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DEPARTMENT OF ECONOMICS

THE IMPACT OF POPULATION GROWTH ON ECONOMIC GROWTH (DEVELOPMENT) IN ZIMBABWE (1980-2022).

BY

MIRRABEL KUMBIRAI MAKUBIKA

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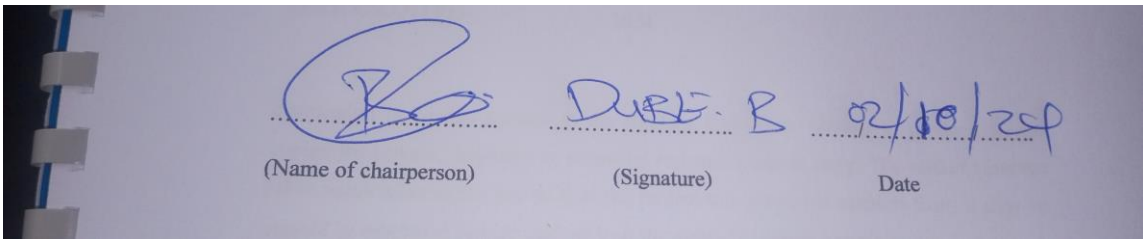
SUPERVISOR: DR DAMIYANO

APPROVAL FORM

The undersigned certify that they have supervised, read and recommend to the Bindura University of Science Education for acceptance of the research project entitled**: THE IMPACT OF POPULATION GROWTH ON ECONOMIC GROWTH (DEVELOPMENT) IN ZIMBABWE (1980-2022)** submitted by **MIRRABEL KUMBIRAI MAKUBIKA** in partial fulfilment of the requirements for the **BACHELOR OF SCIENCE (HONOURS) DEGREE IN ECONOMICS.**

DAMIYANO……………….……….. ……………………….. ..24../……09……../2024……..

(Name of supervisor) (Signature) Date



(Name of chairperson) (Signature) Date

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(Signature of Examiner (s)) (Signature) Date

RELEASE FORM

NAME OF AUTHOR: MIRRABEL KUMBIRAI MAKUBIKA

STUDENT NUMBER: B203068B

PROJECT TITLE: The impact of Population growth on Economic growth (development) (1980-2022)

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16676 GANGES ROAD
BELVEDERE, HARARE

DEDICATION

I dedicate this dissertation to my mother and father for their continued love and support from the start of this journey. I hope to make you proud through my work

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I'd like to begin by expressing my deepest gratitude. First, to God for the gift of life, for guidance, and for the unwavering strength that helped me persevere through my studies. My sincere appreciation also goes to Dr. Damiano, my project supervisor, for providing invaluable corrections and insightful suggestions throughout this research project. Additionally, I'd like to thank Mr. Kanyekanye for his constant support. His willingness to answer my questions, address challenges, and offer clarity on various matters was instrumental in my success. Finally, a big thank you to my classmates for their camaraderie throughout our academic journey. Your support has meant a lot.

My deepest thanks go to my parents for their unwavering love and support, especially during moments of doubt. Their belief in me was a constant source of strength. I also extend my gratitude to my friends and family for their invaluable advice and for offering moments of laughter and respite throughout this journey.

May the Lord bless you all.

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LIST OF ACRONYMS

ADF	Augumented Dick-Fuller
ARDL	Autoregressive Distributed Lag
AIC	Akaike Information Criterion
CUSUM	Cumulative Sum
EC	Electricity Consumption
FDI	Foreign Direct Investment
GDP	Gross Domestic Product
GFCF	Gross Fixed Capital Formation
IMF	International Monetary Fund
PAD	Post dollarization era
PBD	Before dollarization
PDD	Dollarization era
PER	Personal Remittances
POP	Population Growth
UN	United Nations
WDI	World Development Indicators
XG	Export Growth

ABSTRACT

This research investigated how population growth in Zimbabwe affected economic growth between 1980 and 2022. It employed a statistical technique called the Autoregressive Distributed Lag model (ARDL) to analyze secondary data. The independent variables used where population growth. Foreign Direct Investment, Gross Fixed Capital Formation, Export of goods and services and electricity consumption. After estimation, results showed that the relationship between population growth and economic development was negative in the short-run and positive in the long-run. The other independent variables except export of goods and services were statistically significant in the short-run showing a positive relationship among them and the dependent variable. After establishing these short and long-run relationships, the study went on to recommend government policies that help mitigate the negative impact of population growth on economic growth.

CHAPTER ONE

INTRODUCTION

1.0 Introduction

Population growth is a crucial demographic factor that has far-reaching implications for various aspects of a country's development, including its economic growth. Zimbabwe, a landlocked country in Southern Africa, has experienced significant population growth over the years. Understanding the relationship between population growth and economic growth in Zimbabwe is of utmost importance for policymakers and researchers alike, as it provides insights into the country's development trajectory and helps inform strategies for sustainable economic progress. The relationship between population growth and economic growth has been a subject of ongoing debate in the field of economics. While some argue that a larger population can stimulate economic growth by providing a larger labour force and consumer market, others highlight the potential negative effects of overpopulation, such as increased pressure on resources, unemployment, and income inequality. Therefore, examining the impact of population growth on economic growth in Zimbabwe is vital to gain a comprehensive understanding of the dynamics at play.

1.1 Background

Rapid population growth is a global phenomenon with significant economic implications. The world population has exploded from 4.4 billion in 1980 (World Bank, 2020) to 7.8 billion in 2020 (World Bank, 2020), and projections estimate it will reach 9.8 billion by 2050 (United Nations, 2017). African countries are expected to see a particularly dramatic doubling of their populations by that time. Economists grapple with three main theories regarding the link between population growth and economic development: One school of thought argues that population growth can act as a catalyst for economic growth. A larger population can provide a larger workforce and potentially drive innovation. In contrast, (Malthus, 1798) famously theorized that population growth ultimately outpaces resource availability, leading to scarcity and economic strain. Rapid population increase can strain resources like food, water, and infrastructure, hindering economic progress. Some argue that population growth has a negligible impact on economic growth, suggesting other factors play a more significant role

1.2 Population growth and Economic growth in Zimbabwe

Figure 1.1 illustrates the historical pattern of Zimbabwe's population growth and GDP between 1980 and 2022. The population growth rate in Zimbabwe has varied over this period as shown in the figure below. The highest population growth rate was recorded in 1981 at 6.2%. This was just after independence in 1980. In 1982 the growth rate decreased to 3.8% and had a consistent growth rate average of 3.4% from 1982 to 1988. Population continued to decrease to 2.5% in 1992. The lowest recorded population growth was in 2005 at 0.5%.

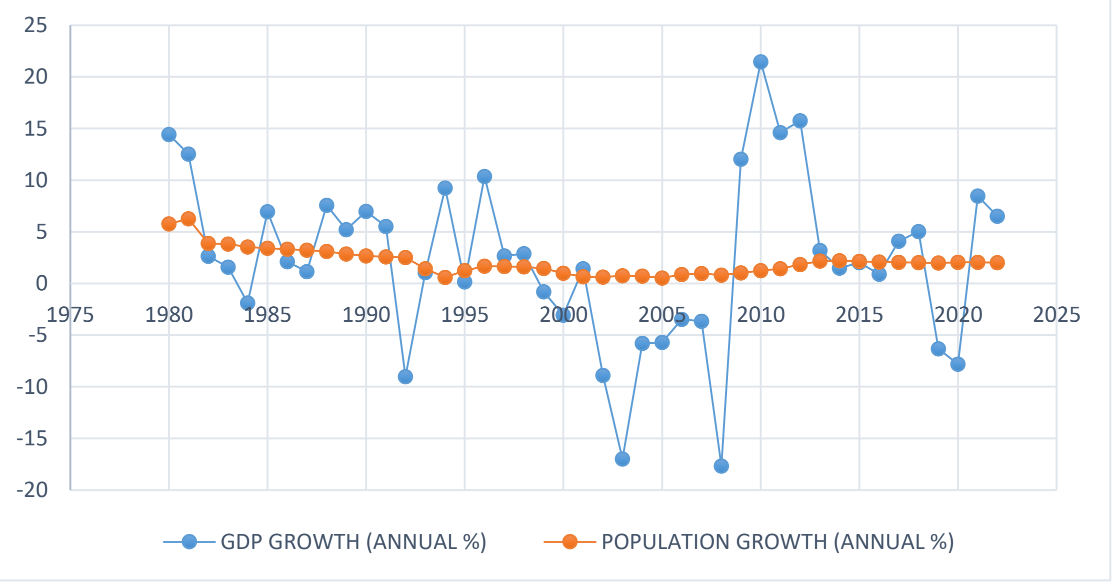


Figure 1.1 Trends in GDP growth and population growth over the period 1980-2022

Source: World Bank Indicators

During the same time period, the rate of GDP was cyclical. As can be observed from figure 1.1, the growth rate has also been fluctuating over the years. Gross Domestic Product growth rate dropped to -7.8% in 2020 from an all-time high of 21.4% in 2010. The Zimbabwean economy went through times of economic hardship between 2000 to 2008 with the lowest recorded growth rate recorded in 2008 at -17.6%. However, Zimbabwe experienced an economic turnaround in 2009 to 2012 recording growth rates of 12.0%, 21.4%, 14,6%, and 15,7% respectively.

1.3 Statement of the Problem

The link between population growth and economic performance is a complex and debated topic. While some see it as a burden, others argue it can unlock positive economic forces. Proponents of this view highlight how a larger population creates a bigger pool of labour, potentially acting as an innovation engine as people seek solutions to meet growing demands. This increased competition can also incentivize businesses to become more efficient and potentially boost a nation's exports. A larger domestic market can further attract foreign investment (FDI) as companies see a wider customer base. As the economy grows alongside the population, its market expands, potentially creating opportunities for new businesses to thrive. This perspective aligns with the views of scholars like (Simon, 1992). However, it's important to acknowledge the ongoing debate and explore the potential downsides of population growth in future research.

When it comes to the relationship between population increase and economic growth, cross-national evidence exhibits inconsistency since different countries employ different underlying factors and assumptions. The material that is now available also emphasizes that, depending on the nation, population expansion may promote, hinder, or even have no effect on economic growth. The fact that the consequences of population expansion vary throughout time helps to explain this. The following research questions surfaced as a result of the disagreement among academics over whether population growth contributes positively or negatively to economic growth:

1. How do population increase and economic growth interact with one another?
2. Is the phenomena of the relationship short- or long-term?
3. How does population expansion react to economic shocks?
4. How does economic growth respond to shocks in population growth?
5. What are the causes of variations on economic growth?

1.4 Research Objectives

1. To determine the relationship between population growth and economic growth in Zimbabwe
2. To determine whether the relationship between population growth and economic growth is in the short-run or long-run
3. To determine the impact of the other research variables on economic growth

1.5 Significance of the study

Population growth is a critical factor shaping a nation's economic development, and this study delves into this complex relationship specifically within the context of Zimbabwe. Motivated by the ongoing debate surrounding the impact of population growth on economic performance, the aim is to contribute valuable knowledge in this area. The study will achieve this by analysing data and trends related to population growth in Zimbabwe and providing insights into how it influences the country's economic development. This research has the potential to serve as a valuable resource for policymakers. By shedding light on the relationship between these factors and the relevant explanatory variables, the study can inform policy evaluation and the formulation of new initiatives to promote economic growth in Zimbabwe.

