region. This means budget deficits are inevitable. The larger the budget deficit, the greater the proclivity to borrow excessively. Therefore, it is necessary that the Ghana Revenue Authority (GRA) widen its tax base and enforce the law on tax evaders to boost revenue mobilization. In line with this, tax revenue should be the major source of revenue for government expenditures

until the optimal threshold is reached. With the advent of the Ghana Card and the growth in technological investment, it foretells Ghana is on the right path to mobilize revenue across all entities necessary.

- More trade with the rest of the world should be encouraged. Trade openness allows private individuals to competitively produce. Therefore, the Trade Ministry (MOT) should invest a lot more borrowed money in import substitution industries while backing them with regulations that can make international trade easier. This also implies a further boost in offshore revenue and an increase in Ghana's foreign reserves, which can be relied on by the Bank of Ghana for exchange rate stability. We also suggest the implementation of a recovery policy based on debt.

5.5 Limitations of the Study

This study focused on the effects of public debt as a whole on economic growth. Having defined the composition of public debt in terms of external and internal types, limited time series data on domestic debt ratios could not permit this study to analyze a possible non-linear effect of the decomposed debts on economic growth for a long period, such as 1965–2018. Moreover, the channel of the effects of public debt on economic growth was limited to public and private investment spending. Future studies can therefore examine the effect of public debt on growth through its decomposed types, while exploring beyond the channels in this study.

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APPENDICES

APPENDIX 1: LIKELIHOOD RATIO TEST (USING STATA 14)

```
regress gdp pdr

      Source |       SS           df       MS      Number of obs   =        54
-------------+----------------------------------   F(1, 52)        =      6.09
       Model |  113.618843         1  113.618843   Prob > F        =    0.0169
    Residual |  969.556067        52   18.645309   R-squared       =    0.1049
-------------+----------------------------------   Adj R-squared   =    0.0877
       Total |  1083.17491        53  20.4372624   Root MSE        =     4.318

------------------------------------------------------------------------------
         gdp |      Coef.   Std. Err.      t    P>|t|     [95percent Conf. Interval]
-------------+----------------------------------------------------------------
         pdr |   .0581102   .0235403     2.47   0.017      .0108731    .1053473
       _cons |   1.279032   1.134783     1.13   0.265     -.9980767     3.55614
------------------------------------------------------------------------------


.
. estimates store linear


.
. generate Psq = pdr^2
```

```
. regress gdp pdr Psq

      Source |       SS           df       MS      Number of obs   =        54
-------------+----------------------------------   F(2, 51)        =      9.24
       Model |  288.136086         2  144.068043   Prob > F        =    0.0004
    Residual |  795.038824        51  15.5889965   R-squared       =    0.2660
-------------+----------------------------------   Adj R-squared   =    0.2372
       Total |  1083.17491        53  20.4372624   Root MSE        =    3.9483

------------------------------------------------------------------------------
         gdp |      Coef.   Std. Err.      t    P>|t|     [95percent Conf. Interval]
-------------+----------------------------------------------------------------
         pdr |   .3069628   .0774279     3.96   0.000     .1515198    .4624058
         Psq |  -.0025506   .0007623    -3.35   0.002     -.004081   -.0010202
       _cons |   -3.05644   1.660017    -1.84   0.071    -6.389063    .2761828
------------------------------------------------------------------------------

.
. lrtest linear

Likelihood-ratio test                                 LR chi2(1)  =     10.72
(Assumption: linear nested in .)                      Prob > chi2 =    0.0011
```

APPENDIX 2: ARDL Results from E-Views

ARDL Long Run Form and Bounds Test
Dependent Variable: D(GDP)
Selected Model: ARDL(1, 0, 0, 0, 1, 0, 1, 0)
Case 3: Unrestricted Constant and No Trend
Date: 04/06/23 Time: 19:19
Sample: 1965 2018
Included observations: 53

Conditional Error Correction Regression

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	2.631541	7.727547	0.340540	0.7351
GDP(-1)*	-0.924936	0.146065	-6.332376	0.0000
PDR**	0.266600	0.122024	2.184814	0.0345
PDR2**	-0.002544	0.000987	-2.577066	0.0136
GOVE**	-0.145194	0.235092	-0.617607	0.5402
GOVI(-1)	-0.292138	0.167813	-1.740858	0.0890
TROPE**	0.101782	0.044670	2.278541	0.0278
INF(-1)	0.014518	0.032839	0.442092	0.6607
POPG**	-1.597758	2.194168	-0.728184	0.4705
D(GOVI)	0.046100	0.201878	0.228357	0.8205
D(INF)	-0.015074	0.025550	-0.589969	0.5584

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

Levels Equation
Case 3: Unrestricted Constant and No Trend

Variable	Coefficient	Std. Error	t-Statistic	Prob.
PDR	0.288237	0.132291	2.178807	0.0350
PDR2	-0.002750	0.001070	-2.569591	0.0138
GOVE	-0.156978	0.252778	-0.621011	0.5379
GOVI	-0.315847	0.185265	-1.704840	0.0956
TROPE	0.110042	0.048371	2.274965	0.0281
INF	0.015696	0.036153	0.434148	0.6664
POPG	-1.727425	2.380522	-0.725650	0.4721

EC = GDP - (0.2882*PDR -0.0028*PDR2 -0.1570*GOVE -0.3158*GOVI +
0.1100*TROPE + 0.0157*INF -1.7274*POPG)