1.6 Limitations of the Study

Focusing on population growth in Zimbabwe from 1980 to 2022, this research offers valuable insights. However, it leaves room for further exploration of how other population dynamics, like aging, density, and age distribution, affect economic growth.

1.7 Definition of Terms

The following variables are the variables that shall be used throughout the study. For easy understanding they are defined as follows from the World Bank data:

1. Gross Domestic Product growth (annual %): GDP is a measure of the total value of all goods and services produced within a country's borders over a specific period, usually a year. It serves as an indicator of the economic activity and the overall size of an economy. According to (Mankiw, 1992) Gross domestic product is the sum of consumption, government spending, investment and net exports (exports minus imports) of a country's economy.
2. Population growth (annual %): Population growth refers to the rate at which the population of a specific area or country increases or decreases over time. It is typically expressed as a percentage and reflects the change in the total number of individuals within a population during a specified period (United Nations, Department of Economic and Social Affairs, Population Division., 2019)
3. Gross fixed capital formation (% of GDP): Gross fixed capital formation includes land improvements (fences, ditches, drains, and so on); plant, machinery, and equipment purchases; and the construction of roads, railways,

and the like, including schools, offices, hospitals, private residential dwellings, and commercial and industrial buildings. According to (United Nations, 2008) Gross Fixed Capital Formation is "measured by the total value of the gross fixed capital formation of resident institutional units"

4. Foreign Direct Investment (FDI), net inflows (% of GDP): Foreign Direct Investment refers to the investment made by an entity or individual from one country (the investor) in another country (the host country), with the intention of establishing a lasting interest and exerting significant control over the operations of an enterprise in the host country. FDI involves the acquisition of equity or ownership stakes in enterprises located in the host country. (IMF, 2013)
5. Electric power consumption (kWh per capita): refers to the amount of electricity consumed per capita within a specific geographical area or country. It is typically measured in kilowatt-hours (kWh) and serves as an indicator of the level of electricity usage by individuals within an economy (World Bank, 2020)
6. Exports of goods and services (% of GDP): Export growth as a % of GDP measures the rate at which a country's exports (the value of goods and services sold to other countries) are growing in comparison to the size of its Gross Domestic Product (GDP). (World Bank, 2020). It quantifies the contribution of exports to the overall economic activity of a country.

1.8 Conclusion

Having established the foundation for our research through the background, purpose, and significance of this study, the following structure will guide the research. Chapter two will delve into the relevant theoretical frameworks and existing research (empirical literature) on the topic. This will provide a strong foundation for understanding the relationship between population growth and economic development. Chapter three, will then outline the research methodology employed in the study. Here, the specific methods used to gather and analyse data, ensuring a clear and replicable approach. Chapter four, will present the results of the analysis along with interpretations discovered. This will be the heart of the research, revealing the insights gained from the data. Finally, the concluding chapter 5, will offer the conclusions based on the research findings and provide recommendations for future considerations. This final chapter will synthesize the research and offer valuable takeaways that can inform policymakers and future research endeavours.

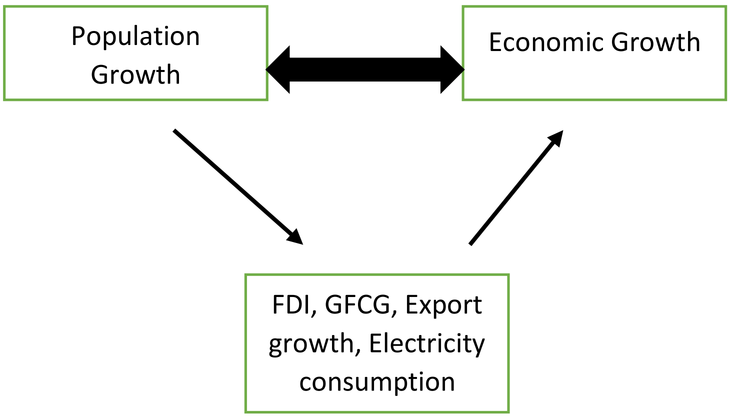
CHAPTER 2

LITERATURE REVIEW

1.0 Introduction

This chapter provides a comprehensive analysis of theoretical and empirical evidence regarding the impact of population growth on economic growth. It explores theories such as the Malthusian growth theory, Demographic Transition theory and the Population-Human Capital theory. The chapter will examine the main premise of the theories and how they contribute to the understanding of the relationship between population and economic growth. The chapter will also review empirical studies that have examined the relationship between population growth and economic growth. Limitations inherent in this area of research shall also be included in this chapter.

2.1 Conceptual Framework



The above diagram is adapted from the study by (Robert, 2020) in his study of the Impact of Population Growth on Economic Growth.

2.2 Theoretical Literature

This section presents an overview of the theoretical frameworks that have been used to analyse the impact of population growth on economic growth. It will examine 3 main theories mainly focusing on the key assumptions, premise, relevance to the topic as well as theory limitations.

2.2.1 Malthusian Growth Model

This theory was proposed by Thomas Malthus in the late 18th century. It attempts to explain the relationship between population growth and economic development. In his work, "An Essay on the Principle of Population", it posits that population growth tends to outpace the growth of resources leading to a struggle for existence and ultimately checks on population growth (Malthus, 1798). The major premise of the Malthusian model is that population growth if left unchecked, it will eventually outstrip food supply, leading to famine, disease and other catastrophic events that limit population size (Leblois, 2022). He believed that the population has a tendency to increase at a faster rate than the availability of resources, leading to a situation where there are more people than the resources are able to sustain.

Thomas Malthus made several assumptions in his model. He assumed that population would grow exponentially. Malthus assumed that population grows at a geometric rate, meaning that it doubles over a fixed period of time, such as over 25 years. Malthus also assumed that there was limited resource growth especially in food production which can only increase linearly. He argued that technological advancements or other factors can only lead to incremental increase in resource availability. Malthus proposed that when population exceeds the available resources, positive checks such as famine, disease, and war would naturally occur, thereby reducing the population to a level sustainable by the available resources.

The Malthusian Growth Model is relevant to the study of the impact of population growth on economic growth because it provides warning about the potential negative consequences on unchecked population growth. Malthus argued that when population outweighs the growth of resources, it can lead to social unrest, poverty and even starvation. However, it is important to note that the Malthusian Model has been subject to criticisms and does in fact have its limitations. The main criticism to the Malthusian Growth Model is that of technological progress and innovation. The model overlooks the role of technological progress and innovation in expanding resource availability and overcoming resource constraints. According to (Strulik, 2019) the Malthusian theory fails to take into account the dramatic increases in agricultural productivity and food production enabled by the Green Revolution and other technological advances.

The Malthusian Growth Model also over simplifies its assumptions (Vollrath, 2020) and does not take into account human ingenuity and adaptability to help mitigate the negative consequences of population growth. Human beings have demonstrated a remarkable ability to adapt and find innovative solutions to challenges posed by population growth. Critics argue that economies have the ability to substitute different resources and production methods as scarcity arises (Leblois, 2022). Malthus argues that it is due to population increase that resources become scarce. Although partially true, governments are able to restructure their limited resources and improve production methods to combat the increase in population.

Lastly, critics suggested that the Malthusian Growth Model lacked foresight in predicting the long term relationship between population growth and economic trends. (Desmet, 2020) stated that the Malthusian theory has struggled to accurately predict long-term population and economic trends, especially in the modern era. Times have changed and economies have grown far more than what Thomas Malthus ever predicted. The famines and population collapses that he predicted simply did not occur in the modern world.

2.2.2 Demographic Transition Theory

The Demographic Transition Theory was proposed by Warren Thompson in the late 1920s and early 1930s. it provides a framework for understanding the historical shifts in population dynamics and fertility observed in industrialised countries (Thompson, 1929). The theory suggest that a society experiences a transition from a state of high birth rates and high death rates to a state of low birth rates and low death rates as it undergoes economic and social development.

Its main premise is that there is a systematic relationship between economic development, social change and demographic patterns. According to (Feeney, 2022) the demographic transition theory posits that as societies progress from agrarian economies to industrialized economies they undergo a series of demographic stages. As death rates start to decline due to improvements in sanitation, nutrition and healthcare, while birth rates remain high, population is likely to increase rapidly. The theory makes two key assumption. Firstly, it assumes that changes in the birth and death rates are primarily driven by socioeconomic factors. These may include improvements in healthcare, education, and living standards. Secondly, it assumes there is a period of rapid population growth known as the ‘demographic transition’ due to a lag between decline in death rates and decline in birth rates.

The relevance of the Demographic Transition Theory to the study lies in its insights into the relationship between population dynamics and economic processes. The theory suggests that with declining death and birth rates, they experience shifts in the population age structure, which can have significant implications for economic development (Bloom, 2021). In the early stages of the transition, the declining death rates lead to population growth. This can potentially contribute to labour force expansion and productivity. However, if not accompanied by appropriate policies and investments in education, employment opportunities and, healthcare, rapid population growth can strain resources and hinder economic development.

As countries continue further more into the demographic transition, they may suffer negative impacts. According to (Choi, 2022) with low birth and death rates, countries face challenges associated with an aging population and a shrinking working force. This can have implications for the economic growth, labour supply, healthcare systems, and pension schemes. The demographic transition exacerbate intergenerational tensions and inequalities as the working-age population bears the burden of supporting a larger dependent population. The Demographic Transition theory highlights the importance of policies and instruments in human capital through improved healthcare systems, education schemes, employment opportunities, and social support systems to ensure that population growth is in harmony with economic development goals (Bloom, 2021).

Critics such as (Kebede, 2022) criticised the Demographic Transition Theory in his work “Demographic heterogeneity, cohort quality, and economic growth”, argued that the Demographic Transition model does not take into account the diversity of country-specific social, cultural and economic factors that lead to the difference in experiences of demographic transition, challenging the models universal applicability

(Boco, 2023) highlights that the model does not sufficiently address that the demographic process can exacerbate social economic inequalities and vulnerabilities. This is caused by the increased burden of the dependent population on the working age population. Critics also argue that the model overlooks the critical role of institutional and policy environments and shaping the pace and outcome of demographic transition. Governments may put into place policies that control the growth of the population depending on how they intend to move the economy forward. Lastly, some critics argue that the Demographic Transition Theory places less emphasis on the consequences of population aging and challenges associated with an aging population (Bloom, 2021) suggests that the model should also incorporate these implications more explicitly as the aging population can strain social security systems and healthcare expenditures.

2.2.3 Population-Human Capital Theory

The Population-Human Capital Theory, also known as the population resource theory has been developed and discussed by various scholars in the field of economics. Notable contributors include Gary Becker, Robert Barro, Robert Lucas, and Oded Galor. The theory suggests that there is a positive relationship between population increase in the human capital base of a society. The Population-Human Capital theory posits that a larger population can lead to an expansion of the skills, education and health of individuals within the population. The major premise of the human capital theory is that a larger population can generate positive effects on human capital formulation which in turn leads to economic development and productivity. This premise suggests that an increase in population size can lead to a larger labour force, increased knowledge, spill overs, enhanced education and health infrastructure, and economies of agglomeration (Acemoglu, 2021).

The theory has four main assumptions. Firstly, it's assumes that a larger population provides a larger pool of workers increasing productivity, innovation, and also economic growth. Secondly, it assumes that a larger population facilitates the exchange of knowledge and ideas among individuals, fostering learning, innovation and human capital development. Thirdly, a larger population also generates increased demand for educational and health care services, leading to greater investment in these areas. Lastly, it assumes that urbanisation and urban agglomeration effects can improve access to education and enhance educational attainment and boosting human capital (Duranton, 2020).

This theory is relevant to the study in that it provides insights to the relationship between population dynamics and human capital formulation. The theory suggests that population growth can contribute to the expansion of human capital base which can have positive effects on economic development, productivity, and overall well-being if associated with investments in education and healthcare (Canning, 2018). The

Population-Human Capital Theory emphasizes the importance of investing in education, healthcare, and other social economic infrastructure to ensure that the population growth leads to an economic development. However, it is important to note that the relationship between population growth and human capital formulation is complex and dependent on various factors. The quality of education measured by student learning outcomes and healthcare systems, government policies, institutional frameworks, and social economic conditions all pay a crucial role in determining the outcomes of population growth and human capital development and economic development (Hanushek, 2020).

As relevant as the population human capital theory is to the study it also has its limitations. One criticism is that they may be a mismatch between skills and job market. Rapid population growth can lead to an oversupply of labour in certain areas or occupations, resulting in underemployment. Critics also argue that population growth can strain available resources and lead to diminishing returns. (Vollset, 2020) argues that rapid population growth can strain the availability of natural resources, infrastructure and public services which can potentially limit the ability to invest in human capital investment.

2.3 Empirical Literature

This section reviews empirical studies that have examined the relationship between population growth and economic growth. The empirics will center on research objectives and look at the various studies that may support or disregard the relationship between population growth and economic development

2.3.1 The relationship between population and economic growth

Using panel data of 167 countries from 1960 to 2019 (Cuaresma, 2022) employed econometric approaches to investigate the relationship between population growth, income per capita, and economic growth. Their study discovered that higher population growth was associated with lower per capita income growth and this was particularly true in low-income countries. In his study "Human Capital and Economic Development," (Barro, 2021) looked at the relationship between population growth, human capital, and economic growth in a variety of countries and historical periods. He found that economic growth was positively impacted by investments in human capital through skill development and education, particularly when these programs were combined with population growth. A research similarly by (Cai, 2020) investigated the connection between China's economic expansion and population increase. They discovered that, the country's market oriented reforms during the period of 1978 to 2000 were accompanied by a positive relationship between population growth and GDP growth, as the expanding labour force contributed to rapid economic expansion.

However, there are also studies that showed a negative relationship between population growth and economic growth. For example, (Guilló, 2021) investigated 115 countries for the past decade for a study. The authors discovered high population, especially in developing nations, is associated with a slowdown in labour productivity growth, suggesting that demographic factors drag economic growth. Another study by (Dasgupta, 2021) found that as the population grows unchecked, environmental challenges such as deforestation,, water scarcity, and pollution can ultimately constrain economic growth and wellbeing.

2.3.2 To Determine if the Relationship between Population growth and Economic Growth is in the long or short-run

The study by (Sanderson A, 2019) investigated the relationship between human capital development and economic growth in Zimbabwe. It utilized time series data from 1980 to 2015. The study proved that there is a long-term and short-term correlation between Zimbabwe's economic growth and the development of its human capital. The relationship has conflicting meanings. Both in the short and long terms, government spending on health care serves as a good proxy for human capital development, which is important for determining economic growth. A healthy labour force is essential to Zimbabwe's economic success, as seen by the favourable long- and short-term relationships between government spending and GDP growth. A workforce in good health will be more effective and productive than one in poor health. The positive correlation between life expectancy, a proxy for health quality, and economic growth adds more evidence to this.

However, the study also discovered that, over time, economic growth is negatively affected by the development of human capital, as measured by government spending on education. This could be because the government's excessive consumption in the form of too frequent and wasteful spending that can "crowd-out" private participation in the economy, which may slowdown economic growth. The results of the study also show in the short-run, government spending on education has no bearing on economic growth. This could be as a result of the delay in adding to the stock of human capital after investing in it.

2.3.3 To determine the impact of the other research variables on economic growth

(Maune A, 2023) Conducted the study using the Time Series Data Linear Regression model TSDLRA and discovered that all of the dependent variables FDI, GCF, and PER had positive and significant effects on the nation's GDP at the 1% significance level based on the results obtained from the model. The research was carried out during three distinct economic conditions, pre-dollarization, during dollarization, and post-dollarization of the Zimbabwean economy. According to the study's conclusion, Zimbabwe's GDP was negatively and significantly impacted by the time before dollarization (PBD), which may have lowered the country's chances for future growth and development. Additionally, the study found that the dollarization era (PDD) significantly and positively impacted the GDP of the nation.

The study also found that the GDP of the nation was significantly and strongly positively impacted by the dollarization (PDD) phase. To put it another way, FDI, GCF, Personal Remittances (PER), and dollarization all directly impacted Zimbabwe's potential for economic growth. However, the post-dollarization era (PAD) had a detrimental impact on Zimbabwe's access to FDI, GCF, and PER, which reduced the country's potential for economic growth. Zimbabwe's GDP growth rates were negatively and significantly impacted by the long-term personal remittances (PER). There was a slight positive correlation between Zimbabwe's GDP and the constant term in the multiple regression model.

2.4 Research Gap

The research is significant in that it is a recent study of the impact of population growth on economic development. Studies obtained in empirical evidence either do not study this impact in Zimbabwe, is outdated, does not have all the variables of the study or does not use the ARDL model. The research aims to bridge the gap between theoretical and empirical study and study the impact of population growth on economic growth in Zimbabwe. Study variable show significance in providing such analysis based on theoretical evidence

2.5 Conclusion

The chapter examined theoretical literature and empirical literature of the study impact of population growth on economic growth. It included theories such as the Malthusian growth model, Demographic Transition theory, and Population-Human Capital theory. The chapter also examine evidence from scholars relevant to the study question and provided the research gap between theoretical and empirical literature and aims to bridge the gap in the following chapters.

CHAPTER 3

RESEARCH METHODOLOGY

3.1. Introduction

This chapter provides an overview of the research methodology employed to investigate the impact of population growth on economic growth. The ARDL approach is chosen as the analytical framework, enabling the examination of both short-term and long-term relationships among variables. The variables considered in the study include Gross Domestic Product, Foreign Direct Investment, Population growth, Export growth as a % of GDP, Electricity Consumption, and Gross Fixed Capital Formation. By utilizing this methodology, the research aims to shed light on the complex relationship between population growth and economic growth.

3.2 Model Specification

This paper builds on Umar's model by adding gross fixed capital formation, electricity consumption and export growth as a % of GDP to find the effect on economic growth. The study used annual time series data between 1980 and 2022. In addition, Eviews9 was used as statistical software for analyzing the available data, which has been transformed to their natural logarithm. All the data are sourced from World Development Indicators (WDI) of World Bank.

From Okun's model we develop a simple equation to capture the objective of this paper;

$$GDP_t = f(POP_t, GFCF_t, FDI_t, EC_t, XG_t)$$

Transforming the model into an econometric model we have the following:

$$GDP_t = \beta_0 + \beta_1 POP_t + \beta_2 GFCF_t + \beta_3 FDI_t + \beta_4 EC_t + \beta_5 XG_t + \varepsilon_t$$

If we transform it into a log form, we have;

$$InGDP_t = \beta_0 + \beta_1 InPOP_t + \beta_2 InGFCF_t + \beta_3 InFDI_t + \beta_4 InEC_t + \beta_5 InXG_t + \varepsilon_t$$

Where:

GDP: Gross Domestic Product, which is the dependent variable β_0, is expected to be positive $\beta_0 > 1$

POP: Population growth with the rate at which the Zimbabwean population is growing. Thus the coefficient is β_1, is expected to be positive on economic growth i.e $\beta_1 > 0$

GFCF: Gross Fixed Capital Formation is an indicator measuring the total value of new fixed assed acquired and produced by businesses, governments and households within an economy during a specific period. Thus, the coefficient is β_2, is expected to be positive i.e $\beta_2 > 0$

FDI: Foreign Direct Investment is an instrument in the form of a controlling ownership in a business in one country by entry based on another country. Thus, its coefficient is β_3, is expected to be positive i.e $\beta_3 > 0$

EC: Electricity Consumption is the amount of electrical energy consumed by individuals, households, businesses, and industries in the country. Thus its coefficient is β_4, is expected to be positive i.e $\beta_4 > 0$

XG: Export growth as a % of GDP qualifies the increase in the country's exports relative to the size of the economy. Thus the coefficient is β_5, is expected to be positive $\beta_5 > 0$

The unrestricted error correction model, (ECM) for ARDL is specified below:

$$\Delta GDP_t = \varphi_1 + \varphi_2 + \sum_{i=1}^{p} \beta_0 \, \Delta GDP_{t-1} + \sum_{i=1}^{p} \beta_1 \, \Delta POP_{t-1} + \sum_{i=1}^{p} \beta_2 \, \Delta GFCF_{t-1} + \sum_{i=1}^{p} \beta_3 \Delta FDI_{t-1} + \sum_{i=1}^{p} \beta_4 \Delta EC_{t-1} + \sum_{i=1}^{p} \beta_5 \Delta XG_{t-1} + \sum_{i=1}^{p} \alpha_0 \Delta GDP_{t-1} + \sum_{i=1}^{p} \alpha_1 \Delta POP_{t-1} + \sum_{i=1}^{p} \alpha_2 \Delta GFCF_{t-1} + \sum_{i=1} \alpha_3 \Delta FDI_{t-1} + \sum_{i=1}^{p} \alpha_4 \Delta EC_{t-1} + \sum_{i=1}^{p} \alpha_5 \Delta XG_{t-1} + \varepsilon_t$$

Where:

φ_1: Short-run intercept

φ_2: Long-run intercept

t: Time

Δ: Difference Operator

3.3 Variable Justification

3.3.1 Gross Domestic Product

This research focuses on the annual percentage change in a country's economic output, measured by Gross Domestic Product (GDP). GDP considers the value of all goods and services produced within a nation's borders, adjusted for inflation (constant local currency). In simpler terms, it reflects the overall growth of the economy year-over-year. The research analyses this metric (GDP growth) as the dependent variable in our model, meaning it's the outcome we are trying to explain or predict based on other factors.

3.3.2 Population Growth

This factor, annual population growth rate, represents the year-over-year change in a country's population. It's calculated as the exponential growth rate between midpoints of two consecutive years (World Bank, 2020).The model includes population growth rate as a key explanatory variable. This research is particularly interested in understanding how population changes might impact economic development.

3.3.3 Foreign Direct Investment

Foreign Direct Investment (FDI) refers to the net inflow of foreign capital into a country, typically in the form of stocks, retained earnings by foreign companies, and long-term loans (World Bank, 2020). This metric is another explanatory variable in our model, and we expect it to have a positive influence on economic development. The idea is that foreign investment brings in fresh resources and expertise, potentially boosting economic growth.

3.3.4 Gross Fixed Capital Formation

This factor, Gross Fixed Capital Formation (GFCF), refers to investments in a country's infrastructure and productive capacity. It includes things like building improvements, machinery purchases, and construction of roads, schools, and homes. (World Bank, 2020). The model considers GFCF because it's expected to rise alongside population growth. As a population grows, the need for more homes, schools, and other infrastructure typically increases. This suggests that GFCF might play a role in influencing economic growth.

3.3.5 Electricity Consumption

This factor, electricity consumption per person (kWh per capita), reflects a nation's electricity use. It considers the net production of power plants, excluding any losses during transmission or the power plants' own consumption (World Bank, 2020). The model incorporates this variable because electricity use is expected to rise as the population grows. More people naturally require more electricity for homes and industries. This increased demand for electricity could, in turn, stimulate economic activity.

3.3.6 Export Growth as a % of GDP

The model also considers a crucial factor: a nation's exports, measured as a percentage of GDP (Gross Domestic Product). Exports encompass the value of all goods and services sold to other countries. This includes physical products, transportation costs, intellectual property rights, and various services like tourism and finance (World Bank, 2020). We expect exports to rise alongside population growth, potentially leading to a positive impact on economic growth. The logic is that a larger population can contribute to a greater production of goods and services for export, generating revenue that flows back into the economy.

3.4 Data Presentation and Analysis Procedures

3.4.1 Diagnostic Tests

3.4.2 Unit root test

The ARDL approach relies heavily on a test called the unit root test to assess the stability of variables in the model. A stable variable, also known as stationary, has statistical properties that don't change significantly over time. Imagine a variable like water level in a lake – it might fluctuate slightly, but overall stays within a certain range. A non-stationary variable, on the other hand, can exhibit trends or drifts over time. Since many economic models require stable variables, the unit root test (like the ADF or Phillips-Peron test) helps us determine if a variable is stationary or not. The test works by checking a specific assumption:

Null Hypothesis (H0): The variable has a unit root, meaning it's non-stationary.

Alternative Hypothesis (H1): The variable is stationary and doesn't have a unit root.

In the ARDL context, we run this test on all the variables in the model, including both the dependent variable (what we're trying to explain) and the independent variables (the factors influencing it). This ensures the variables are appropriate for the model and have the right level of stability.

3.4.3 Optimal Lag Length Test

An important step in the ARDL approach involves selecting the optimal lag length for the model. This refers to the number of times past values of each variable are included to account for their influence on the current outcome.To find this ideal lag length, we typically rely on information criteria like AIC (Akaike Information Criterion), SBC (Schwarz Bayesian Criterion), or HQIC (Hannan-Quinn Information Criterion). These criteria help us balance the model's fit (how well it captures the data) with its complexity (number of parameters). They penalize models with too many parameters to avoid overfitting. The goal is to minimize the chosen information criterion. This indicates the most suitable lag length to include in the model. First estimate the ARDL model with different lag lengths, starting from a minimum and gradually increasing it, then for each iteration, calculate the information criterion. Lastly, the lag length that results in the lowest information criterion value is considered the optimal one. This approach ensures we capture the important past influences on the variables without making the model overly complex.

3.4.4 Cointergration (Bound test)

This test helps us understand if variables in a model have a lasting connection. Imagine variables that fluctuate over time, but somehow stay tethered in the long run. This is cointegration, when multiple variables, though not perfectly stable in the short term, exhibit a stable relationship over extended periods.The cointegration test, specifically the bound testing procedure, works in two steps which are: Building the Model: We estimate an ARDL model, which considers the dependent variable and independent variables along with their past values (determined through a selection process) and Testing for Cointegration: We analyze a specific term in the ARDL model called the Error Correction Term (ECT). This term captures the short-term adjustments that bring variables back to their long-run equilibrium. Essentially, we perform a statistical test (often an F-test) to see if the ECT coefficient is zero. If it's not zero, we reject the idea that there's no long-term connection (no cointegration), suggesting the variables have a stable relationship in the long run.This test is crucial because it allows us to study the underlying, lasting connections between variables, even if they seem to bounce around in the short term.

3.4.5 Multicollinearity

Multicollinearity refers to a high correlation or linear relationship among independent variables in a regression model. In the context of the ARDL approach, the test is conducted to assess the presence and severity of multicollinearity among the independent variables in the ARDL model. There are two main purposes for conducting the multicollinearity test under the ARDL model. Firstly, assessing the stability of the estimated coefficients as multicollinearity can lead to unstable and unreliable coefficient estimates. Secondly, ensuring the reliability of statistical inference. Multicollinearity violates the assumption of independent explanatory variables which can affect the accuracy of statistical inference. By addressing multicollinearity, researchers can improve the reliability and robustness of the ARDL model results and ensure accurate interpretation of the relationships between the independent and dependent variables.

3.4.6 Autocorrelation

The ARDL framework pays close attention to whether the errors (the difference between predicted and actual values) in the model exhibit autocorrelation, also known as serial correlation. This means the errors from one-time period might be influencing errors in other periods. A common test for autocorrelation is the Durbin-Watson test. It provides a statistic that indicates the level of autocorrelation in the residuals. Ideally, the value should be close to 2, suggesting no significant autocorrelation. Values below 2 might point to positive autocorrelation, and values above 2 might indicate negative autocorrelation. The test statistic itself ranges from 0 to 4. The following are the null and alternative hypotheses:

H0: There is no autocorrelation in the residuals, indicating that the residuals are independent and uncorrelated.

H1: There is autocorrelation in the residuals, suggesting that the residuals are correlated with one or more lagged residuals.

Rule of decision: If the Chi-Square p-value is more than 0.05, reject H0; if not, do not reject.

3.4.7 Heteroscedasticity (HET)

The ARDL framework relies on an assumption that the errors in the model (the difference between predicted and actual values) are consistent across all observations. This is called homoscedasticity. When this assumption is violated, and the errors become uneven (heteroskedasticity), it can lead to unreliable estimates of the model's coefficients. To check for this issue, we use statistical tests like the Breusch-Pagan or White test. These tests essentially assess if a connection exists between the squared errors (how much each data point deviates from the prediction) and the independent variables in the model. The HET test is important because by identifying heteroskedasticity, we can ensure our statistical conclusions from the model are trustworthy, addressing heteroskedasticity can lead to more accurate and efficient estimates of the coefficients, and lastly uneven errors might signal underlying problems with the model's design, prompting further investigation. In conclusion, the heteroskedasticity test is a crucial step in ensuring the ARDL model's results are accurate and reliable. By correcting for unequal error variances, we can improve the model's overall dependability.

3.4.8 ARCH Test

The ARCH test is another step in the ARDL framework to assess a crucial assumption: constant variance of the errors (the difference between predicted and actual values) in the model. This means the errors should be equally "spread out" across all observations. When this assumption is violated, and the errors become uneven over time (conditional heteroscedasticity), it can affect the model's reliability. The ARCH test helps us identify this issue. If the test statistic is statistically significant, it suggests the error variances are not constant, and the "bumpiness" of the errors might be linked to past shocks or changes in the independent variables. In simpler terms, the volatility of the errors is not random, but potentially influenced by what happened earlier in the data. On the other hand, a non-significant ARCH test indicates the error variances are likely constant, and the model adheres to the assumption of homoscedasticity. The null and alternative hypothesis are as follows:

H0: there is no conditional heteroscedasticity in the data, meaning the variance of the error term is constant over time.

H1: there is conditional heteroscedasticity in the data, meaning that the variance of the error term is dependent on past error terms.
Decision rule: if the p value is less than the significance of 0.05, reject the null hypothesis.

3.4.8 Normality Test

Another important assumption in our ARDL model is that the errors (the difference between predicted and actual values) are normally distributed around zero. This is called normality. It's crucial for drawing reliable conclusions from the model's hypothesis tests. The Jarque-Bera test is a common tool to assess normality. It analyses two key aspects of the error distribution. First is Skewness which measures how symmetrical the distribution is. Ideally, it should be centered around zero. Then kurtosis captures the "thickness" of the tails compared to a normal distribution. The Jarque-Bera test statistic combines these measures and checks if they deviate significantly from what we would expect under normality.

H0: the residuals of the regression are normally distributed
H1: the residuals of the regression model are not normally distributed.
Decision rule: if the p value is less than the significance of 0.05, reject the null hypothesis.

3.4.10 CUSUM Test

The ARDL approach uses a diagnostic tool called the CUSUM test to ensure the stability of the relationships between variables over time. In simpler terms, it checks if the model's results (coefficients) remain reliable over the entire analysis period. The CUSUM test works by tracking the cumulative sum of the differences between predicted and actual values (recursive residuals). If these cumulative sums stay within specific boundaries, we hold onto the idea that the coefficients are stable (fail to reject the null hypothesis). This implies there's no significant change in how the variables influence each other over time.

H0: The coefficients in the ARDL model are stable over time, indicating no structural change in the relationship between the variables.

H1: The coefficients in the ARDL model are not stable over time, suggesting the presence of structural change in the relationship between the variables.
Decision rule: if the cumulative sum of squares is not within the 5% critical zone, reject the null hypothesis.

3.4.11 CUSUM of Squares Test

In contrast to the broader CUSUM test, the Cumulative Sum of Squares (CUSUMSQ) acts as a specific diagnostic tool within ARDL models. Its function is to scrutinize the stability of coefficients over time, essentially checking for any evidence of structural shifts in the relationships between variables within the regression. This scrutiny offers a three-pronged benefit: it bolsters the reliability of inferences drawn from the model, facilitates the evaluation of the model's overall specification, and aids in pinpointing potential instances of structural change within the variable relationships. The hypothesis testing follows a standard format: the null hypothesis (H0) posits that coefficients remain stable, implying no significant alterations in the variable relationships. Conversely, the alternative hypothesis (H1) suggests that the coefficients are unstable, hinting at potential structural changes. The decision rule is straightforward: if the calculated CUSUMSQ value falls outside the designated 5% critical zone (often visualized as lines on a graph), we reject the null hypothesis, indicating instability in the model.

3.4.12 Model Specification Test

This test acts as a quality check to ensure the model we've built accurately captures the real connections between the variables. It assesses three key aspects which are Functional Form, whether the mathematical structure chosen (linear, exponential, etc.) appropriate for the data, Lag Structure: Are we considering the right amount of past data for each variable to understand their influence and lastly, Variable Selection: Have we included all the relevant variables or are there some missing pieces? By performing this test, we avoid two common pitfalls which are overfitting: The model becomes too specific to the data used, potentially missing the broader picture and under fitting**:** The model is too simple and fails to capture the important relationships between the variables. A successful model specification test ensures that the estimated coefficients are reliable and accurately reflect the true influence of each variable on the outcome.

This allows for trustworthy interpretations and better understanding of the underlying relationships.

H0: the functional form of the model is correctly specified.
H1: the functional form of the model is misspecified
Decision rule: if the p-value is less than the significance level of 0.05%, reject null hypothesis.

3.5 Conclusion

The chapter examined the model specification and the justification of the included variables. It also examined the important test to be conducted under the Autoregressive Distributed Lag model which include unit root test, ARCH test, normality test, and CUSUM test among others. The chapter also included the model specification and equation to be used. Regression of data shall be done in the following chapter.

CHAPTER 4

DATA PRESENTATION AND DISCUSSION

4.1 Introduction

This chapter investigates the study question which is the impact of population growth on economic growth. It will specifically look at the period 1980-2022 and in order to analyse this relationship, the chapter will first present diagnostic tests using the ARDL method. These tests offer valuable insights into the unit roots, optimal lag, cointergration and normality tests. Subsequently, the chapter proceeds to discuss the results under each research objective.

4.2 Data Presentation Process

Data will be presented in table form and the results of each table will be discussed below.

4.2.1 Optimal Lag Results

Table 4. 1 Optimal Lag

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-591.3664	NA	6.60E+08	37.3354	37.61022	37.4265
1	-483.1024	169.1625*	7532589	32.8189	34.74268*	33.45658
2	-444.7102	45.59063	8372547	32.66939	36.24212	33.85365
3	-386.6487	47.17497	4590694.*	31.29055*	36.51223	33.02139*

The Optimal lag of the group is 3 as shown by the table above. The rule of thumb states that the lowest value of the selected method criteria is picked as the optimal lag. From the table above the lowest value under Akaike Information Criteria is 31.29055 and this is under lag 3.

4.2.2 Unit Root Results

Table 4. 2 Unit Root

Variable	**ADF Stat**	**Critical Value**		**Intercept**	**Trend**	**P-Value**	**Integration Order**
GDP	-4.025973	1%	-2.621185	NO	NO	0.0002	I(0)
		5%	-1.948886				
		10%	-1.611932				
POP Growth	-4.113671	1%	-4.219126	YES	YES	0.013	I(1)
		5%	-3.533083				
		10%	-3.198312				
Gross fixed capital formation	-8.313522	1%	-4.198503	YES	YES	0	I (1)
		5%	-3.523623				
		10%	-3.192902				
FDI	-4.195605	1%	-3.596616	YES	NO	0.0019	I(0)
		5%	-2.933158				
		10%	-2.604867				
Electricity Consumption	-4.931308	5%	-4.262735	YES	YES	0.0019	I (1)
		10%	-3.552973				
		1%	-3.209642				
Export growth	-6.646194	1%	-3.605593	YES	NO	0	I(1)
		5%	-2.936942				
		10%	-2.606857				

The Unit Root test was conducted to test the stationarity of the study variables. The results from the above table reveal that Gross Domestic Product (GDP) and Foreign Direct Investment are integrated at levels I (0), meaning they have a stable long-term trend between them. On the other hand, Population Growth, Gross Fixed Capital Formation, Export growth and Electricity Consumption were all stationary at 1st level I (1). The variables have a mixed level of integration; thus the following test is a cointergration (bound) test. The cointergration analysis is crucial because it analyses whether the variables move together in the long run, indicating a stable and meaningful relationship among them.

4.2.3 Cointergration (Bound) Test

Table 4. 3 Cointergration Results

F-Bounds Test	Null Hypothesis: No levels relationship			
Test Statistic	Value	Signif.	I(0)	I(1)
F-statistic	6.778477	10%	2.26	3.35
k	5	5%	2.62	3.79
		2.50%	2.96	4.18
		1%	3.41	4.68

The bound test cointergration results above indicates that the F-statistic value is 6.778477, which surpasses the critical values at significance level of 10%, 5%, 2.5% and 1%. From the results above the F-statistic value is greater than the upper and lower bound levels at various significance levels providing evidence to support the presence of a meaningful and stable long-term relationship between population growth and economic growth.

4.2.4 Multicollinearity

Table 4. 4 Multicollinearity Results

	GDP	POP	GFCF	FDI	XG	EC
GDP	1	0.37566498	0.343860425	0.07727409	-0.35558063	-0.13763832
POP	0.37566498	1	0.345025964	-0.30605556	-0.70861579	0.41968541
GFCF	0.34386042	0.34502596	1	-0.02899237	-0.22535349	0.209118477
FDI	0.07727409	-0.3060556	-0.028992368	1	0.450676183	-0.3354675
XG	-0.3555806	-0.7086158	-0.225353495	0.450676183	1	-0.02845103
EC	-0.1376383	0.41968541	0.209118477	-0.3354675	-0.02845103	1

Multicollinearity results in the table above show that none of the variables have a correlation coefficient above 0.7, this results suggest that the explanatory variables in the regression model are not strongly related to each other. This means that the variables do not have a linear relationship. This is a positive result because it shows that the explanatory variables in the model are providing distinct and independent information to the regression. Coefficients can now be estimated precisely, leading to more reliable and statistical inferences due to the absence of multicollinearity.

4.2.5 Autocorrelation

Table 4. 5 Autocorrelation Results

Breusch-Godfrey Serial Correlation LM Test:				
F-statistic	0.91281	Prob. F(2,9)		0.4356
Obs*R-squared	5.39644	Prob. Chi-Square(2)		0.0673

To test whether autocorrelation or serial correlation is present in the model the Breusch-Godfrey Serial Correlation LM Test was conducted. The Null hypothesis was there is no autocorrelation in the model and the alternative being that autocorrelation is present in the model. We compare the obtained p-value with a predetermined significance level of 0.05 to determine whether the regression model is satisfactory or not. If the p-value is greater than the significance level, we fail to reject the null hypothesis, thus concluding that there is no statistically significant evidence of serial correlation in the model. Based on the above results, the p-value is 0.4356 which is significantly higher than significance level of 0.05, suggesting that there is no serial correlation present in the model. Thus the model is deemed satisfactory in terms of autocorrelation and serial correlation. This means that the models assumption under autocorrelation that the error terms are independent is likely true.

4.2.6 Heteroscedasticity

Table 4.6 Heteroskedasticity Results

Heteroskedasticity Test: Breusch-Pagan-Godfrey				
F-statistic	0.83159	Prob. F(20,11)		0.6541
Obs*R-squared	19.2611	Prob. Chi-Square(20)		0.5049
Scaled explained SS	2.5417	Prob. Chi-Square(20)		1

The Breusch-Pagan-Godfrey test for heteroskedasticity was done to test the presence of heteroskedasticity in the model. This test is done to check if residuals are constant across all levels of the independent variables. The null hypothesis is that there is no heteroskedasticity in the regression model and the alternative is that heteroskedasticity is present in the model. To determine its presence, the study compared the p-value with a significance level of 0.05, if the p-value is greater than this significance level then we fail to reject the null hypothesis. From table 4.5 the p-value is 0.6541which is significantly higher than the significance level of 0.05. This result suggests that there is no significant heteroskedasticity in the regression model. Based on these results it can be concluded that the regression model is statistically satisfactory in terms of heteroskedasticity.

4.2.7 ARCH Test

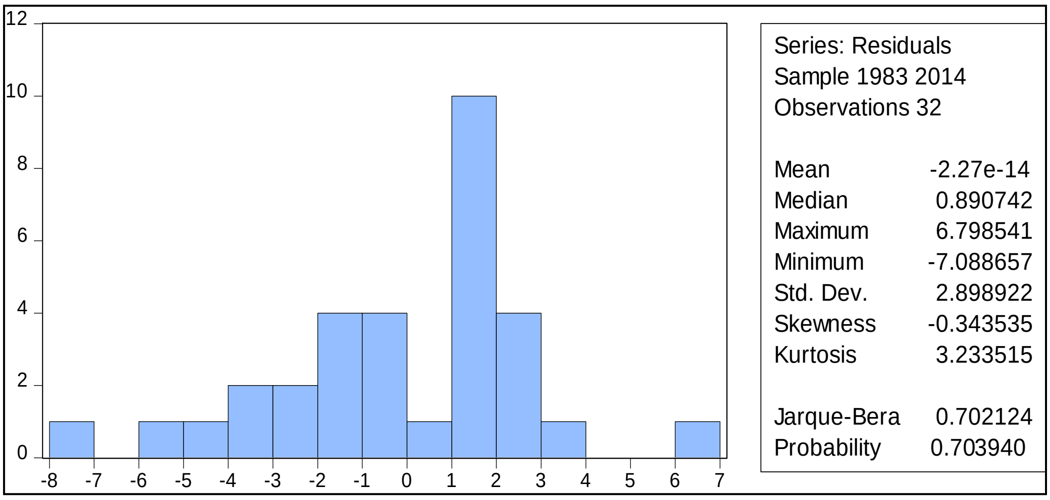
Table 4.7 ARCH results

Heteroskedasticity Test: ARCH				
F-statistic	0.30381	Prob. F(1,29)		0.5857
Obs*R-squared	0.32139	Prob. Chi-Square(1)		0.5708

In addition to the Breusch-Pagan-Godfrey test for heteroskedasticity, the study also conducted an additional test called the Autoregressive Conditional Heteroskedasticity (ARCH) test. Similar to the previous test, the p-value represents the likelihood of obtaining the observed test statistic or more extreme value, assuming that the null hypothesis is true. The null hypothesis is that there is no conditional heteroscedasticity in the regression model. Once again the p-value is compared to a predetermined significance level of 0.05. If the p-value is higher than this. then we fail to reject the null hypothesis. In this case the results show that the p-value is 0.5857 which is significantly higher than 0.05 so we fail to reject the null hypothesis and conclude that there is no evidence of conditional heteroskedasticity present in the model.

4.2.8 Normality Test

Figure 4.1 Normality Results



The normality test was conducted using the Jarque-Bera test. The Jarque-Bera test is a statistical test that evaluates whether or not a data set is normally distributed by examining the skewness and kurtosis of the data. From the table above it was observed that the Jarque-Bera test was 0.702124, and the associated probability was 0.703940. For the Jarque-Bera test, the null hypothesis is that the data follows a normal distribution. To determine the normality of the results, the obtained p-value is compared to a predetermined significance level of 0.05. if the p-value is greater than the chosen significance level, we fail to reject the null hypothesis and conclude that there is no statistical evidence to suggests that the data is not normally distributed. With the results of this test on the study, we can conclude that the results demonstrate normality in the data set.

4.2.9 Model Specification

Table 4.8 Model Specification Results

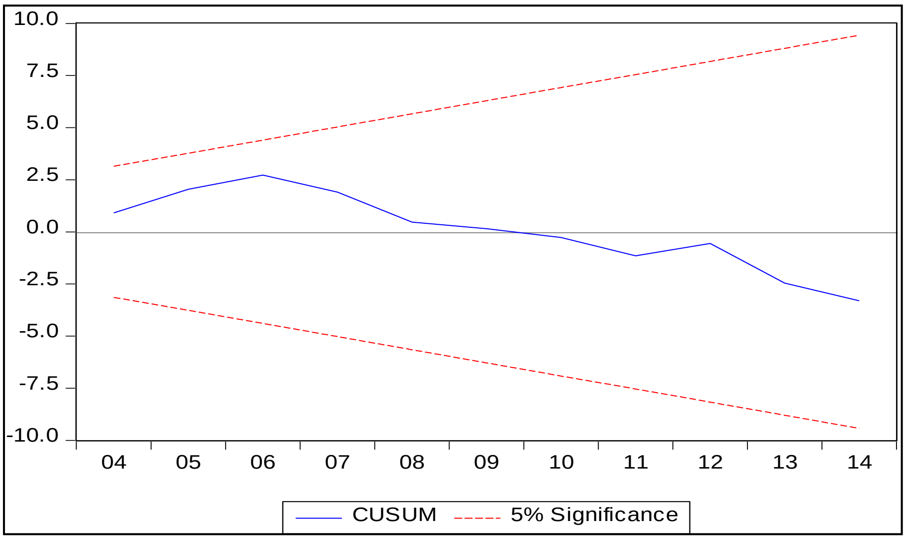
	Value	df	Probability

t-statistic	0.250671	10	0.8071
F-statistic	0.062836	(1, 10)	0.8071

The Model Specification test is a statistical test that provides insight into the overall adequacy of the regression model. The overall significance of the independent variables in the model is measured by the F-statistic. The null hypothesis states that the independent variables collectively have no significant effect on the dependent variable. To test this, the study compares the p-value is compared to a predetermined significance of 0.05. If the p-value is higher than the significance level, then we fail to reject the null hypothesis. As seen from table 4.7 the F-statistic value is 0.062836 and the associated p-value is 0.8071 which is well above the significance level, thus we fail to reject the bull hypothesis. In conclusion the model is correctly specified as there is no evidence to suggest otherwise.

4.3 Objective 1: CUSUM Test

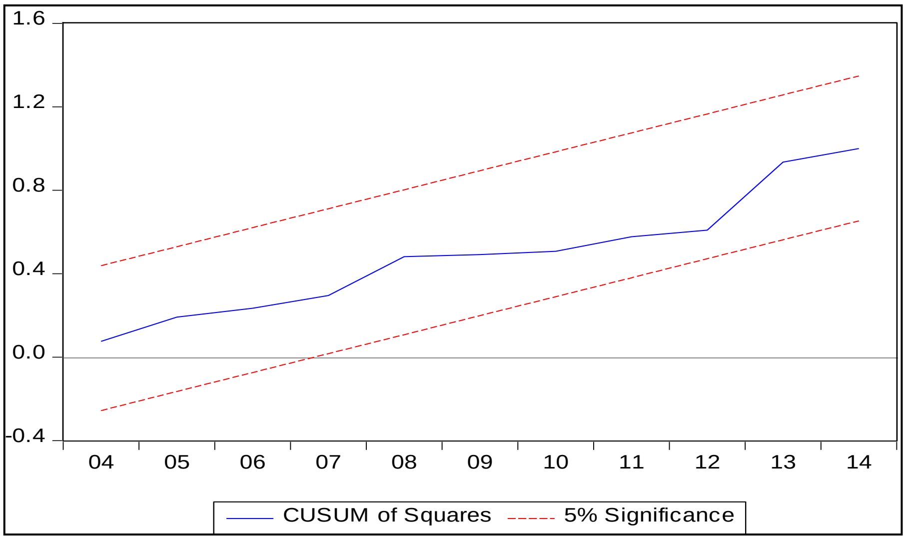
Figure 4.2 CUSUM Results



This test is done to detect structural changes or shifts in the regression model's parameters over time. The Cumulative Sum (CUSUM) assesses whether the residuals in the model exceed a critical range, which indicates a significant relationship between the variables. It can be observed from figure 4.2 above that CUSUM results remained in the acceptable range of 5%. Thus in conclusion, there is no significant evidence that the presumed relation between population growth and economic growth is not true. There is a relationship between the study variables. The model adequately captures the underlying relationship between population growth and economic growth and the relationship is stable over time. The findings support the idea that population growth has a constant impact between population growth and economic growth in Zimbabwe throughout the period of the study.

4.3 CUSUM of Squares

Figure 4.3 CUSUM of Squares Result



The CUSUM of Squares test is also a statistical regression method used to assess the stability of model parameters over time. Specifically, it examines whether or not the squared residuals of the regression model exceed a critical range, which will indicate a significant departure from the assumed relationship between the variables. From the above figure, it can be observed that the squared residuals do not go out of the critical range of 5%, meaning the squared residuals remain within the acceptable range and thus there is no significant evidence of deviations from the assumed relationship between the dependent and independent variables. In conclusion it was correct to assume that there is a relationship between population growth and economic growth, meaning that population growth impacts economic growth over time as seen in objective 1.

4.3.1 Objective 2: Estimated Short-run and Long-run Results

Table 4.9 Estimated Short-run Results

ECM Regression				
Case 3: Unrestricted Constant and No Trend				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	25.52621	3.431891	7.43794	0
D(GDP(-1))	0.388902	0.134213	2.89765	0.0145
D(POP)	-9.70963	2.956297	-3.28439	0.0073
D(POP(-1))	-5.947	1.831656	-3.24679	0.0078
D(POP(-2))	-4.45056	1.5224	-2.92339	0.0139
D(GFCF)	0.607101	0.260815	2.3277	0.04
D(GFCF(-1))	1.773674	0.275513	6.43771	0
D(FDI)	1.35673	0.696861	1.94692	0.0775
D(FDI(-1))	1.670388	0.807571	2.06841	0.0629
D(FDI(-2))	2.985997	0.766652	3.89485	0.0025
D(XG)	-0.43921	0.227494	-1.93063	0.0797
D(XG(-1))	-0.5523	0.18517	-2.98267	0.0125
D(EC)	0.099621	0.017751	5.61211	0.0002
D(EC(-1))	0.174337	0.028604	6.09489	0.0001
D(EC(-2))	0.056079	0.023059	2.43196	0.0333
CointEq(-1)*	-1.47673	0.191997	-7.6914	0

The result from the Error Correction Form (ECF) analysis reveals that the coefficient of CoinEq(-1) is -1.47673 and t-stat of -7.6914 and probability of 0.0000. The negative sign of the coefficient signifies a short-run speed of adjustment. This signifies that any deviations from the long-run equilibrium among the variables will be rectified over time. To get the percentage short-run speed of adjustment CointEq(-1) is multiplied by 100 to give us -147.673%. This percentage implies that for each percentage point deviation from the long-run equilibrium, economic growth adjusts around 147.673% in the short-run, with other variables held constant.

Table 4.10 Estimated Long-run Results

Levels Equation				
Case 3: Unrestricted Constant and No Trend				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
POP	8.873929	3.03847	2.92053	0.0139
GFCF	-0.407771	0.32399	-1.2586	0.2342
FDI	-0.891432	1.92682	-0.4626	0.6526
XG	1.01898	0.56455	1.80493	0.0985
EC	-0.065832	0.01959	-3.3606	0.0064

Table 4.9 and 4.10 provide the results for the impact of population growth both in the long and short-run. In the short-run the coefficient for population growth is -4.45056 and the associated probability is 0.0139. This is an indication of a statistically significant negative relationship between population growth and economic growth. The negative coefficient suggests that an increase in population growth is associated with a decrease in economic growth in the short-run. Several factors may be able to explain this relationship. One could be the economy takes time to adjust its resources to the growing population so the economy suffers a negative shock. Additionally, if the economy does not adjust its resources in time, the growing population will continue affecting the economy negatively and it will continue to decline. In the long-run, the coefficient for population growth is 8.873929 and the associated p-value is 0.0139. The positive coefficient indicates a potential positive relationship between population growth and economic growth. However, the p-value is not statistically significant as it is lower than 0.05. This suggests the relationship between population growth and economic growth in the long-run is not statistically robust. This relationship is in accordance with the Malthusian growth theory referenced in chapter 2.

4.3.2 Objective 3: Mediating impact of research variables in the short-run and long-run

Tables 4.9 and 4.10 also show the associating impact of the other research variables on economic growth, namely Gross Fixed Capital Formation, Foreign Direct Investment, Export Growth and Electricity Consumption on economic growth. Firstly, the coefficient for GFCF in the short-run is 1.773674 with an associated probability of 0.0000. This result suggests that in the short-run, there is a positive relationship between Gross Fixed Capital Formation and economic growth, that is when GFCF increases in the short-run so does economic growth. This is because GFCF allows firms to expand their production capacity by acquiring more capital stock. This growing capacity allows firms to meet their growing demand and thereby produce more output, driving GDP growth in the short-run. Additionally, GFCF has a multiplier effect. Increases in investment, employment and income from Gross Fixed Capital Formation has ripple effects throughout the economy. These effects lead to further rounds of increased spending and economic activity, magnifying the short-run effects of GFCF on economic growth.

In the long-run, the coefficient for GFCF is -0.407771 and the probability is 0.2342. The negative coefficient suggests that as Gross Fixed Capital formation increases in the long-run, economic growth decreases. This is due to diminishing returns on investment. As the country continues to invest in capital formation, the marginal returns on these investments will diminish over time. Meaning that each additional unit of capital will produce smaller increases in output compared to the initial investments, leading to slower economic growth in the long-run hence the negative relationship.

The second variable is Foreign Direct Investment. From tables 4.9 and 4.10 the short-run and long-run results of the impact of FDI on economic growth are shown. In the short-run the coefficient for FDI is 2.985997 and the probability value is 0.0025. The results suggest that there is a positive relationship between Foreign Direct Investment and economic growth in the short-run. The p-value is less than the significance value 0.05 which shows that it is not statistically significant, meaning that the relationship is not statistically robust. The positive relationship means that as FDI increases, GDP growth also increases in the short-run. This is because FDI represents the inflow of capital from foreign investors into the domestic economy. This capital infusion increases the overall level of investment and productive capacity in the short-run which therefore boosts economic growth. In the long-run, the coefficient is -0.891432 and probability is 0.6526. The negative coefficient result shows that there is a negative relationship of the variables in the long-run. As Foreign Direct Investment increases in the domestic economy, Gross Domestic Product will decrease and this is due to a number of factors. Firstly, FDI crowds out domestic investment meaning that foreign firms displace local firms and take a lion's share of the market. Additionally, increased dependence on FDI can make Zimbabwe vulnerable to global economic fluctuations in capital flows and economic conditions.

Thirdly, the export of goods and services is also evaluated in tables 4.9 and 4.10. The coefficient in the short-run is -0.5523 and the probability is 0.0125 which is not statistically significant compared to the significance level of 0.05. The result suggests that export of good and services has a negative relationship with economic growth in the short-run, thus when export growth increases, economic growth decreases. In Zimbabwe, this can be due to commodity dependence. The country's exports are dominated by a few primary commodities such as minerals such as gold and diamonds and agricultural products like maize and tobacco. Fluctuations in global prices and demand could make export earning volatile, thus instability and uncertainty in the short-run on economic growth. In the long-run, the probability is 0.0985 and coefficient of 1.01898. These results suggest a positive long-run equilibrium between economic growth and export growth. As export of goods and services increases GDP also increases. This could be due to the fact exports generate foreign exchange earnings, which can be used to finance the importation of capital goods and raw materials as well as advanced technologies. This can enhance the productive efficiency and capacity in the economy. Potentially growing the country's GDP.

Lastly, the results of the impact of electricity consumption on economic growth is shown in tables 4.9 and 4.10. From the tables the coefficient for electricity consumption in the short-run is 0.056079 and the associated probability is 0.0333. From these results it can be concluded that there is a positive relationship between economic growth and electricity consumption. Meaning that as the amount of Kwh of electricity increases, GDP also increases. This could be due to the fact that reliable and abundant electricity supply increases industrial and commercial activity. Increased utilization of production capacity in industries, factories and commercial establishments leads to higher output, productivity and economic activity in the short-run. However, in the long-run the relationship between the two variables is negative. The coefficient is -0.06832 and the probability is not statistically significant at 0.0064 which is lower that the predetermined exchange rate 0.05. This result suggests that in the long-run as electricity consumption increases, Gross Domestic Product decreases. This may be due to the unsustainable generation of electricity in the economy. If electricity generation capacity in the country and infrastructure are not developed in a sustainable manner, relying heavily on electricity intensive economic activities may become unsustainable in the long-run.

4.4 Conclusion

The chapter looked at and discussed the results on diagnostic tests. These tests and the discussion was done to avoid the generation of biased regression results. The diagnostic test done show no evidence of issues such as autocorrelation, specification errors and heteroskedasticity thus enhancing the reliability of the results. The chapter also looked at the short-run and long-run ARDL results. The relationship between population growth and economic growth was seen to be a long-run relationship. All other variables except export growth were seen to be statistically significant in the short-run. in the long-run, electricity consumption and Foreign Direct Investment were observed to have a negative impact on economic growth.

CHAPTER 5

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

This chapter is the last chapter of the research project. The aim of this chapter is to conclude the entire research project giving summaries, conclusions and recommendations on the impact of population growth on economic growth in Zimbabwe from the period 1980 to 2022. This closing chapter will also give final thoughts on the research project and following this shall be the references and appendices of diagnostic results.

5.2 Summaries

5.2.1 Summaries on Objective 1

The core of this research was to investigate the connection between population growth and economic growth in Zimbabwe. This initial step aimed to establish the very foundation of the study: does a relationship between these two variables even exist? Chapter two provided context by introducing the Malthusian Growth Theory, which proposes a negative long-term relationship between population growth and economic prosperity. However, the analysis in chapters three and four yielded different results for Zimbabwe during the specific timeframe studied. The findings suggest evidence of a connection between population growth and economic growth in the country.

5.2.2 Summaries on Objective 2

The research delved deeper to explore the nature of the relationship between population growth and economic growth. Existing studies, like the one by (Sanderson A, 2019) found a short and long-run link between human capital and economic growth, informed the research into both short-run and long-run dynamics. Following established procedures, the study's diagnostic tests revealed evidence supporting both a short-run and a long-run relationship between economic growth and population growth in Zimbabwe.

5.2.3 Summaries on Objective 3

Lastly, the research project looked at the impact of the other variables in the study on economic development that is Gross Fixed Capital Formation, Foreign Direct Investment, Export of goods and services and Electricity consumption. The impact of these study variables had different impacts on economic growth both in the short-run and long-run in Zimbabwe during the period under study.

5.3 Conclusions

5.3.1 Conclusions on Objective 1

There is significant evidence of a relationship between population growth and economic development as theorised by (Malthus, 1798). The CUSUM and CUSUM of Squares test showed that there was no significant evidence that the presumed relation between population growth and economic growth is not true. This is because the residuals of the model stayed within the acceptable range of 5% and was stable over time. In conclusion, the model adequately captures the underlying relationship between population growth and economic growth.

5.3.2 Conclusions on Objective 2

The relationship between population growth and economic growth is negative in the short-run and positive in the long-run. The negative relationship in the short-run is due to the fact that it takes time to for the economy to adjust its resources to absorb the growing population growth and in the long-run the growing population actually boosts or encourages economic growth to increase as well. This was evidenced by the results obtained in the Error Correction Form tests both in the short-run and long-run.

5.3.3 Conclusions on Objective 3

The impact of the other independent variables except population growth on the dependent variable economic growth was also conducted using the ECM short-run and long-run tests. Gross Fixed Capital Formation, Foreign Direct Investment and Electricity consumption all had a positive impact on economic development in the short-run with Export of goods and services being the only one showing a negative impact on GDP in the short-run. However, in the long-run the opposite is true of the short-run impact was observed for all the independent variables.

5.4 Recommendations

5.4.1 Recommendation on Objective 1

For data sets to continue being statistically significant and show a stable relationship between population growth and economic growth, the government should post or provide annual data of selected variables so as to not have missing variables and correlated residuals that will distort the steady relationship.

5.4.2 Recommendations on Objective 2

One of the ways that the government of Zimbabwe can mitigate the negative impact of population growth on GDP growth in the short-run is by developing labour intensive public work programs. These could include infrastructure development and environmental conservation to create short-term employment opportunities. It should also ensure that these programs are focused in areas with high population growth. The government can also promote agricultural production and food security. Investments in agriculture, post-harvest storage and transportation infrastructure should be done to boost agricultural productivity.

5.4.3 Recommendations on Objective 3

One of the major ways in which the government of Zimbabwe can mitigate the negative impact of export of goods and services on economic growth in the short-run is by diversifying the export base. The government should identify and invest in new export sectors instead of relying on agricultural products and minerals. Proving incentives and supporting businesses to expand into higher value added exports will also help mitigate the negative impact in the short-run.

5.5 Conclusion

The chapter looked at the summaries under each objective that was studied in the research project as well as subsequent conclusions and recommendations on potential negative impacts in the short and long-run.

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APPENDICES

Appendix 1 Data Set

IMPACT OF POPULATION GROWTH ON ECONOMIC GROWTH ZIMBABWE (1980-2022)						
YEAR	GDP GROWTH (ANNUAL %)	POPULATION GROWTH (ANNUAL %)	GROSS FIXED CAPITAL FORMATION (% OF GDP)	FOREIGN DIRECT INVESTMENT, NET INFLOWS (% OF GDP)	ELECTRICITY CONSUMPTION (kWh per Capita)	EXPORT OF GOODS AND SERVICES (% OF GDP)
1980	14.42068391	5.752350726	14.10249868	0.023202878	992.2089962	23.3673918
1981	12.52542485	6.275565521	17.2078664	0.044262879	967.5580954	19.42522642
1982	2.634297147	3.884506684	18.37424583	-0.009851458	955.4252353	16.92558031
1983	1.585305462	3.803060295	18.04319824	-0.026716947	898.4308116	16.44292482
1984	-1.90736011	3.541265073	17.00645134	-0.039171093	846.4539248	20.56113844
1985	6.944387768	3.417110498	14.27809787	0.050531809	955.9847719	22.20577471
1986	2.099029125	3.310659933	15.0646583	0.119744266	892.6818125	24.04941054

1987	1.150737203	3.225202012	16.11463192	-0.452539836	902.5072304	24.01571046
1988	7.55237451	3.091061035	15.56941413	-0.230762893	883.2929814	23.7403462
1989	5.199766444	2.859899104	14.00993833	-0.122862257	911.3025279	23.34228306
1990	6.988552933	2.680960131	18.20973222	-0.138958362	892.6335289	22.86684557
1991	5.531782374	2.576033141	20.58535633	0.032291753	881.1103301	23.88346897
1992	-9.015570075	2.509119078	22.36275964	0.221431698	806.3712065	27.22726311
1993	1.051458647	1.431392244	23.59172221	0.425897783	757.5787051	30.7196169
1994	9.235198825	0.588137237	21.37146361	0.502837235	806.458	34.59997605
1995	0.158025687	1.239655854	24.57726015	1.655119106	854.1900108	38.23634361
1996	10.36069677	1.66094599	18.0404905	0.945850735	895.4953364	36.13007288
1997	2.680594179	1.634688796	18.04965093	1.583901352	924.4524991	37.59527266
1998	2.885211796	1.623403532	20.60148315	6.940053217	891.381671	43.39308496
1999	-0.817821033	1.445039673	2.553698826	0.860307485	935.265909	37.40857975

2000	-3.059189749	1.003968752	11.79797761	0.346788445	901.4188475	38.15975456
2001	1.439615396	0.64266297	12.11780113	0.056068824	872.9761737	34.95891269
2002	-8.894023631	0.616566778	10.17249068	0.408381024	876.121143	31.83479887
2003	-16.99507473	0.757960497	13.81376201	0.066345508	872.8179964	32.39705909
2004	-5.807538023	0.701855596	5.107807664	0.149855352	845.8268772	34.46979901
2005	-5.711083707	0.523850609	2.000441269	1.786206014	881.0811965	33.54864819
2006	-3.461495188	0.86122262	2.224682266	0.734767827	859.5765456	35.95616853
2007	-3.653326835	0.96911875	5.078394447	1.301977507	748.3192735	37.7853733
2008	-17.66894633	0.798207024	3.28590955	1.168556906	619.3454253	41.46684872
2009	12.01955997	1.026265007	9.929205707	1.086305042	578.3998341	19.47749803
2010	21.45206092	1.253649854	17.01173025	1.018021731	599.9328181	29.64089522
2011	14.62020726	1.438339133	14.63470971	2.441511459	629.8276841	34.80080156

2012	15.74487708	1.822308562	12.14834026	2.044131278	601.8696405	25.1632537
2013	3.196730887	2.163267473	9.181371137	1.954060076	619.2356092	21.98775864
2014	1.484542622	2.191391056	9.609292486	2.425172602	597.2970217	20.93014592
2015	2.023649996	2.136294238	9.995566525	1.999687364	..	19.16017579
2016	0.900955396	2.081805725	9.807839172	1.669274353	..	19.94353155
2017	4.080263903	2.043619899	9.663851194	1.746884527	..	19.6589048
2018	5.009866783	2.020537288	11.04830634	2.101721082	..	26.16397313
2019	-6.332446426	1.989252748	10.69935177	1.142805585	..	27.55415643
2020	-7.816950618	2.0311171	10.04608116	0.699033511	..	22.29306297
2021	8.468016909	2.045714878	12.40705787	0.881174075	..	22.77524072
2022	6.522375287	2.0240363 1	11.32697566	1.247870255	..	27.95524577

Appendix 2 ARCH Test

Heteroskedasticity Test: ARCH

F-statistic	0.303806	Prob. F(1,29)	0.5857
Obs*R-squared	0.321392	Prob. Chi-Square(1)	0.5708

Appendix 3 HET Test

Heteroskedasticity Test: Breusch-Pagan-Godfrey

F-statistic	0.831591	Prob. F(20,11)	0.6541
Obs*R-squared	19.26107	Prob. Chi-Square(20)	0.5049
Scaled explained SS	2.541702	Prob. Chi-Square(20)	1.0000

Appendix 4 Group lag

VAR Lag Order Selection Criteria
Endogenous variables: GDP_GROWTH__ANNUAL___ POPULATION_GROWTH__A...
Exogenous variables: C
Date: 05/30/24 Time: 22:35
Sample: 1980 2022
Included observations: 32

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-591.3664	NA	6.60e+08	37.33540	37.61022	37.42650
1	-483.1024	169.1625*	7532589.	32.81890	34.74268*	33.45658
2	-444.7102	45.59063	8372547.	32.66939	36.24212	33.85365
3	-386.6487	47.17497	4590694.*	31.29055*	36.51223	33.02139*

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

Appendix 5 Bound Test

F-Bounds Test		Null Hypothesis: No levels relationship		
Test Statistic	Value	Signif.	I(0)	I(1)
F-statistic	6.778477	10%	2.26	3.35
k	5	5%	2.62	3.79
		2.5%	2.96	4.18
		1%	3.41	4.68

Appendix 6 GDP Unit root

Null Hypothesis: GDP_GROWTH__ANNUAL___ has a unit root
Exogenous: None
Lag Length: 0 (Automatic - based on AIC, maxlag=9)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-4.025973	0.0002
Test critical values:	1% level	-2.621185	
	5% level	-1.948886	
	10% level	-1.611932	

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

Appendix 7 Population Unit root

Null Hypothesis: D(POPULATION_GROWTH__ANNUAL___) has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 3 (Automatic - based on AIC, maxlag=9)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-4.113671	0.0130
Test critical values:	1% level	-4.219126	
	5% level	-3.533083	
	10% level	-3.198312	

Appendix 8 FDI Unit root

Null Hypothesis: FOREIGN_DIRECT_INVESTMENT__NET_INFLOWS____OF_GDP_ has a uni...
Exogenous: Constant
Lag Length: 0 (Automatic - based on AIC, maxlag=9)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-4.195605	0.0019
Test critical values:	1% level	-3.596616	
	5% level	-2.933158	
	10% level	-2.604867	

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

Appendix 9 GFCF Unit root

Null Hypothesis: D(GROSS_FIXED_CAPITAL_FORMATION____OF_GDP_) has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 0 (Automatic - based on AIC, maxlag=9)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-8.313522	0.0000
Test critical values:	1% level	-4.198503	
	5% level	-3.523623	
	10% level	-3.192902	

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

Appendix 10 XG Unit root

Null Hypothesis: D(EXPORT_OF_GOODS_AND_SERVICES____OF_GDP_) has a unit root
Exogenous: Constant
Lag Length: 1 (Automatic - based on AIC, maxlag=9)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-6.646194	0.0000
Test critical values:	1% level	-3.605593	
	5% level	-2.936942	
	10% level	-2.606857	

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

Appendix 11 EC Unit root

Null Hypothesis: D(ELECTRICITY_CONSUMPTION__KWH_PER_CAPITA_) has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 0 (Automatic - based on AIC, maxlag=8)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-4.931308	0.0019
Test critical values:	1% level	-4.262735	
	5% level	-3.552973	
	10% level	-3.209642	

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

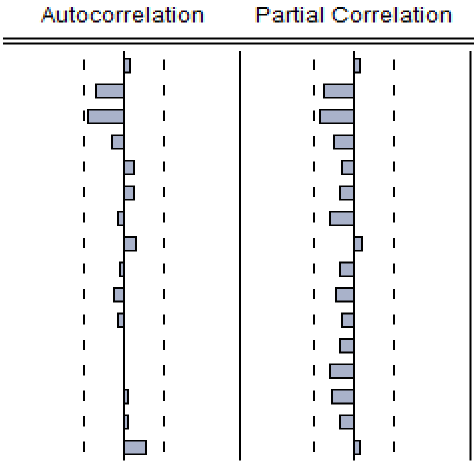
Appendix 12 Serial LM test

Breusch-Godfrey Serial Correlation LM Test:

F-statistic	0.912809	Prob. F(2,9)	0.4356
Obs*R-squared	5.396436	Prob. Chi-Square(2)	0.0673

Appendix 13 Autocorrelation

Date: 05/30/24 Time: 23:11
Sample: 1980 2022
Included observations: 32
Q-statistic probabilities adjusted for 2 dynamic regressors



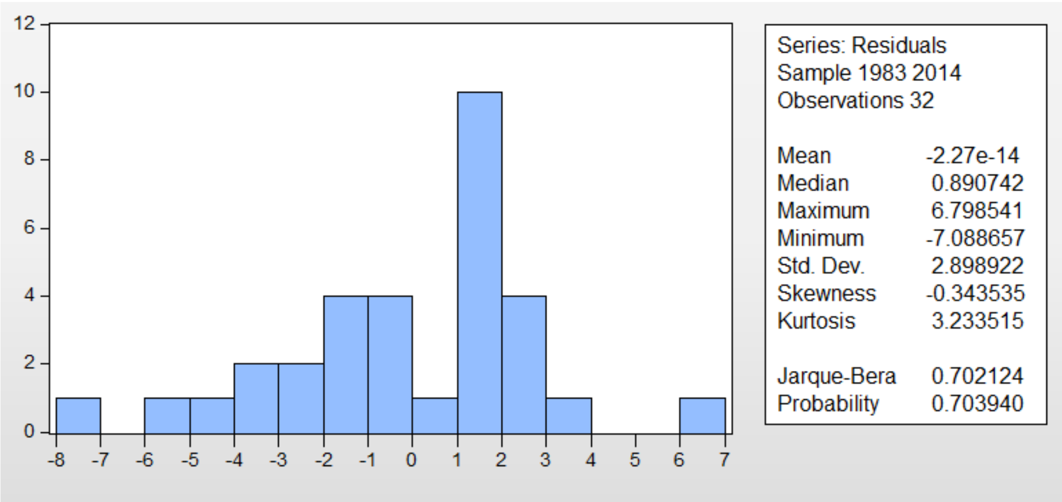
Lag	AC	PAC	Q-Stat	Prob*
1	0.057	0.057	0.1159	0.733
2	-0.260	-0.264	2.5625	0.278
3	-0.322	-0.311	6.4597	0.091
4	-0.109	-0.188	6.9232	0.140
5	0.086	-0.105	7.2192	0.205
6	0.087	-0.119	7.5389	0.274
7	-0.064	-0.211	7.7188	0.358
8	0.108	0.067	8.2483	0.410
9	-0.042	-0.136	8.3302	0.501
10	-0.096	-0.164	8.7882	0.552
11	-0.051	-0.110	8.9223	0.629
12	0.002	-0.134	8.9226	0.710
13	0.007	-0.212	8.9255	0.779
14	0.035	-0.195	9.0000	0.831
15	0.039	-0.133	9.0977	0.872
16	0.204	0.064	11.940	0.748

*Probabilities may not be valid for this equation specification.

Appendix 14 Multicollinearity

	Correlation					
	GDP_GRO...	POPULATIO...	GROSS_FIX...	FOREIGN_D...	EXPORT_O...	ELECTRICIT...
GDP_GRO...	1.000000	0.375665	0.343860	0.077274	-0.355581	-0.137638
POPULATIO...	0.375665	1.000000	0.345026	-0.306056	-0.708616	0.419685
GROSS_FIX...	0.343860	0.345026	1.000000	-0.028992	-0.225353	0.209118
FOREIGN_D...	0.077274	-0.306056	-0.028992	1.000000	0.450676	-0.335468
EXPORT_O...	-0.355581	-0.708616	-0.225353	0.450676	1.000000	-0.028451
ELECTRICIT...	-0.137638	0.419685	0.209118	-0.335468	-0.028451	1.000000

Appendix 15 Normality test



Appendix 16 Error Correction Form

ECM Regression
Case 3: Unrestricted Constant and No Trend

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	25.52621	3.431891	7.437943	0.0000
D(GDP_GROWTH__AN...	0.388902	0.134213	2.897646	0.0145
D(POPULATION_GRO...	-9.709631	2.956297	-3.284390	0.0073
D(POPULATION_GRO...	-5.946995	1.831656	-3.246785	0.0078
D(POPULATION_GRO...	-4.450561	1.522400	-2.923385	0.0139
D(GROSS_FIXED_CAPI...	0.607101	0.260815	2.327704	0.0400
D(GROSS_FIXED_CAPI...	1.773674	0.275513	6.437706	0.0000
D(FOREIGN_DIRECT_I...	1.356730	0.696861	1.946916	0.0775
D(FOREIGN_DIRECT_I...	1.670388	0.807571	2.068410	0.0629
D(FOREIGN_DIRECT_I...	2.985997	0.766652	3.894854	0.0025
D(EXPORT_OF_GOOD...	-0.439205	0.227494	-1.930625	0.0797
D(EXPORT_OF_GOOD...	-0.552301	0.185170	-2.982674	0.0125
D(ELECTRICITY_CONS...	0.099621	0.017751	5.612109	0.0002
D(ELECTRICITY_CONS...	0.174337	0.028604	6.094886	0.0001
D(ELECTRICITY_CONS...	0.056079	0.023059	2.431955	0.0333
CointEq(-1)*	-1.476729	0.191997	-7.691399	0.0000

R-squared	0.896212	Mean dependent var	-0.035930
Adjusted R-squared	0.798911	S.D. dependent var	8.998357
S.E. of regression	4.035129	Akaike info criterion	5.934806
Sum squared resid	260.5162	Schwarz criterion	6.667674
Log likelihood	-78.95690	Hannan-Quinn criter.	6.177731
F-statistic	9.210706	Durbin-Watson stat	1.847496
Prob(F-statistic)	0.000032		

* p-value incompatible with t-Bounds distribution.

Appendix 17 Cointergration test

Omitted Variables: Squares of fitted values

	Value	df	Probability
t-statistic	0.250671	10	0.8071
F-statistic	0.062836	(1, 10)	0.8071

F-test summary:

	Sum of Sq.	df	Mean Squares
Test SSR	1.626757	1	1.626757
Restricted SSR	260.5162	11	23.68329
Unrestricted SSR	258.8895	10	25.88895

Appendix 18 R-squared Result

R-squared	0.896212	Mean dependent var	-0.035930
Adjusted R-squared	0.798911	S.D. dependent var	8.998357
S.E. of regression	4.035129	Akaike info criterion	5.934806
Sum squared resid	260.5162	Schwarz criterion	6.667674
Log likelihood	-78.95690	Hannan-Quinn criter.	6.177731
F-statistic	9.210706	Durbin-Watson stat	1.847496
Prob(F-statistic)	0.000032		

* p-value incompatible with t-Bounds distribution.

Appendix 19 Long-run Form

Levels Equation
Case 3: Unrestricted Constant and No Trend

Variable	Coefficient	Std. Error	t-Statistic	Prob.
POPULATION_GROWT...	8.873929	3.038469	2.920526	0.0139
GROSS_FIXED_CAPITA...	-0.407771	0.323988	-1.258600	0.2342
FOREIGN_DIRECT_INV...	-0.891432	1.926819	-0.462644	0.6526
EXPORT_OF_GOODS_...	1.018980	0.564554	1.804928	0.0985
ELECTRICITY_CONSU...	-0.065832	0.019589	-3.360610	0.0064

EC = GDP_GROWTH__ANNUAL___ - (8.8739*POPULATION_GROWTH__ANNUAL___ -0.4078*GROSS_FIXED_CAPITAL_FORMATION____OF_GDP_ -0.8914*FOREIGN_DIRECT_INVESTMENT__NET_INFLOWS____OF_GDP_ + 1.0190*EXPORT_OF_GOODS_AND_SERVICES____OF_GDP_ -0.0658*ELECTRICITY_CONSUMPTION__KWH_PER_CAPITA_)

Appendix 20 Model Specification

Omitted Variables: Squares of fitted values

	Value	df	Probability
t-statistic	0.250671	10	0.8071
F-statistic	0.062836	(1, 10)	0.8071

F-test summary:

	Sum of Sq.	df	Mean Squares
Test SSR	1.626757	1	1.626757
Restricted SSR	260.5162	11	23.68329
Unrestricted SSR	258.8895	10	25.88895